REVIEW OF LITERATURE
Chapter 2

Review of Literature

Getting a new idea adopted even when it has obvious advantages is often very difficult. Many innovations require a lengthy period often of many years from the time they become available to the time they are adopted. Therefore, a common problem for many individuals and organisations is how to speed up the rate of diffusion of an innovation (Rogers Everett 1995. p1).

An innovation is an idea, practice or object that is perceived as new by an individual, a firm or any other unit of adoption. Innovations that are perceived as having greater relative advantage, compatibility, triability, observability and less complexity will be adopted more rapidly than other innovations. The decision to adopt usually takes time. People normally do not adopt a new practice or idea as soon as they hear about it. They may wait several years before trying the idea and still longer before permanently adopting it. The final decision to use a new practice is usually the result of a series of influence operating through time - awareness, interest, evaluation and trial adoption (Lionberger 1960 p3). Therefore, the adoption
process is defined as "the mental process an individual passes from first hearing about an innovation to final adoption". Adoption behaviour requires a favourable mental attitude and a successful physical act; the first is internal and symbolic and achieved through technical knowledge and conviction of its value; the second is external and physical and achieved through ready availability of requisite production inputs and related services such as seed, fertiliser, credit, markets, education, etc., (Leagans 1979 p44).

When a new technology is introduced usually it is adopted by a few individuals initially, others wait and observe before they make a decision to adopt or not. Those who are the first to adopt the new technology are the leaders and the ones who are last to adopt are the laggards. What makes some, leaders in technology adoption and others not. There may be several social and economic factors that can significantly affect the decision to adopt the new technology (Mann 1989 p133). Leagans (1979) felt that adopter’s interaction with his environment largely patterns his behaviour and that variances in adoption behaviour can be largely accounted for by individual difference, the differential stimulus characteristics of forces in his
environment, and the quality of interaction between the elements of each.

In agriculture, it is believed that lack of credit, limited access to information, aversion to risk, inadequate farm size, inadequate incentives associated with farm tenure arrangements, insufficient human capital, absence of equipments to relieve the labour shortages, chaotic supply of complementary inputs and inappropriate transport infrastructure are considered to be hindrances to adoption of new technology (Feder et al. 1982 p1). Adoption behaviour differs across socio-economic groups and overtime. Some innovations have been well received while other improvements have been adopted by only a very small group of farmers (ibid. p2). Final adoption is not always permanent adoption. Even though a person has decided to fully adopt a new practice and has integrated it into his ongoing operation there is no guarantee he will continue indefinitely to use it (Lionberger 1960 p5).

Griliches (1957) argued that adoption of a technology depended on the profitability of the technology compared to the existing one. Mansfield (1961) was of the opinion that imitation is the process with which the technology is
adopted. The speed of the technology adoption depends on the profitability. However, the "threshold" adoption models argue the adoption and diffusion of a technology is explicit maximising behaviour of a heterogeneous population. Therefore, identifying the various dimensions of heterogeneity in the population that are relevant for the adoption of specific technology and incorporating them in the model is important.

The dichotomous nature of a decision, that is, adopt or not adopt implies there is a threshold in the dimension of the explanatory variables. The thresholds of all members in a sample are distributed among different values of the explanatory variable $T_1, T_2, T_3, \ldots T_n$ (Fig 2.1). A distribution of thresholds within a random sample would be expected because of individual differences such as farm size, quality of land, family size, educational background etc. Since the threshold of an individual is influenced by numerous variables focused into a single response, distribution of thresholds in a large number of sample individuals can logically assumed to be normal and the expected functional relationship between the adoption of a technology and explanatory variables will be a normal sigmoid curve such as AB(Hill and Kau 1973).
Fig 2.1: Aggregated Decision Thresholds

Source: Hill, Lowel and Paul Kau (1973) (p. 20)
The main characteristic of a normal sigmoid curve is the existence of sections in the lower and upper ranges of the explanatory variable in which an increase in the explanatory variable would not exert any influence on the decision variable. A sensitive response in the decision variable can be observed only in the segment between the two extremes. The end point of the lower range may be regarded as the 'threshold' of that explanatory variable. Beyond the threshold point, a normal sigmoid curve first increases at an increasing rate and then increases at a decreasing rate finally reaching a maximum at a probability value of 1. Therefore, the sigmoid curve is a functional form which represents the threshold concept (ibid).

