CHAPTER FIVE

FACTORS AFFECTING ADOPTION OF THE NEW AGRICULTURAL TECHNOLOGY — summary of findings of some relevant studies.

V.1 Farmers' adoption of any agricultural innovation, which may be comprised of a single improved practice or a package of such practices, depends primarily on 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 conditions. In other words, the extent of adoption will differ from farmer to farmer depending on the socio-economic and physical condition of farming. For instance, the adoption pattern of the new agricultural technology in India has been found to have varied across crops, seasons, regions and categories of farmers. A lot of research has been done to understand and explain the uneven diffusion of the high yielding variety seed based new technology in the country. The present chapter is an attempt to summarise the findings of some of these works.

V.2 Difference in the rates of adoption of high yielding varieties of wheat and rice.

Studies, as well as statistics, reveal that the adoption rate of high yielding varieties of wheat has been generally much faster (in the sense of time lag between introduction of a variety and its adoption by farmers) and higher (in terms of the proportion of area under H.Y.V.s in
the total acreage of the crop) than that of the new rice varieties. As a consequence of higher and faster adoption of H.Y.V.s by the wheat farmers, wheat has been able to contribute far more substantially than rice to the growth of foodgrain production in India since the introduction of these varieties in the mid-1960s. Analysing the trends, in foodgrain production in India in the post 'Green Revolution' period P.S. George and V.V. Chaukidar found that while wheat had contributed about 56% of the total increase in cereal production during the period 1964-65 to 1970-71, the contribution of rice towards this increase was only 18%.

The difference in the rate of adoption of H.Y.V.s of wheat and rice has been attributed more to economic and technical factors than to any greater inherent progressiveness of wheat farmers. According to Shymal Roy, 'low net profit per acre of H.Y.V. paddy relative to H.Y.V. wheat mainly accounts for the slower spread of area under H.Y.V. paddy'. Technically, H.Y.V.s of rice - particularly the ones which were introduced in the early years under the new agricultural strategy, in contrast with those of wheat, have been found to be 'more susceptible to bacterial diseases, more sensitive to photoperiod and more subject to risks and uncertainties in agriculture. Being a kharif crop in most parts of the country it presents a serious water management problem and for these reasons' according to A.S. Kahlon, 'the adoption rates of these varieties is much lower than that of the new wheats.' W. David Hopper and Wanye
Freeman found that the two varieties on which the H.Y.V.P. of rice was built initially did have characteristics which slowed their diffusion. 'But', they added, 'the rapid spread of T.N.-1 and I.R.-8 in just two seasons indicates clearly that the rice farmers is willing and anxious to innovate - all he needs is an annual supply of inputs capable of underpinning a profitable transformation of his agriculture.' D. Gohain's study based on a sample of hundred farmers from Sibsagar district of Assam, predominantly a rice growing area, also confirms that farmers donot lack enthusiasm for H.Y.V.s. But nevertheless, he found that the area allocated to H.Y.V.s constituted a very small part of their total cultivated area. 'This', according to Gohain, 'is due to the fact that H.Y.V. production is not very much higher than local improved varieties like Manohar Sali and Prasad Bhog, while the former are more susceptible to disease, flood etc.' In this context R.Barker makes some interesting observations while examining a possible declining trend in the yield rates of H.Y.V.s with the increase in the number of farmers adopting them and in the extent of their area sown. He finds that the decline in the yield difference between the traditional and the modern varieties with the greater adoption of H.Y.V.s is not so much due to fall in the absolute productivity of H.Y.V.s as for the increased yield rates of the traditional varieties. Adoption of modern varieties is usually accompanied by adoption of other improved practices such as application of complementary inputs like fertilizers and pesticides in
higher doses and more intensive crop care. With the widespread adoption of modern varieties farmers tend to extend these accompanying improved practices to traditional varieties as well. Thus with the wide adoption of H.Y.V.s 'the traditional varieties also benefit from higher levels of inputs and care and hence their yields tend to increase.'

V.3 Difference in the adoption rates of modern rice varieties in the dry and the wet seasons.

Considerable difference has been observed in the rates of adoption of modern rice varieties between the dry and the wet seasons. G. Parthasarathy and D.S. Prasad found from their study in Andhra Pradesh, India, that the progress of H.Y.V.s of rice was much slower in the wet kharif season than in the dry rabi season. They rationalise the difference in terms of economic factors of costs and productivity. They argue that the yields of H.Y.V.s in kharif and rabi seasons do not differ significantly while those of local varieties are much less in the rabi season. The H.Y.V.s, which require greater cost per hectare than local varieties, therefore do not fare very well in the wet kharif season compared to the established local varieties. In the rabi season however, the relatively higher productivity of H.Y.V.s makes them more attractive to the farmers than the local varieties.

