CHANGES IN RESOURCE USE STRUCTURE, RESOURCE PRODUCTIVITIES AND ALLOCATION EFFICIENCY ON FARMS IN MAHARASHTRA

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By

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C E R T I F I C A T E

I, hereby, certify that the thesis entitled

" CHANGES IN RESOURCE USE STRUCTURE, RESOURCE PRODUCTIVITIES AND ALLOCATION EFFICIENCY ON FARMS IN MAHARASHTRA ",

submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth (Agricultural University), Rahuri, Dist. Ahmednagar (Maharashtra), in fulfilments of the requirements, for the degree of Doctor of Philosophy (Agriculture) in Agricultural Economics, is a record of bonafide research carried out by Jagannathrao R.Pawar under my guidance and supervision and that no part of the thesis has been submitted for any other degree or publication.

The assistance and the help received by Jagannathrao R. Pawar during the course of this investigation and the sources of literature have been duly acknowledged.

Rahuri,

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A C K N O W L E D G E M E N T S

There is a common belief that the new high-yielding agricultural production technology has not made much head'way in the State of Maharashtra in its contribution to increased agricultural productivity and production. The crux of the problem of modernization of agriculture in the State is observed to be associated with the availability of capital resources, efficiency in allocating these limited resources to different uses, nature of technology and extent of its adoption determined by agro-economic considerations on different types of farms. The present investigation, therefore, attempts to understand the growth of agriculture in the region by way of estimating relative changes in resource use structure, resource productivities and allocation efficiency on farms during the pre-technological and post-technological change periods.

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Chapter 1

INTRODUCTION

1.1 Indian Agriculture During Pre-Technological Change Period :

Though the process of modernization of agriculture has been started since the beginning of India's Five Year Plans in early 'fifties, the low productivity encountered on the farms, in general, is acting as a bottleneck in the economic development of the country. Through the first three plan periods, Indian agriculture succeeded in meeting roughly the growth in demand for food and in absorbing about three-fourths of the growth in labour force. However, during 'fifties the success of Indian agriculture was achieved largely without benefit of major technological change (Mellor, 1972). The production increase resulted from expansion of the total land area and of the area under irrigation, and from increased labour (Shah, 1966). The Indian agriculture during this period represented typically the traditional nature of agriculture in the developing countries, wherein the possibility of enhancing agricultural productivity at a substantial rate was remote. While it will not be quite accurate to characterise the post-independence as stagnation, it cannot be denied that the inadequacy of agricultural production proved to be an obstacle to the overall economic development (Dantwala, 1972). Moreover, technology and factor proportions in agriculture remained relatively constant. Besides, in the absence of technological breakthrough, the various institutional reforms, practised during the 'fifties, proved to be 'sterile and ineffective' in the attempt to increase agricultural production (Dantwala, 1970). All the while the country was facing the problem of shortages of agricultural production, particularly of foodgrains, and had to depend on imports in order to meet the internal demand.

1.2 Transforming Indian Agriculture :

A perceptible technological transformation, however, has been under way in India during the last few years. With the introduction of high yielding varieties of seeds in 1964-65 and increases in the availability of chemical fertilisers, Indian agriculture is no longer traditional as it was during the 'fifties. The state of the arts has changed significantly. The technical properties of the factors of production at the disposal of the community have altered and new useful knowledge about factors of production has become available. In short, the costs and returns pertaining to alternative economic opportunities in agriculture have undergone a marked change. There is enough evidence to show that the technological change has resulted in an upward shift in production functions for major crops, especially for wheat. These technological improvements can be expected to disturb the stable state of long-run equilibrium of 'traditional' agriculture in India. The resulting disequilibria, according to Schultz (1964) is "rooted in economic growth. It can persist for decades and is presently most evident in some of the countries in which agriculture is technically in the vanguard". The advent of the HYV technology combined with a package of complimentary inputs has undoubtedly contributed to increase in agricultural productivity and brought about a remarkable change in the approach and behaviour of the Indian farmer.

The year of 1964-65, which was marked with the introduction of HYV technology and which gave real momentum to increased agricultural production and productivity in India, may be considered as the transition year dividing the post-independence economic growth in Indian agriculture into pre-technological and post-technological change periods. Whereas pre-technological period was characterised by stagnant agriculture, the post-technological period indicated the real hopes of attaining self-sufficiency in Indian agriculture.

1.3 The Differing Regional Impacts of Technological Change :

There are, however, some doubts regarding distribution of benefits of new agricultural technology over the farms and regions in India. Reliance on new agricultural technology has admittedly raised aggregate output, but at the same time it has benefited only the large farmers who possess the requisite resources to use the new technology. On the other hand, resource restraints, particularly in regard to credit and working capital, and the risks and uncertainties involved in shifting from traditional to modern inputs have come in the way of wider adoption of the new technology by the small farmers (Sen, 1972). Besides, the influences of a wide range of highly variable agro-climatic factors have caused considerable diversity in the impact of technological change over small regions in India. Areas with assured supply of water have benefited more by new technology than by the dry farming areas. Whereas high yielding varieties have been developed for irrigated areas, suitable varieties are still not available, which can give high yields under rainfed-conditions (Kahlon, 1970).

On the whole, the distribution of benefits among the regions have paralleled the existing resource endowment. The high yielding varieties have been observed to be the most productive in regions with favourable natural (agro-climatic) conditions and/or with substantial past investment in infrastructure development, such as irrigation, roads and power. The gains from technology during the decade of 'sixties have been maximum in the north-western States of Punjab, Haryana, Gujarat, Rajasthan and perhaps western Uttar Pradesh. The gains have been more or less confined to wheat crop. Isolated rice areas have done well but areas dominated by other cereals have not made much headway (Jha, 1974). The inter-regional disparities in the adoption of new technology have proved that technological improvements certainly overcome many of the limitations imposed by natural conditions, but beyond a point increases in productivity or removal of uncertainties cannot be possible.

By inter-regional diversity both in respect of natural conditions and past investments in various developmental programmes implies that the success of technological breakthrough in agriculture, as is observed in some of the north-western

States, cannot be generalised for the country as a whole. The process of transformation of Indian agriculture, therefore, needs to be analysed on regional basis.

1.4 The Problem of Agriculture in Maharashtra :

The State of Maharashtra is one of the several regions in the Indian Union where technological advances in agriculture have not made much headway in their contribution to increased productivity and production. The State has all the while remained on the forefront in adopting various developmental strategies including institutional reforms in order to increase agricultural production. However, the contribution made by these strategies has been observed to be relatively more conspicuous in the limited areas endowed with irrigation facilities and/or assured rainfall where cultivation of sugarcane and cotton crops is predominant. The major areas of Maharashtra, however, could not make much progress in modernizing agriculture because of their excessive dependence on natural (agro-climatic) factors. The crux of the problem of modernization of agriculture in these areas is observed to be associated with the availability of capital resources, efficiency in allocating these limited resources to different uses, nature of technology and extent of its adoption determined by agro-economic considerations on different types of farms.

'Changes in resource use structure, resource productivities and allocation efficiency on farms in Maharashtra' in order to understand the growth of agriculture in the region in its right perspective.

The present study depicts relative changes in resource use efficiency that have taken place on the farms during the pre-technological and post-technological change periods. The study is based on the data collected under the two series of Farm Management Studies in Ahmednagar District. The district typically represents the major soil-crop complex of the State. The production function estimates have been used in the study at two points of time (i.e., for the years 1956-57 and 1970-71), since comparison of such estimates provides empirical evidence of the differentials that exist in productivity of resources and their allocation to different uses over a period of time. Moreover, such data may serve to indicate in what directions and to what extent it may be desirable to change the value systems of policy makers and farmers so as to free the way for greater resource use efficiency.

The detailed information of productivity of different resources for various types of farming may be used by the policy makers to assess the possibilities of intensifying the resources in areas where the specific resources command productivity. In addition, the knowledge of changes in the productivities of resources over a period of time may also be used since it provides guidelines for adopting suitable developmental strategies, and a measure of technological lag confronting with the individual regions or farms.

At the micro-level, an analysis of the shifts in production functions and resource use over a period of time would help the farmers who are confronted with the problems of determining profitability either of increasing the use of capital resources or of reallocating limited capital resources for production. The primary value of such analysis lies in the direct indications it offers of economic equilibria/disequilibria in the use of capital resources, both at a specific time period and over a period of time. Such quantitative evidence is essential in an attempt to improve or optimise the allocation of scarce resources either within or between farms.

On the whole, it is contended that such data may enable us to assess the relative need for the introduction of more advanced production processes and to decide the adoption of new production functions whose primary aim is to increase resource use efficiency within a given technological environment.

1.6 Objectives :

In the light of the above observations the main objectives of this study may be stated as under :

1. To study the changes in the pattern of resource use structure on different size groups of farms over a period of time.
2. To determine relative changes in the profitability of farms over a period of time.

3. To examine changes in elasticity of production of various resources used in production of individual crops and farm business as a whole.
4. To study changes in scale relationship for individual crops as well as farm business as a whole.
5. To determine and compare marginal productivities of individual resources and changes thereof over a period of time in respect of individual crops and farm business as a whole.
6. To find out economic optimum levels of use of different resources in production of individual crops and farm business as a whole and probable reasons for a gap between the optimal and actual levels of resource use at two points of time.
7. To estimate changes in relative factor shares in agriculture over a period of time.

1.7 Conceptual Framework :

The major problems of agriculture revolve round supply functions and relationships of product output with factor inputs. These provide a framework for adjusting production and resource employment to promote general economic development. One of the main objectives of a productive unit is to co-ordinate and utilise resources or factors of production in such a manner that together they yield the highest net returns. Agricultural development occurs when the quantity and quality of resources are being improved and combined effectively to maximise output and when the institutional environment is being modified to ensure that the output is being used directly and indirectly for the well-being of cultivator families (Evans Sr., 1969). One of the major difficulties in Indian agriculture is thr lack of detailed and systematic knowledge of input-output relations. A more serious problem, and one which has not received the attention it deserves, arises from the complex nature of input-output relations in agriculture : complementarity among inputs is just about as pervasive as the phenomenon of substitution (Minhas and Vidyanathan, 1972). Extension of irrigation and fertiliser use, for instance, go together; whereas human labour and animal draft power can substitute for machinery.

Relative prices of product output and factor inputs also play an important role in the process of economic development as they determine supply functions, combinations and substitutions in respect of output as well as inputs. In an economy characterized by capital scarcity, population pressure and general labour unemployment, the supply price of capital is high relative to that of labour and therefore, economically most efficient organization of agriculture leans in the direction of labour technology. Given similar technical and management skills under labour technology, small farms can probably be just as efficient as large farms. However, as economic development progresses with capital becoming relatively abundant and labour becoming relatively scarce (agricultural production functions remaining constant), the relative prices of capital and labour resources turn to favour substitution of machinery for labour (Heady, 1962).

Sometimes, backwardness of the farmer is considered as a cause for low productivity in traditional agriculture. However, the chief limitation to increased agricultural production is not the backwardness of the farmer but rather inadequacy of the supply of current inputs (Minhas and Srinivasan, 1968). Inadequacy of capital resources and their inefficient use coupled with traditional techniques of production are some of the important causes of low production per hectare on Indian farms. By long trial and error, "farmers reach a point after which they can make little or no contribution to economic growth because there are few inefficiencies in the allocation of factors, the removal of which would increase current production, and because investment made to increase the stock of traditional factors would be a costly source of economic growth " (Schultz, 1964). The preposition that a substantial rate of increase in agricultural production can be achieved largely through the more effective use of resources already committed to the agricultural sector and with only modest requirements for the critical resources of high opportunity cost is essentially an empirical generalization (Johnston and Mellor, 1969). By implication farmers in traditional agriculture have reached an equilibrium (Hopper, 1964) although at a lower level.

Agriculture in many developing countries could not move ahead, because research was stagnant and there was nothing worthwhile to be extended to the farmers (Hopper, 1965). In traditional agriculture, since the output is mainly derived from land (of whose supply is fixed) and labour (of whose marginal productivity is almost equal to zero) inputs (Mellor, 1969), output could not grow at a faster rate because of low elasticity of the production function resulting from a fixed land area and no development of new techniques or resource forms.

The only way to stimulate agricultural growth in the developing countries is to raise investment opportunities by supplying new agricultural factors that embody improvements in technology and are therefore profitable for farmers to adopt (Schultz, 1964). Technological improvement is a superior resource that will produce for the economy a higher rate of return relative to its cost than will the (normal) established inputs employed in production. The most practical and economical approach to achieving sizable increases in agricultural productivity and output, therefore, lies in enhancing the efficiency of the existing agricultural economy through the introduction of modern technology on a broad front[1]. Modernized agriculture embodies the use of a profitable technology based on continuous and sustained research leading to higher productivity and higher returns to resources.

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1. R.H. McAlexander, comments made in a private discussion when he was in India as an Expert Adviser to the Mahatma Phule Agricultural University, Rahuri (Maharashtra) in its early stages of establishment.

Mosher (1969) has described five essentials (transportation, marketing, new innovations, access to supplies and incentive to produce) for transforming traditional agriculture. But the process of transformation may start in chronic deficit nations with the availability of profitable technology and needed inputs alone. Once this process starts, the entire input structure and decision making on the farm is marked by substantial changes.

The main characteristics of modern agriculture is the application of more capital inputs, consequent to technological changes such as new varieties of seeds, fertilisers, pesticides, machinery, etc., which in their respective ways raise the productivity of resources. It also enhances the scope to substitute inputs of elastic supply such as fertiliser with those having inelastic supply such as land. The effective supply of capital for land and labour depends on relative prices as well as relative productivities and marginal rates of substitution. Diminishing marginal productivity of conventional capital items has always been offset by development of new capital items or technologies with greater marginal rates of productivity and substitution (Heady, 1962), i.e., shift of production function.

The process of transformation of traditional agriculture into a modernised one implies that with the process of change it shifts the production surface upwards from lower level of equilibrium to a higher level of equilibrium (Solow, 1956 and

Hsieh, 1972). Conceptually, the total improvement in the input-output relation can be measured by shifts in the aggregate production function (technical change) and movements along the production function (economies of scale).

Changes in technology not only cause changes in product and income per unit of total inputs but they also cause changes in the proportional combinations of the factors of production. The manner in which the relative importance of the factors of production (land, labour and capital) will be affected through modernization will depend upon the extent to which the new technology is labour/capital/land intensive or otherwise and the degree of elasticity of demand for the said factors. Modernization of agriculture and its improvement with the help of technical advances necessitates a constant growth in capital investment per agricultural unit. There is a feeling that the recent breakthrough in Indian agriculture and the new economic environment have considerably affected the rate of capital formation and pattern of investment in agriculture. Due to higher use of capital resulting from technical advances, its absolute share in production would increase provided the elasticity of demand is more than unity.

The shifting levels of technology change not only the productivity of all resources but also they generate timing problems in scheduling required complementary resources (Douglas, 1962). In fact, the complementary resources are frequently crucial to a determination of the changing productivities (Heady, 1967). In India irrigation is the key to the reform and development complex, in that it is the chief means by which it is possible to see real hope of raising yields and providing the secure basis needed for investment in the complementary inputs. Besides, the returns to investment in technological change depend very much upon the nature of the underlying physical resources (Mellor, 1972). Limitations on environmental control prevent farmers from achieving the much higher yield potentials embodied in the new varieties of different crops.

Since the endowment of resources by nature to agriculture is not equal over space, differential advantage will occur by regions as encouraged by changing resource and product prices, and as allowed by technical knowledge (Heady, 1944). Under the varying natural conditions, a development strategy which aims at increasing the use of all kinds of inputs at a time risks very much to become less than optimal in its husbanding with scarce resources. A selective strategy according to different regions, is therefore more likely to make the most of what the country has (Dovring, 1972).

It is most likely that depending upon time factor and agro-economic variations, there exists a transitional stage which lies between traditional agriculture (with lower level of equilibrium) and modern agriculture (with higher level of equilibrium) in certain regions. This phase is characterized by the large inequities in the returns of resources with their costs, resulting in disequilibrium.

1.8 Hypotheses :

In the light of the foregoing theoretical propositions and the review of literature presented in the next chapter, the following hypotheses are proposed to be tested for fulfilling the requirements of the objectives of this study.

1. There has been a change in the pattern of resource use in agriculture in the region.
2. The change in resource productivity of different factors of production is relatively more prominent in case of the crops grown under irrigated conditions.
3. The sige of farm is an important factor to influence the resource productivity and profitability at the farm level.
4. The returns to scale are constant in agriculture.
5. The marginal value productivities of conventional inputs are low in relation to their acquisition/opportunity costs.
6. The efficiency in resource allocation has improved during the period.
7. The relative factor shares with respect to labour and capital have undergone a change.

REVIEW OF LITERATURE

Chapter 2

REVIEW OF LITERATURE

The low productivity per hectare of land in Indian agriculture, in comparison with other countries of the world, has received the attention of many economists. It is sometimes attributed to the inadequacy and/or inefficient use of capital and other factor inputs. Accordingly, many of the economists recognised a need for estimating and comparing the productivity of various forms of capital used on farms with a view that such attempts would provide relevant information to the policy makers and farmers who in turn may assess the possibilities of intensifying the resources in areas where specific resources command higher productivity. They maintained that the knowledge of prices and the marginal productivities of various resources will serve as an important guide to prescribe the directions of the shift of resources from one use to another on the same type of farms or from one type of farms or areas to another.

2.1 Agricultural Productivity in India in Fifties – Inverse Relationship :

Very few studies however, have been done in India in 'fifties with the main objective of determining the productivity of inputs used in production of crops. The studies in the economics of farm management sponsored by the Ministry of Agriculture, Government of India in six States has been one of the systematic attempts in this direction where the methods of cross tabulation analysis, correlation analysis and in a few cases regression analysis with only few inputs have been used to estimate resource productivity. These studies proved to be very useful as in each of the six States, the regions were selected in such a way that they represented the most important and typical soil-crop complexes in the State concerned.

Realizing the usefulness of these studies, the second round of studies in economics of farm management was completed in late 'sixties in sixteen States of India. These studies have thrown out lot of information on the resource use structure and resource productivity on the farms. The comparison of the studies conducted in 'fifties and in 'sixties provides relevant information on the process of modernization of agriculture in the country that has taken place during the plan period.

Some attempts in this field have also been made by some authors using either primary or secondary data available from Farm Management studies. Some scholars and research workers tried to probe into this field on their own accord and relied upon the survey data. The approaches of various authors varied considerably as some of them measured the productivity of only major input factors such as land, human labour, bullock labour and to some extent manure and irrigation; while others included a few more input factors such as plant protection measures, capital assets, etc., in addition to the above input factors. The choice of forms of production function employed inthe study also varied depending upon overall significance of the functions, ease in computation and the theory underlying the production process.

Driver and Desai (1959) used partial regression analysis to determine marginal productivity of human labour, bullock labour and manure input for different crops in the districts of Ahmednagar and Nasik with the data collected by two methods, namely, Cost Accounting and Survey Method. In Ahmednagar district it was surprising to find that the marginal value productivity of manure input was negative being Rs. -0.384 for unirrigated bajra. In 1956-57 they fitted Cobb-Douglas function to the data to study productivity of inputs used in various crops.

Basak and Chaudhari (1959) fitted linear functions to study the influence of different factors of production in terms of their physical quantities for two important crops, namely, Aman paddy and jute. Out of the four independent variables considered for the study, namely, area in acres, human labour, bullock labour and manure, only statistically significant variables were retained in the production function. The variable, manure was found to be absent in most of the equations probably due to the association of the dosage of manure with fertility of the soil. They concluded that less fertile land required more manure than more fertile land for the same acreage output.

Zacharias (1960) used Cobb-Douglas function to estimate marginal value productivity of different resources in selected crop enterprises in the districts of Coimbatore and Salem in

Madras State at different levels of inputs. From the changes in the productivity resulting from change in the proportionality of the variable inputs, he concluded that a change in the composition of other inputs was required for maximizing returns.

* Agrawal (1957) determined marginal value productivities of land, bullock labour and human labour for farm business and marginal physical products for irrigated wheat by fitting Cobb-Douglas function to the Farm Management data for the year 1954-55 in Uttar Pradesh. He observed a low value productivity of human and bullock labour and came to the conclusion that any further addition would lead to a decline in the returns and productivity of these resources. He suggested that resources should be increased with an increase in the other associated inputs. A non-significant relationship was observed between bullock labour and wheat crop yields as well as total farm returns and also between output and human labour of wheat crop. An increasing return to scale was found in case of farm business as a whole although decreasing return to scale was noted for wheat crop.

Rao (1966) studied resource use and productivity of farm inputs in West Godavari district of Andhra Pradesh in 1957-58. He worked out the marginal value products of different resources for the farms in Paddy and Tobacco zones and also in both zones combined. Except land, the productivity of all the resources was higher in case of Tobacco zone. On an average, an additional rupee spent on 'production expenses' gave a return of Rs. 1.36 and Rs. 1.90 for Paddy and Tobacco zones respectively and Rs. 1.56 for both the zones combined. The marginal value productivity of an additional rupee investment (excluding value of land) was quite low in both the zones.

Mathur (1960) used Cobb-Douglas production function for different crops individually and multiple regression equations for cotton-jowar-tur combinations. He was handicapped in drawing conclusive information from the elasticities of production as all the equations attempted turned out to be statistically insignificant.

Ram Saran (1964) used production function approach to measure the productivity of agricultural inputs by fitting Cobb-Douglas function to the input-output data obtained from the studies in the Economics of Farm Management. He fitted functions for farm business as a whole, as well as for important crops, with the input variables namely, land in acre, human and bullock labour, working expenses and manure in rupees. He compared productivity of inputs, particularly capital services, between different regions and found that in all the three States, namely Uttar Pradesh, Andhra Pradesh and Madras, the expenditure on use of manure and fertilizer, unimproved seed, etc., could increase farm income. The only exception was paddy in Madras where lesser use of manure was needed for optimum allocation of resources.

Bhardwaj (1974) attempted to examine relationship between farm size and productivity by an approach based on some broad characteristics of rural markets and the nature and extent of participation of different groups of peasantry in them. Data from Farm Management Studies in West Bengal, Bombay, Madhya Pradesh, Punjab, Uttar Pradesh and Madras were used to the explanations already advanced regarding the inverse relationship between farm size and productivity and to suggest how the relations between utilization (and productivity) of inputs and farm size could be interpreted in terms of unequal and diverse nature of market involvements of different groups of peasantry.

Agrawal and Foreman (1959) studied resource productivity in Western Uttar Pradesh for farm business as a whole as well as planted sugarcane and wheat separately. They observed that profitability could be increased by increasing use of human and bullock labour in sugarcane and seed, manure and irrigation in wheat.

Hanumanth Rao (1965) studied costs and returns for farm business as a whole and also fitted production functions to the data. He observed that on the average, land is being cultivated more intensively among smaller farms through greater application of labour input, although labour still has positive returns, and that among larger farms, where production elasticity of land is very low, there is relatively greater scope for increasing output through a more intensive cultivation of land by applying increasing labour inputs.

Rajkrishna (1964) fitted Cobb-Douglas function to estimate marginal value productivity of inputs for Punjab farms. He used three sets of equations by grouping some of the input variables in order to remove multicollinearity. He concluded that the marginal value productivity estimates of farm inputs are not so widely out of line with their acquisition costs as the usual references to the irrationality of Indian peasants imply.

Hopper (1965) studied the allocation efficiency in a traditional Indian agriculture in 1954 in village Senapur, District Jaunpur in Eastern Uttar Pradesh, using the production functions of crops grown with traditional method of production. He studied operations of 43 farms managed by resident land owners in the peak period (September-December) and fitted Cobb-Douglas function for each crop, namely, barley, wheat, pea and gram. By examining the price implicit in the allocation of resources among various crops during the peak periods of agricultural activity, he found that the use of the resources was efficient within the static economic meaning of the terms. The farmers, on an average, appeared to have successfully economized their scarce resources.

Sahota (1968) studied resource allocation efficiency in Indian agriculture with the help of production functions fitted to pooled data for three years, 1954-55, 1955-56 and 1956-57 collected under Farm Management studies in six typical regions of India. Average and marginal productivity differences were derived for a number of inputs in the production of different crops, across different regions, and over various farm sizes. The results, on the whole, do not lead to the rejection of the hypothesis that there are comparatively few inefficiencies in resource allocation in Indian agriculture.

Naik (1965) attempted to study impact of the different inputs on gross agricultural production through production function approach. He fitted Cobb-Douglas function to the data obtained from the sample of farms in Ankodia village. The study revealed that the use of human and bullock labour is relatively very high on the farms, thereby resulting into low marginal value productivities in relation to their opportunity costs.

2.2 Inverse Relationship or Constant Returns to Scale :

The Farm Management Studies of the 'fifties and other studies referred so far gave out 'inverse relationship between farm-size and productivity'. The studies conducted by Sen (1962), Hanumanth Rao (1963), Sen (1966), Mazumdar (1963), Paglin (1965), Rudra (1968), Hanumanth Rao (1966), Mazumdar (1965), Rudra (1968) and Rao (1967) also supported the hypothesis of 'inverse relationship between farm-size and productivity' in Indian agriculture. Moreover the phenomenon of the 'inverse relationship between farm-size and productivity' as revealed by these studies is a matter of relationship between output (output per acre) and only a single input without holding other inputs constant. These studies, mostly lacked in multi-variate analysis in an attempt to determine returns to scale in agriculture. The multi-variate analysis was, however, attempted in some other studies.

Saini (1969) studied the resource use efficiency and returns to scale underlying agricultural production on different categories of farms in Uttar Pradesh (Meerut and Muzaffarnagar districts) and Punjab (Amritsar and Ferozepore districts) on the basis of disaggregated farm management data for the years 1955-56 and 1956-57. The study indicated constant returns to scale inthe regions. The study also revealed that the farmers in the region were seen to be responsive to economic stimulus, though there existed possibilities of increasing farm incomes through adjustment in resource use.

The studies conducted by Khusro (1964), Raj Krishna (1964) and Chennareddy (1967) also revealed constant returns to scale in agriculture in the 'fifties in the respective regions. With returns to scale being constant, the 'inverse relationship' can be explained away in terms of the operation of the law of variable proportions.

2.3 The Decade of 'Sixties Marked by Technological Change :

The Farm Management Studies and other studies conducted by various authors in the 'fifties revealed inverse relationship between the size of farm and productivity per acre of land. It has also been inferred from the other studies that the farmers, on the average, are fairly efficient in the use of their factors of production. All these findings mostly related to an era of stagnant technology in Indian agriculture. Recent technological breakthrough in agriculture caused by seed-fertilizer-irrigation revolution has given rise to several structural changes in the farm economy.

Since all the studies mentioned above pertained to the 'fifties, it would be worthwhile to examine how efficiently the farmers were using their factors of production in the 'sixties.

Grewal and Kahlon (1973) have studied the farm size and productivity relationship in Punjab. They have observed that because of recent technological breakthrough in agriculture, the importance of the traditional inputs in the input-mix is on the decline and non-conventional inputs such as fertilizers, pesticides and machine power have become important. This seems to have altered the traditional farm size productivity relationship. Large farms have greater access to indivisible technological inputs such as tractors and allied farm machinery.

Crown and Nagadevara (1973) tried to test the hypothesis that the operators of various-sized holdings have improved their level of economic efficiency during the 'sixties, directly with a mathematically rigorous model quantified with data collected under the auspices of Government of India's studies in the Economics of Farm Management for Punjab, Uttar Pradesh and Tamil Nadu, 1956-57 and 1967-68. They observed that although all operators have probably become more efficient, operators of larger farms improved most rapidly. Further, the rates of improvement shown by large farm operators may have been sufficient to make them relatively more efficient than small farm operators, thus reversing the traditionally accepted proposition concerning the superior efficiency of small farm operators in India.

Singh and Patel (1973) examined the validity of the hypothesis of inverse relationship between farm size and productivity and returns to scale in the context of recent technological developments taking place in India, with particular reference to Meerut District of Uttar Pradesh. To examine the nature of returns to scale, a Cobb-Douglas type function was fitted to the data of 120 selected farms in the district. They concluded that increasing returns to scale prevailed in the selected farms of the district. The per hectare productivity and farm size relationship indicated that the hypothesis of inverse relationship does not hold true under the new agricultural technology in the area.

Bardhan (1973) used individual farm level data for nearly 1,000 Indian farms to analyse farm size and productivity relationship, returns to scale and imperfections in the labour market. He observed constant returns to scale in predominantly wheat areas and diminishing returns to scale in predominantly paddy areas. In both paddy and wheat agriculture, however, the observed negative relation between output per acre and farm size is likely to be the result more of an inverse relation between size and other inputs than that of scale economies. The production uncertainty in agriculture and some other factors involving the interlinked phenomenon of land and labour market imperfections might have contributed to such an inverse relationship.

Singh and Patel (1974) examined the productivity of resources and allocation efficiency on different sizes of farms adopting new technology. They fitted Cobb-Douglas functions to the input output data on per standard hectare. They observed that in general the resources were efficiently used except for irrigation on medium and large farms and for human labour on large farms. The optimum allocation of the limited capital indicated an increasing trend in the returns over the existing returns with an increase in farm size. Therefore, at the existing allocation of resources, the inefficiency in resource allocation was maximum on large farms followed by medium farms.

Singh and Kahlon (1973) compared marginal value productivities of different resources used on farms at varying levels of technology. They fitted Cobb-Douglas production functions to the data collected from a sample of 188 farm holdings in Punjab. The marginal value productivities of almost all the resource categories were higher on the farms with higher level of technology.

irrigation, land and capital assets command higher marginal value productivities in relation to their acquisition/ opportunity costs, there exists scope for increasing farm income by increasing use of these inputs.

Sethuraman (1971) examined resource use efficiency and returns to scale in Indian agriculture with the help of production function approach. He observed that the resources are being used efficiently and there prevails constant returns to scale in Indian agriculture.

Srivastava, Nagadevara and Heady (1973) studied the farm level data for the years 1967-68 through 1970-71 and observed that the technological change has resulted in an upward shift in production functions for major crops, especially for wheat.

Harrison (1973) attempted comparison of resource use efficiency on small and large farms in a wheat growing district (Ferozepur) and a paddy growing district (Thanjavur). The results indicated that in general small farmers adopt the new varieties as rapidly and use complementary inputs as intensively as larger farmers. The crop production functions structured to identify differences in levels of efficiency, output elasticities and economies of scale for different levels of technology and farm size groups, revealed that large farmers are not significantly more effective than small farmers at input-output conversion.

Pawar and Patil (1977) analysed size-efficiency relationships of small and large farms in dry farming area of Ahmednagar District in Maharashtra. They observed that small scale farming is as efficient as large scale farming in dry farming areas. The use of different resources, cost of production, gross returns and net returns moreover, depended on the scale of farming. Even the marginal value productivities of different resources did not show substantial difference on the two types of farms under the existing technology.

Acharya and Pawar (1977) have examined the productivity of resources by fitting Cobb-Douglas functions to the input-output data of a sample of 143 farms in Ahmednagar district. They observed that the productivity of resources are greater than their respective costs for the crops grown under irrigated conditions. There was also inefficiency in resource allocation on the sample farms. The use of bullock labour on farms was observed to be in excess as its marginal productivity turned out to be negative.

2.4 Technological Change and Regional Inequalities :

Eventhough the recent breakthrough in agricultural technology has enabled the country in becoming self-sufficient, the performance of agriculture is not even in different regions of the country. Agrawal (1974) has observed that the 'New Strategy' of Agriculture has contributed to significant increases in food production but its impact is most conspicuous in wheat and in regions with assured irrigation.

While examining the regional variations in production efficiency and accomplishments in the production of important foodgrains since the launching of the 'New Strategy', Singh (1974) has observed that in spite of efforts to transform the traditional agrarian economy, the impact is insignificant in large parts of India and agriculture is yet in a deplorable state. The prototype success as observed in wheat production in Punjab and Haryana is absent in the production of other foodgrains such as rice and jowar. These facts are highlighted with simple cartographic techniques but effective methodology.

Jha (1974) has observed that the gains from technology during the decade of 'sixties have been maximum in the north-western States of Punjab, Haryana, Gujrat, Rajasthan and perhaps Western Uttar Pradesh. The gains have been more or less confined to wheat crop. Isolated rice areas have done well but areas dominated by other cereals have not made much headway.

Mellor (1969) has identified the contributing factors for regional variations in agricultural growth. According to him, on the whole, the distribution of benefits among the regions would parallel existing resource endowment. The high yielding varieties would be the most productive in regions with favourable natural (agro-climatic) conditions and/or with substantial past investment in infra-structure development, such as irrigation, roads and power. But these regions had already been in the forefront of agricultural progress and had already been prosperous.

Falcon (1970) has stated that the benefits to the regions with inadequately developed agricultural infra-structure and natural resources are exceedingly small in comparison with the developed regions.

According to Raj (1969) the scope of high yielding varieties could be enlarged to a certain extent by extending irrigation facilities to unirrigated areas. But the scope for a rapid extension of irrigation is severely limited. A large part of the more easily available water resources has already been exploited. Areas with proven resources of water that can still be tapped with relative ease are few.

Kahlon (1970) and Rao and Singh (1974) have emphasised a need to develop such varieties of crops which give high yields under conditions of stress in areas with low rainfall. Ladejinsky (1973) has stressed the need for overcoming both man-made and natural inadequacies encompassing skills, irrigation facilities, allocation of resources and the whole gamut of physical inputs, research, organization and communication.

Ketkar (1975) has made an attempt to measure inefficiency in Indian agriculture with the help of farm level data obtained from Maharashtra, Tamil Nadu, Punjab and Bihar. With respect to efficiency/inefficiency of resource use within each State, it turns out that the apparent high total inefficiency in Maharashtra and Tamil Nadu is due to the adverse climatic conditions. In Punjab, the extent of inefficiency in the use of agricultural resources is very low and it is entirely due to excessive diversification of the cropping pattern. In Bihar, on the other hand, the total inefficiency is on account of both excessive diversification and selection of less efficient processes.

2.5 Technological Change and Relative Factor Shares :

Since the beginning of the technological transformation of agriculture in India, there has been increasing demand for non-conventional inputs. At the same time labour employment and relative factor shares of labour and capital have been disturbed to some extent.

Grewal and Kahlon (1974) studied the factors influencing labour employment in Punjab State in 1969-70 in five important crop regions on a cross-section of fifty farm situations from each crop region. They observed that production expenditure on yield increasing technology (manures, fertilisers and plant protection) and intensity of irrigation use increased human labour employment in a significant manner both on mechanised and non-mechanised farms.

Kaul and Mehta (1972) studied movement of relative shares of factors of production in total agricultural income with the help of production function analysis for selected Punjab farms for 1955-56, 1966-67 and 1967-68. They noted a great disparity in the relative shares of various factors of production for 1955-56. This had lessened somewhat in 1966-67.

In spite of the fact that wages had risen, the relative share of labour in total farm income did not show a corresponding trend.

Srivastava and Heady (1976) studied the changes in relative factor shares with application of Constant Elasticity of Substitution (CES) production function framework. They used data derived from Farm Management surveys conducted on cross-section sample of farmers in the Ferozepur (Punjab) and Muzzaffernagar (Uttar Pradesh) districts at two points of time : the mid ' fifties and late 'sixties, conforming with an a priori classification of pre-technological and post-technological change periods in Indian agriculture. The study revealed that there has been a decline in the relative factor share of labour in value added. This decline has occurred despite a marked increase in the wage rate, particularly in peak season. It seems to indicate that technological change has been labour-saving in nature.

2.6 Selection of Production Function :

Various algebric forms could be selected for the production function to be estimated. From the view point of production theory, one may select transcedental or log-log-inverse function. According to Haltar *et al.* (1957) both these functions incorporate all the three stages of neo-classical function. However, theory also says that the economic optimum decisions lie only in the second stage of production function. This is, of course, true only under perfect competition. On the other hand, the Cobb-Douglas function provides a direct test on the existence of rational production behaviour. This is because it accounts for only the so-called second stage of neo-classical production function. Furthermore, Heady and Dillon (1961) and Klein (1953) have stated that the Cobb-Douglas function completely disregards the existence of the third stage of production which is characterized by zero and negative marginal productivity. Disregarding zero and negative marginal productivity implies that as input use increases production increases though at a decreasing rate _ad infinitum_ !.

In the case of Cobb-Douglas function, the estimates of elasticities, however, remain unchanged over the range of input levels to which the function is fitted and to which it might be applied. Such constant elasticities are most likely not a true reflection of the real-world situation. They are merely an algebric attribute to the Cobb-Douglas model. Heady and Dillon (1961) are of the opinion that provided over restrictions are also met, the estimated elasticities do validly represent the real-world situation at the geometric mean input levels. Besides, according to Hayami (1962) the Cobb-Douglas function assumes that factors are substitutable and therefore, excludes the possibility of estimating a production function in which factors is the more appropriate assumption. In this sense, Heathfield (1971) suggested that Cobb-Douglas function should be used only to define the long-run relationship between factors.

Plaxico (1955) has however, stated that in spite of the above weaknesses, the Cobb-Douglas functions are usually selected as the appropriate function because it specifies diminishing productivity and diminishing marginal rates of substitution among the factors. Besides, according to Hodges (1969) and Tintner (1944), this function is also easy to fit because the coefficients of the ordinary least-square equations are the elasticities of production of the respective factors. Heady (1952) contended that the Cobb-Douglas function in the analysis of Farm Management data is due to its conformance to economic theory and ease of statistical computation.

The elasticities of production of inputs obtained from the Cobb-Douglas production function, thus, facilitate examination of resource use efficiency on neo-classical criterion that each factor of production is paid equal to its marginal productivity. This examination of efficiency/inefficiency in resource use is always relevant at the average level.

Rudra (1973) has however, questioned the whole approach of examining the allocative efficiency of farmers by using Cobb-Douglas production function and judging it on the criterion of the equality of marginal value product (at geometric mean of input) to the market price of inputs, which is relevant for the 'average farms'. It has been contended that " the equality of market price to the marginal value productivity at average point directly implies that one section of farmers are over-allocating the resource concerned and the remaining under-allocating it. In other words, every individual farm is - by the assumption of model itself - inefficient ".

But according to Singh (1975) if all the farms are equally efficient, they would be expected to have the same size, same input combinations and the same input-output ratios. With the result they would be on the same point in the input-output space and hence there could be no regression. Yotopolous (1968) is of the opinion that apart from these methodological problems there are reasons to believe that even if all the farmers try to maximize their profits, they may not be equally efficient in the use of their factors of production because of imperfections in the factor and product markets and also because of price and weather uncertainties resulting in widening gaps between expected and actual returns. In spite of these limitations, the test of allocative efficiency for the 'average farmer' is quite relevant, at least, for knowing whether agricultural production of a region or a country could be increased profitably to a significant extent by making adjustments in the existing use of the factors of production.

Besides, according to Agrawal and Foreman (1959), it is also true that despite the known weaknesses and pitfalls in the methods of analysis employed, no method of estimating resource productivity and judging resource use efficiency which is superior to Cobb-Douglas production function has been developed by economists.

There is enough empirical evidence to show that production function studies for agriculture in developing economies have assumed the Cobb-Douglas form to be logically appropriate to the data. Very little effort has been made to verify the actual value of the elasticity of substitution with the exception of studies by Yotopoulos et al. (1971) and Heady et al. (1976). In the Cobb-Douglas form, the relative factor shares remain unchanged even with a change in relative factor prices and factor ratios (substitution between factors) because the elasticity of substitution between inputs is forced to unity. Technological change is expressed in the Cobb-Douglas function by a change in the partial elasticities of production, and/or a change in the intercept term in the function (A). Technological change alters relative factor shares only when it changes the ratios of the partial elasticities of production. Bardhan (1973) has recently tried to verify the elasticity of substitution between land and labour by means of a " Kmenta approximation " for some of the post-technological change data obtained from the Farm Management Studies in Uttar Pradesh and Punjab of the 'late sixties. The elasticity of substitution between land and labour inputs was found to be significantly different from unity. This pioneering study throws some doubt on the elasticity of substitution assumption under-lying the studies with Cobb-Douglas production function.

Arrow *et al.* (1961) formulated the CES (Constant Elasticity of Substitution) production function which eliminates the assumption of an elasticity of substitution equal to unity. Brown *et al.* (1963) and Brown and Murray (1966) have shown that the relative shares of capital and labour, in terms of the CES function, depend on the ratio of labour to capital substitution, on capital intensity, and elasticity of substitution parameters. They have derived the estimating form of the equation.

In the present study, the changes in resource productivity and resource use efficiency in agriculture in the region over a period of time are examined by making use of Cobb-Douglas production function. At the same time, the changes in relative factor shares have been examined in the CES production function framework. The application of CES production function is, however, restricted to capital and labour factors only.

2.7 Classification and Aggregation of Farm Inputs for Resource Productivity Analysis :

In an attempt to study resource productivity, a great deal of caution is essential in the selection, classification and aggregation of input variables used in the production process. Many a times, new research workers are confronted with a problem of selection, classification and aggregation of farm inputs as different research workers, in the past, have classified and aggregated farm inputs in different ways suitable for their studies. Next few pages in this chapter have, therefore, been devoted to discuss various ways of classifying and aggregating input variables in production function studies together with a brief description of variables used as explanatory variables in the present study.

Land :

Land is the most important explanatory variable in the production function studies. It has either been used in monetary terms or physical units. Gilson and Yeh (1959), Auer (1961), Heady (1946), Swanson (1954), Heady and Swanson (1952), Saunders (1960), Agrawal and Foreman (1959) and Singh and Sirohi (1973) used either dollar or rupee value as a measure of land input. Excepting the study by Gilson and Yeh, in all other studies the land input measured in monetary terms also include the value of farm buildings and other permanent fixtures.

Quintana (1960) and Knight (1950) used physical form (total hectares of crops) as the basis of unit on the logic that monetary information, such as land value and value of improvements associated, need not reflect the productivity of land services and also, it is subject to bias from the value placed on land for attributes other than productivity.

Acharya (1965) used ' farm peak tons cane', i.e., tonnage of cane accepted by the mills as the independent variable measuring the land input, because it is the most precise measure of the area of land actually used in producing the required quantity of cane.

Agrawal (1957), Acharya and Pavar (1977), Basak and Chaudhary (1959), Pawar and Patil (1977), Saini (1969), Zacharias (1960), Shah (1969), Khan and Tripathy (1972), Chaudhari (1969), Sankhayan and Sirohi (1971), Lal (1976), Desai (1973), Singh 1976), and Ram Saran (1964) used total area under crops as the unit of measurement of land.

Use of land input in physical terms may vitiate the results because simple acreage tends to ignore the fertility differences among and within the farms. To overcome this difficulty, Rao (1966), Radhakrishna (1962), Hanumanth Rao (1965), Rajkrishna (1964), Hopper (1965), Khusro (1964), Sen (1967) and Singh (1975) used standardised acres as unit of land either by taking land revenue or land value as an index of soil fertility.

