

**TECHNICAL EFFICIENCY IN GRAM PRODUCTION
OF AMRAVATI DIVISION**

THESIS

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**Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
in partial fulfilment of the requirements
for the Degree of**

**MASTER OF SCIENCE
IN
AGRICULTURE
(AGRICULTURAL ECONOMICS)**

**By
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Enrolment Number - JJ-2173

2013



DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the thesis entitled "**TECHNICAL EFFICIENCY IN GRAM PRODUCTION OF AMRAVATI DIVISION**" or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis / publication of any University or Scientific Organization. The sources of material used and all assistance received during the course of investigation have been duly acknowledged.



Place: Akola.

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Date: 31 / 5 / 2013

Enrolment No. JJ-2173

CERTIFICATE

This is to certify that the thesis entitled “**TECHNICAL EFFICIENCY IN GRAM PRODUCTION OF AMRAVATI DIVISION**” submitted in partial fulfilment of the requirement or the degree of “**Master of Science In Agriculture (Agricultural Economics)**” of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Rede Ganeshkumar Dilipkumar** under my guidance and supervision.

The subject of thesis has been approved by the Student's Advisory Committee.

Place : Akola
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@	:	at the rate
%	:	Per cent
AE	:	Allocative Efficiency
APC	:	Agriculture Prices Cell scheme
CV	:	Coefficient of Variation
EE	:	Economic Efficiency
et al.	:	et alia (and associates)
GCA	:	Gross cropped area
hrs	:	Hours
ha	:	Hectare
i.e.	:	that is
kgs	:	Kilograms
MLE	:	Maximum Likelihood Estimate
N	:	Nitrogen Fertilizer
P	:	Phosphorus Fertilizer
qtls.	:	Quintals
R ²	:	Coefficient of determination
Rs.	:	Rupees
RUE	:	Resource Use Efficiency
SD	:	Standard Deviation
TE	:	Technical Efficiency
W.C	:	Working Capital

F)

THESIS ABSTRACT

- a) Title of the thesis : **“TECHNICAL EFFICIENCY IN GRAM PRODUCTION OF AMRAVATI DIVISION”.**
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ABSTRACT

The research entitled “Technical Efficiency in Gram Production of Amravati Division” The present study was an attempt to study the technical efficiency and resource use efficiency in gram production of Amravati division.

The objectives of the study were:

- 1) To study the socio economic characteristics of selected farmers.
- 2) To study the level of input use in gram production.
- 3) To estimate the technical efficiency and resource use efficiency in Gram production.

The present study carried out in Amravati division of Vidarbha region of Maharashtra where Gram is commonly grown by farmers.

Amravati division comprises the five districts namely Akola, Amravati, Washim, Buldhana and Yavatmal. For the present study the data collected from Agriculture Prices and Costs Scheme (APC) located in The Department of Agriculture Economics and Statistics, Dr. PDKV, Akola.

The data was collected for the year 2011-12. For this purpose a sample of 75 cultivators were collected for the study. The simple tabular analysis was carried out to accomplish the socio-economic characteristics of selected farmers and level of input use in gram production. While, the Stochastic frontier assuming a Cobb-Douglas production function was used to study the technical and resource use efficiency.

The average family size of holding as a whole was worked out of the selected farmers was 6 members per family. The number of male per family was 3 (50 per cent) and followed by female was 2 (33.33 per cent). The average number of children's per family was 1 (16.67 per cent).

The highest percentage of the educational level was high school level (30.66 per cent). It is followed by secondary school level and the percentage of illiterate was 9.33 per cent. The average size of land holding of the selected gram growers was 2.23 hectare and the net sown area was 2.19 hectare. The average gross cropped area of the selected gram growers was 3.18 hectares with cropping intensity 142.16 per cent.

The cropping pattern of the selected gram growers, it illustrated that the share of pulses was higher in the total cropped area. Among the pulses share of gram crop was highest (29.68 per cent).

The average technical, allocative and economic efficiencies estimated for the entire sample of 75 farmers was 82, 90 and 74 per cent respectively, it implies that there is scope to increase the productivity of gram.

Functional analysis of gram crop revealed that Seed rate, Human Labour, Machine Labour, Bullock labour and Phosphorous Fertilizers, had the elasticity of 0.54, 0.059, 0.044, 0.055 and 0.14 respectively and was statistically significant.

The value of MVP in respect of Seed rate (4.39) and phosphorus fertilizer (1.29), were more than unity level and the MVP value of human labour (0.43), Machine labour (0.37), Bullock labour (0.87) and Nitrogen fertilizer (-3.57) were found to be less than unity level.

CHAPTER I

INTRODUCTION

1.1 Background information.

Agriculture being one of the major sectors associated with country's population has attracted much attention since independence. The first two decades after independence did not show much growth of agricultural sector. It was attributed to expansion of land, area sown under different crops and not by technological changes. Economic environment has changed through greater urbanization and planned agricultural development programs of the nation, with the introduction of new technology, high yielding variety seed, fertilizer, pesticides, labour saving devices and machines, improved cultural practices and additional irrigation facilities. The traditional equilibrium in agricultural is showing way to system of agricultural characterized by dynamic equilibrium.

Role of pulses in Indian agriculture needs hardly any emphasis. India is a premier pulse growing country. The pulses are an integral part of the cropping system of the farmers all over the country because these crops fit in well in the crop rotation and crop mixtures followed by them. Pulses are important constituents of the Indian diet and supply a major part of the protein requirement.

India grows a variety of pulse crop under a wide range of agro-climatic conditions and has a pride of being the world's largest producer of pulses. Major pulse crop grown in the country are chickpea, Pigeon pea. Urdbean, mug bean, lentil, field pea, lathyrus, moth bean and horse gram. Unique characteristics like high protein content (2-3 times more than cereals), nitrogen fixing ability, soil ameliorative properties and ability to thrive better under harsh conditions make pulses and integral component of sustainable agriculture particularly in dry land area. The most important pulse crop in the country is gram (gram), which accounts for (38 %) production followed by Pigeon pea (16 %), Mung bean (12%).

Gram (*Cicer arietinum* L.) is leguminous pulse crop which belongs to leguminasae family and Chromosome number is $2n=14, 16$. It is best pulse crop from nutrition point of view. Pulses are main source of protein

in vegetarian diet. Legume has unique role in human and animal nutrition as well as in improvement of soil fertility by improving physio chemical and biological properties of the soil.

Gram is commonly known by various names in different states of India such as 'chana', 'chickpea', 'harbara', 'chhole', and 'Bengal gram'. The name chana has been mostly derived from Sanskrit word 'chanakam' or 'chennuka'. The most common Indian name is Gram. In Maharashtra state gram is sown in rabi season. Gram contains 21.10% protein, 61.50% Carbohydrates and 2.4-5.0% Fats. Besides its contain Iron, Calcium, Niacin in sufficient quantity and also contain Malic acid and Oxalic acid in gram.

The light brown coloured pulse is considered to be a good source of protein (25 to 29 per cent) and is also called by name 'Garbanzo beans'. Channa is used as an edible seed and is also used for marketing flour thought the globe. It is also used in marketing snacks, namkeen, sweet product etc. Saponin contain in gram is high and its inclusion in human diet lowers the plasma cholesterol and reduce the risk of heart disease. Gram also enriches the soil by fixing nitrogen through its root nodules. It is used for human consumption as well as for feeding to animals. It is eaten both whole fried or boiled and salted, or more generally in the form of the split pulse which is cooked and eaten. Both husks and bits of the 'dal' are valuable cattle feed. Fresh green leaves used as vegetables (sag). The grains are also used as vegetables (chhole) and gram flour (besan) is used in the preparation of various types of sweets. Gram is considered to have medicinal effects and it is used for blood purification.

Gram rank third in world production among peas and beans. It accounts 31.77 per cent of the area and 45.70 per cent of production in India. The global scenario of gram observed that the area under gram in India during 2009-10 was 8.56 million hector producing 7.35 million tones and the productivity account's about 859 kg/ha (Anonymous-2010).

There are some countries like Pakistan, Bangladesh, Myanmar and Australia, which are producing gram in the world. Large portions of gram are consumed in same country where they are produced. India alone accounts for more than 50 per cent of the world production.

India account 70% area, production and consumption of gram in the world (2011). In India, major gram growing states are Madhya Pradesh, Rajasthan, Bihar, Maharashtra and Uttar Pradesh etc. In India Madhya Pradesh leads in the production of gram (44.20 per cent) followed by Maharashtra, Andra Pradesh, Karnataka, and Rajasthan.

Among these states Maharashtra ranks third in acreage under gram after Madhya Pradesh and Rajasthan. Madhya Pradesh produces the major share of 40 per cent of total India's production. The area under gram in Maharashtra contributes about 15.80 per cent of total area under gram in India, and production of gram has share of 14.90 per cent in the total production in gram in India (economic survey of Maharashtra 2009-10).

The area under chickpea was 13.95 lakh hectare whereas the production was 13.01 lakh tons in Maharashtra, during 2010-2011. The area under chickpea was 3.65 lakh hectare and the production was 3.55 lakh tons in Vidarbha during 2010-2011. In Vidarbha Akola, Amravati, Yavatmal, Buldhana, Nagpur and Washim are the major districts which growing chickpea on large area.

The rural economy of vidarbha is the basically the crop economy. The principal kharif crops are cotton, soybean, jowar, tur, mung, sunflower etc, and the principal rabi crops are wheat and gram. Through contribution of sub sector like horticultural, forestry is incising over time the cropping sector remains the major contributor to the domestic product.

Thus gram is one of the major crops grown in Vidarbha region. It is usually grown on available soil moisture during winter season after harvesting kharif crop. Since the irrigation facility are very limited in this region, the rabi crop gram acts as a good source of income to the farmers in rain fed area and also helps in increasing cropping intensity of this region giving economic support to the farmers.

Considering economic importance of gram attempts are being now made to bring more area under its cultivation in rabbi season. Moreover it must be taken into account that gram has proved its profitability over other many crops. One more important characteristics of this crop are it is short duration crop hence it becomes possible for farmers to take next crop and utilize available soil moisture. New technology has been so far introduced in

gram cultivation leading to increasing production levels. The government is also formulating new policies due to which farmer's efforts to produce different pulse crops are increasing which is helpful to increase in income of the farmers in the state.

