AN ENQUIRY INTO THE DETERMINANTS OF ADOPTION OF NEW TECHNOLOGY IN AGRICULTURE BY TRIBAL AND NON-TRIBAL FARMERS—A CASE STUDY OF BARPETA DISTRICT OF ASSAM

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ABBREVIATIONS USED IN THE THESIS

CACP – Commission on Agricultural Costs and Prices

AICRIP – All India Coordinated Rice Improvement Project, Hyderabad

ARIASP – Assam Rural Infrastructure and Agricultural Service Project

ARSAC – Assam Remote Sensing Application Centre

CADP – Command Area Development Programme

CD Block – Community Development Block

CDP – Community Development Programme

CIMMYT – International Centre for Wheat and Maize Improvement, Mexico

DEEO – District Elementary Education Office/ Officer

FMC – Field Management Committee

GDP – Gross Domestic Product

ha. – hectare

HYV – High Yielding Variety

IAAP – Intensive Agriculture Area Programme

IADP – Intensive Agricultural District Programme

ICAR – Indian Council of Agricultural Research

IEP – Intensive Extension Programme

IPM – Integrated Pest Management

IRRI – International Rice Research Institute, Philippines

LLP – Laboratory to Land Programme

NABARD – National Bank for Agriculture and Rural Development

NAEP – National Agricultural Extension Project

NAIS – National Agricultural Insurance Scheme

NARP – National Agricultural Research Project

NGO – Non-governmental Organization

NHB – National Horticulture Board

NSB – National Seed Board

NSC – National Seed Corporation

ORP – Operational Research Project

RAWE – Rural Agricultural Work Experience

RKBY - Rashtriya Krishi Bima Yojona

SDP – State Domestic Product

SKY – Samriddha Krishi Yojona

STW – Shallow Tube Well

T & V – Training and Visit Programme

VLEW – Village Level Extension Worker

CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem

Agriculture is the dominant sector of the Indian economy and crop production occupies the most important part of agriculture. The colonial rule in India left agriculture in most neglected condition for which it became difficult to feed the growing population of the country. Food became the main concern of the national government and it became necessary to give attention to increase food production on a priority basis.

Increase in agricultural production in an economy can come about in two ways viz: (a) through an increase in the land area under cultivation and (b) way through more productive utilization of land already under cultivation. The first source of agricultural growth; i.e., increase in the land area under cultivation may be important for a country where population is sparse and cultivable land is available in abundance. Obviously this source of agricultural growth was important and practicable for Indian agriculture till 1960's when Indian population was sparse and cultivable land was abundant. But with the rapid growth of population the scope of bringing about more land surface under cultivation for increase in agricultural production by now, therefore, must come primarily from more productive utilization of existing cultivated land area.

It is technological innovation and its adoption in agriculture that can bring about required agricultural changes through more productive utilization of the existing cultivated land and basically it is through this innovation and adoption of modern technology that Indian agriculture has acquired a high degree of resilience in recent years. Indian agriculture has been modernized to a great extent through the introduction of science and technology into the Indian farming system. The Indian agriculture, in recent years, has shown encouraging sign of changing from traditional to modern one through conversion of agricultural technology into productive accomplishment. The success story of Indian agriculture has become a model for agricultural growth and development for many underdeveloped countries of the world. The increase of production may be attributed to the introduction and adoption of HYV seeds, proper irrigation, fertilizer application, plant protection measures, multiple cropping etc. The green revolution in crops, yellow revolution in oil seeds, white revolution in milk production, blue revolution in horticulture bear ample testimony to the contribution of new technology. During the year 1999-2000 as many as 47 High Yielding Varieties (HYVs) of different crops were released (Indian Economic Survey, 2000-2001).

Introduction and incorporation of modem technology into the Indian farming system has made it possible to increase agricultural production manifold in recent years. Between 1945-50 and 1996-97 index (base 1980-81) of agricultural production increased from 4.9 to 176, index of foodgrains from 52 to 161 and non-food grains from 45 to 201. Index of per-hectare yield (all crops) increased from 74 to 149. Between 1950-51 and 1994-95 gross cropped area increased from 132 million hectares to 180 million hectares which implies a rise in cropping intensity from 111 to 132. Similarly use of agricultural inputs like improved seeds, fertilizers, pesticides, electricity etc. has increased manifold.

But despite impressive achievement in agricultural sector the level of adoption of modem agricultural technology is not upto the mark. The adoption level varies from state to state and within a state from region to region and even within a region from crop to crop. The main reason for this is not the lack of technological and scientific discoveries needed for agricultural development but converting them into production accomplishment and using the same as an instrument of agricultural growth and social change. This could depend to a great extent on the understanding of the totality of the situation on which the new technologies are created, processed and communicated and integrated into the Indian farming system.

Available agricultural statistics for the pre-independent period, though sketchy and defective, indicate that during the first half of 20th century agricultural production rose only marginally as compared to the growth of population. India's population rose by 38 percent between 1901 and 1946, but the area of cultivated land rose only by 18 percent, the average productivity of all crops rose by only 13 percent and of food crops by only 1 percent. The increase of population had, thus, overtaken the increase in food. The common belief held at that time was that there was deterioration of fertility of land and a general decline in efficiency of agricultural practices. This belief was clearly reflected in the conclusion and findings of Indian Council of Agricultural Research and the Grow More Food Enquiry.

Keeping in view the growth rate of population the food grain production has to be raised manifold. By the year 2020 the demand for food grains will increase to about 325 million tones from the same land. This will call for taking more crops in a year by way of reducing the turn around time. To achieve the above target an appropriate technology has to be evolved and it is emerging very fast by the efforts of scientists. Agricultural researches have shown the immense potentiality that the science possesses and also the fact that it can alone solve the manifold problems of the teeming millions. This has largely been due to the new strategy of agricultural production with the various agricultural development programmes for higher production. This development is concerned with higher production per unit area and per unit time.

During the post-independence period particularly after 1966 Green Revolution has been initiated in the Indian agriculture and a number of measures have been launched by successive governments to promote agricultural growth. Though some impressive progress has been achieved through various development programmes, still much remains to be done. There are still many gaps in the agricultural development which need to be bridged. Imbalances in production persists both region-wise and crop-wise. Productivity levels in many crops are still far behind the world average not.to speak of levels obtained in advanced countries. India ranked 15th in the paddy production, average of 2629 kg per hectare against the world average of 3504 kg per hectare, 11th in the wheat production average of 2274 kg per hectare and 14th in pulse average of 582 kg per hectare against the world's average of 851 kg/ ha. But as regards regional imbalances, in Punjab the yield of rice shot up from 1932 kg/ ha in 1967-68 to 3257 kg/ ha in 1991-92 and in Haryana it rose from 1132 kg/ ha in 1967-68 to 2851 kg/ ha in 1990-91 whereas it was only 1291 kg per hectare in Assam in 1990-91. Indian agriculture, even after 55 years of independence, has been far from achieving its potential yield and consequently there is still huge gap between potential yield and achieved yield. Potential yield and national average for various crops are given in Table 1.1.

Table 1.1 Yield Gap of Some Important Crops in India

Crops	Potential yield (kg/ha)	National Average (kg/ha)	Yield Potential	
			Toped (%)	Untoped (%)
Rice	4877	1903	30	70
Wheat	4960	2582	52	48
Maize	6022	1729	29	71
Sorghum	4437	842	19	81
Pearl-millet	2755	779	18	82

Source : R B Singh and Praduman Kumar (2002), "Acceleration of India's Agricultural Growth during the Tenth Five year plan and Beyond" Agricultural Situation in India August, 2002.

It appears from the Table that yield gap as compared by percentage ference between potential and achieved (national average of farmers) yields reveal the bridgeable gap which is quite high ranging from 45–85 percent. At the national level, 15 to 55 percent of potential yield is achieved. The yield gap was highest for cotton (85 percent) followed by Sorghum (81 percent), Maize (72 percent), Rice (70 percent), Wheat and Brassica (48 percent) and minimum for pigeon pea. Thus there is ample scope for increasing average yield and this can be done by adopting new agricultural technology. The gap between potential and achieved yield can be bridged by:

(i) extending the area under high yielding varieties;

(ii) increasing the use of fertilizers based on soil test results;

(iii) timely planting under quality and treated seed;

(iv) ensuring desired plant protection;

(v) strengthening agricultural services, including appropriate processing and timely disposal of surplus production;

(vi) ensuring efficient use of irrigation water and

(vii) mechanizing agricultural sector.

For stepping up agricultural production, new agricultural technology must be developed and diffused to the farmers so that they may accept it and make use for enhancing agricultural productivity.

Various government programmes launched have indicated that rapid increase in production is possible if certain factors such as improved seeds, irrigation facilities, fertilizer, plant protection measures, easy farm credit and agricultural extension services are made available to the farmers simultaneously. If any particular item which constitute this package, is not given in time it may upset the entire programme as these items are all supplementary to each other for sustainable agricultural growth.

India has achieved, no doubt, a major breakthrough in agriculture adopting modern agricultural technologies. But this breakthrough has not been uniform throughout the different states of Indian union and among different farmers engaged in agricultural activities. The empirical studies in different parts of the country show that the extent of adoption of improved practices is higher in the state of Punjab, Haryana, Kamataka, Tamil Nadu, W. B. and some other western states of India. Their success stories are pretty impressive. But still many states of India such as Bihar, Orissa and the entire North-Eastern states are lagging behind in modernization of their agriculture. Adoption of improved agricultural practices is still in the initial stage in these states. Conditions of agriculture in these states are particularly deplorable. Green revolution has only partially touched these states, whereas it is entering the 2nd phase in other states. The Dobhasi Committee (1981) opined that the Green Revolution did not touch Assam. Productivity in the green revolution belt has been found to be much more higher than the non-green revolution belt. Assam is still lagging behind in basic infrastructural facilities in comparison to most other Indian states which is shown in Appendix VIII.

Agriculture in India is the occupation of 2/3rd of Indian population and contributes about 30% of our GDP. But bulk of the farming community is constituted by small and marginal farmers. According to 1990-91 agricultural census about 78% of our land holdings are below 2 hectares of which 59% is below 1 hectare. These two categories cover 32.3% and 14.9% land respectively. So 3/4th of the farmers are small and marginal farmers and only 10% of landholders operate about 1/3rd of land. Therefore, sustainable agricultural development must primarily come from small and marginal farmers and this could be achieved if improved agricultural technology is adopted by these farmers along with the rest. But various literatures on adoption of agricultural technology by different farmers show that adoption rate of agricultural technology is very low among the small and marginal farmers. Not to speak of only small and marginal farmers even large farmers in some regions are found to be low adopters of agricultural technology for a number of reasons. Facilities of improved seeds, fertilizers, irrigation, plant protection measures and farm credits are least appropriated by small and marginal farmers and even in many cases by large farmers due to economic and non-economic factors.

It also appears from literature that adoption rate of modem agricultural technology is even lower among the tribal farmers who constitute a sizable portion of Indian farmers. According to Chandra and Sing (1992) although the technological breakthrough as such in Indian agriculture is no longer a new phenomenon, yet it has got a significant relevance particularly for the regions which are still lying in the embryonic state of agricultural development. Tribal dominated regions falling under such conditions of agricultural backwardness have not yet been able to benefit from the fruits of technological innovations fully or even partially.

In Assam out of 2,24,41,322 population (1991 census) 28,44,441 i.e., nearly 13 percent is tribal population. Literature on tribal economy shows that majority of the tribal population i.e., about 80% do farm operation for their livelihood. But their operation technique is still by and large traditional and most of the tribal farmers are not in the habit of using modern agricultural technology. Such being the condition, a comprehensive agricultural development is not possible until and unless technological innovations are not adopted by all categories of farmers. There are three crores and 90 lakh farmers belonging to both tribal and non-tribal farming community who either have not land or own less than half acre of land. They have been living under abject poverty and therefore, improved agricultural technologies are not emphasized by them for sustainable agricultural growth.

The goal of any programme to uplift the rural masses by improving agrarian situation can be achieved only if it has been framed by taking into account the situational, agro-economic and socio-economic factors of different categories of farmers which determine their adoption pattern regarding utilization of various inputs like improved seeds, fertilizer, irrigation facilities, credits etc.

A question, therefore, arises in our mind as to what are the determinants and factors for which new agricultural technology (improved high yielding seeds, irrigation facilities, fertilizers, agricultural implements and plant protection measures) in agriculture has not been successfully adopted by all categories of farmers. From the existing literature, it appears that very few studies have been undertaken in Assam on this problem, though there have been some studies in some other states in India. Hence an attempt has been made to conduct a systematic study of different categories of farmers of both tribal and non-tribal community to ascertain the determinants of adoption of new technology in agriculture and influence of geographical, personal and communication factors affecting the adoption of agricultural technology. A special aspect of this study is to make a comparison between tribal and non-tribal farmers regarding the role of different factors in the adoption of new agricultural technology.

1.2 Objective of the Study

The basic objective of the study is to investigate into the determinants of adoption of new technology in agriculture by tribal and non-tribal farmers. New technology in agriculture consists of three components: (a) biological, (b) mechanical and (c) biological-mechanical. Biological input refers to the use of new varieties of seeds, fertilizers, pesticides, insecticides and other related inputs. Biological inputs affect and create agricultural production functions by improving the fertility of soil and genetic quality of plants. The mechanical type of technological change involves the use of new farm tools and machines like tractors, pumping sets, combine harvesters, threshers etc. Biological mechanical refers to the use of biological and mechanical inputs in combination. Plant protection through the use of pesticides and spray machines is a case of biological-mechanical input.

All these inputs are likely to increase agricultural production and productivity if they are adopted by farmers in adequate manner. Adoption of new agricultural technology depends upon various socio-economic factors of the farmers and it is subject to various constraints.

The main objectives of this study are:

1. To identify the factors that influence the adoption of new agricultural technology by the tribal and non-tribal farmers in study blocks.
2. To assess the altitudinal differences of the tribal and non-tribal farmers having different sizes of land in respect of adoption of new agricultural technology and to find the major factors responsible for the differences.
3. To evaluate the impact of adoption of agricultural technology on the growth and productivity of agriculture.
4. To find out the constraints to adoption of new technology by different categories of farmers.
5. To study the role of governmental and non-governmental extension services in motivating the farmers to adopt improved technology of production.

6. To suggest measures for accelerating agricultural development by adopting new technology in the area under study.

The above factors in respect of adoption and impact of improved agricultural technology were examined in the context of a cross section of about 240 farm households of 12 villages in 6 Development Blocks of Barpeta district of Assam.

1.3 Justification of the Study

The majority of people in the underdeveloped countries are ruralities engaged in subsistence farming. It is the traditional farmer or more appropriately the peasant who forms the backbone of the underdeveloped societies; and it is agriculture which forms the backbone of underdeveloped economies. The peasant and agriculture go together. How to strengthen these backbones is the crux of the problem. The man who farms as his forefathers did, cannot produce much, no matter how rich is the land or how hard he works. The farmer who knows about soils, plants, animals, tools and implements can produce in abundance, though the land is inherently poor (Schultz, 1975).

The key variable explaining the differences in agricultural production is the human agent. This is evident from the fact that the agricultural production in Japan has been increasing at the rate of 4.6 percent per annum whereas in India only at the rate of 2.1 per cent, although, on per capita basis, India has the six times as much agricultural land as Japan has. Similarly, Western Europe with a population density, much greater than India's and with relatively poor endowment of land resources, has been increasing its agricultural production at the rate much faster than that of India. In the U.S.A. the farm output has been secularly increasing while the farmland as well as the labour force in agriculture have been decreasing. These examples are given here to show that even in the most primary of our industries it is the knowledge or technology that counts. In many of the underdeveloped countries where agricultural production is low, investment in human beings have lagged behind those in other factors of production. To produce abundance of farm products the farmer must have access to what science knows about the land he owns, the plant he grows, the animals he tends, and the machines he runs. He must be quick in adopting the new techniques of agricultural production.

To develop an underdeveloped agricultural system, and thus to extend the fruits of economic development to the maximum number of people, the process of adoption of agricultural technology must be accelerated. In other words, the new farm technology must be made available to the people in the form it is intelligible to them. The diffusion of agricultural innovations involves not only the supply of new farm technology to the farmers but also the changing of the new technology to suit the environmental framework within which the farmers work.

There are a number of conditions which must be met before a given agricultural technology can be accepted by the farmers. Some of these conditions are the result of physical environment but many others are the by-products of the cultural background of the farmers. To make the adoption of agri-technology possible one must understand the environmental framework in which the process of adoption operates. In the absence of such an understanding useful innovations will remain unutilized. There is, thus, a definite need in countries like India for conducting scientific enquiries which may lead to the better understanding of the process of adoption of new agricultural technology. The present research work is the result of the realization of such a need and hence justifies the present study.

1.4 Research Hypotheses

We would like to test the following research hypotheses in the present study:

1. That the levels of adoption of New Technology are different for tribal and non-tribal fanners;
2. that there is a positive relation between farm size and adoption of new technology in agriculture. ;
3. that adoption of new technology in agriculture is positively correlated with the income level of the fanners;

4. that institutional credit facilities the adoption of new technology in agriculture.
5. that adoption of improved agricultural practices depends upon availability of assured irrigation facilities;
6. that well developed market for agricultural output fairly facilitates the adoption of modem technology in agriculture.
7. that prices of modem agricultural inputs stand in the way of adoption of improved practices;
8. that the level of education is positively related with the adoption of new agricultural technology;
9. that the agricultural extension service of the government play an important role in motivating farmers to adopt modem agricultural technology.

1.5 Significance of the Study

The main purpose of the study would be to identify the factors that influence the adoption of new technology in Indian agrarian situation in general and that of Barpeta District of Assam in particular .Identification of such factors would obviously help us to suggest measures to be taken by the government as well as by the fanners for adoption of modem agricultural technology.

1.6 Methodology

The present study is a cross-section study of both the tribal and non-tribal farmers who have adopted the new agricultural technology and those who have not. The discussion on the topic "An enquiry into the determinants of adoption of new technology in agriculture by tribal and non-tribal fanners in Barpeta District" is based on aggregated data about the agricultural sector of Barpeta District of Assam collected from various government and semi-government sources. But this macro level study cannot provide proper insight into the real factors existing in Barpeta district. Basically it is micro level studies i.e., village level studies that can describe the present state of affairs in the agricultural sector of Barpeta district. Macro-level studies cannot answer satisfactorily the questions such as which factors are responsible for slow adoption of new agricultural technology by tribal and non-tribal farmers in the district. To obtain answers to such questions it is necessary to approach the problem from micro-point of view i.e., to analyze the problems of agricultural technology at the farm level. This, in turn, calls for field study with individual farm households as unit of observation and accordingly a field survey was carried out as a part of the study at a few selected areas of the district.

The ultimate aims of the field survey were to identify the factors affecting the adoption of new agricultural technology by tribal and non-tribal farmers in the Barpeta district and to prescribe policies for removal of obstacles to the adoption of agricultural technology in the district in particular and agricultural sector of our economy in general. With this end in view collection of data about the sample survey was carried out with an eye towards identification of various factors affecting the adoption of agricultural technology by tribal and non-tribal farmers and to provide some suggestions based thereupon for adoption of agricultural technology for sustainable development.

1.6.1 Selection of Area for Field Survey

The field survey to be more representative should cover fairly a large number of villages representing sufficiently the entire district. But due to resource and time constraints we have selected 6 Community Development Blocks (C. D. Block) out of 12 in the district on the basis of purposive sampling: These development blocks being Jalah, Gobordhana, Bajali, Chakchaka, Barpeta and Mandia development blocks. Jalah, Gobardhana and Bajali blocks house 4,30,588 population (2001 census) of which about 2,25,000 i.e., 52.25 percent are tribal (Bodo) people. So these three blocks in Barpeta district are tribal dominated blocks. Again the region consisting of Chakchaka, Barpeta and Mondia blocks houses about 5,30,000 population of which 4,45,000 i.e., 80 per cent people are non-tribal. Hence it can be said that these three blocks are predominantly non-tribal population blocks.

Therefore, in conformity with the present study for tribal sample, 6 revenue villages (two from each block) from three development blocks-Jalah, Gobardhana and Bajali C. D. Blocks-with majority tribal (Bodo) population were selected. On the other hand for non-tribal sample, 6 revenue villages (two from each block) with majority non-tribal population were selected. In both the cases random sampling procedure was adopted. Therefore, for field investigation, altogether 12 revenue villages-6 tribal population dominated and 6 non-tribal population dominated villages were selected. The selection of the villages was done based on two considerations. First the selected village should be fairly representative of the whole block i.e., it should contain the basic characteristic feature of the block. Secondly, the necessary infrastructure for the use of the new agricultural technology should be available at least in some households of the selected village.

1.6.2 Selection of Sample

For sample selection a multistage random sample method was used in the first stage of selection, from each community development block two villages were selected at random. In the second stage 20 farm households from each selected village were selected at random for study. Therefore, in all 240 farm house holds (120 tribal and 120 non-tribal farmers) from 12 villages were selected for study as ultimate units of observation.

1.6.3 Collection of Data

Data on the general background and data relating to the adoption of agricultural technology by each farm household in the sample have been collected by interviewing a senior member, usually the head of the household of the farm family. For carrying out these interviews and for recording the information a schedule of questionnaire was used. This schedule of questionnaire was prepared in consultation with the supervisor of the study and finalized after a number of tests and checks in the fields.

1.6.4 Selection of Respondents

The purpose of the study is to enquire into the determinants and constraints of adoption of agricultural technology by different categories of farmers of both tribal and non-tribal groups. For this purpose farmers are divided into large, medium and small farmers as the ultimate unit of sample.

Various studies reveal that farmers can be categorized either on the basis of their land holdings or on the basis of their assets, income and employment. Therefore, an ideal method of categorization would be one which uses both size of holdings as well as assets of farmers. But it is very complex and time consuming laborious process. At the same time evaluation of assets is not an easy job under varied situation and individuals. On the other hand size of the holdings can be determined fairly, easily and accurately for the categorization of large, medium and small farmers. Therefore, size of holdings is considered as criterion for selection of large, medium and small farmers in the present study. The following is the categorization of farmers of both tribal and non-tribal type adopted in the study.

Category of farmers		**Land holdings**
Small farmers	-	upto 1 hectare (upto 7.5 bighas)
Medium farmers	-	1 to 2 hectare (7.5 to 15 bighas)
Large farmers	-	2 hectares and above (15 bighas & above)

For the selection of the farmers a list of 20 farmers from one village was selected at random. The selection of respondents from each village was of the following order:

Table 1.2 List of Selected Villages and Number of Respondents

Sl. No.	Name of the village	Selection of respondents			
		Small farmers	Medium farmers	Large farmers	Total
1.	Mandiagaon (non-tribal)	7	7	6	20
2.	Khoirabari ,,	7	6	7	20
3.	Gandharipara ,,	6	7	7	20
4.	Moutupri ,,	7	7	6	20
5.	Anandapur ,,	7	6	7	20
6.	Nichuka ,,	6	7	7	20
7.	Oxigurigaon (tribal)	7	7	6	20
8.	Labdangurigaon ,,	7	6	7	20
9.	Salbari ,,	6	7	7	20
10.	Majrabari ,,	7	7	6	20
11.	Pakriguri ,,	7	6	7	20
12.	Dhumarpathar ,,	6	7	7	20

Therefore, a sample of 240 fanners of three categories of whom 80 small, 80 medium and 80 were large farmers in total. Data and information were collected from the respondents on the basis of personal interview with them.

1.7 A Brief Review of Literature

Both in the developed and developing countries of the world a plethora of researches have been conducted in the field of adoption of agricultural technology. These studies have analysed the problem from different angles such as social, economic, psychological, cultural, ecological, agricultural and purely technical. A review of some of the major studies is necessary to formulate and project the problem of the present study in its wider theoretical perspective.

Fliegel (1956), in his article "Multiple Correlation Analysis of Factors Associated with adoption of farm practices" has offered an important study in regard to analysis of factors associated with adoption of new farm practice. He has stated that adoption could be treated as a single dimension analysis. According .to him, it has been established that familism, contact for information on farm matters, levels of living and attitude towards farm practices account for a significant proportion of variation of new farm practices, along with the other independent variables also taken into account. Size of operations and authority in farm matters were not, as he thought, significantly related to adoption.

Heady (1963), in his study of "Basic Economic and Welfare Aspects of Farm Technological Advance" pointed out that technological changes in agriculture can be divided into three main categories: (a) biological, (b) mechanical, and (c) biological-mechanical. Biological changes affect and create agricultural production functions by improving the fertility of soil and the genetic quality of plants. The high yielding varieties of crop and use of fertilizer and other chemicals represent such technological change. Such a technological change has been found to be particularly suited to development of traditional agriculture. The mechanical type of technological change involves the use of new farm tools and machines. It contributed to an increase in the productivity of labour. It also raised the productivity of land because of better ploughing, transplanting etc. The third type of technological change characterized is biological-mechanical. Plant protection through the use of pesticides is a case in point.

Chaudhury and Maharaja (1966), conducted a study on "Acceptance of Improved Practices and Their Diffusion Among Wheat Growers in the Pali District of Rajasthan". The study was related to the acceptance of improved practices by farmers (wheat growers) and the rate of diffusion of those practices in the Deauri Block of the Pali District. Data have been obtained from a sample of 90 wheat-growing holdings from three villages of Desuri block for the year 1963-64. The study was based on the introduction of I. A. D. P ., with package practices and the old traditional practices followed by the cultivators. The study reveals that the diffusion rate is higher in the case of larger holdings than smaller holdings and the diffusion rate is observed to be quite high in the upper-income group as against that in the lower-income group. When a new element of change is introduced in the farming community it has to face resistance. Income, size of operational holding and literacy are some of the factors which favourably affect the rates of acceptance of improved practices by farmers. The study emphasizes that higher level of income, better schooling of farmers and larger holding accelerate the rate of acceptance of improved agricultural practices. It is to be noted that the degree or association between literacy and acceptance is stronger than those of holding size and income.

White (1968), in his article "The Adoption of Modern Dairy Practices" observed that the age of the farmers influenced the adoption of modern practices. Old aged farmers were less responsive towards adoption of new agricultural innovations.

Quaraishi (1974), in his article "New Vistas for the Small and Marginal Farmers" expressed that fragmentation of holdings, insecurity of tenure, lack of significant credit facilities for inputs and arrangement of marketing and storage are the common difficulties standing on the way of deriving benefits of improved technology.

Sharma and Nair (1974), in their article "A Multivariable Study of Adoption of HYV Paddy" observed a positive and significant association between adoption of recommended agricultural practices and credit orientation of the farmers. They found that farmers having easy accessibilities of agricultural credits could afford to purchase and adopt agricultural innovation. They also found that most of the farmers i.e., about 99% made use of fertilizers but majority of them used less than half of the recommended dose. Full dose of fertilizers were applied by only 6% of respondents. They also concluded that majority of farmers (63%) growing high yielding varieties of paddy adopted plant protection as a curative measure. However 12% adopted seed treatment.

Mohammed and Majeed (1979), in their study have analyzed the impact of socio-economic factors on technological change and spatial diffusion of agricultural innovations in a district of eastern U. P. They have found that socio-economic factors play a very vital role in the adoption of innovations. They have selected 5 social factors viz., education, training, value orientation, caste and age. They found significant and positive relationship of these variables with the process of adoption. Among economic factors, they have taken six factors viz., size of holding, tenurial status, irrigation, yield, credit and input. The study has revealed that the extent of adoption of innovation by farmers has significant and positive relationships with these factors. Finally, the study has revealed that there is a strong and positive relationship between the prompt availability of inputs and the adoption of improved agricultural practices. The rate of diffusion of such agricultural innovations which give increased yield is much higher compared to those who do not contribute to a substantial increase in the overall production and higher profit yield. It has been suggested that if the farmers are assured of increased production and better gain, they will respond in large number to all the agricultural innovations. They have recommended that the economic factors of adoption of innovation should be given much higher emphasis.

Iqbal (1979), in his article on "High yielding varieties of seeds and their impact on agricultural development in India" has found that the rates of adoption has been widely different between wheat and rice as also among different regions and different classes of farmers. The spread has been more extensive in case of HYV of wheat while the spread of HYV of rice has been restricted only to a few pockets in the rice growing regions. The main reason for the restricted spread of high yielding rice is unfavourable environmental conditions prevailing in the rice belt. The adoption of new varieties of wheat has been much less affected by the environmental conditions. Further, there has been differential adoption of HYV among different classes of farmers. Small farmers have lacked far behind the big farmers in the adoption of new varieties of wheat and rice. Uneconomic size of small holdings and the shortage of finances are the main reasons attributable for this. The unfavourable character of the size of holdings has been more pronounced in paddy growing areas than in the areas under wheat. Thus, there has been differential adoption of HYV between rice and wheat among different classes of farmers.

Titus (1981), in his article "Adoption of Improved Farm Practices" reported that the level of education, economic status of the farmers only help to minimize the degree of risk, but these should not be taken as yard stick for measuring the level of adoption.

Saikia (1982), working on the impact of irrigation on farmers of North-Eastern Region pointed out that irrigation project combined with adoption of the improved technology could transform the farmer into potentially viable units. He opined that HYV seeds in combination with assured irrigation, recommended doze of fertilizer and plant protection measures could increase agricultural output significantly.

Rahman (1983), working on adoption of HYV; Role availability and the supply side problems expressed that large farmers because of their income, economic power, social prestige and link with local political leadership have more assured supply of modern inputs including credit facilities necessary for suitable utilizing the potential of the new technology.

Sarap (1990), in his article "Factors Affecting Small Farmers Access to Institutional Credit in Rural Orissa", expressed that tenancy may be negatively associated with the adoption of modern varieties.

Sharma (1992), in his article "Socio-agro-economic characteristics of tribal farmers and their adoption of modern agricultural technology" has discussed that the utility of modem agricultural innovation depends very much upon the large scale adoption of these innovations by the tillers of the soil. Although the farmers are becoming more and more aware of modern agricultural technology and consequently adopting improved seeds, chemical fertilizers, and plant protection measures, the degree of adoption of the innovations considerably varies from farmer to farmer and it is significantly less in case of tribal farmers than that of non-tribal farmers. The extent of adoption of improved agricultural technology very much depends upon the situation and characteristics of the farmers. The lower rate of adoption of agricultural innovations and least favourable attitude towards agricultural innovations of the tribal farmers might be due to their lower educational levels, lower socio-economic status, small size of land holdings and lower annual income.

Chandra and Singh (1992), in their article "Determinants and Impact of New Technology Adoption on Tribal Agriculture in Bihar" expressed that although the technological breakdown as such in Indian agriculture is no longer a new phenomenon, yet it has got a significance relevance particularly for the regions which are still lying in embryonic stage of agricultural development.

Tribal dominated regions falling under such conditions of agricultural backwardness have not yet been able to benefit from the fruits of the technological innovations fully or even partially.

Tilak (1993), in his article "Education and New Technology in Agriculture" expressed that education enhances the farmers capacity to maximize the perceived profit function by allocating the resources in more effective manner, by choosing which and how much of each output to produce and in what proportion to use the inputs.

Chauhan (1997), in his article "Indian Paper" has expressed that not more than one-forth of the technologies developed by the research system have been adopted by the farmers.

Rogers and Svenning (1969) have made a pioneering study of the process of "Modernization among peasants". This study has provided theoretical insight and empirical models to many further studies. In their study they have described the process by which traditional peasants became modernized, that is, take on a more complex, rapidly changing life style. They have viewed modernization as essentially a communication process in which new ideas are transferred from external sources, such as government agencies and urban centres to the village and its residents. In this study, the individual peasants are the units of analysis. Roger and Svenings have used the key concepts of literacy, mass media exposure, cosmopolitanism and achievement motivation in their analysis of the nature of the modernization process and emphasizing thus the role of communication in effecting changes in human behaviour. They have examined the peasant in a socio-physical context. The data to test the hypotheses about the nature of modernization have come mainly from personal interviews, with peasants in five Columbian villages. A cross-cultural approach has been achieved by comparing the findings with similar data from India, Kenya, Brazil, Turkey and other countries. Rogers and Svenning have described innovativeness as "the degree to which an individual adopt new ideas relatively earlier than others in his social system". Because the adopters' distribution, according to Roger and Svenning, for most innovations overtime is S-shaped and approach is normal ogive curve, the mean and standard deviation may be used to classify the members in any social system into five adopter categories. These are innovators, early adopters, early majority, late majority and laggards. The basis of classification into adopter categories is the nature and degree of innovativeness. The five categories provide a short-hand notion for describing an individual's relative innovativeness. Hence the multiple correlation and configurationally approach have been used to predict innovativeness in the study. Following this typology many subsequent researches in developing countries have been conducted pertaining to the diffusion of innovations.

Rahudkar (1962), in his paper "Farmers' Characteristics Associated with the Adoptions and Diffusion of Improved Farm Practices" has tried to explore: (i) the relationship of selected personal and social characteristics of farmers to the adoption of improved farm practices, and (ii) the extent to which these farmers are reached by communication media for adoption of improved farm practices. As regards the first, the author has found that more of the socio-economic characteristics of the farmers except the level of education are significantly related to the adoption of improved farm practices. Education is an important factor for the adoption of recommended farm practices. Farmers with primary or middle school education tended to adopt half of the recommended practices and with high and college education were likely to adopt greater number of practices. As regards the second, the author has found that farmers with exposure to greater number of information sources were more likely to become adopters than the farmers with less exposure. Adopters tend to use more of impersonal and official sources of information.

Sing and Chand (1991), in their article 'Technical Change and agricultural production in post green Revolution Belt in India' have expressed that the continuous growth of new crop production technology with intensive use of mechanical power brought about the green revolution in the country .For this study a few states where intensive green revolution was high during the last 15 years, were selected. For comparison some states in which the intensity of green revolution was low, were selected as the non-green revolution belt. For the selected states of both the belts, time series data pertaining to the period 1970- 71 to 1986-87 on technological parameters, infrastructural factors, mechanical power, total foodgrains production and productivity were collected. For the different states under each belt, changes and growth in the aforesaid parameters are worked out.

The result of the study revealed that the uneven adoption of modern technology was responsible for bringing about the green revolution with different intensities in the different belts of the country during the recent past. In the states of the green revolution belt such as Punjab, Haryana and Uttar Pradesh where the adoption of modern technology and intensive use of agricultural machinery and implements had taken place because of adequate infrastructural facilities, the agricultural production and productivity increased with steady growth. Hence, in the past green revolution belt, there is need to develop a better crop technology in order to move agriculture at a faster pace. Conversely in the belt of non-green revolution states namely, Orissa, Madhya Pradesh and Rajasthan where the adoption of new technology was relatively low and the infrastructure was poor, the agricultural production and productivity increased only marginally. Therefore, in this belt, in order enhance agricultural production special effects should be made, especially through agricultural extension services, to popularize the adoption of modem agricultural technology.

Misra (1968), in his article 'Diffusion of Agricultural Innovations' reported that there are five basic elements of diffusion of agricultural innovations. The first one is the innovation or the idea or the message in question. The second in the channel of communication through which the innovation moves from one person to another or one place to another. The third component is the social system in which the diffusion occurs and the fourth one is the spatial system in which its end results appear in patterns. And finally is the component of time which an innovation takes to get diffused. To summarize, the diffusion of an innovation takes place through specific channels of communication within a socio-spatial system over a certain amount of time.

It is also reported that many innovations are introduced in an area but only a few get diffused. There are a host of factor which are responsible for this variation. The nature of innovations is one of these factors. In order that an innovation is adopted by a group of people, it must prove to be superior to those it has 10 replace. This superiority should be looked into from the economic as well as other points of view. It must, however, be mentioned here that the superiority of an innovation as viewed by experts in not so crucial as the one viewed by the would-be-adopters. In the case of agriculture it is the farmers who are the decision makers. An expert opinion may help them make right decision, but what counts more is their own perception of the usefulness of innovations.

