CHAPTER II

REVIEW OF LITERATURE
CHAPTER-II
REVIEW OF LITERATURE

Generally, a large number of studies based on production function methodologies are available on the resource use efficiency in crop production based on cross-sectional and time series data. However, studies using Stochastic Frontier Production Function to estimate the technical efficiency of resource inputs are the recent developments. Therefore, an attempt has been made in this chapter to review the past studies relating to the resource use efficiency in crop production based on the empirical methodologies in India and elsewhere. Moreover, while reviewing literature, attention has been made to summarise the methodology adopted in such studies, selection and determination of variables, their limitations, overall results obtained and the implications thereon.

Heady et-al\(^{26}\) (1954) made an attempt to study the Resource Returns and Productivity Co-efficients in Selected Farming Areas in America. Input, output data collected from the random samples of four regions viz., Alabama, Northern Iowa, Southern Iowa and Montana in America for the production year 1950 were used in the study. Cobb-Douglas production function was fitted to evaluate the productivity co-efficients. Inputs and outputs were aggregated in all the regions. Inputs for crops were land, labour and capital services measured in dollar value. The study observed that the ratio of capital to labour was much higher in Northern Iowa and Montana than in Southern

Iowa and Alabama. It was observed that labour productivity for crops was the highest in Northern Iowa and Montana. The study also revealed that marginal productivity of labour on crops and livestock were significant in Iowa and Alabama. Capital returns were significantly greater than the cost of capital for crops in Montana and Southern Iowa. The study concluded that the quantity of resource used was not significantly low in Northern Iowa.

Desai\textsuperscript{27} (1963) conducted a study on the Increasing Income and Production on Indian Farming with referns to Karnataka State. The study was micro level one which indicates for a sustained gain from reallocation of existing farm resources. The study relates to a group of farms in Ahmednagar and Nasik districts of Maharashtra State. The study was based on a sample of 40 farms, for the year 1956-57. The study observed that farmers were also known to operate their farm business at different levels of efficiency and intensity. Employing a single yardstick amounts to subjecting the efficient farmers to inefficient techniques and inefficient farmers to efficient techniques. Such an approach forces on the farm for the intensity of resource use which was not relevant to its resource endowment.

Khusro\textsuperscript{28} (1964) has analysed the Returns to Scale in Indian agriculture. The data for the analysis have been obtained from the Studies in the Economics of Farm Management and the data was based on accounting method. The data was collected for selected two districts of each of the seven

\textsuperscript{27}Desai D.K.: Increasing Income and Production on Indian Farming, Indian Society of Agricultural Economics, Bombay, 1963. (Taken from D.P.Takale)

selected states during the three years i.e. 1954-55, 1955-56 and 1956-57. The main finding of the study was that efficiency does not decrease by farm size. The study observed that as farm size expands, owned labour resources being almost a fixed quantity, spread more and more thinly per acre so that the cost of owned labour declines.

Raj Krishna29 (1964) has studied the allocative efficiency in Indian agriculture. The data relate to 200 holdings, 10 each from 20 villages selected by stratified random sampling. Farm management data for two districts (Ferozpure and Amritsar) of the Panjab were collected for the years 1954-55, 1955-56 and 1956-57. The study includes land, labour, bullock labour, seeds, manures and fertilizers, working capital and irrigation as the explanatory variables in estimating the Cobb Douglas type production functions. The study observed that the bullock labour input was highly correlated with land and manual labour. The mean labour input seems to have been excessive in the first two years.

Schultz30 (1964) has studied the allocative efficiency of traditional agriculture. The study has advanced the hypothesis that "the agriculture sector in a large class of poor countries is relatively efficient in using factors of production at its disposal. The hypothesis was based on particular definition. The rationality in the allocation of resources shown by the farmers in traditional Indian agriculture was pointed out for the first time.

Acharya\textsuperscript{31} (1965) in a study on Resource Productivity and Optimum Allocation on Sample farms of Queensland Sugarcane Farms has analysed the optimum resource allocation of the sample Queensland Sugarcane farms. Cobb-Douglas production function was fitted to the estimation of resource productivity. Inputs like Fertilizer, labour, plant and machinery and land resource were selected to test efficiency. The marginal value productivity criterion applied in the study recommended for the increase in fertilizer usage and decrease in labour and plant and machinery inputs. Operation of Constant Returns to Scale on Queensland Sugarcane farms and Diminishing Marginal Returns to individual factor of production were observed.

Hopper\textsuperscript{32} (1965) has studied the allocative efficiency in traditional Indian agriculture by estimating production functions for four rabbi crops using physical input and output data and showed that equality condition for marginal revenue product and marginal cost hold for the various input factors in their different uses. The study revealed that the September-December period involves a heavy pressure on reserves, it was likely that if expected profits for the total farms were to be maximized, the decision on allocation must be made on the basis of production response, input prices and expected returns that prevail during the period. The labour inputs were hired from among the landless low caste labour pool of the village.


