CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter is devoted to a discussion of the past literature related to the present study. A brief review of related literature would be of great methodological interest. Besides, it would help to examine a varying range of policy alternatives, which have vital importance for resource use in agricultural development.

For better exposition, the review is classified under the following heads: (i) Cost and Returns Structure, (ii) Yield Gap and (iii) Profit Function Approach.

Voluminous literature is available on each of these classifications. Since it would be too ambitious to include all of them, only the most important and related works are reviewed here.

2.1 Cost and Returns Structure

The relationship between cost and returns is of crucial importance in agriculture. The cost of cultivation is an important determinant of the level of price. In agriculture, the cost of cultivation refers to the various input expenditures incurred by the farmers to obtain the finished product. The cost of cultivation consists of two parts, namely fixed cost and variable cost or
operational cost. Fixed cost includes depreciation, taxes, rent, interest, insurance premium and the like. It is constant over time and does not vary with the changes in the levels of output. This cost exists even in the absence of cultivation. Operating cost is the cost incurred by a farmer on factors of production such as seeds, human labour, pesticides, fertilizers, livestock feed, fuel and the like. It varies with the changes in the levels of output. But, it does not exist in the absence of cultivation. In the process of cultivation, operating cost is an important factor, which determines how much and what is to be produced.

Fixed cost is an important factor in decision making on the amount to be produced and various technological methods to be adopted. In the present study, the cost of cultivation of sugarcane is classified into Cost A (operational cost) and Cost C (Cost A plus fixed cost). The following are the items included under each of them.

**Cost A**

1. Value of Human Labour,
2. Value of Bullock Labour,
3. Value of Chemical Fertilizers,
4. Value of Pesticides,
5. Value of Seed,
6. Value of Farm Manures,
7. Irrigation Charges and
8. Miscellaneous expenses (Harvesting, bundling and transportation cost).
Cost C

Cost A plus rent (includes actual rent paid by the tenant or rental value of owned land), interest on fixed capital excluding land, land revenue, cesses, taxes and depreciation of implements and machinery.

The farmer incurs Cost A, when he is the owner and contributes his own land and other resources. Cost C is incurred when, in addition to the above costs, imputed interest is paid on owned fixed capital.

Harrison\(^1\) studied the cost and returns structure of small and large farmer groups in Tanjore district of Tamil Nadu. Data were collected for ADT 27 paddy cultivation in the Kuruvai season (June-October), 1967-68. A stratified random sampling technique was adopted to collect details on farm management. About 10 farms from each of the 15 villages were selected, giving a total sample of 150 farmers.

The study revealed that small farmers cultivated ADT 27 more extensively than the large farmers. The former cultivated rice in more than 50 per cent of their net operated area, while the latter cultivated only about 39 per cent of it. There was also a greater intensity of land use by the small growers than the larger ones. On an average, small farmers used about 22 per cent more of labour per

hectare than the large farmers. More intensive use of family labour accounted for much of this difference. Use of other variable inputs by the two farmer groups tended to follow a similar pattern. Small farmers spent a greater amount per hectare on the inputs. For both size groups, chemical fertilizer was the most important variable expenditure, with seeds remaining a close second.

Hanumantha Rao² analysed the changes in costs and returns structure of high-yielding versus local varieties of rice per acre in Ferozpur district of Punjab. This analysis was based on the farm management data for 1969-70. The study revealed a significant reduction in unit costs and a rise in the share of profit under the high-yielding varieties technology. The new technology and the cost-saving were based on three factors -- land, labour and capital (fixed and variable cost). The great cost-saving was on land followed by labour. However, a significant decline was observed in the unit cost of fertilizers. The greater fall in labour cost compared to capital cost indicated a rise in the over all capital-labour ratio, despite a reduction in the ratio of fixed capital-labour. This rise in the capital-labour ratio was attributed essentially to increase in fertilizer use. For high yielding varieties of rice the expenditure on inputs constituted 48.6 per cent of the total cost as against 41.9 per cent for the local variety.

In the study on the cost and returns of principal crops in the districts of Tamilnadu, Rajagopalan,³ considered only Cost A and Cost C. The two cost concepts included the following components:

**Cost A**

(i) Value of human labour including family labour,
(ii) Value of bullock labour,
(iii) Value of machinery charges,
(iv) Value of Seed,
(v) Value of insecticide,
(vi) Value of manure and Fertilizers,
(vii) Cost of irrigation, and 
(viii) Interest on working capital.

**Cost C**

Cost A + rent (including rent paid by the tenant or rental value of owned land) + interest on fixed capital, excluding land + land revenue, cesses and taxes + depreciation of implements and machinery.

The International Cotton Advisory Committee⁴ performed a study on the cost of production of raw cotton. Costs were divided into direct costs and indirect costs. The costs, which are associated with physical production, are called direct costs. Direct costs include farm production and harvesting costs, and off-farm

costs like transportation and ginning charges. Indirect or overhead costs include management and land costs. These two kinds of costs formed the gross cost for producing seed cotton. Cost A (variable cost) and Cost C (fixed cost) were considered for the analysis of cost and returns structure of LRA-5166 and MCU-5 varieties of cotton. The two categories of cost include the following items.

**Cost A**

A) Human Labour,
B) Bullock Labour,
C) Chemical Fertilizers,
D) Pesticides,
E) Seed cost,
F) Farm Manures,
G) Cost of irrigation and
H) Interest on working capital.

**Cost C**

Rent and interest on fixed capital, land revenue, cesses and taxes, depreciation of implements and machinery are associated with Cost C.