A few years later G. Parthasarathy in West Godavari district of Andhra Pradesh and V. Rajagopalan in North Arcot district of Tamil Nadu again found the improved local varieties to have fared better in the wet season than the
H.Y.V.s. But this time the explanation runs mainly in terms of technical factors. 'In the dry season' writes Parthasarathy, 'short duration modern varieties have an advantage over improved local varieties in that they can be harvested before the heavy rains start in May'. 'Both season considered' he adds, 'modern varieties accounted for 25 percent of the area and many farmers have not shifted to modern varieties. The most serious constraints to shifting were the difficulties in water management in the wet seasons and widespread fear of risk due to pests.' Teresa Anden-Lacsna and Randolph Barker's study based on a sample of villages from a number of Asian countries, found that the largest difference in area planted to modern varieties between the dry and the wet seasons occurred in two villages in Orissa (India), both located within a few kilometres of the Central Rice Research Institute, Cuttack and in two irrigated villages in Thailand. The reason cited for this difference is that modern varieties suitable for wet season conditions in these areas are yet not available. 'In Eastern India and in Thailand' they write, 'it is not uncommon for the fields to be flooded to a depth of half a meter for a considerable period of time. Flooding reduces tillering of the rice plants. Modern varieties that are suitable for poor drainage or waterlogged conditions that characterise many of these sites have yet to be developed'. Alok Chattopadhyay arrives at similar conclusions from a recent study in West Bengal, India. According him 'A major explanation for the sluggish
technological progress in rice cultivation in West Bengal is the absence of modern technologies appropriate for the dominant physical agro-climatic conditions of the state. Sixty percent of cultivable area in West Bengal is unirrigated, parts of which are either hilly, having saline and acidic soil or flood prone or drought prone. Agronomistic experience and farmers' experience have shown that for most of such conditions, it is local and improved indigenous varieties which perform better than the H.Y.V.s. For that part of the cultivable land which has reasonable extent of water control facilities, modern rice technology presents a different picture'.

In concluding their discussion Anden-Lacsna and Barker therefore recommend - 'research for rice production in the national system must be concentrated in development of high yielding rice that are suited to agro-climatic conditions. Varieties are needed that perform well under different growing conditions such as salinity, drought, flooding and deepwater. It is also possible to raise rice yields by improving irrigation systems so that existing varieties and technology can be adopted. To increase production in unfavourable agro-climatic environments both strategies should be pursued with equal determination'.

V.4 Adoption of modern varieties, and farm size and tenurial status of farmers.

Studies relating adoption of modern varieties to farm size and tenurial status of farmers have come up with differences
in their observations. While the early studies usually found a positive relation between farm size and adoption, most of the recent studies indicate that the rate of adoption has not been significantly different between small farmers and large farmers or between tenants and owner operators.

Lockwood, Mukharjee and Shand's study based on data collected by programme evaluation organisation of the Planning Commission for the period 1967-70, found a strong positive relationship between the proportion of farmers adopting H.Y.V.s and farm size (i.e., proportion of adopters was found to be higher in larger farm size groups). M.Schulter and J.Mellor's study, relating to about the same period, also found a positive relating between farm size and adoption. S.S.Achrya found in his case study of Udaipur district of Rajasthan that size of the farm was larger among adopters, many of whom had pumpsets for irrigation.

In contrast to the findings of these early studies of adoption being confined largely to the big farmers, studies relating to subsequent years indicate that the small farmers have been progressively catching up with large farmers in adoption and use of new farm technology. P.K. Mukharjee found no significant difference in the rate of adoption between the owners and the tenants and among different size holding groups. (The study relates to farmers in Punjab, Tamil Nadu and Maharashtra.) C.Muhiah's study for Tamil Nadu also found that tenants were not far behind the owner cultivators in adoption of new technology. Mandal and Ghosh
in their study related to the years 1972-73 and 1973-74, based on sample survey of farm households selected from Burdwan (West Bengal), Shahabad (Bihar) and Sambalpur (Orissa) districts, found that the participation in the new technology was more or less uniform among all section of farming community irrespective of tenurial status and the size of holdings. Their finding of more or less similar adoption patterns among all size groups of farmers conforms to Surjit S. Bhalla's observation that approximately the same proportion of farm area was under H.Y.V.s on large as well as on small farms. But their findings regarding adoption and tenurial status of farmers contradict those of Parthasarathy and Prasad related to farmers in Andhra Pradesh. It was observed that the 'association between tenure and adoption was significant' and that 'the owners had an edge over the tenants.'