It is clear that the adoption of a new technology is a long and complex process. There are several studies both theoretical and empirical which examined the process of adoption as well as the factors which influenced the adoption behaviour of the farmers. These studies covered the adoption behaviour with regard to HYV seeds, farm mechanisation, fertiliser use, irrigation technology, etc. Empirical studies concentrated on farm size, availability of credit, availability of labour, education, tenurial status, extension contact etc., to understand their effect on the
adoption behaviour of the farmer. There are several studies which explored farmer behaviour under risk and uncertainty. Bayesian learning process is considered in some studies wherein the farmer learns while using the technology, the experience and the knowledge gained is used for making decision on subsequent adoption. There are some studies which looked into the constraints in supply side on the rate of adoption.

A common belief is that large farmers possessed the necessary resources to adopt the new technology and capacity to bear risks and uncertainties involved in shifting to new methods in contrast to small farmers who suffer due to inadequacy of resources to do so. Therefore, farm size has been used as an explanatory variable in most of the adoption studies. Biswanger (1978) found a strong and positive relationship between farm size and adoption of tractor in South Asia. Even in scale neutral technology such as HYV seeds small farmers were found to have lagged behind larger farmers (Parthasarathy and Prasad 1978). Small farms which initially lagged behind eventually caught up when more information was known about cost, risk, market etc associated with the technology. Mukherjee (1970) and Muthia
(1971) found small and medium farmers adopted HYV on a larger proportion of acreage than large farmers.

Dobbs and Foster (1972) used partial budgeting and discounting procedures to calculate internal rate of return in order to measure incentives to invest in new packages of agricultural inputs in North India. The packages included high yielding seeds, fertiliser, irrigation and minor inputs. Returns to number of input packages were found to be genuinely attractive. Small size of holdings and high down payment requirements for loans were found to hinder farmer investment in tubewells.

In order to get a holistic picture of the adoption behaviour of farmers, farm size has to be viewed in conjunction with other factors such as availability of credit, family labour, education level of the farmer, irrigation facilities, tenurial status etc. Cost of adoption is another important factor which would affect adoption.

It is often felt that small farmers are at a disadvantage with regard to financial resources as they are not in a position to meet the additional cost in adopting a technology but do not have easy access to institutional
finance such as co-operatives, banks or even government loans. Differential access to capital affects the rate of adoption. Bhalla (1979) found that lack of credit to be the major constraint in the use of fertiliser by small farmers in India. Shakya and Flinn (1985) using probit and Tobit models found a strong relationship between access to credit and adoption of modern varieties of rice in Nepal.

Feder (1980) dealt with the role of risk aversion and credit constraints in the production decisions of farmers who grew both modern and traditional crops. By incorporating a general formulation of a stochastic production function, the importance of inputs risk vis-à-vis output effects was emphasised.

Labour availability is often mentioned as a factor which affects farmers' decisions regarding adoption of new agricultural practices. In case of labour shortage, farmers would adopt labour saving devices subject to other constraints. On the other hand, shortages of family labour would act as a restraint in adoption of certain practices. Hariss (1972) found that shortage of family labour lead to non-adoption of HYV in India. Family labour not only helps to save cost but also in carrying out certain operations on
Akinola and Young (1985) found family labour along with age, experience and distance to input stations significantly affecting chemical use among cocoa farmers in Nigeria.

Human beings are able to educate themselves and alter their physical environment, and they constantly try to achieve and maintain a balance between the internal forces of inherited and developed human traits and the external forces of the environment. This adjustment requires interaction between internal and external forces and results in behaviour change (Leagans 1979). The better educated farmer is quicker to adopt profitable new processes and produce since for him the expected payoff from innovation is likely to be greater and the risk is likely to be smaller for he is better able to distinguish between promising and unpromising ideas and hence less likely to make mistakes. Nelson and Phelp (1966) found that the rate of return to education is greater if the economy is technically more progressive.

Shultz (1964) was of the opinion that traditional agriculture is close to an economic equilibrium in adjusting to relatively stationery techniques but in a dynamic agriculture a factor may be obsolete before its productivity can be fully explored. If educated persons are more adept at
critically evaluating new and reportedly improved input varieties, if they can distinguish more quickly between the systematic and random elements of productivity responses, then in a dynamical context, educated persons will be more productive (Welch 1970).

Some studies classified the farmers as literates and illiterates and used dummy variables to study the effect of education. There are other studies which used the number of years of schooling of the household head as the variable to study the impact of education. Apart from formal learning informal learning such as frequency of contact with extension agents, attending training or orientation sessions etc., were considered in some studies. Learning by using is studied by a number of researchers. As the farmer uses a technology the stock of information increases about the technology which influences the adoption in subsequent season.

