Chapter II

REVIEW OF LITERATURE

The relevant literature has been reviewed for the indigenous and foreign research attempts as given below.

Indigenous Studies

Sahota (1968) carried out the multi-dimensional analysis of resource allocation and concluded that there were few significant inefficiencies of resource allocation in Indian Agriculture. Farm management data covering three cross sections, eight farm size groups and six regions of India were used for this purpose. Along with the important inputs taken as explanatory variables, the year, size and region dummies were introduced in the regression equation with a view to account for the specific characteristics of individual units of the time periods and various cross sections.

Findings on efficiency differences among regions showed that Madras State was at the top of the efficiency list, followed by Uttar Pradesh. Whereas, West Bengal and Bombay were bracketed on the lower side of the state efficiency levels. The size analysis showed that with current techniques of production, farms of more than 30 acres were, on an average, inefficient for bajra. Farms of more than nine acres or so were inefficient for paddy and farms of five acres or less were inefficient for wheat and pulses. Further, the result showed that
i. there was little evidence that investment in fixed capital in general was inadequate;
ii. there was strong evidence of under-investment in specific forms of capital i.e. fertilizer and irrigation water; and
iii. the evidence against the possibility that marginal product of labour may be positive was, if any existed at all, very weak.

Radhakrishna (1969) made the classification of a set of farmers into efficient and inefficient farmers on the bases of a number of efficiency norms through Discriminant Analysis. The issue of determination of efficient farmers arose in the context of formulation of a price policy for agricultural commodities which had to take into account, inter-alia, the cost of production of crops. The determination of efficient farmers was attempted only as the basis of measures of economic efficiency. The data were obtained from the studies in the “Economics of farm management in Andhra Pradesh” and related to ninety three farmers.
who had grown irrigated paddy in the first season. The variables considered for determining efficient farmers were:

i. efficiency criteria namely yield of paddy per acre,

ii. cost of production of paddy per maund (cost c); and

iii. the ratio of value of output to cost.

The Discriminant Analysis demarcated the farmers into efficient and inefficient ones. The average yield per acre and the average cost per unit of produce for all the ninety three farmers were calculated. Of these, whoever had the output-cost ratio more than unity was considered to be an efficient farmer.

Saini(1969) evaluated the efficiency with which farmers in the States of Uttar Pradesh and Punjab used their resources to achieve the highest net returns from crop production. The investigation showed that farmers were quite rational in terms of their response to economic opportunities and made adjustments in resources use. This rationality, however, did not imply that farmers always succeed in operating their farm business at economically optimum levels. The unexploited economic margins as indicated by the existence of an excess of marginal value product over factor costs in the two states suggested that farmers were not always efficient as allocators of resources in exploiting fully the economic opportunities available to them.

Ketkar(1975) determined the potential impact of new technology on Indian Agriculture through programming model. Any shortfall of actual output from programme results was termed inefficiency. These were differentiated on the basis of amounts of N,P,K used as well as the use of irrigation and high yielding seeds in dry and wet season of the year 1968-69.

Four states namely Bihar, Punjab, Maharashtra and Tamil Nadu were selected for analysis. A number of crop production processes were defined for each state. In Punjab and Bihar, the extent of inefficiency was relatively low. In Punjab it was due to excessive diversification of the cropping pattern, while in Bihar, the inefficiency was due mainly to diversification and partly to the selection of less-efficient processes. On the other hand, in Maharashtra and Tamil Nadu, agricultural resources were used inefficiently. The efficient allocation of resources within and between states would increase agricultural incomes per hectare by 42 per cent above the 1968-69 level. The difference between the modal and actual 1968-69 average income in the four states was taken as a measure of total inefficiency. About,
91 per cent of the total inefficiency could be attributable to the misuse of resources and the rest to the misallocation of fertilizer between different states.

Singh and Kahlon (1975) examined the resources use efficiency on sample farms in the Central Plains of Punjab, comprising two general types of farming area viz. Non-Bet and Bet. The farmers were classified into different groups on the basis of source of irrigation and source of draught power. The production elasticities of land and human labour were positive and statistically significant in case of six out of eight farm classifications. The elasticity of production with respect to working expenses was the highest. The production elasticity of expenditure on irrigation, on bullock operated, tubewell plus canal irrigated farms was positive, but that of expenditure on draught power was negative in the Non-Bet area. But because of large holdings in the Bet area, the elasticity of draught power was positive for bullock-operated, tubewell irrigated farms. The analysis also indicated increasing returns to size as well as the rationality of resource use.

Chamak and Singh (1979) examined the resource use efficiency in Punjab Agriculture. They concluded that land, labour and working capital were the significant variables explaining changes in output. As regards fixed capital, its production elasticity was found to be negative but non-significant in all the cases. The marginal value product (MVP) of land was the highest on the small farms followed by the large and medium sized categories. The comparison of MVP of different factors with their respective factor costs indicated significant inefficiencies in resource use for almost all the input factors on all the farm categories and also on the overall farms.

Sharma and Tiwari (1985) studied eight villages along the embankment of river Sutlej. All the cultivators of the selected villages were stratified into categories ‘A’ (<1.5 ha) and ‘B’ (> 1.5 ha). On the category ‘A’ farms, the ratios of MVPs of human and bullock labour to their respective acquisition costs were found significantly less than unity and indicated the excessive use of these resources. In case of fertilizers and manures and expenditure on fixed assets, the ratios were significantly greater than unity implying that production on average farm of category ‘A’ could have been increased significantly by using more of these factors. Land and seed in this category had been used efficiently. On category ‘B’ farms, most of the ratios except bullock labour were not significantly different from one
and hence indicated that these resources had been used efficiently. But the bullock labour was excessively used on category ‘B’ farms.

Moorti et al (1986) studied the allocative efficiency of farm resources in Kangra district of Himachal Pradesh. They tried the production function for different enterprises on different sizes of farms, viz. marginal, small and large. Paddy and maize in the kharif season and wheat and oilseeds in rabi season were important crops in the study area. The higher cropping intensity on small farms showed more rational use of land on these farms. Expenditure on human labour per farm was the highest on all farms followed by bullock labour, F.Y.M, fertilizer and chemicals. The marginal farms were more human labour intensive than for other inputs. Returns to scale on different sized farms showed that productivity could be increased through additional use of inputs other than human labour.

Banerjee and Santra (1988) analyzed the farm size, productivity and resource use efficiency in agriculture of the Nadia district of West Bengal. The results from the regression model relating input to farm size demonstrated a decreasing intensity of input use per farm as the farm size increased. There was a positive correlation between farm size and productivity. However, the inverse relationship between farm size and productivity was not a confirmed phenomenon. It was observed that the elasticity of input use with respect to farm size was less than unity for each factor input. Further, the elasticity of labour use with respect to farm size was much higher than the elasticity of any other input with respect to farm size.