The early hesitancy of the small farmers in adopting modern varieties has been generally attributed by economists to their inability to undertake the risk of introducing a new innovation owing to their relatively weaker resource base. Gelia T.Castilbo writes 'while the early adopter large farmers used partial adoption as a means of reducing risks, the small farmers had a 'wait and see' attitude. With demonstrated results from the large farmers, the small farmers were then willing to go all the way with new seeds.'

In light of the conflicting findings regarding adoption and tenurial status of farmers, and from the personal
experience of this writer from the field survey in Assam (carried out during 1987-88 in connection with the present study), it is probably safe to conclude that it is not tenancy as such but the nature of the terms of tenancy which affects the rate of adoption of new technology. When tenancy takes the form of sharing of output in some pre-agreed upon proportion, (which is 50:50 in most cases of tenancy in Assam), without similar sharing of costs between landlords and tenants, the tenant farmers' incentives for adoption of new technology is likely to be adversely affected. (For, the new technology promises larger output which is to be shared with land-owners, while its application also involves extra costs which are primarily to be borne by the tenants.) However, in cases where land-owners not only share the output but also the cost of cultivation with the tenant farmers, or in cases where tenants are required to pay a fixed quantity of cash or crop output to the land-owners irrespective of the total production, tenancy need not be a discouraging factor for adoption of new technology.

V.5 Irrigation and adoption of modern varieties.

Expectedly availability of irrigation facilities has been found to be an important favourable factor for adoption of modern varieties. A comparative study of local and high yielding varieties in the West Godavari district of Andhra Pradesh by P.S. George and V.V. Chaukidar found in 1972 that cultivation of H.Y.V.s was confined largely to the delta areas having adequate irrigation facilities. Bandhudas Sen

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found irrigation to be a far more important factor than farm size or tenancy in explaining the uneven diffusion of new varieties among farmers. He observed that a broad spectrum of farmers in which the small and the medium size farms dominated, were using the new varieties. Widespread adoption of this nature was, according to him, not so much due to the scale neutrality of new seeds as to the government initiated mass action programme under which all irrigated land and all irrigated farms - small, medium, and large, were sought to be covered.

While irrigation is certainly a strong favourable factor in adoption of H.Y.V.s, it is not always indispensable for using these modern varieties, particularly for those of rice cultivated in the wet season. The discussions in section V.3 above indicate that in many traditionally rice growing regions, (such as Eastern India), which are prone to frequent flooding and waterlogging of fields in the wet seasons, successful adoption of modern varieties requires more of drainage and pest control measures than irrigation. In such areas excess of water, rather than lack of it, is the problem for modern rice varieties in the wet season. Herdt and Capule's study on 'adoption, spread and production impact of modern rice varieties in India' dispels the misconception that the new varieties of rice were ideally suited to assured irrigated land condition only. Data represented by the authors tend to show that adoption of modern rice varieties in India has spreaded much beyond the
irrigated fields. (They point out that in India 50% of area under rice was under modern varieties while only 30% of area under rice was irrigated at the time of their study.

In the dry season however irrigation is undoubtedly a crucial factor for adoption of modern rice varieties. In fact in main rice growing areas irrigation along with the use of short duration modern varieties has enabled farmers to increase their cropping intensity. 'One almost universal impact of modern varieties' writes Galia T. Castilho, 'is the change in the cropping pattern which they have brought about in combination with irrigation. In fact their adoption is almost synonymous with the adoption of double cropping. Although high yielding capacity is the characteristic most associated with the new varieties, their yields did not exceed those of local varieties in many villages where adoption has taken place. They were adopted because of their shorter growing period and non-photoperiodism.' Studies by U. Phukan and V.M. Rao and R.S. Despande also provide statistical evidence confirming the positive contribution of irrigation towards increasing cropping intensity.

V.6 Application of fertilizers.

Use of fertilizer in farming is of crucial importance in the present scheme of modernisation of Indian agriculture. Increasing agricultural production in general, and utilisation of potential productivity of the new varieties in particular, depend largely on application of chemical fertilizers in adequate quantities. The present section takes
a look at the findings of some studies analysing the adoption of the use of chemical fertilizers by farmers. Both environmental and economic factor have been cited by these studies as determinants of rate of fertilizer application by farmers.