Sing (2000), in his article 'Education, Technology Adoption and Agricultural Productivity' has discussed the importance of education in relation to adoption of agricultural technology. The study reveals that the agricultural productivity is directly related with the technology adoption by the individual farmers and its diffusion on a large scale are influenced by the education of the individuals and of the society. There is increasing evidence and recognition that the capability of people to be effective and productive economic agents human capital counts more significantly in the development process. It is reported that the education and skills of the agricultural workers are significant factors in explaining the inter-farm, inter-regional and inter-country differences the agricultural performance, along with the availabilities and potential of natural resources of land and water, and infrastructure and institutional investments in inputs, credits, research etc. It is even stressed that the fundamental problem of agricultural growth is an education problem. In fact the human resource development requires, among other things, considerable investment in education health and nutrition. The better the education the better well fed the people, and the better their health, the better would be the capacity, capabil1ty and appreciation of the human beings to be better productive economically. Education enhances the farmers capacity to maximize the perceived profit function by allocating the resources in a more effective cost efficient manner, by choosing which and how much of each output to produce and in what proportion to use the inputs. The central theme of the allocative effects lies in 'evaluating' and 'adopting' the more profitable new technologies. The worker effect of education includes the ability to perform agricultural operations more efficiently in the economic sense. It is translating the allocative efficiency into productive efficiency. The increased capability to process and apply the information is seen through lowering the marginal cost and raising marginal benefit with the given set of inputs. Education also facilitates the more rapid entrepreneurial adjustments to changes in output and input prices, input availabilities / constraints and new opportunities.

Janaiah and Hossain (2003), conducted farm level studies on hybrid rice technology from Philippines, Vietnam, Bangladesh, Tamil Nadu, Andhra Pradesh and Karnataka and reported that hybrid rice had shown higher yielding potential under farmers' field in all study sites except in Tamil Nadu. Yield gains of hybrid rice were associated with additional production costs in all study sites. In India, lower market price for hybrid rice grown was reported, which resulted in negative relative profitability for hybrid rice farmers. This implies that there was much / marginal improvement/ refinement in the technology over the period in India. This explains why hybrid rice adoption at farm-level is very slow and lingering across regions/state within India without continued adoption in any region over the period.

They also found that small and marginal farmers in North and central Vietnam, and Bangladesh have shown more interest than the larger commercial farmers in India and Philippines in hybrid rice. The significant negative effect of the farm size variable on hybrid rice adoption in Vietnam and Bangladesh further confirmed that this technology relatively more preferred by small and marginal farmers as they are interested in additional production that they can get from the limited land holdings with higher capacity utilization of under-utilized family resources. Thus small and marginal farmers are likely to be the potential adopters and beneficiaries of hybrid rice technology compared to the commercial and progressive farmers. The additional cost on hybrid seeds is one of the main reasons for slower hybrid rice adoption. As seeds account for only a small portion of gross revenue, higher seed cost may not be a serious constrain if yield gains are adequate with improved grain quality. Further production and distribution of hybrid seeds in private sector may be a constraint, if there is a demand for hybrid rice seeds among the farmers as hybrid rice production is 65 percent more profitable than inbred rice cultivation. It is expected that as the technology picks up and seed yield increases the marketing margin and the seed cost would decline with economics of scale and growing competition in the seed business.

Janaiah and Hussain also found that Vietnam is the only country in tropical Asia where hybrid rice adoption has been growing largely in the north and central Vietnam, which has closely similar agro-ecological, political, socio-economic and institutional features as south China. It appears that the Vietnam's success in hybrid rice is due to the use of Chinese hybrid rice seeds, as well as serious government commitment for vigorous seed production programme in the public and private sector. Moreover, farmers' cooperatives and communes in north Vietnam still play an important role in farmers' decision on farm operation like in China.

Sing (1984), conducted a study on "Technological Transformation in Agriculture of Rajasthan" opined in conclusion that because of the availability of canal irrigation in Ganganagar district of Rajasthan, a significant number of cultivators in all acreage categories have been able to adopt HYV technology. However, the proportion of adopters is relatively low in the small acreage categories. In general, the higher the size of the operational holdings, the higher is the percentage of adopters in each category. The initial resource base of big farmers seen to have enabled more of them to adopt the HYV technology.

Wheat, rice and Bajra are the only HYV crops being cultivated in Ganganagar district. Of these HYV wheat is the most important in all acreage categories of adopters. Despite the existence of some erratic pattern in some individual acreage categories, the cropping pattern of adopters and non-adopters is similar. For both, wheat is the dominant crop during Rabi and cotton during Kharif. The HYV technology has not led to any significant change in the cropping pattern. He also found that the proportion of adopters is higher in the large acreage categories. However, the intensity of adoption that is the proportion of area under HYV is relatively higher in the small acreage categories. Despite this, the total area sown to HYV is positively correlated with the size of operational holding. The study indicates that the economic factors have played an important role in the adoption of HYV technology. The regression results shows that the size of operational holdings access to liquid funds and availability of assured irrigation through tubewells in addition to canals constitutes the set of significant explanatory variables for the adoption of HYV technology. New technology in Ganganagar has helped to increase the output and productivity of all categories of adopters. The output per acre are obtained by adopters is significantly greater than their non-adopter counterparts in all acreage categories. This increase in output has been achieved as a result of greater use of modern inputs.

Hossain, Thi and Janaiah (2003), conducted a study on Hybrid Rice Technology in Vietnam and reported that hybrid rice has adopted more by older and educated farmers. The coefficient of age is, however, statistically significant only for the equation for the wet season. The coefficient of education is however statistically significant for both seasons the negative coefficient for farm size variable shows that hybrid rice cultivation relatively more preferred by small and marginal farmers. Presumably, the technology is more attractive to small farmers because the higher yield enables the farmer to produce more food for the family from small land holdings. For the wet season, the availability of irrigation is a significant factor determining the adoption of hybrid rice, which may indicate that it needs a favourable growing environment. The coefficient of irrigation variable is not significant in the dry season, as almost all farms use irrigation during this season, so there is very little variation in the variable. The regional dummy variables are highly statistically significant. The coefficients indicate that the hybrid rice is adopted less in the central highland and substantially more so in the south than in the north. One factor may be that the average size of farm is higher in the central and southern regions and hence there is less subsistence pressure of growing more food. The other factor is the relatively higher seed cost in the cultivation of hybrid rice. In the south where the farmers use direct seeding method of crop establishment that requires much higher seed rate. They reported these factors as determinants of adoption of hybrid rice. In the south where the farmers use direct seeding method of crop establishment that requires much higher seed rate. They reported these factors as determinants of adoption of hybrid rice.

Hossain, Thi and Janaiah also mentioned in their article that many sample farmers reported a serious marketing problem of not readily accepting hybrid rice produce in the market especially in south and central regions. Only 52 per cent of household sample sold hybrid rice grain in the market while the remaining 48 per cent have used hybrid rice grain as feed for livestock specially for pigs. Among those farmers who sold hybrid rice produce only 49 per cent sold it with hybrid name whereas others sold hybrid rice grain with inbred name, because hybrid rice produce was offered at lower price in the market. About 32 per cent sample said that hybrid was lower priced than inbred rice varieties. 72 per cent of sample reported that hybrid rice had a poor grain quality. It was also reported that hybrid rice has no taste as indicated by 19 per cent of sample. They reported these factors as farmers' perception regarding hybrid rice in Vietnam.

Godoy, Franks and Claudio (1997), in their article "Adoption of Modern Agricultural Technology by low land Amerindians in Bolivia: The role of Household, villages, ethnicity and markets" have reported that they have studied the adoption of new farm technologies because new techniques raise the income of small holders, produce broad and equitable benefits to the society and may lower pressure on renewable natural resources. To find out the determinants of new farm technologies, they conducted a survey of 102 Mojeno and 62 Yuracare Amerindian households of the department of Beni in the Bolivian rain forest to measure the household and village attributes, ethnicity and markets on the adoption of chemical herbicides and pesticides of farming. In this regard they took three hypotheses to be tested, viz., (i) Village attributes matter more when there is little integration to the market; (ii) The determinants of adoption among Amerindians integrated to the market should resemble the determinants of adoption among small holders; (iii) ethnicity does not matter in adoption.

To test these hypotheses they did field work among lowland Amerindians in the rain forest of department of Beni, Bolivia. In their survey they found that the first hypothesis—village attributes matter more when there is little integration to the market–is true. It is reported that village attributes—distance to market town and the ratio of villagers to brokers are statistically significant determinants of adoption. Village brokers seem to play a less negative or more positive role in adoption in modem communities; as households become part of market economics, villagers may have to rely more on the vertical ties to get information about new technology. In a more autarkic settings villagers may have to rely more on horizontal ties and less on vertical broker to gain access to new technology.

In their study they have reported that the results do not confirm the second hypothesis—the determinants of adoption among Amerindians integrated to the market should resemble the determinants of adoption among small holders. It is reported that shocks, the number of villagers per broker, and the ownership of a radio seem to produce or to help households to adopt, but distance to the market town and being a Mojeno seem to deter adoption.

Among households variables, radios, shocks, and ethnicity matter. The ownership of a radio and illness were positively associated with adoption. Radios proxy for wealth but they also have an independent, more direct effect on adoption because they allow households to get information about new technologies from local radio stations, which often transmit information about the use of chemicals. On the other hand distance to market town curbs adoption; the farther away the village, the lower the probabilities of adoption.

So far as third hypothesis—ethnicity does not matter in adoption, it is reported in findings that there is negative association between being a Mojeno and adoption. So culture and ethnicity matter in adoption of new farm technology.

In the policy recommendation it is suggested that improvements in extension services could enhance adoption of innovation of farming.

Grabowski, Siran and Tracy (1986), pointed out two types of agricultural technology: (i) Mechanical: Mechanical technology substitutes capital for capital labour; does not generally increase land productivity and is characterized by significant scale economics. It, therefore, allows for greater possibilities for substituting land for labour (land using, labour saving). (ii) Biochemical: Biochemical technology generally involves the development of new seed varieties which are highly responsive to increased application of fertilizer and labour and are yields increasing in nature. It allows for greater possibilities for substitution of labour for land (labour using, land lavishing).

To Grabowski (1987) mechanical technology involves the application of machinery to the production process i.e., tractors, threshers, irrigation pump sets, etc. some part of it results in increased yields. However, for the most part it is thought that this type has little impact on yields. On the other hand, biochemical technology is generally yields increasing and is really a package of inputs: seeds and fertilizer and irrigation water. He argued that these two types are independent of each other in terms of their application. It was further argued by Grabowski that the biochemical technology is neutral with respect to scale and mechanical technology involves scale bias.

Joshi (1979), in his article, 'Technological Potentialities of Peasant Agriculture' reported the character of technical change which supports both Marshall's evolutionary concept ("nature non facit saltun") as well as Marx's revolutionary interpretation (quantity change into quality). He visualized following three broad stages of technical change:

(i) It involves rationalization of land use through the enterprise and initiative of farmers as a result of their release from rigidities of manorial system. Most of these changes were labour intensive and therefore, drew up on labour surplus existing economy. The changes were prompted by the motive to achieve three goals: greater output, better qualities and reserving the crops from natural hazards. In this stage the achievement of these goals calls less for a mechanical revolution but replacement of existing tools. At this stage, existing system was relatively 'self contained' not having the advantages of breakthrough in technology achieved outside the system.

(ii) This stage was distinguished by interlinkage of industry to agriculture through the supply of industrially produced implements and inputs to agriculture. This is the stage of "high farming" means "intensive farming produced highest output per acre". A market characteristic of this stage was the subordination, and in many areas erosion, of peasants agriculture by commercialized large scale agriculture and

(iii) The third stage technological is marketed, by major reliance on scientific research as the source of technological breakthrough in the form of 'biochemical technology' as compared to 'mechanical technology' of the second stage. It is also marked by emergence of an institutional framework of supply of inputs and credit, of marketing and irrigation management, of price regulation for support of agriculture by state. Actually it confirms to the model: Induced technical and institutional change.

Lekhi (1984), in his study on "Technical Revolution in Agriculture" (a case study of Punjab), expressed that the application of fertilizer on paddy and wheat was relatively higher on tractorized holdings than a non-tractorized holdings.

As much as 84.15, 75.47 and 28.72 kilograms of nitrogenous, phosphetic and potasic (N .P. & K.) per acre were applied in the case of paddy and 116.76, 50.60

and 33.28 kilograms per acre in respect of wheat respectively. Maize and berseem, on the contrary, showed higher application of fertilizers on non- tractorized holding. Similarly, sugarcane and American cotton showed higher application of fertilizer on tractorized holdings rather than non-tractorized holdings.

Lekhi also expressed that the average yield of different crops on tractorized and non-tractorized holdings was different in Punjab. In kharif season, the cash crops like paddy PR-106, IR-8, groundnut and potato have the higher yield on non-tractorized holdings whereas paddy-Basmati, maize hybrid and American cotton showed higher yield on tractorized holdings. On the contrary, major foodgrain crops in Rabi season obtained higher yield on tractorized holdings. However, the variation in yield on tractorized holdings and non-tractorized holdings was not much. The higher yield might have been recorded on tractorized holdings due to the fact that it was most time saving, moderate and well-equipped instrument for cultivation.

Lekhi also mentioned that the total area under paddy and wheat was lower on small farmers and it increased with the increase in farm situations. But the percentage of area under small size of holdings was higher than that of medium size and large size groups. The cropping intensity was also higher on small farms. It was 176.34 per cent on small size holdings while it was 163.87 per cent on medium size and 171.57 per cent on large size holdings.

The Birla Institute for Scientific Research (1980) has published a book entitled "Technological changes in Agriculture: Impact on productivity and employment". This comparative study has been undertaken against the background of 21 major countries of the world, with the object of analyzing the pattern of technological progress and its impact on agriculture in the sixties and seventies of this century and the pattern of distribution of Gross Domestic Product (G. D. P.) and labour force between the agriculture and non-agricultural sectors in 21 countries of the world. Since technological changes have affected the core of agriculture through different channels, such as mechanization, varieties of seeds, better irrigation facilities, fertilizer and pesticides, defining a single indicator incorporating all these factors was formed to be well high impossible. Hence it was decided to study the growth pattern of each of them separately; their interrelationship and their impact on yield performance. The study has revealed that even though the end result of these improvements differ in magnitude from country to country, depending on the adoptability of the farming community at the macro level and the institutional infrastructure at the macro level. Other factors which cause such differences are the rate and level of economic development and resource endowment.

Saravanan and Shivalinge Gowda (2003), in their article "Agricultural Extension in the 21st Century—Challenges and Strategy" have mentioned that although public extension service has contributed for achieving self-sufficiency in food grain production in recent past it is generally disappointing in transferring improved agricultural technologies from research to farmers in developing countries. Indian agriculture has recorded an alarming knowledge-practice gap. It is estimated that about 30 per cent of the available technologies are adopted by the farmer (Hansra and Adhiguru, 1998). The main causes of this gap according to Saravanan and Gowda are inadequate effective extension education, inadequate input supplies, inadequate credit support and inadequate marketing infrastructure. To Saravanan and Gowda technologies drived from 'top down' centralized research are inappropriate to farmers. Recently it has been realized that fanners' knowledge should be incorporated for better results. Current public extension system transferring technologies are not economically viable, not operationally feasible, not suitable, not matching with the farmers needs and not compatible with fanners overall fanning system. They have opined that public extension policy and extension personnel never considered women cultivators as independent entities, they always treated women cultivators in rural areas as a part of household or appendage on men. Agricultural technologies are often designed and disseminated without considering women cultivators. Men extension workers mainly concentrate on male farmers and it is not easier to communicate by male extension agent to women cultivators in rural areas due to socio-cultural difficulties. In the article they concluded that agricultural extension in the 21st century demands structural and functional changes through appropriate strategies such as farmers participatory technology generation and dissemination, more concentration on women cultivators, phased manner of privatization of extension service and application of information technology to disseminate innovations. This will make extension system more efficient and effective to meet the current challenges and future needs of the farming community.

Sharma, Sharma and Sharma (2001) conducted a study on attitude of tribal farmers towards adoption of modern and indigenous technology of agriculture in Chhattisgarh state during 1977-78. This study was conducted in Surajpur block of Surguja district of Chhattisgarh which is inhabited by huge tribal population (57%). For the study out of 119 villages, in total, six villages were selected. From each village 20 farmers were selected randomly by lottery method. Thus the total number of respondents were 120. The data were collected with the help of interview schedule containing 16 statements on attitude towards indigenous and modem technologies of rice cultivation. For assessing attitude of respondents towards modern technology as well as indigenous technology, three point continuum scale was adopted, i.e., less favourable and more favourable (with a score of 1, 2, and 3).

During the field investigation they found that majority of respondents showed their favourable attitude towards indigenous technology and about 27.5 per cent respondents reported highly favourable response towards the indigenous technology. Only 24 per cent farmers commented less favourable response towards indigenous technology. It showed that majority of respondents had favourable attitude for ITKs. This may be due to low cost, no cost, easy in operation and nearly sustainable with low productivity under adverse situation.

As far the attitude of farmers towards modern agricultural production technology, perception of majority of the farmers (72%) has favourable attitude about the technology and about 9 percent farmers commented more favourable attitude towards adoption of modern technology of agriculture. The results are contrary to indigenous technology, which indicate that farmers have more belief towards indigenous technology rather than modern technology.

From the study they concluded that the majority of farmers showed favourable attitude towards modern technology since by application of modern technology higher production can be obtained. But side by side they want to abide by the indigenous technology because tribal farmers have strong belief on these practices since these practices are based on experiences of many generations and also they require less input, locally available, compatible to their farming situations and at a lower cost.

As regards suggestions regarding improvement in their existing ITKs majority of respondents were interested in less full improvement in increasing efficiency implements/ tools, increase in yield of local varieties, improvement in local system of rice cultivation and modification in their existing storage system.

Ghosh (2003), in her article "Extension in Agricultural Development: A Learning Process" has explained that the use of new technology, stress on mechanization of farming, availing of irrigation facilities, use of improved seeds, pest and diseases causing crop loses—all these depend on the knowledge, skill and willing inclination of farmers to adopt these. The adoption of new practice generally goes through five stages before an individual arrives at a decision to adopt it. These five stages are awareness, interest, evaluation, trial and adoption. This is termed as the diffusion process by which new ideas are spread among members of a society. The mass media and extension workers have their greatest impact increasing awareness and evoking interest.

According to Ghosh application of new technology for increased productivity depends on adequate flow of information to farmers regarding new techniques of production, new inputs and their availability, marketing facility, price and credit support, facilities for storage, preservation, processing and transportation and above all knowledge about how to obtain this information. It remains the function of agricultural agency to serve the farmers with educational, informational and advisory services so as to motivate and build confidence in them by introducing new practices of farming. This is the function of agricultural extension. Sri Ghosh further opines that extension communication is seen as the vehicle for (i) transferring innovations from the donor or development agencies to their clients, and (ii) preparing individual recipients for change by establishing a climate for modernization. Extension education should aim at making people conscious enough to feel their real needs and identify their constraints, serving them with information in response to their articulated needs, motivating farmers to participate in decision making, and increasing their ability to take decision. The ultimate objective of extension education is to effect an attitudinal and behavioural change in the desired direction through communication, diffusion and persuasion.

According to Ghosh apart from mass media, folk media also can perform the role of change agents effective by way of diffusing persuasive information among the farmers. However, both mass media and indigenous channels of communication are seldom sufficient to produce any attitudinal or behavioural change unless they are used in combination with interpersonal channels and with the organizations in the village. This highlights the crucial role of the extension workers. Agricultural extension to be more effective and fruitful, as Ghosh opines in concluding remarks, must be based on co-equal sharing of knowledge where both the extension officers and the farmers have equal chance influencing each other not only in solving problems during the adoption of an innovation but also in deciding the suitability of adopting the innovation.

1.8 Importance of the Study

The economy of India is mainly agricultural in nature. About 70% of the population in our country is engaged in agriculture for their livelihood. Hence agriculture is the foundation of the economy of India. Sustainable agricultural development for sustainable livelihood is only possible when new agricultural technology is properly used in agriculture. But introduction of improved agricultural technologies like HYV seeds, fertilizer, irrigation, plant protection measure have not been successfully adopted till today. They have met only with partial success as measured by observed rate of adoption. The main purpose of this study is to identity the factors that influence the adoption or non-adoption of new technology in Indian agrarian situation in general and the agricultural state of Barpeta district of Assam in particular. Identification of such factors would obviously help those to some extent to know how they will be able to use modern agricultural technology by all types of farmers for agricultural growth and what measures are to be taken by the government as well as by the farmers for adoption of agricultural technology.

1.9 Limitations of the Study

Every investigation and study has certain limitations. Similarly the present study about the adoption and constraints of adoption of improved technology by tribal and non-tribal farmers has certain limitations of time, study area, sample and other investigation facilities. But to make the variables as objective as possible considerable care and thought have been exercised. The present investigation was conducted in a limited geographical area consisting of particular agro-climatic and socio-economic conditions of Barpeta district of Assam. Therefore, the findings emanating from the study may not be applicable in all types of agro-climatic and socio-economic condition of our country. Of course the findings of the present study would be applicable in Assam and elsewhere having similar agro-climatic and socio-economic conditions, while the general conclusion arrived at may be of value in other spheres subject to local adjustments.

CHAPTER 2

A PROFILE OF AGRICULTURAL DEVELOPMENT IN ASSAM

2.1 Introduction

The economy of Assam is mainly rural and agrarian. Agriculture occupies a vital position in the economy of Assam. As per population census of 2001 about 53 percent of the total working force are engaged in agricultural activities in the state. The contribution of this sector in the state domestic product (SDP) at constant (1993-94) prices was 31.84 percent and at current prices was 32.56 percent in 2001-2002.

Assam is producing both food and cash crops. Main food crops in Assam include rice, wheat, pulses, vegetables, maize etc. The principal cash crops are tea, jute, oilseeds, tobacco, sugar-cane, mesta etc. The area under these crops have increased considerably since 1951. The area under food crops in Assam increased marginally from 27 lakh hectares in 1975-76 to about 28 lakh hectares in 2000-2001. Total area under rice increased from 23.0 lakh hectares in 1976-77 to 26.46 lakh hectares in 2000-2001, which accounts for nearly 74 percent of the total cultivable area of the state. Area under non-food crops, except jute, registered an increasing trend.

Out of the total geographical area of 7852 thousand hectares, net sown area in Assam up to 1999-2000 was to the extent of 2734 thousand hectares and area sown more than once was 1352 thousand hectares making the total cropped area in Assam to 3503 thousand hectares. There are 80 thousand hectares of cultivable waste land and 110 thousand hectares of fallow land. In 1999-2000 total cropped area of the state stood at 4087 lakh hectares which constitute about 52 percent of the total geographical area of the state against the all India coverage of 51 percent.

According to the agricultural census of 1995-96 there were about 26.8 lakh operational holdings which covered an area of about 37.43 lakh hectare of land compared with the figures of the earlier census, 1990-91, the number of operational holdings during 1995-96 were higher by 6.33 percent and operated area declined by 2.07 percent. The marginal holdings with less than 1 (one) hectare of land accounted for 62.22 percent of the total holdings and 19.80 percent of the total operated area of the state in 1995-96. in the case of small holdings with size class between 1-2 hectare, the share turned out to be 20.91 percent of the total holdings and 24.52 percent of the total operational area. On the other hand, the large holdings (20 hectares and above) constituted only 0.19 percent of the total number of operational holdings, with 10.47 percent of the total operated area in the state. An important feature revealed by the agricultural census is that the average size of operational holdings in the state recorded a declining trend over the successive censuses. The average size of operational holdings, which was 1.37 hectares in 1976-77, recorded marginal decline to 1.36 hectares in 1980-81. In 1985-86, the same declined to 1.31 hectares and in 1995-96, it further declined to 1.17 hectares. At all India level too, the average size of holdings was found to have gradually declined from 1.69 hectares to 1.57 hectares over the period 1985-86 to 1990-91. The following table shows the position of agricultural holdings and operated area from 1970-71 to 1995-96.

Table 2.1 Numbers, Area and Average Size of Operational Holdings in Assam

Item	1970-71	1976-77	1980-81	1985-86	1990-91	1995-96 (P)
No. of Holdings	1964376	2253654	2297588	2419156	2523379	2625390
Total operated area (in thousand ha)	2882	3079	3121	3161	3205	3253
Average size of holdings (in ha)	1.47	1.37	1.36	1.31	1.27	1.24

Source: Directorate of Economics & Statistics, Assam.

Economic Survey 2002-2003, Assam, Page – 19;

P= Provisional

The above table indicates some important features about land holding pattern and operational area in Assam. The table reveals that total no. of holdings in Assam increased from 19,64,376 holdings for 1970-71 to 26,25,390 holdings for 1995-96. Another important feature revealed by the table is that the average size of operational holdings in Assam has been declining day by day. It was 1.47 hectares in 1970-71 and it declined to 1.24 hectares in 1995-96. At the all India level also the average size of holdings have also declined from 2.00 hectares in 1976-77 to 1.57 hectares in 1995-96. But still average size of operational holdings of Assam is lower than all India average holding size. Apart from small average size holdings the geographical land to man ratio in Assam is one of the lowest among the Northern East (N.E.) states.

Table- 2.2 Land to Man Ratio in North-East Region (Hectares/ Person) as on 1991.

State	Geographical Area (Ha)	Population	Ratio
Arunachal Pradesh	83,74,300	8,64,558	9.69
Assam	78,43,800	2,24,14,322	0.35
Manipur	22,32,700	18,37,149	1.22
Meghalaya	22,42,700	17,74,778	1.26
Mizoram	21,08,100	6,89,756	3.06
Nagaland	16,57,900	12,09,546	1.37
Tripura	10,48,600	27,57,205	0.38
All N.E.	2,55,08,300	3,15,47,314	0.81
All India	32,87,26,300	84,63,02,688	0.39

Source: CMIE Report on Agriculture, 1997-98

It appears from the table 2.2 that among the NE States the geographical land to man ratio is the highest in Arunachal Pradesh (9.69 hectares/ person) and the lowest in Assam (0.35 hectares/ person). The table also shows that the overall geographical land to man for the NE region (0.81 hectares/ person) is much higher than the national average (0.39).

The main cause of decline in the average size of holdings as well as land to man ratio in Assam is excessive population pressure due to absence of alternative occupation particularly in the rural areas. A large majority of population i.e. to the extent of more than 70 percent has to depend on agriculture sector alone. Thus this excessive dependence on agriculture is exerting huge pressure on agricultural land holdings. According to 2001 census more than 53 percent of the total working population in Assam are engaged as cultivators and agricultural labours. The excessive dependence of the population on agricultural sector has been causing continuous subdivision and fragmentation of land holdings in Assam. All these have been resulting in a continuous decline in the average size of holdings and land to man ratio in Assam.

Again the distribution of holdings by size groups is worth mentioning. The proportion of holdings below 1.0 hectare of land is significantly high being about 62.64 percent. Similarly proportion of holdings between 1 and 2 hectares also account for a large number of holdings. As per 1995-96 agricultural census data, the proportion of operational holdings, percentage of area and average size of different farm categories are shown in the table 2.3 below:

Table 2.3 Percentage Distribution of Operational Holdings in Assam, 1995-96

Sl. No.	Category	Size of holdings/farms	%of holdings	% of land area	Average size (in ha)
1.	Marginal farm	Below 1 ha	62:64	21.16	0.37
2.	Small farm	Between 1& 2 ha	20.85	26.18	1.39
3.	Semi medium	Between 2 & 4 ha	12.86	30.85	2.65
4.	Medium	Between 4 & 10 ha)	3.50	16.05	5.07
5.	Large	10 ha & above	0.13	5.74	47.50

Source: Statistical Handbook, Govt. of Assam, 2002, pp. 50-51

The table 2.3 shows that marginal and small farmers constitute more than 80 percent of holdings. But the average size of their holding is very small which is only 0.37 ha and 1.39 ha respectively which are uneconomic.

What is the size of economic holding is a question often asked. There are various factors which determine the of possibility raising an income, sufficient for an average family to maintain at a reasonable standard of efficiency. This possibility of earning income from a particular size of farm is determined by the nature of land, technical possibilities of raising crops, other important facilities such as HYV seeds, irrigation, availability of other agricultural inputs and expertise of the farmer himself. The agro-climatic conditions being varied within the state, it is not possible to arrive at a precise idea of an economic holding. The underdeveloped nature of agriculture makes it more difficult. However, 2.5 to 3.5 hectares may be considered an economic holding with paddy as the main crop under the existing cropping pattern and technology.

2.2 Cropping Pattern: By 'Cropping Pattern' is meant the proportions of cultivated land at a particular point of time that are devoted to production of different crops, as also changes in those proportions over a period of time.

For a long period of time most of the land (about 90 percent) of Assam was put under food crops and the remaining land was used for the production of non-food crops. But from the middle of this century and particularly from 1960's a changing trend in cropping pattern in Assam has been occurring and this trend is continuing till today. The following table 2.4 reveals the change in cropping pattern in Assam since 1960-61.

Table 2.4 Change in Area under Different Crops in Assam since 1960-61 (in thousand hectares)

Crops/Year	1960-61	1980-81	1990-91	2001-02
1. Total Food grains	4572 (84.9)	2521 (84.2)	2755 (83.5)	2752 (83.99)
Rice	4320 (80.2)	2275 (75.9)	2526 (76.5)	2537 (77.34)
Wheat	09 (0.16)	102 (3.4)	84 (2.5)	69 (2.10)
Other coarse cereals	58	23	32	28 (0.85)
Pulses	185 (3.4)	113 (3.8)	113 (3.8)	118
2. Total Non-food grains	813 (15.1)	474 (15.8)	545 (16.5)	525 (16.00)
Oilseeds	309 (5.7)	233 (7.8)	320 (9.7)	320 (9.7)
Jute	299 (5.5)	112 (3.7)	96 (2.9)	68 (0.03)
Cotton	32	4	2	2
Mesta	11	12	7	5
Sugarcane	62	48	36	27
Potatoes	76 (1.4)	38 (1.2)	56 (1.6)	80 (2.43)
Others	24	26	25	23

Source: Statistical Handbook, 2004 and earlier issues.
Note: Figures in bracket shows percentage figures to total area under different crops.

The above table 2.4 shows that the proportion of area under food crops was 84.9 percent in 1960-61 and it marginally declined to 83.99 percent in 2001-02. So it is evident that proportion of land used for food grain production is still higher. The table also shows that area under non-food grains including various cash crops was only 15 percent in 1960-61 and it increased marginally to 16.5 percent. As regards the production of jute which was at time popular as a cash crop among agriculturists is gradually becoming unpopular in Assam. The area under cultivation of jute in Assam as percentage of total cropped area which was 5.5 percent in 1960-61 gradually declined to 0.03 in 2001-02. Another notable change in the cropping pattern in Assam as seen in the table is that the area under the cultivation of oilseeds as percentage of total cropped area increased gradually from 5.7 percent in 1960-61 to 9.75 percent in 2001-02.

A change in cropping pattern implies a change in the proportion of area under different crops. At one time many believed that cropping pattern in India and more particularly in Assam could not be changed. Sinha (1964) for instance, gave expression to such an opinion when he wrote: "In a tradition ridden country with a very low level of knowledge, the peasants are unwilling to make experiments. They accept every thing with a spirit of resignation and a sense of fatalism. For them, agriculture is a way of life rather than a commercial proposition. In an agricultural community where the members are illiterate and tradition ridden, there is hardly any possibility of crop shifts". This opinion is not correct any more as is clear from the change in cropping pattern in Punjab and Haryana. With the passage of time things have changed a lot in Assam also. Farmers have started to believe that the cropping pattern can be changed and must be changed for further agricultural production and to bring agricultural diversity. Improved agricultural practices like HYV seeds, irrigation, fertilizer and some modern agricultural implements along with remunerative price of produce and economic farm size can play an important role in changing the traditional cropping pattern into a modern one irrespective of physical characteristics of soil, climate, weather, rainfall etc.

2.3 Production and Productivity

Agricultural production in Assam, area, productivity per hectare and total output are influenced in a large measure by rainfall and weather conditions. Monsoon is the most important factor determining agricultural production and productivity in Assam. The rains are totally uncertain in Assam. Sometimes rains are insufficient and sometimes there is too much of rain resulting in heavy floods which cause widespread damage and destruction. It is difficult to isolate the weather factor and study only the effects of agricultural inputs and technology on agricultural growth. Agricultural production and productivity in Assam has been found to be low and varying year to year mainly due to weather and climatic factors.

Production of food grains and other principal crops in Assam are shown in the following table:

Table 2.5 Total Production of Food grains in Assam Since 1960-61 (in lakh tones)

Year	Production of Foodgrains
1960-61	16.79
1968-69	20.41
1969-70	18.26
1970-71	20.34
1974-75	16.67
1975-76	23.66
1980-81	27.05
1985-86	30.30
1989-90	29.51
1990-91	34.42
1991-92	34.80
1992-93	34.02
1993-94	34.16
1994-95	35.17
2000-01	41.73

Sources: Statistical Handbook, Assam, 2002 and earlier issues.

The table 2.5 given above reveals that total production of food grains in Assam has been increasing gradually since 1960-61 and it has become more than double during the last 35 years i.e. from 16.79 lakh tones in 1960-61 to 41.7 lakh tones in 2000-01. But this increase has not been uniform throughout the years under consideration. The main reason for the variation in the production of foodgrains in

Assam is natural factor like weather and climate and non-adoption of improved agricultural technology.

Production of other cereal crops in Assam viz. wheat, maize etc. has registered some increase in recent years. Production of most of the cash crops like sugarcane, potato, oilseeds etc. registered only marginal increase in recent years.

The following table 2.6 shows the trend in the production of principal crops in Assam since 1960-61.

Table 2.6 Production of Principal Crops in Assam (thousand tones)

Crops/Year	1960-61	1980-81	1990-91	1991-92	1992-93	1993-94	2000-01
Autumn rice	267	502	522	494	614	587	58
Winter rice	1367	1978	2565	2487	2442	2556	2760
Summer rice	7	43	183	216	243	219	681
Total rice	1641	2523	3270	3197	3299	3362	3999
Wheat	3	118	105	111	79	101	86
Other coarse cereals	9	17	18	18	18	18	17
Pulses	26	47	49	54	51	56	62
Total food grains	1679	2706	3442	3380	3402	3536	4105
Oilseeds	48	112	169	191	150	144	155
Jute (a)	813	912	866	867	1034	667	668
Sugarcane	869	174(b)	1522	1453	1548	1374	988
Potato	144	224	428	473	388	507	677

Source: Statistical Hand Book, Assam, 2002 and earlier issues.

Note: (a) 000 bales of 180 kg

(b) Production of Gur

The above table reveals that total production of rice which is the most important crop of Assam, has increased from 1641 thousand tones in 1960-61 to 3999 thousand tones in 2000-01. Total production of pulses in Assam which was very low at 26 thousand tones in1960-61 gradually increased to 62 thousand tones in 2000-01. Similarly the table shows that production of most of the crops has increased but growth rate is very slow.

Thus we have seen that although the production of principal crops in Assam have been increasing but it has increased at a slower pace in comparison to that of all India production of principal crops. Following table 2.7 shows the production of important agricultural commodities in India since 1960-61.

Table 2.7 Production of Important Agricultural Commodities in India From 1960-61 to 2000-01 (in million tones)

Commodities\Year	1960-61	1970-71	1980-81	1990-91	1993-94	2000-01
Foodgrains	82.0	108.4	129.6	176.4	182.1	195.9
Rice	36.6	42.2	53.6	74.3	79.0	84.9
Wheat	11.0	23.8	36.3	55.1	59.1	68.7
Pulses	12.7	11.8	10.6	14.3	13.1	10.7
Oil seeds	7.0	9.6	9.4	18.6	21.5	18.4
Sugarcane	110.0	126.4	154.2	241.0	227.1	299.2
Tea	0.3	0.4	0.6	0.7	n.a	n.a
Coffee	Neg.	Neg.	0.1	0.2	0.2	0.25
Jute (bales)	4.1	4.9	6.5	7.9	7.4	10.5
Potato	2.7	4.8	9.7	15.2	17.6	n.a

Source: Govt. of India, Economic Survey 2001-02 and earlier issues.

Cotton Bale – 170 kilo; Jute Bale – 180 kilo

Neg. – Negligible n .a. – Not available

From the above table it appears that during 1960-61 to 2000-01 the production of food grains have been continually increasing year after year. Production of food grains increased from 82.0 million tones in 1960-61 to 195.9 million tones in 2000-01. During 1950 and 1960 import of cheap food grains from the United States under PL 480 (when wheat price was around Rs. 2.00 per kilo) hampered the growth of agriculture. It was only after 1970 when imports of food grains were stopped and minimum prices of different agricultural commodities were guaranteed that production of food grains and non-food grains started increasing. Also during 1970s due to increasing use of hybrid seeds, chemical fertilizers, pesticides and assured supply of water, there took place what has come to be known as the "Green Revolution" in respect of rice and wheat in some parts of India and that explains rising production of food grains especially during 1970-71 to 2000-01.

