CHAPTER 1

INTRODUCTION

A decision problem exists only when the possible consequences are important and yet a person is unsure of what is the best thing to do. When a person is uncertain about the consequences of his decisions, it can be said that it is a risky choice. Risky choice is inherently difficult to rationalise, but procedures have been developed to allow the process to be systematised. These procedures are collectively known as decision analysis. We are interested in the question as to how decision analysis can be used to lead to better decisions in agriculture.

The farmers with their bounded rationality make their decisions in crop cultivation to materialise their objective function of maximising production. The farmers' decision depends upon a number of variables which could be grouped broadly under 'price' and 'non-price' factors. With the given factors of production on
a given piece of land, how farmers make their decisions as to what crops to grow, what inputs to be used, what should be their combination and how much to be produced can be classified as the components of decision making process.

The decision making process of farmers involves a range of factors. Each farmer usually makes choices within the context of the household and is influenced by the households' needs and goals as well as the resources available to the household. These resources include not only land, labour, water, fertilizer and pesticides but also non-price factors such as access to information about the methods or techniques of crop cultivation and credit, and interaction of socio-political forces. It is observed that historically price policy alone is taken as the major plank on which farmers base their decisions.

As mentioned earlier both price and non-price factors influence separately the farmers' decision making process. Price factors (inputs and output) motivate the farmers to take their decisions with more care to increase the production and to generate more profit. Technological improvements in the cultivation of a particular crop yields more output on a given land and consequently generates more profit at the prevailing
price. Naturally, it leads the farmers to cultivate their land more intensively by using modern techniques of production.

Non price factors like environmental factors, dissemination of information, political influence and efficiency parameters in input use (engineering relationship between inputs) too play a major role in farmers' decision making. In the same manner, socio-political factors provide the farmers an easy access to water in canal irrigated area and easy accessibility to credit from commercial banks. Moreover, farmers are being enlightened about the soil silt and degradation of soil fertility due to improper irrigation and input management. Once they are aware of the consequences of poor land management, they plan the input combinations in such a way as to improve the yield from the given land and at the same time maintain the fertility of the soil.

Interaction of the price and non price factors leads the farmers to plan their cultivation in an efficient manner through better management practices keeping the fertility of the soil and profit considerations in mind. Naturally, it leads the farmers to increase the efficiency of farming (optimal exploitation of input efficiency). The range of options
open to the farmers is thus determined by the interaction of the price factors with non-price factors.

In such situations any planning and analysis of agricultural policy needs a careful analysis of the factors which affect the supply of agricultural output. Not only the levels of output but also the composition and efficiency in obtaining it is relevant for the purpose of policy. By and large, agricultural supply is an outcome of a large number of farmers' decisions. Here it is essential to understand as to how the individual farmer decides what, how and how much to produce? What factors affect his decisions? What is the relative role of price and non-price factors?

The contours of an agricultural policy for a densely populated developing economy have to be delineated with the specific objective of maximising agricultural surpluses. Considering that in many developing economies, where the critical minimum rate of agricultural growth necessary for the attainment of a desired level of general economic development is quite high, emphasis has to be shifted from a negative price policy of maintaining low farm prices to a production oriented price policy. It may, however, be noted that whether it is a negative price policy or a policy of incentive prices, a basic premise is that for an
unhindered growth of the economy, large surpluses from the agricultural sector should be available.

In high food drain economies like India, food grain prices play a dominant role in determining the level of production, conditions of production, levels of marketing, intersectoral distribution of income and overall growth of the economy. Higher farm prices encourage the farmers to manage their farms with intensive care to generate more profits since all the resources are privately owned. For all agricultural practices, land is sine qua non but by nature it is a fixed scarce factor. Since extension of cultivable tract has very limited scope (because of the expansion of other sectors), it is essential to concentrate on intensification of agriculture to exploit the original and indestructible powers of the soil (which persist in land according to Ricardo) and to reap a good harvest.

Keeping these prevailing conditions of generating agricultural surplus in view, it is proposed to study the "Decision making process of farmers with respect to price and non price factors in crop cultivation". This study seeks to analyse as to how the price and non price factors influence the farmers to augment the production and marketed surplus while increasing the farming efficiency. The focus of the
study is not only to find out the differential decision making process of farmers' response on output\textsuperscript{5} and marketed surplus to prices and non price factors (which vary with resource position) but also to analyse such responses in diverse decision making environments (developed and underdeveloped region) with controlled variables like new technology and development of agriculture in general.