In the present study, total cropped area in hectares has been used as explanatory variable. Although, there are differences in soil fertility within the village and also some differences among the villages, no effort could be made to control this soil difference, due to lack of information on that count. Besides, it has been contended that the difference in fertility is not as great as to vitiate the results in any appreciable manner.

Bullock Labour :

Animal draught power forms an important source of energy input in crop production process. Some research workers have used total livestock as an independent variable, while others have used only bullock labour in the analysis. Gilson and Yeh (1959), Swanson (1954), Saunders (1960) used livestock as investment in terms of dollars. Rao (1966) and Radhakrishna (1962) included livestock as an input variable in the form of capital investment alongwith other forms of capital investment. Knight (1950) aggregated the livestock input on the basis of T.D.N. "representative unit" based upon the feeding standards. Heady and Shaw (1955), Auer (1961) and Desai (1973) used livestock with other capital items in the form of annual costs and no separate productivity of this input was measured. Quintana (1960) used total annual animal labour days (of 10 hours each).

Among the research workers using bullock labour as an independent variable input, a few are of the opinion that bullock labour used as single variable expressed either in physical or value terms shows high multicollinearity with human labour. In order to avoid the problem of multicollinearity, Chaudhari et al. (1969), Driver and Desai (1960), Hopper (1965), Radhakrishna (1962)& Pawar (1970) have used bullock labour in terms of plough unit days consisting of one pair of bullock labour day and one human labour day comprising one plough unit. Mathur (1960) used plough units in terms of hours. But this also leaves out some of the human labour used with bullock labour. There are certain operations such as threshing and lifting water from wells by traditional '*mhots*' where one human labour can work with one, two or three pairs of bullocks at a time.

Agrawal and Foreman (1969) measured human labour and bullock labour as a single variable expressed in terms of rupees. Ram Saran (1964) and Singh and Sirohi (1973) used bullock labour in monetary terms to measure its productivity. On the other hand Rajkrishna (1964), Zacharias (1960), Basak and Chaudhari (1959), Sankhayan and Sirohi (1971), Chaudhari *et al*. (1969) and Lal (1976) used bullock labour in days and Khan and Tripathi (1972), Singh (1975), Acharya and Pawar (1977), Pawar and Patil (1977), Singh (1976), Pawar (1971) and Saini (1969) used bullock labour in pair days in the analysis.

In this study, bullock labour has been considered as a separate independent variable and it is measured in pair days. Here one pair day means eight hours of work by one pair of bullocks.

Human Labour :

units of time or in value terms. Gilson and Yeh (1959) and Auer (1961) used family and hired labour in terms of man equivalent hours. Knight (1950) and Heady and Swanson (1952) measured labour input in terms of months; while Acharya (1965) measured human labour in man weeks. Naik (1965) and Shah (1969) used all human labour while Driver and Desai (1960), Hopper (1965) and Mathur (1960) used all human labour except those associated with plough units in value terms. Pawar (1970) used residual human labour (not associated with plough unit) in adult man days. Quintana (1960), Basak and Chaudhary (1959), Raj Krishna (1964), Hanumanth Rao (1965), Zacharias (1960), Acharya and Pawar, (1977), Chaudhari et al. (1969), Pawar and Patil (1977), Khan and Tripathy (1972), Desai (1973), Pawar (1971), Lal (1976), Singh and Sirohi (1973), Singh (1976), Saini (1969), Singh (1975), Sankhayan and Sirohi (1971) and Singh (1974) have used all human labour in terms of adult-man days.

In the present study, all human labour (including operator's labour, hired labour and other family labour) required for different operations from land preparation to threshing has been used in terms of man-days of eight hours. The differences in the efficiency of labour have been taken into account by converting female and child labour days into man-days.

Manures and Fertilizers :

Measurement of manures and fertilizers variable in physical units poses a problem in the studies based on farm level data collected through sample surveys. This is because, it goes difficult for the research workers to know exactly the nutrient content of manures and uptake of nutrients by plants. In many of the studies, research workers have measured this input in monetary terms. Naik (1965), Acharya (1965), Parikh (1966), Singh (1974) and Shah (1969) have used chemical fertilisers as separate variable, while Basak and Chaudhary (1959), Raj Krishna (1964), Acharya and Pawar (1977), Saini (1969), Pawar and Patil (1977), Singh (1975), Sankhayan and Sirohi (1971), Singh (1976), Lal (1976), Pawar (1971) and Desai (1973) have used manures alongwith chemical fertilisers as an explanatory variable. Singh and Sirohi (1973) used value of manures and fertilisers alongwith value of seed, while Chaudhari *et al.* (1969) and Khan and Tripathy (1972) included value of manures and fertilisers under working capital.

In the present study, the value of both manures (home produced and purchased including oil cakes) and fertilisers have been clubbed together as an explanatory variable.

Other Working Capital :

may have a small association with production. But inclusion of all these items as separate variables would greatly reduce degrees of freedom. Keeping this point in view, some research workers have aggregated either all these inputs or a few of them in the regression analysis, while others have totally excluded these inputs from the analysis. Singh and Sirohi (1973) have aggregated expenditures on seed, manure and fertilizer and irrigation into a single variable, while Desai (1973 has included all above items excluding expenditure on irrigation but including value of bullock labour into one variable. He has used expenditure on irrigation as a separate variable. Acharya and Pawar (1977), Saini (1969), Pawar (1971) and Singh (1974) have considered expenditure on irrigation as a separate variable input. Chaudhari <u>et al</u>. (1969) and Khan and Tripathy (1972) have aggregated all these inputs into one variable. Sankhayan and Sirohi (1971) have totally excluded this variable from the analysis, but they have used quantity of seed as an independent variable. Singh (1976) and Singh (1974) have defined expenditure on plant protection as a separate input.

In the present study the variable, other working capital, includes expenditure on the items such as seeds, insecticides and fungicides, land revenue, irrigation, repairs and maintenance of implements and machinery, rent on leased-in land if any, interest on borrowed capital for production.

Fixed Capital :

In the production function analysis, several research workers have used this variable as the total investment in fixed capital assets such as implements, machinery, farm buildings, etc. Livestock is not included in fixed capital as bullock labour is considered as an independent explanatory variable. Gilson and Yeh (1959) and Knight (1950) have used farm building as a separate variable. Quintana (1960), Heady (1946), Acharya (1965) and Saunders (1960) have used value of plant and machinery to define fixed capital variable. Khan and Tripathy (1972), Singh (1975) and Chaudhari *et al.* (1969) have aggregated investment in farm buildings, implements and machinery into a single explanatory variable, namely, fixed capital.

Agrawal and Foreman (1959) have used this variable in the form of investment over the annual period to determine its productivity. Lal (1976) and Singh and Sirohi (1973) have used annual working expenditure on implements and machinery to represent fixed capital as an explanatory variable. Pawar (1971) has used this variable in a different manner wherein he has added annual interest on fixed capital to annual depreciation on fixed capital assets (namely, farm buildings, implements and machinery) and designated it as 'annualized capital investment'.

In the present study, 'annualized capital investment' has been used as an explanatory variable. It includes annual depreciation on farm buildings, implements and machinery and annual interest on the investment in these capital assets. This variable has been used only in production function for farm business as a whole.

M E T H O D O L O G Y

Chapter 3

METHODOLOGY

The present chapter is devoted to discuss in brief the methodology adopted for the study. It deals with the type of data needed, sources of data and analytical procedures adopted to fulfil the objectives of the study.

3.1 The Data Requirement :

As the study was related to estimate changes in the resource use structure, resource productivity and allocation efficiency in agriculture, two types of data were needed for the economic analysis contemplated in the following chapters. The data requirement was with respect to

a) Structure of the sample farms,

b) Physical inputs and output of crops

c) Prices of inputs and output of crops, and

d) Selected indicators of the agricultural economy of the district.

a) Structure of the Sample Farms :

Data on the aspects like operational holding, land use pattern, crop pattern, irrigation, investment in different capital assets, family size and work force on farms were required in order to provide background information with regard to structural organization of the sample farms.

b) Physical Inputs and Output of Crops :

The input data included human labour-both family labo and hired labour (permanent and temporary), bullock labour (owned and hired), inventory comprising of land, implements a machinery, and operating capital such as seed, manure and fertilisers, plant protection measures, feed of draught animal and other expenditure associated with the crops grown on the f

The output data included gross output of various crops grown on the farm.

c) Prices of Inputs and Output of Crops :

Prices of inputs included value of land including land improvements, wage rates for hired labour, irrigation charges, cost of seed, manures, fertilisers, insecticides and fungicides.

Prices of output included prices of various crop products The farm harvest prices for crop products were used for the analysis of the crops grown in the villages selected for this study.

pattern, irrigation, population, livestock, rainfall, temperature, average prices of farm commodities and average wage rates.

3.2 Sources of Data :

Inadequacy of data in India is a big handicap for any economic research work. It is more so particularly in the sphere of farm management research. Fortunately, the Government of India, recognizing the dearth of data in farm management research, started farm management investigations in India in the year 1954. The first series of investigations was started in six different regions of India. It was continued for three consecutive years i.e., for the period from 1954-55 to 1956-57. These investigations proved to be successful in providing sufficient data base required for farm management research and formulation of appropriate policies for economic development of agriculture in the country. Realizing the usefulness of these investigations in the process of planning for agricultural development, the Government of India started the second series of investigations in the year 1967. The second series of investigations were extended in sixteen different regions of India It was continued for three years in all the regions excepting for Maharashtra State, where the investigation was extended for four years.

The first series of farm management investigations mostly related to the era of pre-technological change in Indian agriculture, while the second series was started after the emergence of technological change in agriculture in India. The data collected under the two series of farm management investigations thus represent the pre-technological and post-technological change periods in Indian agriculture and could be made use of in measuring the effect of technological change on economic development of agriculture for the respective regions, in particular, and for the country as a whole, in general.

The primary source of data for the present study is the data obtained at farm level by the cost accounting method in Ahmednagar district of Maharashtra State under the two series of the farm management investigations. The data with respect to structure of the sample farms, physical inputs and output of crops and prices of inputs and output of crops were obtained from the original schedules used for conducting farm management investigations under the two series. The data on selected indicators of agricultural economy of the district were obtained from the Office records of the Collectorate, Zilla Parishad and District Statistical Abstracts and Season and Crop Reports published by the Bureau of Economics and Statistics and the Directorate of Agriculture of the State Government, respectively, for the reference periods.

were selected by a well designed sampling technique. The design of sampling adopted for the investigations was what is known as " multi-stage stratified random sampling ", with village as a primary unit and operational holding as the ultimate unit.

The sampling unit was a farm which was termed an operated holding. It was defined as the area consisting of all land operated either by a single cultivator alone or with the assistance of others, irrespective of title of possession or location (i.e., whether within the selected village or outside).

The general procedure followed for sampling in each of the two series of farm management investigations was as follows :

a) Selection of District(s) :

In the first series of the farm management investigations two contiguous districts were selected for study in each region so that they represented the most important soil-crop-complexes in the region or State concerned. Ahmednagar and Nasik districts were selected accordingly to represent jowar, bajra and wheat complex of the old Bombay State.

only and it, therefore, represents the jowar-bajra complex of the State. The district on the whole represents mainly the dry farming area of Maharashtra wherein jowar and bajra are the major crops occupying 41 per cent of the gross cropped area in the State.

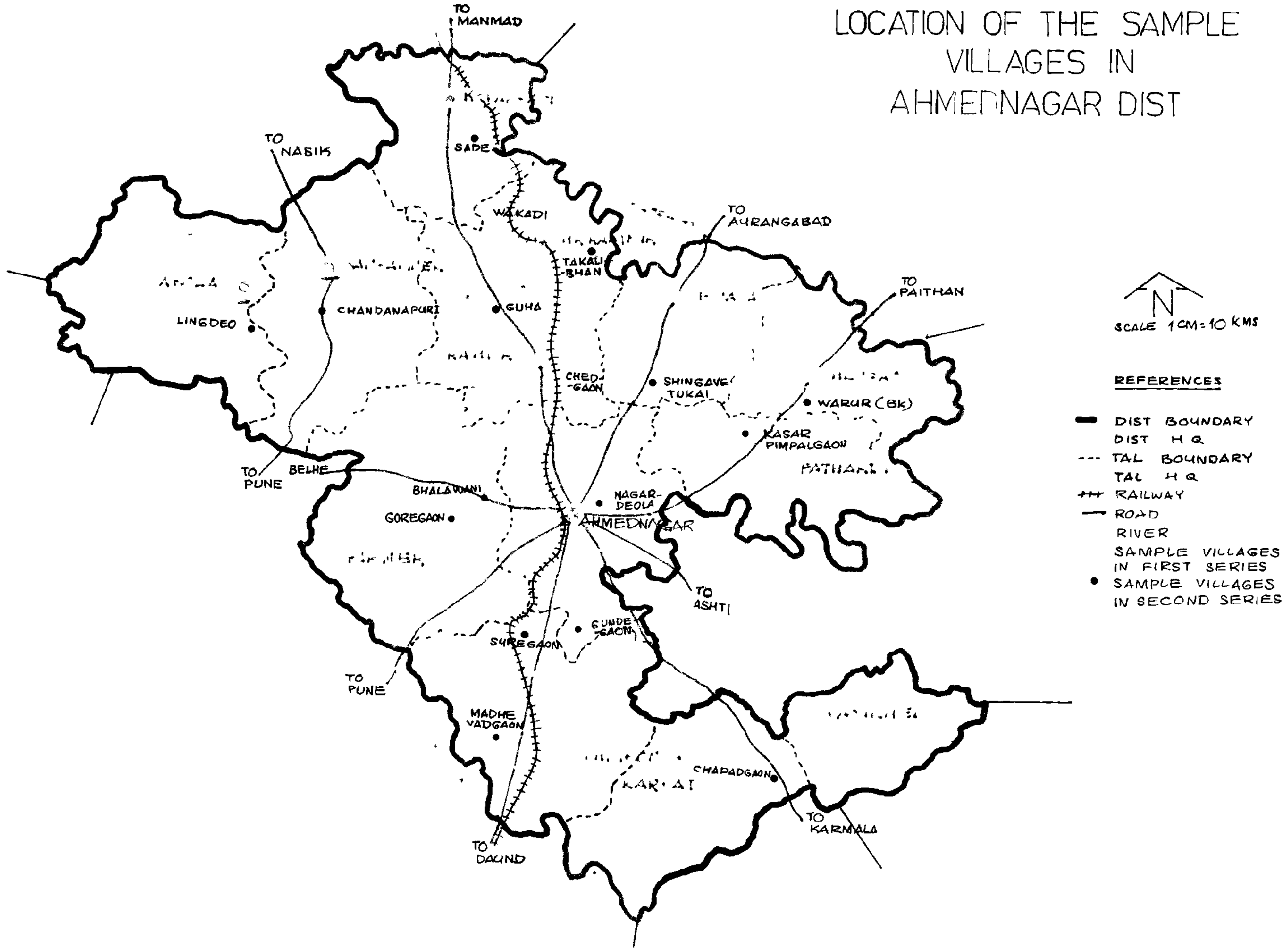
b) Selection of Villages :

In order to facilitate proper selection of the villages, the district was divided into two zones in the first series. These zones were demarcated to be as homogeneous as possible with regard to agriculture and climatic conditions. From each of the two zones demarcated in the first series, five villages were selected at random with probability proportional to cultivating population as given in the census handbooks. In the second series, however, fifteen villages were selected at random from the four zones in probability proportional to the cultivated area in each zone. The location of the villages is shown on the map to indicate the geographical distribution. The importance of selecting farms from different villages lies in the fact that different villages represent variation in the agricultural situation in the region.

c) Selection of Farms :

While selecting the sample farms in the first series of the farm management investigations, all the operated holdings in the individual sample villages were ranked in a descending order with respect to the size of the operated area and then

LOCATION OF THE SAMPLE VILLAGES IN AHMEDNAGAR DIST



grouped into four groups each containing an equal number of holdings. Two holdings were ultimately selected at random with equal probability from each group for the sample villages.

In the second series, however, the total holdings in all the fifteen selected villages were pooled together and arranged in an ascending order of their operational area. These were then divided into five strata in such a way that the cultivated area in each stratum was 20 per cent. Five size group ranges were thus fixed and two holdings were selected at random from each stratum in each village.

Thus in all 80 holdings and 150 holdings were selected from the 8 and 15 sample villages, respectively, in the first and second series of farm management investigations in Ahmednagar district. Besides, out of the 150 sample farms selected for the study in the second series, only 143 sample farms responded well to the enquiry. The study in the second series was,therefore,based on 143 sample farms. The distribution of sample farms over selected villages, zones and size groups is presented in Appendix I and II for the first and second series,respectively.

3.4 The Technique of Data Collection :

The cost accounting method was used for collection of the required data from the sample farms selected under both the series of farm management investigations. Usually, the head of the family or the adult male member of the family who was actively participating in farming was interviewed at home or on the farm. The investigator who was kept in each village was expected to interview the selected farmers daily and fill in the schedules which were specially devised for the inquiry.

3.5 Period of Study :

In fact, under the first series of the farm management investigation, the inquiry in Bombay State was conducted for a period of three agricultural years from 1954-55 to 1956-57. Under the second series, the inquiry was conducted for a period of four agricultural years i.e., for the years 1967-68, 1969-70, 1970-71 and 1971-72. However, in view of the limitations of time and resources available, it was not possible to cover the total period of these inquiries for the present study. Only one agricultural year was selected from each of the two series of investigations for the present study in such a way that the performance of agriculture during these years was more or less normal in the respective periods. Accordingly, the data collected for the agricultural years 1956-57 and 1970-71 were used for the purpose of this study. This gave a time-lag of fourteen years to estimate the changes in the farm economy and efficiency in allocating resources on the part of the farmers in the region.

3.6 Analytical Procedure :

This section deals mainly with the methodology adopted for analysis of the data presented in the chapters that follow. The emphasis here is on the simple tabular analysis based on means as well as on the multi-variate analysis of the production function type.

3.6.1 Classification of Sample Farms :

In order to study agricultural productivity in relation to size of the farm, the total sample farms were divided into three size groups viz., small, medium and large. It may be kept in mind that while scrutinising the data for the purpose of the present study it was observed that 11 cases out of the total of 143 sample farms selected under the second series were lacking in the information on certain aspects of farm economy because of weak reporting and indifferent response. These sample farms are, therefore, dropped out from the present analysis. The size groupwise distribution of sample farms finally selected for the study for the years 1956-57 and 1970-71 is presented below :

Size Groups	1956-57		1970-71	
	Size limits (ha)	No.of sample farms	Size limits (Ha)	No.of sample farms
Small	4.63 & below	27	4.59 & below	44
Medium	4.64 to 9.39	27	4.60 to 10.35	44
Large	9.40 & above	26	10.36 & above	44
Total		80		132

for estimating costs, returns and net returns for the individual crops grown on the sample farms, as well as, farm business as a whole. Eventhough livestock production activity was in practice on the sample farms, it was only supplementary to the regular crop production activity. In view of this, only crop production activity has been considered for the purpose of farm business analysis.

The present study is related to two time periods with a time-lag of fourteen years. During this period prices of all the inputs as well as output of different crops have undergone a tremendous change. The study of this kind is always subjected to give misleading picture about the farm economy if the effects of price changes are not taken care of. In the absence of proper adjustments for price changes, the changes in costs and returns are both due to increases in physical quantities of inputs and output as well as rise in prices of inputs and output. In order to overcome the problem of price changes, the costs and returns for the year 1956-57 have been inflated at the prices that prevailed in the year 1970-71.

The method of evaluation and allocation of costs is discussed in Appendix III. The total input costs have been arrived at by four stages of costs i.e. Cost A1, Cost A2, Cost B and Cost C on the basis of standardized concepts of cost. These concepts of cost are discussed in brief in Appendix IV. These concepts of cost facilitate measurement of returns to different factors of production i.e., income of individual factors of production. The concepts of income are, therefore, discussed in Appendix V.

The costs and returns for the farm business have been estimated on per farm and per cropped hectare basis for the individual size groups. In case of the crops grown on the sample farms, the costs and returns have been estimated on per hectare basis.

3.6.3 Regression Analysis :

It has been felt that simple tabular analysis based on means, frequencies, etc., suffers from some major limitations as it cannot precisely measure the contribution of specific factors in combination with other factors which are responsible for changes in the level of output as a consequence of adoption of new technology. The production function approach does not have this limitation, and therefore, the same has been used in this study. Production function analysis gives the marginal value productivity of resources at their respective geometric mean levels, which is more meaningful in the context of economic development where the aim is to get maximum output from available resources. It also helps in judging the efficiency of resource use under different farm situations as well as under different technological environments.

a) Selection of Production Function :

The empirical evidence from previous studies suggests that the Cobb-Douglas production function of the type

$$Y = a X_1^{b1} X_2^{b2} \;\ldots.. X_n^{bn}$$

is the most appropriate one for studies of this nature as it permits either diminishing, increasing or constant returns without using as many degrees of freedom as other functional forms having the same characteristics would. In this functional form 'Y' is the dependent variable, 'Xis' are independent resource variables, 'a' is constant representing intercept of the production function and 'bis' are the regression coefficients of the respective resource variables. The regression coefficients obtained from this function are also elasticities of production which remain constant throughout the relevant ranges of inputs. The sum of coefficients i.e., $\leq$ bis, indicates the nature of returns to scale. When expressed in logarithmic terms this function transforms into a linear function of the following type.

$$\text{Log } Y = \log a + b_1 \log X_1 + b_2 \log X_2 + \ldots.. + bn \log X_n.$$

i) Output :

The output is a dependent variable and is defined as the gross value of production of all crops grown on a farm in production function for farm business as a whole. In case of production functions for individual crops, the output is expressed in physical quantities in quintals excepting for sugarcane where output is measured in terms of tonnes of cane.

ii) Land :

This input was used as explanatory variable in production functions both for farm business as a whole as well as for individual crops. It was expressed as total cropped area in hectares in the production functions for farm business and as area under crop in hectares in the production functions derived for the individual crops.

iii) Human Labour :

This input was expressed in terms of man-days of eight hours. It included all human labour (including operator's labour, hired labour - permanent and temporary, and other family labour) utilised for performing different farm operations right from preparation of land to threshing. The differences in the efficiency of labour have been taken into account by converting female and child labour days into man-days. For the purpose of converting female and child labour days into man-days, three female labour days were considered equivalent of two man-days and two child labour days as equivalent of one man-day.

iv) <u>Bullock Labour</u> :

Bullock labour used for different farm operations was considered as a separate input and it was measured in pair-days. Here one pair day means eight hours of work by one pair of bullocks.

v) <u>Manures and Fertilizers</u> :

This input variable included expenditure on fertilizers and organic manures including farm yard manure and oil cakes. It was assumed that the average prices for fertilizers and manures are similar for all farms. Such an assumption is tenable for cross-sectional data of farms in a district.

vi) <u>Other Working Capital</u> :

This variable was defined as expenditure on other inputs. These inputs are seeds, irrigation, insecticides and fungicides, repairs (minor) and maintenance of implements and machinery, land revenue, rent on leased-in land and interest on borrowed working capital for production. All these inputs were aggregated into only one variable for the reason that each of these items individually may have a small association with production, and inclusion of all these items as separate variables would greatly reduce degrees of freedom.

vii) <u>Annualized Capital Investment</u> :

In order to estimate contribution of fixed capital to production, a separate explanatory variable was used in the production function. For this purpose only that part of capital used up during the year and cost on total capital investment (in the form of interest) were considered and the input was defined as "annualised capital investment". This variable thus included annual depreciation on farm buildings, implements and machinery and annual interest on the total investment in these capital assets. Since bullock labour is considered as a separate explanatory variable and other livestock is in no way directly concerned with crop production, the investment in livestock was not included in total capital investment while measuring this variable. It may be noted that this variable is used only in production function for farm business as a whole.

c) Estimation of Production Functions :

Production function analysis was used as the analytical approach for estimating resource productivity and determining optimal allocation of capital among the various categories of inputs on the small, medium and large farms. Cobb-Douglas type of production functions were tried for the regression analysis both for farm business as a whole as well as for the individual crops grown on the farms. These production functions were derived for the data of individual years selected for the study.

i) Production Functions for Farm Business :

Production functions for farm business were estimated for the individual size groups of farms as well as for all the farms pooled together for both the years. These functions were of the form

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6}$$

Where,

Y = Gross output in rupees.

X_1 = Gross cropped area in hectares.

X_2 = Human labour in man-days.

X_3 = Bullock labour in pair-days

X_4 = Expenditure on manure and fertilisers in rupees.

X_5 = Other working capital in rupees, and

X_6 = Annualised capital investment in rupees.

ii) Production Functions for Crop Enterprises :

Production functions have been fitted for the following crop enterprises in the two years.

Crop enterprises in 1956-57

1. Jowar (Unirrigated)
2. Jowar (Irrigated)
3. Bajra (Unirrigated)
4. Wheat (Unirrigated)
5. Wheat (Irrigated)
6. Sugarcane (Irrigated)
7. Cotton (Irrigated)
8. Gram (Unirrigated)
9. Groundnut (Unirrigated)

Crop enterprises in 1970-71

1. Jowar (Unirrigated)
2. Jowar (Irrigated)
3. Bajra (Unirrigated)
4. Bajra Local (Irrigated)
5. Bajra Hybrid (Irrigated)
6. Wheat (Unirrigated)
7. Wheat (Irrigated)
8. Sugarcane (Irrigated)
9. Cotton (Irrigated)
10. Gram (Unirrigated)
11. Groundnut (Unirrigated).

The form of the production function was

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5}$$

Where,

Y = Output in quintals (in tonnes in case of sugarcane

X_1 = Area under the crop in hectares.

X_2 = Human labour in man-days.

X_3 = Bullock labour in pair-days.

X_4 = Expenditure on manure and fertilisers in rupees, and

X_5 = Other working capital in rupees.

All the production functions were estimated using ordinary least squares with the help of Electronic Computer. The values of R (coefficient of multiple correlation), R^2 (coefficient of multiple determination), standard errors of regression coefficients and F statistic (analysis of variance) were also estimated for judging overall significance of the production functions and regression coefficients as well.

The values of simple correlations between the values of different variables ranged from 0.0876 to 0.8157 in case of all the production functions. There was, thus, not serious problem of multicollinearity due to high intercorrelation between any two or more inputs.

The problem of multicollinearity is serious if the inter-correlation between different factors is very high. To overcome the problem of multicollinearity, Fox and Conney (1954) have suggested that the production function be estimated under restricted conditions by aggregating highly inter-correlated variables as a bundle of inputs which should be varied in approximately constant ratio of each other. However, the assumptions of the economic model underlying the traditional Cobb-Douglas production function analysis imply that exact multicollinearity should exist among the inputs. Doll (1974) is of the opinion that restricted estimation procedures may lead to parameter estimates with additional economic content. Conventional methods of input aggregation and model specification may result in biased or misinterpreted estimates. Besides, as stated by Heady and Dillon (1961), Multicollinearity was considered high if the 'r' value was more than 0.8. According to Klein (1953), inter-correlation is not necessarily a problem unless it is high relative to overall degree of multiple correlation among all the variables simultaneously.

Another problem confronted in the production function analysis is the existance of non-significant variables. Some researchers have suggested that such non-significant variables be excluded from the production function analysis. However, some other researchers seem to be against this view. To put it in the words of Johnston (1972), exclusion of non-significant variables lowers the R^2 value considerably. This is because some regression coefficients capture the explanations provided by the omitted variables. It may also happen that for some other coefficients the standard errors increase without a sizable increase in the coefficients themselves.

The exclusion of non-significant variables may cause a bias in estimating the coefficients of the remaining variables. Also exclusion of non-significant variables would imply loss of, although imprecise, information. Besides, the practice of exclusion of non-significant variables from some production functions, and retaining the same in other production functions on the ground that they are significant (as is done in some studies), does not facilitate comparison among the fitted production functions of the kind attempted in the present study.

d) Estimation of CES Production Fuction for Determination of Changes in Relative Factor Shares :

The changes in relative factor shares with respect to labour and capital were analysed with application of the constant Elasticity of Substitution (CES) production function framework. The CES production function of the form

$$Y = \gamma \left[\delta K^{-\theta} + (1-\delta) L^{-\theta} \right]^{-1/\theta} \quad \text{-------- (1)}$$

was used for this purpose. In this functional form Y, K and L denote output, capital and labour, respectively. The variables Y and K were measured in rupees, while L was measured in man-days. Besides, in the CES production function γ is a technological parameter, δ is a distribution parameter and θ is the factor substitution parameter.

The parameters of this function (γ, δ and θ) cannot be directly estimated by Linear regression analysis, nor is it

Stage II : Estimating δ

To find δ we now partially differentiate (1) with respect to capital to yield

$$\frac{\partial Y}{\partial K} = I = \gamma^{-\theta} \delta \left(\frac{K}{Y} \right)^{-(1+\theta)} \qquad ------ (4)$$

Dividing (2) by (4) yields

$$\frac{W}{I} = \frac{1-\delta}{\delta} \left(\frac{K}{Y} \right)^{1+\theta} \qquad ------ (5)$$

Since we know $\theta, \left(\frac{K}{L}\right)$ and $\left(\frac{W}{I}\right)$ can find $\frac{1-\delta}{\delta}$ by ordinary regression analysis.

After knowing the value of $\frac{1-\delta}{\delta}$ it is easy to find value of δ.

Stage III : Estimating γ

Finally returning to equation (1)

$$Y = \gamma \left[\delta K^{-\theta} + (1-\delta) L^{-\theta} \right]^{-1/\theta}$$

Since we now know θ, δ, Y, K and L, we can estimate γ directly by regression.

In order to estimate changes in the relative factor shares over a period of time, the CES production functions were fitted to the data on the lines given above for both the years and for individual size groups as well as for all the farms pooled together.

3.6.4 <u>Economic Analysis</u> :

The estimated production functions were used for economic analysis with regard to estimation of returns to scale, marginal productivities of individual resource factors and optimal allocation of different resources on the farms. The differences in the values of these estimates gave an idea about the changes in the productivities of resources and allocation efficiency of the farmers that have taken place in the region over a period of time.

a) Estimation of Marginal Value Products :

The marginal value products (marginal physical products in case of the crop enterprises) of individual resources were estimated by taking partial derivatives of returns with respect to the resource concerned, at geometric mean levels of the resources.

The steps involved in the estimation of MVPs (MPPs in case of crop enterprises) of resources are as follows :

$$Y = a X_1^{b1} X_2^{b2} \ldots\ldots X_n^{bn}$$

Where,

Y = return in rupees (output in quintals/tonnes in case of crop enterprises), and X_1, X_2, ... X_n were the input variables. The partial derivative of return (Y) with respect to the input X_1 is

$$= ab_1 X_1^{b1-1} X_2^{b2} X_3^{b3} \ldots\ldots X_n^{bn}$$

The MVP (MPP) of X_1 was then obtained by substituting the corresponding geometric mean values of X_1, X_2, ... X_n in the above equation. In case of the crop enterprises, the MPP thus obtained was multiplied with per unit price of output to get the MVP of the resource concerned.

The efficiency of resource use was studied through the comparison of MVP of resources with their respective acquisition costs. The significant differences between MVP of resources and their acquisition costs were tested by computing 't' values. The 't' value was estimated as

$$'t' = \frac{MVPi - Pi}{S.E. \text{ of } MVPi^*}$$

Where, MVPi is the marginal value product of ith resource and Pi is its acquisition cost.

b) <u>Estimation of Returns to Scale</u> :

In the Cobb-Douglas type of production function, returns to scale are measured by adding elasticities of all the inputs. Thus for the production function

$$Y = a X_1^{b1} X_2^{b2} \ldots\ldots Xn^{bn}$$

Where, b1, b2 ..... bn are the regression coefficients or elasticities of production, the returns to scale = $\sum$ bis = b1 + b2 + ... + bn. Depending upon the sum of the regression

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* Standard error of marginal value productivity has been worked out by taking the square root of

$$[(\bar{Y}/\bar{X_i})^2 \cdot V(bi)]$$

Where, V(bi) denotes variance of regression coefficient of Xi.

coefficients as less than, equal to or greater than unity, the prevailing returns to scale may be considered as decreasing, constant or increasing, respectively. Since the elasticity coefficients are constant in the Cobb-Douglas production function, the scale returns so indicated simply represent the 'average condition' for the sample farms.

c) Determination of Optimal Allocation of Resources :

From the fitted production functions of Cobb-Douglas type, the optimal allocation of resources was determined both under unlimited and limited capital situations.

i) Unlimited Capital Situation :

The optimal allocation of resources under the unlimited capital situation could be determined as follows :

The profit function is

$$\text{Profit} = Y \cdot P_y - \sum_{i=1}^{n} X_i \cdot P_{xi}$$

Where, P_y = Price per unit of output.

P_{xi} = Price per unit of input.

For estimation of optimum levels of resources to maximize the profits, the partial derivatives of the above equation are set to zero and solved simultaneously, that is,

$$\frac{\partial \text{Profit}}{\partial X_2} = P_y \frac{\partial Y}{\partial X_2} - P X_2 = 0.$$

$$\frac{\partial \text{Profit}}{\partial X_n} = P_y \frac{\partial Y}{\partial X_n} - P X_n =$$

Thus solving the above equations for X_1, X_2, ... X_n, the optimum quantities of resources are obtained. The relation between MVPs and prices of the inputs obtained from these equations is

$$\frac{MVPX_1}{P X_1} = \frac{MVPX_2}{P X_2} = ... = \frac{MVPX_n}{P X_n} = 1.$$

ii <u>Limited Capital Situation</u> :

The available limited capital was optimally allocated among different capital inputs appearing in the production function as follows :

The marginal rate of substitution (MRS) between two inputs was worked out by taking the ratio of the marginal product (partial derivative) of the two inputs. The MRS between two inputs was then equated to the ratio of the prices of these two inputs. Therefore,

$$\text{MRS of } X_2 \text{ for } X_1 = MPPX_2/MPPX_1 = \frac{\partial Y}{\partial X_2} \Big/ \frac{\partial Y}{\partial X_1} = PX_2/PX_1$$

Thus several such equations were obtained. The number of linearly independent equations were equal to the number of input variables in the equation less one. In fact there would be as many equations as the number of variables, but one of these equations will be linearly dependent on the other and, therefore, redundant. In addition to the above, one more linear constraint equation was also available, thereby the number of equations becoming equal to the number of unknown (input variables). The optimum values of these unknown (input variables) were obtained by solving these equations simultaneously. An alternative method could be to maximize a profit function using Lagrange-multiplier with the constraint equation. For the production function

$$Y = a\, X_1^{b1}\, X_2^{b2}\, X_3^{b3}$$

Where, Y is expressed in rupees, and constraint = $PX_1.X_1 + PX_2.\ X_2 + PX_3.\ X_3 = C$

Where, C is finite amount, the profit function is

$$Z = a\, X_1^{b1}\, X_2^{b2}\, X_3^{b3} - \lambda\ (PX_1.X_1 + PX_2.X_2 + PX_3.X_3 - C).$$

Setting the partial derivatives of Z with respect to X_1, X_2, X_3 and λ equal to zero, we have,

$$\frac{\partial Z}{\partial X_1} = b_1\, a X_1^{b1-1}\, X_2^{b2}\, X_3^{b3} - \lambda\ PX_1 = 0.$$

and therefore,

$$b_1\ a\, X_1^{b1}\, X_2^{b2}\, X_3^{b3} - \lambda\ PX_1.X_1 = 0 \quad . \ ... \quad (1)$$

Similarly, for $\dfrac{\partial Z}{\partial X_2}$ and $\dfrac{\partial Z}{\partial X_3}$

$$b_2 a X_1^{b1} X_2^{b2} X_3^{b3} - \lambda PX_2.X_2 = 0 \ ..... \ (2)$$

$$b_3 a X_1^{b1} X_2^{b2} X_3^{b3} - \lambda PX_3.X_3 = 0 \ ..... \ (3)$$

Solving the two equations (1) and (2)

$$b_1 b_2 a X_1^{b1} X_2^{b2} X_3^{b3} - \lambda b_2 PX_1.X_1 = 0$$

$$b_1 b_2 a X_1^{b1} X_2^{b2} X_3^{b3} - \lambda b_1 PX_2.X_2 = 0$$

$$(b_1 PX_2.X_2 - b_2 PX_1.X_1) = 0, \text{ but } \lambda \neq 0.$$

Therefore, $X_2 = b_2 PX_1.X_1 / b_1 PX_2$.

Similarly, $X_3 = b_3 PX_1.X_1 / b_1 PX_3$.

Substituting values of X_2 and X_3 in

$$\frac{\partial Z}{\partial \lambda} = PX_1.X_1 + PX_2.X_2 + PX_3.X_3 - C = 0.$$

We have,

$$PX_1.X_1 + PX_2 \frac{(b_2 PX_1.X_1)}{(b_1 PX_2)} + PX_3 \frac{(b_3 PX_1.X_1)}{(b_1 PX_3)} = C.$$

Therefore, the optimal quantities of X_1, X_2 and X_3 are,

$$X_1 = \frac{b_1 C}{(b_1+b_2+b_3) PX_1}$$

$$X_2 = \frac{b_2 C}{(b_1+b_2+b_3) PX_2}$$

$$X_3 = \frac{b_3\ C}{(b_1+b_2+b_3)\ PX_3}$$

d) <u>Determination of Changes in Relative Factor Shares</u> :

In the fitted CES production function

$$Y = \gamma\left[\delta K^{-\theta} + (1-\delta) L^{-\theta}\right]^{-1/\theta}$$

γ is a technological parameter, δ is a distribution parameter and θ is the factor substitution parameter. The estimated values of these parameters were used for determining the share of labour relative to income. Brown and Murray (1966) have shown that the relative shares of capital and labour incomes, in terms of the CES function, depend on the ratio of labour to capital, on capital intensity, and elasticity of substitution parameters. They derived the share of labour relative to capital under marginal productivity equilibrium from time-series data with the help of the equation -

$$S = \frac{w\ L}{q\ K} = \frac{1-\delta}{\delta}\left(\frac{q}{w}\right)^{\sigma-1}$$

Where, S = The ratio of labour income to capital income,

w = Wage rate per unit of labour,

q = Rental per unit of capital,

$1-\delta/\delta$ = Labour intensity, and

σ = Elasticity of substitution $= \frac{1}{1+\theta}$

In the absence of time-series data, the estimating equation becomes (Srivastava and Heady, 1976),

$$\log\left(\frac{L}{K}\right) = \sigma \log\left(\frac{1-\delta}{\delta}\right) + \sigma \log\left(\frac{q}{w}\right) + E$$

Where,

L = human labour in man-days.

K = value of fixed capital assets on the farm (which includes value of land, machinery, and implements).

w = wage rate in rupees (derived by dividing total wage bill by total number of labour days).

q = rental of capital per unit in rupees (derived by dividing the share of capital in value added on each farm by the total amount of capital on the farm; the share of capital in value added has been calculated by substracting the wage bill and expenditures on intermediate inputs such as seeds, manure, fertilizers, insecticides, pesticides, irrigation, etc., from the total output).

E = Error term.

The above equation was thus, estimated for all the size groups of farms in both the years. Further the logarithm of the share of labour relative to capital in value added was obtained by substracting log ($\frac{q}{w}$) from the estimated equation. The logarithm of the labour intensity parameter ($\frac{1-\delta}{\delta}$) was derived from the estimated intercept term.

AGRICULTURAL ECONOMY OF THE STUDY AREA

Chapter 4

AGRICULTURAL ECONOMY OF THE STUDY AREA

The present study is based on the Farm Management surveys conducted in Ahmednagar district of Maharashtra State at two points of time with a time lag of fourteen years. During this period the agriculture in the district was subjected to various (agricultural) development programmes formulated and administered at the district level under the multi-level planning approach which enjoyed wide acceptance in planning for economic development. The strategy adopted for this purpose was expected to bring about desirable influence at the farm level as it included a resource development approach based on the generalisation of scientific management and development of productive resource for sustained increase in the levels of living of the community as a whole. However, because of a wide range of diversity in resources, climatic conditions and institutional set-up, the agricultural economy is inflicted with economic and technological dualism dividing it into modern leading regions confined to irrigated areas pulsating with impulses of growth and vast lagging regions which remain more or less isolated from the forces of development and require special development effort for putting them on the path of sustained development.

In fact, Ahmednagar district in the State of Maharashtra has seen attempts by the Government to increase agricultural output for the last several years. The agriculture of this district, however, exemplifies the complexity of the agricultural development process in an underdeveloped area. The heterogeneity of the physical environment is largely responsible for this complexity.

4.1 Geography of the District :

Ahmednagar district is geographically centrally placed in Maharashtra State and represents a typical region of agricultural conditions in the State. The agricultural activity in the district consists mainly in the production of cereals like jowar and bajra with limited rainfall. Therefore, the district may be taken to represent the dry regions of the State rather than the rice producing districts in Konkan on the Western coast, the north-eastern wing of Vidarbha and Kolhapur district in the south. However, development of canal irrigation in the northern part has formed two different regions in the district. The southern region which is faced with recurring scarcity conditions is totally different from the northern part with its canal irrigation and cash crops like sugarcane and fruit crops. On the whole, the district can be said to represent the jowar-bajra complex which is the typical crop combination of the State.

The district lies between 18°20' and 1 °20' North latitude and 73°90' and 75°50' East longitude. It is surrounded by Bhir district in the east, Osmanabad and Solapur districts to the South-east, Pune district to the South and south-west, Thana and Nasik districts to the west and north-west, Nasik district to the north, and Aurangabad district to the north-east.

The district is irregular in shape and it appears like a slanting cross. It is about 192 km long and 200 km broad. The area of the district is 16,762.2 sq km and its population in 1971 was 22,69,117. In terms of area and population, the district makes 5.47 per cent and 4.50 per cent of the State of Maharashtra, respectively. For administrative purposes, the district is at present divided in thirteen tehasils.

It is situated partly in the upper Godavari basin and partly in the Bhima basin. Broadly, the northern half of the district comprising of Akola, Sangamner, Shrirampur, Kopergaon, and Newasa tehasils, lies in the Godavari basin and is served by Pravara and Mula rivers, the tributaries of Godavari and the Godavari river itself which flows along the north-east boundary of the district. The southern half comprising of Parner, Ahmednagar, Pathardi, Karjat, and Shrigonda Tehasils lies in the Bhima basin and is served by Sina, Kukadi and Ghod, all tributaries of Bhima and the Bhima river itself which flows along the south-west boundary of the district.

The whole district lies on the elevated table land of the Deccan which has a general slope from west to east. There is only one hill range of Sahyadri and its offshoots in the region. The main Sahyadri range touches Akola tehasil in the west and its three spurs, namely, Kalsubai, Baleshwar and Harischandragad stretch towards the east. All the three main spurs decrease in height as they extend eastwards and form watershed areas in the district.