Lalwani (1990) studied the benefits from crossbreeding indigenous cows with exotic ones and also examined the allocative efficiency of resources in Karnal district of Haryana. Marginal physical products and the MVPs were derived from milk production functions for buffaloes, crossbred and indigenous cows for four farm size groups, viz landless, small (up to 2 ha), medium (2.01 to 8 ha) and large (above 8 ha). The dairy households with land made excessive use and those having no land made less use of green fodder. Concentrates were generally used deficiently, dry fodder use was excessive for indigenous cows. The human labour use for crossbred cows was excessive on landless and medium farm sizes but deficient for buffaloes and indigenous cows.

Datta and Joshi (1992) measured the existing economic efficiencies in agriculture to find the cost and production potential of reclaiming salt affected soils and proposed investment priorities to increase agricultural production. Aligarh district in Uttar Pradesh.
Pradesh was purposely selected. The district was endowed with 70 per cent of the farm land irrigated and had about 20,000 hectares of salt affected soils. Sikandrarao tehsil of the district was chosen because of having about 60 per cent of the salt affected area, largely alkali soils and 93 per cent of the area irrigated. Four villages and 120 farm households were randomly selected and the data on the important aspects of crop production for the year 1990-91 were collected. Wheat and paddy crops were taken up for the analysis. Log-linear production function for these crops was employed and deterministic frontier function estimated using the linear programming technique. The most important determinants of wheat yield were phosphatic fertilizer, hired labour and variable defined as ‘other expenses’ consisting of cost of seeds, chemicals, etc. Their coefficients were significant at one per cent probability level. So, was the case for nitrogenous fertilizer in determining paddy yields. The analysis concluded that

i. yields on normal soils could be increased by about 29 per cent for wheat, 46 per cent for paddy by reducing the gap between best adopted and average level of technology;
ii. salt-affected soils had also enough production potential with the available technology. At the moderate level of input use, the yield of wheat ranged from 1,140 to 1,370 Kg and paddy from 2,430 to 3,470 kg per hectare;
iii. the cost of producing additional output was significantly lower on normal soils by achieving economic efficiencies in comparison to the salt-affected soils. The future investment priorities could be developed accordingly.

Grover et al (1992) examined the impact of farm mechanization on input-use efficiency in Bathinda district of Punjab. The analysis using the Cobb-Douglas function brought out that there was no marked difference in the resource use efficiency among the farms having different levels of mechanization. But, in a broader sense, the intensity of input use increased as the level of mechanization increased, particularly so in the case of human labour and fertilizers. The irrigation resource was found to be over-used on non-mechanized, partially mechanized with tubewells and fully mechanized farm situations. But, it was under-used on partially mechanized farm with tractors but no tubewells. The MVP of irrigation (2.05) which was statistically significant, indicated the possibility for increasing the expenditure on this category of farms. Also, the MVP of expenditure on insecticides and
pesticides (3.66) on the partially mechanized farms turned out to be significant which implied that the expenditure on plant protection could profitably be enhanced.

Grover et al (1992) studied resource productivity of rapeseed and mustard in Punjab. The data were taken from the ‘Farm Management Study in Bathinda District of Punjab’ for the year 1987-88 by using the two-stages stratified random sampling design with village as the primary and operational holding as the ultimate unit of selection. The farm size groups were identified by pooling all the operational holdings raising rabi oilseeds (rapeseed and mustard crops) in the sample villages. Three farm size-groups were thus identified and categorized into small (less than 5.97 ha), medium (5.97 to 12.25 ha) and large (12.25 ha and above) with an overall sample of 389 holdings. Regression analysis was employed to bring out the contribution of farm size and investment in human labour, bullock labour, manures and fertilizers, plant protection and irrigation to gross income from rapeseed and mustard. The findings showed that though the rapeseed and mustard crop competed favourably with the major crops of the region, yet it was more prone to insect-pests and diseases. It was also pointed out that plant protection was the most important factor which highly contributed to the gross income of the oilseed growers of all sizes of farms. Similarly, investment in human labour for producing rapeseed and mustard also had high potential for increasing returns.

Kaur and Singh (1992) examined the resource productivity and use-efficiency in agriculture across different agro-climatic zones of Punjab. The study indicated the prevalence of constant returns to scale in all the zones. The MVP for fertilizers was the highest in Zone I and the lowest in Zone VI. The MVP for insecticides was the highest in Zone II and the lowest in Zone IV. Whereas, for labour it was the highest in Zone IV and the lowest and negative in Zone III. The MVP of expenditure on diesel engine was found negative in Zones V and VI. It was observed that with the optimum use of resources, returns could be increased considerably in all the zones.

Singh et al (1992) investigated the resource use efficiency for unirrigated and irrigated wheat grown in the watershed areas of Kandi region of Punjab. The important variables viz. crop area, human labour, bullock labour and fertilizer were regressed against the gross returns from wheat. The coefficient of multiple determination indicated that about 57 per cent to 79 per cent of the variation in the value of output from unirrigated and irrigated wheat respectively was explained by these variables. It was seen that under rainfed conditions,
fertilizer application was not only essential to get higher yields but was highly remunerative too. The use of human and bullock labour was rather excessive for both the irrigated and unirrigated wheat with negative MVPs thus indicating the need for a look at reducing/rationalizing their use.

Thakur et al (1992) examined the resource use efficiency in agriculture of high altitude areas of Lahaul Spiti district of Himachal Pradesh. Seed potato was the major cash crop of the region covering about 56 per cent of the cropped area. The input use intensity was fairly high in case of seed potato. Human labour was the most crucial factor for crop production and the production elasticities associated with it were significantly high for all the crops on all the farm categories. Seed, fertilizers and bullock labour were found to be non-significant as all the farmers used high doses. Increasing returns to scale were observed on marginal and small farms. The MVP of human labour in all the crops and that of irrigation in case of potato were greater than unity showing the scope for enhancing the use of these inputs.

Chahal and Mander (1994) studied the resources use efficiency in agriculture by selecting Ludhiana as the developed and Bathinda as the less-developed district of the Punjab State. The functional analysis of the data for the year 1991-92 showed that an increase in expenditure on manures and fertilizers on farms of Bathinda district could increase the existing sub-optimal level of output. Whereas, this resource was optimally used on Ludhiana farms. The use of irrigation water and expenditure on pesticides were less than optimum on Bathinda farms as compared to Ludhiana where their use was optimal. Excess capacity and over-investment for tractors and allied machinery were found in both the districts. The expenditure on hired human labour in both the districts was at the optimum level. Certain adjustments in resource-mix were found to help improving the overall farm efficiency. An increase in the size of operational holding by leasing-in more land was one possibility. Extension of irrigation facilities especially in the less-developed areas could raise the farm incomes. In cotton growing areas, additional expenditure on pesticides will help to increase the farm output. As the acquisition cost of tractor and allied machinery was very high, the farmers should prefer hiring-in for improving the earnings.

