Chapter I

CHAPTER I

INTRODUCTION

India is predominantly an agriculture-based country. Agriculture contributes nearly 40 per cent of the gross domestic product, and provides jobs to nearly 65 per cent of the working force [India,a:]. More than 70 per cent of the population live in rural area and their main source of livelihood is agriculture. But the data on the amount of cereal consumption collected by the National sample survey for 1977-78 and published in 1986 show that nearly 68 per cent of the rural people consume much less than the minimum required to supply even 87 per cent of calorie need. This under-consumption of food grains, forced on the majority by the present pattern of asset, income and savings distribution that make them unable to transform their need into an effective demand for the same is the basis for generating, what is called, 'agricultural surplus', needed to sustain non-agricultural populaton in general, and urban and industrial population in particular. Thus poverty and hunger in the rural areas can be eliminated to a large extent by producing more food-grains and by enabling the poor to exercise demand simultaneously on additional food. It would be, however, unrealistic to expect any significant increase in the net sown area over the current level of around 143 million hectares [India,b:]. It is estimated that, at the most a total area of 1.5 million hectares may be reclaimed during the next five years through various land reclamation and development programmes. Another 0.4 million hectares may be reclaimed through soil and water conservation measures. Not all the reclaimed land would, however, become available for raising agricultural crops. The addition to net sown area during the 7th Five Year Plan is unlikely to exceed one million hectares. Planned increase in agricultural production in the coming years will have to be obtained by raising the yield per hectare. This will involve more intensive use of inputs like improved/high yielding variety seeds, manure, chemical and bio-chemical fertilizers and plant-protection measures and the mass adoption of this technology by the peasants.

The breakthrough in adoption of new wheat agricultural technology during the latter part of mid-sixties, popularly known as "Green Revolution", has led to phenomenal growth of wheat and some other crops in some parts of India, though the growth rate of total agricultural production at the national level has been marginally lower than what it was in the decade preceding the period of green revolution.

The rate of growth in food production between 1965, the year preceding the introduction of the HYV's and 1986 at 2.98 per cent per annum is less than the growth rate for the period 1951 to 1965 of 3.5 per cent; but this does not suggest that without HYVs the country's food production figure would have followed the earlier trend. It is, however, known that most of the increase in food production in the fifties and up to the mid-sixties came from an expansion of the area under cultivation. The modest production increase during the late sixties was largely a product of increased land productivity arising, to a large extent, through the adoption of HYV's and the associated inputs. Without the contribution of these and given the existing socio economic structure India in late sixties and early seventies would have been visited by large scale starvation and famines or would have been led to abject dependence on massive import of food grains.

Following the introduction of new wheat, paddy, jowar, bajra and maize technology there has been an unprecedented growth in the production of these crops. In the first three decades after independence the country's food production has been trippled. The new seed varieties have created a production potential which is substantially higher than what has been actually achieved. Therefore, speedy and extensive introduction of technological change is now recognised as the crucial factor in India's agricultural development.

Although there had been a phenomenal increase in food grain production in India from 89.3 million tons in 1964-65 to 152.4 million tons in 1983-84,the highest so far upto 1986-87, or by 70.7 per cent, wheat production has increased by 259.46 per cent and rice production by only 48.49 per cent during the same period. Large part of gains from the new technology still remains restricted to few pockets, few crops and few classes of the farming community. The adoption of new technology was mainly successful in Punjab and Haryana and some other parts of India because of the selective approach of new agricultural strategy of 1965. The farmers in these States, on the other hand, face less risk mainly because these States have good irrigation facilities and proportion of farmers with large land holding is relatively high. The land holding size of more than 6 ha. accounts for nearly 45 to 55 per cent of the total cropped area in these States as against less than 0.5 per cent of the total cropped area in Kerela and West Bengal [Mitra,1977]. Only those areas which were endowed with irrigation system and other favourable infrastructure were selected for the adoption of this new technology. Thus, during 1965-66 to 1986-87, while food grain production in Punjab increased from 3.39 to 6.02 million tonnes, or by 77.58 per cent, the same has declined in Bihar from 7.19 to 6.01 million tonnes or by 16.41 per cent. Again, in these areas only the "progressive farmers" (who were usually the large farmers) were selected for the use of costly, non-local inputs and were motivated for doing so through subsidised inputs and support price for output. The rationale behind this strategy was quite simple : given the existing socio-economic structure and the limitations of supply of modern inputs, these should reach those areas and those people who are supposed to make the optimum use of scarce resource. Rather than spreading the inputs thinly over a large area and among many farmers, this strategy called for the intensive use of the input "Package". This package programme was developed on the basis of the concept of "building on the best" (area and people), necessarily neglecting most of the areas and most of the people, particularly in the context of our country. While the selective strategy was apparently successful in the resourceful wheat areas, altogether at a great cost it was realized by the late sixties and seventies that the food problem for the country, including both increased output and its equitable distribution as a whole could not be solved without developing simultaneously a technology which could be adopted on a mass scale.