But so far as the question of increase in production in Assam is concerned it started increasing only after 1980. Production rate in Assam is lower (already mentioned) than all India level. Prices of agricultural commodities are not still guaranteed and sometimes prices of some commodities decline to the lowest level that discourages agricultural production in Assam. Moreover, use of hybrid seeds, fertilizers, irrigation is still at the preliminary stage that necessarily explains the cause of low productivity in Assam in comparison to all India level.

2.4 Agricultural Yield Rate

The yield rate of various crops in Assam is not at all satisfactory in comparison with the average yield rate of all India. In Assam cultivation is still carried on with traditional techniques and modern inputs like fertilizers, HYV seeds, irrigation and pesticides etc. are yet to be extensively used. Further yield per hectare of land differs from crop to crop and also from place to place. In Assam the yield rate of rice per hectare increased from 1022 kg in 1970-71 to 1220 kg in 1980-81. It had further increased to 1362 kg in 1993-94 and again to 1565 kg in 2000-01. The yield rate of wheat also increased from 583 kg in 1990-91 to 1219 kg in 2000-01. Similar rising trends have also been observed with respect for yield rates of crops like jute, sugarcane, mustard, pulses and maize. The yield rate of most of the crops of Assam and India can be seen from the table 2.8 given below.

Table 2.8 Yield Rate of Crops in Assam and India (kg/ha)

Crops\Year	1970-71		1980-81		1990-91		2000-01	
	Assam	India	Assam	India	Assam	India	Assam	India
Rice	1022	1123	1220	1336	1291	1740	1565	1901
Wheat	583	1307	1158	1930	1248	2281	1219	2708
Jute	1305	1186	1455	1245	1632	1833	1730	2021
Sugarcane	37217	4800	39000	58000	42510	65000	36898	68500
Potato	4524	10000	5888	13000	7240	16000	8254	18000
Rap & Mustard	413	580	485	560	535	940	515	941

Source: (i) Assam Economic Survey, 2002-2003 and
(ii) Statistical Handbook, Directorate of Economics & Statistics, 1994 and earlier issues.

The table 2.8 reveals that the productivity of major crops in Assam is much below the national average. The productivity of rice in Assam in 1980-81 was 1220 kg/ha as against the national average of 1336 kg/ha and regional productivity of 1219 kg/ha. Among the NE states productivity in Assam is one of the lowest. In 1980-81 the productivity of rice was 1447 kg in Manipur, 1333 in Meghalaya and 1354 kg in Tripura. Even the productivity of wheat is comparatively low in Assam as against the regional productivity of 1463. It was 1158 kg in Assam in 1980-81. In fact wheat productivity in Assam has gone down further in recent years. This is not an encouraging sign.

It is evident from the table 2.8 that agricultural yield of various crops in Assam are poor and even declining gradually in the case of some crops.

Thus, the agricultural sector in Assam has been suffering from low productivity. It has not developed significantly for which per capita availability of food grains is still one of the lowest even among the North Eastern states. The table 2.9 shows the per capita availability of food grains in North East.

Table 2.9 Per Capita Availability of Foodgrains (1991-92 & 1996-97) Based on the 1991 Population Census (kg/ annum).

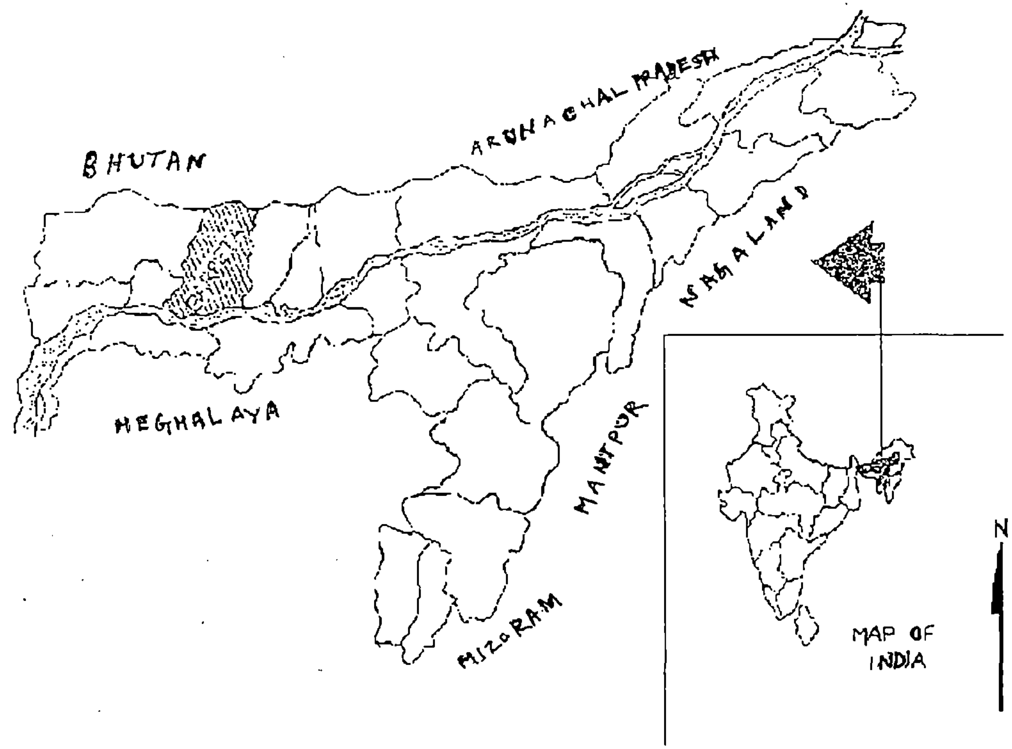
State	Per capita Availability of food grains (kg/ annum)	
	1991-92	1996-97
Arunachal Pradesh	254.23	254.0
Assam	150.76	157.58
Manipur	190.57	212.67
Meghalaya	87.50	85.59
Mizoram	130.77	193.98
Nagaland	168.33	175.19
Tripura	176.52	201.69
All NE	154.84	164.71
All India	198.95	235.52

Source: CMIE Report on Agriculture, 1997 & 1998.

It appears from the table that the per capita availability of food grains in Arunachal Pradesh (254 kg/ annum) is the highest among NE states (164.71) and even higher than the national average (235.52 kg/ annum). The per capita availability of food grains in Assam is lower than not only Arunachal Pradesh but also Manipur (212.67), Mizoram (193.98), Nagaland (175.19) and Tripura (201.69). The table also shows that as per report of 1996-97 the per capita availability of food grains is lower than the national average in all the other NE States except Arunachal Pradesh. It is the lack of adoption of modern technology that explains the agricultural backwardness and food grains deficiency in Assam.

Agricultural productivity in Assam still remains considerably stagnant and poor. The main causes of low agricultural productivity in Assam are small size and uneconomic land holdings, orthodox method of cultivation, lack of assured irrigation facilities and socio-economic factors like farmers conservative outlook, ignorance, illiteracy etc. Present position in Assam is not conducive enough for adoption of improved agricultural technology for augmentation of agricultural production.

KEY MAP OF ASSAM SHOWING BARPETS DISTRICT



CHAPTER 3

SPREAD OF NEW AGRICULTURAL TECHNOLOGY IN ASSAM IN GENERAL AND BARPETA DISTRICT IN PARTICULAR

3.1 Technology in Conceptual Framework

Technology may be defined as systematic application of knowledge to the practical task of production. A particular state of technology is embodied in the manner in which factors of production or inputs are combined to produce output. Technological progress takes place with enhancement of human knowledge and utilization of the same in production process through research and practice. It manifests itself in increased efficiency of production process. Technology shifts production relation between inputs and outputs in such a way that either large output is obtained with given total input of resource or the same output in produced with a smaller amount of inputs.

According to Erdilek (1986), technology refers to a class of knowledge about a specific product or production process and includes the technical skills necessary to manufacture the products or to use the process. An interesting aspect of technology is its 'partial public goods status, when technology as knowledge is made available to another party, that knowledge usually remains available to the transmitting party. However, although one's use of it, the benefit derived from it are generally affected by the number of parties having access of it.

Lionel Goldring (1976) considered technology as any tool or technique, product or process, physical equipment or method of doing or knowledge necessary for the productive functioning of an enterprise. "A technology is designed for instrumental action that reduces uncertainty in the cause and effect relationships involved in achieving a desired outcome" (Thompson 1967).

Agricultural technology in theoretical perspective is a technology that renders farm sector more productive and shifts the production function between farm input and output may be called agricultural technology.

According to Grabowski, Siran and Tracy (1986) to there are two types of agricultural technology:

(i) **Mechanical:** Mechanical technology substitutes capital or labour. It does not generally increase land productivity and is characterized by significant economies of scale. It therefore, allows for greater possibilities for substituting land for labour (land using, labour saving).

(ii) **Biochemical:** Biochemical technology generally involves the development of new seed varieties which are highly responsive to increased application of fertilizer and labour and are yield increasing in nature. It allows for greater possibilities for substitution of labour for land (labour using, land saving).

To Grabowski (1987) mechanical technology involves the application of machinery to the production process i.e., tractors, threshers, irrigation pumps. Some part of it results in increased yields. However, for the most part it is thought that the type has little impact on yields. On the other hand, biochemical technology is generally yield increasing and is really a package of inputs : seeds, fertilizer and irrigation, water. He argued that these two types are independent of each other in terms of their application.

3.2 Nature of Technology

Technology may be either scale-neutral or scale-biased. A technology which brings about an equi-proportionate increase in the productivity of all factor inputs, is scale neutral and it does not change the proportions of factors in a production function. According to Rudra (1982) technology can be called 'scale-neutral' if the responses to the divisible inputs such as water, fertilizer, seed etc. are not found to depend on the size of plots. That technology is scale neutral if it can be effectively and efficiently used on small as well as large farms.

On the other hand, a technology is scale-biased when it changes the productivity of all the factors in different proportions. If a technology increases the productivity of capital more than labour, such a technology will be capital-using and labour-displacing, since the entrepreneurs will find it more profitable to use capital in substitution for labour. A scale-biased technology, therefore, brings about a change in factor proportions with important effects on the structure of output, employment and allocation of resources in the economy.

3.3 Adoption or Application of Technology

In the field of agriculture, adoption of technology means acquisition and adoption of new improved technique and innovations over traditional farming. The essential ingredients of such technique includes use of improved variety of seeds, fertilizers, assured irrigation water, pesticides and improved implements.

It is the adoption or application of technology that leads to technology change. According to Yotopoulos and Nugent (1976) technology is a stock concept and technological change implies changes in this stock. Since, technology can be summarized by an appropriately defined production function, technological changes are reflected in changes in production functions.

Joshi (1979) visualized three broad stages of technological change in agriculture:

(i) It involves rationalization of land use through the enterprise and initiative of farmers as a result of their release from rigidities of manorial system. Most of these changes were labour-intensive and therefore, drew up on labour surplus existing economy. The changes were prompted by the motive to achieve three goals : greater output, better qualities and reserving the crops from natural hazards. In this stage the achievement of these goals calls less for a mechanical revolution but for replacement of existing tools. At this stage, existing system was relatively 'self contained' not having the advantages of break-through in technology achieved outside the system.

(ii) This stage was distinguished by interlinkage of industry to agriculture through the supply of industrially produced implements and inputs to agriculture. This is the stage of "high farming" means "intensive farming producing highest output per acre". A marked characteristic of this stage is the subordination, and in many cases erosion, of peasant agriculture by commercialized large-scale agriculture, and

(iii) The third stage technological change is marked by major reliance on scientific research as the source of technological break-through in the form of 'biochemical technology' as compared to 'mechanical technology' of the second stage. It is also marked by emergency of an institutional framework of supply of inputs and credits, of marketing and irrigation management, of price regulation for support of agriculture by state.

3.4 Appropriate Technology

Appropriate technology is a set of techniques that make optimum use of available resources in given agricultural environment.

According to Sing (1978) a piece of technology may be viewed as appropriate for a society if its design is concerned with real needs of that society in mind, its use fulfils these needs, its continuance and development are based on that society's economic and technical ability to support, service, maintain and even improve upon it. He also presented a model (Fig. 1) to visualize the view of technology, which may be acceptable to people in under developed regions. Sing's model is reproduced below.

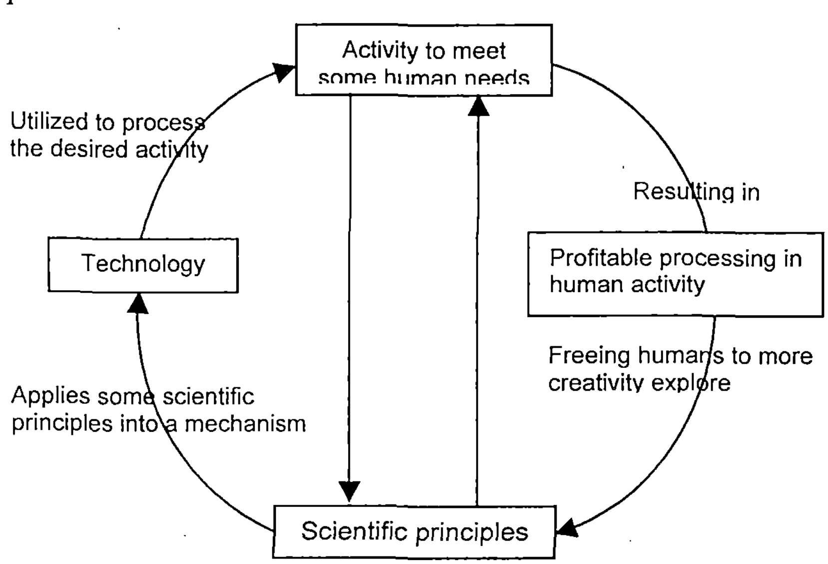


Fig. 1: Sing's Model of Technology

A view of technology which may be acceptable to underdeveloped, or developing countries.

Chattopadhyay (1976) pointed out three attributes, which a new technology must have for making it acceptable to the farmers: (a) economic viability (b) suitability and (c) conformity with socio-economic attributes of the farmer.

Anderson (1979) suggested that the technology must be tested in three conditions of (i) resource appropriateness (ii) needs appropriateness and (iii) goals appropriateness.

3.5 Evolution of New Agricultural Technology in India

The new technology, which was introduced in Indian agriculture in the late 1960s as a part of the new strategy of agricultural development is based on some newly developed crop varieties generally known as the High Yielding Varieties. This new varieties are capable of giving yields much higher than those of the traditional varieties, especially when they are used in combination with a number of complementary inputs such as fertilizers and water. The new varieties prominent among these research centers are the International Centre of Wheat and Maize Improvement (CIMMYT) in Mexico for wheat and International Rice Research Institute (IRRI) in Philippines for rice. In 1942 when India was suffering from acute food shortage and was campaigning for growing more food with those existing crop varieties, agriculture in Mexico was also in a deplorable condition. In 1943 a co-operative agricultural research and training project between the Maxican Ministry of Agricultural and the Rockefeller Foundation was initiated. The scientist chosen by the Rockfeller Foundation in 1944 was Dr. Norman Boarlaug who later became Director of the wheat Department of the International Maize and Wheat Improvement Centre (IMMYT) of Mexico. It was Dr. Borlaugh, the greatest agricultural scientist in the history of agricultural development who produced high yielding varieties capable of responding to very high does of fertilizers and irrigation by incorporating dwarfing genes into these varieties. He produced lines, which were insensitive to daylight and hence fit to be grown over a wide area of the world. The wheat varieties produced by him are remarkably resistant to common wheat diseases. In 1945, Mexico imported to million bushels of wheat but by 1965 it was exporting wheat, yields per acre having tripled.

Indian government imported 250 tones of wheat seed from Mexico in 1965. In 1966, the government sent a team of three scientists to Mexico to get a bulk of shipment of seeds of improved varieties. They visited a number of farmer's field in Mexico and arranged for the import of 18000 tones of seed of the dwarf varieties. This made it possible to spread the high yielding varieties quickly all over the country.

By seeing the tremendous success of wheat cultivation in India Dr. Borlaugh (1966) said, "Never before in the history of agriculture has a transplantation of high yielding varieties coupled with an entirely new technology and strategy been achieved on such a massive scale, in so short a period, and with such a great success".

The success of the co-operative wheat and maize programme in Mexico encouraged the Rockefeller Foundation to launch a similar research programme in rice in which the Ford Foundation joined. As a result of the deliberations between the two foundations and the government of Philippines the International Rice Research Institute (IRRI) was established in 1959 in Philippines. Scientists working in this research institute produced different types of semi-dwarf and dwarf rice variety seed.

India has the world's largest resources of rice germ-plasm and from the very beginning India has co-operated in sharing its germ plasm resources with the IRRI. India was one of the countries to make up the cultivation of IR-8 the first of the new varieties Produced at the IRRI on a massive scale. Several other IRRI varieties and breeding lines have since been recommended for cultivation in different parts of the country. 'IR-8' and other improved breeding lines were used as parents in the breeding programmes not only at the Central Rice Research Institute of Cuttack and the All India Coordinated Rice Improvement Project (AICRIP), Hydrabad, but also in various states of the country. Numerous dwarf varieties of rice seeds have resulted from these crosses. Most of the high yielding varieties of rice released in various parts of India are the descendents of crosses involving 'IR-8' or other breeding lines with improved plant types introduced from the IRRI. India has now become able to produce different types of high yielding crop varieties suitable for different region of the country and it is the various research institutes and agricultural universities that are rendering this tremendous job. In fact Indian agricultural sector has made a major breakthrough by using these different types of high yielding varieties of seeds.

3.6 Spread of New Agricultural Technology in Assam and Barpeta District

The Department of Agriculture in Assam introduced the High Yielding Variety of Paddy in the state in 1965-66. But the spread of high yielding paddy and area under high yielding paddy are very low. Of course the area under High Yielding Varieties (HYV) of rice has been showing a gradual increase over the years. The total area under HYV of rice (Autumn, Winter and Summer), which stood at 11.44 lakh hectares (29.14. percent) during 1993-94, has increased to 14.82 lakh hectares (36.65 percent of the total cropped area) in 2001-02.

The table 3.1 shows area under different HYV Rice from 1993-94 to 2001-02:

Table 3.1 Area Under High Yielding Variety Rice in Assam (In lakh hectares)

Period	Autumn	Winter	Summer	Total	Total cropped area	%
1	2	3	4	5	6	7
1993-94	2.35	7.95	1.14	11:44	39.26	29.23
1995-96	2.39	7.97	1.16	11.52	39.28	29.35
1996-97	2.52	8.21	1.27	12.00	39.31	30.52
1997-98	2.34	8.75	1.36	12.45	39.33	31.65
1998-99	2.18	8.80	1.74	12.72	39.34	32.33
1999-2000	2.08	9.15	2.17	14.00	39.36	35.56
2000-2001	2.16	9.72	2.59	14.47	39.37	36.75

Source: (i) Directorate of Agriculture, Govt. of Assam. (ii) Economic Survey, 2002-2003
(iii) Statistical Hand book, Govt. of Assam, 2002 and earlier issues.

It appears from the table that it is the winter paddy that counts the highest acreage under HYV paddy followed by autumn paddy. This is because of the reason that major part of Assam in flood affected and flood occurs during summer season (between May to August) rendering summer paddy unconducive for high yielding varieties seeds. Apart from that the area under High Yielding Variety of Paddy is not uniform across the districts of Assam. Some districts share more acreage under HYV while some others are lagging behind.

The table 3.2 shows district-wise area under High Yielding Variety of Paddy in Assam, 2000-2001.

Table 3.2 DISTRICT-WISE AREA UNDER HIGH YELDING VARIETY OF PADDY IN ASSAM, 2000-2001

(Area in hect.)

District	Autumn Paddy	Winter paddy	Summer paddy	Total area under HYV paddy	Total cropped area	%Area under HYV paddy
1	2	3	4	5	6	7
Dhubri	2500	32000	32428	89428	236314	37.84
Kokrajhar	15260	24514	6876	46650	136805	34.09
Bongaigaon	11900	31260	9650	52810	151627	34.82
Goalpara	7226	16570	12306	36102	102229	35.31
Barpeta	**25786**	**53446**	**22527**	**101759**	**312331**	**32.58**
Nalbari	5188	72925	14009	92122	199745	46.11
Kamrup	6792	67315	33525	107632	253195	42.50
Darrang	36411	58674	15157	110242	266814	41.31
Sonitpur	12217	86974	8856	108047	246512	43.83
Lakhimpur	3382	37140	3645	44167	155229	28.45
Dhemaji	3240	19280	440	22960	89447	25.66
Morigaon	10850	18213	38808	67871	164132	41.30
Nagaon	35356	92739	46332	174427	364518	47.85
Golaghat	7099	48360	3151	58610	153965	38.06
Jorhat	1892	48327	540	50759	152379	33.31
Sibsagar	444	43081	409	43934	142798	30.76
Dibrugarh	5963	36650	59	42672	165825	25.73
Tinsukia	7053	23090	395	30538	133477	22.87
Karbi Anglong	8470	70389	459	79318	175785	45.12

N.C. Hills		4804	34	4838	35039	13.80
Karimganj	4816	28792	1953	35561	98145	36.23
Hailakandi	6477	17500	2100	26077	59192	44.05
Cachar	10692	39814	5812	56318	142146	39.61
Assam	**251514 (16.96)**	**971857 (65.54)**	**259471 (17.50)**	**1482842**	**3937449**	**37.65**

N.B: Figures within brackets show percentage of total area under HYV paddy.

Sources: (i) Directorate of Economics and Statistics, Assam, 2002

(ii) Directorate of Agriculture, Assam.

The table shows that only 37.65 percent of total cropped area in Assam is under high yielding variety of paddy. More than 60 percent land in Assam is still under traditional variety of paddy whose productivity is much lower than the high yielding variety of seeds. The table also shows that only 32.58 percent acreage is under HYV paddy in Barpeta District, which is lower than the state figure. Among the districts of Assam the district of Nagaon surpasses other districts in respect of cultivable land used for HYV seeds (47.85 percent) followed by Nalbari district (46.11 percent).

Productivity of HYV seeds depends upon the inputs of water and fertilizer. But availability and application of these two inputs are not satisfactory and sufficient which hampers the productivity of HYV seeds in Assam as well as in Barpeta district. Irrigation potential created at govt. level up to 31.3.96 is only for 480078 hectares of land, which constitute only 14.53 percent of the total cropped area. As regards Barpeta district the irrigation potential created up to 31.3. 97 are only for 55505 hectares, which constitute only 17.73 percent of the total cropped area. Again so far as fertilizer consumption is concerned it is only 10.41 kg per hectare in Barpeta district and 16.69 kg/hac. in Assam of which both figurers are lower than the national figure.

Such being the condition in Assam in general and the district of Barpeta in particular the adoption of improved agricultural/farming technology has been very low and slow for which production and productivity is still found to be the lowest among the Indian states.

CHAPTER 4

ADOPTION OF NEW AGRICULTURAL TECHNOLOGY BY NON-TRIBAL AND TRIBAL FARMERS IN BARPETA DISTRICT – A FARM LEVEL ANALYSIS

4.1 The Theoretical Perspective

The green revolution was launched in the late 1960s at a time when many developing countries faced an alarming widening of their national food gaps and rapid population growth. Much of the initial focus was on growing more food, a tenable view at the time given the threat of famine. Green revolution technologies played a major role in increasing food supplies and in lowering food prices. They also increased farm incomes and generated powerful trickle down benefits in the form of additional income and employment in the non-farm economy. These impacts raised an enormous number of poor people out of poverty and prevented many more people from falling into poverty and hunger. But despite these successes at national level green revolution has miserably failed to make any notable dent in Assam. According to Dobhasi Committee (1981) "Green revolution did not touch Assam." From various literatures and from an appropriate observation of agricultural scenario, it is conceivable that green revolution has only partially touched Assam whereas it is entering the 2nd phase in other states. In Assam, agriculture is characterized by low use of modern technology and is primarily rain-fed with minimal ground water utilization. Still there is a high incidence of poverty notwithstanding the abundance of natural resources and high potential for agricultural growth in Assam. More particularly the region housing the tribal people, there is large-scale deforestation and poor husbandry which have resulted in degradation of land. Cropping intensity is low, primarily due to inadequate water harvesting and poor development of irrigation infrastructure. A large proportion of cultivated area comes under rain-fed agriculture, and is subject to the vagaries of the monsoons and frequent natural calamities. As a result, most crop cultivated by tribal farmers are low value crops. Thus it is evident that agricultural practices by tribal and non-tribal farmers in Assam are by and large tradition ridden.

Sustained growth of agriculture in the long run depends on the improvement of farming technology in the country. Introductión of new agricultural technology seems to offer an opportunity to increase output and income substantially. For this reason, adoption of technological innovations in backward agriculture has been drawing attention of development economists. But the point that needs special attention is that till now the introduction of new technology has met with only partial success as measured by the observed rate of adoption. It is technological innovation and adoption by all categories of farmers that can change traditional agriculture into modern one. The importance of technological change in the context of growth and development of traditional agriculture has been analyzed by Schultz (1964) in his book 'Transforming Traditional Agriculture'. According to him, the distinguishing character that sets it traditional agriculture apart from modern agriculture is the type of input and technology in use and not its cultural and institutional attributes citing various pieces of empirical evidence, Schultz argues that farmers in traditional agriculture do not respond to market signals and that do not allocate their resources efficiently in a rational manner. He attributes their poverty to the type of inputs and technique of productivity they use. Transformation of traditional agriculture, therefore, require jerking the system off from its low level of equilibrium with traditional mode of production by introduction of modern inputs and application of science and technology. According to Prof. Schultz, "difference in land are of least importance and differences in the capabilities of farm people are most important in explaining the difference in the amount and the rate of increase of farm production." And it is the modern agricultural technology that can increase the capabilities of farming people to a great extent.

So, adoption of farming technology is very important for shifting our traditional agriculture to modern one. The focus of this chapter is to identify the factors affecting the adoption of agricultural technology in the context of cross section 240 of households of which 120 are non-tribal and 120 are tribal households of 12 villages in the district of Barpeta, Assam. We have only used and analyzed secondary macro level data for Indian state wherever we have felt its necessary.

Farmers' adoption of any agricultural innovation depends primarily upon three factors:

(a) Farmers' awareness of the innovation;

(b) Physical suitability of the innovation to the specific farming environment and

(c) The possible economic benefits of the innovation to the farmers.

Hence a farmer will adopt a new practice only if he is convinced of its economic benefits in his farming condition. In other words, the extent of adoption will differ from farmer to farmer depending on the socio-economic and physical condition of farming. Under such circumstances, given the farmers awareness of the new agricultural technology, it is the farm size that affect the adoption of new technology to a considerable extent.

In fact there are a large number of factors that affect the efficiency of small and large farms. For analytical purpose all these factors can be classified into three groups.

The first group relates to the static factors affecting the efficiency of farms in converting the same inputs into outputs. These include economies of scale which accrue to large farms in the use of indivisible inputs like tractors, tube-wells, farm threshers and harvesters. External economies is another factor that leads to static production efficiency difference on small and large farms. Research, extension, marketing and processing are some of the most important factors. In addition, certain form of institutional organization will reach large farms more efficiently than small arms. For example, the unit cost for providing extension and credit services or supplying other modern inputs may be low in large farms. Another factor that may lead to size efficiency is the superior managerial ability associated with larger size farms.

The second group of factors affects the quality and intensity of input use. Availability of farm family labour (per acre) on the farm and land quality are some important factors which lead to intensive use of different inputs. For example, sometimes it is argued that the land owned by small farmers is superior in quality and therefore, the possibility of more intensive use of other inputs exists on these farms. Another explanation of more intensive use of inputs by small farms may be that they are more interested in maximizing farm profits since they are operating very close to subsistence level.

A third group of factors include the dynamic factors that affect the ability of the farmer to expand his output over time. The willingness and capacity to take risk and innovation, level of education, financial base etc. are some of such important factors which greatly benefit large farmers.

Various literature and field survey highlight that there is a positive association between the farm size and the adoption of HYV technology. In general, large farmers because of their higher income, economic power, social prestige and links with local political leaders, have more assured supply of modern inputs including credit facilities necessary for fruitfully utilizing the potential of new technology. Given the capital constraints, the land allocated to modern varieties will be positively associated with farm size. But farm size is a surrogate for a number of factors such as access to credit inputs and information. As such large farmers enjoy preferential treatment in obtaining input and they are generally the large adopters of HYV seed technology and its other components. We shall discuss the relationship between farm size of both non-tribal and tribal farmers and the adoption of new agricultural technology in this chapter in the following order.

4.2 Farm Size And Adoption of HYV Seeds

Various literature and field survey highlight that there is an association between the size of farm and adoption of HYV seeds. Adoption and expansion of HYV acreage requires a considerable amount of investment. Therefore, lack of cash for investment is likely to be an important obstacle for the expansion of HYV acreage and the use of optimum use of inputs required for HYV seeds. There is a greater likelihood that cash constraint may create more obstacles for HYV crops than for traditional crops. This is because modern varieties need large amount of inputs which are almost beyond the purchasing capacity of small farmers and for this they cannot afford to adopt HYV varieties in full scale. Of course, due to diverse economic and socio-cultural value of non-tribal and tribal farmers, level of adoption may also differ in respect of tribal and non-tribal farmers. Field survey also supports this proposition which is shown in Table 4.1.

Table 4.1 Size of Holdings and Percentage of Adopter Household (Non-tribal) of HYV Seeds

Size group	Total No. of households in the group	Total No. of adopter	Percentage of Adopter
Small farmer	40	20	50
Medium farmer	40	30	75
Large farmer	40	40	100
Total	**120**	**90**	**75**

Source: Field Survey, 2004

Out of the 120 farm households in the sample, 90. i.e., 75 percent of the households had adopted HYV seeds in the reference year. This distribution of adopter households was not uniform across the size of the holdings. The number of small farmers adopting the technology was 50 percent while it was as high as 100 percent in the case of large farmers. Therefore, the hypothesis that households adopting the modern varieties increased with an increase in size of holding is true. But an important point to be noted in this context is that though adopter of HYV seed was 75 percent but the land used for the same purpose was much lower than the adopter figure. Field survey showed that roughly 45 percent of the land of the surveyed households in Barpeta district was brought under HYV seed. Statistical figures also approximately support this figure. As per government data (2000-2001) 32.58 percent of the total cropped area in Bapeta district and 37.65 percent in Assam were brought under HYV seeds. The Table 4.2 shows the percentage of land used for HYV seeds (non-tribal)

Table 4.2 Size of Holdings and Percentage of Land Used for HYV Seeds (Non-Tribal Farmers)

Size group	Total no. of households in the group	Total Land (in Bighas)	Land use for HYV seed (in Bighas)
Small farmer	40	220	45(20.45)
Medium farmer	40	515	280(54.38)
Large farmer	40	690	280(40.57)
Total	**120**	**1425**	**605(42.45)**

Source: Field Survey, 2004

Note: Figures in brackets are percentage of land used under HYV seeds.

One bigha= 0.135 hectare

It appears from the Table 4.2 that land used under HYV seed by small farmers was only 20.45 percent while it was 40.57 percent in case of large farmers. The Table also reveals that more land was brought under HYV seed by the medium farmers. Also, field survey showed that large farmers were lagging behind the medium farmers in adopting HYV seeds. The reason, according to field survey, was that the irrigation facilities were not available to all the cultivable land possessed by large farmers. Most of the farmers in all size groups were found using pumpset as source of irrigation (as government irrigation facility is almost nil) and in most cases it was found that a large farmer owed only single pumpset to irrigate his land. From our personal interviews with the large farmers, it appeared that although most of them could afford to multiply the number of pumpset, but they did not do so for several reasons.

Firstly, A cent percent coverage of their land with HYV seeds would require the complementary use of other inputs like fertilizers, pesticides, machineries, labour etc. total cost of which could be unaffordable for them.

Secondly, for the expansion of area under HYVs among the requirement of many complementary factors, the most problematic one is labour. It was reported that availability of labour even at a fairly high rate of wages at the peak season is an insurmountable problem.

Thirdly, there is aversion to risk among large farmers. The prices of agricultural commodities are fluctuating. As a result, they feel discouraged in expanding the area under HYVs due to the potential risk of heavy losses in the case of a fall in prices. Therefore, the hypothesis that farm size and adoption of HYV technology is positively correlated is falsified in the context of adoption in terms of hectares under HYVs.

Tribal farmers with their particular socio-economic characteristics behave differently while adopting agricultural technology. Tribal farmers are mostly conservative and tradition ridden. Field survey shows that majority of them are illiterate and lack in information of latest agricultural technology. More so there is very poor development of irrigation infrastructure. Their agriculture is mostly rain-fed. Under such circumstances, there is every possibility that adoption of agricultural technology cannot be identical with that of by the non-tribal farmers.

Table 4.3 shows how tribal farmers respond to HYV seeds.

Table 4.3 Size of Holdings and Percentage of Adopter Households (Tribal Farmers) of HYV Seeds

Size group	Total no. of households in the group	Total no. of adopter	Percentage of Adopter
Small farmer	40	7	17.50
Medium farmer	40	10	25.00
Large farmer	40	12	30.00
Total	**120**	**29**	**24.17**

Source: Field Survey, 2004

In the case of tribal farmers out of 120 farm households in the sample, 29, i.e., only 24 percent of the households had adopted HYV seeds in the reference year. In this case also the distribution of adopter household was not uniform across the size of holdings. The number of small farmers adopting HYV technology was only 17.5 percent while it was as high as 30 percent in case of large farmers. Here also the hypothesis that households adopting the modern varieties increased with an increase in the size of the holding is true. It was found during field investigation that large farmers also have access to large income. Basically larger farmer groups and higher income groups are synonymous. But the most important point to be noted is that percentage of area under HYV seeds by tribal farmers is much more lower than their non-tribal counterparts. Field survey showed that a very small percentage of land was put under HYV acreage. Table 4.4 shows the area put under HYV seeds by tribal farmers.

Table 4.4 Size of Holdings and Percentage of Land Used (Tribal farmers) for HYV Seeds

Size group	Total no. of households in the group	Total Land (in Bighas)	Land use for HYV seed (in Bighas)
Small farmer	40	270	14(5.19)
Medium farmer	40	612	52(8.49)
Large farmer	40	865	60(6.94)
Total	**120**	**1747**	**126(7.21)**

Source: Field Survey, 2004

Note: Figures in brackets show percentage of total land used under HYV seeds.

The Table 4.4 shows that land used under HYV seeds by small farmers was only 5.19 percent while it was 8.49 percent and 6.94 percent in case of medium and large farmers respectively. Also, field survey showed that large farmers are lagging behind medium farmers. In all land used under HYV seeds by tribal farmers was much more lower than that of by non-tribal farmers. The reasons, according to field survey, were several.

Firstly, tribal farmers are mostly conservative and tradition ridden. Traditionally they use local varieties. Most of the illiterate tribal farmers were found to be reluctant to shift from traditional variety.

Secondly, it is evident from Table 4.4 that tribal farmers own more cultivable land than non-tribal counterparts. For example, 40 sample small farmers had 270 bighas of land while it was only 220 bighas in the case of non-tribal farmers. Similarly, medium and large farmers of tribal category had much more cultivable land area than non-tribal farmers. According to many tribal farmers, traditional variety in their land can yield sufficient crops to support their family.

Thirdly, nearly 40 percent of respondent farmers reported that they did not get information in time about the latest agricultural technology. Due to insurgency problems which existed during survey period, even village level extension workers did not visit their village and paddy field during the reference period. Talk with same Village Level Extension Worker (VLEW) also supports their claim.

Fourthly, some respondents reported that HYV seeds are more prone to diseases and more susceptible to vagaries of weather for which they have to lose huge amount of paddy each year.

A sizeable percentage of tribal sample farmers reported that they abide by the indigenous agricultural technology because they have strong belief on these practices since these are based on experience of many generations. Also they require less inputs, locally available which are compatible to their farming situation and available at a lower cost.