Krishna Rao et al (1994) estimated resource productivity, returns to scale and resource use efficiency on paddy farms of Rangareddy District of Andhra Pradesh. Six villages in non-watershed, but abutting the Maheshwaram watershed of the above district of the State were
selected for the study during the year 1988-89. Farmers from the watershed and non-watershed areas were termed as adopters and non-adopters of technology respectively. Thus, 240 farms were selected equally from both watershed and non-watershed areas and categorized into small (less than 2 ha), medium (2 to 4 ha) and large (4 ha and above) farms. Cobb-Douglas production function was used to estimate the resource productivity and returns to scale on adopter and non-adopter farms. The variables which influenced the output varied in case of different farm size groups. Human labour was found to be dominantly influencing the output for all farm size groups on the adopter farms. The use of human labour needed to be increased and expenditure on cattle labour and fertilizer to be curtailed on adopter farms. Cattle labour and seed were observed to be influencing the output positively particularly on small and medium farms of non-adopters. The expenditure could be increased on cattle labour, seed and fertilizer in case of non-adopters to move towards the optimum level.

Sharma et al (1995) assessed the resource use efficiency on hill farms of two blocks viz; Nagrota and Nurpur of Kangra district of Himachal Pradesh. Five villages from each block were randomly selected during the agricultural year 1990-91. The farms in selected villages were categorized into small (up to 2 ha), large (above 2 ha) and overall farms. The sample covered 40 small and 20 large farmers. The Cobb-Douglas production function was used to work out the resource use efficiency. The average size of holding stood at 0.97 ha, 2.32 ha and 1.40 ha for small, large and overall farms. The results showed that the area under high yielding varieties of maize and paddy was low and could be increased. The factors affecting the gross value of maize, paddy and wheat were human labour, manure and fertilizers, capital and bullock labour which explained more than 85 per cent of the total variation in productivity of these crops.

Sagar(1995) investigated the response of fertilizer use in Indian Agriculture. The study was an attempt to verify the findings that showed the diminishing marginal physical product of fertilizer in the major cereals viz; paddy and wheat. He used the data related to fertilizer use under field conditions as well as that of experimental and semi-experimental responses from various sources. These included state level crop-cutting experiments, cost of cultivation of principal crops and All India Coordinated Agronomic Research Project. He employed linear and non-linear response functions and also brought out derived fertilizer responses and took up three technological inputs namely, H.Y.V, irrigation and fertilizers.
He found that under the High Yielding Varieties Programme (HYVP), a simple fertilizer response curve depicted diminishing marginal productivity during 1970s’. But during the 1980s’ the cultivators’ use data under the Cost of Cultivation Project did not show the diminishing productivity. It was highlighted that considering the response under “experiments on cultivators’ fields (ECF)” as the norm in Trans-Gangetic and coastal region of Andhra Pradesh and Tamil Nadu, this level in the use efficiency was achieved within the extended range of fertilizer application. The investigation results don’t support the view that efficiency of fertilizer use in India has declined mainly due to the extension of fertilizer rates in farm progressive regions. On the contrary, the less developed regions showed low fertilizer application combined with low to very low use efficiency. The comparison of ECF response curves to those derived under field conditions showed larger curvature for the latter. The possible reason assigned for this was the imbalance in the nutrient mix. Application of farm yard manure being more balanced was found to reduce such curvature and shift the response curve to the right thereby increasing the profitable range of fertilizer application. The agricultural extension network was found to be instrumental in improving use efficiency of fertilizers and needs more emphasis for further improvement in this efficiency and thus for higher consumption of nutrients.

Singh(1996) made an investigation on “Efficiency of Input Use in Indian Agriculture”. He found that the growth rate of aggregate agricultural productivity in India during 1980-81 to 1994-95 had been lower than the growth rate of fertilizer use, power consumption and institutional credit, but more than the growth in irrigation water. The share of modern inputs increased from less than three per cent in pre-green revolution period to more than 33 per cent in 1990s’.

The productivity response surface shifted upwards significantly, by as much as 3871, 6162 and 2216 Kgs/ha in case of wheat, paddy and cotton respectively in Punjab Agriculture between 1979-80 and 1988-89. The marginal productivities of modern inputs increased along with the increased use of these inputs thereby showing improvements in response and the resource use efficiency. The aggregate agricultural production function shifted upwards by about 33 per cent during 1969-72 over 1960-65, but there was no significant shift in the production surface in 1989-92 over 1979-82, inspite of the increase in aggregate productivity by about 47per cent. This was indicative of agriculture coming to operate nearer the flattening
part of the production surface, thereby implying that further growth demands more of the new technological innovations, rather than the finer tunings in the available technology.

It was also brought out that the role of cash inputs had increased. The cost of modern inputs such as fuel and oil, electricity, fertilizers and other chemicals stood at about 70 per cent of the total cash costs on large farms and even higher at about 80 per cent for small farms. The disturbed price ratio of phosphatic fertilizers related to nitrogenous ones led to increased imbalance in the use of fertilizers. The input subsidies especially for fertilizers and electricity thus needed to be carefully assessed.

Chanrashekar and Srinivasa (1996) investigated the resource use efficiency for rainfed groundnut grown in Challakere Taluka of Chitradurga district of Karnataka State. The important variables viz; crop area, human labour, bullock labour, seed, F.Y.M and chemical fertilizers were regressed against the gross returns from groundnut. The efficiency with which the growers used their resources to maximize their farm earnings was examined. The data on the cultivation of the crop of 1991 kharif were collected from 100 growers selected at random in 10 sampled villages. Cobb-Douglas function and frontier production function were employed. Timmer’s Technical Indices were used separately for small, large and overall farmers to determine whether the factors of production were used optimally to achieve the objective. The findings showed that land, F.Y.M and seed contributed significantly to the production in case of small farmers and F.Y.M in case of large farmers. Reallocation of resources such as land, F.Y.M. and seed and withdrawl of certain resources was suggested to make groundnut production more profitable. The education of farmers was emphasized for the adoption of better production technology. Further, the average mean technical efficiency indices of farmers were calculated. The analysis showed that the small farmers were more efficient than the large farmers and obtained higher productivity.