When attempts were made to do this, the scarcity limitations of input supply, particularly controlled irrigation water, which were not apparent as long as the HYV cultivation was restricted to small area, became evident. And the farmers from new areas feared to adopt new technology considering the risk in availability of inputs on time.

Adoption of technology was also restricted to wheat mainly, as mentioned earlier,where yield increase rate was more than five times the same for rice. But why did wheat technology succeed when that for other crops, notably rice failed to achieve similar success . The credit for this goes mainly to the breeders of high yielding wheat varieties, that were made suitable for Indian conditions. Location factor was also significant. The wheat belt is more or less a continuous area from Punjab to Western U.P. with a large degree of ecological and agro-climatic uniformity unlike the rice or millet zones which are interspersed all over the country. The wheat growing areas are more developed in terms of infrastructure, particularly irrigation, than the rice or millet growing tracts. Another reason specific to the production of wheat is that it is a rabi crop and in most of the areas it is a second crop. This makes it possible for the growers to depend on funds obtained from the sale of the first crop. This enhances the capacity of the farmers to innovate and take risks. In addition wheat being a rabi crop it did not have to face the risk of massive attack of insect and pests which thrive in damp conditions.

Though it is a widely accepted view that HYV wheat is a technologically superior product, and was developed to suit the agro-climatic conditions of India, HYV rice and millets are being grown in many parts of India. But their rate of adoption has been far from satisfactory and the adoption has been confined in certain parts of the country and mainly among the big farmers. This low rate of adoption may be ascribed to the low benefit-cost ratios. These ratios might not be high enough to induce the farmers to adopt them on a large scale.

Now the question is why the benefit-cost ratios are so low for rice. The benefits accruing to the farmers from the adoption of HYVs depend on the productivity and its consistency and the price of the product. Given that the productivity of HYVs is higher than that of the local crops, the year to year variability in productivity and price might introduce uncertainty in the benefits from the HYVs if these are adopted on a regular basis. Uncertainties mostly arise from lack of irrigation facility and erratic nature of rains, on the one hand, and fluctuation in prices of both inputs and outputs in the open market, on the other. These uncertainties can however, be measured in the probabilistic sense and these are, then, transformed to risks. Now, the question is how the farmers perceive the risks associated with the adoption of HYVs. The difference in their perceptions of risk results in the difference in their attitude towards risks which in its turn account for the difference in the rate of adoption of HYVs as between different regions and different classes of farmers, along with other factors of adoption.

It has already been noted that the most of the HYV adopters are generally big and medium farmers, having the capacity to bear risks, and the small and marginal farmers are unable to adopt the HYVs perhaps because they feel that they are incapable of taking risk. Given that the physio-graphical conditions are almost the same in a particular region, the difference in the attitude towards risks may, thus, be explained by the socio-economic conditions of the farmers. For example, size of land holding, levels of income, education etc. might condition the level of perception of risks and the attitude of the farmers towards risks. If, however, the physiographical conditions are different, a myriad of physiographical, social and economic conditions will condition the attitude of the farmers towards risks.

The cultivation of the HYVs involves various kinds of uncertainty. First, it is the uncertainty flowing from the varieties themselves, the variability in yield caused by the attack from pests and insects in different environmental conditions. Secondly, it is the uncertainty due to inability to apply all the necessary inputs to cultivation in required amount and at right time and in right-manner because of high cost and their non-availability on time and in required amount and deficiency in extension effort. The market imperfection presents another kind of uncertainties. While the uncertainty attached to HYV cultivation is high for farmers of all sizes, the degree of uncertainty is higher for the small farmers mainly because of their low risk-bearing capacity. These conditions are characterized by their poor economic condition, relatively higher dependence on the private money lenders for funds, usurious rate of interest on the funds borrowed, existence of non-capital sector (sector involving non-wage payment for labour services), their role as price takers in both the commodity market and the factor market, their inaccessibiity to organised markets etc. Thus the farmers, particularly the small and marginal farmers in the under-developed agriculture become vulnerable to two main types of risks : (1) business risks, both external and internal; internal risks relate to family health and managerial skill, and external risks relate to changes in price, yield, technology, changes in legal and institutional frame works, and changes in fiscal and monetary conditions, and (2) financial risks that are associated with financial and operating leverages. The business risks interact with financial risk. Operating leverage reflects the proportion of a farm's total cost that is fixed. Farms with relatively high fixed cost will incur large variations in net returns on the total capital for a given variation in total revenue. Over time, technological development and rising land values have caused fixed cost to rise relatively to the total revenue for most farmers. Similarly, greater financial leverage leads to larger variations in return to equity capital for a given variation in the total revenue. Financial risks arise from the obligations associated with interest and principal payment to lenders. Therefore, behaviour of farmers is vastly influenced by the expected impact of both business and financial risks. These factors force the small farmers to restrict their production plans to a limited number of crops including vegetable and to short time horizons. This means that they are unable to minimize their risks through diversification of risks, whereas a rich farmer can easily plan his production for a number of crops and over a longer period, thus making up the loss sustained in a particular year and/or in a particular crop by profit earned in some other year in future or from some other crop. In addition, the absence of saving by the poor farmers creates the possibility for large farmers to invest their own saving as loan to the poor at high interest rate, rather than investing the same in agricultural production. Similarly, they get the opportunity to get high return by purchasing crop when its price is low and then selling it after few months when the price is high, and also to lease out land at very high rent to the poor peasants. In addition, due to demonstration effect, skillful advertisement etc. there is growing tendency to divert a sizable part of potential saving to durable consumption goods like TV, Radio etc and to invest on education.