Nearly 30 percent respondents reported that indigenous varieties involve low cost and easy in operation and these are sustainable under adverse situation and hence they favour indigenous seeds rather than high yielding seeds.

Agricultural Department and the Indian Council of Agricultural Research have done much to evolve and popularize improved and disease resisting varieties of seeds suitable for different local conditions. These seeds are called quality seeds. Quality seed is identified as seed which is clean and free from dust, daft and broken grains and not a mixture of other varieties. This seed has a high yielding character and possesses high standard of germination. At present, it is expected that seed quality is the basic and crucial input for attaining sustained growth in agricultural production. Seeds are the carrier of new agricultural technology to crop production, propagation and multiplication. Accordingly, production of quality seeds and distribution of the same constitute an important component of govt. agricultural policy.

In Assam, a large number of high yielding varieties like Lakhmi, Salivahana, Bah Kushal, Ranjit, Monohar Sali, Masuri, Maniram, Keteki joha, IR-36, IR-54, Luit etc. possessing high yield potential/quality and resistance to biotic stress have developed and recommended for different rice ecosystem in the state. The state Agricultural Department has been evolving steps for popularizing the above varieties among the farmers which resulted in an increasing trend in the area under high yielding variety of crops over the years.

The expansion of area under HYV has been an important component of the strategy for increasing agricultural production since 1966. In 1966-67, the area under HYV of seeds was only 1.89 million hectares which increased to 31.89 million hectares in 1971-72, 54.1 million hectares in 1984-85, 67.12 million hectares in 1992-93 and 75 million hectares by 1995-96. Presently HYV programme is restricted to only crops namely rice, wheat, jowar, bajra and maize of which wheat and rice account for largest crop area covered by HYV. As of 2000-2001, more than 90 percent of cropped area under wheat (25 million hectares) and 75 percent of the cropped area under rice (42 million hectares) was covered by HYV while in the case of coarse cereals, it was only 50-60 percent. The government is making efforts to expand rice area under HYV so as to increase the productivity.

There exists a skewed distribution of crops under HYV within the Indian states. Among the states at the one end are Punjab, Tamilnadu and Haryana with 94.6 percent, 85.8 percent and 78.8 percent respectively of area under HYV to the total cropped area. On the other hand, Assam, Kerala, Rajasthan and Orissa have only 37.65 percent, 26.8 percent and 31.4 percent respectively of area under HYV to the total cropped area. In the case of paddy, Punjab and Tamilnadu have almost the entire crop area under HYV, while Assam, Rajasthan, Bihar and Orissa have less than 40 percent area under HYV. The Seventh Plan had launched a special rice production programme for the eastern states comprising Assam, Bihar, Orissa and West Bengal, eastern Uttar Pradesh, eastern Madhya Pradesh, where the gap between the potential and actual yields of rice is the highest in the country but which contributes less than 50 percent to the country's rice production.

National Seed Corporation (NSC) established in 1963 and Indian Council of Agricultural Research (ICAR) have been rendering tremendous service in developing and popularizing various kinds of High Yielding Variety of seeds like breeder and foundation seeds. The Indian Council of Agricultural Research (ICAR), The National Seed Corporation (NSC), organizes the production of breeder seed. The state farms corporation of India as well as the Agricultural Universities and research Institutes are also producing breeder seeds. On the other hand, State Seed Corporation (SSC) produce foundation seeds to meet the local requirement.

Apart from breeder and foundation seeds, certified/quality seeds are also produced and distributed for all farmers and in all regions. The distribution of quality seeds has witnessed a phenomenal increase from 1.4 million quintals in 1979-80 to over 9.1 million quintals in 2001-02. The government has a scheme for maintenance of adequate quantities of buffer stocks of seeds to meet unforeseen contingencies like floods, droughts, disease etc. (when seeds are to be made available to farmers in the affected areas at short notice.)

A new policy on seed development was introduced in 1988 aimed at making high quality seeds available from any part of the world for the farmers to enable them to maximize their yields and income. At the same time, a number of fiscal and financial incentives were provided to encourage and promote the growth of the indigenous seed industry. As a result of the new policy, there has been a significant increase in the import of high quality seeds particularly those of oil seeds and vegetables.

A major objective of the agricultural technology is to increase food grains production through expansion of area under location specific HYV. During the last few years, though there has been a considerable increase in the quantum of quality/certified seeds and the area under HYV, there has not been commensurate increase in productivity. The government has launched a project with World Bank assistance to augment the infrastructural facilities for seed development. The domestic effort in evolving appropriate seed technology for vegetables and fruits and pulses has been slow and unsuccessful.

From field investigation, it appeared that large farmers also have access to large income. In practical sense, large farmer groups and large income groups are synonymous. Therefore, findings emanating from discussion between farm size and adoption of new agricultural technology will be in conformity to the findings to be emanated from association between income and adoption of new agricultural technology. Hence, separate study for level income and agricultural technology adoption has not been undertaken.

4.3 Adoption of Agricultural Implements

An appropriate means of having larger volume of agricultural production from the given land resource of a country is the increase in cropping intensity. A country where land has become scarce factor with increasing population, agricultural growth can be achieved through the spread of the practice of double or multiple cropping. However, adoption of multiple cropping by farmer would require modern agricultural implements like tractor, power tiller, thresher, pump set, spray machines etc. and use of short duration crop varieties to release land early enough. All these inputs are required for quicker preparation of land for the next round of cultivation. So, modern agricultural tools and implements form an important part of modern farming technology and without this rapid and sustainable agricultural development is impossible. There is now common belief that progressive agriculture is impossible without modern implements, i.e., mechanization of agriculture. Though progress of farm mechanization is slow in India, it has been getting momentum in recent years. The Table 4.5 shows the progress of farm mechanization in India since 1950-51 to 1992-93.

Table 4.5 Progress of Farm Mechanization in India

Sl. No.	Item	1950-51	1960-61	1970-71	1992-93
1.	Gross cropped area (mha)	132.0	153.0	166.0	183.0
2.	Tractors (Lakhs)	0.1	0.3	0.1	18.0
3.	Oil engines (Lakhs)	0.7	2.3	15.6	52.0
4.	Irrigation pumpsets (Lakhs)	0.2	2.0	16.2	96.2
5.	Consumption of power (Kwh) for agriculture per thousand hectares of gross cropped area	1.5	5.5	27.0	350.7

Source: CMIE, Basic Statistics Relating to the Indian Economy, Vol. 1, Aug. 1994.

It appears from the Table that use of tractors, oil engines, pumpsets etc. in farm sector has increased impressively.

Increased use of agricultural implements particularly tractors and power tillers have been manifested in the increasing sale of the same. The Table 4.6 shows the sale of tractors and power tillers in the recent years.

Table 4.6 No. of Tractors and Power Tillers Sold in 3 –year period (1999-2000 to 2001-02)

States	Tractors	States	Power Tillers
Uttar Pradesh	1,89,984 (25.2)	West Bengal	15,297 (32.9)
Madhya Pradesh	84,410 (11.2)	Tamil Nadu	6,634 (14.3)
Punjab	75,115 (10.0)	Assam	4,123 (8.9)
Rajasthan	59,777(7.9)	Orissa	3,110 (6.7)
Haryana	54,982 (7.3)	Karnataka	4,251 (9.1)
Bihar	46,210 (6.1)	Maharashtra	1,845 (4.0)
Gujarat	44,728(5.9)	Kerala	3,314 (7.1)
Andhra Pradesh	47,572 (6.3)	Andhra Pradesh	3,040 (4.4)
Tamil Nadu	26,332 (3.5)	Tripura	1,032 (2.2)
Maharashtra	45,345 (6.0)	Gujarat	1,027 (2.2)
Karnataka	29,715 (3.9)	Bihar	6 12 (1.3)
Orissa	10,379 (1.4)		
Other states/union territories, export etc.	38,937 (5.2)	Other states/union territories, export etc.	3,187 (6.9)
All India	**7,53,286 (100.0)**	**All India**	**46,472 (100.0)**

Source: Compiled and computed from data provided by the Ministry of Agriculture in Economic Survey (2002-03)

Note: Figures in parentheses are percentages of total.

The Table shows that during the 3-year period (1999-2000 to 2001-02) a total of 7.53 lakh tractors were sold, i.e., an annual average of about 2.5 lakhs per year. A regional breakup reveals that Uttar Pradesh leads in the purchase of about 25 percent of the total sale in India followed by Madhya Pradesh, Punjab, Rajasthan and Haryana. These five states account for nearly 62 percent of the sale of tractors.

So far as power tillers are concerned, West Bengal leads with nearly 33 percent of the total sale in India followed by Tamil Nadu, Assam, Karnataka, Kerala and Orissa. These six states account for 79 percent of the total sale of power tillers in the country.

It also appears from the Table that states having large average size of operational holdings are preferably adopting tractors than power tillers. For example, Rajasthan, Maharashtra, Gujarat, Punjab, Haryana, Karnataka and Madhya Pradesh having average size 4.1, 21.21, 2.93, 3.61, 2.43, 2.13 and 1.56 hectare respectively are progressively adopting factors. All these states have average size holdings more than all India figure of 1.57. On the other hand, states having smaller average size of operational holdings are found using more power tillers than tractors. For example, West Bengal, Tamil Nadu, Assam, Orissa, Kerala all have smaller size of holdings than all India figure of 1.51 and these are preferably adopting power tillers for tilling of their farms. The main reason is that smaller operational holdings are not economical and conducive to tractor use. It is power tillers and other small implements that are convenient and physically suitable for small holders.

In Assam, as the land holding of the farmers (1.31 hectare) are small, power tillers are more useful for tillage operation in all seasons. Assam Agro-Industries Development Corporation has sold tractors and power tillers to farmers. Implements like pumpsets has also been given to farmers under the schemes of Assam Rural Infrastructure for Service Project of World Bank and installation of shallow tube well to Field Management Committee (FMC) of NABARD. Prices of tractor, power tillers, pumpsets etc. had gone up considerably and they are beyond the means of majority of farmers in Assam to acquire.

Review of literature and field survey showed that there is a positive association between farm size and adoption of agricultural implements. Adoption of implements depends largely on the physical suitability of the innovation to the specific farming environment and possible economic benefits of the innovation to the farmers. It is the large farm size that can potentially fulfill these conditions for which large farmers were found adopting more agricultural tools and implements which is shown in Table 4.7 below.

Table 4.7 Adoption of Agricultural Implements by Different Size Groups of Farmers (Non-Tribal Farmers)

Size group	Total No. of households	Tractors used (No.)	Power Tillers used (No.)	Pumpsets (No.)	Spray Machines (No.)
Small farmer	40	0	0	7	10
Medium farmer	40	1	3	20	30
Large farmer	40	7	10	35	45

Source: Field Survey, 2004

The above Table shows that it is the large farmers who used more agricultural implements. Land holding size being bigger, large farmers found their land more economical, convenient and physically suitable for adoption of agricultural implements. The reason as found by field survey was that small farmers were not economically sound enough to purchase modern implements and their land size also is not convenient and physically fit for adoption of modern implements. Medium and large farmers found their land size economically and physically suitable for realization of full potentiality of agricultural tools.

Table 4.8 Adoption of Agricultural Implements by Different Size Groups of Farmers (Tribal Farmers)

Size group	Total No. of households	Tractors used (No.)	Power Tillers used (No.)	Pumpsets (No.)	Spray Machines (No.)
Small farmer	40	0	1	4	5
Medium farmer	40	1	3	22	29
Large farmer	40	1	8	28	28

Source: Field Survey, 2004

The above Table 4.8 shows that it was the medium and large farmers who used more agricultural implements but adoption rate was smaller than non-tribal farmers. In the case of tribal farmers, the number of tractors used was 2 (one medium and one large farmer) while it was 8 in case of non-tribal farmers (one medium and seven large farmers). Similarly, number of power tillers, pumpsets and spray machines used by tribal farmers was smaller than their non-tribal counterparts. It appeared from field survey that land holding size of tribal farmers was larger than non-tribal farmers and hence their land holdings were more economical, convenient and physically suitable for adoption of agricultural implements than the non-tribal sample farmers. But despite their suitability of land their adoption rate was low. The reason found by field survey was that most of the tribal farmers were poor and they could not afford to purchase costly agricultural implements.

4.4 Adoption of Irrigation Facility (Non-Tribal Farmers)

Water is indispensable to agricultural production. In areas where rainfall is plentiful and well distributed over the year, there is no problem of water. But rainfall in certain areas is very scanty as well as uncertain. This is so in Deccan and central India, Punjab and Rajasthan. In these areas, artificial rainfall is absolutely essential for without it cultivation is almost impossible. In certain regions, rainfall may be abundant but it may be concentrated in a short period of the year, the rest of the year being dry. As a result, cultivation may not be possible for the whole year. In these regions, provision of irrigation will facilitate growing more than one crop in the year. More so, there are certain food and cash crops such as rice and sugarcane which require abundant, regular and continuous supply of water. In short, water is a vital input to increase agricultural output to keep the pace with the food requirements of the ever increasing population.

During the 50 years of independence, the government had spent about Rs. 231,400 crores on major, medium and minor irrigation works. As a result, the country's irrigation potential has increased from 22.6 million hectares in 1950-51 to 89 million hectares at the end of 1996-97. With this India has the largest irrigated area among all the countries of the world. This has greatly contributed to the increase in food grain production from 51 million tones in 1950-51 to 203 million tones in 2001-02. The Table 4.9 shows the progress of irrigated area since 1950-51.

Table 4.9 Progress of Gross and Net Irrigated Area in India Since 1950-51 (million hectares)

Year	Net irrigated area	Gross irrigated area	Total cropped area	Gross irrigated area as percent of sown area
1951-52	21	23	133	17
1970-71	31	38	166	23
1990-91	48	62	186	34
1999-2000	57	76	193	39

Source: Agricultural Statistics at a Glance (2002)

It appears from the Table that as a consequence of irrigation, about 17 percent of cropped area was irrigated in 1950-51 while this has increased to 39 percent in 1999-2000. Apart from that there has been a gradual improvement in area irrigated more than once. In 1950-51 area irrigated more than once was 1.7 million hectares, i.e., 8.1 percent of net irrigated area; in 1998-99 this had increased to 18.6 million hectares or 33 percent of the net irrigated area. Area irrigated more than once is a kind of land augmentation and is, therefore, very crucial in raising agricultural output.

In Assam, artificial irrigation was not given much importance in the past since the state used to receive heavy rainfall during those days. But, of late, rainfall in the state has been showing erratic behaviour. At times, there occurs plentiful rainfall and at times, the state experiences drought conditions. After introducing new agricultural technology in Assam, irrigation has become one of the crucial factors in the package of inputs for attaining a higher level of agricultural productivity. HYV seeds require more round of irrigation. The Planning Commission estimated that productivity of irrigated land generally is nearly double or even more compared to that of unirrigated land. Such being the position, irrigation necessarily forms an important component of modern agricultural technology.

But the condition of irrigation in Assam is not satisfactory. It is the poor irrigation facilities that are largely responsible for low production and productivity in Assam.

The Table 4.10 shows the district-wise irrigation potential created upto 31-3-99 through government irrigation scheme.

Table 4.10 District-wise Irrigation Potential Created Through Govt. Irrigation Scheme upto 1999

Sl. No.	District	Total cropped area (in ha)	Total irrigation potential created for land (in ha)	Percentage of land irrigated
1.	Dhubri	227000	14168	6.24
2.	Kokrajhar	143000	22870	15.93
3.	Goalpara	153000	8112	5.30
4.	Bongaigaon	98000	11474	11.70
5.	**Barpeta**	**313000**	**55505**	**11.73**
6.	Nalbari	197000	17870	9.07
7.	Kamrup	223000	32894	14.75
8.	Darrang	479000	50319	10.50
9.	Sonitpur	223000	51419	23.05
10.	Lakhimpur	175000	10357	6.59
11.	Dhemaji	90000	5271	5.85
12.	Marigaon	126000	15685	12.44
13.	Naogaon	381000	86605	22.73
14.	Golaghat	175000	16073	9.18
15.	Jorhat	164000	12151	7.40
16.	Sibsagar	164000	15649	9.52
17.	Dibrugarh	160000	11269	7.04
18.	Tinsukia	12800	5312	4.15
19.	Karbi Anglong	181000	22834	12.61
20.	N.C. Hills	35000	5191	14.83
21.	Karimganj	108000	2892	2.67
22.	Hailakandi	60000	3621	6.03
23.	Cachar	139000	5382	3.87
	Assam	**3906000**	**482551**	**12.29**

The above table shows that total irrigation potential created in Assam upto 1999 was of the order of 482551 hectares of which only 23.70 percent of the created potential were utilized. Till the end of March, 1999, total irrigation potential created in Assam in percentage of ultimate potential was only 12.29 percent for all India.

The irrigation programme in Assam consists of (a) major and medium irrigation programme and (b) minor irrigation programme. Upto March, 1999, a total of 482551 hectares of irrigation potential have been created of which 180789 hectares are developed under major and medium irrigation programme and the rest 301762 hectares are developed under minor irrigation programme. The irrigation potential created in Assam so far, covers only 12.29 percent of the total cropped area of the state which is very poor in comparison to the potential created in some other states. Further, the actual utilization of the irrigation potential created in the state remained as low as 23.70 percent in 1998-99. This is mainly due to the absence of field channels, nonfunctioning or damage of canal irrigation, absence of assured supply of electricity, reluctance of cultivators to adopt the envisaged cropping pattern etc.

The following Table 4.11 shows the district wise irrigation potential created and utilized during 1998-98.

Table 4.11 District-wise Irrigation Potential Created and Utilized During 1998-99 (in ha)

Sl. No.	District	Kharif	Rabi and Pre-Kahrif	Total irrigation potential used	Total irrigation potential created	% of irrigation potential used
1.	Dhubri	110.107	670.24	780.31	14168	5.50
2.	Kokrajhar	4186.00	65.00	4251.00	22870	18.58
3.	Goalpara	1009.16	318.76	1327.92	8112	16.36
4.	Bongaigaon	1887.30	2559	1912.89	11474	16.67
5.	**Barpeta**	**6994.90**	**1579.55**	**8574.45**	**55505**	**15.44**

6.	Nalbari	397.74	147.50	545.24	17870	3.08
7.	Kamrup	12614.60	2945.70	15560.30	32894	47.30
8.	Darrang	13699.00	855.00	14554.00	50319	28.92
9.	Sonitpur	19825.10	261.50	20086.60	51119	39.29
10.	Lakhimpur	92.30	10.60	102.30	10357	0.98
11.	Dhemaji	30.75	77.60	107.75	5271	2.04
12.	Marigaon	2072.00	307.10	2879.10	15685	18.47
13.	Naogaon	21701.50	3492.50	25194.00	86605	29.09
14.	Golaghat	675.40	94.05	789.45	16073	4.91
15.	Jorhat	473.00	77.60	550.60	12451	4.53
16.	Sibsagar	433.30	27.00	460.30	15649	2.94
17.	Dibrugarh	76.50	25.50	102.00	11269	0.90
18.	Tinsukia	397.60	25.00	404.00	5312	7.60
19.	Karbi Anglong	1885.00	1085.00	12970.00	22834	56.80
20.	N.C. Hills	2858.60	-	2858.00	5191	55.65
21.	Karimganj	-	80.00	80.00	2892	2.76
22.	Hailakandi	62.04	86.12	148.16	3621	4.09
23.	Cachar	77.91	91.00	168.91	5382	3.13
	Assam	**101560.57**	**12846.71**	**114407.28**	**482551**	**23.70**

Source: Chief Engineer, Irrigation Department, Assam Statistical Handbook 2002 and earlier issues.

The Table shows that out of the total 4,82,551 hectares of irrigation potential created, only 23.70 percent, i.e., 114407.28 hectares of irrigation potential was used in 1998-99. So, the actual irrigation potential used was only 2.91 percent of total cropped area since the total irrigation potential used was 114407.28 hectares and the total cropped area was 3926000 hectares.

The main reason for this low adoption of irrigation potential created under major irrigation programme has not been working successfully. Most of the canal irrigation programme has been found either partially working or completely out of order or damaged. It is the minor irrigation that is shallow tube well irrigation which is working successfully in most parts of Assam. Field survey also supported this proposition.

The Table 4.12 shows the adoption of irrigation potential by different farmers in Barpeta district.

Table 4.12 Adoption of Irrigation Potential by Different Categories of Non-Tribal Sample Farmers

Categories of farmers	Total no. of households	Total Land (in Bighas)	Total irrigated land	% of irrigated land
Small farmer	40	220	40	18.18
Medium farmer	40	515	267	51.84
Large farmer	40	690	271	39.28
Total	**120**	**1425**	**578**	**40.56**

Source: Field Survey, 2004

The Table depicts that a total of 120 households out of 1425 bighas of cropped land only 578 bighas of land was under both major and minor irrigation programme that is only 40 percent land was irrigated.

Again among irrigation facilities adopted by 120 households of different groups it was minor irrigation that counted for the major source of irrigation facilities.

Table 4.13 shows the pattern of irrigation facilities adopted by 120 non-tribal households of different farm groups.

Table 4.13 Pattern of Irrigation Facilities Adopted by Non-Tribal Sample Farmers

Categories of farmers	Total no. of households	Total irrigated Land (in Bighas)	Major irrigation (in Bighas)	Minor irrigation (in Bighas)
Small farmer	40	40	7	33
Medium farmer	40	267	10	257
Large farmer	40	271	20	251
Total	**120**	**578**	**37**	**541**

Source: Field Survey, 2004

The Table depicts that a total of 578 bighas of irrigated land, there were provisions for minor irrigation (canal irrigation) only for 37 bighas of land and remaining 541 bighas, i.e., 99.87 percent land was irrigated by shallow tubewell irrigation while in field survey, it was reported that presently canal irrigation, though it was in operation earlier, is not operative in the surveyed villages.

4.5 Adoption of Irrigation Potential by Tribal Farmers

Tribal Farmers are lagging behind not only in HYV technology and agricultural mechanization but in irrigation facilities also. Field survey showed that tribal farmers were more backward in terms of irrigation potentialities. The Table 4.14 shows the adoption of irrigation potential by tribal farmers.

Table 4.14 Adoption of Irrigation Potential by Different Tribal Sample Farmers

Categories of farmers	Total no. of households	Total Land (in Bighas)	Total irrigated land (in Bighas)	% of irrigated land
Small farmer	40	270	42	15.56
Medium farmer	40	612	275	44.93
Large farmer	40	865	280	32.37
Total	**120**	**1747**	**597**	**34.17**

Source: Field Survey, 2004

The Table depicts that a total of 120 households out of 1747 bighas of land, only 597 bighas, i.e., merely 34 percent of cropped area was brought under irrigation while it was 41 percent in case of non-tribal farmers. It also appears from the Table that it was the medium size group that counted the highest acreage under irrigation facility followed by large and small farmers. Therefore, the hypothesis that there is positive association between farm size and adoption of modern agricultural technology is falsified here.

In recent years, in response to the growing popularity and convenience of tube well irrigation in Assam, the Department of Agriculture is implementing a scheme, viz. Samriddha Krishi Yojona (SKY) with NABARD's finance wherein irrigation through Shallow Tube Well (STW) with 5 HP pump sets are provided to a group of farmers having continuity of land possession by organizing Field Management Committee (FMC). The basic objective of this scheme is to increase the area under irrigation for increasing productivity and cropping intensity to bridge the gap between production and requirement. A total of 98,652 numbers of STWs have so far been installed under this scheme upto July 2002.

The state has also been implementing the Assam Rural Infrastructure and Agricultural Service Projects (ARIASP) from the year 1995-96 with IDA credit available from the World Bank. The scheme has provision to install STWs to create irrigation potential for boosting up food grains in the state. The district-wise position of installation of STW is shown in the Table 4.15.

Table 4.15 District-wise Installation of STW under ARIASP and SKY Programme Since 1997-98 to July 2002

Sl. No.	District	Under ARIASP	Under SKY	Total
1.	Dhubri	4946	15919	20,865
2.	Kokrajhar	1300	2400	3700
3.	Goalpara	2942	4500	7442
4.	Bongaigaon	2805	7800	10605
5.	**Barpeta**	**5728**	**7786**	**13514**
6.	Nalbari	3108	8900	12008
7.	Kamrup	5265	11000	16265
8.	Darrang	2500	9000	11500
9.	Sonitpur	2395	2830	5225
10.	Lakhimpur	951	950	1901
11.	Dhemaji	890	520	1410
12.	Marigaon	2496	4000	6496
13.	Naogaon	5446	11550	16996
14.	Golaghat	2041	3055	5095
15.	Jorhat	1322	1348	2610
16.	Sibsagar	1050	2424	3474
17.	Dibrugarh	1295	3600	4895
18.	Tinsukia	1160	1070	2230
19.	Karimganj	N. A.	N. A.	N. A.
20.	Hailakandi	N. A.	N. A.	N. A.
21.	Cachar	N. A.	N. A.	N. A.
	Assam	**47640**	**98652**	**1,46,292**

Source: Directorate of Agriculture, Assam Economic Survey, Assam (2002-03)

N. A. – Not available

The Table above shows that a total of 1,46,292 pumpsets have been distributed in Assam during a period of just 5 years. In Barpeta district also as many as 13514 pumpsets have been distributed to the farmers since 1998 and there is ever growing demand for pumpsets as expressed by the offices of Assistant Executive Engineer, Sorbhog and Pathsala Branch of Barpeta District.

In fact, it is the tube well irrigation that has brought about a significant change in the agricultural scenario in Barpeta district. It is due to tube well irrigation that the district of Barpeta has attained almost self-sufficiency in food grains and exporting vegetable to various parts of Assam as well as some other parts of India. The district of Barpeta has been recognized by the Department of Agriculture, Assam as successful district in respect of agricultural production and productivity. But still due to lack of capital and institutional credit a large number of farmers, specially small and medium farmers cannot afford to purchase pumpsets for irrigation.

While irrigation is certainly a strong favourable factor in adoption of modern high yielding variety it is not always indispensable for using these modern varieties. Particularly for those of rice cultivation in the wet season. Field survey showed that the areas prone to frequent flooding and water logging of fields in the wet season, successful adoption of modern varieties require more of drainage and pest control measures than irrigation. In such areas, water, rather than lack of it, is the problem for modern rice varieties in the wet season. For this reason, farmers in the flood prone area in Barpeta district are found cultivating modern rice varieties in the dry season rather than during the wet season. In the dry season, however, irrigation is undoubtedly a crucial factor for adoption of modern rice varieties.

4.6 Adoption of Fertilizer

In many system of intensive agriculture, the harvesting of crops takes place in succession, often several times a year. This involves a recurring drain of nutrients from the soil and sustained agricultural production at a high level will be impossible unless the nutrient element removed from the soil are regularly returned to it. Nitrogen (N), Phosphorus (P) and Potash (K) are the important nutrients which are taken by the plants in large quantity and are removed from the soil during cropping. Therefore, if crop yields are to be increased and maintained, these elements have to be compensated to the soil. India's soil though varied and rich is deficient in Nitrogen (N) and Phosphorus (P) – two plant nutrients which together with organic manure greatly influence crop return. Therefore, use of fertilizer in farming is of crucial importance for agricultural output. More importantly utilization of potential productivity of the new varieties depends largely on the chemical fertilizer in adequate quantities. High yielding varieties need much more amount of fertilizer for realization of potential productivity of both high yielding and local varieties.

In view of increasing need and demand for fertilizer, government of India took to produce fertilizer within the country. As production gesture fertilizer industry produced 39,000 tonnes fertilizer in 1951-52. Since then there has been considerable increase in the domestic production of fertilizer over the years. In 1999-2000, production of fertilizer was about 19 million tonnes. But internal production of fertilizer is not enough to keep pace with the increase in consumption. As internal production has been found short of continuously increasing demand, the government had to depend upon imports. A total import of fertilizer was 52,000 tonnes in 1951-52 and it shot up to 4.0 million tonnes in 1999-2000. The Table 4.16 shows production, import and consumption of chemical fertilizer in India.

Table 4.16 Production, Import and Consumption of Chemical Fertilizer Since 1951-52 to 2001- 02 (in 000 tones)

Year	Production	Import (000 tonnes)	Consumption	Consumption per hectare of cropped area (in Kgs)
1951-52	39	55	70	0.5
1960-61	166	420	290	1.9
1970-71	1060	630	2260	13.1
1980-81	3000	2760	5510	31.8
1990-91	11860	2760	12550	76.8
2001-02	14630	2400	17360	90.1

Source: Economic Survey, 2002-03

It is evident from the Table that since the adoption of the new agricultural technology in the sixties, the consumption of chemical fertilizers has been growing rapidly. From a mere 70,000 tonnes in 1951-52, consumption of fertilizer rose to 2,90,000 tonnes in 1960-61 and to 17.36 million tonnes in 2001-02.

In spite of rapid increase in the consumption of fertilizers in the country in recent years, India's position is far behind of other progressive countries. Table 4.17 shows fertilizer consumption of some countries of the world.

Table 4.17 Fertilizer Consumption Kg/ha (1996-97) of Some Countries

Sl. No.	Name of countries	Fertilizer consumption (Kg/ha)
1.	South Korea	400
2.	Egypt	370
3.	Japan	340
4.	China	290
5.	Netherlands	275
6.	Belgium	225
7.	U. S. A.	140
8.	Pakistan	140
9.	India	100
10.	Brazil	90

Source: Govt. of India; Economic Survey; Ministry of Finance;
New Delhi, Various Issues for 1980-81 to 1998-99 figures

The above Table depicts that international consumption level of fertilizer is much higher than the consumption level of India. It is to be noted that fertilizer consumption in India declined to 90.1 Kg/ha in 2001-02 from 100 Kg/ha in 1996-97 due to drought in many parts of the country. With the beginning of HYV strategy in Assam, consumption of fertilizer has been found to be on the rise. But overall consumption of fertilizer in Assam as well as in Barpeta district has been found to be very low in comparison to other states and all India level.

District wise fertilizer consumption in Assam, during the year 1999-2000 is shown in Table 4.18

Table 4.18 District-wise Consumption of Fertilizer in Assam, During the Year 1999-2000

Sl. No.	District	Total cropped area (in Ha)	Total fertilizer used (in Kg./ha) N+P+K	Fertilizer used per hectare (in Kgs)
1.	Dhubri	227000	3920000	17.26
2.	Kokrajhar	143000	1607000	11.23
3.	Goalpara	98000	2703000	27.58
4.	Bongaigaon	153000	4038000	26.39
5.	**Barpeta**	**313000**	**4425000**	**14.13**
6.	Nalbari	197000	4723000	23.97
7.	Kamrup	223000	7063000	31.67
8.	Darrang	479000	5637000	11.76
9.	Sonitpur	223000	1965000	8.81
10.	Lakhimpur	157000	512000	3.26
11.	Dhemaji	90000	109000	1.21
12.	Marigaon	126000	946000	9.50
13.	Naogaon	381000	12492000	32.78
14.	Golaghat	175000	1979000	11.30
15.	Jorhat	164000	2414000	14.71
16.	Sibsagar	164000	1808000	11.02
17.	Dibrugarh	16000	3891000	24.31
18.	Tinsukia	128000	447300	34.94
19.	Karbi Anglong	181000	197000	1.08
20.	N.C. Hills	35000	20000	0.57
21.	Karimganj	108000	681000	6.30
22.	Hailakandi	60000	1524000	25.4
23.	Cachar	139000	2460000	17.69
	Assam	**3926000**	**78102000**	**19.89**

Source: Directorate of Agriculture, Assam; Statistical Hand Book, Assam, 2001, 2002.

Scanning of the above Table 4.18 shows that per hectare consumption of fertilizer in Assam is only 20 Kg., which is much less than the all India consumption figure of 90 Kg. As regards the consumption figure of Barpeta district, it is only 14.13 Kg/ha which is lower than the state figure of 20 Kg/ha. Among the districts of Assam, it is again Karbi Anglong and North Cachar Hills using the lowest quantity of fertilizer due to their particular type of (shifting cultivation) cultivation. Various statistical figures and filed survey showed that fertilizer consumption in Assam is one of the lowest among the Indian states.

The following Table 4.19 shows the fertilizer consumption figure of different states.

Table 4.19 Fertilizer Consumption Figure in Different States (2001-02)

States	Fertilizer consumption/ha (in Kgs)	States	Fertilizer consumption/ha (in Kgs)
Punjab	173	Bihar	90
Haryana	155	Karnataka	70
Andhra Pradesh	143	Maharashtra	60
Tamil Nadu	150	Madhya Pradesh	50
Uttar Pradesh	125	Rajsthan	45
Gujarat	100	Orissa	40
West Bengal	100	Assam	20

Source: Economic Survey, 2002-03

The above Table 4.19 depicts that fertilizer consumption is the highest in Punjab and lowest in Assam (20 Kgs/ha).

Our field survey also showed low level of use of fertilizer by non-tribal as well as tribal farmers in Barpeta district.

Table 4.20 Adoption of Chemical Fertilizers by Different Non-tribal Group Size of Farmers

Level of adoption	Large Farmers N=40		Medium Farmers N=40		Small Farmers N=40		Total N=120
	No. of adopter	P.C.	No. of adopter	P.C.	No. of adopter	P.C.	
High	26	65.00	20	50.00	7	17.50	53
Medium	12	30.00	11	27.50	15	37.50	38
Low	2	5.00	9	22.50	18	45.00	27

Note: High – 40 Kg and above per bigha; Medium – 20 Kg and above but below 40Kg/bigha; Low – upto 20 Kg/bigha.
Source: Field Survey, 2004.

Table 4.20 shows distribution of large, medium and small farmers on the basis of their adoption of chemical fertilizer. Of the large farmers, 65 percent are high adopters; only 30.00 and 5.00 percent large farmers are medium and low level adopters respectively. Again a majority of the medium farmers, i.e., 50 percent also fall in the high level adoption group. In the case of medium farmers, 27.5 percent and 22.5 percent fall in the group of medium and low adoption level respectively. But in case of small farmers, a majority of them, i.e., 45.00 percent is low adopter and only 20.00 percent of them are high adopter of chemical fertilizer. Therefore, it is evident that adoption rate of chemical fertilizer is not uniform across large, medium and small farmers. As a result, production and productivity rate is obviously different among the three groups of farmers.

It can be concluded that majority of the non-tribal farmers in the large category use maximum amount of nitrogenous, phosphoric and potassium fertilizers, whereas low level of adoption is observed in the case of small farmers. The medium and low level of adoption by majority of medium and small farmers is due to their poor economic condition, which might not permit them to apply the recommended dose of fertilizer for their crop production. Further, inadequate supply arrangement of fertilizer in rural areas and difficulty in transportation to farms, lower propensity of farmers to use purchased inputs, lack of irrigation facilities particularly during rabi season etc. are some important factors that are responsible for low level of fertilizer consumption by the farmers especially small and medium farmers. Despite these difficulties a section of farmers, particularly large and medium farmers, have become fertilizer minded. In some areas, where vegetable crops are grown in large scale, there is high demand for fertilizers. The use of fertilizer has gone up only in the recent years.

But an important point in this context is that majority of farmers do not use fertilizer as per recommendation.

During field survey, an attempt was also made to know about how many of the sample farmers were using recommended dose of fertilizer and the result of which is presented in Table 4.21 below.

Table 4.21 Distribution of Farmers (non-tribal) According to Knowledge About Recommended Doses of Fertilizer Use

Category of farmer	Total no. of household	No. of farmers having knowledge of recommended dose	No. of farmers having no knowledge of recommended dose
Large farmers	40	14 (35)	26 (65)
Medium farmers	40	13 (32.5)	27 (67.5)
Small farmers	40	5 (12.5)	35 (87.5)
Total	**120**	**32 (26.66)**	**88 (73.34)**

Note: Recommended dose (NPK): 4:2:1 for rice and wheat

„ „ (NPK): 6.4:2.7:1 for cash crops-horticulture and plantation

Source: Field survey, 2004

The Table 4.21 shows that only 26.66 percent farmers of which 35 percent large, 32.5 percent medium and 12.5 percent small farmers use recommended dose of fertilizer. Remaining 73 percent of which 65 percent large, 67.5 percent medium and 87.5 percent small farmers do not use fertilizer as per recommendation of the expert authority (village level extension worker, agriculture extension officer etc.). It is also to be noted that some farmers reported to have used over dose of fertilizer. Use of fertilizer in over dose is certainly destroying the natural productivity, potential of land for future. Fertilizer to be more effective requires soil testing and more importantly chemical fertilizer should be used in conjunction with organic and compost green manure in judicious manner to ensure higher productivity. But field survey showed that few farmers are acquainted with soil testing, as soil testing facility is still very inadequate. Field survey also revealed that most of the sample farmers rely largely on chemical fertilizer, particularly for rice cultivation. Of course, some farmers used organic and compost manure in large scale in conjunction with chemical fertilizer for vegetable production, as reported by some progressive vegetable growers in the study area (Nichuka and Kalahabhanga villages in Rupshi block and Monipur village in Gobardanga block).