A brief review of studies relating to cost and returns could provide a better understanding of the subject. The following are the important findings of some of the related studies on cost and returns structure.
Madalia and Kukadia\(^5\) in their study, “Costs and Returns in Vegetable Cultivation”, found that in the cultivation of various vegetables, the variables cost alone accounted for 96 per cent and the fixed cost accounted only for 4 per cent of the total cost. Among the various inputs, the human labour accounted for substantial amount of expenditure. The plant protection, chemical fertilizers and irrigation were also important items of cost structure.

The Department of Economics and Sociology\(^6\) examined the changes in cost and return structure of principal crops at Zonal levels for the year 1976-77. The report revealed an understanding of the adoption level of various inputs by sample farmers in the three zones under study. Cost of production was worked out on the basis of Cost A, A\(_2\), B and C. In the case of American cotton, operational costs accounted for 57.48 per cent and fixed cost for 42.52 per cent of the total cost. In operational cost, human labour alone constituted 32.18 per cent of the total cost. Cost on Bullock labour was next in importance (11.1 per cent). In fixed cost, the rental value of owned land formed 24.5 per cent of the total cost. It was followed by rent for leased land. Interest on fixed capital amounted only to 2.81 per cent of the total cost.


Senthil Kumar\textsuperscript{7} studied the economics of production of different varieties of banana, using primary data. In his study cost A\textsubscript{1} included expenditure on human labour, bullock power, machine labour, irrigation charges, seeds, manures and fertilizers, plant protection chemicals, land revenue, depreciation on buildings, tools and implements and interest on working capital. He concluded that the Cost A\textsubscript{1} of cultivation of banana per hectare was Rs.14,174.69, Rs.17,394.80, Rs.17,308.38 and Rs.16,190.15 for Nendram, Poovan, Rasthali and Karpooravalli varieties respectively. The study clearly showed the existence of differences in cost of cultivation of different varieties of banana.

R. Haridoss,\textsuperscript{8} in his study on sugarcane cultivation, has used Cost ‘A’ and Cost ‘C’ concepts to analyse the cost and returns for two groups of farms producing New and Standard varieties of sugarcane in Madurai district. For this, he had surveyed 150 sugarcane cultivators in this District. The major findings of the study were that the costs incurred on harvesting, bundling and transportation constituted the major component of total cost in sugarcane production. The expenditure on irrigation was higher for Standard variety compared to New variety. Similarly, the expenditure on seeds per acre was found to be higher for Standard variety than for the New variety. The returns per acre and the net


income of small farmers cultivating both varieties were higher than those of the large farmers.

Malik and Singh\(^9\) studied the break-up of cost and returns of sugarcane production in Reserve and Free areas of sugar mills in Hardwar district of Uttar Pradesh. Their survey was based on 150 respondents comprising 75 each from Reserve and Free area. The data pertained to the agricultural year 1994-95. In order to analyse the cost of cultivation, the following cost concepts were used in the study.

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\begin{align*}
\text{Cost } A_1 &= \text{All actual expenses in cash and kind incurred in production by owner} \\
\text{Cost } A_2 &= \text{Cost } A_1 + \text{rental value paid for leased-in-land} \\
\text{Cost } B_1 &= \text{Cost } A_1 + \text{interest on value of owned capital assets (excluding land)} \\
\text{Cost } B_2 &= \text{Cost } B_1 + \text{rental value of owned land and rent paid for leased-in-land} \\
\text{Cost } C_1 &= \text{Cost } B_1 + \text{imputed value of family labour} \\
\text{Cost } C_2 &= \text{Cost } B_2 + \text{imputed value of family labour}
\end{align*}
\]

They concluded that the sugarcane cultivation was more beneficial in the adjoining area of sugar mills.

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Kale. et.al.\textsuperscript{10} in their study on Sugarcane and its problems discussed Cost and returns structure of sugarcane in Western Maharashtra during the agricultural years 1987-88 and 1992-93. They worked out three cost concepts, namely Cost A, Cost B and Cost C for three planting types of sugarcane, Adsali, Suru and Ratoon.

Cost A included the cost of hired human labour plus hired and owned bullock labour, hired machinery charges, owned machine labour, seed value (both farm and purchased), value of manures and fertilizers, insecticides and pesticides, irrigation charges, depreciation, land revenue and cesses and interest on working capital.

Cost B comprised Cost A plus imputed rental value of owned land and imputed interest on owned fixed capital (excluding land).

Cost C comprised Cost B plus imputed value of family labour.

The findings of the study were that the average per hectare cost of cultivation of Adsali, Suru and Ratoon sugarcane during the year 1987-88 was Rs.28,472, Rs.22,515 and Rs.15,493 respectively. The proportion of operational cost and fixed cost for Adsali sugarcane crop was 62.22 and 37.78 per cent respectively. The proportion of variable and imputed cost for Suru sugarcane was

58.73 and 41.27 per cent respectively. The proportion of direct and indirect cost of Ratoon sugarcane was 50.67 and 49.33 per cent respectively. The proportion of variable and fixed cost was on the declining note for planting types due to different maturity periods. Working capital ranged between 41 to 50 per cent for the planting types. Out of the variable cost, hired labour and fertilizer were important cost items and ranged between 12 to 14 per cent. Out of the imputed cost, the rental value of land constituted about 32 to 42 per cent for the planting types. The per quintal cost of production of Adsali, Suru and Ratoon sugarcane was Rs.25.24, Rs.23.03 and Rs.18.05 respectively. The gross value of output for Adsali, Suru and Ratoon crops was Rs.37,392, Rs.29,939 and Rs.25,910 per hectare respectively. The net income for Adsali, Suru and Ratoon crop was Rs.8,920, Rs.7,424 and Rs.10,417.54 respectively with output input ratio 1.31, 1.33 and 1.67.

