CHAPTER II

REVIEW OF LITERATURE
In this chapter, an attempt is made to review the earlier research work done in the fields of costs and returns, resource use efficiency and technical change in paddy production. The review is presented under the following three major heads:

2.1 Costs and returns
2.2 Resource use management
2.3 Technical change

2.1 COSTS AND RETURNS

The period since independence has been a growing volume of efforts by different agencies in the country to collect data relating to cost of production of various crops. Agencies like the Indian Council of Agricultural Research (ICAR), Commodity Committees, the National Sample Survey (NSS), the Ministry of Food and Agriculture (Government of India), the State Governments, Universities and Research Institutions, have tried to carry out or sponsor studies aimed at the collection of information regarding cost of production of various crops.

The first systematic effort in the direction of studying the economics of crop production began as far back as 1933-34 with the studies conducted under the auspices of the ICAR in the principal sugarcane and cotton growing tracts of India. Though the scope of the cost
studies organised under the various organisations particularly ICAR, during the subsequent years has gradually widened, no worthwhile cost studies were undertaken till 1952-53 in the case of paddy crop. The NSS conducted an enquiry on some aspects of cost of cultivation of paddy along with other crops during its fifth, sixth (1952-53), seventh (1953-54) and eleventh (1956-57) rounds and those surveys covered almost all the States in the country. In all these studies, single crop approach was adopted and the data were collected by the survey method. This formed the first phase in the collection of cost data on paddy in our country.

Studies in the Economics of Farm Management were launched by the Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India, in collaboration with the Research Programmes Committee of the Planning Commission in 1954-55 in five regions. Subsequently (1962-63) these studies were extended to eight more regions. The objective of these studies was two-fold: to obtain guideline data for formulating agricultural policy and for extension work, and to determine the relative merits of the cost Accounting and Survey methods for the collection of data on costs and returns. In these studies, though only a few selected districts in each State were covered, the whole farm approach was
followed for data collection. These studies constituted the second phase in the cost studies of paddy.

A number of Agro-Economic Surveys were carried out before 1970 in different regions of the country to collect information on cost of production of various crops, including paddy. These surveys, carried out at different points in time with diverse objectives by different agencies, did not follow uniform cost concepts and could not provide information for all the major crops on a comparable basis. Most of them were not specifically designed to collect data on costs with a view to formulating price policy at National and State levels.

The need for collecting data on costs of cultivation of agricultural commodities on a comprehensive and continuing basis had been felt for a long time in the context of formulating appropriate price policies for these commodities. The Government of India, therefore, decided in 1968, to launch a "Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops grown in the country, on the recommendations of the Standing Technical Committee on Indices of Input Costs (1967). So a comprehensive scheme was initiated in all the States in the seventies and implemented through the Directorate of Economics and Statistics at Central level and through the Agricultural Universities in the
All the defects and deficiencies encountered in the earlier studies were overcome in the All India Coordinated Project. The salient feature of the scheme was that the data collection was done through Cost Accounting Method and exhaustive data on inputs and outputs for all the enterprises (whole farm modelling) of a sample farmers were collected. Sponsoring of Comprehensive Scheme constituted an important phase in the studies related to the economics of paddy in India. Voluminous data accumulated under the scheme served as a fund of information for the agro-economic researchers in India, in coming years.

2.1.1 Costs and Returns of paddy in Andhra Pradesh

According to the studies on the Economics of Farm Management conducted by the Andhra University (1957-58 to 1959-60) in West Godavari district (Andhra Pradesh), the average cost of cultivation of paddy for the above three years amounted to Rs.328 per acre for kharif and Rs.297 per acre for rabi. The rental value, human labour and bullock labour were the major items in the total costs of production. The average yields per acre, were 24.54 and 21.18 mounds (6.08 and 5.94 q.) while the gross returns were Rs.314 and Rs.286 per acre for kharif and rabi paddy respectively. The cost of production per mound of paddy was worked out at Rs.12.28
and Rs.12.86 respectively in kharif and rabi seasons. No perceptible trend was observed between these costs, returns and size of farms. The average bulk line cost was Rs.15/- and Rs.15.50 per mouth of paddy in kharif and rabi seasons respectively. The farmers in the district incurred a loss of Rs.14/- and Rs.9/- for every acre of paddy cultivated in kharif and rabi seasons respectively. The number of man-days required to cultivate an acre of paddy was 48 and 45 in kharif and rabi seasons respectively. About four-fifths of labour was hired in all the farms irrespective of the size. The overall bullock pair labour-days utilised per acre of kharif and rabi paddy came to 8.07 and 7.96 respectively. The proportion of hired bullock labour was very small.

According to the study undertaken by the Department of Agricultural Economics, Andhra Pradesh Agricultural University (APAU), Hyderabad, into the Agro-economic Effects of Lift Irrigation (1962-65) in Hyderabad (presently Rangareddy) and Karimnagar districts the cost of cultivation of paddy (grown under flow irrigation) amounted to Rs.246 and Rs.227 per acre respectively for kharif and rabi crops in Rangareddy district and Rs.261 and Rs.324 per acre for Karimnagar district. The gross returns were Rs.317 and Rs.354 per acre of kharif and rabi paddy respectively in Rangareddy district and Rs.441 and Rs.440 per acre for kharif and rabi paddy in Karimnagar district.
The study further revealed that there were no consistent trends between input costs and farm size except in irrigation charges. The irrigation charges varied inversely with farm size. The small and large farmers incurred almost the same total costs under flow irrigation, while medium farmers spent less in Rangareddy district. On the contrary, the small and medium farmers incurred almost an equal amount, while the large farmers spent less in the Karimnagar district. No perceptible relationship was observed between gross returns from paddy and farm size in Rangareddy district, while in Karimnagar an inverse trend was observed.

According to a study (1964-65) conducted by the Directorate of Economics and Statistics, Government of Andhra Pradesh in Krishna, Chittoor and Nizamabad districts, the estimated cost of cultivation of paddy worked out to Rs.373 and Rs.380 per acre of kharif and rabi paddy respectively, the estimated gross returns were Rs.419 and Rs.373 per acre for kharif and rabi paddy. The productivity was 9.82 q/acre of kharif and 9.42 q/acre for rabi paddy. The costs of production were estimated at Rs.37.97 and Rs.40.38 per quintal of kharif and rabi paddy respectively.

The cost of cultivation by season and variety was estimated in a study undertaken by the Agro-Economic Research Centre, Andhra University, during 1968-69 in
Andhra Pradesh. According to this study, the cost of cultivation per acre of HYV paddy amounted to ₹.587 in kharif and ₹.325 in rabi season, while the corresponding figures for the local varieties of paddy were ₹.419 and ₹.587.

Parthasarathy (1968-69) in his report on "Economics of Rice Production in West Godavari district, Andhra Pradesh" estimated the cost of cultivation at ₹.772/- and ₹.525/- per acre of HYV and local varieties of kharif paddy respectively and the corresponding gross returns at ₹.967 and ₹.689. The cost of cultivation of rabi HYV and local paddy were estimated at ₹.806 and ₹.538 per acre and their gross returns at ₹.1,539 and ₹.900 per acre respectively. The costs of cultivation of kharif paddy (1966-67) were ₹.550, ₹.418 and ₹.400 per acre in the case of small, medium and large farms respectively. The corresponding costs in the case of rabi paddy were ₹.555, ₹.435 and ₹.515 per acre. The gross returns from kharif paddy were ₹.754, ₹.554 and ₹.569 per acre in the case of small, medium and large farms respectively and the corresponding values for rabi paddy were ₹.998, ₹.756 and ₹.703 per acre.