4.7 Adoption of Chemical Fertilizers by Different Categories of Tribal Farmers

Use of fertilizer by any cultivator largely depends on the type of seeds he adopts and assured irrigation facility available to his cultivable land. From various literature (Bezbaruah, 1989) and field survey, it appears that a farmer uses more fertilizer if he uses high yielding variety of seeds and his cultivable land has more assured irrigation facility for any time. But field survey showed that majority of the tribal farmers were using mostly traditional varieties and majority of their cropped areas lacked in assured irrigation facility. Under such circumstances, it is likely that tribal farmers use low level of chemical fertilizers in their paddy field. Field survey also supported the low level of fertilizer adoption proposition by the tribal farmers.

Table 4.22 Adoption of Chemical Fertilizers by Different Categories of Tribal Farmers

Level of adoption	Large Farmers N=40		Medium Farmers N=40		Small Farmers N=40		Total N=120
	No. of adopter	P.C.	No. of adopter	P.C.	No. of adopter	P.C.	
High	16	40.00	15	37.50	8	20.00	39
Medium	20	50.00	18	45.00	12	30.00	50
Low	4	10.00	7	17.50	20	50.00	31
Total	**40**	**100**	**40**	**100**	**40**	**100**	**120**

Note: High – 40 Kg and above per bigha;
Medium – 20 Kg and above but below 40Kg/bigha;
Low – upto 20 Kg/bigha. Source:
Source: Field Survey, 2004.

Table 4.22 shows the distribution of large, medium and small tribal farmers on the basis of their adoption of chemical fertilizers. In the case of tribal farmers, percentage of higher level adopter is 40 percent as against 67.5 percent of non-tribal farmers. But as high as 50 percent of large farmers are medium adopter and only 10 percent large farmers are low adopter of fertilizer. Again, a majority of medium farmers, i.e., 45 percent belong to the medium level adoption group. In the case of medium farmers, 37.5 percent and 17.5 percent fall in the group of high and low adopters respectively. But in case of small farmers of tribal category as high as 50 percent is low adopter of fertilizer and 20 percent are high adopters. Therefore, it is evident that majority of the sample farmers were medium and low adopters. Moreover, adoption rate of fertilizer was not uniform across large, medium and small farmers of tribal category.

It can be concluded that majority of the farmers in the large and medium categories use medium amount of fertilizer whereas majority of the small farmers, i.e., 50 percent are low adopter of fertilizer. The main reasons for low adoption of fertilizer as stated by sample farmers during field survey are:

(i) Poor economic condition;

(ii) Lack of irrigation facility particularly during rabi season;

(iii) Inadequate supply arrangement of fertilizer in some areas etc.

It was also found from field investigation that a very small number of tribal farmers follow recommended dose of fertilizer. As dose recommendation practice majority of the sample farmers reported that they followed the advice of some progressive farmers and inputs suppliers. Tribal farmers are more dependent on other than public extension system for getting technical advice as well as faring inputs.

4.8 Adoption of Plant Protection Measure

Plant protection measures also constitute an important segment of modern agricultural technology. While improved irrigation, high-yielding varieties, fertilizers, agro-chemicals are the basic inputs to increase agricultural productivity, plant protection measures are required to save the crops in the field from the ravages of pests and diseases. It is a common experience that pests and diseases can damage large quantity of crops if adequate preventive and curative measures are not taken in time. Increasing crop loss due to pests is a major constraint in sustaining agricultural production and productivity. The potential yield loss worldwide due to weeds, diseases and pre and post-harvest pests is estimated at 45 percent (Gwo-Chen-Li, 1999). In India, on an average, 33 percent of crop loss occurs due to pests and diseases (Puri et al, 1999) and runs to an estimated Rs. 200 billion (Sing, 1999).

Pesticide is an essential ally in the farmers' struggle to protect their crops. Despite pesticide use, loss throughout the production system remains high. The incidence of pests and diseases on different crops has been estimated by Pesticide Association of India to be about 18 percent of the cropped area in India. The losses caused by the plant diseases and pests are shown in Appendix V.

Pesticide consumption in India is 288 g/ha which is low compared with a global average of 900 g/ha (Agnihotri, 2000). However, consumption has not been uniform in the country and it varies with the intensity of pests and diseases, cropping pattern and agro-ecological regions. Pesticide use is high in regions with good irrigation facilities and in areas where commercial crops are grown. For instance, cotton and paddy are grown in 5 percent and 24 percent of cropped area and receive about 45 percent and 20 percent of total pesticides respectively (Shetty, 2004).

Since HYV technology involves high cost of production and hence under such condition one cannot afford to lose his crops. The application of higher doses of fertilizer promotes vegetative growth of weeds and increase vulnerability of those for the attack of pests and diseases.

In Assam, climate being more humid, chances of incidence of pests and diseases in HYV crops are greater in comparison with semi-arid regions like Haryana and Punjab. But consumption of pesticides is not very encouraging in Assam. During field survey, attempt was made to find out the level of adoption of plant protection measures by both non-tribal and tribal farmers of different group sizes. The following Table shows the distribution of farmers on the basis of their adoption of plant protection measures.

Table 4.23 Distribution of Farmers (non-tribal) on the Basis of Their Adoption of Plant Protection Measures

Category of farmers	No. of households	Level of adoption		
		High	Medium	Low
Large farmers	40	26 (65.00)	8 (20.00)	6 (15.00)
Medium farmers	40	25 (62.5)	9 (22.5)	6 (15.00)
Small farmers	40	10 (25.00)	14 (35.00)	16 (40.00)
Total	**120**	**61(50.83)**	**31 (25.83)**	**28 (23.33)**

Note: High: 100 percent recommended dose;
Medium: 50 percent and above but below 100 percent of recommended dose;
Low: Below 50 percent of recommended dose.
Figures in the parentheses imply percentages.
Source: Field Survey, 2004

An examination of Table 4.23 reveals that out of 120 non-tribal sample respondents, only 61, i.e., 50.83 percent of farmers adopted high level of plant protection measures. It is due to their better economic condition and better knowledge of plant protection measures. Among the large farmers, 20 and 15 percent respectively are medium and low adopters. In the case of medium farmers as high as 62.5 percent are high adopters while 22.5 and 15.00 percent are medium and low adopters. So, there is no significant difference between large and medium farmers. But in the case of small farmers, majority of them, i.e., 35.00 and 40.00 percent are medium and low adopters. This might be due to their lack of knowledge, lack of education, lack of risk taking ability etc. High cost of plant protective chemicals is another important reason for low and medium level of adoption. It appeared from field investigation that many of the high level adopters belong to servicemen and business categories. They do not suffer from lack of finance. Moreover, being educated they can apply plant protection chemicals efficiently.

4.9 Adoption of Plant Protection Measure by Tribal Farmers

About 80 percent of the tribal population (Bodo population) depends upon agriculture as occupation and hence it is the mainstay of livelihood. As such they cannot afford to expose their crops to pests and diseases. During field survey, tribal farmers were also found to adopt plant protection measures. The Table 4.24 shows the adoption of plant protection measures by tribal farmers.

Table 4.24 Distribution of Farmers (Tribal) on the Basis of Their Adoption of Plant Protection Measures

Category of farmers	No. of households	Level of adoption		
		High	Medium	Low
Large farmers	40	23 (57.50)	9 (22.50)	8 (20.00)
Medium farmers	40	15 (37.50)	18 (45.50)	7 (17.50)
Small farmers	40	7 (17.50)	15 (32.50)	18 (45.00)
Total	**120**	**45(37.50)**	**42 (35.00)**	**33 (27.50)**

Note: High: 100 percent recommended dose;

Medium: 50 percent and above but below 100 percent of recommended dose;

Low: Below 50 percent of recommended dose.

Source: Field Survey, 2004

An examination of Table 4.24 reveals that out of 120 sample respondents, only 45, i.e., 37.5 percent of tribal farmers adopted high level of plant protection measures and the remaining 35.00 and 27.5 percent farmers are respectively medium and low adopters.

It also appears from the Table that majority of the large farmers, i.e., 23 out of 40 (57.5%) are high adopters of plant protection measures. It is due to their better economic condition. Among the large farmers, 22.5 and 20.0 percent respectively are medium and low adopters. In the case of medium farmers, only 37.5 percent are high adopters while 45.0 and 17.5 percent are medium and low adopters. In the case of small farmers, a majority of them, i.e., 45 percent are low adopters, only 17.5 and 32.5 percent of them are high and medium adopters respectively which is almost identical with adoption behaviour of non-tribal small farmers. On the basis of the Table, it can be concluded that there is not much difference between tribal and non-tribal farmers in respect of adoption of plant protection measures. The only difference is that since majority of tribal farmers use traditional variety on major parts of their cultivable land, it is medium and low level adoption of plant protection measures that can save their crops from pests and diseases and hence majority of the tribal farmers are found in the group of medium and low adopters.

Another important aspect as was found during field investigation is that unlike non-tribal farmers, tribal farmers do not use over dose of pesticides as means of plant protection measure.

Plant protection is a highly capital intensive as well as labour intensive measure. For successful operation of the measure, a well knit organization from research centre to the field is essential, supported with adequate field staff, sufficient number of machines, transport facilities and adequate quantity of pesticides and insecticides. Incentive should be provided in the form of subsidy for the purchase of plant protection chemicals and equipments.

A majority of the respondents considered that the use of pesticides brings down the pest population and thereby increases crop yield by about 30 –50 percent. However, they are of the opinion that the prescribed doses in the package of practices are not effective in controlling pests and diseases. The problem of pest resurgence in plants has increased over the years. This has provoked farmers not only to use a higher dose and increase the frequency of application of pesticides but also to resort to combinations of insecticides.

The pro-active approach and extensive network of pesticide companies help in popularizing and promoting pesticides in rural areas. It appeared from our field investigation that the dealers promote the products of those companies that give maximum incentives. Besides, unlicensed dealers and retailers who are not completely aware of the toxicity of pesticide also sell them. This uncontrolled marketing has escalated pesticide misuse in some areas. Interaction with some of the pesticide dealers revealed that actual pesticide consumption was higher than the available figures in the government department. The Insecticide Act specifies that every dealer should display the stock of the product that are being sold and should provide details of actual sales and turnover. However, most pesticide dealers are found, trying to hide the facts regarding the purchase of pesticides from within or outside the state in order to avoid taxes. In addition, it could also found that banned pesticides like DDT and BHC are still being sold and used for agricultural purpose. The sale of spurious or substandard pesticides of local companies is also flourishing in the study region. The sale of such pesticides is not recorded in the logbook either.

Continual and excessive use of pesticides has disturbing consequences on agro-ecosystem and human health. One of the important pesticide-induced problems was reported by some sample farmers during field investigation, is the development of resistance by the insect pests. Pesticides resistance is a dynamic phenomenon dependent on biochemical, physiological, genetic and ecological factors (Mehrotra, 1992). Resistance development is higher with pests having shorter life cycles (Agnihotri et al, 1999). Another problem associated with use of insecticide over a long period is the development of cross-resistance in insect pests. It is generally observed that when an insect develops resistance to a particular insecticide, it automatically becomes resistant to all other insecticides having the same target or activity. Globally, about 504 insects and mites, 150 plant pathogens and 273 weeds are known to have developed resistance (Shetty, 2004). Large scale and repeated application of pesticides have led to the development of resistance in these pests. In addition, delayed rains and changes in climatic conditions are also identified as causes for resurgence of insect pests. It was reported that application of sub-lethal doses of insecticides brings about changes in reproduction cycles of insect pests leading to their resurgence (Chelliah, 79). Pesticides are potent poisons and have adverse effects on any organism having physiological functions similar to the target organisms. Some pesticides have greater detrimental effect on non-target organism than on target organisms. With the present pesticide use pattern, the sustenance of non-target organisms, that is, beneficial organisms, natural enemies of pests, parasites and pollinators are greatly jeopardized. Pesticides that reach water bodies as runoff kill fish, water bugs, snails and aquatic plants which are a part of the food web and play an important role in maintaining eco-balance. Overuse of pesticides has brought about a decline in the biodiversity of non-target organisms in our study area. About 40 percent of the respondents in the study area reported a significant decline in the population of beneficial organisms. According to them, the population of natural enemies of pests like Chrysoperla carnea, ladybird beetles, green lace-wings, spiders and parasitoids like Apanteles spp, Trichogramma spp and Chelonus black burni, have come down drastically in the past few years. The respondents also said that a significant decline in population of birds and earthworms was noticed in the fields treated with pesticides. Some of the major socio-ecological concerns among farmers include the declining population of beneficial organisms, natural enemies of pests and also the increased expenditure on synthetic pesticides.

A majority of the farmers do not follow any recommended safety measures while handling pesticides, such as wearing gloves, shoes, facemask and other protective clothing. They found these protective measures uncomfortable in the hot weather and also as a hindrance to their work. In addition, the excessive sweat due to the heat may result in dermal absorption of pesticides. It is also observed that some farmers take up spraying activities in the hot sun and irrespective of wind direction. Many farmers who take up spraying reported that they often faced problems of headaches, dizziness, nausea, nasal discharge, skin and eye irritation while handling and spraying pesticides. And these are due to the unhealthy practices of pesticide use.

Integrated Pest Management (IPM) is a widely adopted alternative plant protection model. It is more effective, safer and economical. Biopesticides form an integral part of IPM. In 1999-2000, 874 metric tones of biopesticides (Neem and Bt) were used in India. However, the IPM programme covered only 1 percent of the total 143 mm ha. of cropped area and only 2500 villages out of over 6 lakh in the country (Singhal, 2000). Biopesticides like Neem, NPV formulations and herbal pesticides are gaining importance in many states of India. Therefore, efforts should be made to initiate and popularize biopesticide and herbal pesticides in the study area. For this purpose establishment of IPM units or cells in the study area will help to monitor crop pests on a day to day basis and also provide information about the economic threshold level. Unemployed-educated youth need to be encouraged to participate in IPM activities and to produce IPM inputs at the village level as a cottage industry, by providing them with necessary assistance and training. Pest and natural enemy identification kits should be provided to farmers in the form of photographs.

The government needs to stipulate a certain educational qualification, either a diploma or a degree, for distributors and retailers in order to obtain a license for trading agro-inputs, as they closely interact with farmers and often provide information related to agriculture. Besides, they also need to undergo regular training on development in agriculture particularly on plant protection. The government also needs to make an effort to improve pest related surveillance and forecasting, location specific spray schedules to optimize pesticide use. Pesticide application methods in pace with the development of technology, labeling of the products in local languages and also effective regulation of pesticide trade. Only registered pesticide companies could be authorized to market the products. Through regular checks and strict legislation, marketing of spurious or substandard chemicals can be prevented.

The pesticide industry needs to promote chemicals that are not only effective but also environmentally safe. It is observed that company representatives have established an extension network with some progressive farmers in the study area. It is evident from the fact that a sizeable number of respondents in the study area are dependent on either company representatives or dealers for information on plant protection. This network can be used for regular flow of pesticide stewardship information. In addition, regular checks are required to prevent the sale of outdated pesticides.

It is important that farmers follow safety norms while handling pesticides and also rotate the use of pesticides with safe information in order to avoid the development of resistance by insect pests. Efforts should be made for the timely application of pesticides and in appropriate doses. Care need to be taken to prevent the clogging of sprayer nozzles to ensure the application of appropriate quantity and uniform spraying of pesticides. The need of the hour is transformation from chemical based farming practice to eco-friendly alternatives, such as diversification in cropping pattern, crop rotation, inter-cropping, integrated pest and disease management, integrated nutrient management and increasing use of green manure in fields. Mixed cropping will discourage monoculture without disturbing the yield or profits by encouraging the activities of natural enemies of pests and also reduce the dependence on extensive and hazardous chemical inputs.

4.10 Credit and New Agricultural Technology

The introduction of new agricultural technology since the middle of 1960s has increased the financial involvement of farming in a number of ways. The new technology in essence consists of the use of high yielding variety (HYV) seeds, which besides giving higher yield than traditional varieties, and generally photoperiod sensitive and take shorter duration for maturing. But full utilization of potentials of these seeds requires application of chemical fertilizer and irrigation. Moreover, being more delicate than the traditional varieties, the new varieties require better watching, care and protective measures during the entire course of the crops. This is, in turn, increases the requirement of pesticides and weedicides and also of labour in plant protection operations. Hence to adopt new technology, farmers require larger working capital for inputs, such as HYV seeds, fertilizers, pesticides etc. and also for meeting energy costs, water charges etc. required for such operations as irrigation and drainage.

The requirement of working capital may also increase because of the fact that the new technology is likely to encourage farmers to increase their cropping intensity for acquiring the flow inputs, i.e., seed, fertilizer, labour etc.

Besides, increasing the working capital requirement of farming, adoption of new agricultural technology also necessitates large fixed capital investment for such as preparation of land for irrigation and drainage installation and purchase of implements and machinery such as tractor, pumpsets, sprayer, weeder and so on.

Since bulk of farmers are marginal and small farmers and a vast majority of them are poor, the process of transfer of agricultural technology, which involve larger injection of both working and fixed capital investment into the farming sector, cannot be expected to make much headway without sizeable expansion in the institutional credit support for agriculture. Lack of adequate institutional credit in the present economic system, has therefore, been primarily responsible for slow transfer of agricultural technology.

With the nation following a new strategy of agricultural development since the late 1960s and the accompanying intensification of effects to strengthen institutional credit to the farm sector, the process of development of institutions of agricultural credit has taken place in the state of Assam too. Some institutions so far set up for providing agricultural loans and primary agricultural credit societies are Assam state Co-operative Banks, Primary Land Development Bank, a Central Land Development Bank, Nationalized Commercial Banks, Regional Rural Banks like Pragjyotish Gaonlia Bank, Lakshmi Goanlia Bank, Subansiri Gaonlia Bank, Langpi Denangi and Cachar Gramin Bank and lastly the National Bank of Agricultural and Rural Development (NABARD).

All these institutional development notwithstanding, institutional credit is yet to become a vehicle of overall agricultural development of the state. Institutional agricultural credit in Assam has been found to be very negligible since the inception of green revolution in India. Even in the last stage of post-green revolution (1977-78), total agricultural credit issued by financial institutions in Assam came to only Rs. 6/- per hectare of gross cropped area of the state, as compared to Rs. 134/- per hectare of gross cropped area of the country as a whole.

The following Table 4.25 shows the loan issued per hectare of gross cropped area in some states in India.

Table 4.25 Loan Issued Per Hectare of Gross Cropped Area in Some States in 1977-78

States	Amount (Rs.)	States	Amount (Rs.)
Kerala	343	West Bengal	110
Tamil Nadu	341	Orissa	75
Punjab	273	Rajasthan	60
Haryana	234	Jammu and Kashmir	56
Gujarat	178	Madhya Pradesh	52
Maharashtra	176	Bihar	47
Karnataka	164	Himachal Pradesh	38
Andhra Pradesh	162	Assam	6
Uttar Pradesh	125	**National Average**	**Rs. 134**

Of course agricultural credit situation in Assam has changed in recent years. But agricultural credit made available to farmers is still far from satisfactory and very low in comparison with other states of India. Banking facility in Assam is still inadequate and cannot cater to the increasing demand of farmers for agricultural loans throughout the districts of Assam. The following Table 4.26 shows the district-wise Bank and population per bank.

Table 4.26 District-wise No. of Bank (Commercial & Rural) and Population Per Bank, 1999-2000

Sl. No.	District	No. of Bank	Population per Bank	Sl. No.	District	No. of Bank	Population per Bank
1.	Dhubri	51	31104	13.	Tinsukia	75	15274
2.	Goalpara	53	15007	14.	Jorhat	76	13647
3.	Kokrajhar	39	24438	15.	Golaghat	64	15583
4.	Bongaigaon	40	24032	16.	Sibsagar	76	14222
5.	**Barpeta**	**86**	**19181**	**17.**	**Naogaon**	**120**	**18781**
6.	Nalbari	76	15921	18.	Morigaon	39	19525
7.	Kamrup	176	13528	19.	Cachar	87	16631
8.	Darrang	76	20345	20.	Hailakandi	24	22275
9.	Sonitpur	111	15275	21.	Karimganj	68	14479
10.	Lakhimpur	69	12962	22.	Karbi Anglong	88	8964
11.	Dhemaji	23	24782	23.	N.C. Hills	25	7180
12.	Dibrugarh	80	15512				
	Total				**Average-16360**	**1631**	**26683200**

Source: Population estimated on the basis of Expert Committee of Population Projection, Registrar General of India; Qtrly. Handout, RBI, 1999-2000; Statistical Handbook, Assam, 2000.

The above Table depicts that average population per Bank is more than 16 thousand which is higher than many states of India. Among the districts of Assam, two hill districts Karbi Anglong and N. C. Hills have better banking facilities in terms of population per bank. Among the plain districts Lakhimpur, Kamrup and Jorhat have more number of banks in terms of population per bank.

If we assess the credit situation in Assam in terms of only scheduled commercial banks, the credit situation seems to be more poor and deplorable in comparison to other states.

Table 4.27 Scheduled Commercial Banks (as on 31st March, 1993 and 1999) in Some States

State	1993		1999	
	No. of Banks per lakh of population	Per capita Bank credit (Rs.)	No. of Banks per lakh of population	Per capita Bank credit (Rs.)
Andhra Pradesh	9.03	1671.58	6.9	3496.00
Assam	5.46	580.25	4.9	876.00
Arunachal Pradesh	7.87	319.01	6.0	616.00
Bihar	5.67	499.22	5.2	809.00
Gujarat	6.29	2048.24	7.8	4207.00
Goa	22.23	5194.17	20.6	8797.00
Haryana	7.81	1706.67	7.6	3158.00
Himachal Pradesh	14.35	1139.86	12.0	1827.00
Jammu and Kashmir	10.30	1287.60	8.5	2847.00
Kerala	9.91	1961.15	10.3	4324.00
Karnataka	9.64	1270.80	9.3	4870.00
Madhya Pradesh	6.67	889.35	5.8	1638.00
Maharashtra	7.18	5085.27	7.5	11194.00
Manipur	4.63	482.54	3.6	784.00
Meghalaya	9.80	434.81	7.6	881.00
Mizoram	10.87	342.00	8.6	692.00
Nagaland	5.79	807.00	4.4	725.00
Orissa	6.71	756.18	6.3	1263.00
Punjab	10.69	2654.13	10.8	5471.00
Rajasthan	7.02	909.77	6.4	1791.00
Sikkim	8.12	727.75	7.8	1305.00
Tamil Nadu	7.82	2924.27	8.0	6793.00
Tripura	6.53	713.22	5.0	863.00
Uttar Pradesh	6.15	774.41	5.5	1185.00
West Bengal	6.23	1831.63	5.8	2967.00

Source: Quarterly Handout, R.B.I.; Statistical Handbook, Assam, 1994 & 2000 issues.

From the above Table 4.27, it is evident that per capita bank loan in Assam in 1993 was only Rs. 580.25 which was more among the north eastern states and Bihar but also lower than the most other states of India. In 1993, per capita bank credit was the highest in Goa (Rs. 5194.17) followed by Maharashtra (Rs. 5058.27), Tamil Nadu (Rs. 2924.27), Punjab (Rs. 2654.13), Gujarat (Rs. 2048.24) and other states. Per capita bank credit in Assam increased from Rs. 580 (1993) to Rs. 876 in 1999 which was marginal in comparison to other states. For example, per capita bank credit in Andhra Pradesh increased from Rs. 1671 in 1993 to Rs. 3496 in 1999, in Maharashtra, it increased from Rs. 5058 to Rs. 11194 in 1999, in Punjab, it increased from Rs. 2654 to Rs. 5471 in 1999. Except Assam and few other states, per capita bank loan increased by double or more than that during this period.

All the statistical figures relating to number of banks and availability of credit indicate that Assam has been receiving very inadequate institutional credit facility right from the beginning of green revolution and till the date. Institutional credit facility in Assam is one of the lowest among the Indian states. In the absence of adequate institutional credit facility, the cultivators in the study villages very often depend on non-institutional or informal sources for production and consumption loans. A section of private lenders are found to advance credit with a view to extract high rate of interest.

During field survey, it was also found that many farmers (both tribal and non-tribal) resorted to take loans from money lenders, traders and commission agents to tide over their temporary difficulties. Some private lenders are found to advance loan with a view to interlock the labour services or output of the borrowers. In many cases, it happens that borrowers fail to pay the interest and loan principal in due time and as remedial measure, they take money from the money lender keeping mortgage of their cultivable land and property. During field investigation, it was also found that many small and in some case medium farmers are losing out sizeable portion of their land and becoming the victims of non-institutional loans which are responsible for relative impoverishment of the poor farmers.

Findings of the field survey in relation to credit facility to both non-tribal and tribal farmers are presented in Table 4.28 and Table 4.29 respectively.

Table 4.28 Distribution of Various Groups of Non-tribal Farmers Having Accessibility to Credit Facility

Farm Size	Total No. of households	No. of farmers with Institutional credit	No. of farmers with Non-Institutional credit	No. of farmers with no credit facility
Small farmer	40	10(25.00)	12(30.00)	18(45.00)
Medium farmer	40	14(35.00)	6(15.00)	20(50.00)
Large farmer	40	22(55.00)	3(7.5)	15(37.5)
Total	**120**	**46(38.33)**	**21(17.5)**	**53(44.17)**

Source: Field Survey, 2004

Note: Figures in brackets show percentages.

The Table 4.28 shows that out of 120 sample farmers, 46, i.e., 38.33 percent had the access to institutional credit. Again, out of these 46 recipients, 22 were large, 14 were medium and 10 were small farmers. So, small and medium farmers are provided with less institutional credit facility. It is due to the asset based credit procedure and complex loaning process. It was large farmers who were found getting more institutional credit and it was due to their large asset base and better knowledge of loan schemes.

The Table also shows that small farmers are more dependent on non-formal sources of loans for which they have to pay exorbitant rate of interest.

Due to the poor economic condition and inadequacy of institutional agricultural credit that most farmers, particularly small and medium farmers cannot afford to adopt improved agricultural technology.

4.11 Tribal Farmers and Agricultural Credit

Table 4.29 Distribution of Various Groups of Tribal Farmers Having Accessibility to Credit Facility

Farm Size	Total No. of households	No. of farmers with Institutional credit	No. of farmers with Non-Institutional credit	No. of farmers with no credit facility
Small farmer	40	5(12.50)	12(30.00)	23(57.50)
Medium farmer	40	8(30.00)	12(30.00)	20(50.00)
Large farmer	40	14(35.00)	1(2.5)	25(62.5)
Total	**120**	**27(22.50)**	**25(20.83)**	**68(56.67)**

Source: Field Survey, 2004

Note: Figures in brackets show percentages.

Table 4.29 shows that out of 120 tribal sample farmers, only 27, i.e., 22.5 percent had access to institutional credit. Again, out of 27 recipients, 14 were large, 8 were medium and only 5, i.e., 12.5 percent were small farmers. On the other hand, number of non-tribal households with institutional credit was 46, i.e., 38.33 percent of which 22 were large, 14 were medium and 10 were small farmers. Therefore, non-tribal farmers have more accessibility to institutional credit facility than tribal farmers. The Table also depicts that it was again small and medium farmers who were provided with less institutional credit facility. Number of farmers with institutional credit was 25, i.e., 20.83 percent which was greater than non-tribal farmers (21). Therefore, it can be concluded that tribal farmers are lagging behind the non-tribal farmers in terms of accessibility to institutional agricultural credit facility and to a considerable context they are still dependent on non- institutional credit for which they have to pay high rate of interest. The main reasons as was found during the filed investigation are (i) illiteracy, (ii) lack of information, (iii) complex loaning procedure and insurgency problem which debar tribal farmers, particularly small and medium farmers raising institutional credit for agricultural operations.

Due to inadequacy of institutional agricultural credit, poor economic condition and lack of information that many tribal farmers cannot afford to adopt improved agricultural technology.

4.12 Education and Adoption of Agricultural Technology

Agricultural productivity is directly related with the technology adoption and technology adoption by individual farmers and its diffusion on a large scale are influenced by the education of the individuals of the society. There is increasing evidence and recognition that the capacity of people to be effective and productive-economic agent, in short, human capital, counts more significantly in the development (Schültz, 1981). In fact, the resource development requires, among other things, considerable investment in education, health and nutrition. The better the education the better well fed the people, and the better their health, the better would be the capacity, capability and appreciation of the human beings to be better productive economically. Education enhances the farmers' capacity to maximize the perceived profit function by allocating the resources in a more effective cost-efficient manner by choosing which and how much of each output to produce and in what proportion to use the inputs (Janison and Mook, 1984). The central theme of the allocation effect lies in evaluating and adopting the more profitable new technologies. The worker effect includes the ability to perform agricultural operations more effectively in the economic sense. It is translating the allocative efficiency into production efficiency. The increased capability to process and apply the information is seen through lowering the marginal costs and raising the marginal benefits with the given set of inputs. Education also facilitates the more rapid entrepreneurial adjustment, to changes in output and input prices, input availabilities/constraints and new opportunities etc.

Educated farmers irrespective of caste and creed are found to have more positive attitude towards the adoption of new agricultural technology than the uneducated farmers. High level of literacy would enable the farmers to improve efficiency of farming also and it would enable them to be more scientific in the application of various inputs.

There are many farm level production function studies with education of the farmer as one of the explanatory variables. These studies show that the level of farm production is significantly higher on farms where the decision maker is literate than where the decision maker is illiterate. A Study covering 31 countries concluded that if a farmer had completed 4 years of elementary education, his/her productivity was on an average 8.5 percent higher than that of a farmer who had not education at all. (Planning Commission, 2002: 49). This was reported for Haryana where it was also found that the impact of the level of education on farm production is relatively strong with secondary education and weak, though positive, with both primary and middle education (Singh, 1974). The percentage increase in farm production at geometric mean level of other inputs due to the literacy was found to be 19.1 percent; it was 15.1, 17.1 and 47.9 percent if the farmers had primary, middle and secondary level education respectively. This underlines the importance of formal education upto a minimum of secondary level that can change farmers' production behaviour. Similarly, the profit functions for farm level data for paddy in Tamil Nadu also showed that the educated farmers are technically and allocatively more efficient and that the contact with the extensive service significantly increases profit (Puraisamy, 1988). Field survey revealed that the educational status of farmers was significantly related with the adoption of new agricultural technology. It can be inferred from the findings of the field survey that higher the level of education, greater is the adoption of new agricultural technology among large, medium and small farmers. This might be due to the fact that level of education changes the outlook of the farmers and makes them more responsive to agricultural technology. The persons with higher level of education can understand and catch the new ideas easily and early and act accordingly.

The following Table 4.30 depicts the distribution of non-tribal respondents in respect of education and attitude towards adoption of new agricultural technology.

Table 4.30 Distribution of Non-tribal Respondents on the Basis of Education and Attitude Towards Adoption of New Technology

Level of Education	Large Farmers N=40		Medium Farmers N=40		Small Farmers N=40		Total
	Favourable	Unfavourable	Favourable	Unfavourable	Favourable	Unfavourable	
Illiterate	10 (25.00)	1 (2.5)	10 (25.00)	5 (12.5)	10 (25.00)	13 (32.5)	49
Primary level	10 (25.00)	0 (0.0)	7 (17.5)	2 (5.00)	4 (10.00)	6 (15.00)	29
High School level	9 (22.5)	0 (0.0)	8 (20.00)	2 (5.00)	2 (5.00)	1 (2.5)	22
Higher Secondary level	5 (12.5)	0 (0.0)	3 (7.5)	1 (2.5)	2 (5.00)	0 (0.0)	11
Graduate level	5 (12.5)	0 (0.0)	2 (5.00)	0 (0.0)	2 (5.00)	0 (0.0)	9
Total	**39 (97.5)**	**1 (2.5)**	**30 (75.00)**	**10 (25.00)**	**20 (50.00)**	**20 (50.00)**	**120**

Source: Field Survey, 2004

Note: Figure in parentheses indicate percentage of total respondent in each farm size

Proper scanning of the above Table makes it clear that farmers with higher level of education have more positive attitude towards new agricultural technology. Out of 40 sample large farmers, 39 have favourable attitude towards agricultural technology and out of these 39 farmers, only 10 are illiterate and the remaining 30 farmers are educated of which 5 have higher secondary level and 5 have graduate level of education. This shows that 97.5 percent large farmers have positive attitude towards new technology of which only 25.00 percent respondents are illiterate. It also appears from the Table that only one large farmer has unfavourable attitude who is illiterate.

In case of medium farmers, out of 40, 7 have primary level, 8 have high school level, 3 have higher secondary level and 2 have graduate level of education. It is seen that 30 medium farmers, i.e., 75.00 percent medium farmers have favourable attitude towards agricultural technology in which share of illiterate farmers is 25.00 percent.

In case of small farmers, out of 40 respondents, 20, i.e., 50.00 percent have positive attitude towards new agricultural technology in which share of illiterate farmers is 50.00 percent. It is also clear that 2.5 percent illiterate large farmers, 12.5 percent illiterate medium farmers and 32.5 percent illiterate small farmers have negative attitude towards new agricultural technology. The Table shows that some educated farmers have no positive attitude towards agricultural technology. But their percentage is very small. For example, only 5, i.e., 12.5 percent educated medium farmers and 7, i.e., 17.5 percent literate small farmers have negative attitude and prefer non-farm activities. The most important finding is that farmers of all categories having education level of higher secondary and graduate have the highest positive attitude towards adoption of new technology with one exception in case of medium farmers. It appears from the Table that out of 20 farmers of all categories having education level of higher secondary and graduate, 19 farmers, i.e., 95.00 percent have positive attitude towards adoption of new technology in agriculture.

The above findings clearly show that level of education of farmers is an important factor determining the adoption of modern agricultural technology. Of course, mere education of farmers, as reported by many respondents, cannot make the adoption of technology a realization until and unless it is supported by financial capacity. Over and above the level of education, economic status of farmers play an important role in reference to the adoption of modern technology in agriculture. But given the economic status higher the level of education of farmers higher is the level of adoption of technology.

Table 4.31 Distribution of Tribal Respondents on the Basis of Education and Attitude Towards Adoption of New Technology

Level of Education	Large Farmers N=40		Medium Farmers N=40		Small Farmers N=40		Total
	Favourable	Unfavourable	Favourable	Unfavourable	Favourable	Unfavourable	
Illiterate	2 (5.00)	14 (35.00)	1 (2.5)	16 (40.00)	1 (2.5)	18 (45.00)	52
Primary level	3 (7.5)	6 (15.00)	2 (5.00)	6 (15.00)	2 (5.00)	7 (17.50)	26
High School level	2 (5.00)	3 (7.5)	2 (5.00)	4 (10.00)	2 (5.00)	5 (12.5)	18
Higher Secondary level	3 (7.5)	2 (5.00)	2 (5.00)	4 (10.00)	2 (5.00)	2 (5.00)	15
Graduate level	4 (10.00)	1 (2.5)	3 (7.5)	0 (0.0)	1 (2.5)	0 (0.0)	9
Total	**14 (97.5)**	**26 (2.5)**	**10 (75.00)**	**30 (25.00)**	**8 (50.00)**	**32 (50.00)**	**120**

Source: Field Survey, 2004

Note: Figure in parentheses indicate percentages of total respondent in each farm size

A close examination of the above Table 4.31 makes it clear that farmer with education have more positive attitude towards new technology in agriculture. Out of 120 tribal sample farmers, 68 farmers are literate of which 28, i.e., 41.18 percent have positive attitude towards new agricultural technology. On the other hand, out of 120 sample farmers, number of illiterate farmers are 52 of which only 4, i.e., only 7.69 percent have adopted modern agricultural technology. It is evident from the Table, total farmers with higher level of education have more positive attitude towards new agricultural technology. For example, in the Table, total number of farmers having primary and high school level of education is 44 of which 13, i.e., 29.55 percent have favourable attitude towards new agricultural technology. On the other hand, total number of farmers having higher secondary and graduate level of education are 24 of which 15, i.e., as high as 62.5 percent have favourable attitude to new agricultural technology. Therefore, the hypotheses that level of education is positively related with the adoption of new agricultural technology is testified in case of both non-tribal and tribal farmers.