Kuber Ram et-al\textsuperscript{33} (1965) in a study on Estimation of Relationship Between Farm Management Factors and Farm Income. The study was based on the data collected by the Division of Agriculture Economics, Indian Agricultural Research Institute under the project, "Economics of Farm Management in Kanjhawla Block of Delhi Villages, covering the period 1960-61. The data was collected by random sampling method and included 60 sample farms. The study revealed that several of the widely used measures of factors of farm management tested for their influence on farm earnings have sufficient predictive ability. The study also indicated that the farm earning could be increased by increasing labour and capital efficiency and output-input ratio.

Venkareddy et-al\textsuperscript{34} (1967) have studied the Resource-Use Efficiency in various crops in South Indian agriculture. The study reports for the correlation coefficients between some at the explanatory variables of the order of 0.9. Such high coefficient of correlation in studies of this type were signals of warning about the presence of multicollinearity. The study measured capital in stock terms as against the accepted practice of using the rent of capital to measure its actual input.

Sahota Gian\textsuperscript{35} (1968) has studied the efficiency of Indian farmers in allocating resources available to them among different production

alternatives. For this purpose, Farm Management data covering three cross sections, eight farm size groups and six regions of India were used to the production function with respect to the input variable. The input variables were measured separately for different crops. The variables included human labour, bullock labour, fixed capital, land, seeds, fertilizers and manures and irrigation. The study observed that the multidimensional analysis of resource allocation indicates comparatively few significant inefficiencies of resource allocation in Indian agriculture. It would be difficult to defend the often advanced assertions that the Indian farmers are tradition ridden and not rational and economisers or that marginal product of labour is zero.

Saini\(^36\) (1969) has studied the resource-use efficiency in different categories of farms in the States of Uttar Pradesh and Punjab for the years 1955-56 and 1956-57. Cobb-Douglas production function was fitted to estimate the resource-use efficiency.

The function specified was as follows.

\[
Q = C A^{b_1} L^{b_2} B^{b_3} F^{b_4} I^{b_5}
\]

The log-linear transformation of this production function fitted to this data was as follows;

\[
\log Q = \log c + b_1 \log A + b_2 \log L + b_3 \log B + b_4 \log F + b_5 \log I
\]

where,

Q = Gross value of output of crops (Rs.)
A = Land (acres)
L = Human labour (adult man- days)
B = Bullock labour (Pair days)

F = Farm manure and fertilizers (Rs.)
I = Irrigation expenditure (Rs.)

The study revealed that farmers were quite rational in terms of their response to economic opportunities and make adjustments in resource-use. Farmers in a traditional agriculture were generally efficient in the use of resources. The allocative efficiency of the farmers by comparing the marginal product of input factors derived from the estimated production elasticity parameters, with their respective acquisition cost and concluded that farmers were in fact very rational in the use of their resources.

Sankhayan et al.\(^{37}\) (1971) have studied the resource productivity and allocative efficiency on seed potato farms in Himachal Pradesh. The data were collected from Mahasu district. A sample of 30 observations was selected from three villages of Theog Tahsil. Cobb-Douglas and Quadratic Production Functions were used. The resources like land, human labour, bullock labour, seed, manures and fertilizers were selected for potato and maize crop. The study concluded that constant returns to scale operated in the case of seed potato farms. In the case of maize crop diminishing returns to scale was observed. The farm resources within each crop were optimally allocated in the case of seed potato.

Desai\(^{38}\) (1973) has examined the Resource-Use on Sample Farms of Central Gujarat. For the study, Baroda district was selected. The data collected from the Indian Institute of Management, Ahmedabad during the


agriculture year 1968-69 was used. The study found that the factor pervades so deeply that it seems to have also caused an economic use of hired labour and sub-optimum use of fertilizers and manures in the region. Irrigation resource was more reliable and adequate in the sample farms.

Dey et-al\textsuperscript{39} (1973) explained the rational allocation of resources under Cobb-Douglas production technology. The study has tested the hypothesis that Indian farmers are rational in resource allocation. The study rejected the hypothesis of profit maximization under Cobb-Douglas production function. Their main concern was the relative proportions in which labour and material inputs were used.

Rathore et-al\textsuperscript{40} (1973) have studied the Resource-Use Efficiency and Return from some Commercial Crops of Himachal Pradesh. The data for five commercial crops, namely potato, ginger, tomato, french been and chilli were collected for the year 1973-74 by survey method. The sample, for the study included 25 farmers for each of the selected crops. Cobb-Douglas production function was fitted to each crop on per hectare basis. The study revealed that human labour use alone accounts for more than one third of the total cost in all crops, except potato and ginger crops. The ratio of marginal value productivity to the factor cost for the selected commercial crops indicated that increased bullock labour use will be profitable but the small size of terraced plots allows very limited use of this resource.