The Farm Management studies were extended to Rayalaseema region of Andhra Pradesh during 1969-70. According to those studies, the cost of cultivation and
grows income were respectively Rs.1,766 and Rs.1,631/ha. for kharif and Rs.1,861 and Rs.1,428 for rabi paddy. The productivity was estimated at 24.96 and 19.85 quintals of paddy/ha. for kharif and rabi respectively. The corresponding cost of production worked out at Rs.61.23 and Rs.73.53/q. of paddy. The cost of cultivation during kharif did not reveal any relationship with farm size. For rabi, however, total costs generally declined with increase in the farm size. In contrast, the gross income varied proportionately in kharif, except in the 5th farm size group, whereas in rabi no particular relation was observed with the farm size.

Rao (1969-70) in his study on Economics of IR-8 (IIIV) and improved paddies in West Godavari district, Andhra Pradesh reported that cost of cultivation of IR-8 paddy was Rs.890/acre and for improved varieties it was Rs.531/acre. The gross returns were Rs.1,389 and Rs.759/acre for IR-8 and other improved varieties of paddy respectively. The productivity of IR-8 paddy was 25.66 quintals of paddy per acre and that for other improved varieties, while was 14.00 quintals, while net returns were Rs.872 and Rs.446/acre of IR-8 and other improved varieties, respectively.

for 1971-72, the estimated cost of cultivation was £1,476/ha, gross income £1,746/ha; yield 25.22 q/ha; and the cost of production £51.33/qt. of paddy. These results were based on data from 216 sample holdings selected for the study. For the kharif season, the cost of cultivation was £1,461/ha; yield 25.37 q/ha; gross income £1,745/ha; and cost of production/quintal £50.62. The yield per hectare increased and the cost of production (per quintal) declined with an increase in the farm size.

As regards the rabi season, the estimated cost of cultivation was £1,711/ha. and gross income £1,803/ha. The yield per hectare was 25.74 quintals, whereas cost of production was £60.15 per quintal of paddy.

The costs and returns were also worked out by source of irrigation. According to these estimates, cost of cultivation amounted to £1,394, £1,535, £1,357, £1,178, £1,312 and £1,072 under wells with pumpsets, tube wells, canals, tank, other irrigation sources and rainfed paddy, respectively, whereas the corresponding yields of paddy were 25.21, 26.70, 25.18, 22.74, 23.43 and 19.90 quintals per hectare and the corresponding cost of production per quintal of paddy came to £55.29, £57.42, £48.14, £51.31, £55.99 and £53.96. Of them, the canal irrigated holdings registered the highest yield and the lowest cost of production.
Estimates of costs and returns along with other details relating to paddy production in Andhra Pradesh as summarised by the Government of India under Comprehensive Scheme for selected years are presented in Table 2.1.

Table 2.1. Costs, Returns and other details of Paddy in Andhra Pradesh for selected years

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost of cultivation</th>
<th>Gross income</th>
<th>Net income</th>
<th>Yield of production</th>
<th>Farming days</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-72</td>
<td>1,476</td>
<td>1,746</td>
<td>270</td>
<td>25.22</td>
<td>51.33</td>
<td>110</td>
</tr>
<tr>
<td>1975-76</td>
<td>2,195</td>
<td>2,224</td>
<td>31</td>
<td>23.60</td>
<td>76.98</td>
<td>127</td>
</tr>
<tr>
<td>1979-80</td>
<td>3,146</td>
<td>3,264</td>
<td>118</td>
<td>30.33</td>
<td>93.33</td>
<td>146</td>
</tr>
<tr>
<td>1980-81</td>
<td>3,874</td>
<td>4,115</td>
<td>341</td>
<td>33.77</td>
<td>104.94</td>
<td>147</td>
</tr>
</tbody>
</table>

The cost-return figures increased over the period under review. The rate of increase in the cost of cultivation was greater than that of gross income. Hence the net farm profit did not increase. Instead it resulted in not losses in some years.
Reddy (1980) estimated the cost of cultivation of paddy for Nalabhnagar District, Andhra Pradesh at Rs.3,037/ha, and the gross income at Rs.5,232/ha. The total costs were inversely related with farm size. The gross income declined generally in all farm sizes with an increase in farm size.

Suryanarayana (1980) had incorporated many aspects of economics of paddy in the final technical report of the research project "Economic Aspects of Yield Increasing Technology in Producing Foodgrains in Andhra Pradesh. The survey covered three districts of Andhra Pradesh namely, West Godavari, Chittoor and Elgonda representing the three principal agro-climatic zones of the state. Farm level data were obtained from 180 farm families in each district for three consecutive agricultural years (1975-76 to 1978-79). The cost of cultivation of local varieties of kharif paddy was Rs.2,442, Rs.2,040 and Rs.2,340/ha. in West Godavari, Chittoor and Elgonda districts, respectively, while the corresponding costs in respect of HUV paddy were Rs.2,742, Rs.2,674 and Rs.2,614/ha. The estimated costs of cultivation of rabi local varieties of paddy were Rs.2,714 and Rs.2,223/ha. in Chittoor and Elgonda districts and no sample farmer grew local varieties of paddy (in rabi) in West Godavari district. The total costs of cultivation in the case of
rabi HYV paddy were Rs. 2,970, Rs. 3,083 and Rs. 2,979/ha, in West Godavari, Chittoor and Nalgonda districts, respectively. In all the farm sizes and districts, the human labour, manures and fertilizers constituted the major components in the total costs.

Gross returns from local varieties of kharif paddy were Rs. 2,658, Rs. 1,947 and Rs. 1,432/ha, in West Godavari, Chittoor and Nalgonda districts. The returns from HYV kharif paddy were Rs. 2,902, Rs. 3,211 and Rs. 2,308/ha. The corresponding figures for rabi local varieties of paddy were Rs. 2,746 and Rs. 1,593/ha, in Chittoor and Nalgonda districts, and Rs. 3,558, Rs. 3,645 and Rs. 2,627/ha. of rabi HYV in West Godavari, Chittoor and Nalgonda districts, respectively.

The per hectare yields of local varieties of kharif paddy were 27.50, 21.30 and 15.30 quintals in West Godavari, Chittoor and Nalgonda districts respectively and in the case of HYV kharif paddy, the corresponding figures were 29.90, 31.50 and 24.90. The yields of rabi local varieties were 34.30 and 18.80 in Chittoor and Nalgonda districts, while those of HYV rabi were 34.30, 36.70 and 29.60 q/ha in West Godavari, Chittoor and Nalgonda districts, respectively.

The Farm size-wise total costs indicated that they varied inversely with the farm size in the case of both the varieties of kharif paddy in West Godavari and Chittoor
Districts, while no specific trend was witnessed in Nalgonda district. In respect of rabi paddy of both varieties, the total costs declined with an increase in the farm size in West Godavari and Chittoor districts, while no consistent relationship was observed in Nalgonda district.