1.1 Decision making process of farmers

The major thrust of the empirical economists of this day is the observation of the behaviour of producers and consumers in relation to their economic environment and changes in it. Understanding of this relationship allows one to predict the behaviour in situations which is expected to occur. This power of prediction may help to understand fully the circumstances surrounding the actions of economic agents. It is towards this deeper understanding that the study of decision making is intended to contribute.

While studies in the past have been mostly concerned with the behaviour of human aggregates, the psychologists have made considerable contribution to the literature of human behaviour at the individual level.
The main concern of this study is that an economic theory can also best take the individuals as its frame of reference for the consideration of behaviour of groups. Thus, the level of enquiry chosen here is that of the behavioural psychology, though the approach is essentially an economic one.

According to D S Thornton,6 (1962) "the decision is one element of behaviour, it consists of that chain of mental activity which follows either the reception of stimuli from the outside world or the growth of a desire for change within the individual; decisions are thus the necessary precursors of choice, either between action and inaction or between alternative actions".

The definition of Thornton extends the scope of decision making of individuals into both psychological and economic terms. Hence, their views (psychologists and economists) have to be taken into account with great care. The views of psychologists and economists are briefed here.7

**Psychologists view:** It is concerned with laboratory studies of human choices and of certain kind of human information processing leading up to these choices. It is organised around two concepts and two
principles. The two concepts are utility, or the subjective value of an outcome, and probability, or how likely it seems to the decision maker that a particular outcome will occur if he makes a particular decision. Both of the principles are normative or prescriptive; they specify what an ideal decision maker would do and thus invite comparison between performance of ideal and of real decision makers. One, the principle of maximising expected utility, in essence asserts that one should choose the action that on the average will leave him better off. The other, a principle of probability called Bayes' theorem is a formally optimal rule for transforming opinions in the light of new information and so specifies how you should process information.

The basic conclusions reached as a result of comparison of actual human performance with these two principles is that men do remarkably well at conforming intuitively to ideal rules, except for a consistent inefficiency in information processing.

Economist's views: The total literature can be grouped into prescriptive and descriptive theories of decision making. While the former is concerned with logic - a system of formally consistent rules of thumb, the latter is about the psychology of thinking.
Descriptions, consequently predictions of behaviour, are presumably a task for psychologists or anthropologists. Pedagogical techniques are objects of descriptive study. To illustrate the prescriptive, one has to depend on the rule called transitivity of preferences because of its special similarity with transitivity of inclusion. The descriptive and prescriptive approaches become clearly distinguished by directing more attention to economic decisions under uncertainty and to non-quantifiable decisions. Adam Smith explains the role of incentives and freedom in making human beings to work hard and maximise the efficiency and achieve common good through automatic operation of market. The Neo-classicals always start with the basic assumption that all human behaviour is motivated by the maximising principle (profit maximisation) and human-beings behave rationally while making economic decisions.

In consonance with these theoretical explanations of decision making, it is common sense that the farmers make decisions under extreme price and weather risk. The farmer has, as is invariably true, multiple goals. The problems of decision making, thus, becomes more complex. The situation is further complicated when risky choices prevail, i.e., when the
consequences of actions are uncertain due to stochastic influences.

In this context emerges a new ramification in economics which provides much importance to the role of expectations for the uncertain future. This is called rational expectation.

The pioneer in this field was John Muth (1961). In his seminal paper in Econometrica (1961), Muth hypothesises that rational expectations are informed predictions of future events and profit maximising expectations. Indeed the Classical and Neoclassical economists assert the analogous assumptions but they neglected the expectation and uncertainty which are hidden in future events.

In his own words Muth says, "expectations since they are informed predictions of future events are essentially the same as the relevant economic theory... expectations of firms (or more generally the subjective probability distribution of outcomes) tend to be distributed for the same information set about the prediction of the theory (or the objective probability distribution of outcomes)."

The rationale of expectationists amount to an assertion that economic agents will learn to eliminate
systematic expectational error. When the economic actors make decisions and execute them, they learn from mistakes and experience and they do not continue to do the same mistake. But if there are some errors, they are in the nature of random error because of non-availability of complete information.

1.2 **Statement of the problem:**

The gist of the problem is simple to state. A choice must be made from a set of acts $A_1, A_2, \ldots, A_m$, but the relative desirability of each act depends upon the prevailing "state of nature" $S_1, S_2, \ldots, S_n$. As decision makers are aware that one of several possible things is true, which one of it is relevant choice, but it is not known about the relative probabilities of their truth. In general, to each pair $(A_i, S_j)$, consisting of an act and a state, there will be consequence or outcome. The decision makers' preferences among these outcomes are consistent in the sense that they may be summarised by means of a utility function.

