

**ECONOMIC EFFICENCY OF CHILLI
PRODUCTION IN GUNTUR DISTRICT OF
ANDHRA PRADESH**

By

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B.Sc. (Ag.)

**THESIS SUBMITTED TO THE
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CERTIFICATE

Mr. BODDEPALLI SARATHBABU has satisfactorily prosecuted the course of research and that the thesis entitled **“ECONOMIC EFFICIENCY OF CHILLI PRODUCTION IN GUNTUR DISTRICT OF ANDHRA PRADESH”** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that neither the thesis nor its part thereof has been previously submitted by him for a degree of any University.

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CERTIFICATE

This is to certify that the thesis entitled “**ECONOMIC EFFICIENCY OF CHILLI PRODUCTION IN GUNTUR DISTRICT OF ANDHRA PRADESH**” submitted in partial fulfilment of the requirements for the degree of ‘**Master of Science in Agriculture**’ of the Acharya N. G. Ranga Agricultural University, Guntur is a record of the bonafide original research work carried out by **Mr. BODDEPALLI SARATHBABU** under our guidance and supervision.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part and all assistance received during the course of the investigation have been duly acknowledged by the author of the thesis.

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I, **BODDEPALLI SARATHBABU**, hereby declare that the thesis entitled “**ECONOMIC EFFICIENCY OF CHILLI PRODUCTION IN GUNTUR DISTRICT OF ANDHRA PRADESH**” submitted to the **Acharya N. G. Ranga Agricultural University** for the degree of **Master of Science in Agriculture** is the result of original research work done by me. I also declare that no material contained in the thesis has been published earlier in any manner.

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Date:

(Boddepalli Sarathbabu)

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LIST OF SYMBOLS AND ABBREVIATIONS

%	:	Per cent
\geq	:	Greater than or equal to
AE	:	Allocative efficiency
APMIP	:	Andhra Pradesh Micro Irrigation Project
APSRTC	:	Andhra Pradesh State Road Transport Corporation
ATMA	:	Agricultural Technology Management Agency
b	:	Coefficient
BC ratio	:	Benefit Cost ratio
CACP	:	Commission on Agricultural Costs and Prices
CPO	:	Chief Planning Office
CRS	:	Constant returns to scale
DEA	:	Data Envelopment Analysis
DEAP	:	Data Envelopment Analysis (computer) Programme
DMU	:	Decision Making Unit
EE	:	Economic efficiency
<i>et al.</i>	:	And other workers
<i>etc.</i>	:	And so on
Fig.	:	Figure
GOAP	:	Government of Andhra Pradesh
Ha.	:	Hectare
Hrs. ha ⁻¹	:	Hours per hectare
<i>i.e.</i>	:	That is
ICDP	:	Intensive Cotton Development Programme

IPM	:	Integrated pest management
ISO POM	:	Oil seeds production programme
kg	:	Kilogram
km	:	Kilometer
l	:	Litres
MFC	:	Marginal Factor Cost
MLR	:	Multiple Linear Regression
MSP	:	Minimum Support Price
MVP	:	Marginal Variable Cost
N	:	South-Western Nigeria currency symbol
NFSM	:	National Food Security Machine
No.	:	Number
PE	:	Priority Estimate
PR	:	Proportion of response
q	:	Quintal
RPI	:	Response Priority Index
Rs.	:	Rupees
Rs. ha ⁻¹	:	Rupees per hectare
Rs. q ⁻¹	:	Rupees per quintal
S. No.	:	Serial Number
SE	:	Standard error
Sq. km	:	Square Kilometer
SRI	:	System of Rice Intensification
TCOC	:	Total cost of cultivation
TE	:	Technical efficiency
Tk	:	Malaysia currency symbol
<i>viz.</i> ,	:	Namely