Productivity of local varieties in both the seasons showed a positive relationship with farm size, except in lharif in Chittoor district. The productivity of IIV in both the seasons was negatively correlated in West Godavari and Chittoor districts with the farm size, while no perceptible relation was observed in Nalgonda district.

Sangothi Rao (1980) analysed the data on costs obtained for paddy under the Comprehensive Scheme relating to Andhra Pradesh for the years 1971-72 to 1975-76 to work out the growth rates (considering the 1st year as a base) in costs, yields and returns, besides presenting the break-up of costs for all these 5 years. His study showed that the growth rates of both yield and cost rose simultaneously, which meant increased yield with an increase in investment. The growth rates of costs were relatively higher. He also pointed out that this would be a problem of high cost economy which is required to be corrected either by raising the productivity or the
prices of outputs. The results of input-output analysis indicated that the rate of return on investment was 10 per cent during the first year, and 26 per cent during the 4th year, declining to almost zero in the last year of his study.

Adinarayana (1981) had reported costs and returns for 1977-78 along with other results for paddy by season and variety. His results were arrived at based on the data obtained from the two large-sized agro-economic projects namely the Comprehensive Scheme and the RL 480 Project. According to his study, the costs of cultivation were £2.710, Rs.2.909, Rs.3.517 and Rs.3.136/ha. of paddy HYV kharif, HYV robi and HYV respectively. He also maintained that the charges towards human labour and fertilizers constituted the major components in the total costs. The Gross returns were Rs.2.646, Rs.3.474, Rs.3.894 and Rs.3.632/ha in paddy of HYV kharif, HYV robi and HYV paddy respectively and the corresponding net returns worked out to Rs.566, Rs.377, and Rs.495 as against a net loss of Rs.64/ha. from paddy in general.

The productivity levels were 26.43, 37.45, 42.18 and 39.23 quintals of paddy per hectare of paddy, HYV kharif, HYV robi and HYV respectively and the corresponding costs of production per quintal of paddy were £.87.99, 69.33, 75.00 and 71.56. According to his study the
the utilisation of human labour was maximum in HY rabi and next came HY kharif. The additional employment generation was estimated at 47 and 26 days in HY rabi and HY kharif of paddy respectively.

2.2 RESOURCE USE MANAGEMENT

Most of the studies have examined different aspects of resource use efficiency in conjunction with farm size. In a review of this type, it is difficult to cover all of them. However, an attempt has been made to confine this review to the following two major areas relevant to the present study (1) Resource productivity and farm size; and (2) Resource use efficiency and returns to scale.

2.2.1 Resource productivity and farm size

Heady (1946) derived marginal productivity of real estate, labour, machinery and equipment etc. from linear production functions estimated for a random sample of Iowa farms. He observed that marginal productivities of all resources were higher on large farms than on the small ones. The marginal productivity for land was more on cash grain area than that on Feature area.

Olson (1954) stated that a farmer was concerned with changes in farm size as they affected his total net income through changes in his margin per unit and his
volume of output. He also concluded that reports on these studies, generally, had shown an upward progression of net income as farm size increased in favourable years and frequently a downward progression in the more unfavourable years.

Bhattacharjeo (1955) conducted a study on the resource use and productivity during the years 1942-50. The study revealed that the marginal productivity of a ton of chemical fertilizer was highest followed by human labour in agriculture.

Lionberger and Congheenour (1957) reported that large farms encouraged the use of improved farm practices. They, therefore, suggested a "Critical Minimum" size of farm for the successful adoption of improved practices.

Shah (1959) studied the problems of small farms in Kodinar taluk and observed that the small farmers worked their farms with relatively low efficiency. Due to indivisibility of certain forms of capital they could not own vital assets like bullocks and implements in adequate quantity. The small farmers used more irrigation water and farmyard manure, but used very little of improved seeds, fertilizers and implements. The small size of farm prevented them from adopting better rotational practices and thus the economy of small farmers hanged on a thin thread of hard labour.
Suryanarayana's (1958) study of the resource returns in Telangana farms revealed a definite relationship between input factors and output. It showed that diminishing returns to inputs were encountered in the Telangana region of Andhra Pradesh in each of the three districts studied and for each type of farms. It also exhibited that an increase in acres without simultaneous increase in labour and capital per acre resulted in decreased production per acre in the districts.

Tosio Shishido (1961) concluded that agricultural production and productivity could be increased by abundant investment of capital on land for intensive farming, where land was scarce resource as in Japan.

Auer (1961) estimated the productivity of resources on farms in Newdale Hamisten area of Manitoba for the year 1937 by fitting Cobb-Douglas type of production function to a stratified random sample of 85 farmers, for small, medium and large categories, ranging from 300 to 600 acres. The analysis indicated the existence of a surplus of farm labour, a mis-allocation of capital and the prevalence of increasing returns to scale. He attributed increasing returns to scale in the study to more efficient use of farm machinery on the larger farms than on the small ones.

Sen (1962) while listing certain results that were found to be broadly valid in Indian agriculture, pointed
out that by and large productivity per acre decreases with an increase in the size of the holding.

Kasundar (1965) also stated that as the size of the farm increased, the output per acre decreased.

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

Achari (1965) undertook a study on sample Queensland (Australia) sugarcane farms, and estimated resource productivity and resource allocation. His study indicated that marginal return of fertilizer was greater than marginal cost. Labour productivity was below prevailing wage rate due to the seasonal nature of sugarcane farming. The irrigated farms had relatively higher marginal returns as compared to dry farms. Marginal productivity for land input was high but it was low for machinery.

Salono (1965) reported that as the size of farm increased there was a tendency to decrease the application
of fertilizer per acre and that the cultivator having irrigation facilities tended to adopt improved farm practices more than the cultivators without irrigation facilities.

Singh and Roddy (1965) found that there was no significant relationship between the size of the farm and acceptance of improved farm practices. On the other hand, they observed that in the presence of other factors such as socio-economic status and social participation, the size of farm was negatively associated with the adoption of improved practices.

Singh (1966) studied cost of cultivation in relation to farm size in respect of wheat. His results indicated that there was an increasing trend in output per acre with increase in holding sizes. The differences between size classes were not significant. Human and bullock labour inputs decreased with increase in farm size and consequently the cost per acre decreased. He also studied the trend of cost with holding size with the help of regression analysis. He fitted the second degree equation taking net cost of production per mand and per acre and these results revealed that upto 40 acres farm size there was a perceptible gain in efficiency.

Sen (1967) pointed out that the variation in output per acre were partly due to variation in inputs
per acre. The use of inputs on small farms was higher than the large farms. The variation in inputs per unit of size explained most of the variations in output per unit of farm size. When acreage and output were adjusted by a soil condition, output per unit of size was found to be still inversely associated with farm size.

Subrahmanian (1967) conducted a study of farm size and resource use relationship with a view to empirically examine the nature of resource use between selected farm sizes in Coimbatore district. The study indicated that under irrigated conditions a relatively larger marginal product could be obtained on medium and large farms for additional doses of labour, manure and fertilizers. The productivity of land was explained as the productivity of all factors and not just land. The empirical results obtained clearly showed that small farms were more efficient than large and medium farms.