During the year 1992-93, the average cost per hectare of Adsali, Suru and Ratoon sugarcane cultivation was Rs.34,846, Rs.33,838 and Rs.24,708 per hectare respectively. Gross returns per hectare for Adsali, Suru and Ratoon crop was Rs.60,699, Rs.62,273 and Rs.55,474 respectively. The cost per quintal of production was Rs.32.53, Rs.31.22 and Rs.26.32 respectively. Decrease in cost on account of hired human labour and fertilizers was observed during the year 1992-93. The Ratoon crop was more remunerative than Adsali and Suru crops.
David Groenfeldt\textsuperscript{11} in his study stated that paddy cultivation forms the basis of traditional Southeast Asian societies and the livelihoods of the people who comprise those societies. Historically speaking, paddy cultivation has always (at least for several millennia) been multi-functional – providing not only the raw material for subsistence and trade, but also serving as the central focus for family and community life as well as spiritual and religious expression. While times have certainly changed, this paper suggests that the multi-functional nature of paddy cultivation continues to be important, and that our concept of rural “livelihood” should incorporate these cultural dimensions.

Kumar et al.,\textsuperscript{12} in their study on “Technical Efficiency of Rice Farms under Irrigated Conditions of North West Himalayan Region – A Non-Parametric Approach” stated that hill agriculture is practiced under tough conditions because of its unique character. The hill and mountain ecosystem is unique because of topographical features and climatic variations along the gradient. In general, hills receive 750 to 1250 mm precipitation; however, only about 10 per cent of the area is under irrigation in Uttarakhand hills that too confined to the lower valleys. Sub-optimal hydro-thermal regimes and shallow soil depths thwart further extension of

\textsuperscript{11}David Groenfeldt, “Appreciating the Hidden Values of Paddy Cultivation Towards a New Policy Framework for Agriculture”, \textit{INWEPF/SY}/2004(03).

cultivated land. Small and scattered land holdings and limited land use is also the main feature of hill agriculture. Therefore, the food produced is not sufficient to sustain for the whole year. These biophysical and socio-economic constraints result in low technical efficiency as well as discourage farmers to bear the risk. In this context increasing technical efficiency assumes significance. Improving efficiency levels under these conditions is a big challenge for farmers in the NWH region. Rice being the most important staple food in NWH region, improvement in efficiency levels is one of the major means of sustaining their staple food production and thereby ensuring food security.

This study was taken up to determine the efficiency of rice cultivation under irrigated conditions in NWH region. Moreover, the study also explores the possibility, if any, the difference in technical efficiency levels between the local and improved technology (i.e., variety) in rice growing farms. The factors associated with inefficiency are also analysed.

The overall technical efficiency in the case of improved rice growing farms is higher than that of rice farms growing local varieties. The results also indicate that in case of local rice growing farms, the scale inefficiency contributes more to the overall technical inefficiency. From the policy point of view, increasing the share of rice cultivation under irrigated situation in the total farm area can bring about improvement in the overall technical efficiency. With regard to farms
growing improved rice varieties, pure technical inefficiency makes the greatest contribution to the overall inefficiency. By emulating the best practices of relevant efficient farms, less efficient farms growing improved rice varieties can eliminate pure technical inefficiency under irrigated conditions.

A. Suresh and T.R. Keshava Reddy\textsuperscript{13} in their study on “Resource-use efficiency of Paddy Cultivation in Peechi Command Area of Thrissur District of Kerala: An Economic Analysis” undertaken in the Peechi Command Area of Thrissur district in the Kerala state, has examined the resource productivity and allocative as well as the technical efficiency of paddy production. The study has used the primary data collected from 71 rice farmers of the command area using the stratified random sampling. The cost of cultivation of paddy in the command area has been found as Rs 21603/ha, resulting in a BC ratio of 1.34. The elasticity coefficients for chemical fertilizers, farmyard manure and human labour have been observed significant and positive. The allocative efficiency has indicated that marginal return per one rupee increase under these heads would be Rs 2.83, Rs 1.57 and Rs 1.17, respectively. The average technical efficiency of the paddy farmers in the command area has been found as 66.8 per cent. Education of the farmer and supplementary irrigation provided during the water-stress days have

been identified as the factors which could enhance the technical efficiency. The study has called for an equitable distribution of canal water and enhanced extension services for resource management in the area.

Ansari and Ismail\textsuperscript{14} in their investigations were conducted at the farms of Uttar Pradesh Bhumi Sudhar Nigam at Shivri, Lucknow during the Kharif season in 1998-99 to assess the impact of organic amendment vermicompost in comparison to chemical fertilisers on paddy (variety-Sarju-52) in sodic soil and in relation to soil fertility, yield parameters and economics. Results indicated an increase in soil organic matter from 0.38 to 0.96 \%, organic carbon from 0.22 to 0.56 \%, available nitrogen (N) from 499.52 to 1245.44 kg /ha, carbonate ions from 0.20 to 0.23 meq/100 g of soil, calcium ions from 0.89 to 1.09 meq/100 g of soil and decrease in pH from 8.74 to 8.25, electric conductivity (EC) from 0.86 to 0.69 dSm\textsuperscript{-1}, sodium ions from 11.85 to 1.47 meq/100 g of soil and exchangeable sodium percentage (ESP) from 67.51 to 57.42, suggesting qualitative improvement of soil, in the plots amended with vermicompost. Paddy yield of 4975 kg/ha was recorded from plots amended with vermicompost while 4900 kg/ha, from plots amended with chemical fertilizers, as control. Cost benefit ratio was found to be 1:1.5 for cultivation of paddy using vermitech where as in case of

chemical fertilisers, it was 1:1.06 suggesting that by the application of vermicompost in paddy, the cost of production could be reduced without compromising on harvest.