WBM	:	Water Bound Macadam
θ	:	Theta
λ	:	Lambda
Σ	:	Summation

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ABSTRACT

Name of the Author	: BODDEPALLI SARATHBABU
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Production of chillies plays an important role in improving the economic conditions of farmer's specially marginal and small farmers at one side and help to meet out the nutritional requirements of the people on the others side. The present study entitled "Economic efficiency of chilli production in Guntur district of Andhra Pradesh" was undertaken with the objectives

- (i). to study the cost of cultivation of chilli in Guntur district of Andhra Pradesh;
- (ii). to estimate the economic efficiency levels of chilli production;
- (iii). to identify the factors affecting the technical efficiency levels of chill production, and
- (iv). to analyse the constraints in chilli production

The multistage purposive and random sampling technique was adopted in designing sampling frame for the study. In the first stage Guntur district selected based on the highest area under chilli cultivation in Andhra Pradesh. In the second stage, four mandals *viz.*, Veldurthi, Sattenapalle, Bollapalle, Medikonduru were selected based on the highest area under chilli. Similarly, in third stage, 3 villages were selected based on highest area under chilli, 10 farmers each from selected village of the mandal were selected at random, in view of spread of chilli growers in villages. Thus, the sample size constituted 120 farmers for the study. The primary data from sample farmers were collected by personal interview method by using pre-tested structured questionnaire. The primary data on cultivation of chilli from farmers pertained to 2015-16 agricultural year.

The value of total assets per hectare was highest on large farms followed by medium and small farms. The value of non-land assets related directly with farm size.

The human labour utilization was directly related with the farm size. Harvesting accounted for maximum share of total labour utilization. Family labour utilization was inversely related with the farm size.

Variable costs, fixed costs and total costs were varying in the three groups of farmers, the per cent contribution of variable costs and fixed costs to total costs remind same in all the three groups. The large farmers were incurring high cost of cultivation, followed by medium and small group of farmers, inferring that the total cost of cultivation was varying directly with the farm size. Variable costs contributed to the extent of 87.30 per cent of total cost of cultivation in sample as a whole and same was maximum in medium farmers when compared to small and large farmers.

There was a direct relationship between the farm size and productivity of chillies. Both the gross and net returns were positively correlated with farm size. All the income measures also showed direct relationship with farm size.

The results of economic efficiency of pooled sample indicated that, chilli farmer could decrease current input by 15.90 per cent to produce the same amount of output. The result for mean allocative efficiency also suggests that cost of production could be reduced by 24.80 per cent had farmers used the right inputs and low cost to input costs. On the other hand, it was observed that only about 10 per cent of farms, *i.e.* 12 farmers of the total 120 farmers under constant returns to scale performed with economic efficiency level equal to 0.90 or greater. The mean efficiency score was 0.632. Based on this, it could be inferred that remaining 108 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 36.80 per cent and maintain the same level of chilli production as achieved by 10 per cent of the farmers.

The results of regression equation fitted to identify the determinants of Technical efficiency indicated that among the significant variables, human labour and irrigation had a greater influence on technical efficiency of chilli in all farm sizes, followed by the cost of production.

The sample farmers prioritized the high cost of human labour during chilli production as the major constraint for the production of chilli with a score of 0.98 followed by high cost of irrigation (0.89) and pest and disease management (0.80).

Chapter I

INTRODUCTION

Agriculture is one of the oldest and most important occupations of man. Therefore, in countries like India almost half of the economic status directly or indirectly depends on agriculture. The role of agriculture in development can be similarly assessed on the basis of how it helps the development of an underdeveloped economy from stagnation stage to the progressive stage. Agriculture also supports many industries by providing raw materials to them. Development of agriculture always depends on fertility of soil, rainfall, water resources, good and suitable climate, chemicals, improved seeds from technology, *etc.*

The contribution of agriculture to India's national income has always been notable share. At present, the share of agriculture and allied activities in our national income is nearly 17.9 per cent. With the process of development, the share of agriculture in the national income decreases, while the share of industry rises. In spite of this, agriculture working force (51%) still has the largest share in India's national income as compared to Secondary sector (22%) and Tertiary sector (27%). Further, it is estimated that for many years to come in future. In agriculture, horticulture plays a key role and the percentage share of horticulture output in agriculture is more than 33 per cent. India is the second largest country in exporting the vegetables in the world (www.indiainfoline.com).