A similar study was conducted by Jha (1967) on farm size and resource use relationship in Ahmadnagar and Nasik districts. The study indicated that small farms were not inefficient in comparison to larger farms. Hence, there was no pressing economic need for creating big farms of cooperative or collective nature. Productive efficiency could be achieved even within the institutional framework of small peasant proprietorship.
Even under the existing peasant proprietorship with small farm units production and farm income could be increased to a significant extent.

Shrivastava (1967) studied the resource problems of the small farmers in Lucknow district and came to the conclusion that the small holdings did not permit optimum resource utilisation and were inefficient from the point of view of productivity per acre.

Kailon and Kapur (1968) examined the differences in the form and intensity of input-mix and output pattern on the small and large farms in the IANDP district of Ludhiana. The authors observed that there was hardly any difference in the form of input use between small and large farms. However, the intensity of use of non-conventional inputs such as improved seeds, fertilizers, irrigation facilities etc., was higher on the large farms than on the small farms which resulted in higher per acre yield on the large farms.

Adinarayana (1970) studied the resource use efficiency in Rice-Fallow cotton of Krishna district, Andhra Pradesh by working out marginal value products. According to his results, the land was used most inefficiently particularly in small and large farms as their marginal value products were negative. There seemed to be excessive expenditure on non-conventional
inputs, fertilizers and plant protection chemicals in all the three farm sizes, as all the marginal value products were far less (even negative in medium, small and large farms for fertilizers and plant protection) than their acquisition costs, except in the case of human labour where marginal value products were very high particularly in small and large farms than their wage rates. He therefore concluded that there was much scope to reorganise the resource use pattern which would result in earning more profits.

Sharma (1971) had studied the relationship between farm size and productivity, taking into account certain other relevant variables like average annual rainfall, irrigation etc. He observed a tendency of per acre productivity to decrease with increase in holding size, other things remaining the same. He also observed that between rainfall, irrigation and holding size, holding size accounted for the largest (55.10) variation in productivity at all India level, followed by irrigation and rainfall, which accounted for 30 per cent and 15 per cent respectively.

Singh and Potal (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 development 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 of 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 did not hold true under the new agricultural technology in the area.

Grewal and Kohlon (1973) had studied the farm size and productivity relationship in Punjab. They pointed out that because of technological break-through in agriculture, the importance of the traditional inputs had declined and non-conventional inputs such as fertilizers, pesticides, machine power etc, had become more important. Large farms had greater access to individual technology inputs such as tractor and allied farm machinery.

Nathore (1974) in his study on business efficiency of different farm sizes in Udaipur district of Rajasthan, commented that the output per farm and the various categories of inputs were positively correlated with the size of the holding.

Singh and Patel (1974) examined the productivity of resources and allocation efficiency on different sizes of farms adopting new technology. They fitted
Cobb-Douglas function to input-output data on per standard hectare basis. 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 level of allocation of resources, the inefficiency in resource allocation was maximum on large farms followed by medium farms.

Parthasarathy (1974) studied the resource productivity and returns to scale on sugarcane farms in Andhra Pradesh. He pointed out that in sugarcane farming human labour and fertilizers contributed very little to production. He also opined that there existed opportunities for approaching optimal efficiency through the substitution of one resource to another. His results also revealed that too much labour and fertilizers were used and he suggested to decrease the use of these two resources drastically and increase the use of land and seed as this adjustment would result in increasing profits from the sugarcane cultivation. Further, his findings showed that constant returns to scale seemed to have prevailed in sugarcane farming in Andhra Pradesh.

Subramanyam (1979) in his study on 'Adoption of new technology on small farms, the role of credit and its requirements "stated that provision of credit for
small farms in most cases resulted in the introduction of paddy into optimum crop plans and it also helped in increasing the area of HYV paddy on the farms where it was grown.

Acharya and Pawar (1977) had examined the productivity of resources by fitting Cobb-Douglas function to the input-output data from a sample of 143 farms in Ahmadnagar district of Maharashtra. They observed that the productivity of resources were 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 was observed to be in excess as its marginal productivity turned out to be negative.

Hasan and Parthasarathy (1981) studied the resource productivity variations in mechanised and non-mechanised farms of Bodhan taluk, Nizamabad district, Andhra Pradesh. They fitted Cobb-Douglas production function and estimated regression coefficients, marginal products and ratios of marginal value products to opportunity costs. Their results indicated that the reduction of farm size would lead to increase in net profits. MVP of human labour was more in both types of farms than the wage rates while the MVP of bullock labour was more in mechanised farms. This indicated that profits could be increased by applying more units of human labour.
2.3.2 Resource use efficiency and Return to scale

Agarwal and Foreman (1959) obtained diminishing marginal returns for each of the three resources, land, human and bullock labour and concluded that constant returns to scale were prevailing in Western Uttar Pradesh.

Bantwala (1959) in his study based on the data from Farm Management studies in Uttar Pradesh concluded that scarce resources were extensively used on sample farms. His results showed that per acre value of output revealed a diminishing trend with an increase in the size of the farm.

Khusro (1964) studied returns to scale in Indian agriculture taking the data from the Farm Management studies of seven States. Unlike many earlier studies, in this study farm size was defined in terms of corrected and uncorrected acreage. Output and efficiency measures like returns per acre, farm business income per acre and paid out cost per unit of output etc, revealed the following trends:

1) If acreage was taken at its (uncorrected) face value, then as acreage increased, gross output per acre (O/A) decreased.

2) With an increase in (uncorrected) acreage, farm business income per acre (Y/A) decreased though at a slower rate than O/A.

3) With an increase in (uncorrected) acreage, net profit per acre (P/A) increased and though
frequently negative in the smallest farms rose to positive but small values in all cases.

4) As farm acreage increased, the average quality of the soil generally decreased and this was seen in the decline in land revenue per acre in almost all states.

5) If acreage was corrected with an index of fertility (which can be land revenue per acre itself) gross output per corrected acre remained constant as farm size increased.

6) Farm business income per corrected acre generally remained constant with an expansion of farm size.

7) Net profit per corrected acre, negative in few cases, generally increased with an expansion in farm size.

8) An alternative study of efficiency and size was also conducted with efficiency measured by average (paid out) cost per unit of output, CP/O and size by output itself. This revealed, in all areas studied, a remarkable constancy of CP/O as output increases. The impression of constant returns to scale was quite strong.

9) No less remarkable than the absence of a slope in the average (paid out) cost curve was the similarity in the levels of CP/O in all the areas studied. CP/O varied generally between 40-60 per cent, the most common value was 50 per cent.

10) Paid out cost per unit of income CP/Y, also remained constant with an increase in the size of income.
11) Judging by all these results it would appear that the use of simple, uncorrected acreage as a measure of farm size was apt to create an optical illusion about the behaviour of returns to scale and if proper variables were chosen, there was a strong general tendency towards constant returns to scale in Indian agriculture.