The present study seeks to analyse how the decision maker determines his preference under uncertain weather conditions at a particular point of time on a given piece of land. On a given piece of land,
different categories of farmers cultivate their lands with different intensity and with different intensive care. For instance, the large farmers may make the decision of cultivating a crop under an uncertain climate with one goal while a tenant farmer and an owner cultivator with entirely different goals in the same conditions of production. This study seeks to probe the decision making process of different categories of farmers (owner cultivators, tenant cultivators and large farmers) in diverse situations (in developed or wet region as against underdeveloped region or dry area).

This problem is identified because in countries like India, the demand for agricultural produce increases with increasing population. In contrast, the growth in agricultural production does not increase correspondingly to meet the increasing requirements of the nation. Likewise the growth in yield per hectare of cereals is also very negligible compared to other countries.

Given the constraints of horizontal expansion, as stated earlier, for increasing production, it is necessary to concentrate on vertical growth. In other words, it is necessary to get higher returns from the same unit of land by intensive and efficient cultivation.
Intensive cultivation is a practice of producing maximum crop yield from given land by special soil and crop treatments and providing all factors in the quantities needed and at the right time considered conducive to high yields.\(^{10}\) It implies the handling of inputs (HYV, mechanisation, water management, fertilizer and pesticides) with intensive care to augment production. The farmers decide to go in for intensive cultivation only when the prices prevailing in the market is commensurate with the cost of cultivation. The decision of intensive cultivation, therefore, depends on off-farm produce prices which the farmer gets in the produce market and the prices in the factor market.

Efficient cultivation, on the other hand, implies the farmer's decision to maximise the output through efficient management practices and optimum exploitation of input efficiency on a given unit of land with the given input combinations. The choice of input basket leads to higher farm efficiency only when there is a judicious combination of price and non price factors (engineering relationship of inputs). Consequently, at once it brings down the cost of cultivation and keeps the land more fertile.
The next important thing to be considered is the disparities that exist in factor endowments among the farmers. A large number of farmers remain with less resource base cultivating fragmented plots. Their relatively low risk bearing capacity to fluctuating prices in both the input and output markets ends up in disaster to their material well being and so their response. Likewise each group demonstrates its response in its own way to the same policy. Any price policy or policy affecting the decision making should, therefore, consider the differential response of the farmers.

From the foregoing paragraphs emerge the following issues.

1. What is the decision environment that a cultivator faces to go in for intensive and efficient cultivation?

2. What is the impact of macro level price policy on the micro level production process at a particular point of time?

3. What should be the micro and macro objectives of an incentive scheme and how best to reconcile the two situations.
1.3 Theoretical Framework

The problem of decision making in agriculture has been chiefly quantified with the help of six models, viz., expected utility, Bayesian, Safety first, Cautious Optimising, Shackle’s focus loss, and pure behavioural models. These models can be sorted on the basis of three criteria.

(a) On the basis of the assumption that the decision maker acts in accordance with personal probabilities.

(b) On the basis of specification of the decision making process.

(c) On the basis of purpose of learning the model.

The following Table elucidates the category on which the models lean.

<table>
<thead>
<tr>
<th>Model</th>
<th>Personal probabilities</th>
<th>Decision process</th>
<th>Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Expected utility</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2. Bayesian</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3. Safety first</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>4. Cautious Optimising</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5. Shackle</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6. Pure behavioural</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
The assumption of personal probabilities (i.e., subjective "degrees of belief") is accepted as a useful one in all the models except the shackle and pure behavioural models which are not sufficiently developed to serve as viable alternatives to the other models.

In what follows, the major models are discussed in brief.

Both the Bayesian and expected utility models are widely regarded as full optimality models because the solution they prescribe is the best the individual can do, given the relevant constraints. Safety first and cautious optimising models are called 'behavioural' because they are based on feasible and practical decision rules, and they are built on the principle of bounded rationality. Rationality, as used in conventional economics, describes the process by which the decision maker picks the best possible alternative, given his preferences and constraints, without regard to what decision making process is used. Rationality is therefore the hallmark of full optimality decision models. Bounded rationality model thus emphasises the decision process itself.

Kunreuther (1974) embeds a safety first constraint in a satisficing framework by stipulating
that the decision maker strives to maximise expected profits subject to constraint that the risk (probability) of profits falling below a critical minimum (disaster level) must not exceed a given level (e.g. ten per cent). If aspiration level proves to be too high, then it is gradually adjusted downward until an alternative is found that satisfies the constraint.

Lexicographic Safety First (LSF) model is closely related to the Kunreuther Satisficing Model. Formally, however, the LSF is a full optimality model because in it the decision maker acts in accordance with a complete preordering of preferences.