Chilli is a lucrative commercial crop, grown all over India not only for a huge domestic market but also for export to other countries. Chillies are the dried fruits of the genus "Capsicum" of Solanaceae family.

At present, the chillies are an indispensable and common ingredient of South Indian diet and an important condiment throughout the country. Chillies are used both in green and dried form. Chillies are used primarily for pungency and colour. The mild pungent types are used for salads, pickles, baking and

stuffing. Chillies contain a remarkable amount of colouring material (carotinoids), hence, it is used as a colorant, apart from its major role in imparting pungency to the dietic dishes. The chillies especially when green are an important source of vitamin 'C'.

India the 'Land of spices' is the largest producer, consumer and exporter of spices with a mammoth share in the world trade. Chilli is popularly known as 'wonder spice' is a major spice crop as well as vegetable crop grown in many countries (Rao and Rao, 2014). It gained its popularity through more than 400 varieties available all over the world with different pungency, size, shape and colors and its usage. India is the largest producer and consumer of chilli, and rich in almost 50 varieties with the contribution of 36 per cent to the total world production. Chilli is an indispensable condiment and used in the daily diet of every Indian household in one or the other form. India is meeting approximately 25 per cent of the world's chilli requirement and considered a leader in chilli exporting followed by China with 24 per cent. Indian chilli exports are mainly influenced by domestic demand and uneven production which is interrupted by erratic monsoon, drought and yield factors.

Although a substantial portion of the total output is consumed internally India is still one of the major exporters of chillies. Nearly 3475 metric tonnes are annually exported from India to Sri Lanka, United Kingdom, Bahrain Islands, South Africa, East Germany, France *etc.*

India is the largest producer and consumer of chillies in the world with a production of 16.05 lakh tonnes harvested from 7.61 lakh hectares during 2014-2015. The acreage under chilies in India has gone up from 5.92 lakh hectares during 1950-51 to 7.61 lakh hectares during 2014-15. The total production also enormously increased from 3.51 lakh tonnes to 16.05 lakh tonnes from 1950-51 to 2014-15 (www.indiaagrystat.com).

Andhra Pradesh, Karnataka, Maharashtra and Orissa together accounted major share in total area and total production of the dry chillies in the country during 2014-15. Andhra Pradesh, with an area of 1.35 lakh hectares and production of 7.39 lakh tonnes in 2014-15 ranked first both in area and production among the chilli growing states in the country (www.indiaagristat.com).

Guntur, Prakasam and Krishna are the important chilli growing districts of Andhra Pradesh. The selected district, Guntur, ranked first in area and production of chillies among the districts of Andhra Pradesh with 0.63 lakh hectares of area and 4.08 lakh tonnes of production during the year 2014-15 (www.indiastat.com).

PROBLEM STATEMENT

Apart from different agro-climatic conditions, the chilli crop is facing challenges from many directions. The increased cost of inputs particularly the fertilizers, pesticides and labour has greatly resulted in doubling or trebling its cost of production. Another important challenge is the pest and disease menace and consequent costly control measures, which escalate the total cost of production. Despite the high cost of certain inputs, some of the cultivators in their anxiety to control pests and diseases are indiscriminately using scarce inputs, thus adding more to the already existing cost of production. These problems are only further compounded by the wide fluctuations in chilli prices. All this has led to the unremunerative nature of chilli farming and thereby an uncertainty in the allocation of land to this crop, which needs a thorough investigation.

Scarcity of resources has led the production economists to think about the reallocation of existing resources to have more output with given level of input combinations or to produce a prescribed level of output with the minimum cost without changing the production technology. Thus, the measurement of the production efficiency in agricultural production is an important issue because it

gives pertinent information for making sound management decision in resource allocation. In this context, assessment of the existing level of economic efficiency which include technical efficiency and allocative efficiency in production of chilli assumes paramount importance. Hence, the present study on **“Economic efficiency of chilli production in Guntur district of Andhra Pradesh”** has been selected with the following objectives.