Bassvaraja et al.,¹⁵ in their research notes stated that the quantitative analysis of agricultural production systems has become an important step in the formulation of agricultural policy. A number of empirical studies have attempted to investigate producer responsiveness to product and input price changes, to estimate economies of scale, to assess the relative efficiency, and to measure the impact of technological change. In particular, there has been a considerable amount of theoretical and applied econometric research on the measurement of the impact of technological change. As knowledge of new and more efficient methods of production (cultivation in agriculture) becomes available, technology changes. The adoption of new or improved method of production / cultivation can shift the production function. In other words, production can be increased with new technology by using same quantities of resources that were used in old technology or alternatively, the production level in old technology can be attained with new technology by using fewer quantities of inputs. The recent

breakthrough in rice cultivation known as System of Rice Intensification (SRI) method is one such case which may be considered as disembodied technology.

The study was based on the input-output data obtained from sample paddy growing farmers in Andhra Pradesh selected through multi-stage sampling design. At the first stage, four major paddy growing districts, namely Prakasam, East Godavari, West Godavari and Guntur districts following both traditional and SRI methods of rice cultivation were purposively selected. From each district, three major paddy growing mandals following both the methods of rice cultivation were selected purposively at the second stage. Then at the third stage, four major paddy growing villages following both methods were purposively chosen from each mandal. In the final stage, ten farmers were randomly selected from each village such that they included five farmers in SRI method and five farmers in traditional method of rice cultivation. Thus, 480 farmers (240 farmers growing paddy by traditional method and 240 farmers growing it by SRI method) spread over four districts of Andhra Pradesh were interviewed during kharif season of 2005-06. The data on various inputs used in paddy cultivation like chemical fertilizers, plant protection chemicals, seed materials and human labour, and cultivation practices such as land preparation, transplanting, irrigation, inter-cultivation and harvesting along with labour requirement for these operations were collected from the sample farmers.
The findings of this study demonstrate the superiority of SRI in terms of yield and returns advantage. However, it is worth mentioning here that the actual adoption rate of SRI among paddy growers is very low, which appears to be a puzzle given the encouraging performance of the new technology. There are several reasons for this kind of poor response of farmers to SRI method. First, the farmers, particularly in the head reaches of command areas, where paddy is grown extensively, have not fully realised the importance of water in view of market and policy failure in pricing the resource appropriately; second, intensive care particularly during transplanting of seedlings and higher weed infestation demands more labour and hence farmers in labour scarce areas are hesitant to adopt SRI; third, only soils with good drainage facility and low clay content are suitable for SRI cultivation and finally, there is not enough awareness among farmers about its superiority.

M. Shivamurthy et al.,\textsuperscript{16} in their study stated that rice growing situations prevailing in different regions of India largely determine the system of rice cultivation. The two principle systems of cultivation in Karnataka are dry and wet. The dry system of cultivation is mainly confined to tracks which depend on rains only. Upland rice, which is predominantly cultivated in the arid and semi-arid

zones has noticed a gradual decline in its area and quantum of production in the recent years. The factors attributing to this decline are lack of suitable high yielding varieties and drought resistant varieties, decline in relative profitability of rice cultivation and shifting from food crops to cash crops etc. The present study was conducted to identify the constraints faced by farmers cultivating rainfed paddy in Eastern Dry Zone of Karnataka.

The study was conducted in Bangalore Rural, Tumkur and Kolar districts under Eastern Dry Zone of Karnataka State during 2005. Out of 24 taluks belongs to these three districts, six taluks (Kanakapura, Channapatna, Tumkur, Gubbi, Kolar and Bangarpet) were selected based on the highest area under paddy cultivation. From among these six taluks, 25 villages were selected randomly. In each of the 25 so selected villages, a list of farmers growing rainfed paddy during 2003-04 *kharif* season was prepared. From each village four rainfed paddy growers were selected by adopting simple random sampling technique. Thus, 100 rainfed paddy growing farmers spread over 25 villages were selected for the study. The data was collected from 100 rainfed paddy growing farmers with the help of a pre-structured interview schedule.
2.2 Yield Gap

Davidson\textsuperscript{17} and Martin surveyed the variations in yield on farms and at experimental stations for different crops, including rice, in Australia. The yield gap between farms and experimental station was observed to vary according to the cultivation season. During good years, the yield at experimental station was found to increase more rapidly than the yield of farmers within the same district. This was mainly because the farmers were more interested in maximising their profits by limiting their input investment, while the experimenters only aimed at maximising yield and had no cost restraints.

Gomez\textsuperscript{18} in his study defined the factors responsible for yield gap as yield constraints. Yield gap I was hypothesized to be caused by either environmental differences between experimental station and farmer’s field or by non-transfer of technology. Yield gap II was caused by biological and socio-economic constraints. Biological constraints referred to the uncontrollable natural factors and socio-economic constraints to the social and economic factors that prevented the farmers from using the recommended technology. Gomez developed the confectional model of yield gap.


Tripathy\textsuperscript{19} in his study concluded that, about 17 per cent of the gap in the yield was caused by technology gap. The different packages of practices individually account for the technological gaps. Of the gaps water management, disease and pest control, and nitrogen application caused 20.34 per cent, 17.92 per cent and 12.37 per cent respectively. Another 19.83 per cent of the gap was due to the ecological factors like temperature, soil, rainfall and sunshine intensity.