The cautious optimising model is also based on the principle of bounded rationality but it emphasises the way the individual farmer adjusts to changing conditions and information. For pragmatic reasons, cautious optimising involves the very simple decision rule of moving each period, in the right direction but not more than some maximum distance. Here the distance may be defined as the percentage of arable land that is shifted to a new crop or technique. This distance or amount of change has been referred to by some as risk, but this definition seems to confound the notion of change with the consequences of unfavourable states-of-the-world. This is particularly true if the research objective is to investigate the effect of risk aversion
on the adoption of new techniques. The advantage of cautious optimising lies not in studying the effect of risk preferences on the allocation of resources but in modelling dynamic programming problems in order to trace, for example, the effect of new technology adopted on yields.

Both the expected utility and behavioural approaches have serious problems. The expected utility approach rests on unreasonable assumptions, especially when applied to single period decision problems, and estimation of the utility function is sensitive to interview techniques. On the other hand, the behavioural approach rests on a somewhat arbitrary selection of decision rule and method of calibration.

The above appraisal of the decision making models clearly reveals the superiority of cautious optimising (behavioural approach) in comprehending the decision making process of the farmers in comparison with other models. Further, the cautious optimising model suits well in to the framework of the present study.

Cautious optimising theory assumes farmers as 'adaptive man'. According to Day and Singh, (1977) adaptive man is an agent who makes short horizon plans,
not because he is rational, but because he is seldom prescient; he is cautious in adapting to a changing environment because tradition and experience show him that caution is often a wise tactic in the game of economic survival; he responds to feedback from the market and the behaviour of other agents because the task of estimating competitors' behaviours far exceeds the capacity of any individual's computational ability, even as it far exceeds the capacity of the largest and most sophisticated economic modelling centre.

With this premise of adaptive man, a brief note of the decision making process is presented. To grasp the model, certain strategic details have to be understood clearly. The important ones are:

(a) decision tactics for uncertain decision environment
(b) adaptation in response to feedback
(c) adaptation in response to learning
(d) adaptation in response to satisficing
(e) adaptation in response to multiple goals

It is a generalised fact that farming is highly uncertain in many of its aspects. Making it predictable or accountable in one way or other is perforce the concern of farmers as well as the economist if he is to understand agriculture. It is hazardous,
nevertheless, to think that the farmer's decision strategies are the same as those used by sophisticated gamblers in St. Petersburg or Monte Carlo.

The dependence upon uncertain weather and the inability to prevent crop disease and pest attack leave the farmer at the mercy of an unpredictable environment over which he has little control. In an environment where subsistence farms dominate, there is very little margin for error, because the outcome of the production decisions determines survival. Farmers cannot afford to be wrong; since the opportunity cost of an unfavourable outcome is very high. Therefore, the farmer is likely to depart from the traditional method with a lag.

Farmer's information about outcome is derived from long experience and is based upon an ultimate knowledge of the environment. As farmers are aware of the survival value of traditional methods, the marginal pay off between traditional methods and new ones should be large for farmers to change. Farmers must have confidence based on experience - his own or successful neighbours - to justify modifying traditional modes of behaviour.

The basic ingredient of adaptive behaviour according to these observations is 'caution'. Caution
alone is sufficient to explain why small changes in relative prices or in the quantities of traditional inputs are unlikely to bring about any long run departure from traditional equilibrium, as argued by Schultz.

Another thing closely related to caution is anticipation. All economic decisions which have possible future outcome are based upon more or less vague anticipation. Anticipation must be based upon the knowledge of past behaviour of events and upon guesses about environment. Since the rate of change is slow in traditional agriculture, the past information is reliable guide to future. This reliability breaks down when large structural changes begin to occur. Here is the rub. Farmers cannot predict the future events as their information is based on traditional events. Here comes the necessity of a kind of feedback mechanism of actual outcomes. A feedback mechanism based on actual outcome makes it possible to adjust anticipation in right direction. Thus, feedback becomes an essential element in the analysis of the decision behaviour of traditional farmers in a dynamic environment.

The next one is learning process. As learning process proceeds, farmers gain more and more familiarity with the adoption practices and confidence in
ability to explore successfully the alternatives. Therefore it is taken as axiomatic in this theory. The activities that are feasible from technological and financial points of view are further circumscribed by adapting constraints that accommodate the cumulative effects of experience and observation of neighbours' experiences.