OBJECTIVES:

1. To study the cost of cultivation of chilli in Guntur district of Andhra Pradesh
2. To estimate the economic efficiency levels of chilli production
3. To identify the factors affecting the technical efficiency levels of chill production
4. To analyse the constraints in chilli production

SCOPE OF THE STUDY

The results of the study would be useful to chilli growers of Guntur district in particular and the state of Andhra Pradesh in general, in identifying the pitfalls in the present pattern of resource use efficiency and technical efficiency to obtain the maximum economic efficiency in the chilli production. Empirical data on cost studies would be useful to know the comparative input demand and economics of chilli cultivation with other crops in the district so as to advocate changes in cropping pattern.

LIMITATIONS OF THE STUDY

This study is confined to a particular agro climatic region and hence the conclusions drawn are applicable to that area and the areas with similar conditions only. The data for the study have been collected for the agricultural year 2015-16 which is too short a period for making any generalization. Further, the data used in the study are the outcome of the recall memory of the sampled cultivators and as such, it will have certain inherent limitations but all necessary

precautions were taken in obtaining a fairly reliable data from farmers by putting many cross questions and checks. The survey method was adopted for want of time and other resources. Because of these built-in limitations, the conclusions drawn from the study will have the selective scope of application.

ORGANISATION OF THE THESIS

The study organized into six chapters.

CHAPTER-I: Introduction - General introduction on chillies, problem statement, objectives, scope and limitations of the study are presented.

CHAPTER-II: Review of literature - Review of the past studies relating the present study are discussed.

CHAPTER-III: Material and methods - The methodology, techniques of analysis and terms and concepts used in the study are presented.

CHAPTER-IV: Agro-economic features - A profile of agro economic features of the study area is given.

CHAPTER-V: Results and discussion - The results of the analysis are presented and discussed.

CHAPTER-VI: Summary and conclusions - The summary and conclusions of the study with suggestions are set out.

Chapter II

REVIEW OF LITERATURE

In this chapter, the most relevant literature is presented keeping in view the objectives and methodology of the present study. The reviews of past studies are presented under the following heads.

2.1 Cost of cultivation of chilli

2.2 Economic efficiency of production

2.3 Factors affecting the technical efficiency of production

2.4 Constraints in production

2.1 COST OF CULTIVATION OF CHILLI

Srikala *et al.* (2016) in their study analyzed the total per hectare cost of cultivation of chillies for the period from 2005-06 to 2010-11 for Andhra Pradesh. The operational costs ranged from Rs. 93, 332 in 2005-06 to Rs. 1, 84,391 in 2010-11. The total costs varied from Rs. 1,09,597 to Rs. 2,21,656 for the corresponding periods. Among the operational costs the percentage of labour component in the total costs increased from 35.13 in 2005-06 to 40.00 in 2010-11. Analogously, among fixed costs, rental value of owned land as a per cent of total cost rose from 12.77 in 2005-06 to 15.79 in 2010-11. During the corresponding period, net returns increased from Rs. 66, 403 to Rs. 1, 63,430 per hectare. In total cost of cultivation human labour charges constitutes 40 per cent to the total cost of cultivation.

Patel *et al.* (2015) conducted study on economic performance of chilli cultivation in Raigarh district of Chhattisgarh in their study revealed that average cost of cultivation of chilli was estimated as Rs. 1,22,935.62 per hectare and observed the highest i.e. Rs. 1,30,302.58 per hectare at small farms. The yield of green chilli was observed 95.81 quintals per hectare, 107.11

quintals per hectare, 123.50 quintals per hectare and 141.31 quintals per hectare at marginal, small, medium and large farms respectively along with 117.40 quintals per hectare on an average. The gross return from chilli crop was observed as Rs. 2,57,072.66 per hectare across the farms. The net return from the same was calculated as Rs. 1,27,451.60 per hectare, while farms spent on an average of Rs. 1,047.15 for one quintal of chilli production. The average ratio of input-output was estimated as 1:2.04 across different farms of the district, which showed cultivation as profitable to the farms of the district. The average use of human labour was estimated at about 521 labour days per hectare. Variable cost and fixed cost constituted 89.35 per cent and 10.65 per cent respectively of the total cost of cultivation.