Singh Uma Shankar et-al\(^4\) (1973) have studied the Resource-Use Efficiency in Relation to Resource Endowments for a Sample of Farms in Rural Delhi for the year 1967-68. The farms were divided into two groups, viz., high income and low income groups. Linear programming technique was used to derive optimal farm plans. The average farm situations indicated that, in general, the high income group farms were more efficient as compared to the low income group farms. It was indicated that all farms having 100 per acre income do not show inefficiency in resource allocation are when the real alternatives available to the farmers.

Singh\(^5\) (1975) has analysed the Resource-Use, Farm Size and Returns to Scale in a Backward Agriculture of Eastern Uttar Pradesh. The study was based on farm level data pertaining to crop enterprises of a sample of 150 farms spread over 15 villages in Deoria district of Uttar Pradesh. The data were collected for the year 1967-68. Cobb-Douglas production function was fitted to work out the elasticities of production of factor inputs. The marginal value product and its ratio to factor price for human labour, bullock labour, manures and fertilizers, fixed capital resources were not significantly different from unity and hence indicated that all the inputs, except land have been used efficiently on the average farms. The elasticity coefficient of bullock labour was greater for the small farms as compared to the large farms.

but the coefficient of manures and fertilizers for the large farms was
significant as compared to the small farms.

Sampath\(^{43}\) (1979) has studied the Nature and Measurement of
Economic Efficiency in Indian Agriculture. The data involved in calculating
the input-output coefficient matrices and objective function coefficient
vectors for the farm size groups were taken from Farm Management Survey
Report for Deoria District of Uttar Pradesh for the year 1967-68. The
resource vector for each group of farms is the sum of all the resources used
by each member of the group. Linear programming model was used for the
measurement of economic efficiency. The conclusion of this aggregate and
disaggregate empirical study is that the inefficiency found in the order of
36.53 percent. The study has analysed the difference between the small
farmer and the large farmer in terms of the level of economic efficiency.
Economic inefficiency of the small farmer is 35.27 percent and is 37.83
percent for large farmer.

Bhardwaj et-al\(^{44}\) (1980) have studied the Resource-Use Efficiency in
Wheat and Maize for Bilaspur district of Himachal Pradesh for the year 1976-
77. The data was collected by survey method in 122 districts of Himachal
Pradesh. A total of 84 cultivators were randomly selected in two villages
namely Dabla and Bhadrog in Tahsil Ghumrwin for the study. The resource
productivities of high yielding and local varieties separately for irrigated and

\(^{43}\)Sampath R.K.: Nature and Measurement of Economic Efficiency in Indian Agriculture, Indian Journal of
Agricultural Economic, Vol.34, No.2, 1979, P.P. 17-34.

Varieties in District Bilaspur of Himachal Pradesh, Agro-Economic Research Centre, Himachal Pradesh University, Simla, 1980.
unirrigated areas, have been compared with the help of Cobb-Douglas type of production function estimates. The resources included in the study were manures and fertilizers, human labour and bullock labour. In case of wheat production the manures and fertilizers indicate more response. The study observed that there was an excess use of bullock labour for the cultivation of wheat and maize in the area of study as marginal value productivity was observed negative.

Rathore⁴⁵ (1984) in his study ‘Contribution of Factors to the Productivity Differential Between Small and Large Farms’, made an attempt to estimate the productivity differential between small and large farms and to decompose this difference into contributing factors which are grouped under three categories, viz., 1) neutral technological differences 2) non-neutral technical differences, and 3) input use contribution. The data used in this study was pertaining to the year 1974-75 for Himachal Pradesh and 1975-76 for the SAT villages of Akola in Maharashtra. Log-linear production function and decomposition analysis have been used to look at the factors and their contribution to the productivity differentials between small and large farms. The results of the study observed that in Himachal Pradesh small farms have higher level of output than large farms while there is no significant difference in the Akola (Maharastra) farms. Secondly neutral technology is in favour of large farms in both Himachal and Maharastra villages. Non-neutral technology is in favour of small farms in hill agriculture but large farms

dominate in the case of semi-arid tropic villages of Maharastra. In the case of input use difference contribution small farms appeared to do better than large farms in both hill agriculture and agriculture in the semi-arid tropic villages.

Muraleedharan\(^{46}\) (1987) has studied the resource-use efficiency in Kole lands in Trichur district of Kerala. The study was based on primary data collected from a sample of 142 cultivators during the year 1978-79. Cobb-Douglas production function was fitted to the data to study the resource-use efficiency in the area. The study observed that the cultivators have not been able to allocate their inputs efficiently and there seems to be considerable scope for augmenting profit from Kole cultivation by optimum use of resources.

Thakur et-al\(^{47}\) (1990) have studied resource-use, farm size and returns to scale on tribal farms of Himachal Pradesh during the year 1983-84. The tribal district of Lahaul-Spiti was selected for the study. The data from the selected farmers were collected with the help of questionnaire through survey method. Cobb-Douglas production function was fitted to work out the elasticities of production of inputs. The study observed that factors of production were not efficiently used. The elasticity coefficients of inputs, particularly labour do not differ significantly between marginal, small and large farm size. Farm size was important factor to influence the productivity of inputs at farm level cannot be supported.