The last one is based on the growing realisation that economic decision making has a multiplicity of goals. All goals do not have equal priority, and that goals can often be ranked according to a well-defined set of preferences. This has a very special application to traditional agriculture in which the farmer may desire to maximise short-run profits, but only as a lower order goal. His first priority is to meet the food requirements of his personal consumption, especially when these are not available from the market. Such an ordering is basic to his survival.

The important goals are subsistence, cash consumption-saving and unwillingness to modify economic activities. The subsistence goal represents the objective of meeting immediate survival needs. The cash consumption-saving goal represents the trade-off between a desire for consumer durables and a desire for enhanced future cash earnings. The third goal represents the
unwillingness to modify economic activities drastically during any one time period because of an uncertain market feedback. These goals make it possible to decompose the overall farm decision problem into a sequence of simpler problems. This framework is in general followed throughout the study.

1.4 Review of Studies

Some important studies concerning decision making at the farm level are reviewed here. They are grouped on the basis of the methodology, objectives and findings of the studies. On the basis of methodology they are grouped into four. Whereas on the basis of objectives six groups are made.

The major methodology based groups are:

(1) Expected utility based models;
(2) Security based models;
(3) Game theory; and
(4) Others

Expected utility based models: The criterion of maximising expected utility employs Bernoulli's principle which is also popularly known as the expected utility theorem. For quantifying risk and
uncertainty, Bernoulli's principle allows personal valuation of consequences and personal strength of beliefs about the occurrence of uncertain events. This principle also has the normative justification of being a logical deduction from a small number of postulates or axioms which are acceptable and reasonable to many people to the extent that these people would like their choices to conform with these normative postulates. This theorem runs as follows: For a decision maker whose preferences do not violate the axioms of ordering, continuity and independence, there exists a function called 'U' utility function by which (a) cardinal values can be assigned to possible outcomes and (b) whose expected value in terms of probability distribution for outcomes under each choice alternatives gives a comparative measure of attractiveness consistent with the decision maker's preferences for each of the available choice alternatives under uncertainty. Its practical variant is the mean-variance analysis, which makes use of either of the following two assumptions:

(1) The decision maker's utility function is quadratic.

(2) The possible returns associated with each alternative facing the decision maker are normally distributed.
The mean variance analysis, either quadratic programming or some linear alternative to it, is the tool of analysis. (Markowitz, 1952); (Freund, 1956); (Mc Farguhar, 1961); (Officer and Halter, 1968); (Das Gupta S, 1970); (Walter and Dean, 1971); (Hazell, 1971); (Scotland Baker, 1972); (Lin, Dean and Moore, 1974); (Schiuter, 1974) (Singh l J, 1979); (Herath, et al., 1982).

Security Based models: These models present a method for taking uncertainty into account when representing farmers' production decisions. The main assumption is that farmers maximise profit provided the possibility of ruin is negligible. The possibility of ruin is viewed as closely related to Shackle's focus of loss. Roumasset, the chief exponent of these models, reviewed various safety first rules and developed two lexicographic safety first models. He used them along with the risk neutral (or profit maximisation) model and de Janury's model for explaining the levels of fertilizer use in rice by the farmers of two sample in Phillipines. (Bouss and Pett, 1967); (Alain de Janury, 1972); (Roumasset, 1973); (Webster and Kennedy, 1975); (Barry and Robinson, 1975); (Mos cardi and de Janury, 1977); (Day, 1979); (Wright, 1979); (Ortiz, 1979); (Rosegrant and Herdt, 1981).
Games as decision making under uncertainty:
The decision maker (farmer) wishes to choose an optimal set from the set of possible strategies (acts) available to him. One modus operandi for the decision maker to generate an a priori probability distribution over the states (pure strategies) of his adversary (nature) is by taking into account both the strategic aspects of the game and what information is known about his adversary. Then to choose an act which is best against this a priori distribution. The decision maker might imagine a series of simple hypothetical side bets whose pay-offs depend upon the strategy his adversary employs.

But in actual practice, the peasant's decisions depend upon a number of non-economic factors than the economic factors. The prominent non-economic factors are literacy, environment and technical advice available in the nearest big town. The peasant behaviour in India is, thus, a game of Matching Pennis Nature as Neumann and Morgensten predict. Since the pure strategies cannot explain the things correctly, the need for mixed strategy. Neumann and Morgensten visualise that such games have the 'best strategy' and a calculable pay-off for each player (Michael Lipton, 1975); (Aliben Zaid Salmi, 1977); (Kawaguchi and Haruyama, 1985).
In addition to these, there are a number of models to compute the decision making under uncertainty. The important models are over shooting model (monetary policies influence on decisions) (Frankel, 1986) Mean-Variance decision rules (variance and covariance matrix of joint distribution of returns for uncertain events) (Chelfant, et al., 1990). Exponential utility moment generating function (Gbur and Collins, 1989) and stochastic dominance (first degree stochastic dominance based on the first order derivative of the outcome of a new technology and if it is positive, risk averse decisions and second degree is based on mean variance) (Anderson, 1979). Since these models are not used widely due to its inapplicability to different locations or systems, these models are not presented in detail.