The transition from the hilly to Desh (plain area) is rapid, from the crest of Sahyadris where rainfall varies from 3750 mm to 5000 mm to the town of Akola, only 32 km away, where it averages 500 mm only. The Desh area of the district presents an endless topographical variety. In the north, centre and east are the fertile alluvial plains of Kopergaon, Shrirampur, Rahuri, Newasa and Sheogaon lying in the valley of Godavari; in the extreme south are the alluvial but less fertile plains of Shrigonda and Karjat lying in the valley of Bhima. Between the Godavari and Bhima valley, there is every combination of base hill and cultivated delta especially in the tehasils of Sangamner, Parner, Ahmednagar and Jamkhed.

The chief kinds of soils generally found in the district are black, red, laterite and the grey of inferior quality including white. A major part of the district lies in the zone of low rainfall between 508 mm and 635 mm annually.

between rural and urban and other details of population for the district for the 1951 and 1971 population censuses are presented in Table 4.1

Table 4.1 : Population and Other Details of Population in Ahmednagar District for Selected Census Years

Particulars	Census year		% increase during the period
	1951	1971	
Population - Persons	1410873	2269117	60.83
Males	715763	1160205	62.09
Females	695110	1108912	59.53
Urban population	214832	251500	17.07
Rural population	1196041	2017617	68.69
Percentage urban population	15.23	11.08	
Percentage rural population	84.77	88.92	
Sex ratio	971	956	
Literate and educated persons	266655	822181	208.33
Literacy percentage	18.90	36.23	
Density of population (i.e., number of persons per sq km)	83	133	
Number of households	242532	387973	59.97
Average family size	5.82	5.85	

Source : Census Reports of Ahmednagar District for the years 1951 and 1971.

In 1951 the sex ratio was 971 and it decreased to 956 during the period of 20 years. Nearly 85 per cent of the population in Ahmednagar district was living in rural areas in 1951. During the period under reference there has been considerable increase in the rural population. The rural population formed 88.92 per cent of the total population in the district in 1971. The density of population has increased from 83 persons per sq km to 133 persons per sq km during the period. The increase in the number of households has been observed to be in accordance with the increase in the population during the period. As a result, the average family size has remained almost the same. The spread of education in rural areas have had desirable effect on the literacy percentage. The literacy percentage has increased from 18.90 to 36.23 during the period.

4.3 Livestock Population :

Livestock production forms an important activity next to crop production in the rural areas of Ahmednagar district. The details of livestock population in the years 1956 and 1972 are given in Table 4.2.

There has been an increase in the total livestock population from 170 lakhs to 177 lakhs during the period. This increase was mainly on account of increase in the population of sheep, goat and other livestock. The total buffalo population also increased by 8.08 per cent during the period. In case of the cattle population, however, there was a decrease by 6 per cent during the period. The poultry production activity seems to have gained popularity among the

Table 4.2 : Livestock Population in Ahmednagar District in 1956 and 1972

Livestock	Census year		% change during the period
	1956	1972	
Cattle			
Males over 3 years	372975	352600	- 5.46
Females over 3 years	275486	260645	- 5.39
Young stock below 3 years	219632	202706	- 7.71
Total cattle	868093	815951	- 6.01
Buffalo			
Males over 3 years	4929	3754	-23.84
Females over 3 years	46386	54056	16.54
Young stock below 3 years	30430	30536	0.35
Total buffalo	81745	88346	8.08
Total bovine	949838	904297	- 4.79
Sheep	228988	298722	30.45
Goat	501263	547000	9.12
Other Livestock	20905	23048	10.25
Total livestock	1700994	1773067	4.24
Total poultry	623537	773317	24.02

Source : Livestock census Reports for the years 1957 and 1972.

people as the poultry population has increased from 6.25 lakhs to 7.73 lakhs (almost by 24 per cent) during the period.

The bovine population consisted of 3.73 lakh bullocks, 2.75 lakh cows, 0.56 lakh buffaloes and 2.50 lakhs of young bovine stock in 1956. The respective figures for 1972 were 3.53 lakhs bullocks, 2.61 lakhs cows, 0.54 lakh buffaloes and 2.32 lakhs of the young bovine stock. The number of bullocks per 100 hectares of sown area worked out to 29.88 in 1956 and 25.75 in 1972.

The cattle in the district is mainly of non-descript breed and is maintained for supply of bullock power for cultivation. The popular breed of buffalo in the district is Pandharpuri.

4.4 Climate and Rainfall :

There are three seasons. The rainy season starts from June and lasts upto the end of September, when the mean monthly temperature varies between 21°C to 33°C. The rainy season is followed by winter from October to February, and during the season the mean monthly temperature varies between 13°C to 33°C. Summer starts in March and lasts upto May and mean monthly temperature varies between 17°C to 39°C.

The major portion of the district lies in the zone of low rainfall i.e., 508 mm to 635 mm annually. Western parts of Akola tehasil get the highest rainfall. Towards east it drops down with very sharp transition. The monthwise rainfall distribution in Ahmednagar district for the years 1955-56, 1956-57, 1969-70 and 1970-71 is given in Table 4.3.

Table 4.3 : Rainfall Distribution in Ahmednagar District (Milimeters)

Month	1955-56	1956-57	Average	1969-70	1970-71	Average	Normal
May	19.83	7.77	13.80	-	-	-	-
June	82.35	73.20	77.77	195.26	45.75	120.51	84-09
July	66.85	1[illegible]4.53	110.69	140.10	36.75	88.42	50·28
August	152.50	139.79	146.15	119.79	152.98	136.39	1[illegible]7 35
September	162.41	177.92	170.17	235.25	167.50	201.37	159·26
October	158.60	132.42	145.51	103.41	152.58	128.00	134·45
November	1.02	15.23	8.12	20.72	11.22	15.97	14·54
December	-	-	-	-	-	-	14·51
January	-	-	-	-	-	-	-
February	-	-	-	-	-	-	-
March	3.56	5.85	4.71	-	0.42	0.21	-
April	11.69	24.40	18.04	1.15	0.33	0.74	0·38
Total	658.81	[illegible]1.11	624.96	815.68	567.53	691.61	574-8[illegible]

Source : Office of the District Inspector of Land Records, Ahmednagar District.

The rains start from early in June and last till the middle of October. The intensity of rainfall is the greatest in September. Though the major part of precipitation in the district is experienced during June and September, the season usually closes with some showers in November. Stray instances of thunder-showers in March and April have also been recorded.

It may be observed from the table that the annual rainfall is not certain and varies from year to year . The district being the dry farming area, low rainfall causes bad effects on farming. Many a times kharif sowings are delayed to a considerable extent because of scanty rainfall from south-west monsoon and the rabi crops are severely affected if the rainfall is insufficient during October and November. The district is, however, preminantly a rabi crop region.

A mention may be made here, that parts of the district, have been affected by scarcity conditions from early times. The 'Fact Finding Committee' appointed by the State Government in 1960 has reported that the rainfall is not dependable in the , following areas and they are likely to be affected by scarcity conditions as shown below :

Area	Estimated Frequency of Scarcity
1. Shrigonda tehasil and Rashin Circle of Karjat tehasil	Once in three years
2. Parner, Ahmednagar and Karjat (excluding Rashin circle) tehasils	Once in six years
3. Sangamner, Pathardi and Jamkhed tehasils.	Once in ten years

The remaining six tehasils viz., Akola, Kopergaon, Shrirampur, Rahuri, Newasa and Shevgaon are comparatively agriculturally betterof as the annual rainfall is relatively high and dependable.

4.5 Size of Holding and Distribution of Cultivating Households

The distribution of cultivating households and area owned by different sizes of land holdings are given in Table 4.4 for the years 1956-57 and 1970-71.

Table 4.4 : Distribution of Cultivating Households in Ahmednagar District by Size of Land Holding in 1956-57 and 1970-71

Size Group	1956-57		1970-71	
	Number of households	Area owned (hectares)	Number of households	Area owned (hectares)
Below 2 hectares	89355 (41.90)	118504 (10.49)	116157 ([illegible]7.06	185119 (14.96)
2 to 5 hectares	55571 (26.06)	232420 (21.44)	82570 (3[illegible].68	273145 (22.07)
5 to 10 hectares	41869 (19.64)	343535 (30.40)	39390 (17.[illegible])	389253 (31.46)
10 to 40 hectares	24981 (11.72)	490607 (29.70)	20709 (9.52)	404537 (27.84)
Above 40 hectares	1447 (0.68)	90099 (7.97)	624 (0.24)	45476 (3.67)
Total	213223 (100.00)	1290067 (100.00)	259458 (100.00)	1297530 (100.00)

(Figures in parentheses are the percentages to the total).
Source : Collectorate, Ahmednagar District.

The information presented in the table reveals that there has been structural change in the distribution of cultivating households and area owned in different sizes of land holdings during the period. The successful implementation of Ceiling on Land Holdings Act and sub-division of land holdings due to bifurcation of farm families may be cited as some of the reasons for this change.

4.6 Land Use Pattern :

During the period under reference the total geographical area in the district has remained almost the same i.e., 1701.60 thousand hectares. The details of land use pattern in the years 1956-57 and 1970-71 are presented in Table 4.5.

Table 4.5 : Land Utilization in Ahmednagar District in 1956-57 and 1970-71.

(Area in thousand hectares)

Land Use	1956-57	1970-71	% change during the period
1. Forests	199.59 (11.73)	185.63 (10.91)	- 6.99
2. Barren and uncultivable land	145.50 (8.55)	166.86 (9.81)	14.68
3. Land put to non-agricultural use	1.23 (0.07)	1.01 (0.06)	-17.89
4. Cultivable waste	19.78 (1.16)	7.36 (0.43)	-62.79
5. Permanent pastures and other grazing land	28.94 (1.70)	24.49 (1.44)	-15.38
6. Land under misc. trees, groves and crops not included in area sown	0.20 (0.01)	0.40 (0.02)	100.00
7. Current fallow	23.24 (1.37)	15.89 (0.93)	-31.63
8. Other fallow land	34.93 (2.06)	47.05 (2.77)	34.70
9. Net area sown	1248.19 (73.35)	1252.91 (73.63)	0.38
Total	1701.60 (100.00)	1701.60 (100.00)	-

(Figures in parentheses are the percentages to the total geographical area).

Source : Office of the District Inspector of Land Records, Ahmednagar District.

The proportion of net cropped area to the total geographical area was already as high as 73.35 per cent in 1956-57 and it increased to 73.63 per cent by 1970-71.

During this period there was considerable reduction in the area under forests, cultivable waste area, pasture and grazing land and current fallow land. However, at the same time there has been remarkable increase in the other fallow land and barren and uncultivable land. Although a part of the forest land, cultivable waste land, grazing land and current fallow land was brought under cultivation during the period through various land improvement programmes, an equal proportion of net cropped area became unfit for cultivation because of field drainage problem, sub-mergence of land under water in the dams and extension of road works in the rural areas.

Although there has been expansion in the net cropped area by about 0.38 per cent during the period, the same was not commensurate with the growth in the population. As a result the net cropped area per 100 persons in the district declined from 88.47 hectares in 1956-57 to 55.22 hectares in 1970-71. Figures given in Table 4.6 to show the relationship between irrigated and cropped area in the district in the years 1956-57 and 1970-71 also indicate that there has been increase in the net area irrigated as well as gross area irrigated from 116 thousand hectares to 148 thousand hectares and from 136 thousand hectares to 174 thousand hectares, respectively, during the period. The proportion of net area irrigated to the net cropped area increased from 9.27 per cent to 11.80 per cent and that of gross area irrigated to the gross cropped area increased from 10.30 per cent to 13.19 per cent during the period. The extension in the gross cropped area was only by 0.22 per cent indicating thereby the possibility of allocation of area additionally brought under irrigation to annual crops like sugarcane and other perennial fruit crops. The cropping intensity, in fact, has decreased slightly from 105.69 per cent to 105.52 per cent during the period.

Table 4.6 : Relationship Between Irrigated and Cropped Area in Ahmednagar District in 1956-57 and 1970-71

(Area in thousand hectares)

Particulars	1956-57	1970-71	% increase during the period
Total net area irrigated	115.69	147.85	27.80
Total gross area irrigated	135.85	174.42	28.39
Total net cropped area	1248.19	1252.91	0.38
Total gross cropped area	1319.21	1322.09	0.22
Percentage of net area irrigated to net cropped area	9.27	11.80	
Percentage of gross area irrigated to gross cropped area	10.30	13.19	
	105.69	105.52	

net area irrigated from 115.69 thousand hectares to 147.85 thousand hectares in Ahmednagar district during the period from 1956-57 to 1970-71. The break-up of the net area irrigated according to source of irrigation is presented in Table 4.7.

Table 4.7 : Progress of Irrigation by Source in Ahmednagar District During the Period 1956-57 to 1970-71

(Area in thousand hectares)

Source of Irrigation	1956-57	1970-71	% increase during the period
Area irrigated by wells	65.68 (56.78)	103.95 (70.31)	58.27
Area irrigated by Govt. canals	48.78 (42.16)	43.64 (29.52)	-10.54
Area irrigated by private canals	1.23 (1.06)	0.26 (0.17)	-81.30
Total net area irrigated	115.69 (100.00)	147.85 (100.00)	27.80

(Figures in parentheses are the percentages to the total net area irrigated).

Source : Office of the District Inspector of Land Records, Ahmednagar District.

Wells and Government canals formed the major sources of irrigation in the district; while private canals were the minor source of irrigation. The proportion of area irrigated by wells to the total net area irrigated increased from 56.78 per cent to 70.31 per cent, while that of area irrigated by canals (both irrigated by wells from 65.68 thousand hectares to 103.95 thousand hectares, the area irrigated by canals has shown reduction from 50.01 thousand hectares to 43.90 thousand hectares during the period. The main reason for reduction in the area irrigated by canals could be found in reallocation of irrigation resource to the crops like sugarcane, cotton and fruit crops requiring higher quantity of irrigation water.

Well irrigation thus forms the important source of irrigation in the district. Table 4.8 presents information in respect of number of wells and number of mechanized lifts on the wells in Ahmednagar district for the years 1956-57 and 1970-71.

Table 4.8 : Number of Wells and Number of Mechanized Lifts in Ahmednagar District in 1956-57 and 1970-71

Item	1956-57	1970-71	% increase during the period
Total number of wells for irrigation purposes	53663	71114	32.52
Number of wells per thousand hectares	42.99	56.76	
Number of wells used for irrigation	46003	69886	51.92
Number of wells per thousand hectares	36.86	55.78	
Number of oil engines	9812	13205	34.58
Number of electric motors	121	8794	7167.77

Source : Office of the District Inspector of Land Records, Ahmednagar District.

The number of wells used for irrigation has been gradually increasing during the period. Total number of wells in the district was 53663 in 1956-57. Availability of soft credit since the 'fifties facilitated the construction of new wells in the district. The number of wells increased by 32.52 per cent between 1956-57 and 1970-71 i.e., on an average 1247 new wells were added per year during this period. The density of wells was 42.88 per thousand hectares in 1956-57 and increased to 56.76 per thousand hectares in 1970-71.

About 14.27 per cent wells were not in use in 1956-57. The facility of loans for repairs to old wells helped reduction in the number of wells not in use. By 1970-71 the proportion of wells not in use declined to 1.73 per cent.

The number of wells with mechanised lift in Ahmednagar district was 9933 (i.e., 21.59 per cent of the wells) in 1956-57. There has been a rapid increase in the mechanisation of wells. About 12000 wells were fitted with mechanised lifts during the period from 1956-57 to 1970-71. Oil engines have been the mainstay for the mechanisation of wells in the early period. There were only121 electric pumps as against 9812 oil engines. Because of intensification of electrification programme in the district, nearly 8800 wells were fitted with electric pumps upto 1970-71.

4.8 Crop Pattern :

Distribution of area under different crops in the district for the years 1956-57 and 1970-71 is presented in Table 4.9.

Table 4.9 : Area Under Different Crops in Ahmednagar District in 1956-57 and 1970-71

(Area in thousand hectares)

Crop	1956-57 Area	1956-57 Percentage	1970-71 Area	1970-71 Percentage	% change during the period
Paddy	8.42	0.64	7.67	0.58	- 8.91
Wheat	47.94	3.63	49.06	3.71	2.34
Jowar	564.97	42.83	507.92	38.42	-10.10
Bajra	304.83	23.11	370.69	28.04	21.61
Other cereals	15.60	1.18	12.84	0.97	-17.69
Total cereals	941.76	71.39	948.18	71.72	0.68
Gram	27.74	2.10	20.18	1.53	-17.25
Horse gram	42.90	3.25	31.63	2.39	-16.17
Tur	18.31	1.39	22.07	1.67	20.54
Other pulses	43.81	3.32	46.42	3.51	5.96
Total pulses	132.76	10.06	120.30	9.10	-9.38
Total cereals & pulses	1074.52	81.45	1068.48	80.82	-0.56
Sugarcane	28.70	2.17	51.75	3.92	80.31
Condiments and spices	1.97	0.15	3.59	0.27	82.23
Fruits and vegetables	8.00	0.61	9.15	0.69	14.38
Total food crops	1113.19	84.38	1132.97	85.70	1.78
Groundnut	41.34	3.13	23.09	1.75	-44.15
Safflower	53.84	4.09	56.75	4.29	5.41
Other oilseeds	8.22	0.62	5.75	0.43	-30.05
Total oilseeds	103.40	7.84	85.59	6.47	-17.22
Cotton	30.06	2.28	31.01	2.34	3.16
Tobacco	0.64	0.05	0.26	0.02	-59.47
Misc. non-food crops	71.92	5.45	72.26	5.47	0.47
Total non-food crops	206.09	15.62	189.12	14.30	-8.23
Gross cropped area	1319.21	100.00	1322.09	100.00	0.22

Source : Season and Crop Reports for the years 1956-57 and 1970-71.

Around 81 per cent of the total area sown was under foodgrains in both the years. The area under cereals remained almost the same during the period. Although there has been reduction in the area under jowar, paddy and other cereals, the area under wheat and bajra has shown increase during the period. Jowar and bajra are the important foodgrain crops in th district and together they shared a little over 66 per cent of the total sown area. The proportion of area under pulses which was 10 per cent in the total sown area declined to 9 per cent during the period.

There has been a continuous increase in the area under sugarcane, condiments and spices, fruits and vegetables, cotton and safflower in the district during the period. This shows development of commercial outlook among the farming community. The area under sugarcane cultivation has increased from 28.70 thousand hectares to 51.75 thousand hectares i.e., almost by 80 per cent during the period. The increase in the area under sugarcane over the period has been mainly under the impulse of extension of well irrigation and reallocation of canal irrigation to sugarcane crop in response of setting up of co-operative sugar-factories in the district. While sugarcane cultivation is being extended, there has been some decline in other crops grown under irrigated conditions.

Groundnut is one of the important cash crops in the district. The proportion of area under groundnut in the total sown area has however, declined from 3.13 per cent to 1.75 per cent over the period under consideration.

4.9 Productivity and Production of Important Crops :

It would be now appropriate to examine the impact of the developmental efforts on the performance of agriculture in the district. Development in agricultural activity will have to be reflected in the improvement in agricultural productivity. The only quantitative indicator of agricultural productivity about which information is available is the yield per hectare. The per hectare yields of some of the important crops are presented in Table 4.10 for the years 1956-57 and 1970-71.

Table 4.10 : Average Yield Per Hectare of Important Crops in Ahmednagar District in 1956-57 and 1970-71

(Kilograms per hectare)

Crop	1956-57	1970-71	% change during the period
Paddy	662	775	17.07
Wheat	425	521	22.59
Jowar	366	435	18.86
Bajra	210	339	61.43
Gram	354	312	-11.86
Tur	551	449	-18.51
Sugarcane (gur)	9928	7898	-20.45
Cotton (lint)	61	153	150.82
Groundnut	689	558	-19.01
Tobacco	316	395	25.00

Source : Season and Crop Reports for the years 1956-57 and 1970-71.

There has been significant improvement in the yield per hectare of bajra during the period. The yield increased from 2.10 quintals per hectare to 3.39 quintals per hectare, almost by 61 per cent. The major factor responsible for this improvement was the spread of improved seeds of bajra.

The per hectare yields of paddy, wheat and jowar also showed improvements during the period. The increase in per hectare yields was from 6.62 quintals to 7.75 quintals in case of paddy, from 4.25 quintals to 5.21 quintals in wheat and from 3.66 quintals to 4.35 quintals in jowar. The improvement in yields of these crops during the period may be attributed to the introduction of improved varieties and agronomic practices.

The performance of gram, tur, sugarcane and groundnut has been observed to be disappointing as the per hectare yields of these crops have declined considerably during the period. Significant improvement in the yields of cotton and tobacco is noted during the period.

Table 4.11 presents total production of major crops in the district in the years 1956-57 and 1970-71.

The total foodgrain production has increased from 2.75 lakh tonnes to 2.95 lakh tonnes i.e., by 7.17 per cent during the period. The major contribution to increase in the total foodgrain production was from the increase inthe production of wheat, bajra, horse gram and some minor cereals like maize , ragi, etc. The decline in the production of jowar, gram and some minor pulses has been noticed during the period.

Table 4.11 : Production of Major Crops in Ahmednagar District in 1956-57 and 1970-71

(in hundred tonnes)

Crop	1956-57	1970-71	% change during the period
Paddy	62.41	62.18	- 0.37
Wheat	248.04	287.12	15.76
Jowar	1412.21	1328.82	-5.90
Bajra	671.09	958.58	42.84
Other cereals	47.04	63.91	35.86
Total cereals	2440.79	2700.61	10.64
Gram	125.27	63.85	-49.03
Horse gram	33.58	40.55	20.76
Tur	96.97	97.21	0.25
Other pulses	56.04	47.71	-14.48
Total pulses	311.86	249.32	-20.06
Total foodgrains	2752.62	2949.93	7.17
Sugarcane (gur)	2666.94	4138.87	55.19
Cotton (lint)	30.84	132.67	330.19
Groundnut	270.58	150.10	-44.53
Safflower	22.00	38.83	76.50
Other oilseeds	8.05	11.93	48.20
Tobacco	2.80	2.63	-6.07

Source : Season and Crop Reports for the years 1956-57 and 1970-71.

Among the cash crops, there has been significant increase in the production of sugarcane, cotton and safflower. The production of groundnut has declined considerably during the period.

4.10 Agricultural Implements and Machineries :

Agricultural implements and machineries form one of the contributing factors towards development of agriculture in the district. Figures presented in Table 4.12 give an idea about the progress made by the cultivators in acquisition of agricultural implements and machineries during the period under consideration.

Table 4.12 : Agricultural Implements and Machineries in Ahmednagar District in 1956-57 and 1970-71

Implements/machineries	1956-57	1970-71	% change during the period
Wooden ploughs	26223	27967	6.65
Iron ploughs	43524	46867	7.68
Bullock carts	59697	67334	12.79
Oil engines	9812	13205	34.58
Electric motors	121	8794	7167.77
Tractors	191	502	162.83
Sugarcane crushers	1692	1160	-31.44

Source : Office of the District Inspector of Land Records, Ahmednagar District.

There has been significant development in mechanization of wells during the period. The number of tractors also increased from 191 to 502 during this period. During the period under reference, the number of traditional implements like wooden ploughs, iron ploughs and bullock carts has shown increase by about 7 to 13 per cent. The number of sugarcane crushers has, however, declined from 1692 to 1160 during the period. The decline in the number of sugarcane crushers may be mainly on account of increasing tendency among the sugarcane growers to divert sugarcane to sugar factories rather than crushing the same for production of gur (i.e., jaggary).

4.11 Agricultural Prices :

One of the factors adjudged to be of crucial importance for efficient farming is the prices obtained by the cultivators for agricultural produce. During the period under consideration, the prices of almost all the agricultural commodities have shown an increasing trend. Table 4.13 presents average annual prices of important agricultural commodities in the years 1956-57 and 1970-71.

The prices of cereals like jowar, bajra and wheat have nearly doubled during the period. In case of groundnut the increase in price was by about 139 per cent, while the prices of gram, tur, sufflower and gur have increased by 202 per cent to 267 per cent during the same period. It may be noted that in order to meet the challenges of foodgrain shortages and curb the prices of foodgrains, government had adopted policies like monopoly procurement, statutory rationing and zonal restrictions on movement of foodgrains, especially, jowar, paddy, bajra and wheat. As a result, prices of these commodities increased at a slow rate. There were no restrictions of any kind on the prices of other commodities.

Table 4.13 : Average Annual Prices of Important Agricultural Commodities in 1956-57 and 1970-71

(in rupees per quintal)

Agricultural Commodities	1956-57	1970-71	% increase during the period
Jowar	44.64	90.88	103.58
Bajra	44.92	85.47	90.27
Wheat	51.26	102.20	99.38
Gram	30.10	110.37	266.68
Tur	35.27	115.40	227.19
Safflower	36.93	111.47	201.84
Groundnut	58.97	140.65	138.51
Gur	39.13	123.32	215.15

Source : Season and Crop Reports for the years 1956-57 and 1970-71.

4.12 Agricultural Wages :

In the early stages of development of agriculture, labour forms the major item of cost of production of crops.

Table 4.14 gives an idea about the wages of field labourers and the other workers prevailing in the years 1956-57 and 1970-71.

Table 4.14 : Average Daily Wages of Field Labourers and Other Workers in Ahmednagar District in 1956-57 and 1970-71.

(in rupees)

Item	1956-57	1970-71	% increase during the period
Field Labourers :			
Men	1.13	3.40	200.89
Women	0.72	2.35	226.39
Children	0.72	1.55	115.28
Herdsmen :			
Men	1.07	3.15	194.39
Women	0.56	2.05	266.07
Children	0.46	1.35	193.48
Others :			
Blacksmith	2.75	7.50	172.73
Carpenter	2.87	7.85	173.52
Cobbler	2.59	6.80	162.55
Bullock pair	2.98	8.20	175.17

Source : Collectorate, Ahmednagar District.

There has been considerable increase of about 226 per cent to 266 per cent in the wages of the women labourers during the period. The wages of men labourers have nearly trebled during the period, while that of child labour by 115 per cent. The wages of other workers like blacksmith, carpenter and cobbler have increased by 163 per cent to 174 per cent, respectively. The increase in the wages of bullock pair was by a little over 175 per cent during the period under consideration.

STRUCTURE OF THE SAMPLE FARMS

Chapter 5

STRUCTURE OF SAMPLE FARMS

In the process of modernization of agriculture, the improvement in production efficiency at the farm level is largely dependent, among other factors, on the changes in the farm structure and organizational ability of the farmers. During the period under consideration, various agricultural development programmes were formulated and implemented in the district. The various institutions catering to the needs of the agriculturists also transformed their activities making them more production-oriented. Improvements in marketing system, changes in prices, availability of credit, technological advancement, land reform measures, etc., ought to have exposed the agriculturists in the district to various advancements forcing them to change their value systems and adopt modern methods of agriculture.

As a prelude to the main analysis concerning deployment and use of farm resources, their productivities and technological change, some important aspects of the structure of farms and their organization in the district at two points of time may be briefly examined in this chapter. The aspects examined in the discussion that follows relate to size of holdings, farm family size, irrigation facilities, land use pattern, capital investment and crop pattern at two points of time.

5.1 Area Operated and Size of Farms :

The distribution of sample farms according to different size groups is presented in Table 5.1 for the years 1956-57 and 1970-71.

There were 80 sample farms in the earlier period and 132 farms in the latter year. Out of the 80 sample farms in the former year there were 27 farms in the small size group, 27 in the medium size group and 26 in the large size group, whereas in the latter year each of the three size-groups had equal number of farms i.e., 44 in each size group. The distribution of area amongst the different size groups reveals that there was greater concentration of area in the higher size groups. The small size group operated a little over 10 per cent area whereas the medium size group operated a little over 27 per cent. The concentration of area in the large size group was a little over 62 per cent. The trend in the distribution of cultivable area amongst the different size groups was observed to be in accordance with the distribution of operated area in the respective size groups during both the years.

It may be noted that during the period under consideration, various land reform measures like tenancy legislation, land ceiling act and consolidation of holdings act were in operation. However, there has been hardly any effect on the distribution of area amongst the different size groups.

5.2 Tenurial Situations :

Although the distribution of area amongst the different

Table 5.1 : Distribution of Sample Farms by Size Groups in 1956-57 and 1970-71

Particulars	1956-57 Size Groups			Total	1970-71 Size Groups			Total
	Small	Medium	Large		Small	Medium	Large	
Number of holdings	27 (33.75)	27 (33.75)	26 (32.50)	80 (100.00)	44 (33.33)	44 (33.33)	44 (33.33)	132 (100.00)
Total operated area (hectares)	75.33 (10.22)	202.77 (27.51)	459.06 (62.27)	737.16 (100.00)	113.52 (10.24)	301.40 (27.19)	693.44 (62.57)	1108.36 (100.00)
Total cultivable area(hectares)	72.63 (10.83)	187.38 (27.93)	410.80 (61.24)	670.81 (100.00)	108.24 (10.58)	285.12 (27.87)	629.64 (61.55)	1023.00 (100.00)
Average size of holding (hectares)	2.79	7.51	17.66	9.21	2.75	7.23	17.48	9.15

(Figures in parentheses are the percentages to the total).

size groups remained almost the same during the period under consideration, there was significant effect on the ownership of land. Table 5.2 gives information regarding the extent of area owned, leased-out and leased-in during the years 1956-57 and 1970-71.

It will be seen from the data that in the year 1956-57, the proportion of owned area in the total operated area was 78.14 per cent at the overall level. The proportions of owned area in the total operated area, however, declined from 94.98 per cent to 72.72 per cent over the size groups, indicating thereby relatively higher concentration of leased-in area in the higher size groups. It is obvious that because of the better financial and social position and command over resources, the farmers belonging to higher size groups appear to have succeeded in enlarging the operated area through leasing-in practices. There were also a few cases wherein some of the sample farms had leased-out a part of owned land. The proportion of owned land leased-out was, however, higher i.e., 5.02 per cent in the small size group. In case of the medium and large size groups the proportion of owned land leased-out was almost negligible.

The picture was distinctly different in the 1970-71 sample farms. There was not a single case of leased-out or leased-in area and the entire area operated-by the sample farms was owned. This tremendous change in the tenurial situation in the two samples may be attributed to the effective implementation

Table 5.2 : Extent of Area Owned, Leased-Out and Leased-In of Sample Farms in 1956-57 and 1970-71

(Hectares)

Particulars	1956-57 Size Groups			Total	1970-71 Size Groups			Total
	Small	Medium	Large		Small	Medium	Large	
Area owned	71.55 (94.98)	170.64 (84.15)	333.84 (72.72)	576.03 (78.14)	113.52 (100.00)	301.40 (100.00)	693.44 (100.00)	1108.36 (100.00)
Area leased-out	3.78 (5.02)	1.08 (0.53)	1.56 (0.34)	6.42 (0.87)	-	-	-	-
Area leased-in	7.56 (10.04)	33.21 (16.38)	126.78 (27.62)	167.55 (22.73)	-	-	-	-
Net area leased-in	3.78 (5.02)	32.13 (15.85)	125.22 (27.28)	161.13 (21.86)	-	-	-	-
Total operated area	75.33 (100.00)	202.77 (100.00)	459.06 (100.00)	737.16 (100.00)	113.52 (100.00)	301.40 (100.00)	693.44 (100.00)	1108.36 (100.00)

(Figures in parentheses are the percentages to the total operated area).

of tenancy abolition act in the state with effect from 1-4-1957 as a result of which the tenants of the land became owners and thereafter land owners refrained from the land leasing-out practices.

5.3 <u>Land Use Pattern</u> :

The land use patterns prevailing on farms in different size-groups during the years 1956-57 and 1970-71 are presented in Table 5.3.

It is clear from the table that the land use patterns remained almost the same during both the years. At the overall level, there has been a slight change in the land use pattern wherein the proportions of fallow area and current fallow area in the total operated area have declined by less than one per cent. The size groupwise land-use patterns were practically the same in both the years. On the whole the proportions of total fallow area and annual current fallow area in the total operated area increased with the increase in holding size in both the years. The reverse was the trend with respect to the proportion of net area sown in the total operated area. The proportion of net area sown in the total operated area declined from 91.40 per cent to 80.52 per cent over the size groups in the years 1956-57 and 1970-71, respectively.

Table 5.3 : Average Land Use Pattern on Sample Farms in 1956-57 and 1970-71

(Hectares)

Particulars	1956-57 Size Groups: Small	Medium	Large	Overall	1970-71 Size Groups: Small	Medium	Large	Overall
Total operated area	2.79 (100.00)	7.51 (100.00)	17.66 (100.00)	9.21 (100.00)	2.75 (100.00)	7.23 (100.00)	17.48 (100.00)	9.15 (100.00)
Total fallow area	0.10 (3.58)	0.57 (7.59)	1.86 (10.53)	0.83 (9.01)	0.17 (6.18)	0.38 (5.26)	1.74 (9.95)	0.76 (8.31)
Total cultivated area	2.69 (96.42)	6.94 (92.41)	15.80 (89.47)	8.38 (90.99)	2.58 (93.82)	6.85 (94.74)	15.74 (90.05)	8.39 (91.69)
Annual current fallow	0.14 (5.02)	0.42 (5.59)	1.58 (8.95)	0.70 (7.60)	0.12 (4.36)	0.37 (5.11)	1.45 (8.30)	0.65 (7.10)
Net cropped area	2.55 (91.40)	6.52 (86.82)	14.22 (80.52)	7.68 (83.39)	2.46 (89.46)	6.48 (89.63)	14.29 (81.75)	7.74 (84.59)

(Figures in parentheses are the percentages to the total operated area).

As regards the annual current fallow land, it may be said that low fertility of soil and insufficient and untimely rainfall usually impose a constraint on bringing this land under cultivation. Generally, these lands are situated either on the slopes or at the foot of hills and are rocky and shallow.

5.4 Irrigation :

Information regarding extent of irrigation on the sample farms is presented in Table 5.4 for the years 1956-57 and 1970-71.

Availability of irrigation is the major constraint with regard to modernization of agriculture. There was however, an improvement in the extent of irrigation on the farms. At the overall level, the proportion of net area irrigated in the net cropped area increased from 15.89 per cent to 28.29 per cent, while the increase in the proportion of gross area irrigated in gross cropped area was from 17.86 per cent to 32.26 per cent during the period. The supply of canal irrigation remaining the same, the reason to be adduced for such phenomenal increase in the extent of irrigation may be found in the participation of farmers in the well sinking, well repair and well energisation programmes sponsored in the district with the help of necessary finance through the land Development Bank. There has been, however, differential increase in the extent of irrigation between the size groups. In 1956-57, the farms belonging to small size-group were relatively better endowed in terms of extent of irrigation. The proportion of irrigated area in the

Table 5.4 : Extent of Irrigation and Intensity of Cropping on Sample Farms in 1956-57 and 1970-71

(Hectares)

Particulars	1956-57 Size Groups			Overall	1970-71 Size Groups			Overall
	Small	Medium	Large		Small	Medium	Large	
Net cropped area	2.55	6.52	14.22	7.68	2.46	6.48	14.29	7.74
Net area irrigated	0.70	1.08	1.90	1.22	0.69	2.32	3.56	2.19
Percentage of net area irrigated to net cropped area	27.45	16.56	13.36	16.89	28.05	35.80	24.91	28.29
Gross cropped area	2.71	7.02	15.23	8.23	3.15	7.65	15.33	8.71
Gross area irrigated	0.81	1.28	2.37	1.47	0.96	3.07	4.41	2.81
Percentage of gross area irrigated to gross cropped area	29.89	18.23	15.56	17.86	30.48	40.13	28.77	32.26
Intensity of cropping	106.27	107.67	107.10	107.16	128.05	118.06	107.28	112.53

cropped area showed a tendency to decrease as the farm size increased. In 1970-71 however, the extent of irrigation has remained almost the same in the small size-group, while it has nearly doubled in the medium and large size groups. The differential capacity of farmers to self-finance and debt-finance the well-sinking and energisation projects and possible scale economies of these projects on larger farms may be looked into as the reasons for differences in increase in the extent of irrigation among the size groups during the period.

5.5 Family Size and Farm Family Labour :

Table 5.5 gives the size of farm family in relation to size of farm in both the years. Further break-up of the family members into earners and dependents is given in Appendix VI, whereas the picture regarding availability of family workers and annual farm servants for work on the farm is presented in Appendix VII.

It is evident from the tables that the farm family size increased as the farm size increased in both the years. At the overall level, the size of the farm family in the year 1970-71 exceeded the farm family size in 1956-57 only by 0.69 persons. It was further revealed that the pattern of composition of the farm families in different size groups remained the same in both the years with slight variation, in that the proportion of women in the family increased while that of children declined during the period.

Table 5.5 : Composition of Average Farm Family in 1956-57 and 1970-71

Family members	1956-57 Size Groups: Small	Medium	Large	Overall	1970-71 Size Groups: Small	Medium	Large	Overall
Men	1.67 (27.83)	1.78 (28.76)	2.58 (27.36)	2.00 (27.86)	1.82 (27.49)	2.14 (26.07)	2.50 (28.41)	2.15 (27.32)
Women	1.63 (27.17)	1.63 (26.33)	2.27 (24.07)	1.84 (25.62)	1.91 (28.85)	2.30 (28.01)	2.55 (28.98)	2.25 (28.59)
Children	2.70 (45.00)	2.78 (44.91)	4.58 (48.57)	3.34 (46.52)	2.89 (43.66)	3.77 (45.92)	3.75 (42.61)	3.47 (44.09)
Total	6.00 (100.00)	6.19 (100.00)	9.43 (100.00)	7.18 (100.00)	6.62 (100.00)	8.21 (100.00)	8.80 (100.00)	7.87 (100.00)

(Figures in parentheses are the percentages to total).

As regards the break-up of the family members into earners and dependents, it was observed that at the overall level, the number of earners in the family increased while that of dependents decreased during the period. The number of earners in the farm family showed an increasing trend over the size groups in both the years. The number of family workers engaged in farm work also increased over the size groups. It is, however, evident that the availability of family workers for farm work was relatively higher in the latter year in all the size groups.

The relative strength of the workers, inclusive of family members and annual farm servants, available for farm work is presented in Table 5.6. For purposes of standardization, all the figures are given as adult male equivalents[1].

Table 5.6 : Per Farm Availability of Farm Family Workers and Annual Farm Servants on Sample Farms Expressed as Adult Male Equivalents in 1956-57 and 1970-71

Size Groups	1956-57			1970-71		
	Adult male equivalents of			Adult male equivalents of		
	Family workers	Annual farm servants	Total	Family workers	Annual farm servants	Total
Small	2.13 (95.95)	0.09 (4.05)	2.22 (100.00)	2.22 (96.94)	0.07 (3.06)	2.29 (100.00)
Medium	2.27 (90.80)	0.23 (9.20)	2.50 (100.00)	2.73 (93.49)	0.19 (6.51)	2.92 (100.00)
Large	2.81 (87.27)	0.41 (12.73)	3.22 (100.00)	3.08 (78.37)	0.85 (21.63)	3.93 (100.00)
Overall	2.41 (90.60)	0.25 (9.40)	2.66 (100.00)	2.69 (85.94)	0.44 (14.06)	3.13 (100.00)

(Figures in parentheses are the percentages to the total).

1. One and a half adult female and two children respectively, have been reckoned as equivalent to one adult male.

It is clear from the table that there was a tendency for the strength of work force available for farm work to increase with the increase in the size of farm in both the years. At the same time it is evident that although the strength of workers, both of family members and annual farm servants, showed a tendency to increase as farm size increases, the proportion of family members contributing to farm work tended to decline over the size groups. The figures further reveal that the strength of the workers available for farm work was relatively higher in the latter year in all the size groups.

In order to get a clear idea about the changes inthe land-man relationships, Table 5.7 gives the average cultivated area per head of family member, family farm worker and total farm worker in all the size groups in both the years.

Table 5.7 : Average Cultivated Area Per Head of Family Members, Family Workers and Total Workers in 1956-57 and 1970-71

(Hectares per head)

Particulars	1956-57 Size Groups			Over-all	1970-71 Size Groups			Over-all
	Small	Medium	Large		Small	Medium	Large	
Cultivated area per head of family member	0.45	1.12	1.68	1.17	0.39	0.83	1.79	1.07
Cultivated area per head of adult male equivalent of family workers	1.26	3.06	5.62	3.48	1.16	2.51	5.11	3.12
Cultivated area per head of adult male equivalent of total workers	1.21	2.78	4.91	3.15	1.13	2.35	4.01	2.68

Although it is obvious that availability of cultivated area per head of family worker as well as farm worker increased with the increase in the size of the farm, there has been a decline in the availability of cultivated area per head of family member and per farm worker during the period.

5.6 Investment on Farms :

In order to examine the changes in patterns of farm investment in different size groups during the period, the investment in fixed assets on the farms, per farm and per cultivated hectare, are shown in Tables 5.8 and 5.9, respectively. The fixed assets on farms include items like land, well, farm structures, implements, machinery and livestock.

It is evident from the figures given in both the tables that the investment in farm assets in the year 1970-71 is almost five to eight times higher than that in the year 1956-57. This phenomenal increase in the quantum of investment may be attributed partly to added capital formation that might have taken place through new investments and partly to the rise in the prices of certain capital assets during the period. The former reason is true in case of the capital assets like wells, farm structures, implements, machinery, etc., whereas the latter reason is more appropriate in case of the land. As noted earlier, there has been no increase in the size of the farm during the period. However, at the overall level, value of land has increased by a little over eight times. As a matter of fact, land is by and large, the costliest item, accounting

Table 5.8 : Per Farm Investment in Capital Assets on Sample Farms in 1956-57 and 1970-71

(in rupees)

Capital Asset	1956-57 Size Groups Small	Medium	Large	Overall	1970-71 Size Groups Small	Medium	Large	Overall
Land	3075.78 (72.92)	4123.63 (73.57)	6672.42 (69.44)	4598.34 (72.43)	13854.09 (71.38)	35057.05 (75.97)	63864.20 (80.15)	37491.78 (77.61)
Well	465.22 (11.03)	554.96 (9.90)	1366.04 (14.21)	788.28 (12.42)	1548.50 (7.98)	3425.00 (7.43)	4404.91 (5.54)	3126.14 (6.47)
Farm structures	131.52 (3.12)	166.85 (2.98)	168.08 (1.75)	155.33 (2.45)	2205.11 (11.35)	2891.75 (6.27)	4935.57 (6.19)	3344.14 (6.92)
Implements	75.67 (1.79)	98.48 (1.76)	211.88 (2.21)	127.64 (2.01)	332.25 (1.71)	684.82 (1.48)	883.68 (1.11)	633.58 (1.31)
Machinery	105.56 (2.50)	142.59 (2.54)	249.27 (2.59)	164.76 (2.60)	535.45 (2.76)	2081.73 (4.52)	2707.68 (3.40)	1774.95 (3.68)
Livestock	364.36 (8.64)	518.63 (9.25)	941.31 (9.80)	513.92 (8.09)	936.05 (4.82)	1998.86 (4.33)	2870.16 (3.61)	1935.02 (4.01)
Total	4218.11 (100.00)	5605.14 (100.00)	9609.00 (100.00)	6348.27 (100.00)	19411.45 (100.00)	46139.21 (100.00)	79666.20 (100.00)	48305.61 (100.00)
Total assets excluding land	1142.33	1481.51	2936.58	1749.93	5557.36	11082.16	15802.00	10813.83

(Figures in parentheses are the percentages to the total).