Bhise et-al\textsuperscript{48} (1992) have studied the Input Use Efficiency on Energized Farms in Nizamabad District of Andhra Pradesh. The study covered paddy and sugarcane crops based on a study of a sample of 120 energized farms. Cobb-Douglas production function was used to estimate resource-use efficiency. The analysis revealed that the marginal value productivity to opportunity cost ratios for all the input variables in both crops indicated a high degree of resource use inefficiency. Constant returns to scale prevailed in the case of paddy and increasing returns to scale in the case of sugarcane.

Chandra Dinesh\textsuperscript{49} (1992) has studied the Resource-Use Efficiency on Different Irrigated Systems in Ghaziabad District of Uttar Pradesh. The different irrigation systems are canal farms, tubewell farms, canal cum-electric tubewell farms which are being used in the study area. Multistage random sampling method was used for the selection of sample farmers. The data were collected from 100 farmers, pertaining to the year 1987-88. Cobb-Douglas production function was fitted to examine the resource-use efficiency. The results of the study showed that the inputs considered in the functional analysis explained 90 percent of the variation on all the irrigation systems. The study observed that human labour, bullock labour and tractor power were used in excess on all the irrigation systems.


Raja\textsuperscript{50} (1992) has studied the Farm Size, Resource Use Pattern and Productivity in Indian Agriculture – A case study of Periyar district in Tamil Nadu. The study was confined to a sample of 160 farmers selected from the two main blocks viz., Gobichettipalayam and T.N.Palayam of Periyar district in Tamil Nadu, pertaining to the year 1989-90. The main objective of the study was to examine the factors influencing the productivity of high yielding variety paddy (J.13) and the extent of inter-farm variations in the productivity of paddy in relation to various inputs used per unit of cultivated area. Cobb-Douglas type of production function was fitted to the cross-sectional data, by taking paddy output as the dependent variable and farm size, human labour, organic manure, chemical fertilizer, pesticides and rainfall as explanatory variable. The results of the study showed that the output elasticity of paddy tends to decline when the farm becomes larger in size. Among the inputs used the output elasticity of labour was the highest, indicating that the farming activity of different size groups in the region is still considered as a labour intensive activity. However, the sum of output elasticities with respect to the explanatory variables was more than unity in all size groups of farms, indicating the first stage of production function. The study concludes that productivity of paddy could be increased with readjustment in the use of resource inputs.

\textsuperscript{50} Raja A.: 'Farm Size, Resource Use Pattern and Productivity in Indian Agriculture – A Case Study of Periyar District in Tamil Nadu, Indian Journal of Agricultural Economics, Bombay, 1992, PP.541-542.
Shete et-al\textsuperscript{51} (1992) have studied the Resource Use and Input-Output Relationship of Mixed and Arable Farming in Ahmednagar District of Maharashtra. The sampling design adopted for the study was two-stage stratified random sampling. There were 120 sample farms selected in 12 villages from two Tahsils of Ahmednagar district. Cobb-Douglas production function was fitted for mixed and arable farms of both irrigated and unirrigated regions. The study found that the use of all resources was higher on mixed farms compared to arable farms in both the irrigated and unirrigated regions. In mixed farms of irrigated region total value of output increased with increase in gross cropped area and human labour, while it decreased with the expenses on livestock.

Singh et-al\textsuperscript{52} (1992) have studied the Input Use Efficiency in Wheat Crop in Haryana. The data was collected from a sample of 200 farmers under the Comprehensive Scheme to study the Cost of Cultivation of Principal Crops. The data was pertaining to the year 1980-82 and 1986-88. The sample was selected from small, medium and large farms. The study showed that as the size of farm increases, the marginal value productivity of human labour increases in the case of wheat cultivation. The study also observed that there was more use of human labour on small farms. On medium and large farms, more use of machine labour and less use of human labour has resulted in higher marginal value productivity of human labour.


Chhotan Singh et-al\textsuperscript{53} (1994) have studied the Resource Allocative Efficiency on Various Sizes of Farms in Salem District of Tamil Nadu. The primary input-output data were collected from different sizes of farms of Salem District under the project 'Economics of Farm Mechanisation and Agricultural Inputs'. The selected 182 sample farms were classified into three size groups viz. small, medium and large. Linear, quadratic, semilog and Cobb-Douglas production functions were used separately to estimate the relationship between inputs and outputs for the various size groups. The study revealed that expenditure on fertilizers, irrigation and bullock labour significantly increased the farm returns on all sizes of farms. As regards the allocative efficiency of resource use, land was being used efficiently on all the farms. Bullock labour was not being used with full efficiency on all categories of farms. Lastly the study suggested that there was a lot of scope for increasing the use of various inputs up to the optimal level.