Kuo, Wu and Li\textsuperscript{20} in their study, “Rice Production in Taiwan’s Agriculture”, attempted to identify the factors associated with variations in yield, using a regression model. Data were collected from a sample of 60 farmers of Tah-yia, Taiwan in 1975. Fertilizers, labour, net returns, technician’s value and number of practices constituted the main explanatory variables. The analysis showed that the independent variables explained 51 per cent of the observed variability in rice yield. The result suggested that more extension services were needed in rice production. They also indicated that natural manure; complementary irrigation and hand-weeding produced positive effect on rice yields.

\textsuperscript{19} A. Tripathy, \textit{A Study of Technological Gap in Adoption of New Rice Technology in Coastal Orissa and Constraints Responsible for the Same}, (Unpublished Ph.D. Thesis, Indian Agricultural Research Institute, New Delhi, 1977).

\textsuperscript{20} Yi-chung Kuo, Carson Wu and Cheng Chang Li, “Rice Production in Taiwan’s Agriculture, Constraints of High Yields on Asian Rice Farms”, \textit{An Interim Report}, IRRI, Philippines, October 1977, pp177-201.
Agricultural scientists have evolved high-yielding varieties through increase in productivity rather than through expansion of the area cultivated. It involves the transfer of research from experimental laboratories to the farm. Agricultural research centres strive to maximise yield through optimum use of resources. These centres seek to develop technologies suitable to the socio-economic conditions of a region, through integrated socio-economic and biological research. Undertaking on-farm testing, demonstrations, operational research projects and the like examines the validity and viability of experimental findings. However, the farmers’ yields are often reported to be lower than those obtained at the experimental stations. The difference between the experimental station yield and the actual farm yield is referred to as “yield gap”.

There are two common ways of defining the concept of yield gap. First, by directly comparing the experimental station yield to the yield at farm; second, by comparing the yield of the best farm with that of the average or the poorest farm. Thus, yield gap may be classified into two kinds – Yield Gap I and Yield Gap II. The Yield Gap I represents the difference between experimental station yield and potential farm yield. The Yield Gap II corresponds to the potential farm yield and actual farm yield. The maximum yield obtainable from a variety under a

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particular situation is called ‘potential yield’, while the average yield attained under farm conditions is known as the ‘actual yield’. The factors that prevent farmers from achieving the potential yield under farmers’ conditions are known as ‘yield constraints’.

Yield gap analysis becomes instrumental in measuring the magnitude of gap in the yields and in the identification of constraints responsible for it. It is not proper to consider Yield Gap I in a study, as experimental stations rarely encounter the constraints experienced by the farmers. Such estimates would be biased and larger than what it is actually under the farmers’ conditions.23 Hence, Yield Gap II has been examined in this study. It is defined as the difference between the highest yield obtained by the most efficient farmer in the sample and the average level of yield achieved under farmer’s conditions.

Many studies have identified yield gap by defining it in different ways. The main findings of some of the studies conducted by various researchers are reported here. Besides, a brief review of studies relating to the determinants of yield is also presented. It would provide an insight into the determinants of yield and yield gap under different conditions in different regions of the country and the world.

Saini\textsuperscript{24} in his study, “Allocation Efficiency in Agriculture-crop Level Analysis”, covered 200 farms of 100 each, in the districts of Meerut and Muzaffarnagar in Uttar Pradesh. The analysis was based on the Farm Management data for 1955-56. Cobb-Douglas production function was fitted with output as the dependent variable and area, labour, bullock labour, farm manures and fertilizers and irrigation as five independent variables. The analysis indicated that output was highly responsive and significantly related to land, followed by human labour.

Fujimoto\textsuperscript{25} in his study analysed the determinants of rice yield with respect to cultivation techniques, using a regression model. The functional relationship between yield and four independent variables-labour, fertilizers, pesticides and farmers’ educational levels was estimated using the data for 1977-78, the main season of Wellesley Province in Malaysia. The analysis revealed that 41 per cent and 63 per cent of the variations in yield among the Malay and Chinese farmers respectively, were jointly explained by the independent variables. Education was the most important determinant of yield in both groups. However, its influence on the Chinese was significantly greater than on the Malaysia. It emphasized the role


of technical knowledge in the determination of rice incomes. The findings indicated that different technical improvements were required to raise the levels of yield for different farm groups. It was also clear that differences in production attitudes, farm management and institutional arrangements were reflected in the actual process of farm operations and the resultant average yield per acre.

Suryawanshi and Gaikwad,\textsuperscript{26} in their study “An Analysis of yield gap in Rabi Jowar in Ahamednagar district”, found that, there was a wide gap in yield when new technology was adopted. The yield was just 2.12 quintals/ha. under traditional method of cultivation, 3.42 quintals/ha. when there was partial adoption of technology and 7.02 quintals/ha. when it was fully adopted as in demonstration plots. Multiple regression analysis showed that early sowing not only increased yield of jowar but also resulted in the increase of productivity of the resource. Recommended varieties, fertilizers and timely sowing were found to be important ways to reduce the yield gap.

Fale\textsuperscript{27} et al., in their study, “An Economic Analysis of Yield Gap in Rice in Ratnagiri District”, argued that yield obtained at the experimental station couldn’t be achieved on farms because of differences in environment, input use and management. Therefore, they defined yield gap as the difference between the


potential yield, that is, yield obtained in the demonstration plots and the actual farm yields. They defined potential yield as the yield that could be obtained in farmers’ field by adopting the improved technology. They observed that, the gap between yields on experimental stations and those obtained on national demonstration plots (Gap I) was quite narrower (2 qtls/ha. or 3.83 per cent). However, the gap between potential yields and the actual yields on farmers’ fields was very wide (i.e., 27 qtls/ha or 52 per cent). There existed difference in utilisation of improved inputs such as fertilizers and labour. Higher level of input was used on national demonstration plots as compared to farmers’ level.