1.2 Importance of Study.

Agricultural production has increased manifold due to the introduction of high yielding varieties along with the use of improved production practices. The cultivation practices are varied from farmer to farmer even in same village. It is the well known fact that the agro-climatic condition differ from area to area and as such the finding of research in one region may not be fully applicable to other region resource allocation is the important factor problem in farm management more ever the optimum allocation of resources which are scare in nature directly affect the welfare of society.

Studies on technical efficiency and resource use efficiency are important in various contexts result of such studies help the policy maker to formulate policies concern in increasing in agricultural production. The studies also find out the lacuna in the present agriculture production system and suggest the ways to overcome same. Gram is a major pulse crop grown in Vidarbha region and in Amravati division. Vidarbha region is mostly rain fed area. Release of high yielding varieties of gram and development of other improved production technologies have resulted in the increasing in area under this crop and production levels are also increasing.

During the recent past emphasis of the farmers is observed to be shifting from physical production to production in the monetary returns. The present study was an attempt to study the technical efficiency and resource use efficiency in gram production of Amravati division in vidarbha region of Maharashtra.

Based on the studies conducted in passed the hypothesis of the present study was that, under existing input use pattern the inputs are not used optimally or not to their fullest efficiency by the farmers and there is a need for adjustment in the existing input levels for profit maximization.

1.3 Objectives of the Study.

The study area which belongs to Amravati Division is identically suitable to gram cultivation and the farmers of this area are commonly cultivating gram crop. Therefore present research study was conducted on Technical Efficiency of Gram Production in Amravati Division with the following Objectives.

- 1) To study the socio-economic characteristics of selected farmers.
- 2) To study the level of input use in gram production.
- 3) To estimate the Technical efficiency and resource use efficiency in gram production.

1.4 Hypothesis.

On the basis of review available literature and publications following hypothesis was set for the present study as bellow.

'The input levels of selected farmers for all the inputs are equal'.

1.5 Scope and Limitations.

Empirical studies on technical efficiency and resource use efficiency provides basic factors for the considering the input use to boost the agricultural production. In this connection these have appeared over the period of last fifteen years many studies on technical efficiency and resource use efficiency in different parts pertain to Maharashtra, Punjab, Tamilnadu, West Bengal, Karnataka and cover different crops like Cotton, Sugarcane, Wheat, Pulses etc.

It has a wide scope for such studies of technical efficiency and resource use efficiency. The results of which will optimum allocation of resources and to maximize the certainly the way in formulating valuable planning policies of Agriculture of this region.

The success or failure of the Agricultural development programme depends on the way of farmer's response to such programme. It who is ultimately makes the final decision regarding the allocation of land and other resources for particular crop enterprise. Here the problem of product adjustment and resources allocation. The study of resource use efficiency, technical efficiency and input use level will be helpful in identifying the

efficient inputs in cost of cultivation and to formulate the base for some strategies such as use of low cost and location specific resources conservation technologies to improve the yield level ensuring more income to the farmers.

As the present study is concerned with specific area i.e. Amravati division and for specified period. The results will be applicable only to the areas which have similar situation of the area under study.

CHAPTER II

REVIEW OF LITERATURE

An attempt has been made in this chapter to review the earlier studies of the technical efficiency and resource use efficiency of various crops done by several research workers. This chapter is organized into two sections. In first one research work on technical efficiency has been reviewed, while in the other section the research work carried out on the resource use efficiency was discussed.

2.1 Technical efficiency

Ekanayake et al.(1987) compared some methods on measurement of firm specific technical efficiency. The data (pertaining to rice) for the study were collected from two locations (the 'head' and 'tail' of a major irrigation channel) of Mahaweli Development Project in Sri Lanka. The study revealed that the stochastic frontier and Corrected Ordinary Least Squares (COLS) methods yielded sharply contrasting technical efficiency levels for the head while the results from both methods were similar for the tail. The differences between these two sets of results arise from the relative importance of the U (technical inefficiency parameter) and V (statistical noise) terms in total error (E). Deterministic procedures generally tend to over-estimate the average level of technical inefficiency and the extent of this bias is unknown. In contrast, the stochastic frontier model enables the separation of random noise from deviations arising from technical inefficiency. The study also indicated that there was high level of technical inefficiency in the tail reach than in the head.

Duttaet al. (1992) reported that is said to be technically efficient if it consistently yields higher quantities of output from the same level of inputs. It is the ratio of yield derived from average production function and deterministic frontiers function with the average level of inputs use.

Jayaram et al. (1992) revealed that the major of technical efficiency compass the actual level of inputs used to the level at which it would be used by farms '1' to obtain the same output 'y', but at the efficient level.

Shareef (1992) studied the input-use efficiency of rice crop in three regions of KC canal irrigation system in Andhra Pradesh. The study revealed that the coefficient of determination (R^2) was 0.86, 0.68 and 0.79, respectively, for head, middle and tail regions. The coefficient of fertilizer (0.9885 and 0.6784) was found significant in head and middle regions. The coefficient of labour was 0.347 and found significant in the middle region. The marginal value product (MVP) of fertilizer was Rs.116 and Rs.86 for head and middle regions, respectively and was found significant in both the regions. The MVP of labour was Rs.18 in the middle region and found significant. Thus, it was concluded that there existed potentials for maximizing the level of crop output through resource allocation.

Subramanian et al.(1992) analyzed the input-use efficiency in the command area of lower Bhavani project in Tamil Nadu. The multiple regression analysis carried out in the three regions indicated positive and significant influence of fertilizer on the productivity of rice in all the three regions. The marginal value product of fertilizer was Rs.20, Rs.19.80 and Rs.38, respectively, in the three regions indicating that there was scope for increasing the level of fertilizer use to increase the productivity of rice.

Koppad (1993) studied the efficiency in the use and allocation of resources in Malaprabha command area in Karnataka. The study revealed that in the case of hybrid cotton the ratio of marginal value product (MVP) to marginal factor cost (MFC) for land was greater than one in head reach only (1.41). It implied that income could be raised by using more land while it was used uneconomically in the mid and tail reaches. The ratio of MVP and MFC of human labour in head and tail reach indicated the scope for increasing the use of human labour and in the mid reach it was optimum. To achieve optimum utilization in cotton, it could have been better to divert the pesticides expense towards other inputs like seed, labour and manures and fertilizers. Regarding maize, the elasticity of coefficient of land in tail reach was highly significant (0.8587), which indicated that land was the major factor influencing gross income.

Kutaula (1993) applied a frontier technology to wheat crop grown on reclaimed soils of Karnal district in Haryana. The study revealed that there existed a big scope to increase technical efficiency of the wheat

farms with the given level of inputs. The mean technical efficiency was found to be 0.76. This implied that the actual output of wheat on an average was 24.0 per cent less than the frontier output.

Sawant (1993) reported that the degree of technical efficiency at specified level of input may be judged from productivity differences at that point. In practice, the optimum level for a given farm may be lower or higher than the recommended. I.e. is why excess use of fertilizers over the recommended levels may not necessarily be interpreted as over use.

Banik (1994) studied the technical efficiency of irrigated farms in Choto Asulia village of Bangladesh. The results showed that 88 out of 99 farms had a technical efficiency of 71 per cent or above. Thirteen farms showed technical efficiency of 91 to 100 per cent and ten out of these farms belonged to the category of small farms. The average technical efficiency for the entire sample of farms was 78 per cent, indicating that there was considerable scope for increasing the technical efficiency of sample farms as a group.

Rao et al.(1996) reported that the technical and allocative efficiencies were determined for castor cultivation using farm production data collected in 1992-93 from a village in the Mehaboobnagar district of Andhra Pradesh. The use of fertilizers, human labour and plant protection significantly influenced yield of castor. Technical inefficiency was a major reason for low productivity, whereas allocative efficiency was high at 90%.

Shanmugam et al.(2000) reported that the technical efficiency varies widely ranging from 46.5% to 96.7% across sample farms and its time variant. The mean technical efficiency is computed as 82% which indicates that on an average the realized output can be higher than the measures it can be increased by 18% without any additional resources.

Konstantinos et al.(2001) reported that the recent advances in stochastic decomposition methodology to examine the level and the driving forces of technical efficiency for an unbalanced panel data set of 100 wheat farms in Saskatchewan during the period 1987–95. The contributions of resource use and total factor productivity to the output growth of these farms are also investigated. The analysis indicates moderate levels of technical efficiency and a considerable variation of efficiency ratings among

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Saskatchewan farms. The ownership status, composition of labour employed, participation in crop insurance and government income transfer programs, participation in Top Management Workshops, degree of specialization, level of intensification and mechanization of production, type of land used, and the farm debts account for differences in efficiency across wheat farms. Even though the productive efficiency of the farms has been increasing over time, the results show that technological progress was the main source of productivity and output growth during the study period.

Shaha et al.(2004) reported that the green fodder, feed and farm family labour were still most important factors affecting milk production. The mean technical efficiency of milk production study area found to be around 91 per cent signifying high overall production of milk production.

Singh (2007) reported that the farm-specific technical efficiency of wheat cultivation in Haryana at the aggregate and disaggregate levels has been studied using stochastic frontier approach. A high degree of technical inefficiency in wheat farming has been reported, which is due to factors under farm's control. It has been argued that wheat-cultivating farms in the state can increase their production by 27 per cent without increasing the quantity of inputs, i.e. just by way of realizing efficiency. The estimates of technical efficiency have indicated that small-size farms are more efficient than medium- and large-size farms, negating thereby the myth that large-size farming is more profit or business-oriented.

Sharma et al.(2008) reported that the technical efficiency of Himachal farmers, studied using the frontier production function, has been found to vary widely across cereal crops in the state. It has been found that the average yield of all the major cereal crops is below the national average, except the maize crop, which has been found in surplus in the state. Maize, wheat and paddy, wheat have been noted as the major crop rotations being followed in the study area. The analysis of cross sectional data has revealed inefficiency in terms of inputs application. The mean technical efficiencies have revealed that a considerable portion of frontier output is left untapped, it is 35–42 per cent in maize, 44–50 per cent in paddy and 61–67 per cent in wheat. The ratio of marginal value productivity (MVP) and marginal factor cost (MFC) has been found to be more than one in case of 50 per cent inputs

for all the crops. However, the female labour for most of the crops has values less than one and with negative signs as most of the work (agricultural operations) in the hills is being performed by women.