Krishna Rao et-al\textsuperscript{54} (1994) have studied the Resource-Use-Efficiency in Paddy Farms of Rangareddy District of Andhra Pradesh. This study was undertaken with the specific objective of estimating resource productivity and resource use efficiency of farms. Six villages in Maheswaran watershed and three villages in non-watershed in Rangareddy district were selected for the study. Farmers numbering 240 were selected from both watershed and non-


watershed areas at the rate of 120 each. The farmers were categorized into
small, medium and large based on the operational holdings. The data
pertained to the agricultural year 1988-89. Cobb-Douglas production function
model was used to estimate the resource productivity and returns to scale on
adopter and non-adopter farms.

The function is specified as follows;

\[ Y = a X_1^{b_1} \ldots X_7^{b_7} U \]

Where,

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

\( X_1 \) = Land (Hectares)

\( X_2 \) = Human Labour (Rs.)

\( X_3 \) = Cattle Labour (Rs.)

\( X_4 \) = Seed (Rs.)

\( X_5 \) = Manure (Rs.)

\( X_6 \) = Fertiliser (Rs.)

\( X_7 \) = Plant protection measures (Rs.)

\( U \) = Random error

\( a \) = constant and

\( b_1 \ldots b_7 \) are the production elasticities of inputs. The logarithmic
transformation, if the function is:

\[ \log Y = \log a + b_1 \log X_1 + \ldots + b_7 \log X_7 + e \]

This equation was fitted with the help of least square method. To
minimize the effort of multi-collinearity, step down regression procedure was
followed. The study found that the utilization of human labour, cattle labour and fertilizer were not at optimum level in case of adopters. Human labour was found to be dominantly influencing the output in all size groups on the adopter farms.

Sekar et-al\textsuperscript{55} (1994) have examined the Size Productivity Relations in Paddy Farms of Tamil Nadu. The study was initiated with major objective of analysing the resource use efficiency in different size group of paddy farms. The data collected under the "Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops in Tamil Nadu" during the year 1989-90 were used to examine the objectives. A three stage stratified random sampling technique was designed with taluk as the primary sampling unit, a cluster of villages having a minimum of 200 cultivators as secondary sampling unit and the ten operational holdings within each village as ultimate sampling unit. All the 145 paddy farms available in the data base were selected for the study. The sample farms were post stratified into three groups based on area and designated as Group-I, Group-II and Group-III. Conventional percentage analysis was used to analyse the resource use pattern, productivity, and cost of production among various size groups of paddy farms. The results indicated that human labour employed per hectare showed a declining trend as farm size increased. Paddy yield declined as the farm size increased and Gross productivity of land, labour and capital were more in small farms than the other groups.

Chandrashekhar et-al\textsuperscript{56} (1996) have examined the Resource Use Efficiency in Groundnut Production under Rainfed Condition in Challakere Taluk of Karnataka. The data on the cultivation of groundnut crop of 1991 kharif season were collected from 100 groundnut growing farmers. The Cobb-Douglas production, Frontier production function analysis and Timmers Technical Index were used separately for small farms, large farms and all farms in order to determine whether the factors of production were used optimally to achieve the objectives set in the study. The production function analysis revealed that land, farm yard manure and seed in the case of small farmers contributed significantly to the production. The returns to scale were nearer to constant for all the categories of farmers.

Panda\textsuperscript{57} (1996) has examined how efficiency of various farm inputs were used by different tenurial (tenants) farms in agriculture. The data were collected from one village (Nakahurpatna) under Bhubaneswar Community Development Block and two villages (Khadish and Rajarashi) under Gop Community Development Block in Puri district, Orissa during 1993. A total of 165 farm samples from Nakhaupatna and 98 farm samples from Khadish and Rajarashi were taken for the purpose. The Cobb-Douglas production function technique was used in the analysis. The resources like human labour, bullock labour, seeds, manures and fertilizers, pesticides and irrigation were selected for estimation of efficiency. The selected villages were divided into


two categories—More Developed Village (MDV) and Less Developed Village (LDV). The study observed that in both the villages, the resources included in the equation explained 98 percent of gross farm returns irrespective of tenurial groups. The production function analysis showed that human labour was the most important input of all the tenurial farms in both the villages. The study brought out that land ownership has a limited impact on resource use and crop productivity.

Raja\textsuperscript{58} (1996) in his study An Economic Analysis of Resource use Efficiency in Indian Agriculture with Special Reference to Edappadi Panchayat in Salem District of Tamil Nadu, made an attempt to analyse the resource use efficiency and economic feasibility of raising tobacco in the context of technological changes. The main objective of the study was to determine the resource use efficiency of chewing tobacco and the economic feasibility of raising such crops in the context of technological changes in Edappadi Panchayat of Salem District in Tamil Nadu. The study was based on the data relating to the crop year 1992-93, collected from a sample of 150 respondents of four villages in Edappadi Panchayat. Cobb-Douglas production function was fitted to analyse the resource use efficiency. The results of the study revealed that marginal value productivity of land in all size group of farms was found high, indicating higher productivity of chewing tobacco which may be due to the fact that chewing tobacco in the area is being raised as a single crop. Marginal value productivity of human

labour was less than the wage paid to labourer. The excessive or indiscriminate use of pesticides in turn led to a decline in productivity of chewing tobacco in most of the farms.