With this review based on methodological breakthrough in decision making problems, review of the studies based on their hypotheses and findings is in order. On the basis of the nucleus of the studies, they are grouped as follows:

(1) acreage decision making
(2) dynamic decision making process
(3) particular input decisions for a crop or season
(4) farm planning under risk and uncertainty
(5) non price factors in farmers' decisions.
(6) marketing decision.
Under yield and utilisation uncertainties, optimum planted acreage may be estimated using the concept of disequilibrium costs - those costs incurred when production is not matched with utilisation. Since larger disequilibrium costs result from under-production than from over-production, optimum acreage increases substantially when allowances are made for existing yield and utilisation uncertainties. The supply response studies from Marc Nerlove to date exhibit the influence of different economic and non-economic factors for devoting more acreage under a particular crop in farmers' decisions. While the major economic incentives which stimulate the farmers to devote more acreage under particular crop are price incentives and subsidies on seeds and inputs, the major non-economic factors are education, environment and traditional beliefs. These are all based on positivists' and Neo classical views of profit maximisation with the limited resources. But of late the studies which are based on rational expectationists' view visualise that the decision makers always select the prospects with the highest expected value, regardless of dispersion among the various outcomes involved by employing rules of thumb with safety first models (Marc Nerlove, 1956); (Rajkrishna, 1963); (Behrman J R, 1968); (Venkataramanan, L S, 1969);
Most of the researches (mentioned in the foregoing category) on acreage decision of farmers have relied on time-series analysis. But the studies which focus their attention on dynamic decision making process of farmers utilise field production data. The recent researches have shown that farmers use their observations of stages of production (intermediate crop state) to make input decisions, and these input decisions in each stage are correlated with the random component of output. Optimal input decisions are derived from a discrete, stochastic control problem in which the crop state is a Cobb-Douglas function of inputs in each stage. Both linear and non linear system of equations can be used for consistent estimation of production parameters. Each system comprises the production functions for intermediate inputs. The dynamic production models contain eight stages (at the maximum) of production within a single agricultural season. As many as sixty decision alternatives are available to the decision maker at some of the stages. (Aliben Zaid Salmi, 1977); (Hatchett, Stephen Alan, 1984); (Mjelde, James William, 1985); (Robert Neil Collender and James A Chalfant, 1986); (Robert A Collins and Beter J Barry, 1986).
Optimal (profit and utility maximising) input levels are computed based on normative decision-guides developed from experimental data as well as subjective data elicited from several peasants regarding their expectations of prices and yields. Here, most of the studies focus on suggesting an analytical framework which could integrate weather conditions into the decision making on the use of inputs such as fertilizer, irrigation and herbicide. The procedure is based essentially on game theory, while weather conditions are expressed as states of nature with a given probability distribution, input treatments would be the possible strategies the decision maker could adopt in his "game against nature". In some cases, the inputs are correlated with the random component of output and found that yield response was more to fertilizer in the second stage of production while irrigation in the initial stage and the pollination stage. The excess of water in the middle period would be favourable to weeds that are more tolerant to soil saturation and would decrease the competitive capacity of wheat by keeping its root system near the surface (Aliben Zaid Salmi, 1977); (Hatchett S A, 1984); (Sivaramaratnam S, 1985).

The farm planning problems under uncertainty added constraints are convenient in representing
resource limitations, technical relations and other relevant farm constraints. They are also instrumental in incorporating whatever information is available to the farmers regarding the relative strategy frequencies of nature. The farmers are seldom at the stage of 'complete ignorance' that is assumed in game theoretic models. The minimal data required for a reasonable estimation of probability distribution under risk efficient decisions is also probed in some studies through a Monte Carlo study of a rule for smoothing sparse data into cumulative distribution function (Wen, Ronglin, 1973); (Michael Lipton, 1975); (Jock R Anderson, 1976); (Gene Nelson A and Tiffin D Harriss, 1978); (King, Robert Phillip, 1979); (Singh I J, 1979); (Grisley William, 1980); (Hans P Binswanger and Donald A Sillers, 1983).

