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. Introductiön 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.