Singh and Beena (1996) studied resource use efficiency for cash crops viz; sugarcane and onion in Pune district of Maharastra. Out of the twelve tehsils of the district, eight were taken up for this study. The resource efficiency in cash crops was judged by comparing cost A, B and C and comparing the estimated MVPs of various inputs with their respective prices. Output -input ratios were more than one in all the size classes of holdings for the crops indicating that these crops were profitable propositions. The net returns per hectare (at cost C) were higher for sugarcane (Rs.8457) than onion (Rs.5747). While, the sugarcane was an
annual crop and onion was one season crop. The land resource showed the scope for increasing the area under sugarcane. There was a wide gap in the present resource use level for sugarcane (0.52 ha) and the optimum level of land use (2.63 ha). The coefficient of human labour was significant in case of onion. The difference between the present level of use of human labour and the optimum level in onion indicated that there was a wide scope for increasing the profitability of this crop by using more of human labour. The onion crop being highly labour intensive, the timely availability of labour may be the limitation faced by the farmers. There was a negative MVP for bullock labour in onion, it indicated that its use could be reduced and diverted to some other enterprises. In case of manures and fertilizers, the coefficient was also negative for sugarcane thus indicating an excessive use of fertilizers. However, in case of onion a positive coefficient indicated the need for increasing the use of fertilizer.

Singh(1997) estimated the field level response for important crops and examined the changes in response overtime as well as the extent of variation in the use of important inputs and their overall impact on productivity. The crop cutting experiments’ data regarding the principal crops of the Punjab State i.e. wheat, paddy and cotton at two points of time viz; 1980-81 and 1992-93 were collected from the State Department of Agriculture. The analysis was done for three zones of the State separately and for the State as a whole.

The production function analysis revealed that number of irrigations, nitrogenous fertilizers, sowing time and weedicide use were the most important determinants of the crop productivity. While the wheat yield response to nitrogenous fertilizers increased significantly. Overtime, the response to irrigation and weedicide use declined. In case of paddy the significant positive change in the coefficients of nitrogenous fertilizers and weedicides use indicated the overtime increased yield response to these inputs. In case of American cotton, while the response to irrigation increased significantly overtime, the response with respect to nitrogenous fertilizers declined.

Further, the analysis of technical efficiency of farmers brought into sharp focus the extent of inefficiency in the production process of crops and consequently the utilization of resources. While the average technical efficiency of farmers in the production process of wheat, paddy and American cotton increased overtime. It declined marginally in case of the traditional crops viz; basmati paddy and desi cotton.
Kochhar (1997) examined the resource use efficiency on dairy farms in different dairy locations of Ludhiana district. The fixed cost per litre of milk (1996-97) was found to be Rs.1.71, 1.39 and 1.37 in rural, semi-urban and urban dairy farms, respectively. This showed an inverse relationship with the herd-size and implied economies of size. Total variable cost per litre of milk was Rs.5.56 on rural, Rs.5.67 on semi-urban and Rs.6.29 on urban dairy farms and showed positive relationship with the herd-size and negative relationship with the distance of dairy farms from the city. This could be attributed to the higher prices of inputs near the city. The production function analysis showed that the use of resources such as milch animals, green and dry fodder, concentrates, human labour, electricity and veterinary care should be based on their MVPs.

Singh and Grover (1997) studied the economics and resource use efficiency of paddy cultivation in Ludhiana district of Punjab, where paddy was the major Kharif crop. Dehlon and Mangat blocks pertaining to the highest and the lowest productivity in Ludhiana district respectively were purposively selected to facilitate the comparative analysis of the two situations. Two villages from each block were chosen randomly and all the holdings in the selected villages were enumerated and classified into two categories viz; owned tractor farms and custom-hiring farms. Primary information for 1993-94 on output of paddy and various cost components such as seed, fertilizers, chemicals, family labour, hired labour, hiring-in of tractors, threshers, etc. was collected for 120 sample farms. The Cobb-Douglas production function was used to examine the factors affecting the value productivity of paddy crop under different situations/blocks. The findings showed that the total operational costs per hectare of paddy were lower in the highest productivity block as compared to the lowest productivity block. The farm size category comparison showed that the operational costs per hectare of paddy on owned tractor farms were higher as compared to the custom-hiring farms in both the blocks. Whereas, the gross income per hectare from paddy was observed to be higher on owned tractor farms as compared to custom-hiring farms in the highest productivity block. But in case of the lowest productivity block it was found to be lower (though marginally) on owned tractor farms as compared to custom-hiring farms. The returns over variable costs per hectare were observed to be lower on owned tractor farms as compared to custom-hiring farms in both the blocks. The results advocated enhancing the expenditure on nitrogenous fertilizers under all situations, as it would augment the productivity. For the district as a whole, the
regression coefficients for nitrogenous fertilizers and human labour were found to be statistically significant, indicating the over-use of human labour at present and the scope to enhance the use of nitrogenous fertilizers in paddy cultivation.

Thakur et al(1997) studied the resource use efficiency for sheep and goat farming in Himachal Pradesh. Two zones viz; Zone-III and Zone-IV of the State comprising the districts of Shimla, Kangra, Chamba, Kinnaur and Lahul Spiti were selected in view of the higher concentration of sheep and goat. Two stage stratified random sampling technique was followed with villages as the primary and shepherd households as secondary and final units of the sampling. A sample of 268 shepherds with 142 small, 88 medium and 38 large herd-size was selected. To examine the input-output relationship for sheep and goat rearing, the Linear and Cobb-Douglas functions were used. The regression analysis showed that herd-size had significant impact on income of all sizes of farms. The returns to scale indicated that the shepherds should increase the income as they were found to operate in irrational zone (Stage I) of production function. The marginal value productivities (MVPs) also suggested that shepherds should increase the herd-size and increase the use of concentrates.

Shende et al (1998) studied the resource productivity and input use efficiency of three forest crops viz. teak, eucalyptus and bamboo in Akola district of Maharashtra. Data were collected from 80 farmers from 31 villages. For eucalyptus, only those farmers were purposively selected who had harvested the trees in 1995. The productivity and efficiency of inputs used in production were examined through Cobb-Douglas function. In case of teak, the coefficient of determination ($R^2$) was 0.44. The variables which had a positive sign and were significant at accepted level of significance were area under crop, human labour, bullock labour and irrigation charges. While, the other variables had no significant influence on teak production. In case of eucalyptus, the elasticity coefficient of area under crop was positive and significant. The elasticity coefficient for bullock labour and irrigation was negative and significant. The variation in yield explained by all the independent variables was 0.82 per cent.