Venkataramana et-al\(^5\) (1996) have studied resource-use efficiency in tomato cultivation in Kolar district of Karnataka state. Kolar, Chintamani and Srinivasapur taluks of Kolar district were selected for the study. Data from 100 farmers were collected during the year 1991. Cobb-Douglas production function was fitted to determine the efficiency of each resource in the production of tomatoes. The study found that marginal value product and factor cost ratio in the case of small farmers for land, fertilizer and staking materials were more than unity indicated that these resources were under-utilized in tomato production. In the case of large farmers this ratio for fertilizers, human labour and animal labour indicated that these resources were under-utilized.

Koppad et-al\(^6\) (1997) have studied the Resource-Use Efficiency in Maize Crop in three locations of Malaprabha Command Area of Karnataka state. The total sample size was 120 comprising of 40 from head reach, 40 from mid reach and 40 from tail reach. For the resource-use efficiency, only maize growing farmers were considered. Data were collected for the year 1991-92 through survey method. Cobb-Douglas production function was fitted to estimate the resource productivity. The study revealed that land was


over utilized in head reach and underutilized in mid reach and tail reach. Human labour was over utilized in head and mid reach. Manures and fertilizers were overutilized in head reach and underutilized in mid and tail reach.

Velavan et-al$^{61}$ (2000) have studied the resource use efficiency of groundnut cultivation in Salem district of Tamil Nadu. The data were collected from a sample of 120 farmers from three selected taluks namely Thiruchengodu, Sankari and Namakkal. The post classification of sample farmers was done into two groups viz., rainfed and irrigated farmers. The ordinary least square method was used to estimate the resource use efficiency. The study revealed that there was possibility of increasing the groundnut production by increasing human labour, machine labour, bullock labour and increased application of nutrients in irrigated condition and human labour, nutrients and other cost in the rainfed condition. Further, marginal value product to marginal cost showed that there was a more scope to increase the production by increased application of nutrients in irrigated condition, and increased use of plant protection chemicals, gypsum and biofertiliser in the rainfed condition.

Rama Rao et-al$^{62}$ (2003) in their study, Measuring and Explaining Technical Efficiency in Crop Production in Andhra Pradesh made an attempt to examine the levels of technical efficiency in the production of three major

$^{61}$Velavan C. and Balakrishnan V.: Resource Use Efficiency in Groundnut Cultivation of Salem District, Tamil Nadu, Agricultural situation in India, 2000, PP 755-757.

crops, viz., rice, groundnut and cotton. This study also attempted to identify the factors associated with technical efficiency. Stochastic frontier production function was used to estimate the technical efficiency. The average production elasticities and the technical efficiency were examined using the farm level data collected under the Comprehensive Scheme on Cost of Cultivation of Crops. The data were obtained for three representative districts-one each for the crops selected. Thus, three districts, viz., West Godavari, Anantapur and Prakrsam were selected considering that the proportion of the area under the crop concerned was one of the highest in the state. An analysis of technical efficiency indicated that there was considerable scope to improve the yields of the crops in the existing conditions of input use and technology. If the efficiency is improved, farmers will gain considerably in terms of higher profits. As it was found that education influenced technical efficiency significantly, efforts should be strengthened to promote both formal and informal education.

Anjani Kumar et-al\textsuperscript{63} (2004) have made an attempt to study the Technical Efficiency in Shrimp Farming in India: Estimation and Implications. The objective of the study was to estimate the technical efficiency of shrimp farming in a few major shrimp producing States of India and identify the sources of inefficiency in production. The data for this study were taken from the surveys conducted under the ICAR-ICLARM project on "Strategies and Options for Increasing and Sustaining Fisheries and

Aquaculture Production to Benefit Poor Households in Asia sponsored by the Asian development bank. The survey was carried out in three states, viz., Andhra Pradesh, Karnataka and West Bengal covering a total of 105 shrimp farmers. Based on the economic and technological differences, shrimp farms were classified into three types, viz., intensive, semi-intensive and extensive systems. The data collected were confined mainly to the modified extensive system of shrimp farming. Stochastic Frontier Production Function was used to estimate the technical efficiency of shrimp farms and to examine the factors influencing the technical efficiency. The results showed that large farmers appeared to be more efficient probably because of their greater capital investment capacity leased in farms were less efficient than owned farms. Further, technical efficiency improves with the increase in the education of the farmers and their experience in shrimp production.