Manjeet Kaur et al. (2010) reported that the technical efficiency in wheat production across different regions of the Punjab state. It is based on the cross sectional data collected from a random sample of 564 farm households comprising 58, 318, and 188 households from semi-hilly, central and south-western regions for the year 2005–06. The mean technical efficiency of wheat production has been found as 87 per cent, 94 per cent, 86 per cent and 87 per cent in semi-hilly, central, south-western and Punjab state as a whole, respectively. The results signify that farmers of the central region do not have much scope to increase productivity of wheat through technical efficiency improvement under the existing conditions of input-use and technology. In the semi-hilly and south-western regions, the yield of wheat can be improved to the extent of 13 per cent and 15 per cent, respectively through adoption of better practices of technology.

Kachroo et al. (2010) reported that the technical efficiency and factors affecting efficiency of wheat farmers under dryland and irrigated conditions in the Jammu district of J & K state have been reported for the year 2006. The stochastic frontier production function has been used to determine the technical efficiency of these farmers. Technical efficiency has been found different under both the conditions. The estimated mean technical efficiency of wheat farmers under dry condition has been found to be 0.84, indicating 84 per cent efficiency in their use of production inputs, and for irrigated condition it has been found to be 0.88, that means the average output of wheat could be increased by 12 per cent by adopting technology properly.

Shrinivas et al. (2012) reported that the Potato is the second staple food after wheat in Afghanistan. International Centre for Agricultural Research in the Dry Areas (ICARDA) and International Potato Centre (CIP) introduced high yielding potato variety Kufri Chandramukhi (KCM) and its production technology to develop an efficient seed production system that helped in reducing poverty and increasing food production in Bahrak district of Badakhshan province of Afghanistan. Purposive and multistage sampling technique was used for selecting the sample seed potato farmers for the

present study. The economic benefits and technical efficiency levels of farmers were estimated using the data collected from the participating and non-participating farmers in the intervention. A high degree of inefficiency (76%) in the production of seed potato was observed indicating that there is scope for farmers to increase the potato production by 76 per cent just by way of realizing technical efficiency. As the efficiency levels are low, efforts to improve technical efficiency and correct adoption of seed potato production technology would be more productive and cost effective through more trainings, field days, etc.

2.2 Resource use efficiency

The estimated production function underlying crop production enables one to evaluate the efficiency of resource use. An input factor is considered to be used most efficiently if its marginal value product is sufficient enough to cover its cost. Equality of marginal value product and factor cost is therefore, the basic criterion that must be satisfied to obtain efficient resource use.

One of the ways to increase agriculture production is to use the resource in optimum ways. Many studies have been carried out in India to examine whether the resources are optimally used and whether there exists any possibility of increasing production through reallocation of resources in optimum direction. Some of the studies related to resource use efficiency are reviewed in the following paras.

Patil et al.(1974) used the cost concepts generally used in farm management studies in India to estimate and compare the cost of cultivation between sugarcane and banana in two districts of Maharashtra. A modified Cobb-Douglas *type* of production function was employed for estimating the resource productivities of land, human labour, manures and fertilizers and seeds. The analysis revealed that in no case did the coefficients exceed unity thereby indicating diminishing returns to individual factors in both crops.

Verma et al.(1975) studied resource-use efficiency in Jaipur district and found higher marginal productivity of land on small farms as compared to that on large farms. The explanation given for this was that an effort to get more income from the limited area of land available the small farmers cultivated their land more intensively.

Kademani (1983) conducted research on economics of intercropping, in Bijapur and Dharwad districts of Karnataka. To measure the resource use efficiency of various intercropping systems, Cobb-Douglas type production function was used by considering the various variables in their value terms. The regression coefficients worked out for different inputs used in different crop combinations indicated that land was used more efficiently compared to other inputs. Traces of over utilization were observed in the case of seeds, fertilizers, human labour as well as bullock labour in a number of crop combinations.

Pradhan (1983) carried out the study on resource productivity and resource use efficiency in agriculture Akola district. The overall functional analysis showed that out of 17 total functions fitted to different crops, land has shown positive elasticity's i.e. 16 in almost all the functions. Second factor showing positive effect was human labour (11 out of 17). Where as in case of bullock labour negative elasticity's were observed in 11 out of 17 functions.

Muralidharan (1987) studied the resource use efficiency in rice production in Kerala, employing the Cobb-Douglas production function. The adjusted R^2 was 0.84 indicating that 84 per cent of the variation in yield of paddy is explained by the estimated production function. The coefficient of land and human labour were positive and significant at one per cent probability level.

Radha et al.(1989) evaluated the resource-use efficiency in rice-rice and rice-pulse farming systems of Krishna district in Andhra Pradesh. The results indicated that manures and fertilizers and irrigation were quite productively used in both the farming systems. The sum of the elasticity's indicated the operation of constant returns to scale in both farming systems.

Verma et al. (1992) undertook a study on input use efficiency on mechanized farm in Jaipur district of Rajasthan. The marginal value product of human labour was Rs 19.30 on mechanized farms and Rs 107.12 on partially mechanized farms. The MVP of variable expenses on improved inputs like fertilizers, hybrid seeds, plant protection chemicals etc was Rs 4.31 on mechanized farms and Rs 3.17 on partially mechanized farm. The

MVP of labour which is negative on both the categories of farms, because of excessive use, has also increased substantially as a result of mechanization.

Yadav et al. (1992) examined on resource use efficiency in crop production, Etawah district of U.P. the result revealed that the yields of different crops could be maximized from their existing levels to higher level. The additional output of these crops at optimum level over existing levels of inputs was calculated at Rs 1896, Rs 586, Rs 766, Rs 3606, Rs 4672 and Rs 8887 per hectare respectively.

Thakur et al. (1992) studied on resource use efficiency in agriculture of high altitude areas. The result revealed that the production elasticities associated with human labour were significantly higher for all the crops on all the farm categories. Seed, fertilizers and bullock labour were found non significant as all the farms used high doses of these inputs. The marginal productivities of human labour in all the crops and irrigation in potato were greater than unity showing the scope for enhancing the use of these factors.

Aswathareddy et al.(1997) studied resource-use efficiency in groundnut production under rain fed conditions in Challakere taluk of Karnataka. The study revealed that land and farmyard manure in the case of small farmers and farmyard manure in the case of large farmers contributed significantly to production. The average mean technical efficiency indices of small and large farm groups were 0.679 and 0.646, respectively showing that small farmer groups were achieving yield levels, which were more efficient than the large farmer groups.

Naik et al. (1998) while analyzing the resource use efficiency and productivity at various factors involved in onion production using Cobb-Douglas production function observed that land and farmyard manure were positive and highly significant.

Ganesh (2000) analyzed resource use efficiency for mixed farming systems in Gazani lands of Karnataka. Results of the study indicated that about 98 per cent of the total variation in gross income was explained by the variables included in the production function. The resources like fish, fingerlings, manure and labour had significant effect on the gross returns.

Neelappa (2002) studied the technical and allocative efficiency of paddy production in Tungabhadra project area. The per hectare cost of paddy cultivation was Rs.26,192 and Rs.25,938 in Bellary and Raichur districts, respectively. The variable costs (85%) constituted the major portion of the total cost of cultivation. The expenditure on human labour was found to be the major item of variable cost. The fixed cost per hectare was estimated to be Rs.33,896 and Rs.33,746 respectively, for Bellary and Raichur district farmers. Rental value of land formed the major component of fixed cost. The gross returns realized by the farmer in Bellary and Raichur districts for paddy was Rs.42,842 and Rs.40,735 per hectare.

Wadear (2003), while analyzing the resource use efficiency and productivity at various factors involved in different animal based farming systems in the three dry zones of Northern Karnataka, concluded that, the milk production increased with the farm size and ranged from 4.5 – 5.0 liter per day per animal. In milk production, green fodder, concentrates and labour were significantly contributing factors in all the three zones.

Rajeshwari (2004) analyzed resource use efficiency for coconut based farming systems in Tumkur district of Karnataka, using Cobb-Douglas production function observed that the capital and feed in Farming System-I, number of cows in Farming System-II, labour in Farming System-III, land, labour, feed and number of sheep in Farming System-IV and land and number of cows in Farming System-V had positive and significant influence on gross returns.

Singh (2004) in his study on economics of efficiency in vegetable business system reported that cost of cultivation for tomato, onion, arvi, okra, brinjal and potato was estimated at Rs.12,599.00, Rs.13,338.10, Rs.9,742.10, Rs.10,046.40, Rs.11,274.60 and Rs.13,480.20 per hectare, respectively. Further, it also showed that about 95 per cent of the cost of cultivation of these vegetables constituted human labour and working capital cost. The cost on bullock labour for these vegetables ranged from 4 to 5 per cent. The per hectare net profit of vegetable growers for tomato, onion arviokra, brinjal and potato were estimated to be Rs.31470.25, Rs.2644.34, Rs.22015.90 and Rs.31353.60, Rs.29205.40 and Rs.25328.25, respectively.

Saikumar (2005) studied the resource use efficiency in different farming systems of three districts of North Eastern Karnataka employing the Cobb-Douglas production function. The adjusted R^2 was 0.76, 0.58 and 0.54 for Bidar, Bellary and Raichur districts, respectively, indicating that 76, 58 and 54 per cent of variation in yield could be explained by the estimated production function. The coefficient of cost of seeds and cost of feeds + concentrates in Bidar, fertilizer+ FYM cost in Bellary and fertilizer+ FYM cost and labour cost in Raichur district were positive and significant at 5 per cent probability level.

Chapke et al.(2011) reported that the resource-use efficiency in sorghum production in coastal region of Andhra Pradesh. Data for the study were collected from 100 sorghum producers in seven villages in the study area pertaining to the 2008-09 crop season. Farm budgeting technique and production function analyses which incorporate the conventional neoclassical test of economic and technical efficiencies were used as the analytical techniques. Findings revealed that the farmers were inefficient in using the resources. The seeds and irrigations were found to be over-utilized, while fertilizers, labourer and agrochemicals were found to be under-utilized. The results showed that appropriate adjustment is required for optimum allocation of resources and to maximize the revenue from the sorghum cultivation.

CHAPTER III

METHODOLOGY

Adoption of sound methodology has vital importance in economic activity. It comprises the description of study area, the sampling techniques adopted, and the method of survey, the nature and source of data and the various tools and techniques employed in analyzing the data and in evaluating the problems.