Yadava and Gangwar\textsuperscript{28} stated that, per hectare yield gaps were 8 and 10 quintals for early and late maturing rice in Bihar state. In the state, high yielding variety rice was 35.56 quintals per hectare, which was about 160 per cent higher than that of local varieties. Yield gap between potential farm yield and the actual realised yield was quite high indicating future potential for increase in production of rice in the state. The reason for this yield gap was only the partial adoption of new rice technologies. The authors remarked that there was a need to strengthen the extension and input supply services in Bihar immediately.

Subramaniyan and Nirmala\textsuperscript{29} in their study, “Yield Gap Analysis in Rice Cultivation”, analysed yield gap among IR20 and Co.37 rice cultivators in

\textsuperscript{28} R.N. Yadava and A.C. Gangwar, “Rice Production and Constraints in Bihar State”, \textit{Agricultural Situation in India}, Vol.12, No.1, 1986, pp.9-13.

\textsuperscript{29} G. Subramaniyan and V. Nirmala, “Yield Gap Analysis in Rice Cultivation”, \textit{Southern Economist}, Vol.27, No.15, 1988, pp.15-16.
Gokilapuram village of Madurai district for khariff 1986. Yield gap under the former variety (3.54 qtls. per acre) worked out to be higher than that of the latter (2.81 qtls. per acre). Further, Garrett’s ranking technique was used to identify the important constraints to potential yield in the study area. The main constraints observed were water shortage, insects, credit, traditions, weeds and non-availability of seeds.

Umamaheswari in her study, “Yield Gap Analysis of Principal Crops in Palani Taluk, Dindigul-Quaid-E-Milleth District,” identified the technical and socio-economic constraints by using Garrett’s ranking technique. She proved that technical and socio-economic constraints prevented the farmers from achieving the maximum possible yield. Non-availability of required chemicals was the major cause and lack of finance and knowledge was a constraint for the use of recommended levels of plant protection measures in both irrigated and rain-fed crops.

Uma who studied yield gap in Thanjavur district, applied yield gap function, discriminant function and constraint analysis and also applied percentage analysis to identify the factors causing yield gap. She concluded that

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out of several technical constraints, water problem ranked first. Out of 90 farmers interviewed, 79 attributed inadequate and untimely water supply as the major technical constraint leading to yield gap. In socio-economic constraints, 50 per cent of the farmers expressed non-availability of labour as the main factor followed by lack of credit facilities (44.44 per cent), lack of own funds (28.87 per cent) and lack of awareness (22.22 per cent).

Jagadish Lal\(^{32}\) in his study on ‘Raising Sugar Productivity through improvement in Sugarcane Development, Marketing and Supply’ found that the wide gap between commercial and competition plots was due to the non-adoption of the recommended level of technologies. He suggested that consolidation of holdings should be done and effort should be made to develop suitable association of cultivators so as to improve productivity upto 240-280 tonnes of sugarcane.

Mokheyi\(^{33}\) in his study estimated the yield gap ratios in rice production during kharif season in the year 1975-76 the deserved farmers technical competence to be high when the gap ratio was low and vice versa. High yield gap was reported in states like Bihar and Orissa. This was attributed to the fact that

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\(^{33}\)K.K. Mokheyi, Gap Analysis-An Effective Production Increase Concept in Rice, *Summary of a Lecture Delivered at the State Leaven Training Meeting on Rice*, held at Purila Department of Agriculture West Bengal, India July, 1977.
while the demonstration plots were situated in irrigated areas, rice at the farmer was generally produced under rainfed conditions.

David Rajasekar34 studied the relationship between yield gap and the associated input gaps by fitting linear yield gap functions for paddy, irrigated cholam and irrigated cumbu separately and log linear yield gap function for irrigated groundnut. In the case of paddy, the co-efficients of nitrogen gap, human labour gap and technology index were significant which indicated that the yield gap between demonstration plots and farm holdings would be bridged physically by increasing the inputs such as labour, nitrogen and technology level in the sample farm. In the case of groundnut, the coefficient of phosphorous gap, potash gap and pesticides gap were significant. So, the economic optima derived revealed that there existed potentialities for increasing the groundnut yield by bridging the gaps in phosphorous, potash and pesticides.

Chandrasekaran35 in his study examined the relationship between yield gap and the associated input gap by fitting a linear function. The co-efficient of gap is nitrogen, phosphorous and potash were significant which included that the yield


gap between demonstration plots and the farm holdings could be bridged by increasing the input such as nitrogen, phosphorous and potash in the sample farm. He found that the marginal value product of nitrogen, phosphorus and potash were higher than the marginal cost of the respective and be concluded that even at the existing product and factor prices, the yield gap could be reduced.

In the present study, yield gap analysis has been carried out on the basis of yield gap II concepts adopted by most of the authors.

2.3 Profit Function Approach

Most of the studies relating to the supply responsiveness and input demand elasticities have made use of the Cobb-Douglas type production function. According to Lau and Yotopoulos,36 production function approach is not suited to examine the allocative efficiency of farmers, because the prices are not incorporated as exogenous variables nor does the approach allow for different groups of farmers having different endowments of factor inputs. To avoid such limitations, Lau and Yotopoulos37 developed and applied the profit function approach in Indian Agriculture to measure and compare allocative efficiency of farmers on the basis of the following assumptions:

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1) Farmers are profit maximizing,

2) Farmers are price-takers in both product and factor markets, and

3) The production function, which underlies the profit function, is concave in variable inputs.