Huffman (1977) found that investment in education and extension improve the allocative performance of US corn belt farms by increasing the alacrity with which they respond to changes in economic conditions. Lin (1991) found that household head's level of education has positive and
statistically significant effect on the households probability and intensity of adoption of hybrid rice in China. Mann (1989) found that years of schooling played a positive role in the adoption of HYV wheat seeds in India. Singh B (1974) found that education of farm decision maker's had a positive and significant impact on farm production. Duraisamy (1992) in a study of rice farmers in South India found education had a positive and significant effect on agricultural production.

Lockheed, Jamison and Lau (1980) combined the results of 18 studies in low income countries which had 37 sets of farm data found that the effect of education on production positive in 31 of them. They also found that the effects of education were much more positive in modern agricultural environments than in traditional ones. Phillips (1994) using the same set of data used by Lockheed et al. applied a meta regression analysis to find how education affected farm productivity in less developed countries. The study confirmed the result of Lockheed and others in finding schooling influence productivity. But he found that its effect varied in different regions. The effect of education was much stronger in Asia and much weaker in Latin America.
O’Mara (1971) was one of the early researchers to use a specific Bayesian model which took into account the accumulation of knowledge by observing the performance of adopted technology for deciding subsequent adoption and expansion. Linder, Fischer and Pardey (1979) investigated the time lag between initial awareness and actual use. The farmer collects information about the profitability of the technology used by others. Actual adoption would take place when the new technology was found to be more profitable than the existing ones.

Kislov and Bachrach (1973) found that an innovation was first adopted by skilled and experimenting entrepreneurs and diffused down the skills scale. In the innovation cycle model, the allocation problem was timing the adoption of the innovation. In a dynamic economy, the skills are more important.

Feder and Slade (1984) developed a dynamic model of diffusion of a new technology involving a variable input. They concluded that improved knowledge regarding new technologies through accumulation of information over time is important in the adoption of innovation processes. Foster and Rosenzweig (1995) examined household level panel data from a nationally
representative sample of rural Indian households describing
the adoption and profitability of high yielding seed
varieties (HYVs) associated with the Green Revolution. They
found that imperfect knowledge about the management of new
seeds was a significant barrier to adoption, this barrier
diminished as farmer's experience with the new technologies
increased.

Saha, Love and Schwartz (1994) developed a model of divisible
technology adoption under incomplete information
dissemination and output uncertainty. Using the data on the
use of BST (bovine somototropin) adoption among Texas dairy
farmers they found that adoption intensity was conditional
on the farmers knowing about the technology. They also found
larger and more educated farmers are likely to adopt more
intensively.

Goodwin and Schroeder (1994) used probit and tobit models to
evaluate producer's participation in educational programmes
and their forward pricing adoption decisions. They focused
on producers human capital accumulation and its effect on
adoption.
Pomp and Burger (1995) in their investigation of diffusion of technology through copying by late adopters of early adopters found that informational externalities and differences in decision making capabilities as reasons for such behaviour. A possible consequence of the adoption of an innovation by farmer A is that more information about the innovation becomes available to him than others. The neighbours may observe the outcome of the adoption decisions of A before copying. They also found even if the farmers had the same amount of information they may still differ in their capacity to use the information in order to make decisions.

Hiebert (1974) used a stochastic production function and assumed risk aversion to examine the effects of uncertainty and imperfect information on adoption of fertiliser. He found that probability of adoption increases with the stock of information due to extension efforts.

Rauniyar and Goode (1992) investigated the relationships among technological practices adopted by maize growers in Swaziland. They found technology adoption requires simultaneous decisions by farmers regarding the use of practices within a package. The study implies that
understanding interrelationships among practices is important in successful promotion of technology.

Leathers and Smale(1991) were of the opinion that agricultural innovations are promoted as a package but many farmers adopt pieces of the package rather than the whole, in a sequential fashion. They developed a behavioural model which explains sequential adoption as a consequence of learning by adopting farmers. In order to learn more about the entire technological package the farmer may adopt first a part of the package.

Tsur, Sternberg and Hochman(1990) incorporated dynamic factors in modelling a firm’s decision on the adoption of a divisible technology. Learning by using and expectations of future prices of the innovation were used. Of the three factors farm size, discount rate and risk aversion considered in the study, risk aversion was found to affect positively adoption of a new technology.

Traxler and Byrelee(1993) developed a Joint Produce profit maximising behaviour model to study the slow rate of adoption of some semi-dwarf varieties in developing countries. They assumed that the profitability of varietal
technologies is location specific and when evaluated within a joint product framework the ranking of varieties in terms of profitability may depart markedly from the ranking when only grain yield is considered. They found that low straw yield of semi-dwarf varieties under low input conditions is shown to be the plausible explanation for their slow adoption.