In this context, an attempt is made here to examine the extent of risk and risk aversion through descriptive analysis of farmer behaviour in modern farming in respect of the margin for the gains in modern farming as compared with that in the traditional farming as an incentive for accepting the technological change.

Risk is now widely recognised as a critical factor in nearly all farming activities, and has become a major concern especially in relation with the adoption of new technology of farmers. Spurred by the violent fluctuations upto the year 1977 in price of farm products, aggravated further by weather fluctuations, there has been an upsurge of interest in the analysis of risk and uncertainty in farming. Economists realize that recognition of different risk preferences of farmers may explain and perhaps even justify certain decisions of the farmers such as holding resources, diversification of product, attempting to minimise the probability of loss and others. A new technology is adopted by a farmer only after he is satisfied with certain problem in which he judges how risky, reliable the technology is as evidenced from the historical performance under varying climatic and resource situations and how the likely returns compare with those possible from alternative investment opportunities, say, in quarry or trading etc. As mentioned earlier, one of the constraints responsible for tardy rate at which technology is adopted is that of risk aversion behaviour of farmers. While farmers obtain early and scattered information on the productivity of new techniques which is often based on productivity of crops grown at highly supervised experimental station or similar land, not suffering from any constraints - technical, managerial or finacial, the new results are viewed by farmers with a high degree of scepticism and therefore with a high degree of risk aversion. The results from the experimental stations are presented to the farmers in the form of average yields and no information regarding the yield variability is given to the farm operator. In the absence of any such information the farm operator is faced with uncertainty (when the probability of a future outcome cannot be established in an empirical or quantitative sense, it is called uncertainty). To convert this uncertainty into risk, the farm operator attaches his own subjective probability to the new technology (Risk is where the future outcome can be forecast with probability based on past experience or personal knowledge). The more the unfamiliarity with the new technique, the larger is the variation he attaches to the new technique. Even the most illiterate farmer has some knowledge of the probabilities and variation associated with his current practice. On the one hand, he has a new technique with its expected yield calculated on the basis of subjective probabilities and, hence, varying over a wide margin, and on the other hand, he has his old established technique that produces a relatively much narrower range of variability. He is faced with a choice between the two. Even if the expected income from the new technique is greater than that from his established technique, he would not adopt the new technique, unless the variability in production is within his tolerance bounds. More often than not, the farm operator is of conservative and risk averting nature. This is because most of the farm operators cannot afford to take much risk. Under these conditions the subjective variability that the farmer attaches to the expected yield is invariably higher than what it actually is. Higher the variability he attaches to the expected yields, the more cautious he will be in adopting a new technique.

It has been mentioned earlier that, apart from the uncertainties associated with weather and external factors, risk and uncertainty associated with the supply of input and output as well as in their prices also play an important role in the adoptionof HYV technology. These factors taken together determine the subjective probability that the farmer attaches to the occurrence of different levels of yields. Taking the case of HYV, the attractiveness of the variety is reduced by the fact that it is not proven at the farmer's level what the effects of adequate and timely supply of inputs are. Even though the new variety proves to be beneficial and the farmer has the potential to adopt, he will be reluctant because of the uncertainties involved in timely supply of input. Also it involves expenditure in cash which has a high opportunity cost, as mentioned earlier, because of the existence of both non-productive, but lucrative, investment opportunity in usary,speculative commerce etc, and also for consumption. Such drawbacks for the farmer could outweigh the benefits of adopting

HYV's.