COMPOSITION OF CAPITAL ASSETS ON SAMPLE FARMS
IN 1956-57 AND 1970-71

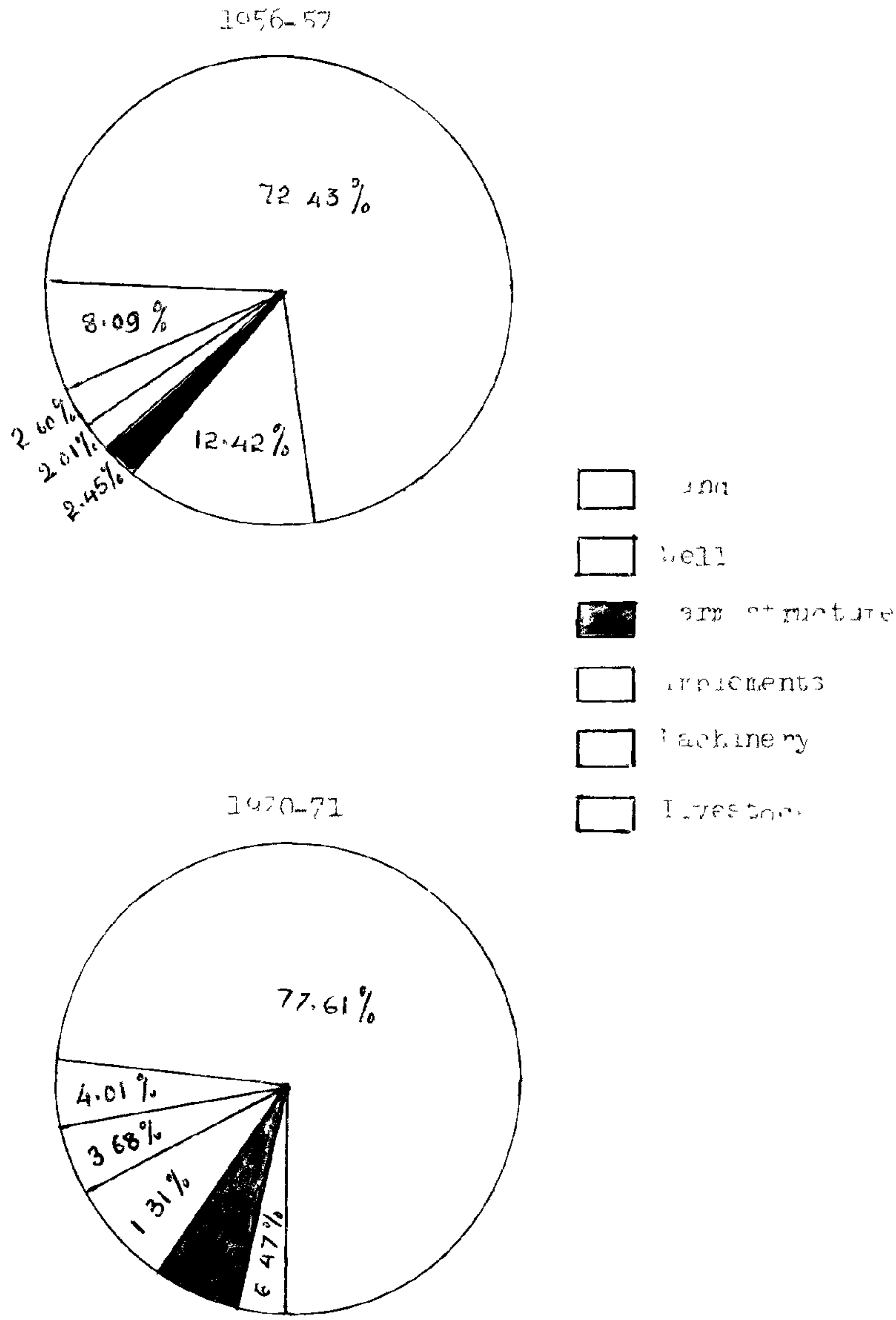


Table 5.9 : Per Cultivated Hectare Investment in Capital Assets on Sample Farms in 1956-57 and 1970-71

(in rupees)

Capital Asset	1956-57 Size Groups			Overall	1970-71 Size Groups			Overall
	Small	Medium	Large		Small	Medium	Large	
Land	1143.41	594.18	422.30	548.73	5369.80	5117.80	4060.04	4468.65
Well	172.95	79.97	86.46	94.07	600.19	500.00	280.03	372.60
Farm structures	48.89	24.03	10.63	18.53	854.70	422.16	313.77	398.58
Implements	28.13	14.19	13.41	15.23	128.78	99.97	56.18	75.52
Machinery	39.24	20.55	15.78	19.66	207.94	303.90	172.14	211.56
Livestock	135.45	74.74	59.58	61.33	362.81	291.80	182.46	230.64
Total	1568.07	807.66	608.16	757.55	7523.82	6735.63	5064.62	5757.55
Total assets excluding land	424.66	213.48	185.86	208.82	2154.02	1617.83	1004.58	1288.90

for nearly 69 to 80 per cent of the total investment on the farms, and the effect of change in its price necessarily influences the aggregate capital investment on the farms. If land is left out of consideration, then the costly asset-items on the farms as a whole are well and livestock in 1956-57 and well, farm structures, livestock and machinery in 1970-71. The picture becomes more clear when the value of fixed assets is considered on per cultivated hectare basis.

Among the size-groups, the value of all the capital assets showed a tendency to increase as the farm size increased in both the years. However, looking to the figures given in Table 5.9, it is seen that the per cultivated hectare value of different capital assets is relatively high in the small size group and declined as the farm size increased. The very fact that the per cultivated hectare value of land is higher in smaller size-groups indicates that these farms possessed land with high fertile soils. Similarly, because of indivisibility of capital assets and smaller size of holding the per cultivated hectare value of different capital assets, other than land, is relatively high in case of the smaller size-groups.

5.7 Animal Draught Power :

The main source of draught power, required for performing different farm operations, was bullock labour in both the years. The information in respect of average number of bullock pairs owned by sample farms is given in Table 5.10.

Table 5.10 : Draught Animals on Sample Farms in 1956-57 and 1970-71

Particulars	1956-57 Size Groups			Overall	1970-71 Size Groups			Overall
	Small	Medium	Large		Small	Medium	Large	
Total number of bullock pairs on sample farms	15	47	64	126	21	56	92	169
Average number of bullock pairs per farm	0.56	1.74	2.46	1.58	0.48	1.27	2.09	1.28
Cultivated area per pair of bullocks (hectares)	4.80	3.99	6.42	5.30	5.38	5.39	7.53	6.55
Net sown area per pair of bullocks (hectares)	4.55	3.75	5.78	4.84	5.13	5.10	6.84	6.05
Gross cropped area per pair of bullocks (hectares)	4.84	4.03	6.19	5.21	6.56	6.02	7.33	6.80

During the period of fourteen years there has been decrease in the average number of bullock pairs in all the size groups of farms. As a result of this, there has been increase in the per bullock pair cultivated area, net sown area and gross cropped area during the period on all the farms.

5.8 Cropping Pattern :

Factors like fertility of soil, availability of irrigation, resource endowment of the farm, decision-making ability of the cultivator under the situations of changing price structure, relative prices of output of different crops, rainfall and other agro-economic factors together influence the cropping pattern on farms to a greater extent. Changes in any of these factors have got a direct bearing on the cropping pattern. It is evident from the discussion attempted so far, that some of these factors were subjected to change, although the degree of change varied considerably, while other factors remained unchanged during the period. The changes in cropping pattern, as a whole, are therefore, obvious. In view of this the cropping patterns prevailing on farms in different size-groups at two points of time are presented in Table 5.11. The break-up of area under each crop into irrigated and unirrigated areas is shown in Appendix VIII and IX for the years 1956-57 and 1970-71, respectively. Further the proportion of area irrigated to total area under each crop and the percentage shares of area irrigated under each crop in the gross irrigated area are set out in Table 5.12.

Table 5.11 : Cropping Pattern on Sample Farms in 1956-57 and 1970-71

(Hectares)

Crop	1956-57 Size Groups			Overall	1970-71 Size Groups			Overall
	Small	Medium	Large		Small	Medium	Large	
Jowar	1.09 (40.22)	3.30 (47.01)	6.10 (40.05)	3.46 (42.04)	1.34 (42.54)	3.89 (50.85)	8.37 (54.60)	4.53 (52.01)
Bajra	0.80 (29.52)	1.83 (26.07)	4.94 (32.44)	2.49 (30.26)	0.95 (30.16)	1.52 (19.87)	3.42 (22.31)	1.97 (22.62)
Wheat	0.13 (4.80)	0.32 (4.56)	0.54 (3.55)	0.32 (3.89)	0.20 (6.36)	0.40 (5.23)	0.90 (5.87)	0.50 (5.74)
Gram	0.07 (2.58)	0.22 (3.13)	0.54 (3.55)	0.28 (3.40)	0.07 (2.22)	0.08 (1.04)	0.27 (1.76)	0.14 (1.61)
Other cereals and pulses	0.27 (9.96)	0.55 (7.84)	1.09 (7.16)	0.63 (7.64)	0.21 (6.67)	0.37 (4.84)	0.81 (5.28)	0.47 (5.40)
Total cereals and pulses	2.36 (87.08)	6.22 (88.61)	13.21 (86.75)	7.18 (87.23)	2.77 (87.95)	6.26 (81.83	13.77 (89.82)	7.61 (87.38)
Fruits and vegetables	0.11 (4.06)	0.09 (1.28)	0.17 (1.11)	0.12 (1.46)	0.09 (2.85)	0.18 (2.35)	0.11 (0.72)	0.14 (1.60)
Sugarcane	0.05 (1.84)	0.09 (1.28)	0.22 (1.44	0.12 (1.46)	0.06 (1.90)	0.53 (6.93)	0.59 (3.85)	0.39 (4.48)
Groundnut	0.02 (0.74)	0.05 (0.71)	0.11 (0.72)	0.06 (0.73)	0.05 (1.59)	0.22 (2.88)	0.25 (1.63)	0.17 (1.95)
Cotton	0.04 (1.48)	0.16 (2.28)	0.41 (2.69)	0.20 (2.43)	0.07 (2.22)	0.25 (3.26)	0.36 (2.35)	0.23 (2.64)
Other crops	0.13 (4.80)	0.41 (5.84)	1.11 (7.29)	0.55 (6.69)	0.11 (3.49)	0.21 (2.75)	0.25 (1.63)	0.17 (1.95)
Gross cropped area	2.71 (100.00)	7.02 (100.00)	15.23 (100.00)	8.23 (100.00)	3.15 (100.00)	7.65 (100.00)	15.33 (100.00)	8.71 (100.00)

(Figures in parentheses are the percentages to the gross cropped area).

Table 5.11 reveals that the share of foodgrain crops in the gross cropped area, on the whole, remained almost unchanged at a little over 87 per cent during the period. The picture was quite different between the size groups. In case of the small and large size groups the proportion of area under food-grain crops in the gross cropped area increased from 87.08 to 87.95 per cent and from 86.75 to 89.82 per cent, respectively. The proportion of area under foodgrain crops to gross cropped area, however, declined from 88.61 per cent to 81.83 per cent in case of the medium size group. As noted earlier, the extension in area irrigated was almost negligible on smaller farms and therefore there has been no increase in the area under non-food and cash crops during the period. On the contrary, in order to meet the need for food, there has been substitution of staple food crops for miscellaneous non-food crops, particularly fodder crop, to some extent in case of the small size-group. Similarly, because of increase in the prices of food-grains, extent of assured irrigation remaining the same, there has been substitution of foodgrain crops for fodder and other non-food crops grown under rainfed conditions on larger farms. In case of the medium size-group, however, due to assured irrigation resource endowment, substitution of cash crops like sugarcane and cotton for foodgrain crops has taken place.

Looking to the area shares of individual crops it is seen that jowar is the most important crop grown in rabi season. At the overall level, the area under jowar increased from 42 to

Table 5.12 : Proportion of Area Irrigated in Total Area Under Various Crops on Sample Farms in 1956-57 and 1970-71

(Percentages)

Crop	1956-57 Size Groups: Small	1956-57 Size Groups: Medium	1956-57 Size Groups: Large	1956-57 Overall	1970-71 Size Groups: Small	1970-71 Size Groups: Medium	1970-71 Size Groups: Large	1970-71 Overall
Jowar	34.86 (46.92)	14.55 (37.50)	14.75 (37.97)	16.76 (39.46)	29.85 (41.67)	30.33 (38.44)	25.33 (48.07)	27.15 (43.77)
Bajra	3.75 (3.70)	1.09 (1.56)	1.42 (2.96)	1.61 (2.73)	12.63 (12.50)	23.68 (11.73)	13.16 (10.21)	15.74 (11.03)
Wheat	69.23 (11.12)	78.13 (19.53)	44.44 (10.13)	59.38 (12.93)	65.00 (13.54)	87.50 (11.40)	60.00 (12.25)	68.00 (12.10)
Gram	14.29 (1.23)	36.36 (6.25)	20.37 (4.64)	25.00 (4.76)	28.57 (2.08)	50.00 (1.30)	22.22 (1.36)	28.57 (1.42)
Other cereals and pulses	-	9.09 (3.90)	10.09 (4.64)	7.94 (3.40)	19.05 (4.17)	16.22 (1.95)	17.28 (3.17)	17.02 (2.85)
Total cereals and pulses	21.61 (62.97)	14.15 (68.74)	10.83 (60.34)	11.56 (63.28)	25.63 (73.96)	31.79 (64.82)	24.04 (75.06)	26.28 (71.17)
Fruits and vegetables	100.00 (13.58)	100.00 (7.03)	100.00 (7.17)	100.00 (8.16)	77.78 (7.29)	94.44 (5.53)	81.82 (2.04)	85.71 (4.27)
Sugarcane	100.00 (6.17)	100.00 (7.04)	100.00 (9.28)	100.00 (8.16)	100.00 (6.25)	100.00 (17.27)	100.00 (13.38)	100.00 (13.88)
Groundnut	-	-	-	-	60.00 (3.12)	18.18 (1.30)	24.00 (1.36)	23.53 (1.42)
Cotton	75.00 (3.70)	62.50 (7.81)	21.95 (3.80)	35.00 (4.76)	71.43 (5.21)	68.00 (5.54)	86.11 (7.03)	78.26 (6.41)
Other crops	84.62 (13.58)	29.27 (9.38)	41.44 (19.41)	40.00 (15.64)	36.36 (4.17)	80.95 (6.54)	20.00 (1.13)	47.06 (2.85)
Total	29.89 (100.00)	18.23 (100.00)	15.56 (100.00)	17.86 (100.00)	30.48 (100.00)	40.13 (100.00)	28.77 (100.00)	32.26 (100.00)

(Figures in parentheses indicate the percentage shares of irrigated area under each crop in the gross irrigated area).

52 per cent of the gross cropped area during the period. There has also been an increase in the percentage area share of another rabi crop i.e., wheat from 3.89 to 5.74 per cent during the period. The increase in area under jowar and wheat has been possible partly because of substitution of jowar and wheat for gram and other miscellaneous non-food crops grown in rabi reason, partly due to reduction in the area under bajra which was kept fallow in kharif season and cultivated in rabi reason, and partly, due to double cropping, wherein cultivation of wheat after cotton was possible to some extent.

The other important foodgrain crop enterprise is bajra, which occupied 30 per cent of the gross cropped area in 195657 at the overall level. The crop, however, suffered due to downy mildew and ergot disease in subsequent years. Its share in gross cropped area was reduced to 22.62 per cent during the period. Similar set back has been observed in case of pulse crops.

Sugarcane, cotton, groundnut and fruits and vegetables are the important cash crops grown on the sample farms. At the overall level, the proportion of area under these crops in the gross cropped area increased from 6 to nearly 11 per cent during the period. The increase in area under cash crops has been more apparent in case of sugarcane as the proportion of area under this crop alone increased by 3 per cent.

Between the size-groups, the increase in area under fruits and vegetables, sugarcane and groundnut has been relatively high in case of the medium size group.

Table 5.12 presents a clear picture with regard to allocation of available irrigation resource to different crops grown on the farms. Different crops were grown under irrigated as well as rainfed conditions. The proportions of area irrigated in the total area under individual crops, however, varied considerably from crop to crop in both the years and between the size-groups. It may be noted that the type of irrigation provided for the crops like jowar, bajra, gram, other cereals and pulses and other miscellaneous crops like fodder was merely protective. These crops were irrigated during period of protracted drought. This irrigation, however, not only protected the crops but also, as could be seen in next chapter, helped in increasing the output of crops.

From the percentage shares of area irrigated of individual crops in the gross irrigated area, it is revealed that nearly 79 per cent of the gross irrigated area was under foodgrain crops and other miscellaneous crops in the year 1956-57. This proportion decreased to 74 per cent during the period under consideration, indicating thereby a larger proportion of gross irrigated area devoted to cash crops in the latter year. It is also evident from the table that the shifts in allocation of irrigation among the crops are more prominant in large size-groups.

5.9 Intensity of Cropping :

The creation of irrigation facilities on farms provided opportunities for multiple cropping. However, because of limited and scanty irrigation supply, there has been a limitation on the extent of double cropping. The details of intensity of cropping prevailing on the sample farms in the years 1956-57 and 1970-71 have already been presented in Table 5.4.

The intensity of cropping on the whole, increased from 107.16 per cent to 112.53 per cent during the period. Between the size groups there has been remarkable increase in the intensity of cropping in smaller size-groups. The intensity of cropping, which was around 107 per cent in case of the small and medium size groups in 1956-57 increased to 128 per cent and 118 per cent, respectively in 1970-71. In case of the large size group, the intensity of cropping remained almost unchanged during the period.

CHANGES IN RESOURCE USE STRUCTURE, COSTS AND RETURNS ON FARMS

Chapter 6

CHANGES IN RESOURCE USE STRUCTURE, COSTS AND RETURNS ON FARMS

There have been sufficient indications to show that the nature of Indian agriculture is undergoing a change in the recent years. By implication, changing agriculture means that at the micro level a farm is subjected to changes in resource use structure over a period of time in response to technical advancements, price changes, and agricultural infra-structure development in the region. The costs and returns of the farm business and individual crop enterprises are also influenced largely depending upon the degree of change taking place in the resource use structure at the farm level. The purpose of this chapter is, therefore, to analyse and better understand the changes in resource use structure, costs and returns on farms in the region over a period of time. Moreover the framework for analyzing changes in costs and returns at farm level, resulting from structural changes in resource use, must be delineated before one can examine changes in resource productivities and allocation efficiency in agriculture. Accordingly, an attempt has been made in this chapter to analyse in some detail the changes in resource use structure, costs and returns both for farm business as a whole as well as for individual crop enterprises on the selected farms in each of the three sample categories. It may be remembered here that as mentioned in Chapter 3 the costs and returns of the base year (i.e., 1956-57) have been inflated to those of the year 1970-71 in order to overcome the effects of price changes and to draw meaningful comparison.

6.1 Changes in Resource Use Structure :

The changes in profitability of farm business can be deduced from the changing relationship between the costs incurred in running the business and the returns accruing from it. In regard to changes in costs, prices remaining unchanged, these mostly stem from changes in the type of resources employed, the resource-mix and the extent of their employment. The primary focus of this section is, therefore, on structural changes in resource use for the crop production business as a whole and for individual crop enterprises as well.

6.1.1 Changes in Resource Use Structure for the Total Crop Production Business :

As mentioned earlier, the farms in the region were subjected to the influences of technological advancement and other external factors. As a result, there had been changes in the cropping pattern and method of cultivation of different crops. This might have led to changes in the resource use structure depending upon the extent of transformation at the farm level. These changes can be readily visualised by comparing the type of resource-mix employed on the sample farms at the two points of time. Accordingly, the utilization of different resources has been presented in Table 6.1 on per farm and per cropped hectare basis for the years 1956-57 and 1970-71 for all the three size-classes of the sample farms.

The figures given in Table 6.1 reveal that there have been structural adjustments in the pattern of resource use on

Table 6.1 : Per Farm and Per Cropped Hectare Resource Use Structure on Sample Farms in 1956–57 and 1970–71

Resource		1956–57			Overall	1970–71			Overall
		Small	Medium	Large		Small	Medium	Large	
Human labour (Man-days)	Per farm	187.73	338.18	611.06	376.08	281.34	535.01	739.80	518.71
	Per cropped hectare	69.27	48.17	40.12	45.70	89.31 (28.93)	69.94 (45.19)	48.26 (20.29)	59.55 (30.31)
Bullock labour (Pair-days)	Per farm	74.35	129.25	272.18	157.17	61.44	127.30	175.28	121.34
	Per cropped hectare	27.44	18.41	17.87	19.10	19.50 (-20.94)	16.64 (-9.63)	11.43 (-36.04)	13.93 (-27.07)
Farm yard manure (cart-loads)	Per farm	8.60	20.62	30.22	19.68	6.68	11.25	23.45	13.80
	Per cropped hectare	3.18	2.94	1.98	2.39	2.12 (-33.33)	1.47 (-50.00)	1.53 (-32.73)	1.58 (-33.89)
Fertilizer (kg)	Per farm	4.78	15.26	5.88	8.68	52.75	256.59	302.51	203.85
	Per cropped hectare	1.76	2.17	0.39	1.05	16.75 (851.70)	33.54 (1445.62)	19.73 (4958.97)	23.40 (2128.57)

(Figures in parentheses indicate percentage variation on per cropped hectare basis).

the farms. At the overall level, the per cropped hectare use of human labour has increased by over 30 per cent (i.e., from 45.70 to 59.55 man-days) during the period. The reason for more human labour use in the latter period was the change in cropping pattern associated with intensive cultivation practices adopted on the sample farms. In fact, transforming agriculture should have caused the substitution of capital for labour. However, the type of transformation that has taken place at the farm level exhibited more or less the low stages of economic development characterised with large supply of labour at low price. As discussed in Chapter 5, it is also true that because of limited scope for off-farm employment the work force on the farms has increased during the period. The cumulative effect of all these factors was seen in increased use of human labour on the sample farms.

The per cropped hectare use of bullock labour, however, has decreased during the period. At the overall level, the per cropped hectare use of bullock labour decreased from 19.10 to 13.93 pair-days (i.e., by 27 per cent) mainly because of the energization of irrigation wells with oil engines and electric motors. The energization of irrigation wells must have released some bullock labour required for lifting water from wells causing thereby substitution of pump-sets for bullock labour to some extent.

As for the use of farm yard manure and fertiliser resources, it is seen that, at the overall level, the use of farm yard manure has decreased almost by 34 per cent from 2.39 cart-loads per cropped hectare and that of fertiliser has increased by twenty-one times during the periods. The farm yard manure, now-a-days, has become a scarce commodity and its supply is inelastic, and therefore, farms have to depend more on farm produced farm yard manure and purchased fertilisers for obtaining better crop yields. The increased use of fertiliser resource not only indicates substitution of organic manure by inorganic plant nutrients but also the response of the farms to new farm technology during the latter period.

As between the farms in different size-classes, the per farm use of different resources, generally speaking, increased with the increase in farm size during both the period. When compared on per cropped hectare basis, it was observed that excepting for fertiliser resource, the use of all other resources decreased as the farm size increased. The per cropped hectare consumption of fertiliser was relatively higher on the farms in the medium size-class as compared to the other two size-classes. It is also true that the structural changes in the use of resources in the individual size-classes were of the type observed at the overall level. However, the extent of change in the use of individual resources varied considerably between the farms in different size classes. Whereas, the per cropped hectare use of human labour increased by 28.93 per cent and 20.29 per cent and that of bullock labour decreased by 20.94 per cent and 36.04 per cent on the farms in the small and large size-classes respectively, the use of these respective resources increased and decreased by 45.19 per cent and 9.63 per cent on the farms in the medium size-class during the period. This shows that the farms in the medium size-class have tended to become more labour intensive as compared to the farms in the other two size-classes.

Table 6.2 gives a further idea of the structural adjustments in the resource use on the farms, in that it depicts the proportions of owned or farm produced and hired or purchased resources employed on the farms during both the time periods. In both the time periods family labour was supplemented with hired labour whenever necessary and there was very little change in the pattern of employment of family and hired labour at the overall level. The proportion of family human labour decreased by only 2 per cent from 71 per cent while that of owned bullock labour remained almost the same at 94 per cent during the period. There has, however, been a major shift in the use of farm yard manure. Because of high cost and non-availability of manure, the farms had to depend solely on farm produced manure for its requirement during the latter period.

It is further observed that during both the time periods, the large farms tended to produce with a higher proportion of hired human labour and lower proportions of hired bullock labour and purchased farm yard manure than did the small farms. The decreasing proportions of owned human labour on larger sized farms during both the time periods indicate general preponderance

Table 6.2 : Proportions of Owned or Farm Produced and Hired or Purchased Inputs in Total Inputs Used on Sample Farms in 1956-57 and 1970-71

(Percentages)

Resource	Owned/Hired or purchased	1956-57 Small	1956-57 Medium	1956-57 Large	Overall	1970-71 Small	1970-71 Medium	1970-71 Large	Overall
Human labour	Owned	74.71	81.84	63.43	70.92	85.58	76.57	65.48	72.93
	Hired	25.29	18.16	36.57	29.08	14.42	23.43	34.52	27.07
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Bullock labour	Owned	92.46	97.34	93.40	94.29	90.87	91.83	98.25	94.76
	Hired	7.54	2.66	6.60	5.71	9.13	8.17	1.75	5.24
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Seed	Owned	90.61	87.37	86.53	87.53	81.07	72.32	78.53	76.90
	Purchased	9.39	12.63	13.47	12.47	18.93	27.68	21.47	23.10
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Farm yard manure	Farm produced	65.41	58.84	90.40	75.73	100.0	99.32	100.00	100.00
	Purchased	34.59	41.16	9.60	24.27	-	0.68	-	-
	Total	100.00	100.00	100.00	100.00	100.0	100.00	100.00	100.00

of hired labour use in preference to use of family labour. At the same time, it is also true that the increased demand for human labour in the latter period has been largely met with through increased use of family labour.

6.1.2 Changes in the Resource Use Structure For Individual Crop Enterprises :

Tables 6.3 and 6.4 further demonstrate how the structural adjustments in resource use took place on the sample farms during the period in producing irrigated and unirrigated crops, respectively. As seen from Table 6.3, the human labour required to produce a hectare of irrigated jowar, sugarcane, unirrigated wheat and unirrigated gram has declined substantially (by about 10 to 30 per cent) during the period, while for irrigated cotton, unirrigated jowar, unirrigated bajra and unirrigated groundnut has increased by about 4 to 32 per cent. In case of irrigated wheat, the use of human labour per hectare has remained more or less the same during the period.

As for bullock labour, it is seen that the per hectare use of this resource has declined substantially for all the crop enterprises. The decline in the use of bullock labour is observed to be relatively more in case of the irrigated crop enterprises. The bullock labour required to produce a hectare of jowar, wheat, sugarcane and cotton grown under irrigated conditions has declined by about 30 to 59 per cent during the period. On the contrary, the per hectare use of bullock labour has declined by about 1 to 10 per cent for all the rainfed

Table 6.3 : Per Hectare Utilization of Different Farm Resources for the Crop Enterprises Produced Under Irrigated Conditions on Sample Farms in 1956-57 and 1970-71

Crop	Year	Human Labour (Man-days)	Bullock Labour (Pair-days)	Seed* (kg)	Farm Yard Manure (cart-loads)	Fertili-ser (kg)
Jowar	1956-57	77.02	31.96	11.31	2.56	-
	1970-71	62.35 (-19.05)	17.15 (-46.34)	10.89 (-3.71)	2.61 (1.95)	2.46
Bajra	1956-57	-	-	-	-	-
	1970-71	43.55	15.81	6.08	2.31	4.76
Hybrid Bajra	1956-57	-	-	-	-	-
	1970-71	52.18	15.15	4.98	1.67	30.95
Wheat	1956-57	93.05	47.18	65.33	2.99	-
	1970-71	93.65 (0.64)	25.79 (-45.34)	58.92 (-9.81)	3.07 (2.68)	28.02
Sugarcane-planted	1956-57	275.83	43.78	4.18	28.96	173.01
	1970-71	195.98 (-28.95)	17.81 (-59.32)	5.00 (19.62)	12.47 (-56.94)	386.32 (123.29)
Cotton	1956-57	118.47	30.75	8.61	7.05	10.71
	1970-71	156.89 (32.43)	21.56 (-29.89)	8.05 (-6.50)	5.82 (-17.45)	59.46 (455.18)

(Figures in parentheses indicate percentage variation during the period).

* Seed input in case of sugarcane is measured in tonnes.

crops excepting wheat in whose case the decline was as high as 56 per cent. The reason for this substantial decline in the use of bullock labour in producing irrigated crops may be found in the substitution of pump-sets for bullock labour used for irrigation purpose.

With regard to seed rate, it is seen that the same has declined during the period by about 3 to 10 per cent for crops such as jowar, wheat and cotton grown under irrigated conditions and gram and groundnut grown under rainfed conditions. In contrast, there has been a tendency to use a higher seed rate for the rainfed crops such as jowar, bajra and wheat in order to ensure against the uncertainty of rainfall.

The use of farm yard manure has been observed to be relatively more in case of cash crops such as sugarcane, cotton and groundnut during both the periods. However, because of limitations on the supply of farm yard manure, its use in producing these crops has declined substantially (by about 17 to 57 per cent) during the period. In case of the other crop enterprises where the use of farm yard manure was already at a lower level, there has been no effect of limited supply of this resource.

As for the fertilizer resource, it is seen that its use was selective during both the periods. In the year 1956-57, the use of fertiliser resource was restricted to only high pay of crops such as sugarcane and cotton. During the latter period, as the fertilizer technology became known, there has been an

Table 6.4 : Per Hectare Utilization of Different Farm Resources for the Crop Interprises Produced Under Unirrigated Conditions on Sample Farms in 1956-57 and 1970-71

Crop	Year	Human Labour (Man-days)	Bullock Labour (Pair-days)	Seed (kg)	Farm Yard Manure (Cart-loads)	Fertilizer (kg)
Jowar	1956-57	24.76	11.38	7.66	1.18	-
	1970-71	28.50	11.32	9.85	1.65	-
		(15.11)	(-0.53)	(28.59	(39.83)	
Bajra	1956-57	31.02	11.27	7.66	1.16	-
	1970-71	32.18	10.26	8.42	1.64	-
		(3.74)	(-8.96)	(9.92	(41.38)	
Wheat	1956-57	34.17	24.34	48.54	0.98	-
	1970-71	26.13	11.17	52.42	2.13	-
		(-29.65)	(-56.11)	(7.99)	(117.35)	
Gram	1956-57	26.94	11.20	53.65	1.71	-
	1970-71	24.30	10.95	48.03	1.14	-
		(-9.80)	(-2.23)	(-10.48)	(-33.33)	
Groundnut	1956-57	51.39	17.81	74.79	5.46	-
	1970-71	67.36	16.42	73.18	3.75	5.87
		(31.08)	(-7.80)	(-2.15	(-31.32)	

(Figures in parentheses indicate percentage variation during the period).

increasing tendency to apply fertilizers to other crops. However, even in the year 1970-71 the use of fertilizers was restricted only to those crop enterprises produced under irrigated conditions. The use of fertilizers was totally absent in case of all the rainfed crops excepting groundnut. The main reason for not using fertilizers in producing rainfed crops is obviously the scanty and irregular rainfall received in the region. Looking to the quantum of fertilizers used for producing a hectare of different crop enterprises it is seen that there existed a great variability in allocating fertilizer resource among different crops. The allocation of fertilizer resource among different crops seems to have been governed more by productivity and output price expectations rather than any other considerations.

It is further observed that excepting for seed resource, the per hectare use of all other resources was relatively higher for the crop enterprises produced under irrigated conditions than that for rainfed crop enterprises during both the time periods.

6.2 Changes in Costs Structure on the Sample Farms :

The structural adjustments in the use of resources bring about changes in the total cost structure to the extent to which these adjustments take place at the farm level. The quantum and proportions of out-of-pocket expenses and imputed costs in the total cost structure either increase or decrease depending upon changes in the use of different resources and substitution of one form of resource for another. The proportion of cash expenditure in the total cost of production of different crop enterprises also increases as, in the process of transformation, farms depend more on purchased resources and less on owned or farm produced resources.

From the earlier discussion, it is evident that during the period under reference there have been structural adjustments in the use of resources for the farm business as a whole as well as in producing individual crop enterprises. It is, therefore, proposed to examine in detail the economic impact of these structural adjustments on the cost structure of the farms.

6.2.1 Changes in Costs Structure of Total Crop Production Business :

Table 6.5 presents per farm and per cropped hectare cost of cultivation at different cost levels (i.e., Cost A1, Cost A2, Cost B and Cost C whose description is given in Appendix IV) together for all the crop enterprises grown on the sample farms in the years 1956-57 and 1970-71. The table also includes the per farm and per cropped hectare actual cash expenditure incurred in producing crops (i.e., monetization of inputs) on the farms during both the periods.

A close examination of these figures reveals the economic impact of the structural adjustments of resource use on the cost structure of the sample farms. At the overall level, the total cost of cultivation per farm (i.e., Cost C)

Table 6.5 : Per Farm and Per Cropped Hectare Cost of Cultivation of Crops on Sample Farms in 1956-57 and 1970-71

(Rupees)

Cost		1956-57 Small	Medium	Larger	Overall	1970-71 Small	Medium	Large	Overall	% change during the period at over-all level
Cost A1	Per farm	970.23	1843.58	3301.49	2022.57	1003.10	2660.20	4003.23	2555.68	26.36
	Per cropped hectare	358.02	262.61	216.77	245.75	318.44	347.73	261.14	293.42	19.40
		(53.30)	(49.59)	(56.57)	(53.71)	(47.17)	(51.00)	(56.74)	(53.25)	
Cost A2	Per farm	989.40	1929.48	3519.92	2129.02	-	-	-	-	-
	Per cropped hectare	365.09	274.85	231.11	258.68	-	-	-	-	-
		(54.35)	(51.90)	(60.31)	(56.54)	-	-	-	-	-
Cost B	Per farm	1490.85	3066.95	4926.00	3139.13	1627.19	4247.14	5854.52	3909.79	24.55
	Per cropped hectare	550.13	436.89	323.44	381.42	516.57	555.18	381.90	448.89	17.69
		(81.90)	(82.50)	(84.40)	(83.36)	(76.52)	(81.42)	(82.98)	(81.46)	
Cost C	Per farm	1820.41	3717.29	5836.81	3765.85	2126.36	5216.30	7055.05	4799.41	27.45
	Per cropped hectare	671.74	529.53	383.24	457.57	675.03	681.37	460.21	551.03	20.43
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	
Moneti-zation of inputs	Per farm	303.68	648.77	1312.43	747.99	342.34	1230.73	1889.56	1154.21	54.31
	Per cropped hectare	112.06	92.42	86.17	90.89	108.68	160.28	123.26	132.52	45.80
		(16.68)	(17.45)	(22.48)	(19.86)	(16.10)	(23.5[illegible])	(26.78)	(24.05)	

(Figures in parentheses are percentages to Cost 'C' per cropped hectare).

increased from Rs. 3765.85 to Rs. 4799.41, which is a little over 27 per cent, during the period. On per cropped hectare basis this increase was 20.43 per cent from Rs. 457.57. The cost of cultivation at Cost A1, and Cost B levels increased by 26.36 and 24.55 per cent on per farm basis and by 19.40 and 17.69 per cent on per cropped hectare basis, respectively. The increase in cost of cultivation at Cost B level was thus relatively lesser than that of Cost A1 and Cost C. The tendency of Cost A1 and Cost C to increase at a faster rate than Cost B indicates the fact that during the period under reference variable costs bypassed the rate of growth of fixed costs. Looking to the proportions of Cost A1 and Cost B in the total cost, it is further observed that the proportion of Cost A1 in the total cost remained more or less the same around 53.50 per cent, whereas that of Cost B declined from 83.36 per cent to 81.46 per cent. The proportion of cash expenditure in the total cost has, however, increased from 19.86 per cent to 24.05 per cent. The per cropped hectare cash expenditure has increased substantially by about 46 per cent during the period.

As for the individual size classes, the data reveal that per farm as well as per cropped hectare cost of cultivation at different cost levels has increased in all the size-classes of farms during the period. From the intra-farm comparison it is observed that the per farm cost of cultivation of crops increased with the increase in farm size in both the years. The comparison of cost of cultivation of crops on per cropped hectare basis,however, gives a different picture, in that in the year 1956-57 the per cropped hectare cost of cultivation of crops at different cost levels declined continuously as the farm size increased, indicating thereby certain economies of scale. In the year 1970-71, however, the per cropped hectare cost of cultivation of crops increased from small to medium size classes and again declined for the large size class where these costs were still lesser than those of small size-class. The cost of cultivation of crops seems to have increased relatively at a faster rate in the medium size-class as compared to the other two size-classes. So far as per farm and per cropped hectare cash expenditure on crop production are concerned, the trends were of the similar order as observed for the cost of cultivation. However, the proportions of cash expenditure in the total cost increased with the increase in farm size during both the periods.

In order to get a clear idea about the changes in item-wise cost of cultivation, the break-up of total cost of cultivation is given in Appendix X and Appendix XI on per farm and per cropped hectare basis, respectively. The proportions of individual items of cost in the total cost are, however, set out in Table 6.6.

It can be seen from Appendix X that at the overall level, the per farm cost on account of all the items of cost excepting farm yard manure was higher in the year 1970-71 as compared to that of 1956-57. By and large, this was true for the individual size-classes also. It is, however, interesting to note that in

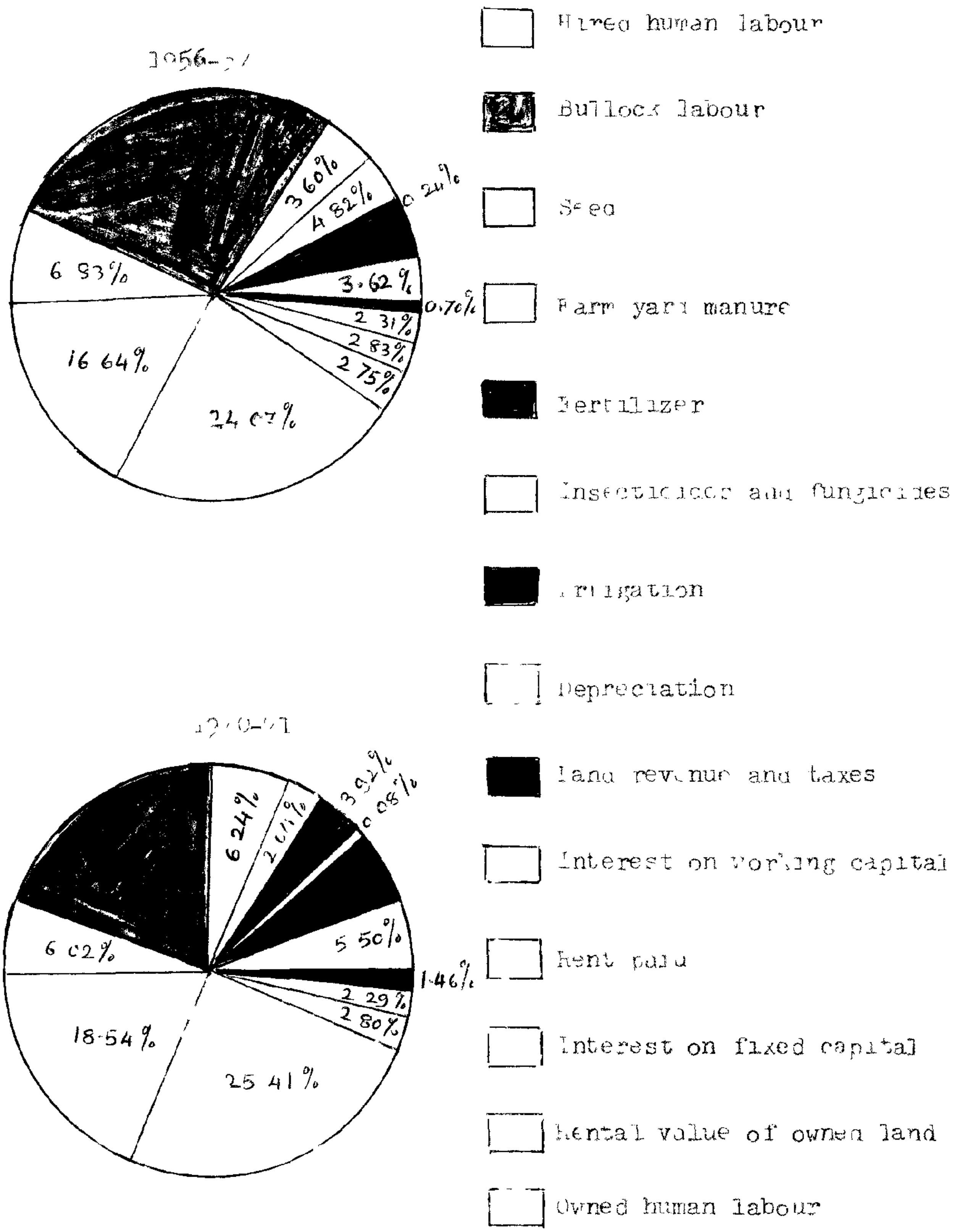
Table 6.6 : Percentage Shares of Different Items of Cost in the Total Cost of Cultivation of Crops on Sample Farms in 1956-57 and 1970-71

(Percentages)

Item of Cost	1956-57				1970-71			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Hired human labour	6.13	3.88	9.00	6.83	3.90	5.03	7.39	6.02
Bullock labour	30.95	26.36	26.78	27.32	21.07	17.38	19.94	19.18
Seed	4.09	3.08	3.79	3.60	4.80	5.34	7.35	6.24
Farm yard manure	4.36	5.11	4.77	4.82	3.08	2.33	2.76	2.64
Fertiliser	0.28	0.43	0.11	0.24	2.04	4.95	3.71	3.92
Insecticides & fungicides	-	-	-	-	0.07	0.06	0.08	0.08
Irrigation	2.03	4.64	4.74	4.27	4.26	6.67	5.87	5.92
Depreciation	2.62	2.85	4.46	3.62	5.07	5.48	5.63	5.50
Land revenue & taxes	0.54	1.10	0.48	0.70	0.85	1.56	1.57	1.46
Interest on working capital	2.30	2.14	2.44	2.31	2.03	2.20	2.44	2.29
Rent paid	1.05	2.31	3.74	2.83	-	-	-	-
Interest on fixed capital	2.33	2.56	3.02	2.75	3.29	3.11	2.43	2.80
Rental value of owned land	25.22	28.04	21.07	24.07	26.06	27.31	23.81	25.41
Owned human labour	18.10	17.50	15.60	16.64	23.48	13.58	17.02	18.54
Total cost i.e., Cost C	100.00 (1820.41)	100.00 (3717.29)	100.00 (5836.81)	100.00 (3765.85)	100.00 (2126.36)	100.00 (5216.30)	100.00 (7055.05)	100.00 (4799.41)

(Figures in parentheses are the per farm total cost of production of crops).