A study of technical efficiency and resource use efficiency in Agriculture provides a sound basis for developing the economic aspects of agricultural production on a pattern that would guide farmer to operate at least cost and high profit combination. The present study mainly concerned to find out technical efficiency and resource use efficiency in gram production. The methodology adopted for present study is described here under following major points.

3.1 Selection of study area

The present study was carried out in Amravati division of Vidarbha region of Maharashtra state where the gram is commonly grown as *rabi* season crop. Amravati division comprises the five districts namely Akola, Amravati, Washim, Buldhana and Yavatmal.

3.2 Period of study

The data pertaining to *rabi* season of 2011-12 was considered for present investigation.

3.3 Source of data

The data of 75 cultivators were collected and compiled from Agriculture Prices and Costs Scheme (APC) of the Department of Agricultural Economics and Statistics, Dr. PDKV, Akola was utilized for present study. Information of recommended technologies of gram crop was collected from Dr. PDKV, Dairy (Krishi Sanvadini 2012).

The farmers selected from the Amravati division are as bellow-

Sr. No.	District	No. of Gram growers
1	Buldhana	14
2	Akola	18
3	Amravati	16
4	Yavatmal	13
5	Washim	14
6	Total (Amravati division)	75



Fig.1. Map of Amravati Division

3.4 Analysis of data

Analytical tools and techniques

The methods of analysis adopted in the present study are elaborated under the following headings,

1. Socio-economic characteristics
2. Level of input utilization
3. Measures of efficiency

3.4.1 Socio-economic characteristics

The socio-economic characteristics of the selected farmers were studied by examining the following attributes,

- Family size
- Educational pattern
- Land utilization pattern
- Cropping pattern

3.4.2 Level of input utilization

Simple tabular analysis was employed for finding the input use level in gram production.

3.4.3 Measures of efficiency

Technical efficiency, Allocative efficiency, Economic efficiency and Resource use efficiency.

i) Technical Efficiency

One of the objectives i.e. to estimate the technical efficiency in gram was evaluated by using Stochastic Frontier Production Function. Farrell (1957) in his seminar paper elaborated the concept of technical efficiency. It involves the farms ability to obtain the maximum obtainable output from a given set of resources.

A Frontier Production Function represents a maximum attainable output for any given set of inputs setting a limit or Frontier on the observed values of output in the sense that no observed value of the output is expected to lie above the production function. Any deviation of a farm from the Frontier indicates the extent of farms inability to produce maximum output from the given set of inputs and they represent the degree of technical efficiency.

Usual production functional approach for studying the resource use efficiencies assumes technical efficiencies across the farms. This

assumption is far away from reality, as we observed that two farmers applying same quantities of inputs achieve different productivities. Considering all other factors constant, the differences can be attributed to difference in adoption of technologies which are termed as technical efficiencies of the farms or farmers (Kalirajan 1990).

As indicated earlier the introduction of technical efficiency in the studies of resource use efficiencies is of the recent origin. Frontier Production Function approach is being used in these days for studying technical efficiencies. Among three categories of Frontier Function namely, deterministic, probabilistic and stochastic Frontier Function. The latter one was considered for the present investigation to assess present technical, allocated and economic efficiencies of the farm of the resources under study.

The Frontier Production is defined as the relationship that describes the maximum possible output for the given combinations of inputs. A Production Function estimated by the Ordinary Least-Squares (OLS) method shows an average response and does not represent the Frontier. Farrell (1957) used the deterministic approach in which he estimated a cost Frontier by using Linear Programming (LP), requiring all observations to lie on or above the cost Frontier.

Aigner and Chu (1968) transformed Farrell's cost Frontier into production Frontier. They observed all observations to lie on or below the production Frontier. Since, the outliers under a deterministic approach affect the results, Timmer (1971) converted the deterministic Frontier into a probabilistic Frontier function. This approach deletes outlier observations or extreme observations until the estimated coefficients are stabilized.

Aigner, Amemiya and Poirier (1976) and Aigner, Knox Lovell and Schmidt (1977) have suggested statistical model for production function that permit output observation to lie above the production function.

The random errors in the Aigner, Amemiya and Poirier (1976) model are mixture of positive and negative truncated normal random variables. The Aigner, Knox Lovell and Schmidt (1977) model is discussed below, although a slight re-parameterization was suggested for estimation purposes.

The Production Frontier Model

The statistical model for the production function that we consider is defined by.

$$Y_t = X_t \beta + E_t, t = 1, 2, \dots, T \quad (1)$$

Such that,

$$E_t = U_t + V_t, t = 1, 2, \dots, T \quad (2)$$

Where,

$Y_t = t = 1, 2, \dots, T$, are observable random variables that are output values.

$X_t, t = 1, 2, \dots, T$ are $(1 \times k)$ vectors of non-negative constants that are input values such that the first element of X_t is one and $\left[\sum_{t=1}^T X_t' X_t \right]$ is nonsingular.

β is a $(k \times 1)$ vector of unknown constants;

U_t , and $V_t, t = 1, 2, \dots, T$. are unobservable random errors that are independently distributed.

The random errors, $U_t, t = 1, 2, \dots, T$ in (2) are assumed to be negative and arise by truncation of the normal distribution with mean zero and positive variance s^2u whereas the random errors, $V_t, t = 1, 2, \dots, T$, are assumed to have a normal distribution with mean zero and positive variance s^2v . The density function for U_t is defined by,

$$f_{ut}(u_t) = 2(2\pi s^2u)^{-1/2} \exp\left[-\frac{1}{2} \left(\frac{u_t}{s^2u}\right)^2\right], \text{ if } u_t < 0 \\ = 0, \text{ if } u_t \geq 0 \quad (3)$$

The negative error, U_t in the model is interpreted with reference to a farmer technical efficiency of production, while the symmetric error, V_t , which can be considered 'measurement error', is associated with uncontrollable factors related to the production process. The presence of the error, V_t , implies that the output value $x_t \beta + U_t$ is not observable.

If the random errors, V_t , are absent from the error model (2), then the model obtained is that considered by Aigner and Chu (1968), which we call the full Frontier model. In this case the range of the dependant random variable depends on the β parameter.

i.e. $y_t = x_t \beta, t = 1, 2, \dots, N$

If the random errors, U_t are the absent from the model (2), then the model obtained is called 'average-frontier model' the one most often estimated econometric studies for the production function (1) having errors, $E_t = V_t$, $t = 1, 2, \dots, T$, the expectation of the output observations for a given vector of input values. x_t is $x_t \beta$, and under the stated assumptions the output observations exceed the expectation with probability 0.5.

The production function (2), in which the variances s^2_u and s^2_v are positive, is referred to in this paper as the 'Pseudo-frontier model'. The average and full-frontier models are limiting cases to Pseudo-frontier model.

The density function for the observable random variable, Y_t , is given by,

$$f_{Y_t}(y_t) = f_{E_t}(y_t - x_t \beta) \dots\dots\dots (4)$$

Where, $f_{E_t}(\cdot)$ denotes the density function for E_t is obtained from the given density function U_i and V_i by the change of variable technique that involves a straight for word but somewhat tedious exercise in integration. That is, by the transformation $E_t = U_i + V_i$ and (say) $W_t = V_t$, where $E_t < W_t$, the joint density function for E_t and W_t , evaluated at E and W_i is the product of the marginal density function for U_t and V_t evaluated at $e_t - w_t$ and w_t , respectively. Thus the density function for E_t is defined by

$$f_{E_t}(e_t) = \int_0^{e_t} f_{U_t}(e_t - w_t) f_{V_t}(w_t) dw_t \dots\dots\dots (5)$$

Where, $f_{U_t}(\cdot)$ is defined by (3) and $f_{V_t}(\cdot)$ is the density function for the normal distribution with mean zero and variance s^2_v . the solution to the integral function (5) is given by

$$f_{E_t}(e_t) = 2 [1 - \Phi(e_t / s)] (2\pi s^2)^{-1/2} \exp(-1/2 e_t^2 / s^2) \dots\dots\dots (6)$$

Where, $s^2 = s^2_u + s^2_v$ and $\Phi(\cdot)$ denotes the distribution function for the standard normal random variable,

$$\text{i.e. } \Phi(z) = \int_{-\infty}^z \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2t^2}\right) dt$$

Equations (4) and (6) imply that the density function for y_t can be expressed by

$$f(y_t) = 2 [1 - \Phi(z_t)] (2\pi s^2)^{-1/2} \exp[-1/2 (y_t - x_t \beta)^2 / s^2] \quad \dots\dots\dots (7)$$

Where,

$$z_t = [(y_t - x_t \beta) / s] [\tau / (1 - \tau)]^{1/2} \quad \dots\dots\dots (8)$$

And

$$\tau = s^2 u / s^2 \quad \dots\dots\dots (9)$$

The expression for the density function for y_t , given by (9), is not identical to the given by Aigner, Knox Lovell and Schmidt (8) in that the later authors express the density function in terms of $\tau = s_u / s_v$ instead of τ . The parameter τ is bounded between zero and one, whereas the parameter τ can be any real positive number. We suggest that estimation of the model in terms of the formulation (7) - (9) is computationally preferable.

It is noted that if variance $s^2 u$ approaches zero, then the variable z_t approaches zero and so the factor $2 [1 - \Phi(z_t)]$ in (7) approaches one. In this case the density function for y_t approaches that of a normal distribution with mean $x_t \beta$ and variances $2 = s^2 v$. This is the density function for the average frontier model'. If, however, the variance $s^2 v$ approaches zero then the variable z_t approaches minus infinity and the factor $2 [1 - \Phi(z_t)]$ in (7) approaches two. In this case the density function for y_t approaches that of the truncated normal distribution that is obtained from (3) by substituting $y_t - x_t \beta$ for u_t .

It should be noted that the parameter $s^2 u$ is not the variance of negative error, U_t . It can be shown that $E(U_t) = (2 s^2 u / \pi)^{1/2}$ and $Var(U_t) = s^2 u (\pi - 2) / \pi$. It therefore follows that the expectation and variance of y_t , in terms of our parameterization of the model are

$$E(y_t) = x_t \beta - (2\tau s^2 / \pi)^{1/2} \text{ and } Var(y_t) = s^2 (\pi - 2\tau) / \pi$$

The primary advantage of Stochastic Frontier Production Function is that it enables one to estimate U_t , and therefore also to estimate farm specific technical efficiencies. The measure of technical efficiencies is

equivalent to the ratio of production of the i th farm to the corresponding production value if the farm effect U_i were zero.