But distinctions between non-tribal and tribal farmers are that (i) tribal farmers are more illiterate (52) in comparison to non-tribal farmers (49); (ii) educated tribal farmers are not as much receptive to new agricultural technology as educated non-tribal farmers. For example, out of 24 tribal farmers with higher secondary and graduate level education, only 15, i.e., 62.5 percent have favourable attitude. On the other hand, out of 20 non-tribal farmers having higher secondary and graduate level education as high as 19, i.e., 95 percent have favourable attitude towards new agricultural technology.

The reasons of educated tribal farmers of being less responsive to new agricultural technology, as was found during field investigation, are:

(i) Lack of effective dissemination of new agricultural technology among the tribal farmers. It was reported, duding field survey, that many farm households; in particular any frontline extension worker for dissemination purpose did not reach the resource poor tribal households.

(ii) Many tribal farmers, even some educated farmers were found to be reluctant to shift from traditional mode of production due to their affinity for age old customs and traditions.

(iii) Lack of financial support, and

(iv) Insurgency problem.

Bodo people in Assam have been demanding a separate state (Bodoland) for them for more than two decades. They are demanding separate land through various organizations such as All Bodo Student Union (ABSU), National Democratic Front of Bodoland (NDFB), Bodoland Liberation Tiger (BLT) etc. Some of these organizations, particularly NDFB and BLT, are rebel organizations and they are resorting to armed struggle. These rebel organizations are involved in various kinds of anti-social activities such as killing, kidnapping exortion etc. Till the date these insurgent groups are serving notices for extortion to collect money for procurement of arms and ammunitions in a bigger way. The worst affected people are the resourceful persons who have to pay large sum of money periodically to the various insurgent groups. Such activities have affected not only the law and order situation in Bodo dominated area but also hampering economic activities to a large extent. Basically most of the people in Bodo dominant area are suffering from a sense of insecurity and frustration. Investment in any economic activity is definitely to be hampered irrespective of any enterprise.

4.13 Age and Adoption of Agricultural Technology

The age composition of the population is one of the important variables influencing the adoption of new agricultural ideas and practices. Basically age of a person has some important bearings on his decision making exercise. Agriculture is no exception to this. The younger generation tends to adopt new ideas and practices quickly as compared to the older generation who are conservative and resist adoption of new innovations. The research question in this connection is to what degree the younger farmers (both tribal and non-tribal) are more prone to the adoption of agricultural technology than the older farmers. Keeping in mind this research question, an attempt was made during filed investigation as to whether age factor has any bearing on the adoption of new agricultural technology. Findings of field investigation in this regard are presented in the Table 4.32.

Table 4.32 Distribution of Non-Tribal Respondents on the Basis of Age and Attitude Towards Adoption of New Agricultural Technology

Age	Large Farmers N=40		Medium Farmers N=40		Small Farmers N=40		Total
	Favourable	Unfavourable	Favourable	Unfavourable	Favourable	Unfavourable	
Young Age 20-30	6 (15.00)	0 (0.00)	7 (17.50)	1 (2.50)	6 (15.00)	1 (45.00)	21
Middle Age 31-50	20 (50.00)	2 (5.00)	14 (35.00)	3 (7.50)	19 (47.50)	2 (17.50)	60
Old Age 50 and above	6 (15.00)	6 (15.00)	13 (32.50)	2 (5.00)	6 (15.00)	6 (15.00)	39
Total	**32 (80.00)**	**8 (20.00)**	**34 (85.00)**	**6 (15.00)**	**31 (77.50)**	**9 (22.50)**	**120**

Source: Field Survey, 2004

Note: Figure in parentheses indicate percentages of total respondent in each farm size

It appears from the Table 4.32 that out of 120 non-tribal respondents, majority of them, i.e., 97 (32 large, 34 medium and 31 small farmers) have favourable attitude for new agricultural technology. It is evident from the data that 15.00, 5.00 and 15.00 percent of large farmers having young age, middle age and old age respectively have favourable attitude for adoption of improved technology in agriculture. The percentage of medium farmers having positive attitude are 17.5, 35.00 and 32.5 in young, middle and old age categories respectively. In the case of small farmers, out of 40 respondents, 34 farmers are having positive attitude in which 15.00, 47.5 and 15.0 percent young, middle and old age categories respectively have positive attitude toward adoption of new technology in agriculture.

The percentage of non-tribal farmers having favourable attitude in large, medium and small farmers are 20.00, 15.00 and 22.5 respectively. Out of this, most of them 75.00, 5.00 and 15.00 percent in large, medium and small farmers group respectively are in old age group of more than 50 years. This clearly indicates that old age farmers are les receptive to new agricultural technology and are not willing to take risk.

Table 4.33 Distribution of Tribal Respondents on the Basis of Age and Attitude Towards Adoption of New Agricultural Technology

Age	Large Farmers N=40		Medium Farmers N=40		Small Farmers N=40		Total
	Favourable	Unfavourable	Favourable	Unfavourable	Favourable	Unfavourable	
Young Age 20-30	4 (10.00)	2 (5.00)	5 (12.50)	3 (7.50)	3 (7.50)	4 (10.00)	21
Middle Age 31-50	16 (40.00)	6 (15.00)	10 (25.00)	7 (17.50)	15 (37.50))	6 (15.00)	60
Old Age 50 and above	4 (10.00)	8 (20.00)	10 (25.00)	5 (12.50)	4 (10.00)	8 (20.00)	39
Total	**24 (60.00)**	**16 (40.00)**	**25 (62.50)**	**15 (37.50)**	**22 (55.00)**	**18 (45.00)**	**120**

Source: Field Survey, 2004

Note: Figure in parentheses indicate percentages of total respondent in each farm size

It is obvious from the Table 4.33 that out of 120 tribal respondents as many as 71 of which 24 large, 25 medium and 22 small farmers have favouravle attitude for new agricultural technology. The Table also shows that 10.00, 40.00 and 10.00 percent of large farmers having young age, middle age and old age respectively have favouravle attitude for adoption of new technology in agriculture. As against this as many as 97 non-tribal farmers (32 large, 34 medium and 31 small farmers) had favouravle attitude which are more than tribal farmers. The percentage of medium farmers having favouravle attitude are 12.5, 25.50 and 25.00 in young, middle and old age group respectively while it is 17.5, 35.00 and 32.5 in case of non-tribal farmers. Again, in case of small farmers, out of 40 tribal respondents, 22 farmers in which 7.5, 37.5 and 10.00 percent young, middle and old age respectively have positive attitude towards adoption of new technology in agriculture while it is 15.00, 47.5 and 15.00 percent in case of non-tribal farmers. Therefore, as is evident from the Table 4.33 that though tribal farmers, as a whole, are less responsive to new agricultural technology in comparison to non-tribal farmers, it is middle age (31-50) farmers who are found more receptive to agricultural technology.

The percentage of tribal farmers having favourable attitude in large, medium and small farmers are 40.00, 37.5 and 45.00 respectively while it is 20.00, 15.00 and 22.5 percent in case of non-tribal farmers. It is also evident from the Table that middle age farmers of all categories are more receptive to agricultural technology than old age and young farmers.

It cannot be inferred from the Table 4.32 and 4.33 that though farmers of all age groups have favourable attitude, but it is middle age farmers (both tribal and non-tribal), between the age group of 31 to 50, who have the highest receptive attitude towards new agricultural technology. Of course, the Table 4.32 and 4.33 show that young and old farmers are not lagging behind much in comparison to middle age farmers. Since the new agricultural technology is more productive and remunerative, young and old age farmers are also becoming more receptive towards new technology. The findings of Pandey and Prasad (1978) in these regards are also in accordance with the findings of the present investigation.

4.34 Summary of Results and Discussion

Let us now summarize the findings of the study obtained through field investigation. In this section, we have made an attempt to ascertain the comparative position of non-tribal and tribal farmers in respect of adoption of various components of modern agricultural technology in a tabular form. The Table 4.34 explains the comparative position of tribal and non-tribal farmers in respect of adoption of agricultural technology.

Table 4.34 Comparative Position of Tribal and Non-Tribal Farmers In Respect of Adoption of Agricultural Technology

Sl. No.	Components of Agricultural Technology	No. of Adopter Respondents		Percentage of Advantage of Non-tribal farmers over tribal farmers (2-3)%
		Non-tribal Farmers N=120	Tribal farmers N=120	
1.	High Yielding Variety of Seeds (HYV)	90 (75.00)	29 (24.17)	50.83
2.	Land used for HYV seeds Total land Non-tribal farmers =1425 bighas Tribal farmers = 1747 „	605 (42.46)	126 (7.21)	35.25
3.	Agricultural Implements			
	a) Tractor	8 (6.67)	2 (1.17)	25.00
	b) Power Tiller	13 (10.83)	12 (10.00)	0.83
	c) Pumpsets	62 (51.67)	54 (45.00)	6.67
	d) Thresher	Nil	Nil	Nil
	e) Spray Machines	85 (70.83)	62 (51.67)	19.16
4.	Irrigation (Irrigated land in bigha)	578 (40.56)	597 (34.17)	6.39
5.	Fertilizer			
	a) High Adopter	53 (44.16)	39 (32.5)	11.66
	b) Medium Adopter	38 (31.67)	50 (41.67)	-10.00
	c) Low Adopter	29 (24.17)	31 (25.83)	-1.66
6.	Plant Protection Measures			
	a) High Adopter	61 (50.83)	45 (37.50)	13.33
	b) Medium Adopter	31 (25.83)	42 (35.00)	9.17
	c) Low Adopter	28 (23.33)	33 (27.50)	4.17

Source: Compiled from information obtained by field survey, 2004

Note: Figures within parentheses are percentages

A close look on the Table 4.34 makes it clear that the non-tribal farmers are in advantageous position in respect of adoption of all the components of agricultural technology. The most important finding, which is evident from the Table 4.34, is that the tribal farmers are lagging far behind in adoption of HYV technology. Adoption of HYV seeds are much more higher in case of non-tribal farmers than tribal farmers and this explains more pronouncedly why production and productivity is lower among the tribal farmers.

CHAPTER 5

FACTORS AND CONSTRAINTS AFFECTING ADOPTION OF NEW AGRICULTURAL TECHNOLOGY

5.1 Introduction

This chapter was based on farm level data collected personally from 12 villages of 6 Development Blocks of Barpeta District of Assam. The data were collected through a questionnaire prepared in consultation with the supervisor of the study. The data were relating to the households of different size group of farmers namely large, medium and small farmers of both non-tribal and tribal category. The distribution of adopter households is not uniform across the size groups of farm households. It was observed from field survey that there are some factors which are mainly responsible for the adoption of new technology in agriculture.

These factors are:

1. There is a positive relation between farm size and adoption of agricultural technology. The greater the size of farm the higher is the adoption rate of new agricultural technology.

2. Income of the farmer is the main factor affecting the adoption of new agricultural technology. It is an important decision making factor in relation to adoption or non-adoption of new technology in agriculture. Income of the farmers is positively correlated to the adoption of new technology for all groups of farmers.

3. It was observed from field investigation that risk bearing ability of the farmers is an important factor for the adoption of new technology in agriculture.

4. Irrigation facility is an important factor for the adoption of new technology in agriculture. Most of the sample farmers particularly non-tribal farmers reported that lack of adequate and timely supply of assured water is the main

obstacle in adoption of modern agricultural technology.

5. Field survey showed that use of fertilizer especially chemical fertilizers (NPK) is extremely essential for adoption of HYV seed which constitutes an important part of modern agricultural technology. Therefore, fertilizer is an important factor affecting adoption of modern technology in agriculture.

6. Credit facility, particularly institutional credit facility also affects the adoption pattern of agricultural technology by the farmers. Farmers who got credit facility were found to be more responsive to the adoption of improved agricultural technology.

7. Education level of the respondents was found to be positively related to the adoption of modern technology. It was found that respondents who are office holders or learned persons are more responsive towards the adoption of new technology since they have direct contact with extension workers and development agencies at block offices.

8. Field study made it clear that market price of agricultural produce is an important factor affecting adoption of new technology in agriculture. Higher price encourages farmers to adopt improved technology in agriculture for higher production. Many respondents reported that prices of agricultural produce like vegetables, jute, rice etc. go down to a considerable extent particularly during the harvesting season. Low price of agricultural produce discourages the farmers from adopting costly new technology.

9. The study revealed that the middle age farmers (between 30 and 40) are more responsive to the adoption of improved agricultural practices.

10. Source of acquiring new knowledge or information about agricultural technologies and their cost effectiveness are also important factors affecting technology adoption. Most of the farmers particularly tribal farmers are unaware of many programmes sponsored by the govt. to promote adoption of improved technologies because of source of acquiring new knowledge or information regarding agricultural activities are either insufficient or non-existent.

11. Traditionalism and castism also play an important role in affecting the adoption pattern of agricultural technology by the farmers. Tribal farmers being more tradition ridden and conservative are found to be less responsive towards the adoption of new agricultural technology.

5.2 Constraints to Adoption of New Technology in Agriculture in the District of Barpeta

Transfer of technology plays a vital role in the process of agricultural development. Transformation necessitates that farmers should be convinced to accept and work for the change. They need to be prepared mentally and emotionally to accept the new agricultural technology with the continuous effort of the government and other extension agencies. Most of the farmers are well informed about the new development in agriculture and they are ready to adopt the new farming technology but are not in a position to adopt the improved technology at full scale due to certain constraints faced by them in day to day life.

In order to find out various constraints of different size group of farmers in the present study, open-ended questions were asked. The constraints mentioned by them (both non-tribal and tribal respondent farmers) were noted which can be classified into the following groups:

(1) Economic constraints

(2) Input constraints

(3) Guidance and training constraints

(4) General constraints

1. Economic constraints comprises the following items:

a) Lack of own capital

b) Inadequate institutional credit

c) High rate of interest of non-institutional credit

d) Lack of collateral of farmers and complex procedure in obtaining credit

2. Input constraints comprises the following items:

   a) Impurity of seeds

   b) High cost of HYV seeds

   c) High cost of fertilizers

   d) Inadequate irrigation facilities

   e) High rate of irrigation charge of private pumping sets

   f) Erratic supply of electricity

   g) Insufficient availability of effective and pure chemicals, pesticides, insecticides etc.

3. Guidance and Training constraints consists of the following items:

   a) Lack of information about new technology

   b) Lesser contact with extension agencies

   c) Lack of knowledge of various development programmes to uplift the poor farmers

4. General constraints comprise the following issues:

   a) Low price of agricultural produce

   b) More proneness of HYV seeds to diseases

   c) Lack of cold storage

   d) Transport problem

   e) Problem of regulated market

   f) Lack of education

   g) Problems of soil testing, water testing, soil salinity etc.

   h) Environmental problem

Among the economic constraints, lack of capital counts the most. Since majority of the farmers are poor, they have not internal sources of their own to purchase the entire or any of the components of new agricultural technology. It is mainly responsible for their low income which does not permit them to adopt more remunerative agricultural technology. As many as 12 large, 30 medium and 60 small farmers reported about lack of own capital for which they could not adopt new agricultural technology at full scale.

Since many farmers do not have their own capital for adoption of new agricultural technology, they have to depend on borrowed capital. Since non-institutional sources of capital are insufficient and bear exorbitant rates of interest, farmers have to depend on institutional credit. But field survey showed that only 65 (81 percent) of large farmers out of 80, 58 (73 percent) medium farmers out of 80 and 42 (53 percent) small farmers out of 80 had access to institutional credit. So, 19 percent large farmers, 27 percent medium farmers and 47 percent small farmers reported credit constraints. The main reason of this inadequacy of bank credit, as reported by sample farmers, is their lack of collateral due to their poor asset base and complex loaning procedure. Most of the farmers, being poorly educated, do not know the procedure of borrowing from nationalized banks. The main problem, therefore, is to evolve a suitable agricultural credit system so that credit is made available to the farmers on easy terms at reasonable rate of interest and without rigorous requirement of security and without irksome formalities. Non-institutional credit sources charge high interest rate. As many as 6 percent large, 30 percent medium and 43 percent small farmers reported about high rate of interest charged by village money lenders and rich men. So far as input problems are concerned, out of 240 sample farmers, 17(i.e., 7 percent) large farmers, 18(i.e., 8 percent) medium farmers and 23(i.e., 10 percent) small farmers reported that many high yielding variety seeds are not pure and very often taking the advantage of ignorance and illiteracy of farmers, many unscrupulous business men sell impure seeds of high yielding varieties at high prices. As many as 32(13 percent) large farmers, 35 (15 percent)medium farmers and as high as 50(21 percent) small farmers reported about high prices of HYV seeds.

During the field survey, it was found that big farmers were possessing more pump sets to irrigate their fields. Some of large and even medium farmers hire out their pump sets to irrigate the fields of their neighbouring small and medium farmers, who do not possess pump sets, at a quite high rental. As many as 6(8 percent) large, 20(25 percent) medium and 43(54 percent) small farmers reported about high charge of pump sets. It was also found, during field investigation, that the supply of irrigation water by govt. scheme is not sufficient and convenient for the beneficiary farmers. This is mostly because of erratic supply of electricity. The shortage of power prevented the govt. tube wells from functioning properly. A sizeable number of farmers, i.e., 12 (15 percent) large, 15(19 percent) medium and 21(26 percent) small farmers complained that the chemicals they purchase from market are not pure and effective. So, the chemicals and pesticides, they reported, are not fully effective in protecting their crops from pests and diseases. As regards fertilizer input which is the most important component of new farming technology, as many as 25 (31 percent) large, 33(41 percent) medium and 65(81 percent) small farmers reported about high price of fertilizer. Due to high price of some fertilizers, many sample farmers could not afford to purchase recommended doze of fertilizers.

As regards the guidance and training constraints, many farmers, especially small and illiterate farmers of non-tribal category and most of the farmers of tribal category complained about lack of information relating to new technology. As many as 30(38 percent) large, 36(45 percent) medium and 57(71 percent) small farmers reported about the lack of information regarding new agricultural technology. Lesser contact with extension workers and lack of knowledge of various development programmes which are meant for the upliftment of the poor farmers also stand on the way of adoption of new technology in agriculture. It was complained by many farmers (particularly tribal farmers) that block officials do not disseminate the necessary information to them regarding the latest improved agricultural practices for which they can not adopt new practices in due time.

As far as the question of general constraints are concerned, out of 240 sample farmers as many as 70(29 percent) large, 61(25 percent) medium and 20(8 percent) small farmers reported about low price of high yielding variety produce. During field survey, many farmers, specially producing marketable surplus, reported that almost every bumper production is followed by lower price and many time particularly during the harvesting season they have to make distress sale.

About 50 percent of the sample farmers, i.e., 48(20 percent) large, 49 (20 percent) medium and 21(9 percent) small farmers expressed that high yielding varieties are more prone to diseases. Similarly 156 sample respondents, i.e., 70 large, 61 medium and 20 small farmers felt the need of cold storage. Field survey showed that more than 80 percent roads are unmetalled and most of them become muddy and unsuitable for transportation of agricultural produce during the entire rainy season. Most of the farmers in the study villages use handcart, van rickshaw, bullock carts etc. as means of transportation of agricultural produce and input. Out of 240 sample farmers, 26(11 percent) large, 25(10 percent) medium and 15(6 percent) small farmers reported about inadequate number of regulated markets to sell their surplus output to and purchase required input there from. Due to lack of adequate number of regulated markets, price of most of the agricultural produce go down during the harvesting season. Due to unremunerative prices, income of the farmers cannot increase reasonably which obviously discourage them to adopt new agricultural innovations. There are about 75, 80 and 92.5 percent of large, medium and small farmers respectively who face the problems relating to test of soil, water and soil salinity.

Besides the above constraints, there are some other constraints which also deserve mentioning. Among them are more proneness of HYV seeds to diseases, problem of skilled labour, lack of education, lack of cold storage, transport problem, problem of regulated market etc.

Some farmers reported about environment problem and ecological imbalances caused by excessive use of chemical fertilizers, pesticides etc. Some educated farmers reported that excessive use of pesticides and insecticides for plant protection measures cause environmental degradation. For example, they mentioned that due to the excessive use of these chemical inputs, some pet animals like cows, goats etc. are affected and even sometimes many useful living beings like frogs, fishes, earthworm etc. which are natural protector of crops die due to the poisonous effect of the chemicals used. Excessive and non-judicious use of plant protection chemicals has not only resulted in environmental pollution but also developed resistance to several pests. Residues of DDT, aldrine, lindane etc. have been found in different food samples which are harmful to health. Moreover, increase in the use of chemical fertilizers and water for increasing agricultural yield bring about a steady depletion of micronutrients from the soil, erosion of topsoil, spread of salinity and water-logging etc. Imbalances in nutrient status leads to significant deficiency of N.P.K., Zn, S and disturbance of soil texture and its physico chemical properties.

Environmental degradation like depletion of stratospheric ozone, nitrate toxications etc. are causing health hazards like cancer, methamoglobinemia, respiratory illness, hypertension etc. (Bhattacharya and Bihari (2003). As many as 19 (8 percent) large, 20(8 percent) medium and 11(5 percent) small farmers reported about ecological imbalances.

On the basis of the results of present investigation some constraints like lack of capital, low price of agricultural produce, problem of insufficient cold storage, inadequate institutional credit, problem of soil and water testing facility, inadequate irrigation facility, high cost of fertilizers, high rental charges of implements and machines, lack of information and problem of regulated market are most important and mainly due to these constraints that the process of adoption of new agricultural technology in Barpeta district has been slow and interrupted.

The important constraints to adoption of technology in agriculture can be summarized in a tabular form as follows:

Table 5.1 Constraints to Adoption of New Technology in Agriculture in the District of Barpeta

Constraints	Large farmers N=80		Medium farmers N=80		Small farmers N=80		Total
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	
1. Economic constraints							
a) Lack of own capital	12	15.00	30	37.5	61	76.25	103
b) Lack of Institutional credit	33	41.25	42	77.5	58	85.00	185
c) High rate of interest of non- institutional credit	5	6.25	22	27.5	34	42.5	61
d) Lack of collateral of farmers and complex procedure in obtaining credit	13	16.25	28	35.00	32	40.00	73
2. Input constraints							
a) Impurity of seeds	17	21.25	18	22.5	23	28.75	58
b) High cost o HYV seeds	32	40.00	35	43.75	50	12.5	117
c) High cost of fertilizers	25	31.25	35	43.75	65	81.25	125
d) Inadequate irrigation facility	7	8.75	22	27.5	36	45.00	65
e) High rates of irrigation charges of private pumping sets	6	7.5	20	25.00	43	53.75	69
f) Erratic supply of electricity	3	3.75	Not mentioned.	-	Not mentioned.	-	3
g) Inadequate availability of pure chemicals, pesticides, insecticides etc.	12	15.00	15	18.75	21	26.25	48
3. Guidance and training constraints							
a) Lack of information about new technology	30	37.5	36	45.00	57	71.25	123

b) Lesser contact with govt. extension agencies	67	83.75	27	33.75	80	100.00	174
c) Lack of knowledge of various development programmes	30	37.5	50	62.5	61	76.25	141
4. General constraints							
a) Low price of agricultural produce	70	87.5	61	76.25	20	25.00	151
b) More proneness of HYV seeds to disease	48	60.00	49	61.25	21	26.25	118
c) Lack of cold storage	70	87.5	61	76.25	25	31.25	156
d) Transport problem	52	65.00	50	62.25	46	57.5	148
e) Problem of regulated market	26	32.5	25	31.25	15	18.75	66
f) Lack of education	41	51.25	46	57.5	49	61.25	136
g) Problem of soil testing, water testing etc.	60	75.00	64	80.00	74	92.5	200
h) Environment problem	19	23.75	20	25.00	11	13.75	50

Source: Field Survey, 2004

5.3 A Special Constraint: Fluctuating Market Price of Agricultural Produce and Market Conditions

Market price of agricultural produce plays a crucial role in the agricultural development of a country. It is an important instrument fro providing incentives fro farmers for motivating them to go in for production oriented investment and technology. In a developing country like India where majority of the population is engaged in agricultural sector, prices affect incomes, consumption and investment decisions of the farmers. Basically agricultural prices strongly work as economic incentives that guide farmers in making production decision and to reward according to its allocative efficiency.

But prices of agricultural produce have been found to be violently fluctuating. And fluctuations in agricultural pries have many harmful results. For instance, a steep decline in the price of a particular crop in a year can inflict heavy losses on the grower of that crop. This will reduce income of the grower of that crop and dampen the spirit to cultivate the crop in the coming year. On the other hand, steep rise in the price of a particular crop can raise the income of the grower of that crop and induce him to invest and grow more of that in the coming year. Therefore, price fluctuation of agricultural produce influence to a great extent on the volume of agricultural production in a country. Therefore, price increase has positive impact and price decrease has negative impact on the production of agricultural commodities.

Agriculture produces food-staffs and raw materials, the demand for which in the aggregate, is relatively stable in the short run, while the supply of agricultural products fluctuates widely from year to year, and from one part of the year to another, on account of the variations in yields, due to

(i) seasonal and weather conditions,

(ii) variations due to supplies being more abundant in certain months of the year,

(iii) deliberate variations attempted by the producer, and

(iv) variations arising out of conditions of marketing.

These fluctuating supplies constitute the most important factor responsible for the wide fluctuation in agricultural prices. These fluctuations in the price of agricultural products are the greatest hurdle in the way of agricultural development, for they bring ruin to many. It was for this reason that agricultural countries suffered during the depression of 1929. According to Sir Roger Thomas, "next to rain, price changes have been the greatest enemy of the farmer."

In Barpeta district apart from cereal crops, the sample farmers also cultivate vegetable crops during Rabi and Kharif season. They cultivate cabbage, cauliflower, tomato, potato, brinjal and some leafy vegetables in Rabi season and ridge gourd, lady's finger and cowpea etc. in Kharif season. Field investigation also showed that the cropping pattern in the district is gradually shifting towards vegetable cultivation since it is more remunerative than field crops- rice, wheat, jute etc.

The comparative analysis of costs involved in paddy and vegetable crop cultivation by the sample farmers showed that the cost involved in vegetable crop cultivation is much higher than the paddy cultivation. It is found that per hectare cost involved in seeds of vegetable cultivation is Rs. 4,404.61 while cost involved in paddy seed is Rs. 415.24 (Assam Agricultural University, Jorhat, Deptt. of Agriculture, Barpeta 2004). The consumption of chemical fertilizer per hectare in vegetable cultivation is 84.02 Kg, which is found to be 105.23 percent higher than paddy (40.94 Kg/Ha) cultivation, It is also found that per hectare cost of cultivation of vegetables are much higher than cereal crops. The total costs involved in vegetable crop cultivation is found at Rs. 31,253.94/Ha, while it is Rs. 14,708.88 per hectare in paddy cultivation. The overall investment in vegetable crop cultivation is higher by 112.52 percent than the paddy crop cultivation. The value of output per hectare on vegetables is estimated at Rs. 72,529.45 while the per hectare return from paddy is only Rs. 18,180.53.

The above analysis sufficiently establishes that the vegetable crops cultivation is more remunerative than the paddy cultivation in the study area. There are also scopes of enhancing per unit of area by adoption of new farm technology in vegetable crop cultivation provided that their prices are remunerative. With the advent of new agricultural technology, agricultural sector has started shifting from subsistence farming to commercial enterprise. Under such circumstances, stable and remunerative prices of agricultural produce is very much essential for the sustainable development of agricultural sector as commercial enterprise. But field investigation, interaction with market functionaries and government records showed that prices of most of the agricultural products fluctuate vigorously. It was also found, through field investigation, that the intensity of the price fluctuation varies from crop to crop, from place to place and also from time to time depending upon the nature of supply, nature of demand and also the condition of roadways meant for transportation of agricultural commodities to different markets. Though prices of agricultural products have been found varying throughout the years, price variation is found to be more pronounced in different seasons in a particular year which have disincentive effect on farmers. During the last couple of years, price changes particularly fall in price has become the main concern for the farmers. This phenomenon acts as a deterrent to the adoption of new technology for improving agricultural production and productivity.

Therefore, during field investigation, an attempt was made to find out the intensity of price variation of different important agricultural commodities (both cereal and vegetable crops) in Barpeta district. Table 5.2 shows the price variation of different important commodities in different seasons in 2004.

Table 5.2 Price Variation of Different Important Agricultural Commodities in Different Seasons, 2004

Sl. No.	Name of the crops	Price of commodities in different seasons (in Rs.)		
		Early season	Peak season	Late season
	Field crops			
1.	Rice (Per Qtl.)	600	500	550
2.	Jute (Per Qtl.)	875	1200	1500
	Vegetable crops			
4.	Cabbage (Per Qtl.)	1000	400	100
5.	Cauliflower ,,	1700	500	150
6.	Tomato ,,	1800	200	400
7.	Potato ,,	800	300	450
8.	Brinjal ,,	1500	400	400

Source: (i) Barpeta Road Market Committee, 2004
(ii) District Agricultural Office, Barpeta

A close look at the Table makes it clear that almost all the crops except jute experienced higher prices during early season. But only a few sample farmers, i.e., as low as 21(9 percent) out of 240 farmers, reported to have benefited by higher prices in early season. It is the peak season when almost all the farmers have generally maximum harvest and marketable surplus. But the Table shows that prices of almost all the crops declines to the minimum during the peak/harvesting season causing losses to farmers. The decline was more pronounced in case of vegetable crops than cereal crops. For example, prices of cauliflower and tomato were Rs. 1700/- and 1800/- respectively in early season which declined to Rs. 500/- and 200/-

in main harvesting season. So was the condition in case of cabbage and brinjal also. During field investigation, some farmers reported they had to sell their products, particularly vegetable products, at such a minimum price which could just make up the transport cost. Price fluctuations of agricultural products have become a regular feature during the last couple of years. It is seen that every bumper harvest is followed by low price. Under such situation farmers cannot make afford to increase production by bringing more and more area under high yielding technology. Besides, the district of Barpeta is more or less a rain fed area and water-logging is a common feature for vast area in the district. Under such agro-climatic condition, early cultivation of both cereal and vegetable crops are subject to vagaries of rains and water-logging. Many times, as was reported by some sample farmers, it happens that crops in the fields are either washed away or damaged by floods and rains and under such circumstances, many farmers become unable to withstand the losses caused by the rains and floods. Therefore, early cultivation for all the time is neither a sustainable exercise nor a profitable proposition. Farmers with only comparatively large amount of culturable land can take up early cultivation with minimum risk.

Apart from low price, farmers are very often deprived of getting the deserving share of consumer's rupee due to existence of large number of marketing channels.

5.4 Share of Growers in Consumer's Rupee

Marketing of agricultural commodities involves a number of marketing functions like purchasing, assembling, cleaning and grading, packaging, transportation, storing and dispersion. In the process of marketing, a number of market functionaries like middlemen, wholesalers, retailers, etc. are involved and operated in different marketing channels.

5.4.1 Market Channels

The marketing channels of agricultural commodities (both cereal and vegetable crops) varies from crop to crop and place to place. The identified market channels for major agricultural crops in the study area are as follows:

Channel-1: Producer-Retailer-Consumer,

Channel-2: Producer-Middlemen-Retailer-Consumer,

Channel-3: Producer-Middlemen-Wholesale- Retailer-Consumer,

Channel-4: Producer-Jute Corporation of India (J.C.I.)

Channel-5: Producer-Middlemen- Jute Corporation of India

Channel-6: Producer-Commission Agent-Kutcha baler-Terminal market wholesaler

The market functionaries operate in different styles at different times. Actually there is no fixed channel through which agricultural products find their ways to the final consumers. The marketing channel varies depending upon the types of products produced by the farmers. But existence of various market channels provide ample scope for price spread.

5.4.2 Price Spread

The analysis of price spread revealed that there is a wide gap between the price received by the producer and the price paid by the consumer. The price spread for agricultural products varied depending upon the volume of production, road communication network and marketing facilities.

5.4.3 Price spread of some major crops in Barpeta district

During investigation, it was found that the larger the number of marketing channel that operates in the market the higher is possibility of price spread. Again if more is the price spread, the producers get lesser amount of consumer's rupee.

5.4.4 Price spread of Rice

Rice grower share of consumer's rupee was found at 70.42 percent in Channel-1, 64.40 percent in Channel-2 and 61.00 percent in Channel-3. The analysis of spread revealed that growers share in Channel-1 is higher than the Channel-2 and Channel-3.

5.4.5 Price spread of Jute

The share of jute growers in Jute Miller's rupee was also found to depend on the nature of market channel. The share of growers was worked out at 59.20 percent in Channel-4, 53.50 percent in Channel-5 and 50.00 percent in Channel-6 (Sri Manik Chand Agarwal, Market wholesaler who supplied raw jute directly to Millers at Calcutta, 2004)

5.4.6 Price spread of Cabbage

The producer share of consumer's rupee was estimated at 48.00 percent in Channel-1, 43.33 in Channel-2 and 43.00 percent in Channel-3. It appeared from analysis of price spread that in Channel-1 the producers were enjoying comparatively higher share of consumer's rupee than that of Channel-2 and Channel-3.

5.4.7 Price spread of Potato

The share of potato producer of consumer's rupee was estimated at 56.40 percent in Channel-1, 50.00 percent in Channel-2 and 50.00 percent in Channel-3. The share of producer in consumer's rupee was found to be higher in Channel –1 than Channel-2 and Channel-3.

It was observed that the crop's growers especially vegetable growers nearby the marketing centers or towns availed the facility of forwarding their produces directly to the retailers. The retailers also used to collect the produces from the growers field. The transportation costs and other expenditures are also low for which the retail buyers could pay higher prices to the growers. The retailers also enjoyed more than 40.00 percent of consumer's rupee in Channel-1. In Channel-2, 3 and 6, middlemen are involved, transportation and other miscellaneous charges are there. Therefore, the buyers from the producers usually offer lower prices and the retailer's margin of consumer's rupee also dropped substantially.

Apart from price fluctuation and price spread as mentioned above, underdeveloped road communication network also cause economic hardship for cultivators. Agricultural commodities meant for sale require well-developed roads for transportation to different market places. In Barpeta district, more than 103 markets are operating in town and rural areas. Out of these 103 markets, only 4 market, i.e., Barpeta, Barpeta Road, Howly and Bohorihat markets are regulated and these are linked by pucca roads. All other 99 markets are non-regulated and are connected by kutcha roads. These are basically rural markets. (A list of markets in Barpeta district is given in the Appendix VII). Most of these markets are connected by kutcha and fair weather roads. Such roads are not usable for motor transport for carrying of harvested crops. Most of these rural roads become almost unusable during the rainy season. But the entire production of agricultural commodities in Barpeta district pass through these rural markets and ultimately reach the hands of the consumers through different agencies engaged in trade. But due to poor conditions of roads, a majority of farmers use handcart to carry their produce to different markets. As much as 201 sample farmers reported about kutcha roads in their areas. They also reported that transportation cost is very high due to undeveloped road communication. Sometimes, due to bad road condition, some agricultural commodities particularly perishable commodities like vegetables, fruits, milk, fish etc. get damaged or quality deteriorates. Perishable commodities require quick transportation to market places for sale which necessitates well developed road communication network. According to an estimate about 30 percent of agricultural produces are carried on head by the producers and this is due to poor communication condition. As per the report of Agricultural office, Barpeta, on an average about 10-15 percent of the agricultural prices offered by traders is to be spent as transport cost. This certainly reduces the producer's share in agricultural price.

Under such circumstances, farmers find it unremunerative to adopt costly modern agricultural technology. As many as 125 sample farmers mentioned low price of their marketable surplus as constraints to adoption of new technology.