The regression analysis for bamboo indicated that the area under the crop was positive and significant at five per cent level of significance while elasticity coefficient of human labour was negative and significant. The value of remaining variables e.g. seedlings and irrigation was negative and non-significant. The coefficient of determination ($R^2$) was
The general and overall picture showed that among the selected variables, area under respective tree crops showed a significant effect on the yield of tree crop.

In case of teak, the ratios’ of MVP to factor price for area under crop, human labour and irrigation were positive and greater than one indicating under-utilization of these inputs. For eucalyptus and bamboo, the ratios’ of MVP to factor price for area under crop were positive and greater than unity indicating that there was under-utilization of this input for both the tree crops.

Nagraj et al (1998) studied the resource use efficiency in the cultivation of various crops under different cropping systems in Tungabhadra command area in Karnataka State. The various cropping systems considered in the study were (i) paddy (sole crop), (ii) Maize-sunflower system, (iii) Jowar-sunflower system and (iv) Groundnut-sunflower system. Multistage random sampling technique was employed to select the sample farmers. Tungabhadra Right Bank High Level Canal command area was selected and the entire area was stratified into three regions based on the length of the canal, namely head reach (up to 50 km), middle reach (50 to 80 km) and tail reach (80 to 105 km). From each stratum, a cluster of four villages was selected. Further, from each village, five large and five small farmers were selected randomly and total sample size was 120. The selected samples were post-stratified and identified the number of farmers who were following different cropping systems such as paddy (sole crop) (34), Maize-sunflower system (29), Jowar-sunflower system (16) and groundnut-sunflower system (13). Thus, the ultimate sample size was 92. The functional analysis was employed for analyzing the resource productivities and resource use efficiency was examined through the Cobb-Douglas function. The findings indicated that the regression coefficients for manures and fertilizers were negative for paddy. All other variables were positive, but those for land (0.4856), plant protection (0.0852) and human labour (0.1904) were statistically significant. In case of maize, the regression coefficients for land (0.2166), manures and fertilizers (0.4638) were both positive and significant, whereas the coefficient for bullock labour was negative but non-significant. The coefficients for land (0.6161) and bullock labour (0.1772) were both positive and significant in case of sunflower. Whereas, those for all other variables turned out to be non-significant. The land in case of Jowar with a regression coefficient of 0.8186 had the maximum influence on gross returns. In case of sunflower, land and human labour were the two factors significantly influencing the gross
returns. The manures and fertilizers and human labour significantly influenced the gross returns of groundnut crop. In case of sunflower in groundnut-sunflower system, land had the maximum influence on the gross returns.

Duggal and Singh (2002) studied farm earnings in the wake of Integrated Watershed Development in Punjab. Among the eight watersheds under development treatments, Dasuya-Langarpur watershed was selected as the project watershed. Hazipur watershed was taken as the non-project watershed. Eight villages of project watershed and five villages from non-project watershed were randomly selected. A sample of 192 and 107 farm households was randomly selected from the respective watersheds. The primary data related to parameters such as size of farm holdings, area irrigated, product-mix, livestock, input use, production levels, input/output prices and returns were collected from the sample farmers for the year 1990-91, 1995-96 and 1997-98 and tabular analysis was made to arrive at the results related to the objectives of the study. It was seen that during 1990-91 to 1997-98, the average size of the sample farm holding decreased from 2.0 ha to 1.68 ha in the project watershed and from 1.86 to 1.16 ha in the non-project watershed. During the kharif season, the cropped area in the project watershed rose from 1.19 ha to 1.42 ha registering a significant increase from 64.4 to 84.0 per cent during 1990-91 to 1997-98. In the non-project watershed, although the kharif cropped area declined from 1.83 ha to 1.08 ha in the above period but the per cent cropped area fell only by five per cent. Whereas, during the rabi season the per cent cropped area showed a considerable increase in project watershed but a marginal decrease in non-project watershed. The cropping intensity increased from 143.1 to 177.6 per cent in project watershed and it decreased from 191.5 to 184.6 per cent in the non-project watershed during the above years.

Inputs used for producing field crops showed that overall fertilizer use increased at the rate of 11.5 per cent (significant at five per cent level) in project watershed and 7.4 per cent (significant at 10 per cent level) in the non-project watershed during the study period. The yield of kharif crops in the project watershed showed a continuous increase during the study period except maize, paddy and sesame which slipped down in 1997-98 from the peak levels in 1995-96. In the rabi season, all the crops performed well in terms of productivity during 1990-91 to 1997-98. Further, the growth rate and gross returns per cultivated hectare in the
project and non-project watershed showed that the growth of development in the project watershed remained faster during the study period.

Singh (2003) measured the technical efficiency of wheat production in Punjab Agriculture through Stochastic Frontier Production Function. The study used the farm level data collected under the “cost of cultivation of principal crops in Punjab” during the years 1990-91, 1991-92 and 1992-93. During these years, a sample of 300 farmers was drawn from 30 selected villages of Punjab following three stage stratified random sampling procedure. The items of cost of cultivation covered both paid-out costs (out of farmers’ pocket expenditure) and the not-paid costs (imputed costs of farmers’ own resources used in production). It was brought out that 95 per cent of the random variations in wheat production were due to differences in technical efficiency of the farmers. On the average, Punjab farmers’ were producing wheat with 80 per cent of technical efficiency during the early nineties. The technical efficiency does not show any significant temporal and spatial variations in the State. However, technical efficiency showed wide inter-farmer variations from as low as 17.5 per cent and as high as 98.0 per cent. Three-fifths of the sampled farmers’ were operating with quite a high technical efficiency exceeding 80 per cent, whereas, 17 per cent had very low technical efficiency below 70 per cent. The findings also suggest that by following the cultural practices of farmers operating on the frontier, lowest one-fourth and one-half of the sampled farmers on the efficiency scale could raise their net earning by 35 and 27 per cent respectively. Exploiting the existing potentials can go a long way in improving the productive efficiency of the Punjab Agriculture so as to enable it to compete in the global environment. It was also observed that besides improvement on technical efficiency, wheat productivity in Punjab could also be increased by investing in land improvement, more intensive and balanced use of fertilizers and judicious and timely application of plant protection measures. There was also the need to identify the factors responsible for low technical efficiency of farmers.

Shanmugam (2003) analyzed the economics of major crops such as rice (season I and II), groundnut and cotton in Tamil Nadu. A total of 600 farms (from 60 Taluks) constituted the sample. The data referred to the input and output details and other socio-economic characteristics of sample farm households for 1990-91 to 1992-93. The stochastic frontier production function was employed to work out the farm specific technical efficiencies. The results indicated that land and labour inputs were the significant determinants of output of
almost all crops in the State. Fertilizer variable also influenced positively the yield level of rice and cotton crops.