Despite a plethora of supply analyses, very few researchers in studying a given country or crop, have come out with explanations of why their results may be similar to or different from those obtained for other areas or crops but all such attempts have been phrased in tentative and qualitative terms. A few have been based on statistical analysis of the underlying infrastructure affecting the cultivators of different countries or different commodities. In a dynamic environment with imperfect information, education
contributes to production as an 'allocative effect', arising from enhanced ability to acquire and process information, as well as "workers effect". Here some studies put forward the hypothesis that cultivators' price responsiveness (in terms of both short run and long run supply elasticity) can be expressed as a function of a number of quantifiable social variables viz family size, environment, education, government intervention and extension programmes, and proved it with the help of regression techniques. In some studies, the communal framework of living as the major factor influencing the decision making process of farmers is also probed. (Richard E Just, 1973); (Ntalaja, Kalanji, 1973); (Cummings, John Thomas, 1974); (Wallace E Huffman, 1974); (Thomas D Knight, 1987).

Studies based on Mathur and Ezekiel (1961) framework have argued that subsistence farmers have an inelastic demand for cash and hence, price and marketed surplus have negative relationship. Some studies argue that marketed surplus falls up to a certain size and then it increases. Thus, there is a 'U' pattern of marketed surplus. A few other studies bring out that a direct relationship between the size of holding and marketed surplus. Some studies which have gone into the details of different systems conclude that it differs
from system to system (Dharm Narain, 1961); (Raj Krishna, 1965); (Utsa Patnaik, 1975); (Ramaiah, 1981).

1.5 Research Gaps

The modern agriculture is characterised by technological developments like HYV, mechanisation, fertilizers and water management. Farmers always attempt to maximise their net returns through better allocation of input combinations. Moreover, in the present world, though most of the farmers are uneducated they are enlightened enough through information network and, training and visit system to adopt modern technologies to augment production. But very few studies have concentrated on this complex issue of decision making process of farmers in a dynamic agriculture, where input decisions in different groups play a role on output especially on the three aspects, viz., price, non price factors and their interaction.

Most of the studies which have concentrated on this field estimate the expected price on the basis of either Cobweb (Naive expectation) model or Nerlove (adaptive expectation) model. But empirically in Indian agriculture wide fluctuations are there in both production and prices. They may go up simultaneously, say for three years and in the fourth year they may move
in the opposite direction. In such situations, demand and supply forces become crucial as causative and curative factors. Here while using the linear equation models the simultaneous equation bias problem arises and the results are not so reliable.

A few studies (like Dharm Narain) demonstrate the 'U' shaped marketed surplus curve and a few others (like Raj Krishna) exhibit the straight line marketed surplus curve. But in practice, marketed surplus is the combined effect of all the factors of production, size of the household and other institutions like tenancy and payments in kind.

In food-drain economies like India, the hike in food grain prices will bring disastrous results to the material well-being of the masses. Hence, instead of economic incentives in the form of price to maximise farmers' objective variable, it would be better to make use of a proper subsidy policy for inputs, seeds, etc to materialise farmers' objective function. This will at once bring down the cost of cultivation and generate more profits to the farmers. Moreover, it keeps the price at low level which helps the masses. But very few studies have endeavoured to study this issue.
One more issue is the differential response of farmers to the state's price policy—whether positive in developed region or insignificant in underdeveloped region. In developed countries too, some argue that the large and medium farmers' response to price is positive and significant while a few others argue that even those who practice subsistence farming also respond positively to the price especially in commercial agriculture. In this context, only a few have attempted a comparative study on farmers' decision making process in two different situations.

This study attempts to fill in some of these gaps.

1.6 Objectives of the Present Study:

General

To examine the decision making process of farmers and to locate the weightages assigned to different components (price and non-price factors) in order to examine the response of different categories of farmers (large farmers, owner cultivators, tenant cultivators) in a developed region as against in under-developed region.
2. To analyse the output and marketed surplus elasticities under diverse situations.
3. To probe the impact of agricultural policies at micro-macro level.

Specific

1. To examine the decision making process of farmers on a given land at a particular point of time with respect to price and non-price factors.
2. To examine the farmers' decision of what crop to produce and how price and non-price factors play their role.
3. To analyse the farmers' decision of how much to produce and to examine the input decisions at different stages at a particular point of time.
4. To probe the differential elasticities of marketed surplus to given price and non-price factors in diverse situations.

1.7 Design of the study

The present study is a comparative study of two dimensional nature i.e., comparison of developed and underdeveloped region and within each region a comparison of the decision making process of tenant
farmers, owner cultivators and large farmers. The study is based both on primary and secondary data. At the micro level, with the help of primary data the individual farmers' decision making process is studied. Based on secondary data, the decision behaviour at the macro level (state and district) and the agrarian structure are studied.