Olayiwola (2014) results showed that the cost of cultivation (cost C_2) of chilli in Oyo state was more in large farmers compared to small and medium farmers it was observed as, N. 31,113.68, N. 35,102.25, N. 38,260.76 and N. 34,825.56 for small, medium, large and pooled farmers respectively. The BC ratio was recorded as 1.56, 1.87, 1.91 and 1.78 for small, medium and large farmers respectively.

Tirlapur and Mundinamani (2014) in their study on the analysis of cost and returns showed that the per hectare cost of cultivation of irrigated chilli was Rs. 36,986.72 and for rainfed chilli was Rs. 29,830. Gross and net returns per hectare of chilli cultivation under irrigated situation was Rs. 89,875 and Rs. 52,888.28 respectively. It was relatively high under irrigated situation compared to rainfed situation, where in the gross and net returns were Rs. 61,715.38 and Rs. 31,884.89. The benefit cost ratio was 2.43 and 2.07 in case of irrigated and rainfed situations, respectively.

Patel *et al.* (2014) revealed that the average total cost of cultivation for drip irrigation method and conventional irrigation method per hectare was about Rs. 1,24,713 and Rs. 1,16,411 respectively. The major portion for cost goes to the cost of planting materials, human labour and fertilizers which were

about 17.50 percent, 15.01 percent and 11.35 percent respectively to cost C_2 . The net profit per hectare in drip irrigation system was Rs. 3,22,265, while in the case of conventional irrigation system it was Rs. 2,50,111. The total cost of production (cost C_2) for drip and conventional irrigation methods were found Rs. 310.18 and Rs. 341.86 per quintal, respectively. The input-output ratio for drip and conventional irrigation system calculated on the basis of cost C_2 were found 3.58 and 3.15 respectively.

Jagtap *et al.* (2012) in their study on chilli revealed that the average gross returns obtained was Rs. 59,871.24, Rs. 66,925.86 and Rs. 74,821.80 for small, medium and large farmers. the average yield and gross returns per hectare increased with size of the farms, because the large sized farmers had incurred more input in the production process of chilli crop. He revealed that the input costs were more in chilli *i.e.*, the hired labour, irrigation charges and plant protection chemicals, which occupied major share, mainly the human labour was seen as the major component of cost A and rental value of land was seen the major component of cost C.

Reddy *et al.* (2011) in their study on economics of chilli in Andhra Pradesh, results indicated that variable and fixed costs accounted to 76.10 and 23.90 percent of total cost of the cultivation. In chilli labour and plant protection costs accounted to 32 per cent and 17 per cent to total costs. Among all the variable costs, labour costs contributing to nearly 40 per cent to total costs. The total cost of cultivation was recorded as 1,31,520.00 per acre. The cost-benefit ratio of the IPM farmers was calculated as 0.66 on total costs and 0.88 on variable costs compared to 0.41 on total costs and 0.54 on variable costs in non IPM farmers, which was considered to be good but still have scope for improving the profitability by increasing the adoption levels.

Sharma (2011) concluded that the cost-benefit ratio for King chilli on pooled data was recorded as 1:4.424. It was found maximum on marginal (1:4.313), followed by small (1:4.278) and least on medium (1:4.134) farm size group.