Navadkar et-al\textsuperscript{64} (2004) have examined the Factors Influencing the Yield Gap for Sugarcane and Cotton in Maharashtra. The data were collected from the selected farm families under the Comprehensive Scheme for Studying the Cost of Cultivation of Principal Crops in Maharashtra State. The data were pertaining to the year 2000-2001. The yield gap was calculated on the basis of per farm potential yield and actual yield obtained. Cobb-Douglas type of production function was used to estimate the functional relationship between the yield gap and inputs responsible for the yield gap. The results indicated that there existed a yield gap in the case of sugarcane and cotton.

production due to deficit use of the important inputs viz., seed and chemical fertilizers in general and manure in particular.

Saha et-al\textsuperscript{65} (2004) in their study Technical Efficiency of Dairy farms in Developing Countries: A case study of Haryana State, India, made an attempt to measure how efficient the small holder dairy farms are. The state of Haryana has been selected for this study considering both the importance of dairying for Haryana's economy and the significance of this study to serve as a model to be replicated in other regions of the country. For this purpose, the Districts of Yamunanagar, Bhivani and Gurgam were selected based on the variations in agro-climatic features, cropping pattern, irrigation intensity, dairy and other livestock enterprises and socio-economic characteristics. From the three selected districts, the blocks of Radaur, Dadri and Sohna, respectively were purposively selected. Two villages from each block were selected in such a way that one village is within the periphery of the town/city and the other away from it in the same block. The data was collected from 180 sample households selected from three districts. The estimation of technical efficiency and its interpretation has been done on the basis of the estimation of the stochastic frontier production using Cobb-Douglas and translog models. The results of the data indicated that the landless dairy farmers in the irrigated zone are more efficient than their counterpart large farmers.

Senthil Kumar et-al\textsuperscript{66} (2005) have studied the Resource-Use-Efficiency in Paddy Cultivation in Lower Bhavani Project (LBP) Command Area in Tamil Nadu. The command area was divided into three reaches such as upper, middle and lower. A sample of 30 farmers from each reach were randomly selected for the year 2000-01. Percentage, average and ratio analysis were used to analyse the data. Cobb-Douglas Production Function was used to determine the input-output relationship. Resource use efficiency analysis showed that marginal value productivity for manure, water and plant protection were found to be greater than marginal input cost in all the reaches. This indicated that there is a possibility to increase the yield by increasing the use of these inputs in the command area.

Koshta et-al\textsuperscript{67} (2005) have studied the economic efficiency of resources in production of rice under irrigated and rainfed situations in Chattisgarh. Stratified random sampling technique was adopted for selecting the farmers. For this purpose, the data were collected from 202 sample farmers from two districts viz Rajpur and Bastar. The data were analysed employing regression and functional analysis. The analysis showed that most of the resources were excessively or uneconomically used in irrigated rice caused due to declining returns to scale. In the case of rainfed rice, diminishing returns to scale was observed. Under both the situations, resources were not utilized upto their potential which retarded the gross


income in rice production. Analysis of cost and return in rice production showed that the cost on materials and labour inputs were comparatively more in the production of irrigated rice than rainfed rice while the profitability was marginally higher in irrigated rice.

Rangappa et-al\textsuperscript{68} (2005) have analysed and compared the Resource Use Efficiency in Canal and Tank Irrigated Paddy in Southern Transition Zone of Shimoga District in Karnataka. The data were collected from 98 farmer respondents, 48 each from canal irrigated and tank irrigated paddy for the Kharif crop season 2000-01. The Cobb-Douglas production function on per hectare basis were estimated. The estimated production functions were significant and good fit for both canal and tank irrigated paddy. The production elasticities of all the inputs except farm yard manure and bullock labour were relatively higher in the canal irrigated paddy compared to tank irrigated paddy. Marginal value productivity of all inputs except plant protection, chemicals and bullock labour were relatively low in tank irrigated paddy. Low productivity of inputs was found with respect to human labour and fertilizer in tank irrigated paddy which might be due to the problems related to water management.

Shanmugam K.R, et-al\textsuperscript{69} (2006) conducted a study on the Technical Efficiency in Agricultural Production and its Determinants. The District Level Data Complied from various secondary sources of 12 Indian States for


the year 1990-91 were used for analysis. Stochastic Frontier Production Model was specified. It was found that Indian districts have a mean technical efficiency of 79 percent, indicating that, on an average, agricultural output can be increased by about 21 percent with existing resources. In nearly half of the sample districts (123 out of 248), Technical Efficiency values lie below 80 percent. Of this set, 84 districts are spread across four states viz., Uttar Pradesh (38), Madhya Pradesh (27), and Maharashtra (17) and Rajasthan (12). These states stand to gain the most from policy interventions towards improving technical efficiency.

The study has shown that health, education, and infrastructure can be powerful drivers of efficiency at the district level. The findings with respect to health are in line with the burgeoning literature, which suggests that health can act as a strong engine for economic growth and poverty reduction. Being the first study (to our knowledge) that studies the macroeconomic impact of health in the context of Indian agriculture, it is believed that future studies would be wise to account for this variable.