Following Battese and Colli (1988), when output is measured in logarithms, the farm specific technical efficiency can be estimated as,

$$TE_i = \exp(-u_i) \dots\dots\dots (10)$$

$$i = 1, 2, \dots, n, 0 = TE = 1$$

The variance ratio r , explaining the total variation in output from the frontier level of output attributed to technical efficiencies, can be computed as,

$$r = s^2_u / s^2_e$$

Model Specification

Technical Efficiency of different resources will be worked out using the Stochastic -frontier production function.

The Stochastic frontier, assuming a Cobb-Douglas specification, can be written as,

$$\text{Log } y_i = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + \beta_6 \log X_6 + u_i$$

Where,

$$i = 1, 2, \dots, n$$

y_i = Output of gram crop (qts).

x_1 = Human labour, including family labour and hired human labour (days/ha).

x_2 = Bullock labour including owned and hired bullock labour (days/ha).

x_3 = Machine labour including owned and hired machine labour (hrs/ha)

x_4 = Seeds including owned and purchased for sowing of crops in (kg/ha)

x_5 = Nitrogen fertilizers applied in the farm in (kg/ha)

x_6 = Phosphorous fertilizers applied in the farm (kg/ha)

u_i = Farm specific technical efficiency related factor and

From the residual, using the equation (3), the farm specific technical efficiencies were estimated.

The parameters of the model were estimated by the method of maximum Likelihood Estimates (MEL).

ii) Allocative Efficiency

The allocative efficiency defined in terms of profit maximization, T.W. Schultz's hypothesis that "there are comparatively few significant inefficiencies in the allocation of factors of production in the traditional agriculture" Given the technology, allocative efficiency refers to the achievement of optimum output so as to maximize profit or net income.

The allocative efficiency can be calculated using following formula.

$$\text{Allocative efficiency (A.E.)} = \frac{Y_0}{Y_E}$$

Where,

Y_0 = Observed maximum yield, among all the farmers.

Y_E = Estimated yield or potential output at the levels of inputs used by cultivators who obtained maximum yield.

iii) Economic efficiency

Economics in many ways a science of efficiency. The policy implications of economic efficiency permeate both the micro and macroeconomic level. Suppose for example, that we can measure the efficiency of small and large farms. We can then determine by how much a given set of farm could be expected increase its output through appropriate reorganization without absorbing additional resource in the aggregate.

Farrell (1957) divided the measure of economic efficiency in to two components, namely 'Technical efficiency' and 'Allocative efficiency'. Technical efficiency refers to the proper choice of production function among all these actively in use by farms in the agriculture.

The measures of technical efficiency of each farmer were averaged over number of observation to reach a single value of each farmer's technical efficiency. Allocative efficiency refers to the proper choice of input combinations. Economic efficiency combines both technical and Allocative efficiency.

iv) Resource Use Efficiency

In present investigation we use the following double log type Cobb-Douglas type of production function -

Cobb-Douglas Production Function

In today's world problems, both economical and social, resource and the resource efficiency play a vital role. The investors have been concerned with increasing productivity of resources by introduction of new ones that lie higher technologies. By replacing the existing production function by new ones that lie higher in output, plane, it is hoped, that this investment leads to production of more output from the same quantity of inputs, or to the same outputs from few inputs (there by releasing resource for other economic activities).

The more important statistics to be presented for each function are noted below. Based on empirical studies conducted in passed by several research workers have selected Cobb-Douglas Production Function for examining resource use efficiencies.

Shankhayan (1988) illustrated the power production function is a non linier production function which is more commonly known as Cobb-Douglas Production Function, after the names of persons who first applied it for empirical estimation , using the time series data pertaining to the American manufacturing industries over the period 1899-1922. The Cobb-Douglas Production Function in the economic analysis of problems relating to empirical estimation in agriculture and industry. In the present investigation also following double-log type of Cobb-Douglas Production Function was considered.

$$Y = a_0 x_1^{a_1} x_2^{a_2} \dots x_n^{a_n}$$
$$= a_0 \prod_{i=1}^n x_i^{a_i} \quad (1) \quad (i = 1, 2, \dots, n)$$

Here, y and x_i ($i = 1, 2, \dots, n$) are the levels of output and inputs.

The constants a_0 and a_i ($i = 1, 2, \dots, n$) represent the efficiency parameter and the production elasticities of the respective input variables. The estimating forms of equations corresponding to (1) are

$$\log y = \log a_0 + \sum_{i=1}^n a_i \log x_i \quad i = 1, 2, \dots, n \quad \dots \dots (2)$$

The Cobb-Douglas type of Production Function was used and is usually defined as follows.

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e^u \dots\dots\dots (3)$$

Where,

- Y = Output of gram crop (qtls. /ha).
- a = Constant term, the efficiency parameters.
- X1 = Human labour, including family labour and hired human labour (days/ha).
- X2 = Bullock labour including owned and hired bullock labour (days/ha).
- X3 = Machine labour including owned and hired machine labour (hrs/ha)
- X4 = Seeds including owned and purchased for sowing of crops in (kg/ha)
- X5 = Nitrogen fertilizers applied in the farm in (kg/ha)
- X6 = Phosphorous fertilizers applied in the farm (kg/ha)
- u = is random variable satisfying necessary assumptions required for the principles of ordinary least squares.

The function given in eq.n (3) can be expressed as,

$$\log y = \log a + b_1 \log x_1 + b_2 \log x_2 \dots\dots\dots b_n \log x_n + u \dots\dots\dots(4).$$

So that, parameters can be estimated by the method of least square. The function was fitted and examined.

1. The adjusted coefficient of multiple determinants R^2 .
2. Significance of regression coefficients and
3. Other economic considerations like the signs and magnitudes of the coefficients, yielding meaningful results.

Elasticity of Production w.r.t.x:

The Elasticity of Production w.r.t. any variable input say x_i can be obtained from (1) as,

$$Ep_i = \frac{\partial y}{\partial x_i} \frac{x_i}{y} = a_i \dots\dots\dots (5)$$

Thus, it may be observed that the power of respective input variable directly gives the elasticity of production w.r.t. i. The elasticity coefficient w.r.t. to each of the input variable are, therefore, constant,

irrespective of the input or output levels. In recent times some efforts have been made to overcome this limitation of the Cobb-Douglas production function.

Marginal Value Productivity (MVP):

The estimated production function underlying crop-production enables us to evaluate the efficiency of prevalent factor proportions.

The MVP was computed by the multiplying the coefficients of the given resource with ratio of the geometric means of the output to the geometric mean of the given resource. For example, the MVP of X_i would be,

$$MVP(X_i) = b_i \frac{Y(G.M.)}{X_i(G.M.)} \dots\dots\dots (6)$$

Where,

G.M. = Geometric Mean.

MVP = Marginal Value Productivity.

b_i = is the corresponding elasticity X_i .

X_i (G.M.) = is the geometric mean of i th resources.

Y (G.M.) = is the computed value of Y at Geometric mean levels of resources.

By comparing the respective input prices with their marginal values, farmers can decide as to whether they should increase or decrease the level of use of that, particular input of products.

Returns to Scale:

The returns to scale can be easily estimated from this type of production function.

Thus, Returns to Scale = $a_1 + a_2 + \dots + a_n$
 $= \sum_{i=1}^n a_i = 1, 2, \dots, n \dots\dots\dots (7)$

Therefore, the summation of the powers of all the input variables provided us directly with a ready estimate of the returns to scale as also the degree of homogeneity of the production function. The returns to scale are decreasing, constant or increasing, depending on whether a_i is less than, equal to or greater than one.

CHAPTER IV

RESULTS AND DISCUSSION

4.1. Socio-economic characteristics of the selected Gram growers.

The selected gram growers have been classified according to the various attributes of the study such as, family size, educational pattern, land use pattern and cropping pattern were studied and presented in this section.

4.1.1. Family size of the selected Farmers.

The family size and its composition are basically the functions of economic and social characteristics, customs and religious belief of the society. It is essential to study the average family size to get an idea about labour force available for farm operations from the family. The details of the average size of family of the sample under study is presented in Table 4.1

Table No. 4.1: Average Family size of the selected farmers.

Sr. No	Age Group	Members	Percent to total
1	Male	3	50.00
2	Female	2	33.33
3	Children	1	16.67
	Total	6	100.00

It is revealed from the Table 4.1 that the family pattern is dominated by the male with single children per family. The member of male per family was 3(50 per cent) followed by female 2(33.33 per cent) and children 1 (16.66 per cent). Indicating that the rurals are also moving towards the nuclear family.

4.1.2 .Educational Status of the selected Farmers.

Education is said to be the third eye of person as it gives foresight in building up carrier and life line. The selected gram growers have been classified on the basis of educational level as the education has not yet reached to the grass root level and most of the citizens residing in village have not yet achieved the desired educational level as of graduate of any faculty.

Education is an important factor in understanding importance and availability of new technology and its adoption. It is also one of the important aspects which affects standard of living of the farmers. The results of the educational status of the selected farmers were presented in Table 4.2.

Table No: 4.2: Educational Status of the selected farmers.

Sr. No.	Educational level	Selected Farmers	Percent
1	Illiterate	7	9.33
2	Primary(1st to 4th std)	11	14.66
3	Secondary(5th to 7th std)	18	24.00
4	High School(8th to 12 th std)	23	30.66
5	Collegiate(above 12th)	16	21.33
	Total	75	100.00

It is observed from the Table 4.2 that picture of education pattern in the era of the information technology, from the above table the highest percentage of the education level of the Gram growers was high school level 30.66 percent .It is followed by secondary school level i.e. 24.00 percent.

The percentage of illiterate farmers was 9.33 percent and the grower educated up to the collegiate level was 21.33 percent. This indicating need of emphasis on farmers education for implementing modern technologies on farm and farm mechanization.

4.1.3. Land utilization pattern of the selected farmers.

Land utilization indicates the area of land actually utilize for different purposes like crop production, irrigated area, unirrigated area, net sown area and current fallow land etc. Table 4.3, represents the land utilization pattern of the selected farmers.