Yotopoulos and Lau\(^{38}\) derived unit output price ((UOP) profit function and factor demand functions. They developed an approach to isolate the technical and price efficiency components between small and large farmer groups. The equations adopted for estimating UOP profit function and factor demand functions were of the form:

\[
\log \pi = \log A^s + \delta_L^* D_L + \sum_{i=1}^{4} \delta_i^* D_i + \alpha_1^* \log W + \beta_1^* \log k + \beta_2^* \log T
\]

(and)

\[
-WL / \pi = \alpha_1^* L D_L + \alpha_1^* S D_S
\]

Where,

\[\pi\] = farm profit (total revenue minus variable cost) in money terms,

\[L\] = labour in man-hours,

\[W\] = money wage rate,

\[D_L\] = dummy for large farmer,

\[D_S\] = dummy for small farmer,

\[ D_t = \text{dummy for states,} \]

\[ K = \text{fixed factors representing interest on fixed capital, and} \]

\[ T = \text{cultivated area.} \]

Adulavidhaya\textsuperscript{39} et.al., in their study, “A Micro Economic Analysis of the Agriculture of Thailand”, estimated a short-run output supply and factor demand function for a sample of rice farmers in Thailand. The profit function approach was used with four variable inputs (labor, animal input, mechanical input and fertilizers) and two fixed inputs (fixed farm assets and farm size). Data were collected from six provinces in the Central Plain and North East of Thailand for the crop year 1972-1973. The hypotheses of profit maximisation and constant returns to scale were tested and confirmed. Output supply and factor demands were highly sensitive to changes in output price. The own price elasticities of output and variable inputs indicated an elastic response of factor utilisation. The cross price elasticities between all variable inputs (except output and labor) indicated that these inputs were complements rather than substitutes.

Kalirajan and Flinn\textsuperscript{40} in their study, “Allocative Efficiency and supply Response in irrigated Rice Production” fitted the restricted Profit function along with input demand functions. The data used in this study were collected by conducting a larger intensive farm management survey from May 1977 to April 1978 in the karrif season. They have estimated profit function along with input demand functions simultaneously by the method of restricted Aitken estimation model. The form of the functions is,

The Restricted Profit Function:

\[
\log \pi^* = \log A^* + \beta_1^* \log W + \beta_2^* \log F + \beta_3^* \log P + \\
\beta_4^* \log B + r_1^* \log L + r_2^* \log C.
\]

Factor Demand Functions:

\[
\frac{Wx_1}{\pi^*} = \beta_1^*
\]

\[
\frac{Fx_2}{\pi^*} = \beta_2^*
\]

\[
\frac{Px_3}{\pi^*} = \beta_3^*
\]

\[
\frac{Bx_4}{\pi^*} = \beta_4^*
\]

Where

\[ \pi^* = \text{normalised restricted profit} \]

\[ A^* = \text{shift parameter for the sample} \]

\[ W = \text{real wage for labour in mandays} \]

\[ F = \text{real fertilizers price} \]

\[ P = \text{real pesticides price} \]

\[ B = \text{real bullock pair day price} \]

\[ L = \text{total cultivated area} \]

\[ C = \text{capital flow} \]

\[ X_1 = \text{total number of mandays used} \]

\[ X_2 = \text{total chemical fertilizers used in Kg.} \]

\[ X_3 = \text{total pesticides used in kg.} \]

\[ X_4 = \text{total bullock pair days applied to the rice crop.} \]

Flinn, Kalirajan and Castillo⁴¹ in their study, “Supply Responsiveness of Rice Farmers in Laguna, Philippines”, fitted profit function model to estimate rice supply and input demand elasticities. Data were collected from farmers using advanced methods of irrigated rice culture during the wet season, in the year 1978. The variables used were fertilizers, pesticides, mechanical power, animal power, labour for transplanting, labour for crop maintenance, rice area and capital service flow.

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The analysis revealed that with the technology and resources at their disposal, the sample farmers maximised their short-run profits with respect to their normalised prices of the variable inputs. The farmers responded to price changes in an efficient manner. The elasticity of rice output with respect to land (0.7) and capital (0.1) indicated that farm size had a substantial impact on farm profits, when compared to increase in capital intensity per farm.

Subramaniyan and Chelladurai\textsuperscript{42} in their study examined some of the issues relating to absorption of labour, farm size and nature of returns to scale in Tamil Nadu Agricultural University. This study was based on Alwarkurichi Village of Kadayam Block in Ambasamuthram taluk of Tirunelveli district in Tamil Nadu. A random sample of 40 small farmers and 40 large farmers was chosen by using stratified random sampling techniques. The data used pertained to the ‘pishanam’ season of December 1983 to March 1984. The study examined “Ponni” variety alone. For this, Lau and Yotopoulos’ profit function was used along with four variable input demand functions relating to labour, fertilizers, pesticides and bullock labour. These equations were estimated by using Zellner’s Seemingly Unrelated Regression model.

\textsuperscript{42} G. Subramaniyan and S. Chelladurai, “Farm Size, Returns to Scale and Absorption of Labour in Tamilnadu Agriculture, A Micro Analysis”, \textit{Paper presented at 23\textsuperscript{rd} All India Econometric Conference}, Osmania University, Hyderabad, January 3-5, 1985.
The study showed that there was no appreciable difference between small and large farming with regard to yield per acre and net revenue per acre. However, there was considerable difference in total revenue, mainly due to the fact that large farmers sold their product at a relatively higher price. Further, supply of paddy was price-inelastic both in the case of small farming and large farming. The demand for labour was relatively more responsive to paddy price than to wage rate. Moreover, the sum of the indirect production elasticities obtained from profit function revealed constant returns to scale.