COMPOSITION OF TOTAL COST OF CULTIVATION OF CROPS ON [illegible] FARMS IN 1956-57 AND 1970-71



the year 1956-57 there was no expenditure of any kind on account of insecticides and fungicides, while the item of rent paid for rented-in land was totally absent in the year 1970-71. Besides, the per farm costs on individual items showed, in general, increasing trend over the size-classes in both the years.

When compared on per cropped hectare basis, Appendix XI reveals that excepting for expenditure on bullock labour and farm yard manure, the expenditure on all other items of cost was higher in the year 1970-71 as compared to that of 1956-57; indicating thereby the tendency of the farms to modernize agriculture. The intra-size-class comparison indicates that the per cropped hectare expenditure on various items declined, in general, in 1956-57 with the increase in farm size. In the year 1970-71, however, the per cropped hectare expenditure on several items increased from small to medium size-classes and thereafterwards declined for the large size-class.

Looking to the data given in Table 6.6 it is observed that at the overall level, the proportions of expenditure on the items like hired human labour, seed, fertiliser, insecticides and fungicides, irrigation, depreciation, land revenue and taxes, rental value of owned land and owned human labour in the total cost have increased during the period. As against this, there has been decrease in the proportions of expenditure on bullock labour, rent paid on rented-in land and farm yard manure in the total cost. The proportions of interest on working capital and interest on fixed capital in the total cost have remained more or less same during the period. As for the individual size classes, the proportions of individual items of cost in the total cost varied in the manner similar to that observed at the overall level. The intra-size-class comparison, however, did not show any specific trends with regard to the proportions of individual items of cost in the total cost during both the periods.

6.2.2 Changes in Cost Structure of Individual Crop Enterprises :

The discussion in the preceding paragraphs has made it clear that during the period under reference there have been changes in the cost structure of the crop production business of the sample farms commensurate with the structural adjustments in the use of farm resources. It will be of some interest to understand what crop enterprises in particular did contribute to these changes during the period. The per hectare costs of cultivation of different crop enterprises grown under irrigated and rainfed conditions are given in Tables 6.7 and 6.8, respectively for both the years.

The data presented in Tables 6.7 and 6.8 reveal that excepting the jowar crop grown under irrigated conditions, the per hectare cost of cultivation of all the crops has increased during the period. The per hectare cost of cultivation of these crops increased by 10.51 to 108.27 per cent during the period, the lowest and the highest being, respectively, for groundnut crop grown under rainfed conditions and cotton crop grown under

Table 6.7 : Per Hectare Cost of Cultivation of Different Crop Enterprises Produced Under Irrigated Conditions on Sample Farms in 1956-57 and 1970-71

(Rupees)

Crop	Year	Cost A1	Cost A2	Cost B	Cost C	Monetisation of inputs	% change in cost C during the period
Jowar	1956-57	304.81 (51.02)	320.13 (53.58)	478.85 (80.15)	597.74 (100.00)	146.01 (24.43)	-
	1970-71	243.99 (44.07)	-	448.66 (81.05)	553.59 (100.00)	78.89 (14.25)	-7.39
Bajra	1956-57	-	-	-	-	-	-
	1970-71	236.94 (54.90)	-	372.32 (86.27)	431.56 (100.00)	85.34 (19.77)	-
Hybrid Bajra	1956-57	-	-	-	-	-	-
	1970-71	288.26 (53.30)	-	444.03 (82.10)	540.85 (100.00)	168.63 (31.18)	-
Wheat	1956-57	336.72 (50.00)	359.20 (53.34)	525.60 (78.04)	673.47 (100.00)	151.58 (22.51)	-
	1970-71	455.31 (54.92)	-	665.03 (80.22	828.97 (100.00)	203.03 (24.49)	23.09
Sugarcane-planted	1956-57	1666.72 (65.09)	-	2103.57 (82.16)	2560.46 (100.00)	998.64 (39.00)	-
	1970-71	2185.83 (68.39)	-	2775.60 (86.85)	3195.96 (100.00)	1936.17 (60.58)	24.82
Cotton	1956-57	231.04 (44.43)	-	412.04 (79.23)	520.06 (100.00)	127.02 (24.42)	-
	1970-71	562.41 (51.93)	-	758.05 (69.99)	1083.11 (100.00)	344.71 (31.83)	108.27

(Figures in parentheses are the percentages to Cost C).

Table 6.8 : Per Hectare Cost of Cultivation of Different Crop Enterprises Produced Under Unirrigated Conditions on Sample Farms in 1956-57 and 1970-71

(Rupees)

Crop	Year	Cost A1	Cost A2	Cost B	Cost C	Monetisation of inputs	% change in cost C during the period
Jowar	1956-57	107.24 (42.42)	125.91 (49.81)	211.67 (83.74)	252.78 (100.00)	57.93 (22.92)	-
	1970-71	141.28 (41.73)	-	286.27 (84.55)	338.59 (100.00)	26.95 (7.96)	33.95
Bajra	1956-57	130.53 (45.46)	136.65 (47.59)	237.43 (82.69)	287.13 (100.00)	48.37 (16.85)	-
	1970-71	131.24 (39.82)	-	275.00 (83.44)	329.57 (100.00)	35.35 (10.73)	14.78
Wheat	1956-57	251.50 (51.18)	289.62 (58.93)	412.48 (83.93)	491.45 (100.00)	89.58 (18.22)	-
	1970-71	270.26 (48.99)	-	469.67 (85.14)	551.67 (100.00)	83.08 (15.06)	12.25
Gram	1956-57	133.34 (40.93)	149.63 (45.93)	255.07 (78.30)	325.78 (100.00)	31.37 (9.63)	-
	1970-71	179.23 (45.74)	-	359.86 (91.83)	391.88 (100.00)	35.23 (8.99)	20.29
Groundnut	1956-57	381.23 (62.05)	389.38 (63.37)	540.91 (88.03)	614.43 (100.00)	154.38 (25.13)	-
	1970-71	409.43 (60.30)	-	609.03 (89.70)	678.98 (100.00)	169.73 (25.00)	10.51

(Figures in parentheses are percentages to Cost C).

irrigated conditions. It is further observed that in case of foodgrain crops, the per hectare cost of cultivation has increased by about 12 to 33 per cent, whereas in case of high-paying crops such as sugarcane and cotton this increase was by about 48 and 108 per cent, respectively. The per hectare cost of cultivation of jowar crop grown under irrigated conditions has, in fact, declined by more than 7 per cent during the period. Based on the relative changes in the per hectare cost of cultivation of different crop enterprises it may be said that during the period under reference, the farms in general have responded to high paying crops not only by way of increasing acreages under these crops but also through increased use of different resources for obtaining higher yields.

6.3 Changes in Gross Returns and Output on the Farms :

The structural adjustments in the use of resources not only bring about changes in the cost structure but also the output and gross returns of crop enterprises are equally influenced to the extent to which such adjustments take place at the farm level. Moreover, the process of structural adjustments in the use of resources is based, among other factors, on the changing nature of productivities of individual resources, since the latter call for further improvements in the allocation of resources leading to increased output and gross returns on the farms. The changes in output and gross returns resulting from the structural adjustments in the use of farm resources over a period of time, therefore, provide indications of the nature of transforming agriculture in the region. An attempt is, therefore, made to analyse the changes in gross returns and output of the crop production business of the sample farms.

6.3.1 Changes in Gross Returns of the Sample Farms :

Table 6.9 presents the per farm and per cropped hectare gross returns from crop production business for the years 1956-57 and 1970-71 for all the three categories of sample farms. At the overall level, the per farm gross returns have increased by about 54 per cent (i.e., from Rs. 4244.19 to Rs. 6547.41) during the period. On per cropped hectare basis, the gross returns increased by about 46 per cent from Rs. 515.70. It is seen from Table 6.5 that at the overall level, the per farm total cost of cultivation of all the crops increased by 27.45 per cent during the same period. That means the structural adjustments in the use of resources have resulted in more than proportionate increase in gross returns on the sample farms.

Table 6.9 : Per Farm and Per Cropped Hectare Gross Returns from Crop Production Business of Sample Farms in 1956-57 and 1970-71

(Rupees)

Size Groups	Gross returns per farm		Percentage change	Gross returns per cropped hectare		Percentage change
	1956-57	1970-71		1956-57	1970-71	
Small	1762.50	2267.32	28.64	650.37	719.78	10.67
Medium	4251.99	6610.36	55.47	605.70	864.10	42.66
Large	6813.24	10764.56	57.99	447.36	702.19	56.96
Overall	4244.19	6547.41	54.27	515.70	751.71	45.76

As for the individual size-classes of farms, it is revealed from the table that the percentage changes in the per farm and per cropped hectare gross returns varied considerably over the size-classes. The per farm gross returns increased by 28.64 per cent, 55.47 per cent and 57.99 per cent in the small, medium and large size-classes, respectively during the period, indicating thereby the tendency of gross returns to increase more than proportionately with the increase in farm size. It is further observed that the per farm gross returns increased with the increase in farm size during both the years. The gross returns per cropped hectare, however, declined from Rs. 650.37 to Rs. 447.36 with the increase in farm size in the year 1956-57. In the year 1970-71 the same increased from Rs. 719.78 to Rs. 864.10 from small to medium size-classes and then declined to Rs. 702.19 for the large size-class. The well-known inverse relationship between farm size and per hectare gross returns of the 'fiftees thus seems to have been altered to some extent in the early 'seventies, particularly in the first two size-classes of the sample farms.

6.3.2. Changes in the Output and Gross Returns of the Individual Crop Enterprises :

From the data presented in Tables 6.10 and 6.11 in respect of per hectare output and gross returns and cost of production per unit of output of different crop enterprises produced in both the years under irrigated and rainfed conditions, respectively, it is revealed that the per hectare output

Table 6.10 : Per Hectare Output and Gross Returns of Different Crop Enterprises Produced Under Irrigated Conditions on Sample Farms in 1956-57 and 1970-71

Crop	Year	Output of main product (Quintals)	Value of main product (Rupees)	Value of by product (Rupees)	Gross value of production (Rupees)	Per Quintal total cost of production (Rupees)
Jowar	1956-57	6.27	506.99	197.81	704.80	68.57
	1970-71	7.21 (14.99)	583.00	181.80	764.80 (8.51)	58.53
Bajra	1956-57	-	-	-	-	-
	1970-71	4.39	405.83	152.15	557.98	71.50
Hybrid Bajra	1956-57	-	-	-	-	-
	1970-71	10.21	779.86	147.87	927.73	44.53
Wheat	1956-57	6.03	614.37	17.26	631.63	108.64
	1970-71	11.37 (88.56)	1123.77	30.72	1160.53 (83.74)	70.60
Sugarcane-planted	1956-57	59.70	5671.50	90.00	5761.50	42.22
	1970-71	72.84 (22.01)	6919.80	108.00	7027.80 (21.98)	43.20
Cotton	1956-57	3.18	640.55	27.60	668.15	156.79
	1970-71	7.56 (137.74)	1657.09	45.80	1702.89 (154.87)	139.41

(Figures in parentheses indicate percentage variation during the period).

Table 6.11 : Per Hectare Output and Gross Returns of Different Crop Enterprises Produced Under Unirrigated Conditions on Sample Farms in 1956-57 and 1970-71

Crop	Year	Output of main product (Quintals)	Value of main product (Rupees)	Value of by product (Rupees)	Gross value of production (Rupees)	Per Quintal total cost of production (Rupees)
Jowar	1956-57	2.07	139.46	102.24	241.70	70.46
	1970-71	2.23 (7.73)	157.47	127.20	284.67 (17.78)	83.99
Bajra	1956-57	1.51	83.13	96.45	179.58	88.02
	1970-71	3.03 (100.66)	226.72	120.27	346.99 (93.22)	71.07
Wheat	1956-57	2.95	279.44	22.43	301.87	154.22
	1970-71	4.12 (39.66)	393.89	23.32	417.21 (38.21)	126.42
Gram	1956-57	2.62	224.76	42.96	267.72	104.39
	1970-71	2.32 (-11.45)	201.84	28.94	230.78 (-13.80)	147.73
Groundnut	1956-57	5.06	749.42	152.80	902.22	100.86
	1970-71	6.78 (33.99)	1005.86	140.26	1146.12 (27.03)	87.89

(Figures in parentheses indicate percentage variation during the period).

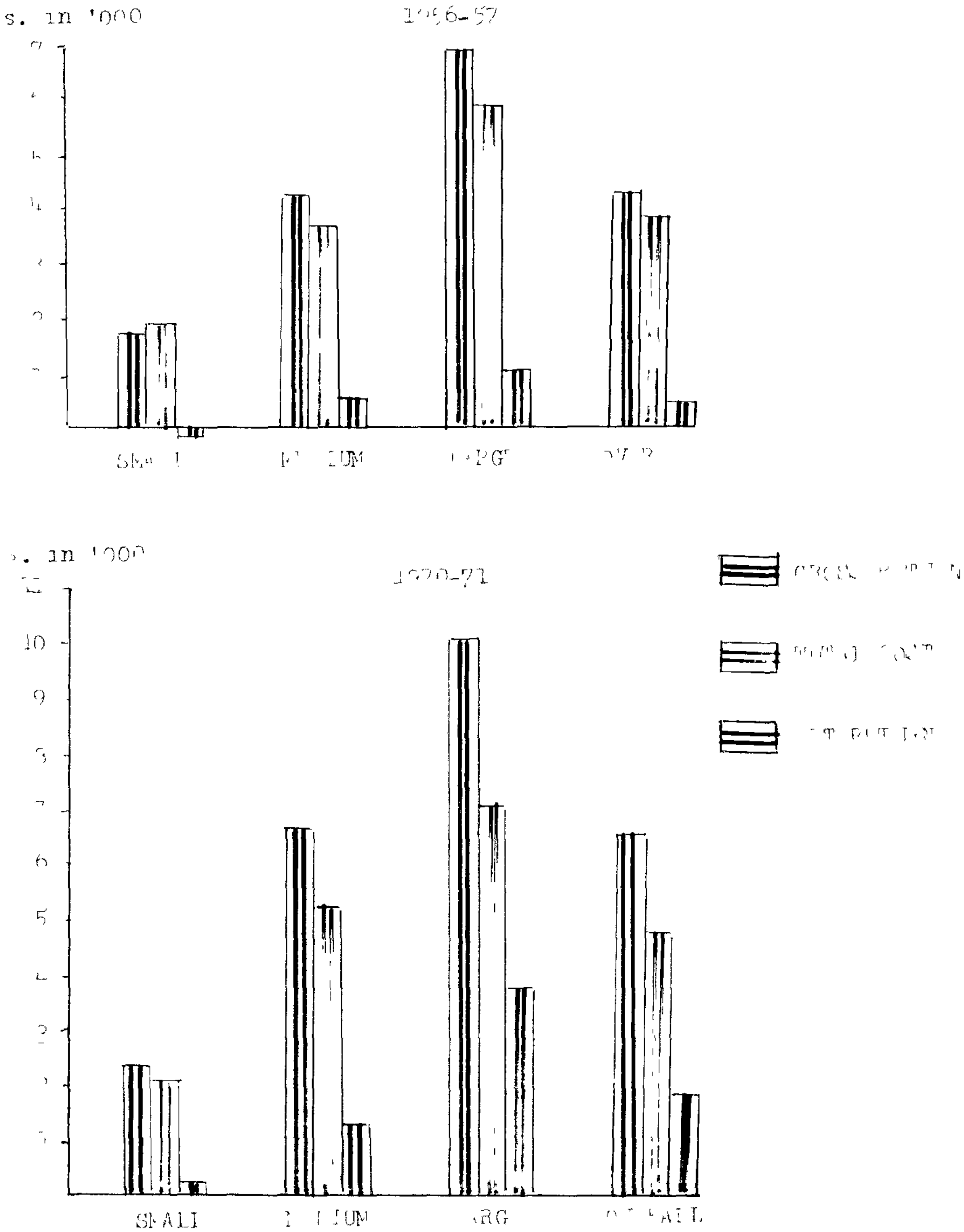
as well as gross returns of all the crop enterprises, excepting gram, have increased during the period. The rate of increase, however, varied considerably among the crop enterprises. The productivity of the crop enterprises produced under irrigated conditions seems to have been increased at a faster rate than that of the crop enterprises produced under rainfed conditions.

Looking to the cost of production per unit of output of different crop enterprises, it is observed that the same has declined consistently during the period for the crop enterprises such as jowar, wheat and cotton produced under irrigated conditions and bajra, wheat and groundnut produced under rainfed conditions. The cost of production per unit of output of jowar and gram crop enterprises produced under rainfed conditions has, however, increased during the period; whereas that of sugarcane has remained more or less unchanged.

6.4 Changes in Net Returns on the Sample Farms :

It is clear from the earlier discussion that there has been simultaneous increase in gross returns alongwith increased cost of cultivation on the farms resulting from the structural adjustments in the use of farm resources during the period. The gross returns have, however, increased more than proportionately as compared to the increase in the cost of cultivation of the crops. The very fact, that gross returns increase at a faster rate than cost of cultivation does, indicates that the structural adjustments in the use of farm resources have contributed

TOTAL COST OF CULTIVATION, [illegible]
CROP PRODUCTION [illegible]



to increased profitability of crop production business on the sample farms. This section is, therefore, devoted to observe and explain the changes in net returns of total crop production business and individual crop enterprises during the period.

6.4.1 Changes in Net Returns of Total Crop Production Business :

Table 6.12 shows the per farm and per cropped hectare net returns from the total crop production business for both the years. Here the net returns themselves are of four types; (i) farm business income, (ii) family labour income, (iii) net income, and (iv) farm investment income. A close examination of this table reveals that the per farm as well as per cropped hectare net returns of all the four types have increased significantly during the period in all the size-classes of the sample farms. At the overall level, the per cropped hectare farm business income, family labour income, net income and farm investment income have increased by 78.31 per cent, 125.51 per cent, 245.23 per cent and 96.91 per cent, respectively. As for the individual size-classes, the increase in net returns was relatively more in the large size-class followed by medium size-class in respect of farm business income and farm investment income and by small size-class in respect of family labour income and net income. This shows that the profitability of crop production business of the large size-class has increased relatively at a faster rate during the period as compared to that of small and medium size-classes.

Table 6.12 : Per Farm and Per Cropped Hectare Farm Business Income, Family Labour Income, Net Income and Farm Investment Income From Crop Production Business of Sample Farms in 1956-57 and 1970-71

(Rupees)

Income		1956-57				1970-71			
		Small	Medium	Large	Overall	Small	Medium	Large	Overall
Farm Business income	Per farm	773.10	2322.51	3293.32	2115.17	1264.22	3950.16	6761.33	3991.73
	Per cropped hectare	285.28	330.85	216.25	257.02	401.34	516.37	441.05	458.29
						(40.68)	(56.07)	(103.95)	(78.31)
Family labour income	Per farm	271.65	1185.04	1887.24	1105.06	640.13	2363.22	4910.04	2637.62
	Per cropped hectare	100.24	168.81	123.92	134.28	203.31	308.92	320.29	302.82
						(102.82)	(83.00)	(158.47)	(125.51)
Net income	Per farm	-57.91	534.80	976.43	478.34	140.96	1394.06	3709.51	1748.00
	Per cropped hectare	-21.37	76.17	64.12	58.13	44.75	182.23	241.98	200.68
						(209.41)	(139.24)	(277.39)	(245.23)
Farm investment income	Per farm	443.54	1672.17	2382.51	1488.45	765.05	2981.00	5560.80	3102.11
	Per cropped hectare	163.67	238.21	156.45	180.87	242.28	389.68	362.74	356.15
						(48.03)	(63.59)	(131.86)	(96.91)

(Figures in parentheses indicate percentage variation during the period).

It is further observed that the per farm net returns of all the four types had a tendency to increase with the increase in farm size in both the years. When compared on per cropped hectare basis, they, however, behaved in a different manner. In the year 1956-57 all the four types of net returns initially increased from small to medium size-classes and afterwards declined for the large size-class. In the year 1970-71, such behaviour patterns were observed only in case of farm business income and farm investment income per cropped hectare. The per cropped hectare family labour income and net income, however, increased continuously with the increase in farm size.

If we consider per hectare net returns of all the types as the measures of efficiency, it may be said that though there have been increases in the net returns in all the size-classes of the sample farms, the medium sized farms have proved to be relatively more efficient in deriving increased net returns over paid-out costs and farm investment costs, as compared to the farms belonging to the other two size-classes. The large sized farms have, however, proved to be relatively more efficient in economizing the use of human labour and thereby increasing family labour income and net income per cropped hectare.

It has been revealed from the earlier discussion that during the period under reference there has been increase in the gross returns, family labour income, farm business income, etc., alongwith simultaneous increase in employment of labour, capital investment and cost of production of different crop enterprises. These changes need further examination to understand improvements in the efficiency of the sample farms in managing the crop production business. So far the measures of farm-efficiency such as per cropped hectare gross returns, farm business income, family labour income, net income and farm investment income have sufficiently supported the fact that efficiency of the farms has improved during the period. Table 6.13 presents other alternative measures of farm-efficiency such as, value of gross output per man-day, returns per man-day of family labour and total labour and percentage capital turn-over, paid out cost per unit of output, total cost per unit of output and output per unit of total cost for the years 1956-57 and 1970-71 for all the three size-classes of sample farms.

The various measures of farm-efficiency presented in this table reveal that there has been significant improvement in the efficiency of the sample farms in managing the crop production business. At the overall level, value of gross output per man-day has increased from Rs. 11.29 to Rs. 12.62. The returns per man-day of family labour and that of total labour have increased from Rs. 4.14 to Rs. 6.97 and from Rs.3.62 to Rs. 5.64, respectively. The capital turnover has showed an increase from 5.86 per cent to 6.42 per cent. Similarly the various ratios in respect of costs and output indicate definite signs of improvement in the farm-efficiency during the period.

Table 6.13 : Alternate Measures of Efficiency of Crop Production Business of Sample Farms in 1956-57 and 1970-71

Efficiency measures	Size Groups						Overall	
	Small		Medium		Large			
	1956-57	1970-71	1956-57	1970-71	1956-57	1970-71	1956-57	1970-71
1. Value of gross output per man-day(Rs.)	9.39	8.06	12.57	12.36	11.15	14.55	11.29	12.62
2. Return per man-day of family labour(Rs.)	1.94	2.66	4.28	5.77	4.87	10.14	4.14	6.97
3. Return per man-day of total labour (Rs)	2.04	2.57	3.93	4.91	3.95	7.34	3.62	5.64
4. Percentage capital turnover	2.63	3.94	7.45	6.46	6.21	6.96	5.86	6.42
5. Paid-out cost per unit of gross output(Rs.)	0.17	0.15	0.19	0.18	0.15	0.19	0.18	0.18
6. Total cost per unit of gross output (Rs)	1.03	0.87	0.86	0.89	0.94	0.79	0.66	0.73
7. Gross output per unit of total cost (Rs)	0.97	1.14	1.17	1.13	1.07	1.27	1.53	1.36

As for the individual size-classes, it is observed that the farm-efficiency has improved relatively at a faster rate in case of the large sized farms.

6.4.2 Changes in Net Returns of Individual Crop Enterprises :

Tables 6.14 and 6.15 present per hectare net returns at various cost levels alongwith output-input ratios at total cost level in respect of different crop enterprises produced under irrigated and rainfed conditions, respectively, during both the years. From the figures presented in these tables it is revealed that the per hectare net returns of all the crop enterprises produced under irrigated conditions have increased during the period. The rate of increase in net returns, however, varied considerably among these crop enterprises. Among the crop enterprises produced under rainfed conditions, the per hectare net returns have increased only in case of bajra and groundnut crop enterprises. Whereas, jowar, wheat and gram crop enterprises produced under rainfed conditions did not yield any surplus returns even in the year 1970-71. On the contrary, there had been increased deficits in the production of these crop enterprises over the total cost. The output-input ratios estimated at Cost C level also indicate similar trends.

From the discussion attempted so far it is clear that the structural adjustments in the use of farm resources have resulted in increased cost of cultivation, increased returns and net returns during the period from the crop production business. The changes in the cost of cultivation, returns and

Table 6.14 : Per Hectare Net Returns From Individual Crop Enterprises Produced Under Irrigated Conditions on Sample Farms in 1956-57 and 1970-71

(Rupees)

Crop	Year	Net Returns Over Cost A1	Net Returns Over Cost A2	Net Returns Over Cost B	Net Returns Over Cost C	Output-Input ratio at Cost C
Jowar	1956-57	399.99	384.67	225.95	107.33	1.18
	1970-71	520.81 (30.21)	-	316.14 (39.92)	211.21 (96.79)	1.38
Bajra	1956-57	-	-	-	-	-
	1970-71	321.04	-	185.66	126.42	1.29
Hybrid Bajra	1956-57	-	-	-	-	-
	1970-71	639.47	-	483.70	386.88	1.72
Wheat	1956-57	294.91	272.43	106.03	-41.84	0.94
	1970-71	705.22 (139.13)	-	495.50 (367.32)	331.56 (792.55)	1.40
Sugarcane-planted	1956-57	4094.78	-	3657.93	3201.04	2.25
	1970-71	4841.97 (18.25)	-	4252.20 (16.24)	3831.84 (19.71)	2.20
Cotton	1956-57	437.11	-	256.11	148.09	1.28
	1970-71	1140.48 (160.91)	-	944.84 (268.92)	619.78 (318.52)	1.57

(Figures in parentheses indicate percentage variation during the period).

Table 6.15 : Per Hectare Net Returns From Individual Crop Enterprises Produced Under Unirrigated Conditions on Sample Farms in 1956-57 and 1970-71

(Rupees)

Crop	Year	Net Returns Over				Output-Input ratio at Cost C
		Cost A1	Cost A2	Cost B	Cost C	
Jowar	1956-57	134.46	115.79	30.03	-11.08	0.96
	1970-71	143.39	-	-1.60	-53.92	0.84
Bajra	1956-57	49.05	42.93	-57.85	-107.55	0.63
	1970-71	215.75	-	71.99	17.42	1.05
Wheat	1956-57	50.37	12.25	-110.61	-189.58	0.61
	1970-71	146.95	-	-52.46	-134.46	0.76
Gram	1956-57	134.38	118.09	12.65	-58.06	0.82
	1970-71	51.55	-	-129.08	-161.10	0.59
Groundnut	1956-57	520.99	512.84	361.31	287.79	1.47
	1970-71	736.69	-	537.09	467.14	1.67

(Figures in parentheses indicate percentage variation during the period).

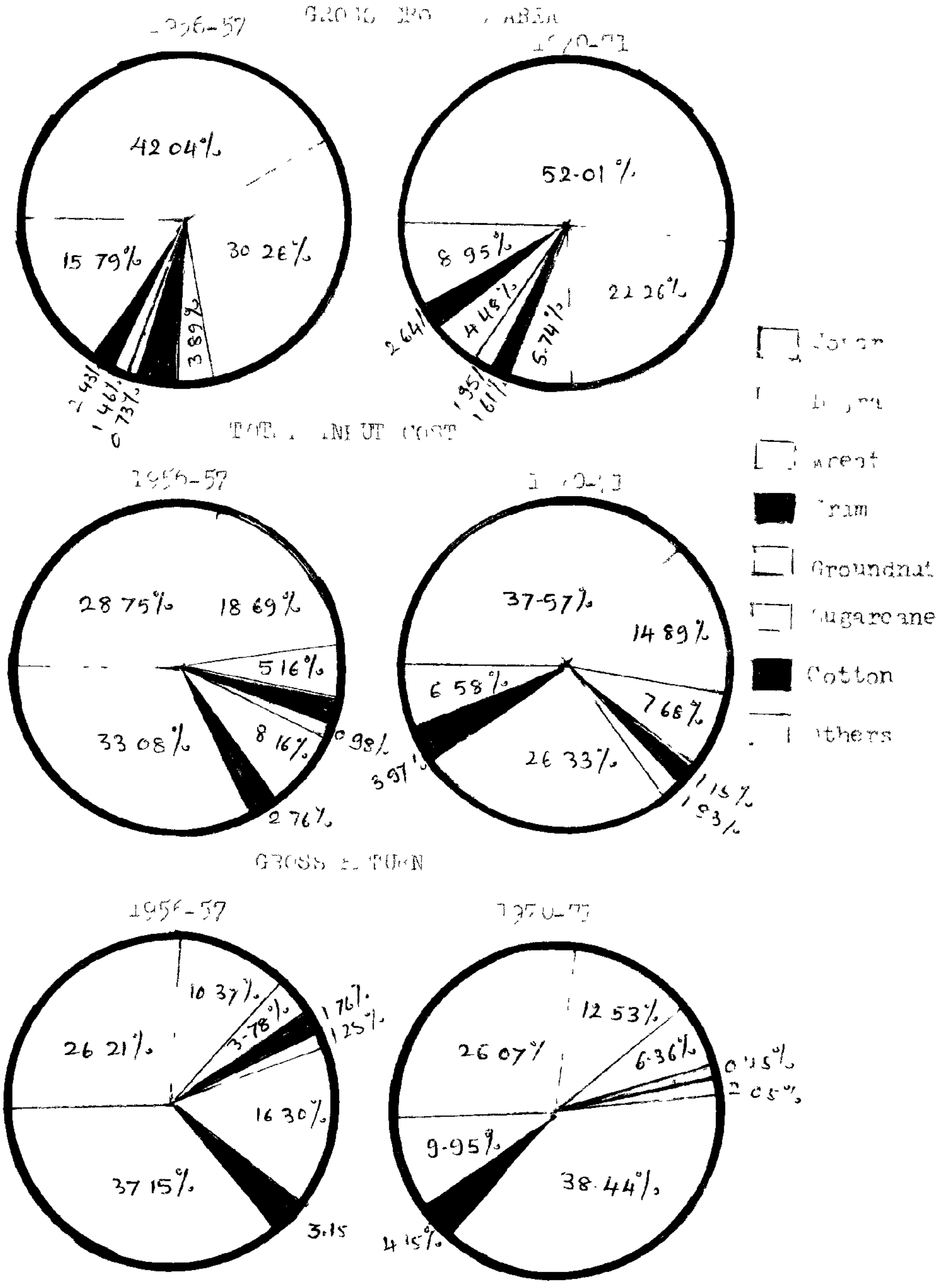
net returns, however, varied considerably among the individual crop enterprises. The variations in the rate of change in the costs of and returns from individual crop enterprises are, in fact, of greater significance as they influence directly the profitability of the crop production business as a whole. It is therefore, necessary to examine the changes in relative shares of individual crop enterprises in the gross cropped area, total input cost and gross returns from the crop production business as a whole. Table 6.16 presents the proportions of individual crop enterprises in the gross cropped area, total input cost and gross returns of the sample farms for the years 1956-57 and 1970-71.

A close examination of the figures presented in this table reveals that eventhough the proportion of gross cropped area allocated to foodgrain crop enterprises has increased from 79.59 to 82.69 per cent and their share in total input cost has increased from 55.02 to 61.29 per cent, the contribution made by these crop enterprises to the gross returns has increased only by 3.29 per cent from 42.12 per cent during the period. On the contrary, the cash crops seem to have played significant role in enhancing gross returns of the sample farms. As against the increase in the proportions of area allocated and total input cost distributed to cash crops from 4.62 to 9.07 per cent and from 11.90 to 32.13 per cent, respectively, their contribution to gross returns has increased

Table 6.16 : Relative Shares of Individual Crop Enterprises in the Gross Cropped Area, Total Input Cost and Gross Returns of Sample Farms in 1956-57 and 1970-71

Crop	Percentage area shares of different crops		Percentage distribution of total input cost over different crops		Percentage contribution of different crops to gross returns	
	1956-57	1970-71	1956-57	1970-71	1956-57	1970-71
Jowar	42.04	52.01	28.75	37.57	26.21	26.07
Bajra	30.26	22.62	18.69	14.89	10.37	12.53
Wheat	3.89	5.74	5.16	7.68	3.78	6.36
Gram	3.40	1.61	2.42	1.15	1.76	0.45
Groundnut	0.73	1.95	0.98	1.83	1.28	2.05
Sugarcane-planted	1.46	4.48	8.16	26.33	16.30	38.44
Cotton	2.43	2.64	2.76	3.97	3.15	4.15
Others	15.79	8.95	33.08	6.58	37.15	9.95
Total	100.00	100.00	100.00	100.00	100.00	100.00

RELATIVE SHARE OF INDIVIDUAL CROP ENTERPRISES IN GROSS CROPPED AREA, TOTAL INPUT COST AND GROSS RETURN



from 20.73 to 44.64 per cent during the period. The proportions of other crops in the gross cropped area, total input cost and gross returns have, however, declined during the period.

It may be concluded that the extent and effect of structural adjustments in the use of farm resources were relatively more prominent in case of the cash crops as compared to the foodgrain and other crops. This is so because, a major proportion of the foodgrain and other crops is produced under rainfed conditions where rainfall is scanty and unevenly distributed. These conditions, in fact, have proved to be the major constraints in the process of modernization of agriculture in the region.

CHANGES IN RESOURCE PRODUCTIVITIES AND ALLOCATION EFFICIENCY ON FARMS

Chapter 7

CHANGES IN RESOURCE PRODUCTIVITIES AND ALLOCATION EFFICIENCY ON FARMS

The analysis presented in the previous Chapter related to the changes in the resource use structure, costs and returns on the sample farms in the region over a period of fourteen years. There had been, however, some limitations of the type of analysis attempted as it cannot measure the contributions of each specific resource in combination with other resources, responsible for changes in the output level during the specific time periods as well as changes therein over a period of time. Moreover, productivities of individual resources undergo a change because of complementarity and substitutability of resources resulting from changes in resource use structure. The changes in resource use structure in turn indicate the improvements in allocation efficiency of the farms as the latter is dependent, besides prices of inputs and output, on productivities of resources associated with technological change in agriculture. The present chapter is, therefore, devoted to understand changes in the resource productivities and allocation efficiency in agriculture in the region during the period under reference by way of multivariate analysis of the production processes of the sample farms at two points of time.

The study of changes in resource productivities and allocation efficiency is based on a comparison of the production functions estimated from the farm management data of the sample farms for the years 1956-57 and 1970-71. Size groupwise and cropwise comparison of production functions is also attempted to study resource use efficiency in different categories of farms and crops. Further, production function estimates are deployed to estimate the returns to scale underlying agricultural production in the region at two points of time and to suggest economic optima in the allocation of resources to maximise farm earnings. An attempt is also made at the end to study changes in relative factor shares resulting from technological change in agriculture.

The postulated production relationship in agriculture is reflected in the algebric form of the function. "Functions estimated from farm samples ordinarily have been of power form because of the smaller number of degrees of freedom involved in estimating the parameters, and partly because a multiplicative model has seemed logically appropriate"(Heady and Dillon,1961). The Cobb-Douglas production function stated in the following equation has, therefore, been chosen for this purpose.

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6}$$

The log-linear transformation of this production function is stated as

$$\log Y = \log a + b1 \log X_1 + b2 \log X_2 + b3 \log X_3 + b4 \log X_4 + b5 \log X_5 + b6 \log X_6$$

Where,

Y = Gross value of output of crops (Rs.).

X_1 = Gross cropped area (hectares).

X_2 = Human labour (man-days).

X_3 = Bullock labour (pair-days).

X_4 = Manures and fertilizers (Rs.).

X_5 = Other working capital (Rs.)

X_6 = Annualised capital investment (Rs.).

Production functions with the above variables are estimated for the crop production business of the sample farms, separately for the years 1956-57 and 1970-71 both for the entire sample of farms and for the individual categories of the sample farms. In case of the individual crops, however, the last input variable, i.e., annualised capital investment is excluded from the analysis and the dependent output variable 'Y' is measured in physical units.

In production function analysis based on cross sectional data, there often exists high correlation between some of the explanatory variables leading to problems of multicollinearity. As a first step to ascertain the problem of multicollinearity, a zero-order correlation matrix for all the explanatory variables was obtained for each function. The following rule was applied to visualize the magnitude of multicollinearity. " The correlation coefficient between a pair of explanatory variables was considered serious if it was greater than 0.8 " (Heady and Dillon, 1961). The zero-order correlation matrix for all the explanatory variables is given in Appendix XII for each function. It was found that in case of majority of the pairs of explanatory variables the correlation coefficient was less than 0.8. In case where correlation coefficient was greater than 0.8 also multicollinearity was not a problem as the correlation coefficient corresponding to them was not high relative to the overall degree of multiple correlation among all the variables simultaneously (Klein, 1953), thus satisfying non-seriousness of the problem of multicollinearity in the analysis.

Use of different statistical tests of significance was also made to judge efficiency of the individual regression coefficients and coefficients of multiple correlation in respect of all the production functions. Further, returns to scale and difference between the marginal value product of inputs and their prices have also been tested statistically. The procedure adopted for estimating different statistical tests of significance is given in Appendix XIII. Lastly, changes in the relative factor shares resulting from technological change in agriculture are estimated by fitting C.E.S. (Constant Elasticity of Substitution) model to the data. The results thus obtained from the production function analysis are discussed below.

7.1 Changes in Resource Productivity on Farms at the Aggregate Level :

The estimated parameters of the production functions of the crop production business are presented in Table 7.1 for the years 1956-57 and 1970-71 at the aggregate level of the sample farms.

The value of R^2 (coefficient of multiple determination) turns out to be quite high and is statistically significant beyond 1 per cent level in both the years. The included variables explained 84.71 and 92.27 per cent of the variations in the logarithms of the gross value of crop output in the years 1956-57 and 1970-71, respectively.

The regression coefficients of all the input variables except bullock labour are found to be positive and significant in both the years. The regression coefficient of bullock labour is positive but it is non-significant, probably because its use might have been far beyond the critical maximum level where diminishing marginal returns must have started. Among the input variables, the regression coefficient of land in 1956-57 and that of human labour, manures and fertilizers, other working capital and annualised capital investment in 1970-71 are significant at 1 per cent level. The regression coefficients of human labour, manures and fertilizers, and other working capital in 1956-57 and that of land in 1970-71 turn out to be significant at 5 per cent level, whereas in 1956-57 the regression coefficient of annualised capital investment is observed to be significant at 10 per cent level. The significant and positive coefficients of all the input variables except bullock labour clearly indicate that land,

Table 7.1 : Regression Coefficients, Standard Errors and Coefficient of Multiple Determination for Crop Production Business as a Whole of All Farms in 1956-57 and 1970-71

Year	Constant ($\log_{10} a$)	Gross Cropped area (Hectares)	Human labour (Man-days)	Bullock labour (Pair-days)	Manures and fertilizers (Rupees)	Other working capital (Rupees)	Annualized capital investment (Rupees)	R^2	'F' value
1956-57	1.20223	.28418	.27566	.11810	.10851	.14540	.08423	.84708	36.9748***
N = 80	*** (.32463)	*** (.10554)	** (.14624)	N.S. (.12320)	** (.06251)	** (.07537)	* (.05888)		
1970-71	1.31915	.22772	.22135	.06110	.13222	.26856	.11819	.92271	211.4798***
N = 132	*** (.19637)	** (.10896)	*** (.07116)	N.S. (.06132)	*** (.02725)	*** (.08896)	*** (.03476)		

(Figures in parentheses are the standard error of respective regression coefficients).

*, ** and *** Significant at 10, 5 and 1 per cent levels, respectively.

human labour, manures and fertilizers, other working capital and annualised capital investment exert significant influence on the gross value of crop output.

The production elasticities of all the input variables were less than unity in both the years, implying decreasing marginal productivity of factor-inputs. This means that if other inputs are fixed at a specified level and only one input is increased, the gross returns will increase at a diminishing rate.

A close examination of production elasticities of individual input variables reveals that land and human labour were the important inputs to which output was highly responsive in agriculture of this region in the 'fifties. The situation seems to have changed during the early 'seventies as the production elasticity of other working capital has not only increased but is greater than that of land and human labour. It is found that the production elasticities of land, human labour and bullock labour inputs have declined,while those of manures and fertilisers, other working capital and annualized capital investment increased during the period. The decrease in the production elasticities of land and labour (both human and bullock) clearly supports the hypothesis that the relative importance of land and labour would decline in the process of transformation of agriculture from traditional to modern methods. On the other hand, the increase in the production elasticities of manures and fertilisers, other working capital

(which includes expenditure on seed, irrigation, plant protection measures, etc.,) and annualized capital investment indicates that there is a greater scope for intensifying application of manures, fertilisers and plant protection measures, adoption of high yielding varieties of seeds, use of irrigation resource and investment in capital assets in agricultural production of this region. Moreover, based on higher production elasticities of non-conventional inputs during the latter period, it would be more correct to say that the process of transforming agriculture in the region places a higher premium on investment in technological changes.

7.2 Farm Size and Changes in Resource Productivity :

The foregoing analysis was based on the entire sample of farms. The estimated production functions indicated, on an average, the type of changes in resource productivity that have been experienced in agriculture in the region during the period under consideration. These estimates, though valid on an average, might tend to iron out and thereby conceal some of the differences which may prevail between farms belonging to different strata of sample. Many a times, resource productivity and resource use efficiency are greatly influenced by the farm size. Besides this, the rate of adoption of new technology is dependent, to some extent, on farm size as the latter also reflects the ability of farms in owning resources required for optimization of farm returns. On the other hand, in the absence of alternate employment opportunities off the farm, the use of labour input is excessive on small farms.

To study the farm size and resource productivity relationship and changes thereof in the region, the production function analysis has been attempted by farm size for both the years separately. This would indicate whether or not there has been change, if any, in economies of scale in agriculture in the region during the period.

The results of the production functions estimated from farm level observations for the three size groups of farms viz., small, medium and large are given in Tables 7.2 and 7.3 for the years 1956-57 and 1970-71, respectively.