The other cost variables were significant only in irrigated groundnut. The returns to scale parameters for production of almost all crops were close to one (constant returns to scale). It was observed that outputs of all selected principal crops were less than their respective potential outputs due to technical inefficiencies. The average technical efficiency values of raising rice I, rice II, irrigated groundnut, rain fed groundnut and cotton were 82, 82, 68, 76 and 68 percent respectively. There was a considerable room for further improvement in the productivity on the sample farms.

There were wide variations in the level of efficiency across sample farms in case of all crops. Almost, 30 per cent of the sample farms that raised cotton and groundnut, the efficiency was below 60 per cent, indicating that they could reduce their input use upto 40 per cent without any production loss. Thus, the sample farms could increase the outputs of crops and farm income through better use of available resources, given the state of technology.

The technical efficiency of raising irrigated groundnut was relatively high in owned land cultivation as compared to leased in land. Farms having high proportion of family members with above middle and higher education were more effective in raising groundnut which indicated that providing higher education to farm families would increase the agricultural productivity. Also, the farmers having large area were more efficient in cultivating cotton meaning that the small farmers could better follow the practices adopted by big farmers to reap more yield or they could shift from cotton to other crops for which they were efficient.

Reddy et al (2005) measured water use efficiency through ‘A study of System of Rice Intensification (SRI) Adoption in Andhra Pradesh. Data from a total of 74 plots including 40 SRI paddy plots and 34 traditional paddy plots were collected during 2005. The plot-wise data were analyzed separately for SRI and traditional plots using descriptive statistics. The differences between the means were tested using paired ‘t’ test. Further, production functions were estimated to assess the input productivities and allocative efficiency at the household level. Hitherto, SRI was being promoted as a land saving method while its water saving characteristic had been made secondary. But, the analysis showed that the prime gain from SRI was its water saving rather than its yield improving capability. SRI programme was found
to provide the double benefits of lower intensity and water saving. It was high time that priorities were shifted towards water saving and water use efficiency as well, which held key to future growth, especially in the rainfed regions. This study also emphasized the efforts for educating the small land holders on the water and other inputs use as well the adoption of SRI programme.

Awasthi et al (2005) studied the effects of technological change on production performance and resource use efficiency in irrigated maize based agro-ecosystem in Madhya Pradesh. The study area consisted of three maize dominating districts namely, Shahdol, Chhindwara and Mandsaur. The extent of adoption pattern of new maize technology and their impact on yield, reduction in cost of production and resource use efficiency, had been analyzed on the basis of the primary data collected from the 300 maize growers during 2002-03. The resource use efficiency had been studied by using the semi-log production function. The farmers of Chhindwara and Mandsaur cultivated mainly hybrid varieties of maize while those of Shahdol, a tribal dominating district were reluctant to do so. The study revealed that a majority of the farmers were still low adopters and only three per cent were medium adopters of modern technologies. All the farmers irrespective of farm size, harvested better maize yield with composite/hybrid variety than the traditional variety. An appreciable reduction in the unit cost of maize production by adopting improved cultivars was observed on all the selected farms. It was because that with composite variety, the cost of production had come down by 2.78 to 19.40 per cent and with hybrid variety from 17.10 to 27.20 per cent in comparison to traditional variety. It was observed from the resource use efficiency that human labour was used in excess, whereas fertilizer and irrigation were under-utilized. The marginal value product (MVP) of these two factors had been found higher than unity, indicating their use at sub-optimal levels.

Kale et al (2005) investigated resource use structure and efficiency in Chilli cultivation in Dahanu tehsil of Thane district of Maharrastra. Six villages having the maximum area under commercial cultivation of Chilli were purposively selected. From each village, five cultivators were selected from small, medium and large groups. Cobb-Douglas production function was used to examine the input-output relationship. To find the resource use efficiency, the marginal value product was compared with its factor cost. Chilli being the labour intensive crop, the cultivators depended relatively more on hired labour. The medium sized group
utilized more bullock labour. There was a positive relationship between the size groups and the use of fertilizers and manures. At the overall level, the average per hectare cost of cultivation worked out to Rs 58,648. A direct relationship was noticed among all the size groups in relation to net returns. The benefit-cost ratio was more than 1.73 for all the size-groups. In nutshell, the human labour, bullock labour and number of irrigations had significant influence on the value of output. The MVP-MC ratio for the land variable was greater than unity denoting higher resource use efficiency. However, fertilizer had the negative impact showing that the fertilizer use could be lowered. The magnitudes of MVP-MC ratio indicated efficient use of most of the resources except fertilizer and other ingredients.

Sharma et al (2005) examined resource productivity, returns to scale and resource use efficiency on wheat farms in Hisar district of Haryana during the year 2001-02. The primary data pertained to 60 respondents scattered in two villages of one selected block (Block B II of Hisar district). It was observed that diminishing returns to scale in wheat crop were in operation. On an average, the production elasticities of the variables, such as human labour, seed expenditure and irrigation exerted positive and significant influence on gross returns. There was a negative resource use efficiency of fertilizer indicating that inefficiency of resource use prevailed and expenses on it needed to be curtailed. It was brought out that the operation of diminishing factor returns and decreasing returns to scale were there in wheat cultivation. The estimated marginal value products of all the inputs for wheat were tested using ‘t’ test, to find out whether marginal value product and opportunity cost (OC) were differing significantly. The utilization of the inputs such as machinery use and plant protection was not optimal in case of small farms. In case of medium and large farms, the ratio of MVP/OC was negative for fertilizer indicating the need to reduce the expenditure on this input.

Banda et al (2005) made the spatio-temporal analysis of resource use efficiency of key factors of production for agricultural crops in different agro-climatic regions of Punjab. The data from ‘comprehensive scheme to study the cost of cultivation of principal crops in Punjab’ for the year 1985-86 and 2000-01 had been used to meet the objectives. The efficiency differentials among the various farm size categories viz; small, medium and large were found. The size-group analysis indicated that the land resource was efficiently used on all farm situations in the State during both the study periods except on large farms in Zone I during
1985-86 and on small and medium farms in Zone II during 2000-01. On small and medium farms during 2000-01, the inefficient use might be due to lower productivity of cotton crop on these farms which the large farms had reversed due to better access to technology. The ratio of MVP of human labour to its corresponding wage rate was not statistically different from unity on all the farm categories indicating the optimum utilization of this resource. The over-use of farm machinery and implements by large farms in Zone I during 1985-86 and by small as well as large farms in Zone II during 2000-01 was observed. This might be due to excessive investment on this capital intensive input. The expenditure on fertilizers and manures was at optimum level on all the farm situations in both Zones during 1985-86, except on large farms where fertilizer use had become excessive. However, the analysis for 2000-01 revealed that farm returns could be increased by increasing the use of fertilizers on all farm situations except on large farms in Zone I. During 1985-86, there was excessive expenditure on livestock on small farms in both Zones and by medium farms in Zone I, while on the other hand in 2000-01, the same was found at optimum level on all farms.