In the Cobb-Douglas production function in the variable inputs with n fixed inputs, the normalized restricted profit function\(^{43}\) is given by

\[
\log n = \log A + \sum_{i=1}^{m} \log p_i + \sum_{j=1}^{n} r_j \log z_j
\]

where

\(
n = \) Normalised restricted profit

\(
A = \) Normalised shift parameter

\(p_i = \) Normalised prices of inputs in the production process

\(z_j = \) Fixed inputs

The levels of variable inputs can be derived from the above equation by differentiating the normalised restricted profit function with respect to the

normalised price for that factor by using Sheppard’s Lemma.\textsuperscript{44} From the equation
the variable input demands function\textsuperscript{45} are derived as

$$-p_i x_i \frac{*}{*} \beta_1$$

\* n

Where $X_i =$ levels of variable inputs

\begin{align*}
i = 1 \ldots m
\end{align*}

The above equations are to be estimated jointly by using Zellner’s\textsuperscript{46} seemingly unrelated regression with an assumption of additive error with zero expectation and finite variance for each of the two equations. The hypothesis of equal relative economic efficiency of two different farms can be tested by using dummy variable in the normalised restricted profit function and examining whether its value is equal to zero.

Kalirajan and Flinn\textsuperscript{47} studied allocative efficiency and supply response in irrigated rice production through profit function. The study was confined to two varieties of rice in the kharif season in Coimbatore district, Tamil Nadu. The data used were drawn from a larger intensive survey conducted from May 1977 to


\textsuperscript{45}M. Fure and D.L. McFadden, \textit{op.cit.}, p.13.


April 1978. They chose 41 farmers for Exotic Modern Variety (EMV) at random. They estimated Lau-Yolopoulus profit function along with input demand equation by using the restricted Aitten’s estimation, imposing the conditions that the co-efficient of variable input are equal in both profit and relevant factor demand equation. The interest terms of the normalised profit function indicated similar technical efficiency of the EMV and LBV producers. The sum of the elasticities of fixed factors (land and capital) indicated that constant returns to scale prevail in both cases.

The output responses to changing rice price were positive, significant and greater than one. This indicated that the farmers in the study area were responsive to changes in rice price. Besides this, farmers supply response for rice was sensitive to changes in the prices of rice, fertilizer and labour wages.

Junakar 48 tested the joint hypothesis of profit maximising behaviour and competitive behaviours of Indian farmers. The study was based on cross sections data pertaining to paddy growing farmers of Thanjavur district in Tamil Nadu, for 1969-70. He estimated Lau-Yotopoulas profit function along with that variable input demand equation by Zellner’s Seemingly Unrelated Regression and tested the restriction implied by theory. Quite contrary to the earlier findings of other studies, assuming competitive conditions, he found that Indian farmers were not

profit maximizers. He argued that small and large farmers in India did not operate in the same credit or labour markets, and therefore, they were not competitive. Hence, he emphasised the need for further research to explain the behaviour of farmers in poor countries.

Kalirajan⁴⁹ studied the economic efficiency of farmer groups (small and large) using Lau-Yotopoulas profit function along with four variable input demand equations relating to labour, chemical fertilizer, pesticides and bullock pair. For the empirical estimation of profit and variable factor demand function a random sample of seventy farmers (35 farmers each) growing HYV. IR 20 in rabi (winter) reason 1977-78 was selected from a progressive village in Coimbatore district, Tamil Nadu.

To test the equality of different efficiencies (economic, price and technical) between the two farmer groups, he estimated the profit function along with demand functions, jointly by using Aitken’s genratlised least squares through the Lagragian Multiplier. This way of estimating profit and factor demand functions is different from the method of Lau and Yolopoulus. The advantage of working with this method is that it is possible to identify which elasticities estimated from

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the factor demand equations differ from those of the profit functions. It helps policy makers to identify which of the factors effect farmer’s decision making.

The major findings of this study were:

1) There was equal relative economic efficiency is the cultivation of IR 20 in rabi season between small and large farm groups.

2) There were equal differences between price efficiency parameters of small and large farm groups; and

3) The null hypothesis of equal relative technical efficiency between small and large farm groups could not be rejected.

These findings indicate that given the same acres to input and equal terms, small farmers would respond to economic opportunities in the same way as large farmers. However, in order to achieve this, special institutional arrangements may be necessary to ensure equal access for small farmers to inputs.

Abhi, Kumar and Mathur\textsuperscript{50} derived indirect production elasticities for three varieties of cotton (Desi cotton, American cotton and Hybrid cotton) using Lau-Yotopoulus profit function along with variable input demand equation relating to labour. They utilized farm level primary data from Akola district in Maharashtra state, for the year 1979-80, for 200 farmers growing three varieties of cotton.

They estimated profit equation along with input demand (labour) equation jointly by using Zellner’s Seemingly Unrelated Regression. The study showed that the share of land in cotton production was the maximum for all varieties of cotton, ranging from 0.42 for Desi cotton to 0.54 for American and Hybrid cotton. The share of labour decreased substantially as one moved from ‘old’ to ‘new’ technology. The share of capital in Hybrid cotton technology was biased towards land and capital, and was against labour.

Thus, it is understood from the above reviews that the studies relating to supply responsiveness and allocative efficiency of factor inputs in sugarcane cultivation by profit function approach are scanty. The present study is to analyse the supply responsiveness and input demand elasticities in sugarcane cultivation by estimating unit output profit function along with inputs demand function in order to fill this gap.