The value of R^2 in all the cases is quite high and ranges between .80919 and .93992. The F-test statistic for the respective production functions is significant at 1 per cent level in all the cases, indicating thereby the overall significance of the estimated production functions. The variation in the logarithm of gross value of crop output explained by the included input variables ranged between 80.92 to 88.14 per cent and between 88.36 to 93.99 per cent over the size groups in the years 1956-57 and 1970-71, respectively. It is further observed that the proportion of variation in the dependent variable explained by the included input variables increased from 82.71 to 88.67 per cent in small size group and from 80.92 to 93.99 per cent in medium size group, whereas it remained around 88 per cent in large size group of sample farms during the period.

Table 7.2 : Regression Coefficients, Standard Errors and Coefficient of Multiple Determination for Crop Production Business as a whole of Small, Medium and large Farms in 1956-57

Size Groups	Constant ($\log_{10} a$)	Gross cropped area (Hectares)	Human labour (Man-days)	Bullock labour (Pair-days)	Manures & fertilizers (Rupees)	Other working capital (Rupees)	Annualized capital investment (Rupees)	R^2	'F' value
Small	1.17022	.25268	.38576	.21165	.14363	.09010	-.03870	.82712	12.9864***
N-27	(.45181)**	(.13891)**	(.21831)**	(.14367)*	(.070730)**	(.06815)*	(.12253) N.S.		
Medium	1.20987	.39744	.37499	-0.05813	.10876	.19302	.07741	.80919	11.5108***
N-27	(.57882)**	(.13483)***	(.20108)**	(.11913) N.S.	(.05869)**	(.10384)**	(.05102)*		
Large	1.24877	.38970	.21671	.10361	.09103	.07371	.12106	.88140	34.9149***
N-26	(.39858)***	(.17913)**	(.12590)**	(.10127) N.S.	(.05155)***	(0.05072)*	(.08106)**		

(Figures in parentheses are the standard error of respective regression coefficients).

*, ** and *** significant at 10, 5 and 1 per cent levels, respectively.

Table 7.3 : Regression Coefficients, Standard Errors and Coefficient of Multiple Determination for Crop Production Business as a Whole of Small, Medium and Large Farms in 1970-71

Size Groups	Constant ($\log_{10} a$)	Gross cropped area (Hectares)	Human labour (Man-days)	Bullock labour (Pair-days)	Manures & fertilizers (Rupees)	Other working capital (Rupees)	Annualised capital investment (Rupees)	R^2	'F' value
Small	1.41981	.29104	.26435	-.08805	.09882	.29866	.14590	.88670	40.2477***
N-44	(.28384)***	(.13255)**	(.11984)**	(.19071) N.S.	(.03217)***	(.06875)***	(.06822)**		
Medium	1.47525	.21493	.22905	.09227	.11878	.22610	.11652	.93992	46.2442***
N-44	(.32108)***	(.09379)**	(.11958)**	(.06503)*	(.02486)***	(.06273)***	(.05059)**		
Large	1.28827	.10971	.26289	.09122	.15908	.26402	.07413	.88363	39.0508***
N-44	(.37254)***	(.11964)*	(.13963)**	(.15572) N.S.	(.03756)***	(.09076)***	(.04291)**		

(Figures in parentheses are the standard error of respective regression coefficients).

*, ** and *** significant at 10, 5 and 1 per cent levels, respectively.

Except for annualised capital investment in small size group and bullock labour in medium size group of farms in 1956-57 and bullock labour in small size group of farms in 1970-71, the regression coefficients of all the input variables turn out to be positive in all the three size groups of farms in both the years. The regression coefficients of annualized capital investment in small size group and bullock labour in medium size group of farms in 1956-57 and that of bullock labour in small size group of farms in 1970-71 have negative sign but are found to be non-significant, indicating that they do not exert significant influence on gross value of crop output. Moreover, the use of these resources seems to have been higher than required for obtaining the optimum level of output in the respective size groups of sample farms. The positive regression coefficients of all other input variables are statistically significant in all the three size groups of farms excepting that of bullock labour in large size group of farms in both the years. The regression coefficient of annualised capital investment which was negative in small size group in 1956-57, however, turns out to be positive and significant in 1970-71, indicating thereby relatively greater efficiency of the small size group of sample farms in undertaking capital investment of a productive nature.

A critical examination of the production elasticities of individual resources in different size groups of farms at the two points of time reveals an interesting relationship between the farm size and productivities of individual resources. In that, it is found that in the year 1956-57 land and labour inputs remained to be the important inputs to which output was highly responsive in all the categories of farms. In the year 1970-71, however, the relative importance of these inputs in influencing output seems to have declined in all the three size groups. This indicates that other input variables like manures and fertilisers, other working capital and annualised capital investment have become more prominent in the crop production business of all the size groups of sample farms during the latter period.

More than this, the production elasticities of individual resources indicate specific and somewhat different trends over the size groups of sample farms. In the year 1956-57, the production elasticities of land and annualised capital investment indicated increasing trend over the size groups of sample farms. As against this, the production elasticities of human labour and manures and fertilisers inputs decreased as the farm size increased in the same year. Also barring medium size group, the production elasticities of bullock labour and other working capital indicated an inverse relationship with the farm size. Together, these trends give a noteworthy feature of agriculture in the 'fifties in which contributions made by land and capital investment inputs to output were relatively higher and that of human labour, bullock labour, manures and fertilizers and other working capital lower on the large farms in the region, and vice-versa.

A quite contrasting picture is, however, noticed in the early 'seventies. The production elasticities of land and capital investment inputs decreased and that of manures and fertilisers increased with the increase in farm size in the year 1970-71. In case of human labour and other working capital inputs, their production elasticities firstly decreased through small to medium size groups and again increased with further increase in the farm size. These findings necessarily imply that owing to the ability of the large farms to command financial and other resources they made relatively more progress in transforming their crop production business during the 'sixties. In case of farms belonging to the small size group, eventhough the production elasticities of other working capital and annualised capital investment have increased during the period, land and human labour inputs occupy relatively a more prominent place in influencing farm output.

The values of the intercept term i.e., constant ($\log_{10} a$) obtained for the individual production functions further indicated that there has been technological change in agriculture during the period on all the size groups of farms.

7.3 Returns to Scale in the 'Fifties and the Early 'Seventies :

As mentioned earlier, the regression coefficients in the Cobb-Douglas production function are production elasticities and their sum indicates the returns to scale. The returns to scale are increasing, constant or decreasing according as the sum of regression coefficients is greater than, equal to or less than unity. Table 7.4 gives the sums of regression coefficients derived from the regression equations estimated for individual size groups as well as at the aggregate level of sample farms of the respective years.

Table 7.4 : Returns to Scale in Different Size Groups of Farms And at the Aggregate Level of Sample Farms in 1956-57 and 1970-71

Size Groups	1956-57		1970-71	
	Sum of regression coefficients	Returns to scale indicated by t-test	Sum of regression coefficients	Returns to scale indicated by t-test
Small	1.04513	Constant	1.01071	Constant
Medium	1.03597	Constant	0.99765	Constant
Large	0.99582	Constant	1.03857	Constant
All farms	1.01307	Constant	1.02913	Constant

At the overall level, the sums of regression coefficients were 1.01307 and 1.02913 for the years 1956-57 and 1970-71, respectively. Over the size groups of the sample farms, these sums of regression coefficients ranged between 0.99582 and 1.04513 in 1956-57 and between 0.99765 and 1.03857 in 1970-71. The sums of regression coefficients were further tested for their deviation from unity. The t-test indicated constant returns to scale in all the cases. This finding confirms the results of some recent investigations (Khusro, 1964 and Rajkrishna, 1964) indicating constant returns to scale in Indian agriculture. The emergence of constant returns to scale is also of particular interest in the context of the much discussed 'inverse relationship between farm size and productivity' (suggested by Farm Management Studies) of the 'fifties which clearly is a matter of relationship between output (output per acre) and only a single input (acreage) without holding other inputs constant. With returns to scale being constant, the 'inverse relationship' can be easily explained away in terms of the operation of the law of variable proportions.

7.4 Changes in Resource Use Efficiency at the Aggregate Level :

The estimated production functions underlying crop production activity enable us to proceed further in an evaluation of the efficiency of prevalent factor proportions in agriculture in the region. The production function analysis has been generally used to determine economic efficiency of resource use, which requires estimation of marginal value products of resources. A resource or input is considered to be used most efficiently if its marginal value product is just sufficient to offset its cost. Equality of marginal value product to factor cost is, therefore, the basic condition that must be satisfied to obtain efficient resource use.

Accordingly, the marginal value products (at geometric mean level) of the individual resources are worked out at the aggregate level of sample farms separately for the years

1956-57 and 1970-71 and the same are presented in Table 7.5 along with the per unit acquisition costs of the respective resources. The differences between the marginal value products of the resources and their per unit acquisition costs are tested for their significance with the help of 't' test. The differences between the marginal value products of the individual resources obtained from the production functions of the individual years are also tested for their significance with the help of 't' test. The geometric means of individual resources and gross returns are given in Appendix XIV.

At the aggregate level, the marginal value productivity of land has increased from Rs. 142.07 to Rs. 150.11 during the period. Although the difference between thr marginal value products of land input obtained from production functions of the two years is non-significant, the slight increase in the marginal value productivity indicates that the type of technological change, that has taken place during the period, has contributed towards increased productivity of land input in the region. Besides, in both the years the marginal value product of land is greater than the imputed rental of land. However, the difference between the marginal value product of land and its imputed rental turned out to be non-significant in both the years, which clearly indicates that, on an average, land input was used at its optimum level in the region.

The comparison of marginal value product of human labour and wage rate indicates that in the process of transformation

Table 7.5 : Comparison of Marginal Value Products of Farm Resources With Their Prices for Crop Production Business as a Whole of All Farms in 1956-57 and 1970-71

(Rupees per unit of inputs)

Items	1956-57	1970-71
No. of observations	80	132
Land		
MVP at G.M.	142.07	150.11
Price (per unit)	123.07	140.02
Difference	19.00	10.09
S.I.	52.76	71.82
Human Labour		
MVP at G.M.	2.09	2.41
Price (per unit)	2.35	2.37
Difference	-0.26	0.04
S.I.	1.12	0.77
Bullock labour		
MVP at G.M.	2.44	2.85
Price (per unit)	6.55	7.58
Difference	-4.11*	-4.73**
S.I.	2.55	2.86
Manures and Fertilizers		
MVP at G.M.	1.70	1.64
Price (per unit)	1.00	1.00
Difference	0.70	0.64**
S.E.	0.98	0.34
Other Working Capital		
MVP at G.M.	1.13	1.88
Price (per unit)	1.00	1.00
Difference	0.13	0.88*
S.I.	0.59	0.62
Annualized Capital Investment		
MVP at G.M.	1.02	1.31
Price (per unit)	1.00	1.00
Difference	0.02	0.31
S.I.	0.71	0.23

* and ** Significant at 10 and 5 per cent levels, respectively.

rationality of maintaining bullocks on the farms. So also, it is difficult to suggest any further reduction in the use of bullock labour on the farms for maximizing net returns. The suggestions for either increasing or decreasing the resource use in response to the difference between marginal productivity and factor cost could easily be made in case of human labour and other capital inputs as their use pattern is characterized by price (wage in case of hired human labour), elasticity of demand and factor substitutability. Difficulties in making such suggestions arise mainly in case of land and bullock labour resources as the former is a scarce input in nature and the latter, as stated earlier, is characterised by specificity and indivisibility. Besides this, the farms have to maintain bullocks for performing different operations as farm mechanisation has not made much head'way in the region and timely farm operations would become difficult if farms are to depend on hired bullock labour for optimizing its use. Under such a situation we cannot attach much importance to the estimates of marginal value product of bullock labour as there seems to be the sensitivity of the production function analysis (Anderson and Jodha, 1973) which gives results removed from reality. Besides, it has been found that the regression coefficient of bullock labour input is non-significant in the production functions of both the years even at 10 per cent level.

In the case of manures and fertilizers input the marginal value product has tended to be quite high in relation to its price in both the years. It is interesting to note that the marginal value product of manures and fertilisers input has remained almost the same (i.e., Rs. 1.70 in 1956-57 and Rs.1.64 in 1970-71) during the period inspite of the fact that its use has almost been doubled on an average sample farm. This may be easily explained by the fact that in the year 1956-57 this input consisted more of manures and less of fertilisers and in the subsequent period the increase in the input was mainly due to fertilisers. As a result of this, the marginal value product was influenced more by manures in 1956-57 and by fertilisers in 1970-71 wherein the use of latter was much below the optimum level. In short it may be said that the use of manures and fertilisers input in agriculture in the region was much below the optimum level in the 'fifties and continued to be low even in the early 'seventies. Moreover, since agriculture in the region in general, is more of dry farming nature in the State farmers refrain from using fertilisers for the crops grown under unirrigated conditions because of uncertainties of monsoon

The marginal value product of other working capital worked out to be Rs. 1.13 and Rs. 1.88 in the years 1956-57 and 1970-71, respectively. The difference between the marginal value product of other working capital and its price was non-significant in 1956-57, indicating thereby an optimum level use of this input in agriculture in the 'fifties. In the year 1970-71, however, the marginal value product of other working capital was significantly much higher than its price inspite of the fact that its use increased almost by 70 per cent during the period. This increase in the marginal productivity of other working capital during the 'sixties is of great significance from the view point of maximizing net returns. As stated earlier, other working capital included expenditures on seed, plant protection measures and irrigation. The increased marginal productivity of other working capital therefore, calls for adoption of seeds of high yielding varieties of crops, exploitation of irrigation resource and increased use of plant protection measures. This clearly indicates that the process of modernization of agriculture in the region is yet in the early stage and needs to be geared up in the immediate future. It may, however, be noted that the region, being a dry farming area dependent upon low rainfall, has got several limitations in this regard.

The marginal value product of annualized capital investment has increased from Rs. 1.02 to Rs. 1.31 during the period inspite of the fact that the annualized capital investment has increased almost by 61 per cent on an average sample farm. By comparing the marginal value product of this input with its acquisition cost, it is found that the technological change has brought about an upward shift in the use of fixed capital assets from the low level equilibrium position in the 'fifties to a high level disequilibrium position in the early 'seventies. It may be said that as agriculture in the region was still practiced on traditional lines in the 'fifties with a near absence of modern implements and farm machineries, there

Table 7.6 : Comparison of Marginal Value Products of Farm Resources With Their Prices for Crop Production Business as a Whole of Small, Medium and Large Farms in 1956-57

(Rupees per unit of inputs)

Items	Size Groups		
	Small	Medium	Large
No. of observations	27	27	26
Land			
MVP at G.M.	143.78	153.47	128.83
Price (per unit)	176.46	160.74	95.10
Difference	-32.68*	-7.27	33.73
S.E.	25.06	57.91	59.22
Human labour			
MVP at G.M.	2.78	3.16	1.62
Price (per unit)	2.35	2.35	2.35
Difference	0.43	0.81	-0.73
S.E.	1.58	1.70	0.94
Bullock Labour			
MVP at G.M.	4.06	-1.32	1.77
Price (per unit)	7.58	7.58	5.74
Difference	3.52	-8.90***	-3.97**
S.E.	2.76	2.70	1.73
Manures and Fertilizers			
MVP at G.M.	2.20	1.66	1.51
Price (per unit)	1.00	1.00	1.00
Difference	1.20*	0.66	0.51
S.E.	0.88	[illegible]	0.86
Other Working Capital			
MVP at G.M.	0.78	1.40	0.52
Price (per unit)	1.00	1.00	1.00
Difference	-0.22	0.40	-0.48*
S.E.	0.59	0.75	0.36
Annualized Capital Investment			
MVP at G.M.	-0.55	1.13	1.29
Price (per unit)	1.00	1.00	1.00
Difference	-1.55	0.13	0.29
S.E.	1.74	0.74	0.86

*, ** and *** Significant at 10, 5 and 1 per cent levels, respectively.

Table 7.7 : Comparison of Marginal Value Products of Farm Resources With Their Prices for Crop Production Business as a Whole of Small, Medium and Large Farms in 1970-71

(Rupees per unit of inputs)

Items	Size Groups		
	Small	Medium	Large
No. of observations	44	44	44
Land			
MVP at G.M.	183.13	176.96	118.93
Price (per unit)	175.90	206.23	109.58
Difference	7.23	-29.27	9.35
S.E.	83.55	68.50	74.60
Human Labour			
MVP at G.M.	2.23	2.65	3.44
Price (per unit)	2.27	2.41	2.43
Difference	-0.04	0.24	1.01
S.E.	1.01	1.38	1.83
Bullock Labour			
MVP at G.M.	-3.53+	4.32+	4.95
Price (per unit)	7.29	7.12	8.03
Difference	-10.82***	-2.80	-3.08
S.E.	4.03	3.05	8.45
Manures and Fertilizers			
MVP at G.M.	1.60	1.66	2.20
Price (per unit)	1.00	1.00	1.00
Difference	0.60	0.66**	1.20***
S.E.	0.52	0.35	0.52
Other Working Capital			
MVP at G.M.	2.43+	1.77	2.37+
Price (per unit)	1.00	1.00	1.00
Difference	1.43***	0.77*	1.37**
S.E.	0.56	0.49	0.81
Annualised Capital Investment			
MVP at G.M.	1.43	1.38	1.19
Price (per unit)	1.00	1.00	1.00
Difference	0.43*	0.38	0.19
S.E.	0.27	0.60	0.69

*,** and *** Significant at 10, 5 and 1 per cent levels, respectively.

+indicates that the MVPs of the input estimated for two years are significantly different from each other.

it has remained constant on medium farms and declined on large farms. In the year 1970-71 the marginal value product of land was the highest on small farms and tended to decrease with an increase in the farm size, indicating thereby more intensive use of land on smaller farms. It is further observed that except for small farms in 1956-57, the differences between the marginal value product of land and its imputed rental were non-significant in respect of all the categories of sample farms in both the years, indicating thereby optimum use of land in all the size groups of sample farms. In case of small farms, the marginal value product of land was significantly lower than its imputed rental in the year 1956-57, meaning thereby its inefficient use on small farms. In the process of modernization, small farms have proved to be relatively more efficient as they have moved from greater than optimal level in the use of land input to optimal level through intensive cultivation.

In case of human labour, barring large farms in 1956-57, the marginal value products are observed to be invariably greater than the wage rate on all the farms in both the years. However, it is noteworthy that the differences in the marginal value product of human labour and wage rate are non-significant, which means rational use of human labour on the farms inspite of the fact that the bulk of labour force came from the farm family itself.

The marginal value products of bullock labour turned out to be negative on medium farms in 1956-57 and on small farms in

1970-71. On the other farms though the marginal value products of bullock labour were positive in both the years, the same were much less than the acquisition costs. This indicates uneconomic use of bullock power on all sizes of farm in the region.

The marginal value products of manures and fertilisers have tended to be greater than the cost on all the farms in both the years. However, the differences between the marginal value product of manures and fertilisers input and its cost in the two years indicate that the small farms have made possible adjustments and moved towards optimum level in the use of this resource during the period. As the marginal value product of manures and fertilisers was significantly greater than the cost on medium and large farms in 1970-71, it meant that there is a greater scope for increasing the use of this resource for maximizing net returns.

The marginal value products of other working capital in the year 1970-71 were greater than those obtained in 1956-57 in all the size groups of sample farms. Besides, in the year 1970-71 the marginal value product of other working capital was significantly greater than its cost on all the farms. This indicates that there is a need for increasing the use of other working capital on all the farms so as to maximize net returns.

The marginal value product of annualized capital investment which was negative on small farms in 1956-57 turned out to be positive and significantly greater than its cost in 1970-71.

Crops grown in 1956-57	Crops grown in 1970-71
4. Wheat (Unirrigated	4. Bajra-Local (Irrigated)
5. Wheat (Irrigated)	5. Bajra-Hybrid (Irrigated)
6. Sugarcane-planted(Irrigated)	6. Wheat (Unirrigated)
7. Cotton (Irrigated)	7. Wheat (Irrigated)
8. Gram (Unirrigated)	8. Sugarcane-planted(Irrigated
9. Groundnut (Unirrigated)	9. Cotton (Irrigated)
	10. Gram (Unirrigated)
	11. Groundnut (Unirrigated)

The variables considered for the production function analysis are :

Y = Output of crop in quintals (tonnes in case of sugarcane).

X_1 = Area under crop in hectares.

X_2 = Human labour in man-days.

X_3 = Bullock labour in pair-days.

X_4 = Manures and fertilizers in rupees.

X_5 = Other working capital in rupees.

The correlation matrix in respect of individual production functions is given in Appendix XV. The estimates of production functions are presented in Tables 7.8, 7.9, 7.10, 7.11 and 7.12, respectively for Jowar (unirrigated and irrigated), Bajra (unirrigated and irrigated), Wheat (unirrigated and irrigated), Sugarcane-planted and Cotton (both irrigated), and Gram and Groundnut (both unirrigated) for the years 1956-57 and 1970-71. The geometric means of output and input variables are given in Appendix XVI.

Table 7.8 : Regression Coefficients, Standard Errors and Coefficient of Multiple Determination for Jowar (Unirrigated) and Jowar (Irrigated) in 1956-57 and 1970-71

Year	Constant (log e 10)	Land (Hectares)	Human labour (Man-days)	Bullock labour (Pair-days)	Manures & fertilizers (Rupees)	Other working capital (Rupees)	Sum of regression coefficients	R^2	'F' value
		Jowar (Unirrigated)							
1956-57	-.80832	.25001	.53403	.11913	.05943	.06180	1.02441	.82245	40.7622***
N=50	(.35752)**	(.17524)*	(.24323)**	(.19980)	(.07087)	(.04392)*			
1970-71	-.33650	.56389	.32688	-.04063	.12571	.06517	1.04103	.81451	72.0165***
N=88	(.20039)**	(.10206)***	(.11960)***	(.13378) N.S.	(.02889)***	(.08210) N.S.			
		Jowar (Irrigated)							
1956-57	.26971	.42634	.41496	.09875	.10975	.02255	1.07234	0.82220	31.4458***
N=40	(.45248) N.S.	(.19573)**	(.17944)**	(.13004) N.S.	(.06839)*	(.11323) N.S.			
1970-71	.17934	.48010	.14402	.02679	.17297	.05706	.88095	.86581	77.7465***
N=74	(.23693) N.S.	(.07337)***	(.09867)*	(.07668) N.S.	(.02767)***	(.03972)*			

(Figures in parentheses are the standard error of respective regression coefficients).

*, ** and *** Significant at 10, 5 and 1 per cent levels, respectively.

Table 7.9 : Regression Coefficients, Standard Errors and Coefficient of Multiple Determination For Bajra (Unirrigated) and Bajra-local and Hybrid (Irrigated) in 1956-57 and 1970-71

Year	Constant (log a 10)	Land (Hectares)	Human labour (Man-days)	Bullock labour (Pair-days)	Manures & fertilizers (Rupees)	Other working capital (Rupees)	Sum of regression coefficients	R^2	'F' value
		Bajra (Unirrigated)							
1956-57	-.29318	.36430	.25833	.05612	.08788	.04808	.81522	.74819	34.4662***
N=64	* (.22410)	*** (.14466)	*** (.10306)	N.S. (.13929)	** (.03892)	N.S. (.07352)			
1970-71	-.05665	.39496	.07539	.18525	.14186	.05431	.85177	.87243	67.0213***
N=55	N.S. (.16474)	*** (.10834)	N.S. (.08689)	** (.09897)	*** (.03281)	N.S. (.06163)			
		Bajra-Local (Irrigated)							
1970-71	-.14375	.36364	.23171	.07864	.11128	.05699	.84227	.86821	27.6692***
N=27	N.S. (.23513)	*** (.12881)	** (.11354)	N.S. (.13443)	* (.07061)	N.S. (.07592)			
		Bajra-Hybrid (Irrigated)							
1970-71	.28191	.29932	.14092	.11995	.15328	.10175	.81523	.86881	37.7925***
N=41	N.S. (.25133)	** (.13006)	* (.10079)	N.S. (.10917)	*** (.03823)	* (.06899)			

(Figures in parentheses are the standard error of respective regression coefficients).

*,** and *** Significant at 10, 5 and 1 per cent levels, respectively.

Table 7.10 : Regression Coefficients, Standard Errors and Coefficient of Multiple Determination For Wheat (Unirrigated) and Wheat (Irrigated) in 1956-57 and 1970-71

Year	Constant (log a 10)	Land (Hectares)	Human labour (Man-days)	Bullock labour (Pair-days)	Manures & fertilizers (Rupees)	Other working capital (Rupees)	Sum of regression coefficients	R^2	'F' value
		Wheat (Unirrigated)							
1956-57	-.43305	.43250	.31844	-.06970	.11634	.14204	.93962	.82479	13.1812***
N=20	(.31777)*	(.30090)*	(.21766)*	(.19556) N.S.	(.07960)*	(.09857)*			
1970-71	.17223	.47013	.03759	.20016	.09048	.03735	.83571	.82227	13.8792***
N=21	(.52069) N.S.	(.20183)**	(.27362) N.S.	(.15642)*	(.06072)*	(.27592) N.S.			
		Wheat (Irrigated)							
1956-57	-.78147	.35236	.59622	-.23233	.20523	.15219	1.07367	.79234	22.6058***
N=40	(.55523)*	(.23692)*	(.21944)***	(.20098) N.S.	(.08937)**	(.22005) N.S.			
1970-71	-.24649	.26838	.36391	.05221	.16224	.07401	.92076	.87207	106.0664***
N=69	(.28044) N.S.	(.10887)***	(.09602)***	(.07813) N.S.	(.03599)***	(.04492)*			

(Figures in parentheses are the standard error of respective regression coefficients).

*, ** and *** Significant at 10, 5 and 1 per cent levels, respectively.

Table 7.11 : Regression Coefficients, Standard Errors and Coefficient of Multiple Determination For Sugarcane-Planted (Irrigated) and Cotton (Irrigated) in 1956-57 and 1970-71

Year	Constant ($\log_{10} a$)	Land (Hectares)	Human labour (Man-days)	Bullock labour (Pair-days)	Manures & Fertilizers (Rupees)	Other working capital (Rupees)	Sum of regression coefficients	R^2	'F' value
				Sugarcane-Planted (Irrigated)					
1956-57	-.10400	.28415	.08910	.11123	.40384	.09191	.98023	.95371	169.3346***
N=21	N.S. (.46269)	* (.18736)	N.S. (.14413)	* (.08613)	** (.18539)	* (.06991)			
1970-71	.12136	.29877	.14766	.09685	.32097	.11670	.98094	.97648	365.4031***
N=50	N.S. (.24105)	*** (.08032)	** (.06792)	** (.05641)	*** (.07132)	** (.04942)			
				Cotton (Irrigated)					
1956-57	-.26715	.67692	.20011	-.07264	.22337	.05155	1.07932	.80139	14.7923***
N=21	N.S. (.73715)	** (.32895)	* (.14961)	N.S. (.30972)	* (.15194)	N.S. (.17432)			
1970-71	.11759	.50673	.29399	.01217	.12119	.05109	.98518	.92601	63.6225***
N=39	N.S. (.21912)	*** (.08247)	*** (.10502)	N.S. (.05954)	*** (.04281)	N.S. (.04568)			

(Figures in parentheses are the standard error of respective regression coefficients).

*, ** and *** Significant at 10, 5 and 1 per cent levels, respectively.

Table 7.12 : Regression Coefficients, Standard Errors and Coefficient of Multiple Determination for Gram (Unirrigated) and Groundnut (Unirrigated) in 1956-57 and 1970-71

Year	Constant (log e 10)	Land (Hectares)	Human labour (Man-days)	Bullock labour (Pair-days)	Manures & Fertilizers (Rupees)	Other working capital (Rupees)	Sum of regression coefficients	R^2	'F' value
Gram (Unirrigated)									
1956-57	-.03061	.37166	.14694	.45661	.14004	-.19894	.92630	.73912	17.4302***
N=33	(.60485) N.S.	(.30633) *	(.09196) *	(.23017) **	(.10902) *	(.41491) N.S.			
1970-71	-.40361	.47686	.26947	-.17198	.11591	.32253	1.01279	.98956	98.0586***
N=27	(.24292) *	(.16257) ***	(.19974) *	(.10128) *	(.03984) ***	(.12789) **			
Groundnut (Unirrigated)									
1956-57	-.22079	.61759	.10161	.09590	.07266	.03371	.92147	.83173	83.9446***
N=22	(.15455) *	(.08799) ***	(.10268) N.S.	(.05618) *	(.01268) ***	(.09113) N.S.			
1970-71	-.46472	.65678	.08899	-.05321	.12832	.03732	.85822	.85615	74.1439***
N=23	(.59824) N.S.	(.22126) ***	(.05925) *	(.08273) N.S.	(.05230) **	(.22709) N.S.			

(Figures in parentheses are the standard error of respective regression coefficients).

*, ** and *** significant at 10, 5 and 1 per cent levels, respectively.

Further, in order to study changes in farmer's allocative efficiency of agricultural resources for different crops, comparisons of the marginal value products of farm inputs were made with their respective per unit acquisition costs. The marginal value products (at the geometric mean level) of all the inputs found significant in the equations (presented in Tables 7.8 through 7.12) were compared with their respective per unit acquisition costs to test the efficiency of their utilization in the production of different crops. The differences between the marginal value products and per unit acquisition costs were tested for their significance with the help of 't' test. The results thus obtained are presented in Tables 7.13, 7.14, 7.15, 7.16 and 7.17 for Jowar (unirrigated and irrigated), Bajra (unirrigated and irrigated), Wheat (unirrigated and irrigated), Sugarcane-planted and Cotton (both irrigated) and Gram and Groundnut (both unirrigated), respectively. The results of the estimated production functions and the comparisons of marginal value products of different inputs with their per unit acquisition costs in respect of individual crops are discussed below separately.

7.6.1 Resource Productivity of Farm Inputs for Different Crops :

It can be made out from the data presented in Tables 7.8 through 7.12 that the multiple correlation coefficients of all the production functions estimated for different crops grown in the years 1956-57 and 1970-71 were statistically significant at 1 per cent probability level, indicating that the form of the production functions gives a good fit. An examination of the coefficients of multiple determination (R^2) of production functions for all the crops indicates that land, human labour, bullock labour, manures and fertilizers and other working capital explained together about 74 to 95 per cent and 81 to 95 per cent variation in the logarithm of output of different crops grown in the years 1956-57 and 1970-71, respectively. The percentage variation in the logarithm of output explained by the included input variables seems to have been increased during the period in case of all the crops grown under irrigated conditions (excepting Bajra) and gram grown under unirrigated conditions, whereas in case of all the other crops it has remained more or less the same.

The regression coefficients of land were found to be significant for all the crops grown in both the years. The regression coefficients of human labour were significant for all the crops excepting sugarcane planted (irrigated), cotton (irrigated), Gram (unirrigated) and Groundnut (unirrigated) grown in 1956-57 and Wheat, Bajra and Ground-nut (all unirrigated) grown in 1970-71. The probable reason for non-significant coefficients of this input for the abovementioned crops may be that the use of human labour for these crops was nearly uniform or varied within a very narrow range. The regression coefficients of bullock labour were found to be significant only in the production functions for Sugarcane-planted (irrigated) and Gram and Groundnut (both unirrigated) grown in both the years, and Wheat and Bajra (both unirrigated) grown in 1970-71.

The regression coefficients of manures and fertilizers were significant in almost all the production functions excepting for Jowar and Gram (both unirrigated) grown in 1956-57 and Groundnut (unirrigated) grown in 1970-71. Other working capital was not found to be significant for Jowar, Wheat, Cotton (all irrigated), and Groundnut (unirrigated) crops grown in 1956-57 and Jowar, Bajra, Wheat, Gram (all unirrigated) and local Bajra and Cotton (both irrigated) crops grown in 1970-71.

The elasticities of output with respect of land, human labour, manures and fertilizers and other working capital were positive in all the crops grown in both the years excepting for other working capital in Gram (unirrigated) grown in 1956-57 where it was negative. The elasticity of output with respect to bullock labour turned out to be negative in the production functions estimated for Jowar (unirrigated), Wheat (irrigated and unirrigated) and Cotton (irrigated) crops grown in 1956-57 and Gram and Groundnut (both unirrigated), grown in 1970-71. The negative elasticity of output with respect to bullock labour for these crops indicates that there was probably an excessive use of this input. But the negative elasticity of output with respect to bullock labour was however found to be statistically non-significant in case of the crops grown in 1956-57.

An examination of the elasticities of production of different inputs with reference to all the crops grown in both the years indicates that the elasticity of production of individual inputs were less than unity, implying decreasing marginal productivity of factor-inputs.

The elasticities of production were highest for land, followed by human labour and manures and fertilizers in case of majority of the crops grown in 1956-57. Even in the year 1970-71, the elasticities of production were highest for land in all the crops but they were followed by manures and fertilizers in some crops and human labour and other working capital in other crops. These elasticities indicate that the output response to a given increase in land input was greater than from a similar increase in the use of other farm inputs (given the use of all other inputs) in both the years. Besides this, it is found that the elasticity of production of land input has increased during the period, particularly for all the crops grown under unirrigated conditions and jowar grown under irrigated conditions. The production elasticity of land input has decreased during the period in case of Bajra, Wheat and Cotton crops grown under irrigated conditions, whereas it has remained the same in case of Sugarcane-planted.

The elasticity of production of human labour input seems to have decreased during the period in majority of the crops excepting Sugarcane-planted and Cotton (both irrigated), and Gram (unirrigated). The elasticity of production of bullock labour has decreased during the period in all the elasticity of production of other working capital has increased in Jowar and Sugarcane-planted (both irrigated), and Gram (unirrigated), while it has decreased in Wheat (irrigated and unirrigated) and remained the same in case of Jowar, Bajra and Groundnut (all unirrigated) and Cotton (irrigated) crops.

An examination of the sums of regression coefficients obtained for the individual production functions reveals that there existed increasing returns to scale for Jowar (irrigated), Wheat (irrigated) and Cotton (irrigated) crops grown in 1956-57. Nearly constant returns to scale have been noticed for Sugarcane-planted (irrigated) and Jowar (unirrigated) crops grown in both the years and Gram (unirrigated) grown in 1970-71. In case of all other crops grown in 1956-57 and 1970-71 there prevailed decreasing returns to scale. The returns to scale were found to have been improved only in case of Bajra and Gram (both unirrigated), whereas there was downward movement in the returns to scale during the period in case of all other crops excepting Sugarcane-planted (irrigated) and Jowar (unirrigated) in whose case the constant returns to scale remained unchanged.

The comparison of the values of the intercept term reveals that there has been technological change in production of majority of the crop enterprises excepting Jowar (both irrigated and unirrigated), Gram and Groundnut (both unirrigated). The degree of technological change, however, varied considerably among these crop enterprises.

7.6.2 Comparison of Marginal Value Product of Inputs With Their Prices For Different Crops :

Based on the data given in Tables 7.13 through 7.17, a comparison is made below between the marginal value products (at the geometric mean level) of all the inputs found significant in the equations (presented in Tables 7.8 through 7.12) with their per unit prices (acquisition costs) to study changes in farmer's allocative efficiency of agricultural resources for different crops over the period under reference.

i) Jowar (Unirrigated :

The marginal value products of land and bullock labour inputs were significantly lower than their prices. in both the years. This indicates that both the inputs were not optimally used in both the years. The differences between the marginal value products of human labour and other working capital and their prices were found non-significant, thus showing the optimum use of these inputs in both the years. As against this, the use of manures and fertilizers, which was found to be optimal in 1956-57, was less than optimum in 1970-71. This means that the returns could be increased by increasing use of manures and fertilisers for Jowar (unirrigated).

ii) Jowar (Irrigated) :

The comparison of marginal value products of inputs with their prices indicated that land, human labour and other working capital were optimally used for Jowar (irrigated in both the years as the marginal value products of these inputs were not

Table 7.13 : Comparison of Marginal Value Products of Farm Inputs With Their Prices for Jowar (Unirrigated) and Jowar (Irrigated) in 1956-57 and 1970-71

Items	Rupees per unit of inputs			
	Jowar(Unirrigated)		Jowar (Irrigated)	
	1956-57	1970-71	1956-57	1970-71
No. of observations	50	88	40	74
Land				
MVP at G.M.	29.81	89.73+	207.95	218.14
Price (per unit)	100.77	132.46	156.53	175.63
Difference	-79.96***	-42.73***	51.42	42.51
S.E.	20.89	16.24	95.47	37.67
Human Labour				
MVP at G.M.	2.50	1.84	3.26	1.20
Price (per unit)	2.32	2.32	2.16	2.16
Difference	0.18	-0.48	1.10	-0.96
S.E.	1.14	0.67	1.41	0.83
Bullock Labour				
MVP at G.M.	1.25	-0.58	1.78	0.63
Price (per unit)	6.52	7.72	4.91	7.02
Difference	-5.27***	-8.30***	-3.13*	-6.39***
S.E.	2.09	1.90	2.34	1.80
Manures and Fertilizers				
MVP at G.M.	1.08	1.62	2.30	4.38+
Price (per unit)	1.00	1.00	1.00	1.00
Difference	0.08	0.62**	1.30*	3.38***
S.E.	1.29	0.37	0.93	0.70
Other Working Capital				
MVP at G.M.	0.78	1.28	0.91	0.84
Price (per unit)	1.00	1.00	1.00	1.00
Difference	-0.22	0.28	-0.09	-0.16
S.E.	0.55	1.61	4.55	0.58

*,** and *** Significant at 10, 5 and 1 per cent levels, respectively.

+, indicates that the marginal value products of the input estimated for two years are significantly different from each other.

Table 7.14 : Comparison of Marginal Value Products of Farm Inputs With Their Prices for Bajra (Unirrigated) and Bajra-Local and Hybrid (Irrigated) in 1956-57 and 1970-71

Items	Rupees per unit of inputs			
	Bajra (Unirrigated)		Bajra (Irrigated) 1970-71	
	1956-57	1970-71	Local	Hybrid
No. of observations	64	55	27	41
Land				
MVP at G.M.	48.78	91.11+	152.02	243.56
Price (per unit)	99.32	128.32	126.05	144.80
Difference	-50.54***	-37.21*	25.97	98.76*
S.E.	19.37	24.99	53.84	
Human Labour				
MVP at G.M.	1.19	0.62	2.47	1.83
Price (per unit)	2.14	2.14	2.43	2.36
Difference	-0.95**	-1.52**	0.04	-0.53
S.E.	0.47	0.72	1.21	1.31
Bullock Labour				
MVP at G.M.	0.74	4.84+	2.35	5.35
Price (per unit)	6.30	6.95	7.37	7.86
Difference	-5.56***	-2.11	-5.02	-2.51
S.E.	1.84	2.40	4.02	4.87
Manures and Fertilizers				
MVP at G.M.	1.79	1.56	1.14	2.03
Price (per unit)	1.00	1.00	1.00	1.00
Difference	0.79	0.56*	0.14	1.03**
S.E.	0.79	0.36	0.73	0.51
Other Working Capital				
MVP at G.M.	0.71	0.85	1.18	1.94
Price (per unit)	1.00	1.00	1.00	1.00
Difference	-0.29	-0.15	0.18	0.94
S.E.	1.09	0.96	1.57	1.32

*, ** and *** Significant at 10, 5 and 1 per cent levels, respectively.

+ indicates that MVPs of the input estimated for two years are significantly different from each other.

significantly different from their prices. The marginal value product of bullock labour was negative in both the years and the difference between the marginal value product and its price was found to be significant. This indicates that the bullock labour input was used in excess. The marginal value product of manures and fertilizers was significantly higher than its price in both the years; indicating thereby lower than optimum level use of manures and fertilizers for the crop. In other words, there existed a scope for increasing returns from Jowar (irrigated) by increasing use of manures and fertilizers in both the years.

iii) Bajra (Unirrigated) :

In case of Bajra (unirrigated) the marginal value products of land and human labour were significantly lower than their prices in both the years, which meant excessive use of these inputs. The marginal value product of bullock labour was significantly lower than its price in 1956-57, but the difference between its marginal value product and price was non-significant in 1970-71. This indicates that the use of bullock labour for Bajra (unirrigated) has become optimal during the period. The use of manures and fertilizers and other working capital in 1956-57 and that of latter in 1970-71, was found to be optimal as the differences between their marginal value products and prices were non-significant during respective years. The marginal value product of manures and fertilizers, however, was found to be significantly higher than its price. There was, thus, a need for increasing its use for maximizing returns.

Table 7.15 : Comparison of Marginal Value Products of Farm Inputs With Their Prices for Wheat (Unirrigated) and Wheat (Irrigated) in 1956-57 and 1970-71

Items	Rupees per unit of inputs			
	Wheat(Unirrigated)		Wheat(Irrigated)	
	1956-57	1970-71	1956-57	1970-71
No. of observations	20	21	40	69
<u>Land</u>				
MVP at G.M.	96.69	222.46	105.69	305.75+
Price (per unit)	154.94	187.86	194.68	186.83
Difference	-58.25	34.60	-88.99	118.92*
C.I.	67.26	95.51	71.07	92.11
<u>Human Labour</u>				
MVP at G.M.	1.73	0.52	1.91	3.90+
Price (per unit)	2.83	3.31	2.15	2.15
Difference	-1.10	-2.79	-0.24	1.75**
C.I.	1.18	3.82	0.70	1.04
<u>Bullock labour</u>				
MVP at G.M.	-0.95	6.62+	-1.79	0.22
Price (per unit)	5.37	8.61	4.17	6.45
Difference	-6.32**	-1.99	-5.96***	-6.23**
C.I.	2.68	5.17	1.55	3.36
<u>Manures and Fertilizers</u>				
MVP at G.M.	1.55	1.56	2.88	2.42
Price (per unit)	1.00	1.00	1.00	1.00
Difference	0.55	0.56	1.88*	1.42***
C.I.	1.06	1.05	1.30	0.54
<u>Other Working Capital</u>				
MVP at G.M.	1.21	0.27	1.51	0.56
Price (per unit)	1.00	1.00	1.00	1.00
Difference	0.21	-0.73	0.51	-0.44*
C.I.	0.84	2.00	2.19	0.34

*, ** and *** Significant at 10, 5 and 1 per cent levels, respectively.