Raj Krishna (1964) estimated some production functions of Cobb-Douglas type taking the data from the farm management studies relating to two districts of Punjab, (Ferozepore and Amritsar) for three years 1954-55 to 1956-57. He arrived at his judgement about the efficiency of the prevalent factor proportions in production, correlations and returns to scale. He also showed how the estimated functions could be used to determine not only the direction of desirable input changes but even the magnitude of the optimum land input and the optimum labour input on certain assumptions. Marginal productivity of land was consistently more than rent. He attributed this to the imperfect land use market and to under-application of this input. On the other hand, in the first two years the wage rate exceeded and in the third it remained much below the marginal product of labour. He also concluded that there was no significant correlation between output and the size of holding, labour or to the cost.
Chennareddy Venkatarreddy (1967) studied resource allocation efficiency in rice farms of West Godavari, Andhra Pradesh. His results showed that these farmers used their resources efficiently. The author reported correlation coefficients between some of the variables of the order of 0.9. Such high coefficients of correlation in studies of this type were signals of warning about the presence of multicollinearity. He measured capital in stock terms as against the accepted practice of using the rental value of capital to measure its actual input. His category of production expenses was an all inclusive basket and one was not sure whether it was an arithmetic sum or a geometric sum of various inputs included. The use of geometric means was commended to avoid aggregation bias.

Rao (1967) attempted an analysis of resource productivities and returns to scale by fitting Cobb-Douglas type of production functions to cross sectional data covering 345 farms of former Hyderabad State. He found that the marginal value productivity of land declined with an increase in farm size and reverse tendency prevailed in regard to marginal productivity of labour which showed increasing trend with the increase in farm size.
Saini (1960) studied resource use efficiency in Uttar Pradesh and Punjab by estimating marginal value productivities and ratios of marginal value products to opportunity costs of factors. He made use of Farm Management data of 1955-56 and 1956-57 years. His analysis showed that the farmers in these two states were quite rational in terms of their response to economic opportunities and made adjustments in resource use. He also opined that this rationality, however, did not imply that the farmers always succeeded in operating their farm business at economically optimum levels. He suggested that the unexploited economic margins could be fully exploited by reorganising their resource use pattern suitably.

He also analysed the data and studied the resource use efficiency in different farm sizes. His results revealed that the efficiency of land use was higher on small farms and tended to decrease with an increase in farm size. Productivity of labour decreased with an increase in farm size. The marginal value products of land, labour and irrigation were greater than their acquisition costs, while they were less in case of bullock labour and fertilizers. This indicated that though the farmers were efficient users in general, there was a possibility of increasing their income through reorganisation of their resources. He concluded that the constant returns to scale seemed to have prevailed in these States.
Rehta (1971) used cross sectional data in the regression analysis for estimating the marginal value productivities of different resources and returns to scale for different categories of farms in Gurdaspur district in Punjab. The variables included in the functions explained the variation in output to the extent of 83 to 95 per cent in different zones. The overall analysis suggested that there were constant returns to scale in the study area and that technical efficiency was better on small holdings as compared to the large ones.

Fawar (1971) studied the resource productivities for input and investment categories on sample farms in Sangli district of Maharashtra. He concluded that fertilizers, irrigation, land and capital assets commanded higher marginal value products in relation to their opportunity costs and, therefore, there existed scope for increasing farm income by increasing the 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 were being used efficiently and there prevailed constant returns to scale in Indian agriculture.
Subrahmanyan (1971) in his study of West Godavari farms, Andhra Pradesh, tried to expose the imbalances that existed in the utilisation of resources by farmers and suggested necessary changes in the existing cropping pattern of different types of farming. He found that the scope of introduction of high yielding varieties of paddy differed from zone to zone and the extent of allocation of resources also differed from zone to zone and on different farm situations in each zone as reflected by the extent of increase in net returns.

Desai (1973) studied the resource use pattern on sample farms of central Gujarat and found that the production functions for the two regions of Baroda district were different. This was primarily ascribed to the differences in the underlying uncertainty with respect to irrigation resource in the two regions. Further this very factor pervaded so deeply that it seemed to have also caused an uneconomic use of labour (hired) and sub-optimum use of fertilizers and manures in less developed regions, while in more developed regions where irrigation resource was more reliable and adequate, the sample farmers maximised the net returns from all inputs.

Singh (1975) while studying the problems of resource use, farm size and returns to scale in backward
agriculture pointed out: (a) the inefficient use of factors of production by the farmer was mainly responsible for the economic backwardness of the region (b) the size of farm was an important factor influencing input productivity at the farm level (c) the returns to scale were constant in agriculture and (d) the marginal productivity of labour was zero.

Dhawan and Bansal (1977) evaluated the economic rationality of resource use on different farm size groups by means of marginal value products and factor costs. They fitted Cobb-Douglas production function for the farm level data of Punjab. Their results indicated that the land was used efficiently on small and medium farms. According to them the large farmers could increase their income by expanding operational size of farm, while small farmers can do that by curtailing the use of human labour, expenditure on irrigation and on draught animals, and by increasing the expenditure on seeds, manures and fertilizers and milch animals. The medium and large farmers were rational in making their expenditure on almost all the resources. Their findings also showed that all the categories of farms could improve their income by more investment on milch animals and by more intensive use of chemical fertilizers.

Acharya et al. (1977) studied the impact of IAD scheme on small farms of Sangli district in Maharashtra
by comparing the marginal value products of participants and non-participants. Their findings revealed that the impact of the IAD scheme on the economy of small farms was positive and encouraging. They also found that decreasing returns to scale, and excess use of human labour, was the common feature in these small farms.

Dutta (1962) was of the opinion that in recent years relative economic efficiency of small versus large farms has been a subject of lively debate in Indian agriculture. While some of the findings of the pre-green revolution period would point to the higher relative efficiency of small farms, those of post green revolution period focussed on the equal relative efficiency of small and large farms. The recent trend seemed to be that large farms were relatively efficient. The explanations of the early batch of researchers were that the small sized farms, by and large, were characterised by the predominance of family labour whose contribution to the raising crops was significant. The managerial ability of small farms and the greater care and attention paid by the family labour would enable them to raise greater productivity and thus put them in a better position vis-a-vis the large farms. The recent findings had their major explanations in terms of technological changes (greater use of modern inputs) which might have, to a large extent, brought about economies of large scale production, thus reducing the relative gains
of small sized farms. Another view was that equal application of biological inputs, other things being equal, would probably leave the relative efficiency of small and large farms at same level. Differential rate of application of biological inputs among the different farm sizes stem largely from the differences in motivation, knowledge, entrepreneurship and accessibility to credit. As such the relative efficiency among different categories of farms would remain to be a debatable question.

2.3 TECHNICAL CHANGE

The review has been divided into following sections:

2.3.1 Concepts of technical change,
2.3.2 Measurement of technical change,
2.3.3 Measurement of the nature of technical change;
2.3.3.1 Macro studies, and
2.3.3.2 Farm level studies.
2.3.4 Effects of technical change on functional income distribution,
2.3.5 Effects of technical change on employment.

2.3.1 Concepts of technical change

Ruttan (1956) defined technical change as the production of greater output with a given quantity of resources. In other words technical change results in higher output per unit of input. This was nothing but shifting of isoquant curve towards origin.
Solow (1957) defined technical change as a catch-all expression for any kind of shift in production function, assuming constant returns to scale, homogenics inputs and competitive equilibrium. According to him any increase in output, not explained by increase in capital and labour was assigned to technical change.