Table no. 4. 3: Land utilization pattern of the selected farmers.

(Area in ha)

Sr. No	Particulars	Area	Percent to C.G.A
1	Average land holding	2.23	70.21
2	Fallow land (current)	0.02	0.62
3	Net cropped area	2.19	68.86
4	Area sown more than once	0.95	29.87
5	Irrigated area	1.06	33.33
6	Unirrigated area	1.17	36.79
7	Gross cropped area	3.18	100
8	Cropping intensity (per cent)		142.60

It is observed from the Table 4.3 that, the sample of selected gram growers as a whole, the average land holding of the gram growers was 2.23 ha, which is 70.21 percent of the gross cropped area. The average gross cropped area was 3.18 hectare and the net cropped area was 2.19 hectare.

It is further confirmed from the table that the average irrigated area of selected gram growers was 1.06 hectares. The area sown more than once was 0.95 hectares.

The fallow land of the selected farmers is relatively less than the holdings which about 36.79 per cent. The proportion of unirrigated area to gross cropped area was 1.17 hectare. The cropping intensity of the selected farmers was 142.60 per cent.

4.1.4 Cropping pattern of the selected farmers:

Cropping pattern of the selected farmers is said to be the result of past experience of farming, the type of soil available, irrigation resources and the pattern of distribution of rainfall. The average cropping pattern of the selected farmers is presented in Table 4.4.

Table No.4.4: Cropping pattern of the selected farmers.

(Area in ha)

Sr. No	Crop	Per ha. Area	Percent to GCA
1	Kharif Jowar	0.217	06.82
2	Rabi Jowar	0.087	02.73
3	Wheat	0.451	14.18
4	Bajra	0.081	02.54
5	Maize	0.062	01.94
6	Other cereals	0.021	00.66
	Total cereals	0.919	28.90
7	Tur	0.080	02.51
8	Gram	0.944	29.68
9	Udid	0.037	01.16
10	Moog	0.053	01.66
11	Other Pulses	0.050	01.57
	Total pulses	1.164	36.60
12	Soybean	0.300	09.43
13	Sunflower	0.021	00.66
14	Groundnut	0.058	01.82
15	Other Oilseeds	0.003	00.09
	Total Oilseeds	0.382	12.01
16	Cotton	0.715	22.48
	Gross Cropped Area	3.18	100.00

The results of the average cropping pattern are presented in the Table 4.4, which reveals that the area under pulses is relatively higher (36.60 per cent) than the area remaining under other crops. Gram crop is the major crop grown in selected area of rabbi season.

The percentage area under gram crop to gross cropped area was highest i.e. 29.68 and other pulses like Tur, Moog, Udid which contributes 2.51, 1.66, and 1.16 respectively. In Cereals i.e. Wheat, Kharif Jowar, Rabi Jowar, Bajra and Maize occupied an area 14.18, 06.82, 02.73, 2.54, and 1.94 per cent to the gross cropped area respectively.

Among the oilseed crops soybean is the most preferred and bagging more than 9.43 per cent area to the gross cropped area. The total area under selected oilseeds was 12.01 per cent.

Next important crop was cotton which has occupied 22.48 per cent area to the gross cropped area. The study on cropping pattern thus shows that the farmers followed diversified cropping pattern. This could be reducing risk and uncertainty arising due to climatic condition.

4.1.5 Cost of cultivation of gram grown by selected farmers:

The cost of different inputs on per hectare basis for the Gram crop was estimated. Net returns per hectare and capital efficiency expressed in the form of output-input ratio is given in the Table 4.5

The costs of different inputs on per hectare basis for Gram crop were estimated. It can be seen from the Table 4.5 that per hectare total cost of cultivation of Gram crop was Rs.24413.70.

The main input of the cost were human labour and rental value of land constituting 25.05 and 21.83 percent to total cost (cost C) respectively. The other important inputs were machine labour (hrs) and bullock labour accounting 19.85 and 9.26 percent respectively.

The cost A which corresponds to direct expenses was found to be Rs.15772.01 constituting 64.60 percent of total cost and the Output-Input ratio at cost C was 1.32, it is found that the crop was profitable.

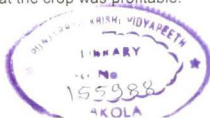


Table 4.5: Per hectare cost of cultivation of Gram.

					(Rs/ha)
Sr. No.	Particular	Unit	Quantity	Value	Percentage
1	Hired human labour				
	Male	Days	18.23	1626.72	6.66
	Female	Days	28.49	2542.16	10.41
2	Bullock labour	Pair days	10.54	2261.64	9.26
3	Machine Hrs.	Hours	66.93	4847.97	19.85
4	Seed	Kg	74.87	2226.43	9.11
5	Manures	CL	-	-	
6	Fertilizers				
	N	Kg	23.27	438.51	1.79
	P	Kg	50.78	909.55	3.72
	K	Kg		---	
7	Plant protection	Rs	-	510.42	2.09
8	Land revenue and ceases	Rs	-	35.69	0.14
9	Depreciation	Rs	-	470.24	1.92
10	Threshing	Rs	-	550.81	2.25
11	Transportation	Rs	-	720.75	2.95
12	Miscellaneous	Rs	-		
13	Interest on W.C. @ 6 % per annum	Rs	-	892.75	3.65
	Total cost A	Rs	-	15772.01	64.60
14	Rental value of land	Rs	-	5329.68	21.83
15	Interest on fixed capital @ 10%	Rs	-	1360.52	5.57
	Total cost B	Rs	-	22462.21	92.00
16	Family human labour				
	Male	Days	10.26	915.49	3.74
	Female	Days	11.62	1036.85	4.24
	Total cost C	Rs	-	24413.70	100.00
17	Production	Quintals	16.01	32271.58	
	Net Returns				
18	Net Returns at Cost A			15606.82	
19	Net Returns at Cost C			7857.88	
	Output – Input ratio at				
20	Cost A			1.93	
21	Cost C			1.32	

Note: figures in parenthesis indicate percentage to total cost (cost C).

4.2. Resource utilization:

Per hectare input used by the Selected Farmers were presented in Table 4.6.

Table 4.6: Per hectare input used by the Selected Farmers.

Sr. No	Inputs	Per ha. Quantity of inputs
1	Seed (kg)	74.87
2	Human labour (days)	68.60
3	Machine labour (hrs)	66.93
4	Bullock labour (days)	10.54
5	Nitrogen fertilizer (kg)	23.27
6	Phosphorus fertilizer (kg)	50.78

From the above table it is revealed that the seed rate applied by the selected farmers was (74.87) which is almost same as that of recommended level (60 to 115 kg/ha). The human labour used by the selected farmer's was 68.60 days per hectare and bullock labour used by the selected farmer's was 10.54 days per hectare. The costly input of machine labour is used optimistically by almost all selected farmers was (66.93 hrs).

The use of Nitrogenous fertilizers was (23.27 kg/ha) which also found to be slightly lower than the recommended level (25 kg/ha), and the use of Phosphorus was approximately same level as recommended (50 kg/ha). It clearly indicated that farmers are not conscious in use Human labour, Machine labour and bullock labour which has caused increase in production cost.

4.3 Technical Efficiency:

Technical efficiency is a measure to quantify the extent of entrepreneur's success to attain to maximum attainable produce from a given set of inputs and given level of technology. It was estimated by using stochastic frontier production function. When output is measured in logarithms, the farm specific technical efficiency can be estimated as

$$Te_i = \text{Exp}(-u_i)$$

$$i = 1, 2 \dots n, 0 = TE = 1$$

The method of maximum likelihood estimate (MLE) is adopted for estimation of parameters of frontier production function.

As described in methodology, allocative efficiency was estimated by formula,

$$A.E. = \frac{Y_0}{Y_E}$$

Where,

A.E. = Allocative efficiency.

Y_0 = Observed maximum yield, among all the farmers.

Y_E = Estimated or potential output at the levels of inputs used by cultivators who obtained maximum yield.

Now, multiplying technical efficiency with allocative efficiency, the economic efficiency can be calculated as,

$$EE = T.E. \times A.E.$$

The Maximum Likelihood Estimates (MLE) of the parameters of Stochastic frontier Cobb-Douglas Production function of gram crop are presented in Table 4.7.

Table 4.7: Maximum Likelihood Estimates of Cobb- Douglas Stochastic Frontier Production Function of Gram crop in Amravati division.

Dependent variable : log y		
Sr. No.	Explanatory variables	β_i
1	Constant	-3.818605
2	Log seed rate	0.541699***
3	Log human labour	0.059582**
4	Log machine labour	0.044570**
5	Log bullock labour	0.055312**
6	Log nitrogen	-0.312013***
7	Log phosphorous	0.140087***
Log Likelihood		68.97
		$\lambda=28.19(0.01)$
Variance of u		$s = 0.67(3.87)$
Variance of v		$s^2u=0.048$
		$s^2v=0.019$
Average technical efficiency		0.82 (82 percent)

***Significant at 1% level of significance

**Significant at 5% level of significance

It is revealed from the Table 4.7, that all the selected variables contributing to Gram production, except of Nitrogen fertilizer. Logarithmic values of Seed, Human labour, Bullock labour, Machine labour and Phosphorus fertilizer are found to be significantly contributing to yield. The result of production function analysis indicated that, the almost all variables who contributed in gram production could explain maximum contribution.

The index of technical efficiency level for each individual farm e^u is calculated by estimating the one-sided error component u_i . The frequency distributions of these efficiencies for all the selected farmers are presented in Table 4.8.

Table 4.8: Frequency distribution of sample technical efficiency for 75 individual cultivators of Gram crop in Amravati division

Efficiency index (per cent)	Number of cultivators
1.00-10.0	-
11.0-20.0	-
21.0-30.0	-
31.0-40.0	-
41.0-50.0	-
51.0-60.0	-
61.0-70.0	11 (14.66)
71.0-80.0	16 (21.33)
81.0-90.0	40 (53.33)
91.0-100.0	08 (10.66)
Total	75 (100)
Technical efficiency	0.82 (0.18)*
Allocative efficiency	0.90(0.10)*
Economic efficiency	0.74 (0.26)*
Maximum of technical efficiency among selected farmers	93 %
Minimum of technical efficiency among selected farmers	61 %

Note: Figures in parentheses indicate percentage of farmers to total farmers.
* Figures in parentheses indicate inefficiency levels.

