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.