Ruttan (1960) modified his earlier definition and called technical change as a change in parameters of the production function or creation of new production function. But basically the two definitions given by Ruttan were the same as stated by Hayami and Peterson (1972).

Domar was not ready to accept this view. Instead of calling 'technical change' he used the term 'the residual' that is, the part of the increased output/man which was left over after the increases in capital/man were accounted for.

Kennedy and Thirlwall (1972) classified studies on technical change into two categories 'macro studies' which attempted to quantify the rate of technical progress as determinant of growth of output and 'micro studies' which sought to explain the process of technical change in disaggregated manner in firms and industries. This study falls under the second category.
Hicks (1963) classified technological progress as capital using, neutral, or labour using accordingly as the marginal rate of technical substitution of capital for labour decreased, remained constant or increased at a given capital-output ratio. In other words, the ratio of marginal products of labour and capital determined the nature of technical change. So technical change could occur only by change in the parameters of production function.

Harrod (1965) defined neutral technical change as the one in which marginal product of capital was unchanged as a constant ratio of output to capital. Labour augmenting technological progress, without disturbing the marginal product of capital and output capital ratio, was Harrod neutral. Ferguson (1971) said that in case of Cobb-Douglas production function both would coincide.

Rao defined (1975) the technological change as the use of new or modern inputs such as fertilizers, HYVs of seeds, tractor, pump set, thresher and harvest combine. In his view 'technique' refers to the actual mix of input factors—whether traditional or modern or both—which was a function of both technology and relative prices of input factors. Thus, technological changes might lead to changes in techniques but some of the changes in techniques would entirely reduce to changes in relative prices of inputs.
Nair (1980) defined technological progress or change, as those changes in the production process which reduced the marginal cost. This change could occur either by employing the existing inputs but in different composition (a change in technique) or by introducing new factors of production either for replacing old ones or simply as additional inputs (technological innovation). He thus stated that technological change in either case was associated with a shift in production function.

2.3.2 Measurement of Technical Change

Tinbergen (1942) was first to estimate technical progress as an exponential factor of time, using aggregate production function of Cobb-Douglas type.

Abromovitz (1956) developed arithmetic index showing growth in output for proportional change in labour and capital inputs. He called this as increase in efficiency.

Solow (1957) derived geometric index of technical change using aggregate production function. He concluded that over 57 per cent increase in output in United States manufacturing industries between 1919 and 1957 was due to technical change and about 12 per cent increase was due to increase in capital. The validity of this measurement was later questioned on the grounds of his assumption on aggregation and elasticity of substitution.
Masse (1960) tried to improve Solow’s estimation by using better quality data, but his results were the same as Solow’s. Solow (1960) however, preferred to give more emphasis on capital.

Johnson (1961) derived a measure of technical change without using the capital data directly. He treated returns to capital and wage rate as fixed.

Kendrick (1961) used Abramovitz’s (1956) index by changing price weights in order to overcome long run change in price not due to technical change.

Leval (1966) used Solow’s (1957) data and Johnson’s (1961) model and concluded that both were similar.

Brown and Popkin (1962) used Cobb-Douglas function to measure the magnitude of technical change in United States.

Brown and Dotani (1963) and Brown (1968) measured the rate of technical change in United States, using constant elasticity of substitution (CES) Production function.

Rao (1975) opined that the magnitude of technological change could be assessed either by estimating the increase in output attributable to modern inputs or by measuring the growth in the use of modern inputs themselves.
He also pointed out that the former was beset with several problems - the non-availability of the relevant information as well as the difficulties of estimation. The latter course was more manageable although it would provide only a rough approximation to the magnitude of technological change. He made use of these two procedures in his study of Technological change and Agricultural growth in India.

2.3.3 Measurement of the Nature of Technical Change

2.3.3.1 Macro Studies

Brown and Popkin (1963) using Cobb-Douglas production function for time series data of United States, isolated 'technological epochs' a period during which there was no non-neutral technical change. But epochs were not characterised by sharp break from the previous ones. They attempted to isolate change in output due to (a) change in inputs (b) economies of scale (c) neutral technological change and (d) non-neutral technological change.

Brown and Decani (1963) used CES production function to isolate 'technological epochs' based on non-neutrality of technical change. They also decomposed change in output due to change in elasticity of substitution, change in rigidity parameter, labour intensity, and change in factor prices.
Beckman and Sato (1969) used Chi-squared and log-linear functions to test various types of neutral technical change in United States, Germany, and Japan. They found that Solow neutrality occupied first rank in United States and Germany, whereas Harrod neutrality was first in ranking in Japan, based on coefficient of multiple determination ($R^2$). Hicks neutrality did not occupy high rank as the other two types.

Tara Shukla (1966) adopted two measures namely (1) study of the ratio of output to input (both suitably aggregated) and 2) Solow's approach of isolating technological change based on aggregate production function to measure technological change in agriculture in India over a period of time (1920-21 to 1960-61). She concluded that the technological change in India agriculture was, by and large, conspicuous by its absence and if at all some improvement seemed to have taken place in technical relations between output and input during the period of her study.

Hayami and Ruttan (1970) compared the technological progress of United States and Japan agriculture from 1880-1960. They found that technological progress in Japan was land augmenting, whereas it was labour augmenting in United States.
Srivastava, Green and Heady (1971) developed a model for measuring bias using Cobb-Douglas production function. They considered factors like land, human labour, bullock labour, mechanical capital and non-mechanical capital. They emphasised the relative change in output elasticities of factors as a measure of bias in technical change.

Binswanger (1974) used Hick's concept of bias in technical change to determine the nature of technical change in United States agriculture from 1912-1968. Using translog cost function he developed two models—one embodying variable rate of bias over time and the other constant rate of bias over time. Using variable rate of bias model, he found that there was land and labour saving bias and machinery and capital using bias during that period. Using constant rate of bias model, he found only labour saving bias, while there was land, fertilizer and capital using bias in United States Agriculture.

2.3.3.2. Farm Level Micro Studies

Gupta and Singh (1966) defined technological change as a change in the parameters of production function resulting from the use of new technology. The effect of technological change in Varanasi district was measured by the difference in the input-output ratio and
the average yield and both of them were found to be more on adopter farms.

Satyanarayana (1970) used both pre and post Green Revolution period data from selected villages of Punjab and Haryana and concluded that there was upward shift in production function in post technology period. However, he did not estimate the nature of shift.

Meedy and Srivastava (1973) used CES production function for Punjab and Uttar Pradesh farm management data for 1955-56, 1956-57 and 1957-58 to determine the bias in technical change.

Sidhu (1974) used Cobb-Douglas production function for estimating the nature of technical change from local wheat to Mexican wheat in Punjab. He collected data from Ferozepur district for the year 1967-68, 1968-69 and 1969-70. He used analysis of variance to know the shift in production function from local wheat to Mexican wheat for the year 1967-68. He found that technical change was neutral in nature. Allowing the intercepts to differ by using intercept dummy he found that slope parameters for both relations were the same. His results showed that the intercept for Mexican wheat was higher by 22.85 per cent.