+ indicates that the MVPs of the input estimated for two years are significantly different from each other.

iv) <u>Bajra</u> (Irrigated) :

In case of Bajra-Local (irrigated) grown in 1970-71 the differences between the marginal value products of all the five categories of inputs and their respective prices were found to be non-significant, indicating thereby optimal level use of these inputs. The use of human labour, bullock labour and other working capital inputs was found to be optimal in case of Bajra-Hybrid (irrigated) grown in 1970-71. There, however, existed greater scope for increasing returns from Bajra-Hybrid (irrigated) by increasing use of land and manures and fertilizers inputs as the marginal value products of these inputs were found to be significantly higher than their prices.

v) <u>Wheat</u> (Unirrigated) :

The difference between the marginal value products of all the categories of inputs used for Wheat (Unirrigated) and their prices was found non-significant in both the years. This reveals that there was optimum level use of these inputs. The only exception to this was bullock labour used in 1956-57, whose marginal value product was significantly lower than its per unit price, indicating thereby excessive use of this input.

vi) <u>Wheat</u> (Irrigated)

The difference between the marginal value products of land, human labour and other working capital inputs and their per unit prices was non-significant in 1956-57, which means that these inputs were used optimally for the crop. The marginal value product of bullock labour was significantly lower than and that of manures and fertilizers greater than their respective prices in the same year. This shows that the use of bullock labour was in excess and that of manures and fertilizers below the optimal level for the crop grown in 1956-57. In the year 1970-71, however, the marginal value products of land, human labour and manures and fertilizers inputs were significantly higher than their respective prices, indicating thereby less than optimal level use of these inputs for the crop. As against this, the marginal value products of bullock labour and other working capital were found to be significantly lower than their prices and therefore these inputs seem to have been used in excess for the crop. The comparison of marginal value products of all the inputs and their prices clearly reveals that there existed greater scope for increasing returns from the crop through optimal level use of these inputs in 1970-71. The returns could be increased by increasing use of land, human labour and manures and fertilizers inputs and by decreasing the use of bullock labour and other working capital inputs. The increase in the marginal productivities of land, human labour and manures and fertilizers during the period may be attributed to the improved seed variety of the crop sown in 1970-71.

vii) <u>Sugarcane-Planted</u> (Irrigated) :

Sugarcane is perhaps the only crop wherein no change in the allocative efficiency of the sample farms is observed during the period. The marginal value products of land and

Table 7.16 : Comparison of Marginal Value Products of Farm Inputs With Their Prices for Sugarcane-Planted Irrigated) and Cotton (Irrigated) in 1956-57 and 1970-71

Items	Rupees per unit of inputs			
	Sugarcane-Planted (Irrigated)		Cotton (Irrigated)	
	1956-57	1970-71	1956-57	1970-71
No. of observations	21	50	21	39
Land				
MVP at G.M.	2145.13	2470.94	320.29	899.58+
Price (per unit)	369.70	581.59	168.33	177.26
Difference	1775.43*	1889.35***	151.96	722.32***
S.E.	1301.76	639.57	155.68	132.60
Human Labour				
MVP at G.M.	3.84	5.46	1.63	2.59
Price (per unit)	2.41	3.31	2.19	3.12
Difference	1.43	2.15	-0.56	-0.53
S.E.	5.98	2.42	4.03	0.84
Bullock Labour				
MVP at G.M.	18.66	19.66	-1.38	0.99
Price (per unit)	6.50	11.74	5.99	6.30
Difference	12.16	7.92	-7.37	-5.31
S.E.	13.91	11.08	5.87	4.37
Manures and Fertilizers				
MVP at G.M.	5.68	2.95	2.04	2.51
Price (per unit)	1.00	1.00	1.00	1.00
Difference	4.68**	1.95***	1.04	1.51**
S.E.	2.51	0.63	1.39	0.80
Other Working Capital				
MVP at G.M.	1.14	1.21	1.09	1.39
Price (per unit)	1.00	1.00	1.00	1.00
Difference	0.14	0.21	0.09	0.39
S.E.	0.84	0.49	3.70	1.12

*,** and *** Significant at 10, 5 and 1 per cent levels, respectively.

+ indicates that the MVPs of the input estimated for two years are significantly different from each other manures and fertilisers inputs were found to be significantly higher than their per unit prices during both the years. This indicates that there existed greater scope for increasing returns from the crop during both the years by increasing the use of land and manures and fertilisers inputs to the optimal level. The difference between the marginal value products of human labour, bullock labour and other working capital and their respective per unit prices was non-significant during both the years, which meant that there was optimal level use of these inputs. It may, however, be noted that limitation on availability of irrigation resource will not permit diversion of additional land for sugarcane cultivation for maximizing returns.

viii) Cotton (Irrigated) :

The difference between the marginal value products of all the categories of inputs and their per unit prices was non-significant in the year 1956-57, indicating thereby optimal level use of these inputs. In the year 1970-71 also, the difference between the marginal value products of human labour, bullock labour and other working capital inputs and their per unit prices was non-significant. The marginal value products of land and human labour inputs, however, are found to be significantly higher than their respective prices in the year 1970-71, meaning thereby less than optimal level use of these inputs. The returns from cotton cultivation could, therefore, be increased by increasing use of these inputs. The comparison

Table 7.17 : Comparison of Marginal Value Products of Farm Inputs With Their Prices for Gram (Unirrigated) and Groundnut (Unirrigated) in 1956-57 and 1970-71

Items	Rupees per unit of inputs			
	Gram(Unirrigated)		Groundnut(Unirrigated)	
	1956-57	1970-71	1956-57	1970-71
No. of observations	33	27	22	23
Land				
MVP at G.M.	80.62	91.73	463.75	755.84
Price (per unit)	117.27	163.91	139.33	180.14
Difference	-36.65	-72.18**	324.42***	575.70**
S.E.	66.45	31.27	66.06	254.63
Human Labour				
MVP at G.M.	1.24	1.99	1.44	1.57
Price (per unit)	2.94	2.91	2.17	2.14
Difference	-1.70	-0.92	-0.73	-0.57
S.E.	2.54	1.48	1.46	2.45
Bullock Labour				
MVP at G.M.	10.50	-1.46++	4.56	-3.51+
Price (per unit)	5.02	7.23	5.67	6.10
Difference	5.48	-8.69***	-1.11	-9.61**
S.E.	5.29	0.86	2.67	5.45
Manures and Fertilizers				
MVP at G.M.	1.88	0.67	2.39	4.59
Price (per unit)	1.00	1.00	1.00	1.00
Difference	0.88	-0.33*	1.39***	3.59**
S.E.	2.81	0.23	0.42	1.87
Other Working Capital				
MVP at G.M.	-0.83	0.89+	0.29	0.20
Price (per unit)	1.00	1.00	1.00	1.00
Difference	-1.83***	-0.11	-0.71	-0.80
S.E.	0.48	0.35	0.78	1.22

*, ** and *** Significant at 10, 5 and 1 per cent levels, respectively.

+ indicates that the MVPs of the input estimated for two years are significantly different from each other.

of marginal value products of all the categories of inputs reveals that the technological breakthrough in cotton cultivation has contributed to increased productivity of all the inputs during the period.

ix) Gram (Unirrigated) :

The use of different inputs for Gram (unirrigated) presents a quite different picture. The optimum resource allocation for the crop was found in case of all the categories of inputs (excepting other working capital) in 1956-57 and human labour and other working capital inputs in 1970-71. The use of other working capital in 1956-57 and that of land, bullock labour and manures and fertilisers in 1970-71 is found to be in excess.

x) Groundnut (Unirrigated) :

The marginal value products of land and manures and fertilisers are found to be significantly higher than their respective prices in both the years, indicating thereby less than optimal level use of these inputs. That means, there existed greater scope for increasing returns through increased use of land and manures and fertilisers inputs during both the years. The difference between the marginal value products of human labour and other working capital and their prices was non-significant during both the years, indicating thereby optimal level use of these inputs. The use of bullock labour input which was found to be optimal in 1956-57 seems to have become excessive in 1970-71 as its marginal value product was significantly lower than its per unit price during the latter year.

As discussed above, the marginal value product of land input was found significantly higher than its price (average imputed rental of land) in case of Sugarcane-planted (irrigated) and Groundnut (unirrigated) crops grown in both the years and Bajra-Hybrid, Wheat and Cotton (all irrigated) crops grown in 1970-71. As against this, the marginal value product of land input was found to be significantly lower than its price in case of Jowar and Bajra (both unirrigated) crops grown in both the years and Gram (unirrigated) grown in 1970-71. These findings indicate that the expansion of area under cultivation would be more profitable in majority of the crops grown under irrigated conditions. Another conclusion that follows from the evidence is that the high yielding varieties of Bajra, Wheat and Cotton grown under irrigated conditions have played a prominent role in the year 1970-71 in increasing the marginal productivity of land input.

The human labour input was found to be optimally used for almost all the crops grown in both the years excepting for Bajra (unirrigated) grown in both the years and Wheat(irrigated) grown in 1970-71. The use of human labour input was found to be in excess for Bajra (unirrigated) in both the years, whereas there existed a scope for increasing returns from Wheat (irrigated) in 1970-71 through increased use of human labour input.

The marginal value product of bullock labour input was lower than its per unit price in all the crops (excepting Sugarcane-planted), although the differences were non-significant in some of the cases. The marginal value product of bullock labour input was significantly lower than its per unit price in case of Jowar (unirrigated), Jowar (irrigated) and Wheat (irrigated) crops grown in both the years, Bajra (unirrigated) and Wheat (unirrigated) grown in 1956-57, and Gram (unirrigated) and Groundnut (unirrigated) grown in 1970-71. This indicates higher than optimal level use of bullock labour input for majority of the crops in both the years.

As regards manures and fertilisers input, it was found that its marginal value product was significantly higher than its price in 4 out of 9 crops grown in 1956-57 and 8 out of 11 crops grown in 1970-71. This indicates that, inspite of the higher use of manures and fertilisers input in the latter year as compared to the former, there is further scope for increasing application of manures and fertilisers for different crops in order to optimise its use and increase returns. Adoption of fertiliser responsive high yielding varieties of some of the crops and better irrigation control might be some of the reasons for such a change. Considering the possible high potential for increasing crop yields through increased use of manures and fertilisers, it may be said that the farms, in general, were less efficient in using this input at the optimal level, particularly in 1970-71, may be due to limitations on availability of required funds for this purpose.

The difference between the marginal value product of other working capital and its price was non-significant in all the crops grown in both the years. The only exception to this was found in Gram (unirrigated) and Wheat (irrigated) grown in 1956-57 and 1970-71, respectively, in whose case the marginal value products of other working capital were significantly lower than its price. It may be concluded that, on the whole, the other working capital input was optimally used in both the years.

The comparison of marginal value products of different inputs with their prices for different crops indicated that the marginal value products of inputs were significantly different from their prices in 15 cases out of the 45 comparisons made in 1956-57 and in 25 cases out of the 55 comparisons in 1970-71. These findings suggest that the degree of efficiency of allocation of agricultural resources was relatively higher in 1956-57 than that in 1970-71. This particular finding is a clear indication of the fact that, since agriculture in the region is in the transitional phase of development it was in a state of disequilibrium in the early 'seventies, and may be, it might take several years to attain a new equilibrium at a higher level.

7.7 Economic Optimal Levels of Inputs for Different Crops :

It has been observed in the previous section that there existed some inefficiencies in the allocation of farm resources in both the years. Keeping this in view, an attempt has been made to study the economic optimal level of farm inputs in the production of individual crops under limited capital (actual used) constraint. The main objective of such analysis is to see the extent to which existing level of input use deviated from the optimal level and find out the possible increase in the output level of individual crops through reallocation of limited capital.

Land is the main resource of the farmers in the production process. The foregoing discussion has shown that the marginal value product of land is much higher than its rental value in majority of the crops. This suggests that the area under cultivation should be increased for its optimal use. However, land being a fixed resource, it is not possible for the farmers with their limited capital to extend the area under cultivation. Therefore, any suggestion on desirability of increasing the use of land resource would not be of practical use. The consideration of economic optimal levels of farm inputs has been, therefore, limited to human labour, bullock labour, manures and fertilisers and other working capital. The economic optimal levels of these inputs have been separately estimated for the individual crops grown in both the years on per hectare basis. While estimating these levels, the levels of land and other non-significant inputs have been fixed at the geometric mean. The estimated existing and optimal levels of farm inputs and output per hectare are given in Tables 7.18, 7.19, 7.20, 7.21 and 7.22, respectively, for the crops Jowar (unirrigated and irrigated), Bajra (unirrigated and irrigated), Wheat (unirrigated and irrigated), Sugarcane-planted and Cotton (both irrigated) and Gram and Groundnut (both unirrigated) grown in 1956-57 and 1970-71.

Table 7.18 : Existing and Optimal Levels of Farm Inputs and Output Per Hectare of Jowar (Unirrigated) and Jowar (Irrigated) in 1956-57 and 1970-71

Items	Jowar(Unirrigated)		Jowar(Irrigated)	
	1956-57	1970-71	1956-57	1970-71
Capital allocated(Rs.)	68.40	78.06	157.36	166.23
Human Labour (Man-days)				
Existing level	25.40	28.32	62.09	54.35
Optimal level	26.42	24.30	57.61	29.63
Difference	1.02	4.02	4.48	24.72
Bullock Labour (Pair-days)				
Existing level	-	-	-	-
Optimal level	-	-	-	-
Difference	-	-	-	-
Manures and Fertilizers(Rs.)				
Existing level	-	12.36	23.25	17.93
Optimal level	-	21.68	32.91	76.87
Difference	-	9.32	9.66	58.94
Other Working Capital(Rs.)				
Existing level	9.48	-	-	30.90
Optimal level	7.09	-	-	25.36
Difference	2.39	-	-	4.54
Output (Quintals)				
Existing level	1.55	2.06	6.03	5.62
Optimal	1.56	2.10	6.08	6.57
Difference	0.01	0.04	0.05	0.95
Percentage increase	0.65	1.94	0.83	16.90

Table 7.19 : Existing and Optimal Levels of Farm Inputs and Output Per Hectare of Bajra (Unirrigated) and Bajra-Local and Hybrid (Irrigated) in 1956-57 and 1970-71

Items	Bajra(Unirrigated)		Bajra(Irrigated)	
			Local	Hybrid
	1956-57	1970-71	1970-71	1970-71
Capital allocated(Rs.)	68.82	87.19	135.85	209.33
Human Labour (Man-days)				
Existing level	29.08	-	39.16	62.63
Optimal level	24.01	-	37.77	31.57
Difference	5.07	-	1.39	31.06
Bullock labour(pair-days)				
Existing level	-	9.53	-	-
Optimal level	-	7.10	-	-
Difference	-	2.43	-	-
Manures and Fertilizers(Rs.)				
Existing level	6.59	20.96	40.69	61.52
Optimal level	17.44	37.81	44.08	81.04
Difference	10.85	16.85	3.39	19.52
Other Working Capital(Rs.)				
Existing level	-	-	-	42.66
Optimal level	-	-	-	53.79
Difference	-	-	-	11.13
Output (Quintals)				
Existing level	1.59	2.75	4.52	10.17
Optimal level	1.65	2.79	4.57	10.37
Difference	0.06	0.04	0.05	0.20
Percentage increase	3.77	1.45	1.11	1.97

Table 7.20 : Existing and Optimal Levels of Farm Inputs and Output Per Hectare of Wheat (Unirrigated) and Wheat (Irrigated) in 1956-57 and 1970-71

Items	Wheat(Unirrigated)		Wheat (Irrigated)	
	1956-57	1970-71	1956-57	1970-71
Capital allocated(Rs.)	159.17	150.58	222.87	446.29
Human Labour (Man-days)				
Existing level	41.07	-	93.73	104.67
Optimal level	31.05	-	77.12	125.86
Difference	10.02	-	16.61	21.19
Bullock Labour(Pair-days)				
Existing level	-	14.30	-	-
Optimal level	-	12.04	-	-
Difference	-	2.26	-	-
Manures and Fertilisers(Rs.)				
Existing level	16.76	27.46	21.35	74.57
Optimal level	32.10	46.88	57.07	120.64
Difference	15.34	19.42	35.72	46.07
Other Working Capital(Rs.)				
Existing level	26.18	-	-	146.68
Optimal level	39.20	-	-	55.04
Difference	13.02	-	-	91.64
Output (Quintals)				
Existing level	2.34	4.95	3.04	11.26
Optimal level	2.72	5.03	3.42	12.17
Difference	0.38	0.08	0.38	0.91
Percentage increase	16.24	1.62	12.50	8.08

use of human labour in 1956-57 and bullock labour in 1970-71 and more manures and fertilisers in both the years for obtaining 3.77 and 1.45 per cent increase in existing level output during the respective years.

iv) <u>Bajra</u> (Irrigated) :

The estimates relating to optimal resource use levels in the production of Bajra-Local (Irrigated) in 1970-71 indicate that there was not much difference in the optimal and existing levels of use of human labour and manures and fertilisers inputs. Reallocation of funds in favour of more manures and fertilisers and less human labour could have contributed to 1.11 per cent increase in the existing level output. Similarly, in case of Bajra-Hybrid (irrigated) grown in 1970-71, it is found that there was the possibility of obtaining 1.97 per cent increase in the existing output level through reallocation of funds in favour of more manures and fertilisers and other working capital and less human labour.

v) <u>Wheat</u> (Unirrigated) :

The comparison of the optimal and existing levels of inputs in the production of Wheat (unirrigated) indicates that less investment in human labour and more on manures and fertilisers and other working capital could have contributed to increase in the existing level output by 16.24 per cent in 1956-57. As against this, there existed the possibility of obtaining 1.62 per cent increase in the existing level output in 1970-71 through reallocation of funds in favour of more manures and fertilisers and less bullock labour.

Table 7.21 : Existing and Optimal Levels of Farm Inputs and Output Per Hectare of Sugarcane-Planted(Irrigated) and Cotton (Irrigated) in 1956-57 and 1970-71

Items	Sugarcane-Planted (Irrigated)		Cotton(Irrigated)	
	1956-57	1970-71	1956-57	1970-71
Capital allocated (Rs.)	1435.86	2916.58	179.23	715.02
Human Labour (Man-days)				
Existing level	-	223.59	58.16	201.68
Optimal level	-	190.71	38.67	162.28
Difference	-	32.88	19.49	39.40
Bullock Labour(Pair-days)				
Existing level	45.01	40.74	-	-
Optimal level	40.51	35.27	-	-
Difference	4.50	5.47	-	-
Manures and Fertilizers (Rs.)				
Existing level	536.40	900.81	51.86	85.78
Optimal level	955.98	1372.27	94.54	208.71
Difference	419.58	471.46	42.68	122.93
Other Working Capital (Rs.)				
Existing level	606.89	797.40	-	-
Optimal level	217.57	498.94	-	-
Difference	389.32	298.46	-	-
Output* (Quintals)				
Existing level	76.51	83.83	2.38	8.10
Optimal level	95.30	92.10	3.00	8.46
Difference	18.79	8.27	0.62	0.36
Percentage increase	24.56	9.87	26.05	4.44

*Output of Sugarcane is measured in tonnes.

vi Wheat (Irrigated) :

The difference between the optimal and existing levels of inputs suggests that less investment should have been made in human labour and more on manures and fertilisers in 1956-57 to obtain 12.50 per cent increase in the existing output level of Wheat (irrigated). In the year 1970-71 also there existed the possibility of obtaining 8.08 per cent increase in the existing output level of this crop through reallocation of funds in favour of more manures and fertilisers and human labour and less other working capital. The optimisation of output exercise indicates that the existing allocation of resources widely deviated from the desired optimal level in the production of Wheat (irrigated) in both the years.

vii) Sugarcane-Planted (Irrigated) :

In the production of Sugarcane-Planted (irrigated) crop, the comparison of the optimal and existing levels of output indicates that there was the need for reallocation of funds in favour of more manures and fertilisers and less for all other inputs in both the years for optimising returns. Such reallocation of limited funds could have contributed to increase in output to the extent of 24.56 and 9.87 per cent over the existing level of output in the years 1956-57 and 1970-71, respectively.

viii) Cotton (Irrigated) :

The estimated optimal levels of resources in the production of Cotton (irrigated) in both the years indicate that there was the need for a lower level use of human labour and

Table 7.22 : Existing and Optimal Levels of Farms Inputs and Output Per Hectare of Gram (Unirrigated) and Groundnut (Unirrigated) in 1956-57 and 1970-71

Items	Gram(Unirrigated) 1956-57	Gram(Unirrigated) 1970-71	Groundnut(Unirrigated) 1956-57	Groundnut(Unirrigated) 1970-71
Capital allocated (Rs.)	137.37	180.57	112.50	172.26
Human Labour (Man-days)				
Existing level	25.44	26.22	-	65.44
Optimal level	9.63	23.62	-	24.24
Difference	15.81	2.60	-	41.20
Bullock Labour (Pair-days)				
Existing level	9.29	-	15.81	-
Optimal level	17.54	-	12.75	-
Difference	8.25	-	3.14	-
Manures and Fertilizers (Rs.)				
Existing level	15.94	33.73	22.86	32.22
Optimal level	21.02	29.57	48.49	101.72
Difference	5.08	4.16	25.63	69.50
Other Working capital (Rs.)				
Existing level	-	70.54	-	-
Optimal level	-	82.27	-	-
Difference	-	11.73	-	-
Output (Quintals)				
Existing level	2.47	2.24	5.06	7.76
Optimal level	2.83	2.49	5.24	8.23
Difference	0.36	0.25	0.18	0.47
Percentage increase	14.57	11.16	3.56	6.06

more of manures and fertilisers input than their existing levels of use to optimise the returns. The comparison of the optimal and existing levels of output indicates that the former was higher by 26.05 per cent in 1956-57 and 4.44 per cent in 1970-71 than the latter.

ix) <u>Gram</u> (Unirrigated) :

In the production of Gram (unirrigated), the comparison of optimal output with existing levels indicates that investable funds should have been used in favour of more bullock labour and manures and fertilisers and less human labour in order to maximize the returns in the year 1956-57. In the year 1970-71, however, there was the need for reallocation of funds in favour of more other working capital and less human labour and manures and fertilisers inputs to optimise returns. These adjustments could have resulted in increasing the output by 14.57 and 11.16 per cent in the years 1956-57 and 1970-71, respectively.

x) <u>Groundnut</u> (Unirrigated) :

The estimated optimal output levels for Groundnut (unirrigated) crop indicate the need for reallocation of funds to permit increased purchase of manures and fertilisers in both the years by way of using less bullock labour in 1956-57 and human labour in 1970-71. These adjustments in the investment funds could have resulted in increased output by 3.56 and 6.06 per cent over the existing level output in the years 1956-57 and 1970-71, respectively.

7.8 Economic Optimal Levels of Farm Resources for Farm Business as a Whole :

Comparisons of marginal value products of farm resources with their prices, in respect of individual crops as well as for the farm business (total crop production) as a whole, have indicated that there existed some inefficiencies in the allocation of farm resources during both the years. The analysis regarding estimation of optimal level use of farm resources for different crops has also supported the fact that there prevailed the possibilities of increasing output and gross returns of individual crops in both the years through optimal reallocation of farm resources. Similar attempt is made in this section to determine economic optimal use levels of farm resources for the total crop production business of the sample farms at two points of time and to study changes therein over a period of time. The economic optimal use levels of different farm resources are, however, determined both under unlimited and limited capital situations.

a) Economic Optimal Levels of Farm Resources Under Unlimited Capital Situation :

The estimated economic optimal use levels of different farm resources (under unlimited capital situation) with reference to each size group of farms and at the overall level of sample farms are given in Table 7.23 along with their existing use levels in the years 1956-57 and 1970-71.

Table 7.23 : Comparison of Economic Optimal levels of Farm Resources Under Unlimited Capital Situation With Their Existing Levels (At Geometric Mean) for Crop Production Business as a Whole of Sample Farms in 1956-57 and 1970-71

Inputs	Level of use	Size Groups: Small 1956-57	Small 1970-71	Medium 1956-57	Medium 1970-71	Large 1956-57	Large 1970-71	Overall 1956-57	Overall 1970-71
Land (Hectares)	Existing	2.06	2.69	6.60	7.07	13.74	13.95	5.66	6.43
	Optimal	1.68	2.81	6.30	5.96	13.61	15.14	6.53	6.89
Human labour(Man-days)	Existing	163.19	200.62	335.98	446.10	607.53	663.93	369.95	390.22
	Optimal	192.91	197.49	452.32	490.68	418.86	941.18	331.90	395.88
Bullock labour (pair-days)	Existing	61.20	42.33	124.91	110.24	265.84	160.32	136.76	90.78
	Optimal	32.81	-	-	66.91	81.99	98.62	51.02	34.17
Manures and fertilizers(Rs.)	Existing	76.65	104.60	185.68	368.53	273.70	630.41	180.24	341.85
	Optimal	168.79	167.56	308.29	613.24	413.47	1383.95	307.02	560.44
Other working capital(Rs.)	Existing	135.33	208.51	390.55	658.30	644.47	969.75	363.82	607.00
	Optimal	105.89	506.41	547.14	1167.30	334.80	2296.90	411.40	1138.35
Annualized capital investment(Rs.)	Existing	82.56	173.25	194.60	436.33	425.53	539.91	234.76	382.16
	Optimal	-	247.39	219.43	601.57	549.87	644.91	238.33	500.97

The comparison of the optimal and existing use levels of farm resources indicated that at the overall level, the optimal level use of land (gross cropped area) exceeded the existing level in both the years. The difference between the optimal and existing levels of land use, however, narrowed down during the period, implying thereby the economic rationality in the use of land resource during the latter period. The estimated optimal use level of human labour is found to be lower than its existing use level in 1956-57. However, in the year 1970-71, the difference between the optimal and existing use levels of human labour was almost negligible. This means that during the period under reference the average farmer in the region has attained the equilibrium position in the use of human labour resource. In case of bullock labour, the optimality exercise indicates that its use was economically irrational in both the years. It is seen that there was greater scope for decreasing the use of bullock labour to maximise net farm returns. The optimal use levels of manures and fertilisers other working capital and annualised capital investment are found to be higher than their existing use levels in both the years, showing thereby the need for increasing the use of these resources for maximising farm returns in 1956-57 as well as in 1970-71. The scope for increasing farm returns through increased use of these resources was, however, relatively more in the latter period. The evidence clearly indicates that the technological change, embodying the use of high yielding varieties of some of the crops, has necessarily pushed up the demand for irrigation resource, manures and fertilizers, farm machineries, etc., during the early 'seventies.

Looking to the existing and optimal use levels of farm resources with reference to different size groups of farms it is seen that the existing level use of land resource was lower than its optimal use level on large farms in 1956-57 and small and large farms in 1970-71. The existing use level of land resource was higher than its optimal use level in case of medium farms in both the years and small farms in 1956-57. This fact reveals that, because of intensive cultivation, small farms have succeeded in increasing productivity of land during the period, whereas in the case of large farms there prevailed the possibilities of deriving economies of large scale farming in both the years. The optimal use level of human labour is found to be higher than its existing use level in all the size groups of farms excepting large farms in 1956-57 and small farms in 1970-71. The existing use level of bullock labour was far beyond its optimal use level on all the farms in both the years. The examination of optimal and existing use levels of manures and fertilizers, other working capital and annualized capital investment clearly indicates that there was greater scope for maximizing farm returns through increased use of these resources on all the farms in both the years.

b) Economic Optimal Levels of Farm Resources Under Limited Capital Situation :

The estimates of economic optimal use levels of farm resources under unlimited capital situation are of limited practical use in the short-run period. This is so because, limitations on the availability of required capital do not permit immediate drastic changes in the resource use pattern in the direction of optimisation of farm resources. In that sense, these estimates merely indicate the potentialities of increasing farm returns in the region. Under the situation of limited capital, the farm returns could, however, be maximised in the short-run period through reallocation of limited capital among different farm resources in such a way that the marginal rate of substitution between two inputs was equal to the ratio of their prices. In view of this, the economic optimal levels of individual resources have been estimated under limited capital situation. While doing so, land and bullock labour inputs are held constant at their geometric mean levels for the reason that the former is a scarce input and the regression coefficients of the latter are found to be non-significant in majority of the production equations. Similarly the last input variable viz., annualised capital investment (representing fixed capital assets on the farms) is also held constant (at its geometric mean) in the analysis with an assumption that immediate adjustments in the use of this resource are not possible. The exercise regarding reallocation of limited capital in the direction of optimization of resource use is, therefore, restricted to only three other resources, namely, human labour, manures and fertilisers and other working capital. The optimal levels of use of these resources and gross returns under limited capital situation are given in Table 7.24 alongwith their existing levels in individual size groups of farms and at the overall level for both the years.

It can be seen from the table that at the overall level, reallocation of limited capital in favour of more manures and fertilisers and other working capital and less human labour could have contributed to an increase in the existing level of gross returns to the extent of 7.87 and 3.19 per cent in the years 1956-57 and 1970-71, respectively. When individual size groups are considered, it is found that the existing use level of human labour was higher than its optimal use level in all the size groups of farms in both the years. This suggests that the use of human labour should have been decreased to its optimal level and extra funds resulting therefrom should have been diverted for purchases of other resources. The optimal use level of manures and fertilisers turned out to be higher than its existing use level on all the farms in both the years. As against this, the optimal use level of other working capital was higher than its existing use level on large farms in 1956-57 and on all the farms in 1970-71. Based on these findings, it may be concluded that reallocation of funds in favour of more manures and fertilisers and other working capital and less human labour could have contributed to an increase in the gross returns on large farms in 1956-57 and on all the farms in 1970-71. Whereas, in case of small and medium farms in 1956-57 funds should have been reallocated in favour

Table 7.24 : Comparison of Economic Optimal Levels of Farm Resources and Gross Returns Under Limited Capital Situation With Their Existing Levels (at Geometric Mean) for Crop Production Business as a Whole of Sample Farms in 1956-57 and 1970-71

Inputs	Level	Size Groups: Small		Medium		Large		Overall	
		1956-57	1970-71	1956-57	1970-71	1956-57	1970-71	1956-57	1970-71
Capital allocated(Rs.)		595.48	768.52	1365.78	2101.93	2345.87	3213.51	1413.44	1873.67
Human labour (man-days)	Existing	163.19	200.62	335.98	446.10	607.53	663.93	369.95	390.22
	Optimal	157.79	135.23	322.03	348.08	567.12	506.79	313.08	281.28
	Difference	5.40	65.39	13.95	98.02	40.41	157.14	56.87	108.94
Manures and fertilisers(Rs.)	Existing	76.65	104.60	185.68	368.53	273.70	630.41	180.24	341.85
	Optimal	138.06	114.75	219.49	435.01	559.82	745.21	289.62	398.21
	Difference	61.41	10.15	33.81	66.48	286.12	114.80	109.38	56.36
Other working capital (Rs.)	Existing	135.33	208.51	390.55	658.30	644.47	969.75	363.82	607.00
	Optimal	86.61	346.81	389.53	828.06	453.31	1236.80	388.08	808.62
	Difference	48.72	138.30	1.02	169.76	191.16	267.05	24.26	201.62
Gross returns(Rs.)	Existing	1175.20	1695.60	2834.63	5162.78	4542.16	8699.71	2829.46	4238.72
	Optimal	1214.00	1795.00	2840.00	5238.00	5002.00	9031.00	3052.00	4374.00
	Difference	38.80	99.40	5.37	75.22	459.84	331.29	222.54	135.28
Percentage increase		3.30	5.86	0.19	1.46	10.12	3.81	7.87	3.19

of more manures and fertilisers and less human labour and other working capital. The reallocation of funds, as suggested above, could have made it possible to increase existing level of gross returns to the extent of 3.30, 0.19 and 10.12 per cent in 1956-57 and 5.86, 1.46 and 3.19 per cent in 1970-71 on small, medium and large farms, respectively. By comparing the possible percentage increase in the gross returns, resulting from reallocation of farm resources under limited capital situation, it is found that these possibilities were relatively more on small and large farms as compared with medium farms in both the years. This means that, as far as allocation of available (limited) capital is concerned, the medium farms were relatively more efficient in judicious use of farm resources in both the years followed by small farms in 1956-57 and large farms in 1970-71.

7.9 Technological Change and Relative Factor Shares in Agriculture :

It has been revealed from the foregoing discussion that during the period under reference agriculture in the region has shown changes in resource use structure, resource productivities and farmer's allocative efficiency. Adoption of new technology, wherever possible, and intensive cultivation have resulted in improvements in the productivities of individual resources. The importance of individual farm resources has also undergone a change as a result of technological transformation of agriculture in the region. As transforming agriculture necessarily brings about changes in relative factor shares, an attempt is made in this section to study changes in relative factor shares in agriculture in the region during the period of fourteen years (1956-57 to 1970-71).

The analysis attempted in the previous sections assumed Cobb-Douglas form of production function to be appropriate for studying factor-product relationships in agriculture. The analysis based on Cobb-Douglas framework has shown that there has been technological change in agriculture in the region as the elasticities of production and intercept term have undergone a marked change during the period. However, this analysis did not throw sufficient light on the changes in relative factor shares because, in the Cobb-Douglas framework the relative factor shares, by assumption, remain unchanged even with a change in relative factor prices and factor ratios (substitution between factors) as the elasticity of substitution between input factors is forced to unity. However, as evidenced by the study, the relative as well as absolute prices of labour and capital inputs and their ratios have undergone a change during the period. Under these circumstances an attempt is made to study empirically the changes in relative factor shares in agriculture with the help of Constant Elasticity of Substitution (C.E.S.) function which eliminates the assumption of an elasticity of factor substitution equal to unity. The C.E.S. function used for this purpose is of the following form

$$Q = \gamma \left[\delta K^{-\theta} + (1 - \delta) L^{-\theta} \right]^{-1/\theta} \quad \text{...(equation 1)}$$

Where, Q, K and L denote output, capital and labour, respectively,

γ is a technological parameter, δ is a distribution parameter and θ is the factor substitution parameter. The values of the parameters in the C.E.S. function have been estimated on the lines elaborated in Chapter 3 for the individual size groups of farms and at the overall level of sample farms, separately for both the years. The results are presented in Table 7.25. Further by making use of these parameters, the logarithm of the share of labour relative to capital in value added under marginal productivity equilibrium has been estimated by deriving the following equation :

$$\text{Log}(S) = \text{Log}\left(\frac{L}{K}\right) = \sigma \text{ Log}\left(\frac{1-\delta}{\delta}\right) + (\sigma - 1) \text{ Log}\left(\frac{q}{w}\right) + E$$

.....(equation 2)

Where,

L = Human labour (man-days),
K = Value of farm assets in rupees,
w = Wage rate per day in rupees in respective years,
q = Rental of capital per unit in rupees,
$1-\delta/\delta$ = Labour intensity,
σ = Elasticity of substitution $(1/1-\theta)$, and
E = Error term.

The estimated parameters of equation 2 are presented in Table 7.26.

It can be seen from the table that there has been a decline in the labour intensity $\left(\frac{1-\delta}{\delta}\right)$ on medium and large farms during the period. Similarly, there has been a decline in the factor price ratio $\left(\frac{q}{w}\right)$ in the same period on all the types of farms. The decline in the labour intensity and factor price ratio has been found to be relatively higher on large farms and medium

Table 7.25 : Estimated Parameters of Constant Elasticity of Substitution Function in Respect of Different Size Groups of Sample Farms in 1956-57 and 1970-71

Parameters	Size Groups						Overall	
	Small		Medium		Large			
	1956-57	1970-71	1956-57	1970-71	1956-57	1970-71	1956-57	1970-71
γ Technological parameter	2.3129	4.1321	3.0701	5.7822	2.4217	5.9170	2.6809	5.7382
δ Distribution parameter	.8375	.7988	.7228	.8477	.6707	.8230	.7572	.8237
$1-\delta$	.1625	.2012	.2772	.1523	.3293	.1770	.2428	.1763
θ Factor substitution parameter	7.2781	1.8417	7.9767	6.0077	3.8972	9.6270	9.8460	3.9505
σ Elasticity of substitution	.0208	.3519	.1114	.1427	.2042	.0941	.0922	.2020

Table 7.26 : Estimated Parameters of Equation $\text{Log}\left(\frac{L}{K}\right) = \sigma \log\left(\frac{1-\delta}{\delta}\right) + (\sigma - 1)\,\text{Log}\left(\frac{q}{w}\right) + \epsilon$ in Respect of Different Size Groups of Sample Farms in 1956-57 and 1970-71

Parameters	Size Groups						Overall	
	Small		Medium		Large			
	1956-57	1970-71	1956-57	1970-71	1956-57	1970-71	1956-57	1970-71
$\text{Log}\left(\frac{1-\delta}{\delta}\right)$	-.7127	-.5988	-.4162	-.7456	-.3090	-.6674	-.4940	-.6695
σ	.0208	.3519	.1114	.1427	.2042	.0941	.0922	.2020
$\text{Log}\left(\frac{q}{w}\right)$	-.2015	-.4059	-.1698	-.4866	-.1238	-.2562	-.0567	-.3795
Actual $\log\left(\frac{L}{K}\right)$	-.6454	-1.0052	-.3851	-1.0321	-.4687	-1.0488	-.4735	-1.0358
R^2	.1144	.4748	.1217	.1726	.1425	.0780	.1782	.2532

farms, respectively. There has, however, been an increase in the elasticity of substitution between capital and labour on small and medium farms. As the decline in the parameters of labour intensity and factor price ratio and an increase in the elasticity of substitution (when labour intensity and factor price ratios are less than unity) cause decline in the share of labour relative to capital in value added, it may be said that during the period under reference the income share of labour relative to capital has gone down in agriculture in the region.

An attempt is also made to determine the importance of forces affecting the relative income shares. For this, the effect of unit change in each of the three parameters - elasticity of substitution (σ), factor price ratio log $(\frac{q}{w})$ and labour intensity log $(\frac{1-\delta}{\delta})$ - on log S (ratio of labour share to capital share) was evaluated. The results are presented in Table 7.27.

Table 7.27 : Computed Partial Derivatives of Log $(\frac{L}{K})$ in Respect of Different Size Groups of Sample Farms in 1956-57 and 1970-71

Size Groups	Year	$\frac{\partial \text{ Log } S}{\partial \ \sigma}$	$\frac{\partial \text{ Log } S}{\partial \text{ Log}(\frac{1-\delta}{\delta})}$	$\frac{\partial \text{ Log } S}{\partial \text{ Log}(\frac{q}{w})}$
Small	1956-57	-.9136	.1208	-.8792
	1970-71	-1.0047	.3519	-.6482
Medium	1956-57	-.5860	.1114	-.8886
	1970-71	-1.2322	.1427	-.8573
Large	1956-57	-.4328	.2042	-.7958
	1970-71	-.9236	.0941	-.9059
Overall	1956-57	-.5507	.0922	-.9078
	1970-71	-1.0490	.2020	-.7980

It was found that a unit change in σ was the most important factor contributing to change in the relative share of labour followed by log $(\frac{q}{w})$ and log $(\frac{1-\delta}{\delta})$, respectively. The relative importance of the individual factors in affecting the relative income shares of labour and capital, however, differed as between the three size groups of sample farms.

Lastly, the marginal value products of labour and capital and the rate of technical substitution between labour and capital have been estimated within the C.E.S. function framework and the same are presented in Table 7.28.

Table 7.28 : Marginal Value Products of Capital and Labour and Rate of Technical Substitution for Different Size Groups of Sample Farms in 1956-57 and 1970-71

Size Groups	Year	Marginal Value Product of		Rate of technical substitution
		Capital	Labour*	
Small	1956-57	.3736	1.9553	.1911
	1970-71	.6590	4.5725	.1441
Medium	1956-57	.8099	2.2793	.3553
	1970-71	.7440	5.5640	.1337
Large	1956-57	.8857	1.7385	.5095
	1970-71	.9518	5.3143	.1791
Overall	1956-57	.6494	2.0854	.3114
	1970-71	.8185	5.5953	.1463

* The average absolute wage rates were Rs.1.13 and Rs.3.40 in 1956-57 and 1970-71, respectively.

It can be seen from the table that the marginal value products of both the factors have increased during the period. However, as there was similar increase in the average absolute wage rate, it may be said that the evidence presented above confirms the decline in the income share of labour relative to capital in value added.

SUMMARY AND CONCLUSIONS

Chapter 8

SUMMARY AND CONCLUSIONS

A perceptible technological transformation has been under way in Indian agriculture since the mid-'sixties. The new high yielding agricultural production technology has resulted in an upward shift in the production functions for major crops, disturbing thereby the stable long-run equilibrium of traditional agriculture. There are, however, some doubts regarding distribution of benefits of new agricultural technology over the farms and regions in India. The distribution of benefits among the regions have paralleled the existing resource endowment. The inter-regional disparities in the adoption of new technology have proved that technological improvements certainly overcome many of the limitations imposed by natural conditions, but beyond a point, increase in productivity or removal of uncertainties cannot be possible.

The State of Maharashtra is one of the several regions in the Indian Union where technological advances in agriculture have not made much head way in their contribution to increased agricultural productivity and production. The crux of the problem of modernisation of agriculture in the State is observed to be associated with the availability of capital resources, efficiency in allocating these limited resources to different uses, nature of technology and extent of its adoption determined by agro-economic considerations on different types of farms.

The main purpose of this study is, therefore, to understand the growth of agriculture in the region by way of estimating relative changes in resource use structure, resource productivities and allocation efficiency on farms during the pre-technological and post-technological change periods. The study is based on the data collected under the two series of Farm Management Studies in Ahmednagar District. The district is geographically centrally placed in Maharashtra State and typically represents the major soil-crop complex of the State. During the period between the two series of Farm Management studies, the agriculture in the district was subjected to various (agricultural) development programmes formulated and administered at the district level under the multi-level planning approach for economic development

Based on the farm level data for the agricultural years 1956-57 and 1970-71, the present study attempts to evaluate the changes in cropping pattern, cropping intensity and resource endowment on different size groups of farms. It also studies the changes in the structure of resource use, farm income, elasticity of production of farm resources and allocative efficiency and scope for reallocation of farm resources for the total crop production business of different size groups of sample farms and for the individual crop enterprises of all farms. Finally, this study addresses itself to the changes in relative factor shares that have occurred during the period as a result of technological change in agriculture in the region.

Primarily, tabular analysis based on simple means and percentages has been used in this study. Production function analysis using Cobb-Douglas framework has been attempted to show changes in resource productivities and allocation efficiency of farm resources. For the above analysis, the costs and returns data corresponding to the first time period have been inflated to the 1970-71 (second time period) prices in order to overcome the problem of price rise. Lastly, the use of Constant Elasticity of Substitution (C.E.S.) model (using original data) has also been made to study changes in relative factor shares.

The comparison of the farm structure at two points of time revealed that the various institutional reforms and other development programmes of the period seem to have influenced the farm structure, directly or indirectly, to some extent. The tenurial system has undergone a tremendous change during the period. As there was a common practice of either leasing-in or leasing-out land in the Mid-'fifties, the owned area of the sample farms in 1956-57 was a little over three-fourth of the total operated area. However, becauseóf successful implementation of Tenancy Abolition Act of 1957, tenants of land became owners and thereafterwards land owners refrained from the land leasing-out practices. As a result, the entire area was owner operated by the sample farms in 1970-71. Besides, though the land use pattern has remained the same during the period, the proportion of net area irrigated in the net cropped area has increased from 15.89 to 28.29 per cent. The farmers have undertaken well sinking, well repairs and well energization programmes with the help of necessary finance through Co-operative Land Development Bank. The outlook of the sample farms in undertaking investments in capital assets seems to have changed to a greater extent. The investment in fixed capital assets has not only increased by five to eight times, but also the proportion of investment on productive assets in the total capital assets has increased during the period. Similarly, though there was decrease in the animal draught power during the period, there has been increase in human labour work force on the farms.