Haque(2006) in his study on “Resource Use Efficiency in Indian Agriculture” highlighted farmers’ tendency to maximize physical productivity per unit of land. It might lead to over-exploitation and degradation of farm resources. He emphasized economic as well as environmental aspects of resource use efficiency. It was observed that the factor productivity in agriculture overtime showed a deceleration. The productivity of major crops such as paddy, wheat, sugarcane and cotton faced this situation in the major growing areas. There was found a scope for raising the crop productivity through improved management practices. As evidenced from the cost of cultivation statistics, there were inter-regional and inter-farm variations in factor productivity. Among the factors influencing crop productivity, such factors of production as irrigation for cotton, seeds in paddy, wheat and cotton were found to possess negative elasticities in major crop growing states. The other factors enlisted include erratic weather, small size of holdings and insecure land tenancies.

He also focused the issues relating to profitable and sustainable uses of land and water resources. The need for macro economic policies on land leasing, subsidization of power and water rates and cost of farm credit was realized. A treatment was given to the existing shape of irrigation charges and water-use efficiency. Crop pricing rather than water pricing was thus
advocated. The emergency issues related to the resource use efficiency in Indian Agriculture were also highlighted.

Kumar et al (2008) worked out the technical efficiency of paddy farmers in Punjab. The cross-section data relating to the various inputs and output for paddy cultivation were taken from the project “Comprehensive Scheme to Study the Cost of Cultivation of Principal Crops” in operation at Punjab Agricultural University. The normal agricultural years 1985-86 and 2002-2003 were chosen for this investigation. The stochastic frontier production function technique was used to estimate the farm specific technical efficiency of paddy farmers. Seed, human labour, tractor hours and application of nitrogenous fertilizers were found to be the major determinants of the paddy productivity in the Punjab State. It was observed that the average technical efficiency of paddy farmers increased from 81 percent in 1985-86 to 86 percent in 2002-2003. The study suggested that the paddy production in the state could further be increased by 14 percent through improving the farmers’ technical efficiency levels at the existing level of input use and technology. Operational area of farm holding or size of paddy plot, education level of the family members and the fragmentation level of the operational holding were the important socio-economic factors which affected the technical efficiency levels of individual farmers.

Singh and Singh (2008) studied the Watershed development in Punjab by selecting 147 farmers and 52 landless households as stakeholders for the Development Project activities. These development activities had forestry, agriculture, horticulture, animal husbandry and soil conservation components.

As a consequence of the execution of above mentioned activities, there was an increase in the area cultivated and its proportion irrigated as well as an improvement in the intensity of mechanization. The quality of milch cattle as well as their productivity grew up. There was an improvement in crop-mixes and the crop productivity. There was found a sustained impact of crops and forestry component demonstrations on the beneficiaries.

The development project positively influenced the environment and also provided protection to arable and non-arable lands in addition to the dwelling through containing the floods. There was a rise in the underground water level and increase in water precipitation and check on soil and water erosion. However, the distribution of irrigation water received through project activities needed much improvement. Similarly, there was a lack of awareness in the
use of improved farm production technology. The stake holders’ participation at the project formulation and execution was lacking and needed to be taken care.

**Foreign Studies**

Easter (1986) studied the monitoring and evaluation aspects of River Basin Development and Watershed Management activities in Thailand and India. He emphasized the need for evaluation staff that should look at the resource use and management. According to him an impact evaluation in this perspective will help to take appropriate corrective measures.

Easter (1988) had a review of the studies on the economics of watershed management in Asia and the Pacific. He stressed the need for an economic analysis of the watershed development planning programmes. It was suggested that an array of alternatives and evaluators would be useful for a proper evaluation of watershed development activities. According to him watershed should be the unit for planning and analysis and this course of action will help improving resources management decisions.

Ali and Chaudhary (1990) studied inter-regional farm efficiency in Pakistan’s Punjab. Agricultural production efficiency was compared on the basis of a probabilistic frontier production function estimated from whole farm survey data for the year 1984-85. The irrigated parts of Punjab were divided into four cropping regions viz; Northern Punjab (Basmati Rice producing region), Central Punjab (Sugar cane producing region, mixed crop region) and Southern Punjab (Cotton growing region). Gujranwala, Faisalabad, Sahiwal and Multan districts were selected to represent rice, sugarcane, mixed crops and cotton regions respectively. Whole farm management survey data collected by the ‘Punjab Economic Research Institute’ for the year 1984-85 having 226 farmers in all regions were used. Farm efficiency was measured in terms of technical efficiency (TE), allocative efficiency (AE) and economic efficiency (EE). It was found that the gross income of farmers could be increased by 13 per cent at the current levels of resource use if the production gap between ‘best practice’ and ‘average farmers’ is suitably narrowed in all cropping regions. This would increase profits by up to 40 per cent. No significant differences in technical efficiency were found across the regions. Economic efficiency was similar across all the cropping regions except in the cotton region, which had significantly lower economic efficiency due to higher allocative inefficiency, which in turn was attributable to the more dynamic production technologies being adopted in that region.
Hussain (1991) made an attempt in Peshawar valley of Pakistan to bring out as to how the farmers allocate their farm resources among alternative production activities and whether this use is optimal or not. He studied the existing scale economies and differences among various farm size categories on the use of production technology. He found that except land, the value marginal product (VMP) of human and animal labour and machinery exceed their prices and called for a larger use. The constant returns to scale were found to be experienced in the agriculture of the valley. The small farms were mostly owner operated; allocated major portion of their operated land to growing wheat and maize; and made extensive use of manual labour and animal/tractor inputs, relative to the large and medium farms.

Sabur and Haque (1992) examined the profitability and resource use efficiency of four winter crops during 1987-88 in Munshiganj and Bogra districts of Bangladesh. The production costs of potato were the highest among all the crops studied. Thus, there was a need for credit availability to ensure farmers to grow more of potatoes. The efficiency of resource use was examined by comparing the estimated marginal value products of inputs with their respective factor costs. They found that the farmers have not been using resources efficiently and there was a scope for augmenting profits through optimal allocation of resources.

Bravo and Pinheiro (1993) reviewed the efficiency of developing countries’ agriculture. Thirty studies relating to 14 different countries showed that the average technical efficiency (TE) was 72.0 per cent. The studies reporting allocative and economic efficiency showed an average of 68.0 and 48.0 per cent respectively. The results showed that there was a considerable room for increasing farm output without additional inputs at the existing technology. The studies reviewed had sought to explain farm level variation in technical efficiency. The major variables used in the review studies were, farmer education and experience, contact with extension, access to credit, and farm size. These variables with the exception of farm size tend to have a positive and statistically significant impact on technical efficiency.