The result indicates the variation of technical efficiency in the range of 60-100 per cent across all the individuals' cultivators. The maximum

and minimum technical efficiencies in the selected samples where 93 per cent and 61 per cent respectively.

In our sample of 75 cultivators, 08 (10.66 per cent) had a technical efficiency in the range of 91 to 100 per cent. Nearly about 40 (53.33 per cent) of the total sampled farmers exhibited technical efficiencies in between 81 to 90 per cent.

Remaining other samples, 16 (21.33 per cent) and 11 (14.66 per cent) had a technical efficiency in the range of 71 to 80 and 61 to 70 per cent respectively. The average technical efficiency for the entire sample of farmers is 82 per cent, indicating the presence of 18 per cent inefficiency. It implies that there is scope to increase the productivity of the farmers to the extent of 18 per cent, if the gap between technology adopted and the technology recommended is minimized.

There prevails an allocative inefficiency to the extent of 18 per cent among average farmers in comparison with the "Best Farmers" who obtained maximum yield. It's important implication is that an average farmer's productivity can be increased to the extent of 18 per cent of his prevailing productivity is being pursued to follow the resource allocation pattern followed by the best farmers. As regards economic efficiency, it can be concluded that 26 per cent farmers are economically inefficient. It implies that there is scope to increase the 26 per cent economic efficiency of the selected gram growers.

4.4 Resource Use Efficiency

Without having the functional analysis and estimating the marginal value productivity (MVPs) the existing levels of inputs, one cannot come to the conclusion that whether the input is being over-used or under-used in production and also the contribution of different resources in the production of gram crop.

For this purpose, as mentioned earlier, the Cobb-Douglas type of production function was fitted to the data and estimates of the elasticities of different inputs are obtained and the same are presented in Table 4.9.

Table 4.9: Coefficients of different input use in gram production.

Sr. No.	Input	Coefficient
1	Constant	-3.81
2	Seed rate	0.54***
3	Human labour	0.05**
4	Machine labour	0.04**
5	Bullock labour	0.05**
6	Nitrogen Fertilizer	-0.31***
7	Phosphorous Fertilizer	0.14***
8	R ²	0.70***
9	Returns to Scale	0.52(sum of elasticity's)

***Significant at 1 per cent level.

**Significant at 5 per cent level.

It can be observed from the above Table 4.9 that seed rate, human labour, machine labour, bullock labour and phosphorous fertilizers, had the elasticity of 0.54, 0.059, 0.044, 0.055, and 0.14 respectively and were statistically significant. This means that one per cent increase in investment on these resources would contribute that percentage increase in gram yield. The values of the elasticity's of these variables reveal further scope for utilization of these inputs.

The coefficient of nitrogen fertilizer (-0.31) was negative and statistically significant and indicated that an increase in nitrogen fertilizer will not significantly effect the gram yield.

The return to scale was less than unity (0.52) indicating decreasing returns to scale. The coefficient of determination (R²) gives an idea about the proportion of the total variation in yield explained by the selected variables. For Gram crop the value of R² was 0.70 this has indicated that the selected variables contribute to the extent of 70 per cent of the total variation in gross returns.

4.5: Geometric mean level and Marginal Value Productivity (MVP).

The result of production function analysis in terms of Geometric mean level and Marginal Value Productivity are presented in Table 4.10.

Table 4.10: Geometric mean level and Marginal Value Productivities of selected inputs.

Sr. No.	Inputs	Geometric mean level	MVP
1	Seed rate	1.93	4.39
2	Human labour	1.82	0.43
3	Machine labour	1.69	0.37
4	Bullock labour	0.90	0.87
5	Nitrogen Fertilizer	1.36	-3.57
6	Phosphorous Fertilizer	1.70	1.29

It is observed from the Table 4.10, that the MVPs of Seed rate (4.39) and Phosphorus fertilizer (1.29) shows more than unity level, which indirectly implies the profitable economic returns on investment made on these resources.

The MVP value for human labour (0.43), Machine labour (0.37) and Bullock labour (0.87) were found to be less than unity level. It could be inferred that, the use of these inputs should be reduced. In respect of Nitrogen fertilizer the MVP value was negative (-3.57). The use of nitrogen fertilizer is less than recommendation, hence the level of use of Nitrogen fertilizer would be curtailed so as to maximize the returns.

CHAPTER V

SUMMARY AND CONCLUSIONS

Agriculture being a typical industry in which the production decisions are mainly based on the agro-climatic conditions of the area. It is the well known fact that the agro-climatic condition differ from area to area and as such the finding of research in one region may not be fully applicable to other region resource allocation is the important factor problem in farm management more ever the optimum allocation of resources which are scare in nature directly affect the welfare of society. Studies on technical efficiency and resource use efficiency are important in various contexts result of such studies help the policy maker to formulate e policies concern in increasing in agricultural production. The studies also find out the lacuna in the present agriculture production system and suggest the ways to overcome same.

The present study was an attempt to study the technical efficiency and resource use efficiency in gram production of Amravati division in Vidarbha region of Maharashtra State. Considering economic importance of gram attempts are being now made to bring more area under its cultivation in rabbi season. Moreover it must be taken into account that gram has proved its profitability over other many crops. One more important characteristics of this crop is that, it is short duration crop hence it becomes possible for farmers to take next crop and utilize available soil moisture.

Vidarbha region is mostly rainfed area. Based on the studies conducted in passed the hypothesis of the preset study was that , under existing resource use pattern the resources are not used optimally or not to their fullest efficiency by the farmers and there is a need for adjustment in the existing resource levels for profit maximization. The specific objectives of the study were:

1. To study the socio economic characteristics of selected farmers.
2. To study the level of input use in gram production.
3. To estimate the technical efficiency and resource use efficiency in gram production.

For the present study the data collected from agriculture price cell (APC) scheme located in the Department of Agriculture Economics And Statistics, PGI, Dr. PDKV, Akola. The data was collected for the year 2011-12. For this purpose a sample of 75 cultivators were collected for the study. The simple tabular analysis was carried out to accomplish the socio-economic characteristics of selected farmers and level of input use in gram production. While, the Stochastic frontier assuming a Cobb-Douglas production function was used to study the technical and resource use efficiency.

The average family size of holding as a whole was worked out of the selected farmers was 6 members per family. The number of male per family was 3 and followed by female was 2. The average number of children's per family was 1.

In case of educational status of selected gram growers was, the highest percentage of the educational level was high school level i.e. 30.66 per cent. It is followed by secondary school level and the percentage of illiterate was 9.33 per cent.

The average size of land holding of the selected gram growers was 2.23 hectare. The net cropped area was 2.19 hectare and area under irrigation was 1.06 hectares i.e. 33.33 per cent of gross cropped area. The area sown more than once was 0.95 hectare. The average gross cropped area of the selected gram growers was 3.18 hectares with cropping intensity 142.16 per cent.

The cropping pattern of the selected gram growers, it illustrated that the share of pulses was higher in the total cropped area i.e. 36.60 per cent it followed by cereals and oilseeds. Among the pulses share of gram crop was highest i.e. 29.68 per cent.

Per hectare input utilisation for gram production as a whole was observed. It is revealed that the seed rate applied by the selected farmers was (74.87) which is almost same as that of recommended level (60 to 115 kg/ha). The human labour used by the selected farmer's was 68.60 days per

hectare and bullock labour used by the selected farmer's was 10.56 days per hectare. The costly input of machine labour is used optimistically by almost all selected farmers was (66.93 hrs).

The use of Nitrogenous fertilizers was (23.27 kg/ha) which also found to be slightly lower than the recommended level (25 kg/ha), and the use of Phosphorus was approximately same level as recommended (50 kg/ha). It clearly indicated that farmers are not conscious in use Human labour, Machine labour and bullock labour which has caused increase in production cost.

Studies on technical efficiency reveled that, the results of Gram crop indicate the variation of technical efficiency in the range of 61 to 100 percent across the all the individual gram cultivators. The minimum and maximum technical efficiencies in the selected sample were 61 percent and 93 percent respectively.

In selected sample of 75 gram cultivators, 08 (10.66 per cent) cultivators had a technical efficiency in the range of 91 to 100 per cent. Nearly about 40 (53.33 per cent) cultivators of the total sampled farmers exhibited technical efficiencies in between 81 to 90 per cent. Remaining other samples, 16 (21.33 per cent) cultivators and 11 (14.66 per cent) cultivators had a technical efficiency in the range of 71 to 80 and 61 to 70 per cent respectively.

The average technical efficiency for the entire sample of farmers is 0.82 i.e. 82 per cent, indicating the presence of 18 per cent inefficiency. It implies that there is scope to increase the productivity of the farmers to the extent of 18 per cent. The allocative inefficiency to the extent of 10 per cent among average farmers, in comparison with the "Best" farmer who obtained maximum yield. The average economic efficiency for the entire sample of selected gram growers is 74 percent, indicating the presence of 26 percent inefficiency. It implies that there is scope to increase the 26 percent economic efficiency of the selected gram growers.

Functional analyses of Gram crop revealed that the seed rate, human labour, machine labour, bullock labour and phosphorous fertilizers, had the elasticity of 0.54, 0.05, 0.04, 0.05, and 0.14 respectively and were statistically significant. This means that one per cent increase in investment on these resources would contribute that percentage increase in gram yield and the coefficient of nitrogen fertilizer (-0.31) was negative and statistically significant and indicated that an increase in nitrogen fertilizer will not significantly effect the gram yield.

The value of MVP in respect the seed rate (4.39) and Phosphorus fertilizer (1.29) shows more than unity level, which implies that the profitable economic returns on these resources and the MVP value for human labour (0.43), Machine labour (0.37) and Bullock labour (0.87) were found to be less than unity level. It could be inferred that, the use of these inputs should be reduced. In respect of Nitrogen fertilizer the MVP value was negative (-3.57). Hence the level of use of Nitrogen fertilizer would be curtailed so as to maximize the returns.

CONCLUSIONS

Following conclusions are emerged from the present study.