The study has also shown that the relative importance of the determinants of technical efficiency across districts depends greatly on environmental factors, such as agro-cilmatic zones, technological factors (such as irrigation regime), and crop mix. The policy implications of the study was made clear that interventions to improve technical efficiency are not “one-size-fits-all”. Indeed, even districts within the same state would
benefit differently from the same set of interventions. In that sense, it might be wise to develop policy interventions at a more localised level.

Essentially, the results and discussion outline a quite ambitions research agenda for the future. While the technical efficiency literature has offered insight into the relative performance of firms or regions with respect to meeting their potential, it is less clear how this information should/can be translated into policy prescriptions. There is certainly a need for increased data collection, so as to expand the analysis of potential determinants of efficiency. Also, as mentioned above, the results indicate the need to carefully incorporate into econometric models how the causes of inefficiency may vary across regions with different environmental and technological characteristics.

Finally, certain limitations of this study should be kept in mind. The major issue here is that the firm level efficiency concept has been applied to district level data, and that data used were aggregated across all crops. Nevertheless, the present result can be interpreted as indicative aggregative efficiency measures of all farms within the concerned districts. Moreover, it is felt that aggregate level studies, such as the one, can greatly complement firm level studies in the formulation of appropriate efficiency generating policies.

Bhende et-al\textsuperscript{70} (2007) in their study on Technical Efficiency of Major Food and Cash Crops in Karnataka (India) made an attempt to estimate the

farm-specific technical efficiency of major food and cash crops. This study used the farm level cross section data compiled by the University of Agricultural sciences, Bangalore, during 1993-94 under the scheme "Cost of Cultivation of Prinicpal Crops" sponsored by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The sample selection was based on stratified multistage random sampling procedure. At the first stage, taluks have been selected from each zone depending on the importance of the principal crops in the zone. In the second stage, one or two villages have been selected from each taluk and 10 farm households were finally selected from each taluk. Data have been collected from 450 sample households drawn from 45 taluks. Farm households have been classified into five farm size groups of technical efficiencies, the Stochastic Frontier Production Function of the Cobb-Douglas type was specified as follows,

$$\ln Y_i = \alpha + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + V_i - U_i$$

Where,

$Y_i$ = Actual output of the i-th farm in quintals
$\alpha$ = Constant term
$\beta_i$ = Unknown parameters to be estimated
$X_1$ = Area Under the crop measured in hectare
$X_2$ = Human labour input used in man-hours
$X_3$ = bullock labour input in pair-hours
$X_4$ = chemical fertilizers (NPK) quantity used in kilograms
$V_i$ = symmetric component of the error term and
$U_i$ = non-negative random variable which is under the control of the farm.
‘U’ takes the value of zero when the farmer is efficient and assumes the value greater than zero when the farmer is inefficient. Negative value of $U$ varies depending on the level of inefficiency. The maximum likelihood estimation (MLE) method enables us to obtain the maximum possible output function. It is assumed that $U$ and $V$ are independent and $U$ follows a half normal distribution with variance $\sigma_u^2$ and $v$ follows a normal distribution $N \sim (0, \sigma_v^2)$. The computer program TEALEC developed at the Australian National University was used to estimate the frontier and firm-specific technical efficiencies.

The following linear regression model was used to identify the socio-economic factors that conditioned the technical efficiencies of sample farms.

$$\ln \left[ \frac{TE_{ij}}{1-TE_{ij}} \right] = \alpha + \beta_1 X_{1ij} + \beta_2 X_{2ij} + \beta_3 X_{3ij} + \beta_4 X_{4ij} + \beta_5 X_{5ij} + \mu_i$$

Where,

- $TE_{ij}$ = Technical efficiency for $i$-th crop on $j$-th farm,
- $\alpha$ = Intercept / constant
- $\beta_i$ = regression coefficients
- $X_1$ = rental value per hectare of cropped area
- $X_2$ = proportion of female workers in total agricultural workers in the family.
- $X_3$ = proportion of children in the family,
- $X_4$ = dummy for adult members having education above primary level,
- $X_5$ = Farm size
- $\mu$ = error term.

The analysis of technical efficiency indicated that there is a considerable scope to improve the productivity levels of both food as well as
cash crops with the existing level of input use and the available technology. Land input, human labour and plant nutrients influence the output of food and cash crops under study. Quality of land represented in terms of rental value and presence of educated adult in the family influences the level of efficiency whereas increase in the farm size tends to reduce the efficiency level.

The above mentioned studies in the context of Indian agriculture connected to the resource-use efficiency indicate that resource utilization has increased but resource productivity has not increased in Indian agriculture. Most of the studies reviewed above have indicated the difficulty, to assert that the Indian farmers are traditional and not rational. It means farmers in traditional agricultural are generally efficient in the use of resources. Land ownership has a limited impact on resource-use and crop productivity.

Hence there is a need for increasing agricultural production by using optimum utilization of resources for the development of agriculture sector in general and the backward regions in particular. No study has so far been conducted on the Resource-Use Efficiency in the Bhavani River Irrigation Project in Erode District of Tamil Nadu. Therefore, the present study is a sincere effort on this direction.