CHAPTER 6

ROLE OF AGRICULTURAL EXTENSION PERSONNEL IN PERCOLATION OF NEW TECHNOLOGY

6.1 Introduction

People are the most valuable resource of any country. Many countries like Japan, South Korea, Singapore, Hong Kong have limited natural resources but developed their economy through planned approach for human resources. Efforts for human resource development for achieving higher and better results were initiated during sixties in India. Long back, former Governor of RBI Sri L. K. Jha while addressing a convocation in Ahmedabad observed that 'Prosperity was a manmade phenomenon', i.e., the prosperity of an organisation or even the country is solely related with its manpower. Efficient manpower is not only essential for innovation of a new idea but also important for its diffusion. Agricultural scientists produce new innovations and their diffusion among the farmers largely depends on agricultural extension personnel. Widespread diffusion of agricultural innovation in a developing country like India ultimately hangs on the effectiveness of the channels of communication between agricultural research and the farming community. Agricultural extension service constitutes the main stay of this communication network. Theodore W. Schultz writes, "The suppliers of modern agricultural factors are, among others, the research people who work in agricultural research stations. Farmers in their role as demander of the new factors accept them when they are truly profitable. But typically farmers in traditional agriculture do not reach for them. In the end much depends on farmers learning to use modern agricultural factors effectively." (Schultz, 1964) In this process of learning the people in the agricultural extension service have a great role to play.

In the process of transfer of technology in agriculture the role of extension service is very crucial. Application of new technology for increased productivity depends on adequate flow of information to the farmers regarding new techniques of production, new inputs and their availability, marketing facility, price and credit support, preservation and processing and above all knowledge about how to obtain this information (Ghosh, 2003). It remains the function of the agricultural agency to serve the farmers with educational, informational and advisory services so as to motivate and build confidence in them by introducing new practices of farming. This is the function of agricultural extension. Bradfield (1966) summarized the philosophy of the extension approach in the following way:

All people desire higher level of livings. Once people are convinced of the value of new methods of solving their immediate problems, they will change their present practices to work toward the standard of living they desire. Therefore the major task of extension is to convince the people of the value of new and better practice. Extension communication is thought as the vehicle for : (i) transferring innovations from the donor or development agencies to their clients, and (ii) preparing individual recipients for change by establishing a climate for modernisation.

An effective communication is central to the success of any extension programme. The task of communication in invoking the desired changes is to ensure a regular flow of information about innovations, to focus on the needs for changes, the methods and means to bring about change and the raising of aspirations of the people for a better way of life. Basically extension workers are supposed to establish linkage between the research institutions and the farmers in the field. They have to carry the teachings and research findings to the farmers for helping them in the betterment of their standard of living.

Keeping in view the essential of agriculture extension workers for agricultural development, the Government of India launched a number of programmes in a phased manner for improvement of agricultural extension services.

The first phase dates from year 1948-1960 as Extensive Extension Programmes which included (i) Grow more food campaign (1948), (ii) Community Development Programme (1952).

The second phase-Intensive Extension Programme (IEP) (1960-1974) included (i) Intensive Agricultural District Programme (IADP), 1960 and (ii) High Yielding Variety Programme (HYVP), 1966.

The third phase started with programmes for research based extension methodology viz. (i) National Demonstration Programme (1966), (ii) Operational Research Project (ORP), 1971, and (iii) Lab to Land Programme (LLP), 1979.

Fourth phase started with introduction of World Bank aided Training and Visit (T & V), 1974 approach for extension through following three projects:

(i) State Agricultural Extension Project (SAEP), 1974-75;

(ii) National Agricultural Research Project (NARP), 1980-88;

(iii) National Agricultural Extension Project (NAEP), 1985-88 and the latest National Agricultural Technology Project initiated in the year 1998.

After going through past trend of agricultural production and status of agricultural extension system in our country, we find the focus of agriculture remained on achieving higher productivity. The Government's interventions also remained focused to achieve this major goal and provide technological support to farmers through extension service and providing inputs. More and more activities were planned for capacity building for extension personnel to enhance their technical skills and capabilities for transfer of technology to farmers through training and field demonstrations. Agricultural extension as a social innovation and a prominent force has been playing an important role in bringing about agricultural development and socio-economic progress. Over the years, Public Extension System has been playing a crucial role in disseminating technologies and to achieve higher production.

Although Public Extension Service has contributed for achieving self-sufficiency in food grain production, in recent past, it is generally disappointing in transferring improved agricultural technologies from research to farmers in India. Indian agriculture has recorded an alarming knowledge-practice gap. India has 30,000 Agricultural scientists generating scientific information (Saravanan and

Shivalinge Gowda, 2002). Today we have nearly 1.2 millions extension personnel recruited by the State Department of Agriculture under T & V system to serve 103 million farm families. There are 127 agro-climatic zones in the country with a variety of crops and animal production system wherein there is lot of scopes for adoption of improved technologies. But it is estimated that only 30 percent of the available technologies are adopted by the farmers (Hansra and Adhiguru (1998). Some common causes for the gap are ineffective extension education, inadequate input supplies, inadequate credit support and inadequate marketing infrastructure (Saranan and Gowda, 2002). According to Hansra and Adhiguru (1998) the current public extension system transferring technologies are not economically viable, not operationally feasible, not suitable, not matching with the farmers need and not compatible with farmers overall farming system. Over and above extension personnels are not evenly distributed among the villages. Some villages are still experiencing shortage or even non-existence of extension workers to disseminate new agricultural technology messages. As was observed during our field survey, majority of the sample farmers of both non-tribal and tribal category had to depend on input suppliers and progressive farmers rather than on extension personnel for information of new agricultural technology. The problem was found to be more serious among the tribal farmers.

During field survey, an attempt was made to ascertain the role of extension personnel as well as other sources of information for both tribal and non-tribal farmers. To make an assessment of the role of extension personnel a question was put as to from where did they get the information about new technology. The answers to the question by both non-tribal and tribal farmers are presented in Tables 6.1 and 6.2.

Table 6.1 Role of Extension Personnel in Disseminating New Agricultural Technology Among Non-Tribal Farmers

Sl. No.	Sources of Information	No. of Farmers obtaining information about new technology		
		Large Farmers N=40	Medium Farmers N=40	Small Farmers N=40
1.	Village level extension workers (formal source)	10 (25.00)	3 (7.5)	0 (0.0)
2.	Input suppliers	30 (75.00)	20(50.00)	10
3.	Progressive farmers	5 (12.5)	20(50.00)	15
4.	Radio	5 (12.5)	5(12.5)	0
5.	Television	0 (0.0)	0 (0.0)	0
6.	Newspaper	2 (5.00)	2(5.00)	0
7.	N.G.O.'s	0 (0.0)	0 (0.0)	0
8.	Any other source	0 (0.0)	1(2.5)	0

Source: Field Survey, 2004

Note: Figures within parentheses are percentages.

It appears from the table that out of 120 non-tribal respondents only 13, i.e., 10.83 percent have obtained information about new technology from extension personnel. The majority of the farmers are obtaining information from non-formal sources, i.e., input suppliers and progressive farmers. The table also shows that out of 40 small farmer respondents, not a single respondent has obtained information about new technology from extension personnel. Small farmers are found to have obtained information from non-formal sources, i.e., from input suppliers and progressive farmers. Therefore, it turns out to be a fact that extension personnels do not usually contact resource poor farmers to disseminate knowledge about new methods and practices of cultivation. Similar is the experience in other developing countries also (Nkowani, Mcgregor and Dent, 1995).

During field survey, the role of extension personnel in disseminating message of new technology among tribal farmers was found to be more negligible and inadequate. Table 6.2 shows the role of extension personnel among tribal farmers.

Table 6.2 Role of Extension Personnel in Disseminating New Agricultural Technology Among Tribal Farmers

Sl. No.	Sources of Information	No. of Farmers obtaining information about new technology		
		Large Farmers N=40	Medium Farmers N=40	Small Farmers N=40
1.	Village level extension workers (formal source)	3 (7.5)	0 (0.0)	0
2.	Input suppliers	12 (30.00)	13(32.5.00)	7(17.5)
3.	Progressive farmers	14(35.00)	15(37.50)	10(25.00)
4.	Radio	0 (0.0)	0 (0.0)	0
5.	Television	0 (0.0)	0 (0.0)	0
6.	Newspaper	0 (0.0)	0 (0.0)	0
7.	N.G.O.'s	0 (0.0)	0 (0.0)	0
8.	Any other source	0 (0.0)	0 (0.0)	0

Source: Field Survey, 2004

Note: Figures within parentheses are percentages of total number of farmers in each group.

Proper scanning of Table 6.2 makes it clear that out of 120 tribal sample farmers only 3, i.e., 2.5 percent are provided with information of new agricultural technology by formal extension service, i.e., extension personnel while the figure is 13, i.e., 18.83 percent in case of non-tribal sample farmers. It also appears from the table that only large farmers that is resource abundant farmers are found to have contact with the extension personnel for agriculture-technology related information. It is evident from the table that non-formal extension services, i.e., input suppliers and progressive farmers are playing a major role in disseminating the agricultural technology related information. Out of 74 information recipients as high as 71, i.e., about 95.95 percent are provided with information by non-formal extension services, i.e., input suppliers and progressive farmers. So farmers are dependent on non-formal sources rather than public extension system for getting advice as well as farming inputs (Schultz, 2000). This appeared to us really astonishing and unbelievable. During our field investigation many tribal farmers particularly illiterate and small farmers reported that they had not even heard the name of agricultural extension personnel, not to speak of being met them. Inadequate and ineffective formal extension services are one of the major causes for slow adoption and non-adoption of agricultural technology both by tribal and on-tribal farmers in Barpeta District.

The diffusion of agricultural technology through agricultural extension did not make much impact on the subsistence farmers in the rural India (Tripathi, 2000, Ghosh, 2003). Ascroft and Gleason (1980) observed that adoption rate in the third world countries were remarkably low when compared with the developed countries. The S-shaped curves that usually show the complete adoption of an innovation in developed countries are far from taking shape in these countries. Scholars have identified several factors that inhibit adoption of new technology by farmers in developing countries.

Development scholars have identified some socio-psychological constraints that usually stand on the way of modernization of peasantry. Rogers (1967) described the socio-psychological constraints as the sub-culture of peasantry and delineated the main aspects of culture as:

(i) mutual distrust in inter-personal relations, (ii) perceived limited good, (iii) dependence on and hostility toward Government authority, (iv) familism, (v) lack of innovativeness, (vi) fatalism, (vii) limited aspiration, (viii) lack of deferred gratification, (ix) limited view of the world, and (x) low empathy.

Studies have also shown that there may be some structural and resource related constraints like lack of an effective system for delivering knowledge and skills or financial and material inputs, inadequate market development, under development of infrastructure, lack of employment opportunities or lack of peoples' involvement in designing, planning and executing development programmes and projects that prevent the subsistence farmers from adopting new technologies and methods of farming. Agricultural extension in our country is primarily concerned with the following main objectives:

(1) The dissemination of useful and practical information relating to agriculture, including improved seeds, fertilizers, implements, pesticides, improved cultural practices, dairying, poultry, nutrition etc.;

(2) The practical application of useful knowledge to farm and home, and

(3) Thereby ultimately to improve all aspects of the life of the rural people within the framework of the national, economic and social policies involving the population as a whole.

To materialize the objectives, the extension work must be based upon some working principle and knowledge of these principles is necessary for an extension worker. Some of these principles as related to agricultural extension are mentioned below:

1. **Principle of Interest and Need:** Extension work must be based on the needs and interest of the people. These needs and interests differ from individual to individual, from village to village, from block to block and from state to state and therefore, there cannot be one programme for all people.

2. **Principle of Cultural Difference**: Extension work should be based on the cultural background of the people with whom the work is done.

Improvement can only begin from the level of the people where they are. This means that the extension worker has to know the level of knowledge and skills of the people, methods and tools used by them, their customs, traditions, beliefs, values etc. before starting the extension programme.

3. **Principle of Participation**: Extension helps people to help themselves. Extension work to be good must be directed toward assisting rural families to work out their own problems rather than giving them readymade solutions. Actual participation and experience of people in these programmes creates self-confidence in them and also they learn more by doing.

4. **Principle of Adaptability**: People differ from each other, one group differs from another group and conditions also differ from place to place. An extension programme should be flexible, so that necessary changes can be made whenever needed to meet varying conditions.

5. **The Grass Root Principle of Organization**: A group of local people in local community should sponsor extension work. The programme should fit in with the local conditions. The aim of organizing the local group is to demonstrate the value of the new practices or programmes so that more and more people would participate.

6. **The Leadership Principle**: Extension work should be based on the full utilization of local leadership. The selection and training of local leaders to enable them to help to carry out extension work is essential to the success of the programme. People have more faith in local leaders and they should be used to put across a new idea so that it is accepted with the least resistance.

7. **The Whole-Family Principle**: The extension work will have a better chance of success if the extension worker have a whole-family approach instead of piecemeal approach or separate and unintegrated approach. Extension work, therefore, should be for the whole family, i.e., for male, female and the youth.

8. **Principle of Satisfaction**: The end-product of the effort of extension is the satisfaction that comes to the farmer, his wife or youngsters as the result of solving a problem, meeting a need, acquiring a new skill or some other changes in behaviour. Satisfaction is the key to success in extension work. "A satisfied customer is the best advertisement."

9. **The Evaluation Principle**: Extension is based upon the methods of science and it needs constant evaluation. The effectiveness of the work should be measured in terms of the changes brought about in the knowledge, skill, attitude and adoption behaviour of the people but not merely in terms of achievement of physical targets.

In recent years, there has been new development world over and shift in agricultural cropping pattern from subsistence to commercial agriculture; our farmers are taking up more and more cash crops. The situation demands new extension approach for benefiting farming community.

6.2 Imperatives for New Strategies and Methodologies for Extension Service

Looking into the development of Indian agriculture and changes taking place to domestic as well as international environment, during the last few years, the strategies and methodologies for agricultural extension will have to be modified. The traditional extension methods are expensive, time consuming, quality of message distorted as it passes through different channels, poor quality of communication by extension personnel. Thus we can say that traditional extension methods are very limited, and cannot reach in all the villages and all the farmers. Review of literature also support the proposition of poor extension service in our country. According to World Bank supported, Government of India, Ministry of Agriculture sponsored study (1990), "with few brilliant exception the village extension workers are neither an educated nor a knowledgeable lot and some of them are even illiterate, they will continue to be so .... are the most unlikely persons to become the engine of technology transformation. Public extension system being inadequate and ineffective, farmers are more dependent on other than public extension system for getting technical advice as well as farming inputs. (Sharma, 2000)

The extension is now becoming more diversified, more technology intensive and more demand driven. This requires the extension worker at the cutting edge level to be master of so many trades, which is wellnigh impossible. The use of Information Technology will help the extension workers to be more effective in meeting farmers' information needs. It is going to play a pivotal role in extending agricultural extension service more effectively to farmers. It is now possible to furnish the latest information to farmers by developing an interactive multimedia for finding solution to various problems faced by farmers at different stages of their farming operations.

Access to information and improved communication is a crucial requirement for sustainable agricultural development in 21st century. Modern communication technologies when applied to conditions in rural areas can help improve communication, increase participation, and disseminate information and share knowledge and skills. It is said that we live in the information age. It is also said that technology will change the world and the people who adopt and use technology make the changes. In this age of information, computer based multimedia is a tool for communicators of all trades and an effective catalyst for change. The computer application in extension will be the major force of technology dissemination in future. Some of them are called "Cyber Extension." Cyber Extension means, "using the power of online networks, computer communication and digital interactive multimedia to facilitate dissemination of agricultural technology. The advent of INTERNET on communication scenario offers enormous potential for two-way on-line communication between distant parties via the telecommunication and computer network spread over the entire globe. The world is rapidly shrinking to a global village. The merger of communication (audio and video) and computer technology has made this combination so powerful that no sector of human activity can afford to ignore it.

Improved communication and information access is directly related to social and economic development. There is a concern that the gap between the information rich and information poor is getting wider. New information and communication technologies are generating possibilities to solve the problems of rural poverty, inequality and giving an opportunity to bridge the gap between information rich and information poor and support sustainable development in rural and agricultural communities. Therefore, computer aided knowledge dissemination mechanism help to reach the un-reached and foster new voices and new leaders. Any kind of effort in this direction will be highly effective way to empower the rural population with the most needed commodity, i.e., information. Computer based information thus can be used as a complement in conjunction with existing extension and rural development. It will widen the scope of extension and improve quality.

In India, more than 70% of the farm work is done by the women (Sulaiman and Sadamate, 2000). In the study area also both tribal (Bodo) and non-tribal women were found to perform more than 60 percent of the farm work. But it appears from existing literature that share of women extension personnel in extension service is very insignificant. As per report of Ministry of Agriculture (1995) only 0.59 percent of all extension officers are women (including Kerala where 25% of extension officers are women). In our study area also not a single extension worker was found to be a woman extension personnel. Men extension workers mainly concentrate on male farmers and it is not easier to communicate by male extension agent to women cultivators in rural area due to socio-cultural difficulties. Public Extension Policy and extension personnel never consider women cultivators as independent entities, they always treat women cultivators in rural areas as part of household or appendage to men (Saravanan and Gowda, 2003). Agricultural technologies are often designed and disseminated without considering women cultivators. Public extension system targeting women should take concerted efforts to promote women access to ownership of land; access to credit; to build technical competency on skill based technologies; to increase participation in decision-making; to organize them into self help groups and; to develop their leadership abilities. The TANWA model, which is quite a success in Tamil Nadu can be expanded further to cover all the villages in Assam. The success achieved in agricultural development till date can be attributed largely to the efforts of the public sector extension. However, in the present era, with the growing importance to cutting edge technologies it becomes difficult for the public sector extension to deliver the goods. Besides, the financial crunch is also adding to the pressure on the government to maintain the extension network. As effective alternative would be to delink certain services from the public sector and allow the private sector to handle those services. The draft policy framework for agricultural extension (2000-2001) states that wherever possible subsidies will be phased out in order to stimulate emergence of a private input supply network to provide hybrid seeds, artificial insemination services, fertilizers, bio-fertilizers, agro-chemicals, animal feed, machinery and equipment and other agricultural supplies and consultancy services to farmers on a full cost recovery basis.

A study conducted in Bihar, Kerala, Maharashtra and Rajasthan showed that the participation of private sector in agricultural extension activities is limited to only few crops (especially horticulture crops) and selected geographical regions (having high potential) (Sulaiman and Sadamate, 2000). An investigation in Tamil Nadu State indicated that the private agricultural consultancies have emerged after mid 1990s. Most of these consultancies are non-registered, mostly run by a single technical person, covering small area, mainly concentrating on all aspects of horticultural crops. Further, the study indicated that 95 percent of farmers had favourable attitude towards privatization (Saravanan, 1999). Similar results have been reported in Haveri district of Karnataka where 76.59 percent of farmers had favourable attitude towards privatisation of extension services (Hanchinal et al, 2000). In our study area of Barpeta district of Assam where Public extension services are found extremely inadequate and ineffective there is every possibility that farmers will support private extension services. Under the T & V system the technology dissemination regime was more supply driven. Research and extension agendas were pre-set based on assumptions about issues in the rural areas. An important reason why research and extension were insensitive to farmers' problems was due to the lack of effective feedback system. The vast majority of small and marginal farmers especially women, are not in a position to influence research and extension priorities. Therefore, what is required is a demand driven extension system that is driven by farmers' needs. For the purpose of improving the feedback systems, farmers need to be organized into functional groups Like self help groups (SHGs). These groups can provide an effective channel for both the dissemination of technologies and they can provide an effective feedback to research and extension.

Public sector extension has undergone several changes since independence. The most significant recent development was the introduction of the Training and Visit (T & V) system starting in the mid 1969-70s. The T & V system profoundly influenced practices and registered impressive gains in irrigated areas but failed to create an impact in rainfed areas. The T & V system was a top-down approach which generated uninformity rather than specificity and has lacked focus on location specific needs of regions, disadvantaged areas, target groups, enterprises etc. Linkage between research extension and farmers remained weak. Its achievements have remained far less than adequate. This system has not proved to be successful in making adequate use of the available technology.

By the early 1990s, it was recognized that extension department should broad base its programmes by utilizing a farming systems approach. Attention should be given to diversifying extension programmers into livestock, horticulture and other value based commodities that would increase farm incomes. Present day agriculture is defined by key concepts of stability, sustainability, diversification and commercialization. There is need for reorientation of the philosophy of extension from technology transfer mode to technology application.

T & V system of extension, though failed in materilising desired objectives in technology dissemination in Indian farming system, it has been found successful in many countries of the world. A good example is provided by Indonesia, which has been introducing the Training and Visit (T & V) system, and has been able to build on a number of traditional groups. Rural people in Indonesia have lived and worked for centuries with strong communal groups or co-operatives such as subak (farmers' associations formed for use of irrigation water), gotong royong (farmers' self-help association) and mapulus (farmers' mutual assistance association). These have a membership, and high loyalty to the leader, and for introducing T & V extension; these farmer groups have become the focus for guidance and technology transfer (Hanchinal, Sundaraswamy and Ansari, 2000)

Historically, they had been rather hierarchical with a tendency to operate in a top-down fashion, and so when the T & V system was introduced the traditional leader often became the contact farmer. Now, however, they have moved to identifying subgroups in adjacent field areas, and matching up farmers with different resources levels to have more representative contact farmers. They discuss and agree their seasonal extension programme, decide on technology appropriate to their situation, and monitor feedback from questions posed at the regular visit of the extension worker. In this way they have become much participatory. The village receives special training in maintaining group dynamics and the local administration gives active encouragement.

Another example is from a pilot project in the Midlands of Zimbabwe that has been running for the last few years. Here again there is a strong tradition of work associations for sharing agricultural labour, and more recently of savings groups that have been especially strong among women. Here farmer groups organized for extension purposes are normally sub-divided when numbers exceed thirty, to keep practical demonstrations effect and retain the groups' cohesiveness. A key feature is that the final stage of dissemination of improved technology is done by farmer representatives themselves, two of whom are selected to attend each training session fortnightly and to report back to the rest of the group. This is a tenet of the T & V system but rarely it is institutionalized and done so effectively. The chosen contact farmers rotate amongst group members depending on their individual attributes related to the topic under discussion. This enables several members of the group to be both trainee and trainer, and by going together it reinforces their mutual knowledge of the lesson being discussed. The fortnightly training sessions, which other farmers may attend as well as group leaders, are conducted on members' plots, and group leaders rotate their training of fellow group members around different member farms. Slogans in the vernacular and songs about the lessons have all helped to motivate keep participation by all members, especially the women. Whereas less than 10 percent of farmers were in groups before the pilot scheme started few years ago, groups covered about 70 percent by mid 1985 (Hanchinal, Sundaraswamy and Ansari, 2000).

If we apply the experiences of Indonesia and Zimbabwe in Indian T & V system we can expect at least some improvement in the existing extension services.

Agricultural extension through T & V system is pertinently one-way top-down communication. Under this system, decisions regarding adoption of new agricultural practices deemed desirable for farmers are taken by the officers who are at the top of the administrative hierarchy and then those recommendations are disseminated among the farmers by extension workers. The down-up approach in communication is thus absent in the system which very often leads to ill-adoption of innovation that does not fit local requirements. Agricultural extension to be effective and fruitful must be based on co-equal sharing of knowledge where both the extension officers and the farmers have equal chance of influencing each other not only in solving problems during the adoption of a technology but also in deciding the suitability of adopting the technology. Gentel (1989) pointed out that the extension system should be managed by the state and farmer groups in cooperation with each other.

In recent years role of Non-Governmental Organizations (NGO) in dissemination process of new agricultural technology has assumed special significance. In this regard a pilot control government scheme, agricultural extension through voluntary organizations was launched in 1994-95 to increase the involvement of NGOs in an effort to strengthen the research extension delivery system. The scheme initially involved 14 NGOs in eight states. Experience has been encouraging both in terms of physical targets and in targeting NGO efforts with those of the main extension system (Govt. of India 1996). The number of NGOs under this programme is being increased to 50 in the Ninth Plan covering more number of states. The states are also encouraging the NGOs to take up the extension activities where an encouraging response has been on the cards.

From our field investigation it appeared to us that the NGOs can be made to contribute significantly to the development of their respective areas/people in many ways such as:

(i) awareness generation, extension and motivation;

(ii) experimentation, innovation and developing micro models;

(iii) organizing farmers, women and others for participating in development activities;

(iv) organization and social audit, making government to work; and

(v) influencing policy making and programme designing (Hirway, 1997).

The technical manpower to cultivator/people ratio of NGOs is generally very low but then these normally operate with only few selected groups of clients. Their funds come from foreign donors or government departments. Several ministers of Government of India have separate provision to fund specific projects and NGOs are availing these opportunities. Mostly the NGOs operate independently in their own areas. NGOs can play effective role in their areas in promoting the adoption of the new agricultural technology through better self-involved education of the farmers and other groups.

Farmers are not only producer of commodities but they also play a role of agri-preneur in coming years for which they will certainly require support from existing extension system. Our field survey experience suggests that to make agriculture a remunerative activity, need for a strong marketing extension has been felt in recent years. With changing scenario extension personnel will require skills in certain areas related with agri-business such as cost/benefit analysis of production and its marketing, handling agriculture marketing intelligence, demand supply analysis of commodities and value addition to agriculture produce etc.

The type and extent of organizational, management and communication skills to be given to extension can be decided according to the framework of organization and management of agricultural extension system likely to emerge in the 21st century. In order to develop a demand responsive extension system for Indian agriculture "National Agricultural Technology Project" is initiated in six stages on experimental basis, suggesting a lot many changes in present systems and organization of research and extension services to farmers. This will also add many new capabilities required for extension personnel, in the agenda for Human Resource Development. To emerge as leaders in agriculture sector, human resource development of extension personnel and farmers will be the most potential area for attention in the new millennium.

CHAPTER 7

SUMMARY, CONCLUSIONS AND SUGGESTIONS

7.1 Summary

India has made impressive strides on the agricultural front during the last three decades. Development in agriculture has made India self-sufficient in food grains and a leading producer of several agricultural commodities in the world. Much of the credit for this success should go to the several million small farming families that form the backbone of Indian agriculture and economy. Policy support, production strategies, public investment in infrastructure, research and extension for crop, livestock and fisheries have significantly helped to increase food production and its availability. During the last 30 years, India's food grain production nearly doubled from 102 million tones in the triennium ending (TE) 1973 to nearly 203 million tones (mt) in the triennium ending 2000. Virtually all the increase in the production resulted from yield gains rather than expansion of cultivated area. Availability of food grains per person increased from 452 gm/capita/day to over 476 gm/capita/day, even as the country's population almost doubled, swelling from 548 million to nearly 1000 million.

The increase in productivity may be attributed to the introduction and adoption of HYV seeds, proper irrigation, fertilizer application, plant protection measures, multiple cropping etc. The green revolution in crops, yellow revolution in oil seeds, white revolution in milk production, blue revolution in fish production and golden revolution in horticulture bear an ample testimony to the contribution of agricultural research and development efforts undertaken in the country. During the year 1999-2000, as many as 47 varieties of different crops were released. (Indian Economic Survey, 2000-01). Therefore, agricultural researches have shown immense possibilities for increasing the productivity of agricultural commodities. India is, now, by no longer an exporter of traditional agricultural commodities like tea, jute and coffee, but a large varieties of agricultural commodities like cereals, spices, tobacco, cashew, oil meals, marine products and many other are being exported from

India and earning valuable foreign exchange. Development of agriculture, particularly during the green revolution and post-green revolution is very much impressive. Between 1947-50 and 1997-98, index (base 1980-81) of agricultural production increased from 4.9 to 176, index of food grains from 52 to 161 and non-food grains from 45 to 201. Index of per hectare yield (all crops) increased from 74 to 149. Between 1950-51 and 1994-95 gross cropped area increased from 132 million hectares to 188 million hectares implying a rise in cropping intensity from 111 to 132. Gross irrigated area went up from 23 million hectare to 71 million hectares.

Between 1950-51 and 2001-02, distribution of improved seeds increased from negligible to 65 lakhs quintals. Fertilizer use increased from only 69 thousand tones to 19,306 million tones with per hectare fertilizer use going up from negligible to 95 kgs. Pesticides use increased from 2.4 thousand tones to about 60 thousand tones. Consumption of electricity in agriculture went up from 15200 million KWH in 1981-82 to about 86000 million KWH in 2001-02. Institutional credit (Cooperative Societies, Commercial Bank and Regional Rural Banks) was 28653 crores in 1996-97 as compared to 66,771 crores in 2001-02. (Source: Economic Survey, 2002-03 and Agricultural Statistics at a Glance, Govt. of India, 1998).

Despite the tremendous development in agricultural sector, there is still ample scope for agricultural produce to get expanded. For stepping up agricultural production, new agricultural technology must be developed and diffused to the farmers so that they may accept it and make use for enhancing agricultural productivity. It has, however, been observed that agricultural innovations like HYV seeds, chemical fertilizers, irrigation, plant protection measures etc. are not adopted by the farmers belonging to different strata of holdings like small, medium and large to the same extent. It has been observed that it is the large farmers who are found in advantageous position in adopting agricultural technology to a considerable extent. But still rate of adoption of new agricultural technology even by the large farmers has not been uniform across the states within the Indian territory. Adoption rate is fairly high in green revolution regions than the non-green revolution regions. State of Assam, where green revolution is yet to have its full scale start, lagging behind in terms of adoption of new technology in agriculture even by the large farmers. Agricultural technology to be a total success requires its adoption by all types of farmers. But it has been observed that farmers belonging to scheduled tribes (i.e., tribal farmers) who also constitute a sizable portion of Indian agricultural community is lagging behind very much in the race of adoption of technology in agriculture. It is also observed that small and marginal farmers who constitute bulk of the farming community in India are lagging behind in the adoption of modern technology in agriculture than the large farmers. The main factors that stand on the way of adopting new innovation in agriculture are: small operational holdings, low income, lack of assured irrigation, lack of education, lack of institutional credit to purchase agricultural inputs, low price of agricultural produces etc.

The average size of holdings in India is only 1.31 ha. More than 76 percent of holdings own less than 2 ha. each. It is the small and medium farmers who share this small holdings but they constitute more than 70 percent of farming community. Small farmers with their small holding size and meagre income cannot afford to adopt fully improved agricultural technologies in their farming operations. Since agricultural inputs like HYV seeds, chemical fertilizers, pesticides, modern agricultural implements all are costly, their incomes fall short of purchasing these inputs. Moreover, small farmers find their holding size uneconomical in using many agricultural inputs like machines and tools which are important for modernization and mechanization of agriculture. It has been found that economic status and education level of farmers, irrigation facility, credit facility, other infrastructural facility, healthy market system are the main determinants of the adoption of new technology in agriculture. Poor economic condition and low education level along with institutional credit constraints, irrigation constraint, power constraint, low price constraint, market constraint, extension service constraint, cold storage constraint, knowledge constraint etc. create high cost of production for most of the farmers especially for small and the medium farmers. Large farmers as well as some medium farmers who have marketable surplus are also hard hit by fluctuating agricultural prices and more pronouncedly by low prices and by paucity of labour during the peak season. Due to the existence of these constraint factors, adoption of technology by tribal and non-tribal farmers in the district of Barpeta has been slow and interrupted and the degree of adoption of new technology has been different among large, medium and small farmers.

7.2 CONCLUSIONS

On the basis of results of present investigation, the following conclusions may be drawn:

(a) Most of the farmers, including of course small and medium farmers, are increasingly adopting new technology in agriculture. Income of the farmers, after adopting new culture practice has increased significantly than before. The farmers of the district under investigation are greatly influenced by modern technology and on the other hand, their dependence on modern technology has been increasing day by day. Most of the farmers, particularly non-tribal farmers, had the favourble attitude towards the adoption of new agricultural practices. Majority of them are acquainted with the components of new agricultural technology such as HYV seeds, irrigation, fertilizer, plant protection measures, modern agricultural implements like power tiller, pumpsets, spraying machine etc.

(b) Though most of the farmers in the study area are increasingly becoming modern agricultural technology minded, rate of adoption of technology by tribal farmers is much more lower than their non-tribal counterparts. It is the traditional outlook, illiteracy, lack of effective extension service about latest technology among the tribal farmers and comparatively larger holding size of majority of tribal farmers that are found working as impeding forces to adoption of modern agricultural technology.

(c) This study revealed that most of the farmers belonging to all categories in Barpeta district were increasingly using HYV seeds for which production of rice and vegetable has increased manifold in recent years. This investigation in Barpeta district found that use of fertilizers and irrigation was becoming a popular practice among the farmers of all categories. Not to speak of large farmers, even some small farmers were found having some agriculture machines and implements like pumping sets, spray machines etc. During field investigation, many farmers were found to begin using pumping sets as source of irrigation and this reduced their dependence on govt. irrigation which is insufficient and inconvenient for beneficiary farmers. After this investigation it can be concluded that all group of farmers are in the way of adoption of new technology though some strong socio-economic problems are present there.

(d) Lastly, we may conclude that since modernization and mechanization of agriculture through adoption of new agricultural practices is the only way to stepping up agricultural production, farmers irrespective of their caste, land size, income and level of education should leave traditional agriculture practices and should and must resort to improved agricultural practices to the extent possible for them.

7.3 SUGGESTIONS

On the basis of above analysis, the following policy measures can be suggested for adoption of new agricultural technology:

1. High yielding variety (HYV) seed is the first and basic component of new agricultural technology. Therefore, better quality of HYV seeds should be made available to the farmers through government agencies as well as private dealers at affordable prices. Sometimes, many private dealers are found selling inferior quality of seeds assuring the purchasing farmers of better results. But use of such seeds proves to be low productive and as such using farmers suffer losses. In such cases, government should take exemplary punishment against such dealers so that they do not get involved in such immoral practices in future. Of course, farmers, themselves should be

aware of such practices on their own and should report about such practices for proper steps.

2. The major cultivable area in Barpeta district is rain-fed area and water logging is common event particularly in rainy season. Sometimes crops of dwarf variety are submerged under water rendering crop fields unremunerative. Hence attempt should be made to evolve and supply tall variety of HYV seeds suitable for rain-fed area.

3. HYV technology for its success depends on inputs like fertilizer, irrigation, plant protection chemicals and some modern implements. Adequate arrangement should be made to supply these inputs well before the on set of the season at a reasonable rate or at a subsidized rate especially for poor farmers.

4. Modern agricultural technology is designated as seed-cum-fertilizer technology. In fact, HYV seeds can give higher yields only when recommended dose of fertilizer is used. But many illiterate farmers do not know about the dose to be used. Therefore, efficacious and judicious use of fertilizer should be initiated through extension worker and various media for the farmers. In this respect N.G.O.s can be made involved to educate the farmers about proper use of HYV seeds and fertilizer.

5. Assured irrigation is a must for HYV technology and it comprises an important part of modern agricultural technology. Recent experiences show that government canal irrigation has failed and it is shallow-tube well, pump set irrigation which is increasingly being used by farmers of all categories as source of irrigation. But small and marginal farmers can hardly afford to purchase costly pumpsets due to their poor economic condition. Therefore, arrangement should be made to supply pumping sets at subsidized rate especially at high subsidy for small and marginal farmers.

6. Hours of electricity supply to tube-wells and pumping sets in the villages should be increased at the convenience of farmers.

7. Supply of electricity to tube-well and pumping sets is inadequate and erratic. Most of the farmers using pumping sets have to use diesel as fuel. But due to high price of diesel, many farmers particularly small farmers cannot afford to purchase the required amount of diesel for fueling their pumpsets (as was reported by many farmers during field survey). It may be suggested that a differential pricing system favouring the farmers should be introduced.

8. In addition to the use of chemical fertilizers, farmers should be encouraged to use organic and compost manure. It is the organic and compost fertilizer and not the chemical fertilizers that can retain the original fertility and productivity of land. India is endowed with various forms of naturally available organic forms of nutrients in different parts of the country. These include green manure, crop residues, farmyard manure, biogas slurry, animal and human excreta, compost, vermin compost bio-fertilizer etc. Village level extension worker with necessary training should take responsibility of educating the farmers about organic and compost manure.

9. Field investigation revealed that excessive and non-judicial use of plant protection chemicals has resulted in environmental pollution. Residue of DDT, aldrine, lindane etc. have been found in different food samples (Bhattacharya and Bihari, 2003). Having taken cognizance of hazards associated with pesticides, emphasis should be given on biological pest management. This can be done either through cultural, biological or organically accepted chemical alternatives.