Bisaliah (1975) used data from Ferozepur district of Punjab for the estimation of technical change using
Cobb-Douglas frame work. First, he identified the structural break in production relation from local wheat to Mexican wheat, using 'Chow-test'. He found that the two relations were statistically different. He identified change in intercept and slope parameters for capital as the cause for structural break, using slope and intercept dummies. Then, by using analysis of covariance, he found that the slope parameters for the two relations were the same, allowing the intercepts to differ. He further concluded that technical change was approximately neutral. He then attempted to decompose the change in output due to neutral and non-neutral technical change, and change in quantity of input used.

Gafsi (1975) determined the nature of technical change when shift took place from local varieties to high yielding varieties of bread and durum wheat in Tunisia. He used Cobb-Douglas production function with type of traction, land topography, type of weeding, nitrogen fertilizer, phosphatic fertilizer and number of land preparation operations as independent variables and wheat output as dependent variable. Further, employing analysis of covariance, he tested for the equality of slope parameters allowing intercepts to vary between local and KVs. He then proceeded to test for the equality of intercepts. He found that in the case of durum wheat technical change was neutral, implying change in both intercept and slope parameters.
Yadyal (1977) used the data collected from Shimoga district of Karnataka state relating to 1975-76 Kharif season for the estimation of technical change using Cobb-Douglas framework. He first identified the structural break in production function because of shift from local varieties to HYV paddy using 'Chow test'. He found that there were significant differences in production functions of local and HYV. Then by using analysis of covariance, he showed that the slope parameters for the two were the same, allowing the intercepts to differ. He found that the technical change was to the extent of 23.45 per cent.

Thamodaran and others (1932) fitted Cobb-Douglas type of production function to the farm level data of Udangudi block in Tirunelveli district of Tamilnadu to compare the resource productivity between HYV and local varieties of paddy and to investigate the nature of technological change involved in switching over from low yielding to HYV paddy. They found that the difference in production function relationship between HYV and low yielding paddy were significant. HYV gave higher yields. The production function coefficients obtained with intercept dummy variable indicated that the differences in slopes of production functions between HYV and low yielding paddy were not significant. However, the difference in intercept among production relationships between the
varieties was significant. They thus concluded that the technological change that took place in paddy in the area was a factor-neutral one and not a biased one.

Bisalich (1977) analysed farm level data relating to Punjab and decomposed the total change in per acre wheat output with the introduction of new technology into proportion due to technical change and the proportion due to change in the input level. He fitted separate Cobb-Douglas production functions to Mexican and local wheat and estimated the percentage changes. According to his study the total change was 40.50 per cent. In that the contribution of technical change was 15 per cent and the extent of change brought out by the use of inputs—labour, fertilizer and capital were 2.10, 15.10 and 8.30 per cent respectively.

2.3.4 Effect of Technical Change on Functional Income Distribution

Dixit and Singh (1970) used tabular analysis to estimate the increases in labour use as a result of adoption of HYV. They used 'Payments' to labour as a measure of labour input. Using the data relating to local and Mexican wheat from Varanasi, they found that the yield per acre increased by 96 per cent and the gross value by 71 per cent, while payments to labour increased by 59 per cent, resulting in 66 per cent increase in the family labour use and only
37 per cent increase in hired labour use. This showed that demand for hired labour did not increase in proportion to either output or 'payment' to labour.

Garg, Singh and Srivastava (1970) estimated by tabular analysis, the share of each factor of production in the additional expenditure incurred in the adoption of HYV. The factors considered by them were human labour, seeds, manures and fertilizer, rent and overhead cost. They observed that expenditure on each of the factor increased by adoption of HYV.

Sisodia and Agarkar (1970) compared the cost-return structures of 50 progressive and 50 less progressive farmers of Malwa region in Madhya Pradesh. By tabular analysis they found that expenditure on all factors increased by adopting HYV. Purchased inputs dominated the expenditure in the case of HYV.

Srivastava, Heady and Crown (1971) suggested a model with Cobb-Douglas production function for measuring change in relative factor shares. They used change in ratio of output elasticities as a measure of change in relative factor shares. The factors they considered were labour, mechanical capital, non-mechanical capital and fertilizer.
Heller and Lele (1973) compared the increase in payments to labour in respect of local varieties and HYV paddy, wheat and bajra for various parts of India. They found that in almost all cases the percentage increase in payments to labour was less compared to the percentage increase in output. On comparing the share of output accruing to various factors, they found that only a marginal increase in output went to labour as compared to the large share going to other factors.

Srivastava and Hoady (1973) used C.E.S. production function to measure the change in relative factor shares. They considered only two factors namely capital and labour as C.E.S. function was difficult to generalize for more than two factors. Using farm management data from Punjab and Uttar Pradesh for the years 1955-56, 1956-57 and 1957-69 they estimated the change in factor shares and decomposed it to sources—change in elasticity of substitution, labour intensity, and rental wage ratio. They found that the relative share of labour was decreasing. They also concluded that the elasticity of substitution was the most important factor in changing factor share.

Raju (1974) used regression analysis to test the change in labour's share in gross output. He used linear as well as power functions of the form $x = a + by$

$$x = ay^b$$
When \( x \) was the average wage bill and \( y \) was the gross output. Using the data for the year 1967-68 and 1970-71 of West Godavari in Andhra Pradesh he compared changes in labour's share by both per farm and per acre analysis. He found that labour's share of wages in gross output increased between 1967-68 and 1970-71 and attributed this to Green Revolution.

Sidhu (1974) used Cobb-Douglas production function for comparing relative factor shares. In Cobb-Douglas relative factor share can change only by shifts in output elasticities. He compared the Mexican wheat output elasticities with those of local wheat. He found that the share of fertilizer had increased.

Bisallah (1975) who used modified version of Hicksian model for determining the changes in relative factor shares based on cross section data of local and Mexican wheat in Punjab for the year 1967-68 and found that the relative shares of land and labour had decreased, while those of fertilizer and capital had increased from local wheat to Mexican wheat.

Rao (1975) using data from 1968-70 from Farozepur in Punjab estimated change in absolute and relative share from local to HYV. Using tabular analysis he found that the relative shares of land, labour and capital increased and that of entrepreneur decreased in wheat. In rice,
the relative shares of labour, land and capital decreased while that of the entrepreneur increased.

Kalirajen (1980) studied the distribution of net profits in relation to farm size on the basis of empirical evidence of farm level data of Coimbatore district (Tamilnadu). He worked out decile distribution and Gini ratios of net profits both for kharif HUV and rabi HUV paddy. His results of analysis revealed that the distribution of profits was more uneven both for kharif as well as rabi crops. He summed up his results saying that the crucial factor determining the distribution of net profits was the pattern of land ownership, but not the pattern of input expenditure nor the farm size.