Pitt and Sumodiningrat(1991) tried to find determinants on rice seed variety choice in a framework of variety specific profit, risk preferences, uncertainty and schooling. The econometric model takes the form of a simultaneous equation switching regimes model with random profit functions. Profitability, quality of irrigation, availability of credit were found to have significantly affected high yielding varieties adoption. Schooling significantly affected variety specific profit.

Tenurial status of the farmer might influence the decision to adopt a technology or not. However, studies about the effect of the tenurial status on adoption showed contradictory results (Feder et al 1982 p36).
Feder et al. (1982) after an extensive review of literature on adoption of agricultural innovations by farmers found ordinary regression were used to quantify the importance of various explanatory variables. They felt that ordinary least square regression was not an appropriate tool as they produce estimates other than zero and one for the dependent variable which did not convey any meaning. To capture a functional relation between the probability of adoption and various explanatory variables qualitative response models such as logit and probit are appropriate.

Logit, probit and tobit models are considered to be appropriate tools to study the various factors influencing adoption on the qualitative dependent variable. There are several studies especially in recent years which used these models to study the adoption behaviour of the farmers.

Hill and Kau (1973) used a probit model to examine the relationship between purchase of grain dryers among US farmers. Size of farm was found to be most significant causal variable in the decision process.

Shakya and Flinn (1985) examined through multivariate probit and tobit regression models factors influencing the adoption
of modern variety rice and fertiliser in Nepal. They found irrigation, tenure status and access to credit to be significantly associated with varietal adoption.

Akinola and Young (1985) used a Tobit model to investigate the factors influencing chemical use of cocoa farmers in Nigeria. They found income, family labour, experience, age and the distance of input buying stations statistically significant in affecting the farmers chemical use.

Akinola (1987) used a probit model to find the factors affecting the use of tractor hiring services in Nigeria. He found farm size, farmer’s age, his education, family labour, source of credit, frequency of attending co-operative meeting had a positive and significant effect on the farmer’s decision to adopt tractor hiring services.

Shrestha and Gopalakrishnan (1993) used a probit model to study the adoption of drip irrigation in Hawaii. They developed a joint discrete and continuous choice framework to determine the factors that affect the choice of technology i.e. drip irrigation. They found that the probability to adopt drip irrigation depends on expected net gain in the farm of yield and revenue from such adoption.
They suggested that in addition to the variables that are generally assumed to influence economic decisions special attention should be given to technical, informational, locational and management factors as well as irrigation specific features that play a significant role in individual decisions.

Green and Ng’ongla (1993) employed a logit model to identify the main factors influencing fertiliser use in Malawi. Crop farming system, crop variety, credit access, income from off farm employment and regular labour are the main factors influencing fertiliser adoption.

Mukhopadhyay (1994) in a study of West Bengal found that farmer’s decisions to adopt new technology depend mainly on the quality of their land, access to irrigation and profitability.

Cooper and Kein (1996) using a bivariate probit double hurdle model found farmer adoption of environmentally sound farming practices as function of the payment offer. They concluded that farmers can be encouraged to voluntarily adopt
environmentally sound management practices through the use of incentive payments.

A bootstrapped simultaneous equation Tobit model was used by Nkonya, Shroeder, Norman (1997) to examine the adoption of maize by farmers in Northern Tanzania. They found nitrogen use per hectare, farm size, farmer education level and visits by extension agents positively affected the adoption of maize.

The review of literature on adoption behaviour of farmers revealed that most of the studies invariably used personal, social and economic characteristics of the farmer as explanatory variables (Fig 2.2). The combined effect of these explanatory variables influence the decision of the farmer to adopt a technology or not. Farmers adoption behaviour was studied with regard to High Yielding Variety Seed, fertiliser, farm mechanisation etc. There is hardly any study which looked into the adoption of seed production as an economic activity by the farmers. Using personal, social and economic variables of individual sample farmers we studied the adoption behaviour of the farmers with regard to seed production activity.
Farmer's Environmental Factors

Technological
Economic
Social
Physical
Institutional
Educational
Political
Communicational
Biological
Religious
Industrial
Related Others

Farmer's Personal Factors

Personal (P)
Economic (E)
Social (S)
Communication (C)

Incentives

Adoption (Y = 1)

X1

Disincentives

Non Adoption (Y = 0)

XD

Er

Er = Residual or Unexplained influence of other factors

Fig. 2.2: Adoption Behavioural Model

Source: Leagans Paul (1979) Adoption of Modern Agricultural Technology by Small Farm Operators (p37 39)