Both qualitative and quantitative data are collected and simple statistical techniques like multivariate linear regression, stepwise regression, double-log function and crop diversification index are used to analyse the data.

1.8 Sources of Data

Primary data are collected for the variables which are shown in the decision tree with the help of well-designed questionnaire (Appendix I) specifically for this purpose for the agricultural year 1986-89. The qualitative variables in the decision-tree (P. 38) are quantified with the help of borrowed scales (Supe and Singh).

The secondary data relating to the ownership holding and holdings of land in Tamil Nadu are drawn from the NSS (8th, 16th, 17th and 26th rounds), World
DECISION TREE

GOVERNMENT POLICIES
[Procurement, Subsidies]

- Risk
  1. Weather conditions
  2. Tenure systems
  3. Traditional values
  4. Environment (socio and economic)
  5. Knowledge & information dissemination
  6. Engineering relationship of inputs (input efficiency parameter)
  7. Political influence

Decision making process of farmers in crop cultivation

Input response decision

Marketed surplus

Household need for produce
- Land (owned & leased in)
- Irrigation

Price of seed, fertilizer, pesticides, organic manures
Labour (owned and hired)
Capital (Banks, Cooperative & money lenders)

Basic data pertaining to past performance of agriculture, area, yield under major crops and changes in cropping pattern are obtained from the two official periodical publications, Season and Crop Reports and Economic Appraisal - Tamil Nadu.

At the district level, the data substantiating cropping pattern, crops irrigated, area under different crops, yield per hectare of major crops are obtained from Deputy Commissioner of Statistics, Irrigation Department, Agriculture Department and Revenue Department. In addition to these, Census data pertaining to population at the village level and different district level are collected from District Census Handbooks for different districts.

1.9 Limitations of the Study

The study is carried out for two distinct situations in Tamil Nadu. Two Taluks are selected from the selected district with entirely different conditions of production i.e., assured irrigated and rainfed agriculture. A village from each of the selected...
selected for intensive study. The period of the study is confined to one agricultural year (one Khariff and one Rabi season) for farmers have limited memory power to give authentic data. The farmers are identified by using census schedule on the basis of their dynamism and progressiveness to cultivate the farm with intensive care. The variables are restricted according to their availability which was studied with the help of pilot survey.

1.10 Approach

The present study is both quantitative and qualitative in nature being based on primary data from two villages of Madurai district in Tamil Nadu. Tamil Nadu has been selected as agriculture in this state has taken big strides during the last two decades towards definite transformation from the stage of chronic stagnancy to sustained growth in production since green revolution, as per the data available. This is discussed in detail in the following chapter.

The study area is identified by taking into consideration the characteristics like cropping pattern, and geographical feasibility to cultivate more than three crops. The study area is selected objectively keeping in view the main focus of the study.
The primary data was collected on the basis of survey method with the help of well structured questionnaire and personal interviews with district and village level offices as primary sampling unit and farmers as ultimate sampling unit in the selected region.

The sample size is determined after learning the characteristics of population in each. The sample size is allotted on the basis of homogeneity or heterogeneity characteristics in each strata. The details of sample selection and sample size are presented in the third chapter.

1.11 Plan of the Study

The study is divided into three parts. The first part consists of three chapters which include the introductory chapter; farmers in Tamil Nadu and description of Tamil Nadu agrarian structure forming the second chapter and the third chapter presenting a profile of the selected district and sample design.

The second part consists of three analytical chapters, the fourth, fifth and the sixth chapter. The fourth chapter deals with the decision making process of farmers on what crop to produce at the field level. The
fifth chapter carries the input decisions of farmers at the different stages of crop cultivation of farmers and the sixth chapter discusses the marketable and marketed surplus decisions of the farmers in the study area.

The third part, containing the seventh chapter, brings out the findings, suggestions and conclusions.


4. According to Theodre Schultz, High food drain economies are those in which expenditure on food, especially foodgrains, forms the bulk of the total consumption budget. For further details see G Parthasarathy and Mohinder S Mudhahar (1976) "Foodgrain Prices and Economic Growth", Indian Journal of Agricultural Economics, XXXI(2), pp. 17-30.

5. Elasticity of output with respect to the appropriate technology and relative price is the sum of elasticity of acreage and the elasticity of yield per acre.


11 This theorem was conjectured by Daniel Bernoulli in 1738 but its theoretical importance was recognised by the works of Von Neumann and Margenstern (1944) and Savage (1954).

12 While tossing two pennies (coins) simultaneously if both the pennies show head, the player will get the bid otherwise he will lose.