1. The study concluded that the average family size of the selected farmers was 6 persons per family with the educational background of family need, up to collegiate for 21.33 per cent and for about 30.66 per cent farmers up to high school and 9.33 to 14.66 per cent illiterate to primary school level.
2. Land use pattern study indicated that the average land holding of the Gram growers was 2.23 ha, which is 70.21 percent of the Gross Cropped area. The average Gross cropped area was 3.18 hectare and the net cropped area was 2.19 hectare.
3. Cropping pattern study concluded that the area under pulses is relatively higher (36.60 per cent) than the area remaining under other crops like oil seed crops, cereals and cotton. Gram crop is the major

crop of selected area grown in rabbi covers 29.68 percent of Gross cropped area.

4. The selected farmers in general have excessively use of human labour, machine labour and bullock labour in the farm of selected gram growers.
5. The average technical efficiency of selected gram growers was shows that 82 per cent. The average technical efficiency of the selected farmers was ranges between 61 to 92 per cent.
6. The average allocative efficiency of the selected gram growers was 90 per cent. The study implied that the output of average farmers could be increased by adopting the allocation of resources fallowed by the best practiced farmers.
7. The economic efficiency of selected gram rowers was 74 per cent .It reveals that there is a considerable scope to increase the productivity.
8. The MVPs of the seed rate and phosphorus fertilizer implies the profitable economic returns on investments on these resources.

CHAPTER VI

LITERATURE CITED

- Aigner, D.J. and Chu, S.F., (1968). On estimating the industry production function. *American Economics Review*. 58(4) : 826-839.
- Aigner, D., Amemiga, T. and D. Poirier (1976). On the estimation of production frontiers. *International Economic Review*. 17 : 377-396.
- Aigner, D., Lovell, Kand P. Schmidt (1977). Formulation and estimation of Stochastic frontier production function models. *J.Econometrics*. 6 : 21-37.
- Ashwthareddy, K.P.; K.S. Chandrashekar and, M.V. Srinivasgowda. (1997): Resource-use efficiency in groundnut production under rainfed conditions- A study in Challakere taluka of Karnataka. *Agricultural Situation in India*.53(12) : 829-831.
- Banik, A. (1994): Technical efficiency of irrigated farms in a village of Bangladesh. *Indian Journal of Agricultural Economics*. 49(1) : 70-77.
- Battese, G. and T. Coelli (1988). Prediction of Firm-level Technical efficiencies with a generalized frontier production function and panel Data. *J. of Econometrics*. 38 pp : 387-399.
- Chapke R.R.and J.S. Mishra (2011): Sorghum. Rice-fallows. Cobb-Douglas Production Function. Resource-use Efficiency .*Journal of Human Ecology* 34(2): 87-90.
- Dutta, K.K and P.K. Joshi, (1992): Economic efficiencies and Land Augmentation to increase Agriculture production: A comparative Analyses for Investment priorities, *Indian Journal of Agricultural Economics*. 47(3), July-Sept: 468-476.
- Ekanayake, S.A.B. And, S.K. Jayasuriya.(1987): Measurement of firm specific technical efficiency : A comparison of methods. *Indian Journal of Agricultural Economics*, 38(1):115-122.
- Ganesh, K. (2000): analysed resource use efficiency for mixed farming systems in Gazani lands of Karnataka, An economic analysis. M.Sc.(Agri.) Thesis, University of Agricultural Sciences, Dharwad.
- Jayaram, H.; G.S. Chandrashekhar, and Lalith Acoth, (1992): An economic analysis of technical efficiency in Rice cultivation in Mandya: Some issues in Resource Pricing Ind. *J of Agril. Econ*.47 (4): 677-682.

- Jyoti Kachroo; Arti Sharma and Dileep Kachroo (2010): Technical Efficiency of Dryland and Irrigated Wheat Based on Stochastic Model. : Agricultural Economics Research Review 23(2): 31-34.
- Kademani, Y.C. (1983): Economics of intercropping in Bijapur and Dharwad districts Karnataka State. M.Sc. (Agri.) Thesis, (Unpublished), University of Agricultural Sciences, Dharwad.
- Kalirajan, K.P.(1990). Rice production : An economic analysis. New Delhi. Oxford and IBH Publishing Co. Pvt. Ltd.:37-70.
- Kataula, S.S. (1993): Application Of Frontier Technology To Wheat Crop Grown On reclaimed lands. Indian Journal of Agricultural Economics, 48(3): 226-235.
- Koppad, M.B. (1993): Economics of cropping systems in Malaprabha Command Area (Karnataka State). M.Sc. (Agri.) Thesis, (Unpublished), University of Agricultural Sciences, Dharwad.
- Konstantinos Giannakas; Richard Schoney and Vangelis Tzouvelekas(2001): Technical Efficiency, Technological Change and Output Growth of Wheat Farms in Saskatchewan, Canadian Journal of Agricultural Economics .49(2): 135-152.
- Manjeet Kaur; Amrit Kaur Mahal; M.K. Sekhon; H.S. Kingra (2010): Technical Efficiency of Wheat Production in Punjab. Agricultural Economics Research Review 23(1): 124-138.
- Muralidharan, P.K. (1987): Resource use efficiency in kole lands in Trichur District Kerala. Indian Journal of Agricultural Economics. 42(4): 578-586.
- Naik, A.D., Shankramurthy, H.G.; M.Y. Teggi, And M.B. Koppad. (1998): Resource use efficiency in onion cultivation in Bijapur district, Karnataka. Karnataka Journal of Agricultural Sciences, 11(1): 277.
- Neelappa Shetty, T. (2002): Technical and allocative efficiency of paddy production in TBP area – An Economic Analysis. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.
- Patil, N.P. and T.K.T. Acharya. (1974): A comparative study of resource productivity and resource allocation on sample sugarcane and banana farms in Nasik, Jalagoan district of Maharashtra. Indian Journal of Agricultural Economics, 29(3): 186-187.
- Pradhan, S.S. (1983): Resource productivity and Resource use efficiency in Agriculture in Akola District. M.Sc. (Agric.) Thesis (Unpub.) Dr. PDKV, Akola.

- Radha, Y., P. Raghuram; S. Seetharaman And G. Subbaiah, (1989): Efficiency of input use – A comparative study in rice-rice and rice-pulse farming systems. *Economic Affairs*, 34(3): 219-224.
- Raghuram, P.; Shreedhar Rao; P. D. Ramanmurthy, And Y.E. Prasad.(1989):Productivity Variations in Agriculture – A Study with Reference to Canal Delivery Systems, Department of Agricultural Economics, Andhra Pradesh Agricultural University, Bapla.
- Rajeshwari, Y.G., (2004): An economic analysis of coconut based farming system in Tumkur district of Karnataka. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.
- Rao, C. A. R.; Y. V. R. Reddy, and M. N Reddy, (1996): Technical and allocative efficiencies in castor cultivation. *Indian Journal of Regional Science*. 28(2): 97-100.
- Saikumar, B.C. (2005):Farming Systems in the tank commands in North Eastern Karnataka. An Economic Analysis of Jala Samvardhane Yojana Sangha managed tanks. M.Sc (Agri.) Thesis, University of Agricultural Sciences, Dharwad.
- Sankhayan,P.L. (1988):Introduction to the Economics of Agril. Production, New Delhi. Prentice Hall of India Pvt. Ltd. 6-25.
- Sawant, S.D. (1993): Input use efficiency in Indian Agriculture. *Ind. J. of Agril. Econ.* 48(1): 38-39.
- Shaha, A.K. and D.K. Jain. (2004): Technical efficiency of Dairy farms in developing countries. A case study of Haryana State, *Ind. J. Agril. Econ.* 59(2): 588-599.
- Shanmugam K.R. and Mithily G (2000): Technical efficiency of Rice growers in -Tamilnadu. *Ind. J. of Agril. Econ.* 55 (1): 14.
- Shareef, S.M., (1992): Input-use efficiency of rice crop in three regions of K.C. canal system in Andhra Pradesh. M. Sc. (Agri.) Thesis, Andhra Pradesh Agricultural University,Bapla.
- Sharma, R.K.; S.K. Chauhan; Sonika Gupta (2008): Technical Efficiency in North-Western Himalayan Region: A Study of Himachal Pradesh Agriculture, *Agricultural Economics Research Review* 21(1): 78-81.
- Singh, M.K. (2004): Economics of efficiency in vegetable business system of Mahakoshal Region in Madhya Pradesh. *Indian Journal of Marketing*, 36(3):3-7.
- Singh, R.P. And Srinivas, N.,(1989): Production of responses of rice farmers in different locations of canal irrigation system. Annual Report, Division of Agricultural Economics, IARI, New Delhi.

- Srinivas, T.; S.J.H Razvi; A Aw-Hassan; A.R. Manan and M.S. Kadian (2012): Technical Efficiency of Seed Potato Farmers of Badakshan Province of Afghanistan, *Potato Journal* 39(2):121-124.
- Subramanian, S.R., Krihsnamoorthy, S. And Umamaheshwari. (1992): Input-use efficiency in the Command Area of Lower Bhavani Project in Tamil Nadu, Center of Agricultural and Rural Development Studies. Tamil Nadu Agricultural University Coimbatore.
- Surender Singh (2007): A Study on Technical Efficiency of Wheat Cultivation in Haryana, *Agricultural Economics Research Review* 20(1): 106-109.
- Thakur, D.R; K.D. Sharma and A.S. Saini (1992): Resource use efficiency in Agriculture of high altitude areas. *Ind. J. of Agril. Econ* 79(3):519-520.
- Timmer, C.P. (1971). Using a probabilistic frontier production function to measure technical efficiency, *J. of Political Economy*. 79(4) : 779-794.
- Verma, J.S. and S.P. Gupta (1992): Resource use efficiency in Vegetable- a case of Ivy guard production *Ind. J. of Agril. Econ* 47 (3): 543.
- Verma, R.C. And S.N. Pareek.(1975): Resource-use efficiency on small size farm vis-a-vis large size farms in Jaipur district of Rajasthan. *Indian Journal of Agricultural Economics*, 30(3): 235.
- Wadear, P.R., 2003, analyzing the resource use efficiency and productivity at various factors involved in Animal Based Farming Systems for Long Term Sustainability in Northern Karnataka. – A Socio-Economic Assessment. Ph.D Thesis, University of Agricultural Sciences, Dharwad.
- Yadav, R.N.; M.P. Arad; S.R. Yadav and L.S.Gupta. (1992): Resource use efficiency in crop production district Etawah, U.P. *Ind. J. of Agril. Econ* 47(3): 516-517.

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