Fertilizer being a relatively costly input, its use have been found to be very little in situations where the risks of losing the investments on it are high. Rao and Siroli’s study related to West Godavari district of Andhra Pradesh found that in areas that were exposed to frequent flood and drought damage, application of nitrogenous fertilizers entailed considerable risks. Accordingly application of chemical fertilizers in these areas was found to be almost negligible. On the other hand, in areas free from natural hazards and in areas which were equipped with proper irrigation and drainage, high returns on investments on fertilizers were almost assured. Consequently, farmers in such areas were found to have used chemical fertilizers on a significant scale. R.Nagraj found irrigation to have dominant influence on the application of chemical fertilizers by farmers, although the use of H.Y.V. seeds and other fertilizer intensive crops also had positive effect on farm’s fertilizer consumption.

In a comprehensive study under the International Rice Research Institute, Christina C. David used regression analysis based on data collected from 36 rice producing villages from South and South East Asia, to identify factors
that explain the variation in the levels of fertilizer consumption among villages and farms. Difference in the physical environment among villages and between seasons were found to have accounted for a major portion of the variation. The writer however adds, 'It should not be concluded from these analysis that price, credit availability (or liquidity position) and other non-environmental factors are unimportant in explaining the levels of nitrogenous fertilizer consumption and yield in Asian farms.' Fertilizer - Rice price ratio and proportion of area planted to modern varieties were also found to be significant factors in accounting for the variation in fertilizer consumption across villages. Given the physical-environmental conditions and other exogenous factors, the variation in fertilizer application per hectare across farms has been generally explained in terms of farmer's liquidity position, and/or access to credit and extension service. Comparatively lower fertilizer consumption per hectare in small farms than in medium and large farms, a frequently made observation in Indian agriculture, can also be largely explained by generally weaker financial base of small farmers and their less easier access to institutional credit and extension service. From the analysis of 'farms size productivity and technological change in India' Surjit S.Bhalla concludes, 'Small farmers are progressive and quick to adopt the new technology, but they are often constrained by lack of credit for their investment and operating expenses. Relaxation of
these constraints should speed the spread of new technology and also tend to diminish the trend of increasing inequality in farm income'. Ramasamy, Chandrasekaran and Prabahan, while observing that fertilizer used for rice cultivation increased with farm size (in South Arcot district of Tamil Nadu), also felt the necessity of providing adequate extension education and credit to enhance fertilizer use in small farms. (The other findings of this study reiterate the importance of the factors already mentioned above in determining the level of fertilizer consumption by farms.)

V.7 Communication network, extension service and diffusion of new agricultural technology.

Widespread diffusion of agricultural innovations in a developing country like India ultimately hangs on the effectiveness of the channels of communication between agricultural research and the farming community. Agricultural extension service constitutes the mainstay of this communication network. Theodore W. Schultz writes, "The suppliers of modern agricultural factors are among others the research people who work in the agricultural experiment stations. Farmers in their role as demanders of the new factors accept them when they are truly profitable. But typically farmers in traditional agriculture do not reach for them. In the end much depends on farmers learning to use modern agricultural factors effectively." In this process of learning the people in the agricultural extension service have a great role to play. K.S. Chauhan finds from his study
that farmers in general adopt innovations in a big way once they are convinced about the good results of these through experience, exposure or extension works of V.L.E.W.s (Villages Level Extension Workers). According to T. Srinivas and M.R. Mukunda reasons for slow spread of adoption is that new innovations donot get communicated properly to the small farmers and interior villages. Accordingly they suggest that demonstrations of improved practices should be more broad based and that small farmers rather than large ones should be selected for demonstrations. 'The village level trained extension workers' they add, 'who now act only as messangers of government, should be made responsible for carrying out more practical work in these decentralised demonstrations.' Other researchers such as S.K.Sahani and V.K.Sing have also made various suggestions for improving the extension service and the flow of farming information. A study by Ram D.Singh has also identified location, education and access to information as crucial factors in adoption of new technology by farmers.

V.A Besides the types of studies mentioned in the above discussion, there is atleast one more category of research work on adoption of new farm technology. Studies in this category examine the role of various socio-psychological attributes of farmers in adoption of agricultural innovations (for example, Narendra Singh and Satvir Singh). Studies of this sort can undoubtedly provide further insight towards understanding the complex process of farmers' adoption of
agricultural innovations. Nevertheless, wide coverage of these works has been avoided in the present study. For, this study on transfer of technology in agriculture in Assam aims to approach the problem from socio-economic and institutional standpoints rather than from the psychological point of view.

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