10. The concept of food quality has changed during the recent years. Increasing number of consumers in developed and developing countries are becoming more health conscious. They have been spending on greener, healthy and natural food products. The international market for organic foods are expanding specially in U. S. A., Europe and Japan. Our country is uniquely placed for organic cultivation due to various agro-climatic regions. Assam being a rain-fed area has good opportunities to take up production of organic food for export and consumption locally.

11. To minimize the harmful impact of rain-fed farming, making forecast of rainfall and fore warning of pests and diseases to the farmers, as suggested by the Swaminathan Committee (2003), may be beneficial to the farmers.

12. To uplift the economic conditions of the poor farmers, their investment needs for modern agricultural technology shall have to be fulfilled through institutional finance. Some more branches of Commercial Banks are to be opened particularly in rural areas to minimize the number of population covered by each branch. Efforts should be made to enhance the present poor credit deposit ration in the survey area by extending more credit to the people. Attempt should be made to prompt delivery of the loan amount to the applicants by simplifying the loan formalities. The existing credit facility is more or less asset based and many farmers having no collateral are denied credit facilities. Therefore, a procedure of need based and asset free credit facilities should be introduced on preferential basis.

13. There are several programmes sponsored by government to promote adoption of improved technologies such as watershed development programme, artificial insemination programme, drought prone area programme etc. But many farmers do not have the information of these programmes. Therefore, effective measures should be taken for disclosing those programmes to the farmers.

14. Adoption and efficient utilization of technology depends upon the knowledge and education of the farmers. Majority of our farmers are still ignorant and illiterate and to a considerable extent they are governed by traditional belief. Government should provide more education facilities on the preferential basis for the farmers.

15. A special cell should be established at the village level to look into the socio-economic problems of small and marginal farmers and to make all efforts to raise the standard of living of the unviable farmers.

16. The actual reasons for slow spread of adoption of agricultural technology is that new innovations are not communicated properly to the farmers and interior villages. Field investigation showed that almost cent percent tribal small and medium farmers were not aware of new innovations, i.e., new innovations are not disseminated among them. Many farmers particularly tribal small farmers reported that they had not even heard the name of village level extension workers. The main reason as was found during field investigation, of slow adoption of new agricultural technology by the tribal farmers is lack of effective dissemination of new agricultural technology. Demonstrations of improved agricultural technology should be made broad based and that small and medium farmers rather than large ones should be selected for demonstration. Village level trained extension worker should be made responsible for carrying out practical work in these decentralised demonstration. Recently some NGOs are seen to have formed in some villages. NGOs with necessary training can also be made involved to disseminate new innovations among the farmers of their respective areas.

17. There is need to establish proper coordination among all the extension agencies working for the welfare of the farmers so that all the isolated efforts are pooled together in a more effective manner.

18. As many other fields of development, in the field of agricultural marketing also, we find ourselves in a vicious circle. Since agriculture in this region has been still more or less at a subsistence level with small surplus for sale, agricultural marketing system has not properly developed. But, unless an efficient marketing system comes about, it will be difficult to lift the region's agriculture above the existing subsistence level and commercialization of agriculture can never be promoted. An efficient marketing system has direct bearing on the growth and diversification of agricultural products.

19. Creation of proper storage facilities has a greater dimension in the context of post harvest loss of some agricultural products like food grains, vegetables etc. The percentage of post-harvest loss of food grains in the North Eastern

Region is believed to be higher than the estimated national average of 9.33% due to frequent natural calamities and absence of proper warehouses (Das, 1989). Therefore, provisions of storage/cold storage facilities for food grains and vegetables should receive greater attention. As the vegetables are highly perishable in nature, apart from careful handling and quick transportation, these need good storage facilities. Commercial cultivation of vegetables with refrigerated storage and processing facilities and scientific marketing would go a long way in encouraging the commercial vegetables growers to produce more to meet domestic requirement.

Marketing reform ought to be an integral part of any policy for economic development. Marketing is as important for better performance in agriculture as production effort itself, since only through adequate marketing facilities, producers will be encouraged to produce surplus for sale. For generating investment in agriculture and other sectors, there is need for saving in the rural sector. Unless there is surplus for sale, it will be difficult to ensure savings to generate investment in rural sector. Only through provision of efficient marketing facilities, it will be possible to sell the surplus produce at remunerative prices. And in this context, it will be appropriate to quote a few lines from Dr. Dubhashi: " after all, mere increase in agricultural production is neither the goal of the planner nor of the producer. Indeed production is not complete till it reaches the consumer and agricultural producer will not be rewarded unless the consumer buys it and pays an adequate price for it. The process of production ends only with final consumption and it is marketing which provides a link between production and consumption."

We can hope that if the suggestions offered are followed farmers will be benefited to a great extent through the accelerated growth of agricultural productivity.

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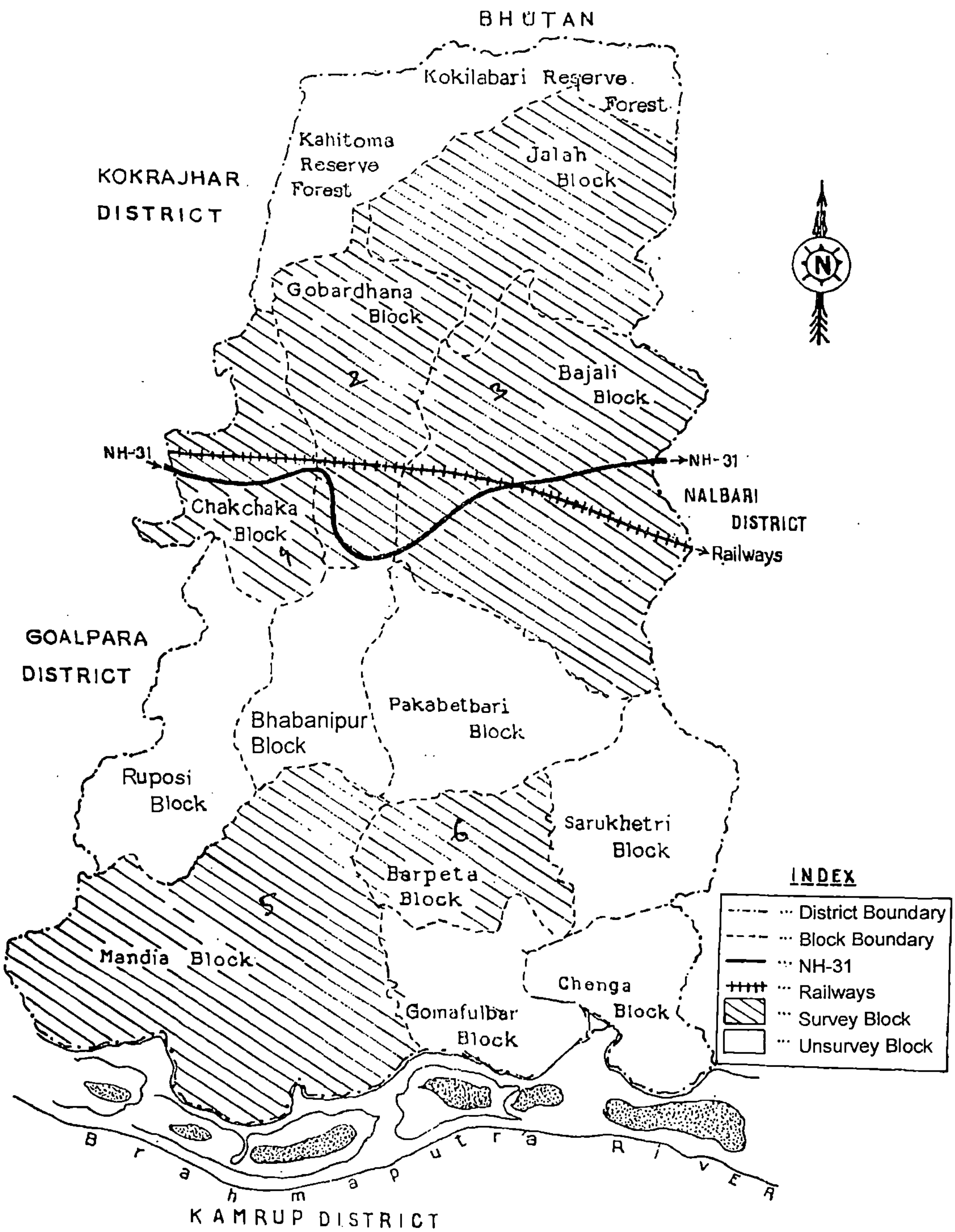
MAP SHOWING THE STUDY AREA IN BARPETA DISTRICT IN ASSAM



APPENDIX I

A PROFILE OF BARPETA DISTRICT

For the purpose of the present study particularly, for obtaining data with which to empirically test the related hypotheses, Barpeta district has selected. It enjoys certain distinctive features with regard to socio-economic as well as climatic factors. The following are the main characteristic features of the district:

1. Situation

The Barpeta district of Assam is located between 26°5' and 26°51' North latitude and 90°38' East longitude. The district boundary is demarcated by Kamrup and Goalpara districts in the South, Nalbari district in the East, and Kokrajhar and Bongaigaon districts of Assam in the West, while Kingdom of Bhutan lies in the North. The district occupies a geographical area of 3245 sq. km. Land is characterized by almost plain topography with a gradual slope toward South. The altitude varies from 200 m in the north, along~ the foothills of Bhutan, upto 18 m from MSL along the riverine plains. Major parts of the district falls in the active flood zone.

2. Climate, Topography and Soil

Climate: Barpeta district falls within lower Brahmaputra valley (North-West) agro-climatic sub-zone, characterised with prevalence of tropical humid climate. The area experiences hot-summer followed by relatively prolonged rainy seasons with heavy rainfall. Winter months are relatively cooler and normally dry. Meteorological data relating to the district is shown in table 1.

Table 1. Meteorological Data Relating to Barpeta District

Months	Rainfall		Temperature °C		Relative humidity (%)	
	mm	No. of days	Max	Min	830 hr	1730 hr
Jan	19.4	3	27.8	8.8	87	67
Feb	30.0	6	28.3	10.3	80	54
Mar	123.8	10	35.8	12.3	75	56
Apr	156.4	17	35.9	17.7	74	62
May	164.9	18	38.1	19.5	74	68
Jun	348.8	22	36.8	22.8	85	80
Jul	199.8	19	37.3	24.0	82	76
Aug	317.8	21	37.0	24.0	84	82
Sep	28.2	10	35.7	21.4	79	79
Oct	141.5	7	33.8	17.8	85	81
Nov	6.6	3	30.3	12.4	85	77
Dec	Nil	-	26.6	9.0	88	74

Source: Meteorological observatory, Guwahati Airport, 2003

Topography : The topography of the district is generally plain but uneven. Only Baghbar hill is situated at Mondia Development Block, but foot hills of Baghbar hill is very low due to erosion of land by the mighty river Brahmaputra flowing through this district and its tributaries namely Beki, Manas, Polla, Pahumara, Kaldia and Tihu are also flowing through this district. The river Kaldia and Tihu meet with Pahumara river.

Soil : Soils in the district have been originated from the rocks of Archaen gneissic complex.

There are three major soil types.

They are :

(a) Younger Alluvial Soils: This type of soil is prevalent in the southern part, light textured (sandy loam) highly fertile, neural in reaction (pH 6.8 to 7.2).

(b) Old Alluvial Soils: This type of soil is prevalent in the central zone extended towards north. It is medium textured and slightly acidic to neutral (pH 5.8 to 7.2).

(c) Mountain Valley Alluvial Soils: This type of soil is predominant in the northern parts along the foothills of Bhutan, extended towards south. Medium to heavy textured (Clayey) acidic in reaction (pH 4.5 to 5.8).

Population:

1.	Total population	:	1642420
	Male	:	846106 (51.53%)
	Female	:	796314 (48.48%)
2.	Rural population	:	1517280 (92.38%)
	Urban population	:	125140 (7.62%)
3.	Schedule Tribe	:	123266 (7.48%)
	Male	:	61586
	Female	:	61.680
4.	Schedule Caste	:	93861 (5.70%)
	Male	:	48694
	Female	:	45167
5.	Total literate persons	:	769225 (46.83%)
	Male	:	456870 (27.82%)
	Female	:	312355 (19.01%)
6.	Total Workers	:	517088 (31.48%)
	Male	:	404737 (24.62%)
	Female	:	112351 (6.84%)
7.	Cultivators	:	209834 (12.77%)
	Male	:	175155 (10.66%)
	Female	:	34679 (2.11%)

8.	Agricultural Labour	:	81929 (4.99%)
	Male	:	60311 (3.67%)
	Female	:	21618 (1.31%)
9.	Other Workers	:	197890 (12.04%)
	Male	:	158740 (9.66%)
	Female	:	39150 (2.38%)
10.	Density of Population	:	506 per sq. km.
11.	Sex ratio (Female per 1000 male)	:	941

Source: Population Census, 2001.

N. B. *Figures within parentheses are percentage of total population.*

Land Use Pattern : In Barpeta district 65.96% of the total geographical area i.e., 2,14,042 hectare is cultivable of which 85.23% i.e., 1,82,445 ha is under cultivation. Percentage of land utilization is higher in Barpeta district than any other part of Assam. Table 2 shows the land utilization pattern in Barpeta district.

Table 2. Land Utilization Pattern

Sl. No.	Description	Unit	Value	Percentage of geographical area
1.	Geographical area.	Sq. km	3245	100.00
2.	Reporting area	Ha	322812	99.48
3.	Area under forest	Ha	57000	17.57
4.	Land put to non-agricultural use	Ha	19000	5.86
5.	Uncultivable land	Ha	32747	10.00
6.	Cultivable waste land	Ha	2000	0.62
7.	Fallow land	Ha	29597	9.12
8.	Net sown area	Ha	182,445	56.22
9.	Total cultivable land	Ha	214042	65.96

Source: Director of Economics & Statistics, Govt. of Assam.

Water Resources : Major parts of the district fall in the active flood zone. The whole district is having a shallow groundwater table. Besides a number of perennial rivers namely Tihu, Pahumara, Palla, Beki and Bhalukadoba, which have origins in Bhutan, flow through the district in the north-south direction to join the mighty river Brahmaputra. As per estimates of the Assam Remote Sensing Application Centre (ARSAC) water bodies formed by rivers cover 39,562 ha in the district. In addition to this there are 784 ha of water spread area locally known as beels. There are large number of ponds in the district which are being used for piscicultureal purposes.

Economy : The economy of the district is basically agrarian. Agriculture is the mainstay of the people and therefore it is the largest enterprise. The district is poor in industrial development. Fishery, animal husbandry, and sericulture are among the subsidiary economic activities. The district represents the typical feature of the underdeveloped agrarian economy of the country with following characteristics :

(i) almost subsistence level of farming;

(ii) low revenue generation from land resource;

(iii) lack of major industrial enterprises, excepting a few agro-based industries;

(iv) high degree of unemployment and underemployment particularly among the rural youth;

(v) high degree of poverty. It is estimated that more than 40 per cent of the population is living below the official poverty line.

Social Infrastructure : There are 5 hospitals, 36 primary health centres, 18 dispensaries, 9 rural family welfare planning centres and 351 sub-centres in the district. The district is also having 1841 L. P. School, 40 M. V. School, 356 M. E. Schools and Madrasah, 157 High School and High Madrasah, 41 Higher Secondary Schools, 29 Colleges, 01 D. I. E. T., 1 Normal School, 2 Basic Training School, 2 Teachers Training College for education. (Source : DEEO Office, Barpeta).

APPENDIX II

A PROFILE OF BLOCKS OF BARPETA DISTRICT

No. of households, population and literacy in different blocks in Barpeta I district as per 1991 census.

Name of Block No. of households. Population Literary

Male Female Total Male Female

Name of block	No. of households	Population			Literacy	
		Male	Female	Total	Male	Female
1. Jalah Dev.Block	23476	75018	72790	147808	37422 (49.88)	22231 (30.54)2
2. Bajali Dev.Block	18938	61280	59080	120360	40619 (66.28)	28950 (49.00)3
3. Gobardhana Dev. Block	26522	84242	77965	162207	30285 (35.95)	15626 (20.04)
4. Rupsi Dev.Block	26310	83588	78141	161729	29793 (35.64)	16873 (21.59)
5. Barpeta Dev.Block	27640	91708	85875	177583	38549 (42.03)	22380 (26.06)
6. Bhowanipur Dev.Block	25054	81632	75812	157444	33356 (40.06)	18672 (24.62)
7. Chenga Dev.Block	19972	68417	64335	132752	23028 (33.65)	13105 (20.36)
8. Mondia Dev.Block	34193	118117	110341	228458	28058 (23.75)	11006 (9.97)

Note: Figures in the brackets show percentage of literacy of male and female in each block. ,

N.B.: Chachaka Dev. Block, Pukabetbari Dev. Block, Sarukhetri Dev. Block and Gumafulbari Dev. Block were formed after 1991 and hence data relating to total households, population and literacy in each block is not found in correct form.

Source: Rural Primary Census Abstract (P.C.A) 1991 D.C.'s Office (Dev. Branch) Barpeta.

APPENDIX III

A Profile of Circles in Barpeta District

Name of Circle	No.of House-holds	Total population	Male	Female	Schedule Caste	Male	Female	Schedule Tribe	Male	Female	Literacy	
											Male	Female
Barnagar	59657	323555	166746	156809	25315	13221	12094	27283	13641	13642	92218	63705
Kalgachia	24515	148199	77221	70978	381	199	182	0	0	0	30145	18954
Baghbar	48478	295402	152502	142900	5295	2722	2573	62	30	32	50274	26933
Barpeta	63081	356686	184072	172614	25955	13355	12580	1674	828	846	99881	70157
Bajali	18324	99540	50817	48723	7065	3569	3496	5746	2914	2832	41812	33402
Sarupeta	29891	163514	83884	79630	11171	5786	5385	33853	16905	16948	50824	34838
Jalah	17928	96337	48475	47862	1702	830	872	45379	22572	22807	33432	23688

Source : Census Report furnished by Development Branch, DC Office, Barpeta.

Note : Data relating to Chenga and Sarthabari Circles are not available separately.

APPENDIX IV A

A Profile of Survey Villages (Non-Tribal)

Name of Villages	No. of House-holds	Total population	Male	Female	Schedule Caste	Male	Female	Schedule Tribe	Male	Female	Literacy	Male	Female
Nichuka	1077	5784	2992	2792	151	81	70	0	0	0	1819	1136	683
Khoirabari	1686	9488	9463	4525	2314	1205	1109	0	0	0	3219	1863	1356
Gandharipara	561	3170	1676	1494	0	0	0	0	0	0	1327	795	532
Moutupri	201	1118	597	521	0	0	0	18	12	6	854	485	369
Mandiagaon	443	2522	1309	1213	442	218	224	0	0	0	1310	792	518
Anandapur	563	3342	1769	1573	0	0	0	0	0	0	1326	835	491

APPENDIX IV B

A Profile of survey villages (Tribal)

Name of Villages	No. of Households	Total population	Male	Female	Schedule Caste	Male	Female	Schedule Tribe	Male	Female	Literacy	Male	Female
Oxiguri	283	1632	804	828	0	0	0	1342	647	595	598	373	225
Labdanguri	317	1883	965	918	0	0	0	996	488	508	855	530	325
Majrabari	394	2080	1041	1039	197	100	97	1878	938	940	968	595	373
Pakrigurigain	407	2072	1066	1006	0	0	0	1022	511	507	942	582	360
Salbari	222	1160	610	550	197	100	97	786	408	378	626	404	222
Dhumarpathar	280	1630	809	826	0	0	0	1500	740	760	701	385	316

Source: Census Report (2001) furnished by Development Branch, D. C. Office, Barpeta.

APPENDIX V

Losses Caused by Plant Diseases

Sl. No.	Name of Crops	Name of Diseases	Probable Annual Loss %
1.	Paddy	Blast, leaf spot and root rot	10
2.	Wheat	Rust, Smuts, bunts	10
3.	Barley	Rust and Smut	5
4.	Jowar	Grain Smut	1
5.	Bajra	Green ear disease	1
6.	Gram	Blight and wilt	5
7.	Ragi	Smut	5
8.	Sugarcane	Red rot wilt and Cane Smut	10
9.	Groundnut	————	—
10.	Cotton	Wilt and root rot	25
11.	Jute	Stem rot	5
12.	Sesamum	Wilt and other minor disease	1
13.	Rape and Mustard	————	—
14.	Linseed	Rust and Wilt	10
15.	Tobacco	Virus disease	10

APPENDIX VI

Losses Caused by Pests

SL No.	Name of Crops	Name of Pest	Probable Annual Loss %.
1.	Paddy	Stem borer, Sucking insects, Green-hoppers	15
2.	Wheat	Termites, Stem borers, Sucking insects	3
3.	Barley	Sucking insects	3
4.	Jowar	Stem borer, Sucking insects	15
5.	Maize	Stem borer, Sucking insects	15
6.	Bajra	Do	10
7.	Gram	Leaf eating Cater Pillers	10
8.	Ragi	Stem borer, Sucking insects	10
9.	Sugarcane	Borers, Sucking insects	10
10.	Gronudnut	Leaf eating Cater pillers	10
11.	Cotton	Leaf eating Cater Pillers, Borer, Sucking insects	15
12.	Jute	Do	5
13.	Sesamum	Do	5
14.	Rape and Mustard	Sucking insects	10
15.	Linseed	Linseed fly	10
16.	Tobacco	Sucking insects	10

Source: Pesticide Association of India, 2001

APPENDIX VII

A List of Rural Markets

Dist. Barpeta

Sl. No.	Name of the Rural Market	Periodicity of Rural Markets		Regulated	Village Market
		Weekly/Biweekly/ Triweekly/Seasonal	Cattle Market		
1.	K.B. Paharpur Bazar	Weekly	-	-	Do
2.	Jadavpur Bazar	Weekly	-	-	Do
3.	Digirpam Charali (Naya Bazar)	Weekly	-	-	Do
4.	Palarpam (Sargaon)	Weekly	-	-	Do
5.	Gopalhat	Weekly	-	-	Do
6.	Manikpur Satrakara	Weekly	-	-	Do
7.	Manikpur	Weekly	-	-	Do
8.	Alirpam Bazar	Weekly	-	-	Do
9.	Baghbar hat	Weekly	-	-	Do
10.	Daharhat	Weekly	-	-	Do
11.	Jahanarpathar	Weekly	-	-	Do
12.	Moinbori hat	Weekly	-	-	Do
13.	Sonabori hat	Weekly	-	-	Do
14.	Balukuri	Weekly	-	-	Do
15.	Sikartari Tarakandi Bazar	Weekly	Cattle Market	-	Do
16.	Alupatima Bazar	Weekly	-	Regulated	Do
17.	Saysima Bazar	Weekly	-	-	Do
18.	Meghibartari	Weekly	-	-	Do
19.	Balikuri	Weekly	-	-	Do
20.	Janata Bazar	Weekly	-	-	Do
21.	Sarbasara Bazar	Weekly	Cattle Market	-	Do
22.	Janaribari Bazar	Weekly	-	-	Do
23.	Saurachara pathar	Weekly	-	-	
24.	Rabibhata Bazar	Weekly	-	-	Do
25.	Bartari Bazar	Weekly	-	-	Do
26.	Chakchaka Bazar	Biweekly	-	-	Do
27.	Bhalukadaba Bazar	Biweekly	-	-	Do
28.	Chandamari Bazar	Biweekly	-	-	Do
29.	Khandakarpara Bazar	Biweekly	-	-	Do
30.	Jaipur Bazar	Biweekly	Cattle Market	-	Do

31.	Garimari Bazar	Weekly	-	Regulated	Do
32.	Patmjagaon	Weekly	-	-	Do
33.	Saderi Bazar	Weekly	-	-	Do
34.	Denartari	Weekly	-	-	Do
35.	Dhumarkur Bazar	Weekly	-	-	Do
36.	Saparbari	Weekly	-	-	Do
37.	Barala	Weekly	-	-	Do
38.	Chaolabori Bazar	Weekly	-	-	Do
39.	Batua	Weekly	-	-	Do
40.	Bhalaguri Bazar	Weekly	-	-	Do
41.	Mahamaya Bazar	Weekly	Cattle Market	-	Do
42.	Bhola Bazar	Weekly	-	-	Do
43.	Bongachara	Weekly	Cattle Market	-	Do
44.	Chukringbari	Weekly	,,	-	Do
45.	Bagariguri Pahar	Weekly	,,	-	Do
46.	Bhangramari	Weekly	,,	-	Do
47.	Kamargaon	Weekly	-	-	
48.	Chayakamar	Weekly	Cattle Market	-	Do
49.	Bhabari	Weekly	,,	-	Do
50.	Kalpani	Weekly	,,	-	Do
51.	Gobardhana	Weekly	,,	-	Do
52.	Kaljar	Weekly	,,	-	Do
53.	Khursabari Bazar	Weekly	,,	-	Do
54.	Bilashipara Bazar	Weekly	,,	-	Do
55.	Goagacha Bazar	Weekly	,,	-	Do
56.	Gaduligaon hat	Weekly	-	-	Do
57.	Barpam hat	Weekly	-	-	Do
58.	Dangrigaon	Weekly	-	-	Do
59.	Nowbutakalindry Bazar	Weekly	-	-	Do
60.	Kadamtala garua	Weekly	-	-	Do
61.	Ghangpana nowsla hat	Weekly	-	-	Do
62.	Daodhora hat	Weekly	-	-	Do
63.	Kamndausha	Weekly	-	-	Do
64.	1 No. Rupahi hat	Weekly	-	-	Do
65.	Salbari Bazar	Weekly	-	-	Do
66.	2 No. Rupahi hat	Weekly	-	-	Do
67.	Barangabari Bazar	Weekly	-	-	Do

68.	Barbori Bazar	Weekly	-	-	Do
69.	Nagaon	Seasonal	-	-	Do
70.	Bagodi	Seasonal	-	-	Do
71.	Gahia	Seasonal	-	-	Do
72.	Sakirbhitha	Seasonal	-	-	Do
73.	Keotkuchi	Seasonal	-	-	Do
74.	Palhaji	Seasonal	-	-	Do
75.	Chilta Bazar	Seasonal	Cattle Market	-	Do
76.	Barbala Bazar	Seasonal	,,	-	Do
77.	Sarthebari	Seasonal	-	-	Do
78.	Neularbhitha	Seasonal	-	-	Do
79.	Bongaon	Seasonal	-	-	Do
80.	Helona	Seasonal	-	-	Do
81.	Dubi	Seasonal	-	-	Do
82.	Raha	Seasonal	Cattle Market	-	Do
83.	Ghugulari Bazar	Seasonal	Cattle Market	-	Do
84.	Kalgachaya	Biweekly	-	-	Do
85.	Balapathar	Seasonal	-	-	Do
86.	Lachenga Bazar	Seasonal	-	-	Do
87.	Odalguri Bazar	Seasonal	-	-	Do
88.	Patacharkuchi	Biweekly	-	-	Do
89.	Kharadhara Bazar	Biweekly	Cattle Market	-	Do
90.	Nityananda	Biweekly	-	-	Do
91.	Jalah	Biweekly	-	-	Do
92.	Baghmara Bazar	Biweekly	-	-	Do
93.	Bahari hat	Weekly	-	-	Do
94.	Puthimari	Weekly	-	-	Do
95.	Palhaji	Weekly	-	-	Do
96.	Chaltia	Weekly	-	-	Do
97.	Ghungumari Bazar	Biweekly	-	-	Do
98.	Nangla Bazar	Biweekly	-	-	Do

Source: District Marketing Officer, Barpeta, Assam.

APPENDIX VIII

STATEWISE LEVEL OF BASIC INFRASTRUCTURAL ITEMS DURING 1993

State	Power		Irrigation		Transport		Fertilizer	Credit and Finance	Health		Marketing		Agri-culture Extension	Agriculture Research
	Percentage of villages Electrified	share of agri in percentage	Irrigated area in percentage	Number of tubewells per 100 hect	Road length per 100 sq kms in kms	Number of transport vehicle per 100 sq kms	Number of depot per 100 hect	Number of Rural banks per lakh population	Beds in Rural hospital (per million population)	Rural infant mortality rate	Number of market (per 100sq kms)	Storage facility as percentage of total food grains prod	Worker Per Million Rural Population	Agri-cultural Scientist Per Million Hect
Andhra Pradesh	100.0	40.25	38.5	13.6	53.3	73.10	1.11	5.15	72.7	88	2.9	33.0	97.0	152
Assam	89.0	2.34	21.1	0.1	33.6	104.70	2.02	4.15	140.0	111	2.2	15.8	140.0	180
Bihar	70.6	21.72	46.7	3.6	49.2	86.70	1.72	4.48	30.9	102	2.5	3.0	560	139
Gujarat	100.0	36.85	27.6	5.6	53.9	191.80	1.28	5.70	102.2	104	1.9	58.4	145.0	112
Haryana	100.0	49.53	75.6	11.5	60.0	167.10	1.78	5.30	34.0	91	6.5	27.9	143.0	459
Himachal Pradesh	100.0	2.76	17.9	0.7	45.9	28.80	6.13	12.38	108.7	90	0.7	3.3	218.0	1027
Jammu and Kashmir	95.0	10.16	42.8	0.5	5.9	49.10	2.74	8.31	53.6	86	0.8	6.8	298.0	68
Karnataka	100.0	36.37	20.3	8.2	67.7	69.00	1.07	6.94	86.0	82	3.5	12.2	173.0	460
Kerala	100.0	4.05	14.9	12.0	356.7	462.10	3.42	2.20	123.3	28	8.9	80.0	116.0	327
Madhya Pradesh	92.0	22.67	24.4	5.2	32.1	23.60	0.75	5.45	23.1	124	1.4	19.5	258.0	65
Maharashtra	100.0	25.20	13.7	9.8	73.0	90.60	1.22	4.75	142.3	73	2.7	32.0	130.0	137
Orissa	70.7	4.83	32.8	1.0	126.0	38.80	1.85	5.47	86.5	127	1.0	10.5	259.0	105
Punjab	100.0	44.27	93.3	15.7	107.8	196.40	1.95	7.21	233.5	71	13.2	54.5	293.0	241
Rajasthan	83.4	30.69	26.4	2.6	36.3	43.90	0.42	5.36	31.4	110	1.1	21.5	135.0	74
Tamil Nadu	100.0	25.50	46.4	2.7	152.3	201.45	3.40	4.93	127.7	93	2.3	20.0	135.0	204
Uttar Pradesh	75.4	39.30	65.6	4.1	69.2	55.21	3.72	4.54	21.8	140	2.2	13.6	24.0	150
West Bengal	75.8	6.96	35.8	1.8	70.0	243.00	6.80	4.19	146.8	75	2.4	14.5	45.0	90
All-India	84.0	28.20	35.2	7.0	62.1	108.66	1.81	4.23	96.8	105	2.4	21.4	95.4	155

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APPENDIX IX

QUESTIONNAIRE

Name of the Survey village :

J.L. ((Mouza) No. :

Name of the Block :

Name of the P.S. :

1. Name of the respondent :
2. Father's name :
3. Age :
4. Educational Qualification :

(a) Special Qualification, if any :

5. Profile of household members :

a) No of members	b) Male	c) Female	d) Working members

6. Literacy :

Male		Female	
Age	Educational level	Age	Educational level

7. Land holding :

(a) Amount of owned land (in bighas) :

(b) Leased in land (in bighas) :

(c) Leased out land (in bighas) with reason :

8. Irrigation :

a) Land irrigated (in bighas) :

b) Unirrigated land (in bighas) :

c) sources of irrigation :

9. Have you adopted HYV seeds ?

a) Yes/No b) If yes, fully or partially ?

c) If not, why ?

i) Lack of irrigation

ii) Lack of credit facilities

iii) Due to high risk

iv) Lack of knowledge/information

v) Any other reason, specify

10. Do you use pesticides ? Yes/No.

: a) If yes, why ?

i) For multiple crops ?

ii) cost incurred per each crop season (Rs.) :

11. What type of Machineries/implements do you use ?

a) Traditional / Modem/ Mix of traditional and Modem

b) If only traditional, why ?

i) Modem implements unnecessary.

ii) Modem implements costly

iii) Lack of purchasing capacity .

iv) Lack of knowledge of application.

v) Any other reason implements.

12. No. of modem implements:

Tractor	Power tiller	Pumpsets	Threshers	Sprayers	Others

13. Expenditure on purchase of Machineries/Implements (Rs.)

Years Rs.	Years Rs.	Years Rs.	Years Rs.

14. Crops grown, production and asproductivity.

a) paddy (Aman, Boro, Aush), Wheat, Vegetables and other crops :

Name of crop	Variety Traditional Modem	Quantity of land employed	Productivity (per bigha)	Total production	Pricr/quintal

15. Cropping Intensity :

a) No. of crops g!own in a particular plot of land in a year, cropwise –

Aman	Aush	Boro	Vegetables	Wheat	Jute	Mustard	others

b) Do you practise Mixed Cropping? If yes, for which crops and in what seasons?

c) Cropping seasons of farmers.,

i) Aman :

ii) Aush :

iii) Boro :

iv) Potato :

v) Cabbage

vi) Cauliflower :

vii) Mustard seeds :

viii) Others :

16. Credit facilities :

a) Do your require credit for production and marketing of produce ? Yes/No

b) If yes, how much for each agricultural crop season ? :

c) have you got any credit facility ? if yes, mention the sources :

Source	Formal	Informal	year	Amount	Rate of interest	Terms and conditions

d) If there is any additional information about the sources/availability of credit:

e) Whether the available credit from both sources adequate?

17. Marketing facility:

a) What type of marketing facilities are available ?

i) Hats

ii) Regulated Markets

iii) Daily local market

iv) Kutcha/ Pucca roads.

v) Others, specify .

b) Whether there is any cold storage nearby? Yes/No

c) Whether present marketing network is satisfactory? If not, what more should be done?

18. Cost of production cropwise (Rs.) per bigha.

a) Paddy

b) Vegetables c) Jute

d) Wheat

e) Mustard seed

f) Others, specify :

19. Risks involved in production and marketing

a) Type of risks :

b) Measures to avoid risks :

(i) Personal (ii) Governmental

c) Suggestions for Minimisation of risks :

20. supply of inputs :

a) Sources of supply.

i) governmental (ii) personal (Traders/Agents/Businessman).

b) Whether supply is adequate? Yes/No

c) Suggestions for improvement of supply of inputs.

21. Use of Labour :

a) How much labour is required per day in each crop season :

b) Whether demand for labour has increased or decreased after the adoption of new F Machines/Implements? Yes/ No.

If yes, how much?

c) Whether demand for labour increased or decreased due to the introduction of biological innovation, like HYV seeds, fertilizers, pesticides etc.

d) How much the demand for labour has increased due to multiple cropping?

e) Any other information.

22. Since when (specify the year)

a) New implements/machines have been introduced?

b) New biological innovations have been adopted?

c) Advantage of use of new implements

d) Disadvantages, if any, of the new implements.

e) Advantages of use of new bio-technology

f) Disadvantages if any of the new biotechnology.

23. Whether gross/net income has increased due to the adoption of new technology.

24. Income :

From crop production	Business	Service	Other services	Total

25. Amount of fertilizer used for specific crop/ bigha (in kg).

	Urea	Potash	Nitrogen	Other manure	Org. manure
Aman					
Boro					
Cabbage					
Cauliflower					
Brinjal					
Chilly					
Other vegetable					
Mustard seeds					
Jute					
Wheat					
Others					

26. From where do you get the information about new technology ?

i) Input suppliers?

ii) Progressive favours?

iii) Govt. Agencies ? Specify .

iv) NGO's ?

v) Mass media ?

vi) Others? Specify.

27. Do you have to incur any cost for gathering information ? Yes/No.

28. Do you treat the available information credible ? Yes/ No.

29. Do you integrate indigenous knowledge and new information ? Yes/No 30. Do you have knowledge about your resource endowments ?

i) About soil fertility status

ii) Water quality

iii) Sustainability of agriculture with improved technology

iv) Soil Microbes

v) Others

31. Do you apply fertilizer based on soil testing ? Yes/No.

32. Do you apply Water Judging ?

33. Do you have the problems of ?

i) Soil erosion?

ii) Soil salinity

iii) Water logging ?

iv) The declining water table etc ?