The crop pattern on the farms has undergone a marked change during the period. Although the proportions of area under foodgrain and non-foodgrain crops remained more or less the same, the area shares of individual crops have changed to a greater extent. The area shares of jowar, wheat, sugarcane, cotton, groundnut, fruits and vegetable crops have increased, whereas those of bajra, pulses and fodder crops have decreased during the period. The intensity of cropping, on the whole, has increased from 107 to 113 per cent during the period, the increase being prominent only on small and medium farms.

The analysis regarding resource-mix employed on the sample farms in both the years indicated that there have been structural adjustments in the pattern of resource use on the farms. At the overall level, the per cropped hectare use of human labour increased by 30 per cent, while that of bullock labour decreased by 27 per cent. The change in cropping pattern accompanied with adoption of intensive cultivation practices has resulted in an upward shift in the demand for human labour, whereas energisation of irrigation wells with pump-sets has substituted some of the bullock labour used for lifting water from wells for irrigation purpose. Since the farm yard manure has become a scarce commodity and its supply being inelastic, the use of this resource has decreased by 34 per cent during the period. As against this, there has been a phenomenal increase in the use of fertilisers. The per cropped hectare use of fertilisers has increased almost by twenty-one times during the period; indicating thereby response of the farms to new farm technology during the latter period.

The structural adjustments in the use of farm resources in different size groups of farms were more or less of the same order as observed for all farms. The per cropped hectare use of all the farm resources excepting fertilisers, however, decreased with an increase in farm size in both the years. The use of fertilizer resource was relatively higher on medium farms as compared to small and large farms. It was also found that during both the time periods large farms tended to produce with a higher proportion of hired human labour and lower proportions of hired bullock labour and purchased farm yard manure than did the small farms. The decreasing proportions of family human labour on larger farms indicate a general preponderance of hired human labour use in preference to family human labour. It is also observed that the increased demand for human labour in the latter period has been largely met with through increased use of family labour.

It was also found that these structural adjustments in the use of farm resources were more prominent in case of the crop enterprises produced under irrigated conditions. Over the period, the structural adjustments in the use of different farm resources for various crop enterprises seem to have been influenced more by considerations of relative prices, yield potentials and type of cultivation practices required in respect of individual crops. There has been, in general, a tendency of the farmers to allocate limited farm yard manure more in favour of cash crops and to use lower seed rate for the crops grown under irrigated conditions. Though the application of fertilizers was extended, besides sugarcane and cotton crops, to other crops during the period, its use was restricted to only those crop enterprises produced under irrigated conditions. The main reason for not using fertilisers in the production of rainfed crops is obviously the scanty and irregular rainfall received in the region.

The structural adjustments in the use of farm resources have had an economic impact on costs and returns of total crop production business as well as of individual crop enterprises of the sample farms. At the overall level, the per farm total cost of cultivation increased from Rs. 3766 to Rs. 4799 and gross returns from Rs. 4244 to Rs. 6547 during the period. The increase in per farm gross returns was by 54 per cent as against 27 per cent increase in the total cost of cultivation, the percentage increase in gross returns as well as cost of cultivation being relatively higher on larger farms as compared to smaller farms. As a result of increased use of different farm resources, the variable costs have increased relatively at a faster rate than the fixed costs. Similarly, the proportion of cash expenditure in the total cost structure has increased from 20 per cent in 1956-57 to 24 per cent in 1970-71. The analysis of costs and returns further indicated that the per cropped hectare farm business income, family labour income, net income and farm investment income have increased by 98, 126, 245 and 97 per cent, respectively, during the period. The increase in these incomes was relatively higher on large farms as compared to small farms.

The estimated farm efficiency measures indicated that there has been significant improvement in the efficiency of the sample farms in managing crop production business. The efficiency of managing the crop production business, however, seems to have improved relatively at a faster rate in the case of the larger farms.

The costs and returns in respect of individual crop enterprises have also undergone considerable changes in response to structural adjustments in the use of farm resources for these crops. The analysis showed that, excepting for jowar (irrigated), the per hectare cost of cultivation of all the crops has increased during the period, the increase being relatively higher in the case of sugarcane-planted and cotton crops. The per hectare output and gross returns of all the crop enterprises have increased during the period, the only exception to this being gram crop enterprise produced under unirrigated conditions. The productivity of irrigated crop enterprises have, however, increased relatively at a faster rate during the period as compared to the unirrigated crops. The cost of production per unit of output has declined consistently during the period in case of all the crop enterprises excepting wheat and gram produced under unirrigated conditions. The per hectare net returns have increased during the period in the case of all the crop enterprises produced under irrigated conditions and bajra and groundnut produced under unirrigated conditions. However, there have been increased deficits in the production of jowar, wheat and gram enterprises produced under unirrigated conditions.

The proportions of individual crop enterprises in the gross cropped area, total input cost and gross returns from total crop production business of the sample farms revealed that eventhough the proportion of gross cropped area allocated to foodgrain crops has increased from 80 to 83 per cent and their share in the total input cost increased from 55 to 61 per cent during the period, their contribution to gross returns has increased only by 3 per cent from 42 per cent. On the contrary, cash crops seem to have played a significant role in enhancing gross returns of the sample farms. As against the increase in the proportions of area allocated and total input cost distributed to cash crops from 5 to 9 per cent and from 12 to 32 per cent, respectively, their contribution to gross returns has increased from 21 to 45 per cent during the period. The extent and effect of structural adjustments in the use of farm resources were, thus, relatively more prominent in case of the cash crops as compared to the foodgrain and other crops.

The changes in the resource use structure, costs and returns have indicated that agriculture in the region is on the move from its traditional stage to modernization. However, its greater dependence on rainfall (which is generally scanty and unevenly distributed) for cultivation of foodgrain and other crops (together occupying nearly three-fourth of the gross cropped area) has proved to be the major constraint in the process of modernization of agriculture in the region.

The examination of production functions for the total crop production business of the sample farms in 1956-57 and 1970-71 revealed that land and human labour were the important inputs to which output was highly responsive in agriculture of this region in the 'fifties. The situation seems to have changed during the period, as in the early 'seventies the production elasticity of other working capital was found to be higher than that of land and human labour. The production elasticities of land, human labour and bullock labour inputs have declined, while those of manures and fertilizers, other working capital and annualised capital investment increased during the period. The decrease in the production elasticities of land and labour clearly supports the hypothesis that the relative importance of these inputs would decline in the process of modernization of agriculture. On the other hand the higher production elasticities of non-conventional inputs, during the latter period, have clearly indicated that in the process of transformation of agriculture in the region there was higher premium on investment in technological changes.

groups of sample farms in both the years. The variation in the logarithm of gross value of crop output explained by the included input variables ranged between 81 to 88 per cent and between 88 to 94 per cent over the size groups of sample farms in the years 1956-57 and 1970-71, respectively.

The estimated production functions for the individual crop enterprises of both the years revealed that during the period under reference the production elasticity of land has increased for unirrigated crops, while it decreased for irrigatec crops excepting sugarcane-planted (irrigated) where it remained the same. The production elasticities of human labour and bulloc labour have decreased for majority of the crops. The relative differentials in the levels of use of manures and fertilizers and other working capital inputs of the period seem to have determine the magnitudes of production elasticities of these resources amon the crops.

To examine the changes in resource use efficiency on the farms during the period, the marginal value products of different farm resources have been estimated (at geometric mean level) and compared with their per unit prices. The comparison of marginal value products of farm resources with their per unit prices revealed that at the overall level, land and human labour were optimally used in both the periods. Although the difference between the marginal value product of human labour and wage rate was non-significant in both the years, it is found that the use of human labour has approached the equilibrium level during the period from its disequilibrium position in the base year. The use of bullock labour was found to be in excess on the farms in both the periods. The differences between the marginal value products of manures and fertilisers, other working capital and annualised capital investment and their prices were non-significant in 1956-57, indicating thereby optimal or near optimal level use of these resources in agriculture in the 'fifties. On the contrary, the marginal value products of these resources were significantly higher than their prices in 1970-71 inspite of the fact that their use increased tremendously during the period. This finding indicates that the new technology in agriculture has resulted in a shift in the low level equilibrium in the use of these resources to a high level disequilibrium position, in which there prevailed a greater scope for increasing farm returns through increased use of these farm resources.

The inter-farm size comparison of marginal value products of different resources with their prices indicated that the pattern of change in the resource use efficiency in the individual size groups of farms was more or less of the same order as has been found for all farms. The small farms have succeeded in optimizing land and manures and fertilisers inputs during the period. However, these farms proved to be inefficient in optimizing the use of bullock labour and also failed to take advantage of maximizing farm returns by increasing the use of other working capital and annualised capital investment inputs. For them, non-availability of sufficient funds was the bottleneck in rationalising use of these inputs. The use of bullock labour input tended to approach the optimal level on medium and large farms. These farms, however, could not take advantage of maximizing farm returns through increased use of manures and fertilizers and other working capital inputs during the latter period.

The changes in allocative efficiency of farms were studied by comparing marginal value products of farm resources used in the production of different crop enterprises in both the years with their per unit prices. These comparisons revealed that human labour and other working capital resources were optimally allocated to majority of the crop enterprises in both the years, whereas the use of bullock labour input was significantly higher than its desired optimal level for these crops. The farms were, however, found to be inefficient in allocating land and manures and fertilizers inputs to majority of the crop enterprises produced under irrigated conditions in both the years. There was the need for expanding area under cultivation and applying higher quantities of manures and fertilizers for these crops for obtaining higher returns. It was found that the marginal value products of inputs were significantly different from their prices in 15 cases out of the 45 comparisons made in 1956-57 and in 25 cases out of 55 comparisons in 1970-71. This suggested that the degree of efficiency of allocation of agricultural resources was relatively higher in 1956-57 than that in 1970-71. This particular finding is a clear indication of the fact that since agriculture in the region is in the transitional phase of development it was in a state of disequilibrium in the early 'seventies, and may be, it might take some time to attain a new equilibrium at a higher level.

The study indicated that there were certain inefficiencies in the use of farm resources and, therefore, there existed a greater scope for increasing returns from crop production through optimizing the use of different farm resources. However, limitations on the availability of required capital will not permit such drastic changes in optimization of resource use on the farms. In view of this, an attempt was made to estimate economic optimal levels of inputs under limited capital situation and to find out the possible increase in the output/gross returns levels through reallocation of limited capital. While estimating these levels, the levels of land and other non-significant inputs were fixed at the geometric mean in case of individual crop enterprises and those of land, bullock labour and annualised capital investment in case of the total crop production business.

The comparison of the estimated economic optimal use levels of different farm resources with their existing use levels revealed that there was the possibility of increasing per hectare output of different crops through reallocation of limited capital. It was found that the existing use level of manures and fertilizers input was lower than the desired optimum level in the production of all the crops. The reallocation of limited capital in favour of more manures and fertilizers (for all the crops) and other working capital (for the crops grown under irrigated conditions), and less human labour and bullock labour is, therefore, advisable to optimise returns from crop production.

The estimated economic optimal use levels of different farm resources (human labour, manures and fertilisers and other working capital) under capital constraint also indicated the need for reallocation of limited capital in favour of more manures and fertilisers and other working capital and less human labour during the 'seventies in order to maximise net returns from agriculture in the region.

Finally, the analysis of changes in relative factor shares in agriculture revealed that there has been a decline in the relative factor share of labour in value added. Technological change in agriculture thus seems to have failed to improve relative income shares of agricultural labourers in the region.

Thus, the conclusion of this study is that agriculture in the region is in the process of transformation from its traditional stage to modernization. The new agricultural technology and institutional reforms have definitely made contributions for the development of agriculture to some extent. However, natural factors and limitations on availability of required capital are the major constraints holding back the development of agriculture. Similarly, as region is a major dry farming area, there is, therefore, a need for evolution and adoption of new dry farming technology in the immediate future.

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APPENDICES

Appendix I

Distribution of Sample Farms Over Selected Villages, Zones and Size Groups in the First Series of Farm Management Investigations in Ahmednagar District

Zone	Village	No. of Farms in Size Groups (Hect.)				Total
		I 4.25 and below	II 4.25 to 6.69	III 6.70 to 10.96	IV 10.97 and above	
I	*1. Chandanapuri	2	2	2	2	8
	2. Chedgaon	2	2	2	2	8
	*3. Lingdeo	2	2	2	2	8
	*4. Kasar-Pimpalgaon	2	2	2	2	8
	5. Wakadi	2	2	2	2	8
	Total	10	10	10	10	40
II	*6. Bhalawani	2	2	2	2	8
	*7. Goregaon	2	2	2	2	8
	*8. Gundegaon	2	2	2	2	8
	*9. Nagardeola	2	2	2	2	8
	*10. Madhe Vadgaon	2	2	2	2	8
	Total	10	10	10	10	40
	Grand Total	20	20	20	20	80

* These villages are covered in the second series of farm management investigations.

Appendix II

Distribution of Sample Farms Over Selected Villages, Zones and Size Groups in the Second Series of Farm Management Investigations in Ahmednagar District

Zone	Village	No. of Farms in Size Groups (Hect.)					Total
		I 4.25 and below	II 4.25 to 7.07	III 7.08 to 10.71	IV 10.71 to 16.38	V 16.39 and above	
I	1. Takalibhan	2	2	-	1	2	7
	*2. Bhalawani	2	2	2	1	3	10
	*3. Goregaon	2	1	3	2	2	10
	*4. Kasar Pimpalgaon	2	2	2	2	2	10
	Total	8	7	7	6	9	37
II.	5. Sade	3	1	1	2	3	10
	6. Guha	2	2	3	1	2	10
	7. Shingave Tukai	2	4	1	1	2	10
	8. Warur (Bk.)	3	3	1	3	-	10
	Total	10	10	6	7	7	40
III.	*9. Nagardeola	5	3	1	1	-	10
	*10. Gundegaon	1	3	2	2	2	10
	*11. Madhe Vadgaon	3	2	1	-	1	7
	12. Suregaon	1	5	2	2	-	10
	13. Chapadgaon	2	2	3	-	2	9
	Total	12	15	9	5	5	46
IV.	*14. Chandanapuri	4	2	2	1	1	10
	*15. Lingdeo	3	1	1	2	3	10
	Total	7	3	3	3	4	20
	Grand Total	37	35	25	21	25	143

* These villages were covered in the first series of farm management investigations.

Appendix III

Evaluation and Allocation of Costs

a) Evaluation of Costs :

1) Crops : Both main and by-products evaluated at prices prevailing in the village at the time of harvesting.

2) Human Labour : Casual hired labour evaluated at the actual amount paid both in cash and kind, the latter at harvest price. Permanent hired labour (annual farm servant) evaluated at the actual amount paid in cash and kind (inclusive of meals, clothes and other perquisites). The total amount paid is cash and kind is divided by the total number of working days to arrive at wage rate per day. In case of family labour, the valuation was done at the wage rates prevailing in the village for hired labour.

3) Bullock Labour : The hired bullock labour evaluated according to actual amount paid in cash and kind. Owned bullock labour on the basis of cost of maintenance.

6) Interest on Working Capital This was charged at the prevailing bank rate of interest on crop loans.

7) Interest on Fixed Capital : This was charged on value of agricultural capital assets excluding land at the rate of 7.5 per cent.

b) Allocation of Costs Over Crops :

1) Depreciation : Depreciation on farm buildings in proportion to the value of output of a crop was allocated. Depreciation on bullock drawn implements was allocated according to number of pair-days of bullock labour used for a crop, while criterion of human labour input was used for allocating depreciation on other implements. In case of the farm machineries, the depreciation was allocated according to their use for different crops.

2) Rental Value of Land : The calculated rental value of land was allocated to the crops grown on a particular piece of land. In case of double cropping, the rent was allocated according to life period of the concerned crops.

3) Land Revenue : Proportional to the area under crop to total cropped area was allocated.

4) Interest on Fixed Capital : Allocated in proportion of the depreciation charged for individual crops.

Appendix IV

Concepts of Cost

The costs of inputs used in production of crops are arrived at according to four cost concepts i.e., Cost A1, Cost A2, Cost B and Cost C. The four costs include items as follows :

Cost A 1 : This covers

i) Value of hired human labour.

ii) Value of hired bullock labour.

iii) Value of owned bullock labour.

iv) Value of seed (farm produced and purchased).

v) Value of manures (farm produced and purchased) and fertilisers.

vi) Value of insecticides and pesticides.

vii) Expenditure on irrigation.

viii) Land revenue and other taxes.

ix) Depreciation.

x) Miscellaneous expenses.

xi) Interest on working capital.

Cost A 2 : Cost A 1 + rent paid on leased-in land

Cost B : Cost A 2 + rental value of owned land + interest on owned fixed capital (excluding land).

Cost C : Cost B + imputed value of family labour.

Appendix V

Concepts of Income

i) Gross Income : Value of main product and by-product at the rate prevailing at the time of harvest.

ii) Farm Business Income :

Gross Income - Cost A 1 (Cost A 2 in case the leased-in land)

iii) Family Labour Income :

Gross Income - Cost B.

iv) Net Income (Profit or Loss) :

Gross Income - Cost C .

v) Farm Investment Income :

Net Income + rental value of owned land + interest on owned fixed capital.

It is the same as

Farm Business Income - Imputed value of family labour.

Appendix VI

Workers and Dependents in the Average Farm Family in 1956-57 and 1970-71

Workers/ Dependents		1956-57				1970-71			
		Size Groups			Overall	Size Groups			Overall
		Small	Medium	Large		Small	Medium	Large	
Workers :	Men	1.37	1.63	2.38	1.79	1.77	2.05	2.32	2.05
	Women	1.11	0.96	1.00	1.02	1.84	2.00	2.32	2.05
	Children	0.33	0.74	0.42	0.50	0.25	0.11	0.18	0.18
	Total	2.81 (46.83)	3.33 (53.80)	3.80 (40.30)	3.31 (46.10)	3.86 (58.31)	4.16 (50.67)	4.82 (54.77)	4.28 (54.38)
Dependents :	Men	0.30	0.15	0.20	0.21	0.05	0.09	0.18	0.10
	Women	0.52	0.67	1.27	0.82	0.07	0.30	0.23	0.20
	Children	2.37	2.04	4.16	2.84	2.64	3.66	3.57	3.29
	Total	3.19 (53.17)	2.86 (46.20)	5.63 (59.70)	3.87 (53.90)	2.76 (41.69)	4.05 (49.33)	3.98 (45.23)	3.59 (45.62)
Grand Total		6.00 (100.00)	6.19 (100.00)	9.43 (100.00)	7.18 (100.00)	6.62 (100.00)	8.21 (100.00)	8.80 (100.00)	7.87 (100.00)

(Figures in parentheses are the percentages to the total).

Appendix VII

Workers Available for Work on the Average Family Farm in 1956-57 and 1970-71

Workers	1956-57				1970-71			
	Size Groups			Overall	Size Groups			Overall
	Small	Medium	Large		Small	Medium	Large	
Family Workers								
Men	1.30	1.55	2.15	1.66	1.48	1.87	2.09	1.81
Women	1.06	0.62	0.77	0.83	0.98	1.22	1.48	1.25
Children	0.25	0.61	0.29	0.39	0.18	0.09	-	0.09
Annual Farm Servants								
Men	0.07	0.18	0.31	0.19	0.05	0.05	0.82	0.38
Children	0.04	0.11	0.19	0.11	0.05	0.27	0.05	0.12
Total Workers								
Men	1.37	1.73	2.46	1.85	1.53	1.92	2.91	2.19
Women	1.06	0.62	0.77	0.83	0.98	1.22	1.48	1.25
Children	0.29	0.72	0.48	0.50	0.23	0.36	0.05	0.21
Grand Total	2.72	3.07	3.71	3.18	2.74	3.49	4.44	3.65

Appendix VIII

Average Cropping Pattern of the Sample Farms in 1956-57 With Break-up Into Irrigated and Unirrigated Areas (Hectares)

Crops	Size Groups						Overall	
	Small		Medium		Large			
	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated
1. Jowar	0.38 (46.92	0.71	0.48 (37.50)	2.82	0.90 (37.97)	5.20	0.58 (39.46)	2.88
2. Bajra	0.03 (3.70)	0.77	0.02 (1.56)	1.81	0.07 (2.96	4.87	0.04 (2.73)	2.45
3. Wheat	0.09 (11.12)	0.04	0.25 (19.53)	0.07	0.24 (10.13)	0.30	0.19 (12.93)	0.13
4. Other cereals	- (-)	0.02	0.02 (1.56)	0.02	0.02 (0.84)	0.05	0.01 (0.68)	0.03
5. Gram	0.01 (1.23)	0.06	0.08 (6.25)	0.14	0.11 (4.64)	0.43	0.07 (4.76)	0.21
6. Other pulses	- (-)	0.25	0.03 (2.34)	0.48	0.09 (3.80)	0.93	0.04 (2.72)	0.55
7. Groundnut	- (-)	0.02	- (-)	0.05	- (-)	0.11	- (-)	0.06
8. Cotton	0.03 (3.70)	0.01	0.10 (7.81)	0.06	0.09 (3.80)	0.32	0.07 (4.76)	0.13
9. Sugarcane	0.05 (6.17)	-	0.09 (7.04)	-	0.22 (9.28)	-	0.12 (8.16)	-
10. Fruits	0.03 (3.70)	-	0.01 (0.78)	-	0.02 (0.84)	-	0.02 (1.36)	-
11. Vegetables	0.08 (9.88)	-	0.08 (6.25)	-	0.15 (6.33)	-	0.10 (6.80)	-
12. Fodder	0.08 (9.88)	0.02	0.07 (5.47)	0.05	0.26 (10.97)	0.16	0.14 (9.52)	0.08
13. Misc. crops	0.03 (3.70)	-	0.05 (3.91)	0.24	0.20 (8.44)	0.49	0.09 (6.12)	0.24
Total	0.81 (100.00)	1.90	1.28 (100.00)	5.74	2.37 (100.00)	12.86	1.47 (100.00)	6.76

(Figures in parentheses are the percentages to the gross irrigated area).

Appendix IX

Average Cropping Pattern of the Sample Farms in 1970-71 With Break-up Into Irrigated and Unirrigated Areas (Hectares

Crops	Size Groups						Overall	
	Small		Medium		Large			
	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated
1. Jowar	0.40 (41.67)	0.94	1.18 (38.44)	2.71	2.12 (48.07)	6.25	1.23 (43.77)	3.30
2. Bajra	0.11 (11.46)	0.65	0.31 (10.10)	0.89	0.22 (4.99)	2.32	0.21 (7.47)	1.29
3. Hybrid Bajra	0.01 (1.04)	0.18	0.05 (1.63)	0.27	0.23 (5.22)	0.65	0.10 (3.56)	0.37
4. Wheat	0.13 (13.54)	0.07	0.35 (11.40)	0.05	0.54 (12.25)	0.36	0.34 (12.10)	0.16
5. Other cereals	0.04 (4.17)	0.09	0.06 (1.95)	0.08	0.14 (3.17)	0.30	0.08 (2.85)	0.16
6. Gram	0.02 (2.08)	0.05	0.04 (1.30)	0.4	0.06 (1.36)	0.21	0.04 (1.42)	0.10
7. Other pulses	- (-)	0.08	- (-)	0.23	- (-)	0.37	- (-)	0.23
8. Groundnut	0.03 (3.12)	0.02	0.04 (1.30)	0.18	0.06 (1.36)	0.19	0.04 (1.42)	0.13
9. Cotton	0.05 (5.21)	0.02	0.17 (5.54)	0.08	0.31 (7.03)	0.05	0.18 (6.41)	0.05
10. Sugarcane	0.06 (6.25)	-	0.53 (17.27)	-	0.59 (13.38)	-	0.39 (13.88)	-
11. Fruits	0.02 (2.08)	-	0.04 (1.30)	-	0.03 (0.68)	-	0.03 (1.07)	-
12. Vegetables	0.05 (5.21)	0.02	0.13 (4.23)	0.01	0.06 (1.36)	0.02	0.09 (3.20)	0.02
13. Fodder	0.04 (4.17)	0.04	0.10 (3.26)	0.02	0.05 (1.13)	0.12	0.06 (2.14)	0.05
14. Misc.Crops	- (-)	0.03	0.07 (2.28)	0.02	- (-)	0.08	0.02 (0.71)	0.04
Total	0.96 (100.00)	2.19	3.07 (100.00)	4.58	4.41 (100.00)	10.92	2.81 (100.00)	5.90

(Figures in parentheses are percentages to the gross irrigated area).

Appendix X

Itemwise Per Farm Cost of Cultivation for Total Crop Production Business on Sample Farms in 1956-57 and 1970-71

(Rupees)

Item of Cost	1956-57				1970-71			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Hired human labour	111.60	144.38	525.18	257.06	82.99	262.29	521.13	288.80
Bullock labour	563.57	979.72	1563.12	1028.85	448.03	905.92	1407.13	920.36
Seed	74.44	114.36	220.99	135.54	102.05	278.51	518.94	299.83
Farm yard manure	79.29	190.12	278.63	181.45	65.57	121.59	194.39	127.18
Fertilizer	5.02	16.02	6.17	9.11	43.36	258.68	261.71	187.92
Insecticides and pesticides	-	-	-	-	1.58	3.22	6.05	3.61
Irrigation	37.05	172.37	276.91	160.67	90.31	347.92	413.84	284.02
Depreciation	47.64	106.12	260.58	136.58	107.91	285.90	397.37	263.73
Land revenue and taxes	9.84	41.10	27.74	26.21	18.10	81.62	110.83	70.18
Interest on working capital	41.78	79.39	142.27	87.10	43.20	114.55	172.39	110.05
Cost A 1	970.23	1843.58	3301.49	2022.57	1003.10	2660.20	4003.23	2555.68
Rent	19.17	85.90	218.43	106.45	-	-	-	-
Cost A 2	989.40	1929.48	3519.92	2129.02	1003.10	2660.20	4003.23	2555.68
Interest on fixed capital	42.39	95.03	176.18	103.68	70.01	162.30	171.34	134.55
Rental value of owned land	459.06	1042.44	1229.90	906.43	554.08	1424.64	1679.95	1219.56
Cost B	1490.85	3066.95	4926.00	3139.13	1627.19	4247.14	5854.52	3909.79
Owned human labour	329.56	650.34	910.81	626.72	499.17	969.16	1200.53	889.62
Cost C	1820.41	3717.29	5836.81	3765.85	2126.36	5216.30	7055.05	4799.41

Appendix XI

Itemwise Per Cropped Hectare Cost of Cultivation for Total Crop Production Business on Sample Farms in 1956-57 and 1970-71

(Rupees)

Item of Cost	1956-57				1970-71			
	Small	Medium	Large	Overall	Small	Medium	Large	Overall
Hired human labour	41.18	20.57	34.48	31.23	26.35	34.29	33.99	33.16
Bullock labour	207.96	139.56	102.63	125.01	142.23	118.42	91.79	105.67
Seed	27.47	16.29	14.51	16.47	32.40	36.41	33.85	34.42
Farm yard manure	29.26	27.08	18.29	22.05	20.82	15.89	12.68	14.60
Fertiliser	1.85	2.28	0.41	1.11	13.77	33.81	17.06	21.58
Insecticides and pesticides	-	-	-	-	0.50	0.42	0.39	0.41
Irrigation	13.67	24.55	18.18	19.52	28.66	45.48	26.99	32.61
Depreciation	17.58	15.12	17.10	16.59	34.25	37.37	25.91	30.28
Land revenue and taxes	3.63	5.85	1.82	3.18	5.75	10.67	7.23	8.06
Interest on working capital	15.42	11.31	9.34	10.58	13.71	14.97	11.25	12.63
Cost A 1	358.02	262.61	216.77	245.75	318.44	347.73	261.14	293.42
Rent	7.07	12.24	14.34	12.93	-	-	-	-
Cost A 2	365.09	274.85	231.11	258.68	318.44	347.73	261.14	293.42
Interest on fixed capital	15.65	13.54	11.57	12.60	22.23	21.22	11.18	15.45
Rental value of owned land	169.39	148.50	80.76	110.14	175.90	186.23	109.58	140.02
Cost B	550.13	436.89	323.44	381.42	516.57	555.18	381.90	448.89
Owned human labour	121.61	92.64	59.80	76.15	158.46	126.69	78.31	102.14
Cost C	671.74	529.53	383.24	457.57	675.03	681.87	460.21	551.03

Appendix XI

Appendix XII

Zero Order Correlation Matrices for Gross Returns From Total Crop Production Business of Sample Farms in 1956-57 and 1970-71

	Gross Returns (Rs.)	Gross Cropped Area (Hectares)	Human Labour (Man-days)	Bullock Labour (Pair-days)	Manures and fertilizers (Rs.)	Other Working Capital (Rs.)	Annualized capital investment (Rs.)
	Y	X_1	X_2	X_3	X_4	X_5	X_6
All Farms 1956-57							
Y	1.000	0.663	0.903	0.760	0.528	0.802	0.632
X_1		1.000	0.748	0.800	0.182	0.612	0.405
X_2			1.000	0.972	0.488	0.735	0.695
X_3				1.000	0.347	0.734	0.729
X_4					1.000	0.463	0.519
X_5						1.000	0.689
X_6							1.000
All Farms 1970-71							
Y	1.000	0.732	0.831	0.659	0.792	0.900	0.793
X_1		1.000	0.703	0.779	0.516	0.640	0.563
X_2			1.000	0.794	0.682	0.720	0.627
X_3				1.000	0.537	0.514	0.442
X_4					1.000	0.690	0.656
X_5						1.000	0.734
X_6							1.000

Appendix XII (Contd.)

	Y	X_1	X_2	X_3	X_4	X_5	X_6
	Small Farms 1956-57						
Y	1.000	0.536	0.848	0.763	0.577	0.681	0.618
X_1		1.000	0.674	0.761	0.295	0.505	0.551
X_2			1.000	0.804	0.448	0.779	0.699
X_3				1.000	0.373	0.782	0.802
X_4					1.000	0.358	0.553
X_5						1.000	0.754
X_6							1.000
	Medium Farms 1956-57						
Y	1.000	0.160	0.802	0.310	0.570	0.778	0.602
X_1		1.000	0.197	0.325	0.095	0.147	0.144
X_2			1.000	0.678	0.558	0.669	0.779
X_3				1.000	0.178	0.251	0.693
X_4					1.000	0.653	0.500
X_5						1.000	0.588
X_6							1.000
	Large Farms 1956-57						
Y	1.000	0.499	0.837	0.737	0.630	0.812	0.643
X_1		1.000	0.575	0.620	0.227	0.350	0.212
X_2			1.000	0.749	0.657	0.781	0.647
X_3				1.000	0.616	0.702	0.685
X_4					1.000	0.603	0.488
X_5						1.000	0.649
X_6							1.000

Appendix XII (Contd.)

Appendix XII (Contd.)

	Y	X_1	X_2	X_3	X_4	X_5	X_6
	Small Farms 1970-71						
Y	1.000	0.544	0.778	0.586	0.769	0.820	0.724
X_1		1.000	0.508	0.707	0.248	0.398	0.331
X_2			1.000	0.754	0.670	0.616	0.593
X_3				1.000	0.480	0.413	0.417
X_4					1.000	0.593	0.665
X_5						1.000	0.533
X_6							1.000
	Medium Farms 1970-71						
Y	1.000	0.244	0.682	0.782	0.748	0.901	0.689
X_1		1.000	0.366	0.377	0.245	0.317	0.132
X_2			1.000	0.446	0.511	0.626	0.393
X_3				1.000	0.151	0.113	0.185
X_4					1.000	0.630	0.514
X_5						1.000	0.616
X_6							1.000
	Large Farms 1970-71						
Y	1.000	0.610	0.718	0.440	0.670	0.856	0.714
X_1		1.000	0.544	0.615	0.398	0.536	0.507
X_2			1.000	0.669	0.408	0.505	0.382
X_3				1.000	0.346	0.177	0.159
X_4					1.000	0.557	0.444
X_5						1.000	0.783
X_6							1.000

Appendix HH

Statlrtlcal Teg% »f Sjg&flMMt

1. ODest of Signlfiettio* of Deviation of SWB of the Elwticltles (^ fc±) frotB Otoity -

t * S.1 . of (^ M)

\js(c11 4C22 4C33*....+ac12^ac:L3^c2 3 ..

Where, SOB of squares due to «rror

Ko« of degrees of freedom

• Variance estimate,

(Bote i 0^5 c22 •..-C12 %.., are the variance (elewent* of>» Covarlanoe iaverae matrix)•

2* Xe»t of Significance of the Dif ft renee of J&rginal Value Product (KVP) of Input With Its Price -

KVp*l « price aa

sju. of MVPal

Where, s#t. of HVPil « \| Attjj² V <bX)

AVr refer© to average value product.

3. Seat of significance of the X&fftrenee of *Tw* HIPe ocviitg fro© Two Lquationa •

MVp xl.I . HVP XU2

S.r.. of <MVP*U1 - :n?I>*U2)

Vih»W, S.L. of (WPxl.l - KVPX.12)

Appendix XV

Zero Order Correlation Matrices for Different Crops Grown on Sample Farms in 1956-57 and 1970-71

	Yield (Quintals)	Land (Hectares)	Human Labour (Man-days)	Bullock Labour (Pair-days)	Manures & fertilizers (Rs.)	Other Working Capital (Rs.)
	Y	X_1	X_2	X_3	X_4	X_5
Jowar (Unirrigated) 1956-57						
Y	1.000	0.723	0.520	0.605	0.688	0.732
X_1		1.000	0.791	0.806	0.400	0.770
X_2			1.000	0.785	0.534	0.751
X_3				1.000	0.313	0.717
X_4					1.000	0.438
X_5						1.000
Jowar (Unirrigated) 1970-71						
Y	1.000	0.754	0.726	0.710	0.497	0.635
X_1		1.000	0.638	0.759	0.615	0.814
X_2			1.000	0.784	0.250	0.534
X_3				1.000	0.125	0.685
X_4					1.000	0.417
X_5						1.000
Jowar (Irrigated) 1956-57						
Y	1.000	0.762	0.831	0.655	0.751	0.633
X_1		1.000	0.739	0.754	0.492	0.758
X_2			1.000	0.684	0.589	0.746
X_3				1.000	0.499	0.649
X_4					1.000	0.408
X_5						1.000
Jowar (Irrigated) 1970-71						
Y	1.000	0.766	0.627	0.552	0.759	0.528
X_1		1.000	0.617	0.683	0.347	0.583
X_2			1.000	0.723	0.455	0.249
X_3				1.000	0.302	0.158
X_4					1.000	0.303
X_5						1.000

Appendix XV (Contd.)

Appendix XV (Contd.)

	Y	X_1	X_2	X_3	X_4	X_5
	Bajra (Unirrigated) 1956-57					
Y	1.000	0.717	0.798	0.775	0.611	0.740
X_1		1.000	0.755	0.762	0.338	0.780
X_2			1.000	0.753	0.512	0.753
X_3				1.000	0.448	0.756
X_4					1.000	0.338
X_5						1.000
	Bajra (Unirrigated) 1970-71					
Y	1.000	0.816	0.743	0.779	0.826	0.659
X_1		1.000	0.780	0.778	0.587	0.745
X_2			1.000	0.740	0.525	0.670
X_3				1.000	0.567	0.681
X_4					1.000	0.549
X_5						1.000
	Bajra-Local (Irrigated) 1970-71					
Y	1.000	0.792	0.866	0.781	0.790	0.632
X_1		1.000	0.662	0.688	0.632	0.623
X_2			1.000	0.795	0.705	0.548
X_3				1.000	0.689	0.395
X_4					1.000	0.531
X_5						1.000
	Bajra-Hybrid (Irrigated) 1970-71					
Y	1.000	0.804	0.746	0.697	0.669	0.750
X_1		1.000	0.816	0.798	0.432	0.785
X_2			1.000	0.786	0.539	0.655
X_3				1.000	0.459	0.637
X_4					1.000	0.399
X_5						1.000

Appendix XV (Contd.)

Appendix XV (Contd.)

	Y	X_1	X_2	X_3	X_4	X_5
Wheat (Unirrigated) 1956-57						
Y	1.000	0.818	0.863	0.787	0.737	0.817
X_1		1.000	0.750	0.712	0.645	0.774
X_2			1.000	0.731	0.706	0.753
X_3				1.000	0.650	0.703
X_4					1.000	0.639
X_5						1.000
Wheat (Unirrigated) 1970-71						
Y	1.000	0.771	0.763	0.747	0.550	0.748
X_1		1.000	0.723	0.741	0.133	0.780
X_2			1.000	0.786	0.404	0.736
X_3				1.000	0.263	0.772
X_4					1.000	0.231
X_5						1.000
Wheat (Irrigated) 1956-57						
Y	1.000	0.724	0.815	0.703	0.283	0.657
X_1		1.000	0.803	0.760	0.058	0.785
X_2			1.000	0.807	0.107	0.702
X_3				1.000	0.088	0.689
X_4					1.000	0.309
X_5						1.000
Wheat (Irrigated) 1970-71						
Y	1.000	0.828	0.803	0.575	0.888	0.765
X_1		1.000	0.815	0.636	0.688	0.767
X_2			1.000	0.753	0.654	0.700
X_3				1.000	0.536	0.356
X_4					1.000	0.638
X_5						1.000

Appendix XV (Contd.)

Appehdix XV (Contd.)

	Y	X_1	X_2	X_3	X_4	X_5
	Sugarcane-Planted (Irrigated) 1956-57					
Y	1.000	0.978	0.935	0.936	0.984	0.971
X_1		1.000	0.769	0.755	0.763	0.752
X_2			1.000	0.744	0.701	0.720
X_3				1.000	0.705	0.708
X_4					1.000	0.776
X_5						1.000
	Sugarcane-Planted (Irrigated) 1970-71					
Y	1.000	0.968	0.940	0.807	0.977	0.703
X_1		1.000	0.725	0.807	0.749	0.702
X_2			1.000	0.790	0.714	0.716
X_3				1.000	0.656	0.552
X_4					1.000	0.699
X_5						1.000
	Cotton (Irrigated) 1956-57					
Y	1.000	0.834	0.770	0.643	0.685	0.070
X_1		1.000	0.798	0.741	0.424	0.045
X_2			1.000	0.732	0.401	0.121
X_3				1.000	0.377	0.020
X_4					1.000	0.152
X_5						1.000
	Cotton (Irrigated) 1970-71					
Y	1.000	0.849	0.858	0.406	0.724	0.531
X_1		1.000	0.696	0.344	0.445	0.545
X_2			1.000	0.446	0.668	0.477
X_3				1.000	0.279	0.104
X_4					1.000	0.391
X_5						1.000

Appendix XV (Contd.)

Appendix IV (Contd.)

	Y	X_1	X_2	X_3	X_4	
	Gram (Unirrigated) 1956-57					
Y	1.00	0.670	0.698	0.736	0.384	0.672
X_1		1.000	0.718	0.782	0.378	0.800
X_2			1.000	0.790	0.453	0.771
X_3				1.000	0.400	0.744
X_4					1.000	0.528
X_5						1.000
	Gram(Unirrigated) 1970-71					
Y	1.0	0.976	0.971	0.905	0.649	0.967
X_1		1.000	0.772	0.808	0.553	0.740
X_2			1.000	0.730	0.601	0.719
X_3				1.000	0.596	0.702
X_4					1.000	0.575
X_5						1.000
	Groundnut (Unirrigated) 1956-57					
Y	1.00	0.977	0.969	0.951	0.601	0.934
X_1		1.000	0.772	0.728	0.482	0.747
X_2			1.000	0.750	0.519	0.748
X_3				1.000	0.448	0.764
X_4					1.000	0.394
X_5						1.000
	Groundnut (Unirrigated) 1970-71					
Y	1.000	0.968	0.882	0.768	0.819	0.952
X_1		1.000	0.800	0.768	0.760	0.770
X_2			1.000	0.733	0.728	0.768
X_3				1.000	0.681	0.753
X_4					1.000	0.790
X_5						1.000

Appendix XVI

Geometric Means of Inputs and Output of Different [illegible] and 1970-71

	Year	Inputs: Land	Human Labour	Bullock Labour	Manures and fertilizers	Other Working Capital	Output*
		(Hectares)	(Man-days)	(Pair-days)	(Rupees)	(Rupees)	(Quintals)
1. Jowar (Irrigated)	1956-57	0.73	45.61	19.88	17.09	8.92	4.43
	1970-71	1.36	73.89	26.32	24.38	42.02	7.64
2. Jowar (Unirrigated)	1956-57	3.38	85.92	38.49	22.21	32.08	5.23
	1970-71	3.62	102.47	40.54	44.70	29.28	7.47
3. Bajra (Unirrigated)	1956-57	2.04	59.41	20.70	13.46	18.49	3.26
	1970-71	2.22	62.16	21.15	46.52	32.57	6.10
4. Bajra-Local(Irrigated)	1970-71	0.67	26.15	9.33	27.17	13.48	3.02
5. Bajra-Hybrid (Irrigated)	1970-71	0.85	53.22	15.50	52.28	36.26	8.68
6. Wheat (Irrigated	1956-57	0.28	26.30	10.92	5.99	8.48	0.85
	1970-71	0.43	44.82	11.07	31.93	62.81	4.82

Appendix XVI(Contd.)

Appendix XVI (Contd.)

Geometric Means of Inputs and Output of Different Crops in 1956-57 and 1970-71

Crops	Year	Inputs: Land	Human Labour	Bullock Labour	Manures and fertilisers	Other Working Capital	Output*
		(Hectares)	(Man-days)	(Pair-days)	(Rupees)	(Rupees)	(Quintals)
7. Wheat (Unirrigated)	1956-57	0.27	11.17	4.48	4.56	7.12	0.64
	1970-71	0.61	20.57	8.68	16.67	39.64	3.00
8. Sugarcane Planted (Irrigated)	1956-57	0.40	69.64	17.89	213.22	241.24	30.41
	1970-71	0.60	135.27	24.65	544.99	482.43	50.72
9. Cotton (Irrigated)	1956-57	0.17	9.87	4.24	8.80	3.79	0.40
	1970-71	0.45	91.58	9.94	38.91	29.66	3.67
10. Gram (Unirrigated)	1956-57	0.34	8.65	3.16	5.42	17.34	0.84
	1970-71	0.37	9.70	8.43	12.48	26.09	0.83
11. Groundnut (Unirrigated)	1956-57	0.42	22.43	6.71	9.70	37.04	2.15
	1970-71	0.45	29.45	7.86	14.50	96.12	3.50

* Output of Sugarcane is measured in tonnes.