Ghedake (1983) evaluated the impact of improved technology in Toddpally village in Medak district of Andhra Pradesh, on factor shares. He defined relative factor shares as the ratios between the expenditure on factors and the value of output. His analysis revealed that the adoption of the improved technology had raised gross revenue substantially on all the three farm sizes, and the relative factor shares of all factors except fertilizers and tool carrier. He summed up his results saying that dry land improved technology appeared to benefit the following factors in order of importance (1) variable expenditure; (2) labour; (3) non-land assets and (4) land.
George et al. (1983) estimated factor proportions in the total cost of production and their shares in the total value of output and determined how these shares varied among different regions. They worked out factor shares for paddy in Andhra Pradesh along with other crops of other states. Their results showed that the share of human labour, interest, purchased inputs had increased substantially from triennium 1957-60 to 1978-81, while the share of land declined steeply. The share of management had increased up to triennium 1971-74 (19.66%) and decreased then onwards and it was a minimum (1.46%) in 1978-81.

Rajagopalan and Varadarajan (1983) estimated factor shares through temporal changes in rent, wage and fertilizers costs during seventies by means of index numbers and parity. Those results were also tested by fitting Cobb-Douglas form of production function assuming constant returns to scale, by adopting dummy variable technic using 150 HYV and 30 local paddy farm level data of Tamil Nadu. They found that rent/wage and rent/fertilizer cost parity indices showed steeper rise than wage/fertilizer cost parity index. It would imply that the new technology had brought significant gains to land owners while it had remained rather neutral in the use of labour and capital with no appreciable change in their relative share in income. The results of functional
analysis also proved the hypothesis that the new high yielding rice variety represented a neutral technology in the use of labour and capital.

Singh (1963) had worked out share of factors in the total cost of production, on the assumption that the returns to scale were constant and prices of various factors of production were proportional to their marginal value products. He worked out share of factors under three broad categories i.e. land, labour and capital. His results were based on the studies in the Economics of Farm Management and Comprehensive Scheme. He estimated percentage share of factors in total cost for rice in Andhra Pradesh and Orissa. The factor shares in Andhra Pradesh (1971-72) were 36.01, 29.61, and 32.38 per cents for land, labour (human 22.43%, bullock 7.18%) and capital (working 24.94%, fixed 7.44%) respectively and the corresponding values for Orissa were 32.98, 47.35 and 19.47 per cent. In the view of the author the wider differences between the two states were due to differences in agro-climatic conditions and the extent of adoption of HYV technology.

2.3.5 Effects of Technical change on Employment

Billings and Singh (1969) studied the labour requirements of a 10 acre well irrigated farm in Punjab for evaluating month-wise labour requirements under
different levels of technology, mechanisation, and cropping pattern. They found that labour requirement increased significantly with the adoption of HYV from 50 mandays per acre to 60 mandays per acre. But when mechanisation was introduced, the labour demand fell down to 25.5 mandays per acre. However, this was compensated by increased cropping intensity.

Mishra and Sukla (1976) compared the demand for labour on HYV farm with that on Local variety farm in Pilkhini village near Varanasi (UP). They found that per hectare labour use on HYV farm was 124 mandays in contrast with 97 mandays in the case of local variety farm.

Satyanarayana (1970) using pre-and post Green Revolution period data from Punjab and Haryana, found that the per acre labour requirement did not change significantly as a result of adoption of HYVs.

Kahlon, Gupta and Sondhi (1971) using time series data from 1966-67 to 1969-70 for 24 farms in Jullundhar, Amritsar and Gurdaspur districts of Punjab estimated per hectare labour use (in hours) for different crops and farm as a whole for different seasons. They found that labour use per hectare did not rise as a result of adoption of HYV of crops. However, on account of increased cropping intensity, the labour use for the farm as a whole went up.
Wills (1972) used linear programming technique to estimate the change in employment due to adoption of HWVs, assuming availability of modern inputs and technical knowledge to all farms. He estimated that the total employment increased by 30 to 50 per cent by the adoption of HWVs. But the increase in relative income of labour was less than that of farmers.

Donovan (1974) also used linear programming technique to estimate the employment generation as a result of adoption of HWV technology in Kandiya district of Karnataka state. He considered dairying and other allied fields also for employment generation. He estimated that the employment could be increased by 75-100 per cent through multiple cropping and adoption of advanced technology with other facilities.

Rao (1975) who used farm management data from Ferozepur district of Punjab for the year 1968-69 and 1969-70, found that the employment potential increased significantly and it was evenly distributed all over the year as a result of adoption of modern technology. The wage rates also rose significantly and they were at peak in April, May and June.

Srivastava and Singh (1980) studied 50 sample farms from 5 villages in Kalyanpur block of Kanpur district (UP). They compared aggregate labour use per
hectare at various stages of adoption of HYVs. When
the area of HYV was 10.84 per cent in 1966-67, the
average per hectare labour use was 94.5 mandays. In
1970-71, the percentage area under HYV was 46.18 per
cent and the employment of labour per hectare rose to
143.24 mandays. They also found that the share of hired
labour in the total wage bill increased between 1966-67

The study conducted in Andhra Pradesh (1980) on
Economic aspects of yield increasing practices revealed
that the labour employment did not change in any season
in West Godavari district, in kharif season in Kalgonda
district and in rabi season in Chittoor district, while
there was a substantial increase in labour employment in
kharif season in Chittoor district and rabi season in
Kalgonda district due to the adoption of HYV paddy.

Adinarayana (1981) in his study 'Economics of
paddy cultivation in Andhra Pradesh', estimated that the
labour requirement had increased for HYV paddy by 5 and
44 mandays per hectare for HYV paddy of kharif and rabi,
respectively, over the local varieties of paddy.

Joshi (1981) and others studied employment effect
of technical change in Uttar Pradesh by decomposing the
the total change in agricultural labour employment between
1966-67 to 1977-78 in terms of important components like
irrigation, high yielding varieties, tractorization, cropping intensity etc. Their decomposition results indicated a positive change in labour absorption due to adoption of HYV programme in case of wheat and paddy crops, though the increase was marginal (22.2 man-hours/ha.). However the overall direct impact of technological progress in these two crops on employment was negative to the extent of 21 and 40 man-hours per hectare in wheat and paddy, respectively. They concluded that agricultural production in the State per se was not labour absorbing.

Naidu and his co-workers (1981) studied the relationship between farm size, cropping intensity and labour use in Cuddapah district of Andhra Pradesh. Their results indicated that as farm size increased, the crop intensity declined, but results of functional relationship for the last year of study (1969-70) indicated that the inverse relation was disappearing slowly. In their view, the reason lay in the greater interest evinced by the large farmers in using land more intensively in the wake of higher profitability offered by the Green Revolution. Their analysis showed that large farmers were taking advantage of the new technology by resorting to improved practices in greater number and also by adopting these practices over greater acreage of land. They concluded that their relationship between farm size and labour use
was negative in the first two years (77-79) but turned out to be positive during the next year. Their explanation for this trend was that, as farm technology undergoes a change, large farmers take greater interest in using land more intensively. With modern inputs used at the proper time, greater amount of labour input per hectare was used on large farms as compared to small ones.

Shaw (1991) analysed the data pertaining to Philippines to assess the employment implications of Green Revolution. His results showed that HYV paddy absorbed 30-50 per cent of additional human labour days over the local varieties. This estimate was made excluding labour requirement for harvesting and threshing operations and he was of the view that another 20-30 man days per hectare would be needed for these two operations. So the total additional human labour absorbed due to adoption of HYV paddy technology worked out to around 30 man days/ha.