In this thesis an attempt has been made to measure the effect of risks on the rate of adoption of new technology among the various categories of farmers such as marginal, small, and big farmers belonging to different geophysical regions such as flood prone areas, drought prone areas and normal irrigated areas. Also an attempt has been made to suggest certain product plans for these farmers in these areas so that they can minimize the risk arising out of vagaries of weather. In other words, an attempt has been made to suggest whether a particular class of farmers will produce only traditional or only HYV's and/or any combination of them so that their net return is maximum and the risk they have to face is minimum. Given the present technological and socio-economic framework where the farmers have to depend on the rainfall for the irrigation of their crops and where they have almost zero control over the factor or product market, how can the farmers plan their production so that they can produce more and can make the best use of their material inputs. This thesis makes an attempt to find answers to these problems.

The objectives of this study can be detailed in the following way :

i) to study whether technology (HYV) adoption varied significantly between different geophysical regions,

ii) to study whether risk, particularly natural risk, is an important constraint for the adoption of HYVs at the farmers' level,

iii) to determine whether adoption of HYV is feasible for all categories of farmers in these three different regions,

iv) to suggest how the farmers can adjust their product plans to variations in rainfall and update their plans if information on future rainfall is known to them,

v) to suggest product plans that will maximise yield and at the same time minimise its variations and lastly,

vi) to estimate risk premiums to be paid to different categories of farmers of different regions so that they are induced to adopt HYVs.

Considering the fact that the managerial abilities are same for a given category of farmers and the behaviour is rational (i.e., the possibility of randomness in the discussion is ruled out because it will then be difficult to come to a particular decision) a case study of the above problems was made in 3 blocks of Midnapore district in West Bengal, India. Midnapore district is bounded by Bankura and Hoogly in the North and 24-Paraganas in East and by Singbhum of Bihar and Mayurbhanja of Orissa in West. The district lies between 21° 36' to 20° 57' north latitude and 86° 33' to 88° 12' East longitude. Annual average rainfall varies from 140 cm to 175 cm, the major portion of which comes during May to October. Principal crop of the district is paddy. Besides paddy, there are also areas for Jute, pulse, oil seeds, potato and vegetables. But this district is a deficit foodgrains area which can hardly cater to the minimum food grain needs of the population, including that needed to get inputs and other consumption goods in exchange. The trend in agricultural development even during the post-independence period is apparently much lower than even the minimum required. It is largely due to severe natural calamities specially the drought and flood caused by erratic distribution of rain as well as much limited progress in exploring irrigation potentialities in the district leading to very limited adoption of new technology. In this context, an indepth study is made under the following chapters to find out the possibility of increasing substantively the adoption of high yielding variety in Aman season as nothing much can be done in the Boro season as the potentiality of irrigation water is very poor in the district, particularly in most parts of the district.

The plan of work is as follows:

Chapter II : Survey of literature developed in the area of decision- making, particularly in agriculture.

Chapter III : Sample design and Economic and Physiographical Characteristics of the area under study.

Chapter IV : Risk and HYV adoption -
In this Chapter an attempt has been made to estimate the difference in adoption rate of HYV among the different categories of farmers such as marginal, small, and medium and large farmers and also to identify the factors that significantly affect the rate of adoption among the farmers. Lastly, the relationship between risk and the rate of adoption has been found.

Chapter V : Decision-making on adoption of HYV : Aspiration Level -
In this Chapter an attempt has been made to determine the output level of HYV crops that a farmer must aspire for in order to accept the

HYV in preference to the local variety. On the basis of these estimated levels, the farmers' choice for the HYVs has been determined.

Chapter VI : Decision - making on HYV adoption under natural risk : Bayesian Technique-

In this Chapter explicit recognition of risk involved in the variation in rainfall has been made while deciding on the production plan of the farmers under different climatic conditions. Bayesian a priori probability distribution method for rainfall has been used to consider the past information on rainfall and production plan has been drawn on this basis. Expected rainfall data have been incorporated in the analysis and the production plans have been updated. Winters' Three-Parameter forecasting technique has been used to get information on the expected rainfall.

Chapter VII : Maximising yield and minimizing risk : Fuzzy Programming Technique-

The results in the preceding Chapters are obtained on the assumption that the farmers are more concerned with the profit from a particular variety under the condition of uncertain rainfall. In this Chapter the objective of the farmers has been assumed to be the maximization of profit and at the same time, the minimization of variability in profit. Again, it is assumed here that the farmer is not certain about the relative importance of these objectives. In other words, it is assumed that in practice, much of the decision - making in the real world takes place in an environment in which the objective is not known precisely to the farmers. To tackle this problem fuzzy-set approach is adopted.

Chapter VIII : Measuring risk premium : Certainty Equivalence-

In this Chapter risk premium has been considered as an inducement for the farmers to adopt a particular HYV variety, and an attempt has been made to measure these premiums by estimating the certainty equivalence using Von-Neumann utility function.

Chapter IX : Conclusion and recommendation.