Mobata (1996) reported that the private farms realized a higher net profit per hectare than the government farms in the River State of Nigeria. In addition, the private farms were technically more efficient in the use of factors of production as seen from the Chow Test. However, the test of economic efficiency in the use of inputs showed that the two groups were inefficient in the use of labour, land, fertilizer, seed, and machines. Both groups of farms over-
utilized labour and land but under-utilized fertilizer and seed. The major policy prescription that emerged from this study was that the government should withdraw from direct food production and instead focus its attention on food policy formulation that would enhance production on the private farms.

Tzouvelekas(1998) studied the impact of resource use and total factor productivity on output growth in Greek Agriculture. The results showed that the olive producing sample farms had both technical and allocative inefficiency in all the three study regions. The production growth was the result of supply response to protected market and price support for this commodity. The output growth could be attributed to the increased use of conventional inputs. It was observed that the improvement in resource allocation would prove a costless measure for improving output levels. The productive frontiers could be put on higher elevations through the adoption of better production technology. But for this the pre-requisite is the improvement in the farmers’ technical skills and managerial abilities.

Awudu and Wallace(2000) studied structural adjustment and economic efficiency of rice farmers in four districts viz; Tamale, Savelugu, Tolon and Gushiegu-Karaga of Northern Ghana. The data used were a sub-sample of a random sample survey conducted in 1992-93 of 256 farmers and an additional survey data were obtained from the Northern Region Ministry of Agriculture in Tamale district. The data related to farm and non-farm activities, as well as demographic and locational characteristics. Information on farm activities included fertilizer applications, prices, wages, capital assets and livestock production, earnings including cash oriented non-farm activities. A stochastic translog profit frontier model was used to examine rice production efficiency. The results showed that the mean level of profit efficiency was relatively high, but significant variation in efficiency and inefficiency existed.

The inefficiency analysis suggested that higher household heads’ education, access to credit and greater specialization, and being located in districts where extension services and better infrastructure were available were significant variables for increasing profit efficiency. Increasing participation in non-farm activities by farmers however, tends to lower profit efficiency. The finding on the relationship between inefficiency and access to credit also suggested that improving farmers’ access to institutional credit would improve production
efficiency. Improving the efficiency of resources would require streamlining the acquisition of credit among small farmers.

Ruttan (2002) in his review of growth in world agriculture brought out that the principal sources of high productivity in modern agriculture were the reproducible sources. These constitute material inputs, skills and other capabilities required to use such inputs successfully. But these modern inputs were seldom ready made. What was available was a body of knowledge, which had made it possible for the advanced countries to produce for their own use factors that were technically superior to those employed elsewhere. This body of knowledge could be used to develop similar, and as a rule superior, new factors appropriated to the biological and other conditions that were specific to the agriculture of poor countries. What this required was the capacity to generate location-specific technology; the capacity to develop, produce and market new technical inputs; and the non-formal education of ruralities to enable them to use the new knowledge and technology effectively.

Igbekele and Abdulkadri (2004) studied the impact of size of farm operation on resource use efficiency in small scale farming in Ondo State of Nigeria. Within the state there were three distinct ecological zones, the mangrove forest of the South, the rain forest in the middle belt and the derived Savannah to the North. Farm level data were collected from 200 small-scale farmers employing multistage procedure for the selection of the farmers. The State is well suited for the production of crops such as maize, cassava, yam and cocoyam. The bulk of agricultural products come from manually cultivated rain-fed crops. Mixed cropping system of farming was common in the State. Majority of the farmers in the study area were of small-scale with an average farm size of about one hectare. Technical efficiency levels of a group of small-scale farmers in the State were examined to determine the effects of individual farmers’ size of operation on the resource use efficiency. The stochastic frontier production function was used to estimate the technical efficiency of the farmers, given the available resources. It was found that the major farm resources were significant determinants of output level and that increasing returns to scale existed on the farms. A wide variation in the level of technical efficiency was observed. For land resource, farmers with total cropped area between 1.00 to 1.49 hectares of land had the highest mean technical efficiency of 0.70. For labour resource, the highest mean technical efficiency of 0.71 was from the farmers with 100-199 mandays of labour and for capital resource, farmers with a value of capital resource in the range of N4000
to N6999 had the highest mean technical efficiency of 0.72. It was concluded that resource availability did not directly translate to efficiency, as the farmers with less intensive use of land, labour and capital resources were more efficient in the use of these resources than the farmers with more intensive use of the resources.

Teschay et al (2005) investigated the level of resource use efficiency achieved by tenant households on own and sharecropped-in plots, and the determinants of achievements in efficiency levels. The data were obtained from the data base of the research project on “Policies for sustainable land management in the highlands of Tigray, Northern Ethiopia”. The data base contained information on the basic socio-economic and resource conditions of 500 households in 100 villages of 50 Tabias in 26 districts of the four zones viz; (Southern, Central, Eastern and Western Zones) in the State. A total of 115 households and the plots (358 owned and 208 sharecropped-in, they were operating during the 1998 production season) were included for the study. These households practiced sharecropping and a household had at least sharecropped-in one plot during the 1998 season. It was assessed as to whether tenancy status affected the technical efficiency levels using plot data, where sharecropping was the dominant form of land contracting among subsistence households. Stochastic frontier production function analysis results showed higher level of technical efficiency scores on own than sharecropped-in plots. Besides tenancy status of the plot some household, plot and village location factors had influence on technical efficiency. Higher technical efficiency levels were achieved by tenants located in villages with good annual average rainfall and operating good quality plots. Tenants with better draught power endowment and in densely populated villages showed lower level of inefficiency.

The foregoing review of literature showed that the researchers have brought out the use levels of different farm resources and correlated the same with their associated output performance on various size-groups of farms. Most of the studies covered either a block, a tehsil or a district of a particular state. A few studies had a coverage of a state or the country as a whole. Similarly, a considerable number of studies revolved around only one or a few crops and some observed the resource use at macro levels. Those who probed the impact in the wake of watershed development activities remained wide away from providing a comprehensive treatment on resource use in the context of with/without project situations. The efficiency of the resource use was measured only for their existing use levels by computing the marginal
value productivities and then comparing the same to associated factor costs. Thus, this study is
an attempt to investigate the use of resources under the impact of project development
activities as well as without the project involving the whole farm production process. It has
been tried to visualize the resource use at the existing as well as the improved technology
levels.