Shukla (2010) conducted research on economics of chilli cultivation in Jaipur district of Rajasthan, stated that cost of producing one ha chilli was Rs. 25,155 which included material cost, labour cost in nursery and labour cost in main field. On an average the yield from one ha was 22.03 q. The market price of that was Rs. 83,273.40. The total benefit received by farmers by cultivating chilli was Rs. 58,118.4 per ha. The BC ratio of one ha was recorded 3.31. Also raising commercial crops like chilli, which is labour intensive, labour cost increased was nearly 36 per cent of the total cost of cultivation.

Singh and Chahal (2009) their study on economic analysis of chilli cultivation in Punjab. Results revealed that, the net returns over variable costs for green chilli were estimated to be Rs. 29,114 and Rs. 35,400 per acre in Patiala and Amritsar districts, respectively. The net returns over variable costs for paddy were estimated to be Rs. 13,621 and Rs. 12,570 per acre in the above said districts. This showed that chilli cultivation was more profitable than paddy cultivation in the study area. It also provided that there existed a possibility of shifting of some paddy area to chilli crop for increased returns.

Rajur *et al.* (2008) conducted an analysis on the economics of chilli in Karnataka. The results indicated that material costs occupied major share (63.08%) in the total cost of cultivation. The labour costs (33.54%) are also more in chilli of cultivation. Cost A₂ accounted for 30.70 per cent in Gulbarga, 28.81 per cent in Raichur and 32.30 per cent in Bijapur districts. Cost B₂ accounted for 50.25 per cent in Bijapur, 44.54 per cent in Raichur and 47.09 per cent in Gulbarga districts. Returns over cost C₃ was highest in Raichur district (Rs. 34,955.50) followed by Gulbarga (Rs. 33,870.40) and Bijapur (Rs. 28,836.26) districts, which was due to the lower total cost of chilli production in Raichur district compared to Bijapur and Gulbarga districts. Overall BC ratio was 1.73.

Mishra *et al.* (1999) studied on production and marketing of chillies the production and marketing cost of chillies and found that the total cost incurred by marginal farmers was Rs. 22,782.63 per ha, while it was Rs. 18,488.90 in

the case of medium farmers. Of the total cost, expenditure on manure and fertilizer and human labour accounted for 28.19 per cent and 16.56 per cent, respectively. However, there were no substantial differences in the yield between marginal and medium farmers.

2.2 ECONOMIC EFFICIENCY OF PRODUCTION

Asravor *et al.* (2015) concluded that the total cost of chili pepper production in the study area is significantly influenced by all the input price variables. However, the output does not significantly influence total cost though they are positively related. Chili farms in the study area are operating below the economically efficient frontier and this is largely due to the presence of both technical and allocative inefficiencies in chili production. It is, however, evident from the results that technical inefficiency effects constitute a more serious problem to EE than allocative inefficiency effects. This, therefore, means that EE could be improved substantially by improving both TE and AE, however, improvement in TE offers a higher potential for enhancing EE than in AE. This further suggests that chilli farmers in the study area generally take good decisions with respect to resource allocation rather than good decisions regarding the efficient transformation of inputs into output.

Mohammed *et al.* (2015) revealed that the mean technical efficiency was 90 and none of the sample chilli pepper farmers reached the frontier threshold. Thus, within the context of efficient agricultural production, the output can still be increased by 10% using available inputs and technology.

Ouedraogo (2015) conducted study on technical and economic efficiency of rice production in the Kou valley and the results recorded that the technical, allocative and economic efficiencies of producers are, on average, 80.15 per cent, 92.70 per cent and 74.43 per cent respectively. A 25.00 per cent improvement of rice production was possible if producers optimize their economic efficiency.

The results of Data Envelopment Analysis (DEA) by Lubis *et al.* (2014) showed that the farmers were inefficient in pineapple production with mean technical, allocative and economic efficiency level of 70.10 per cent, 34.10 per cent and 24.10 per cent, respectively. The study, however, revealed that market distance and capital productivity can improve technical efficiency. Labor productivity and land ownership also can improve the economic efficiency.

Thabethe *et al.* (2014) results indicated the average technical efficiency index of 68.3 per cent in sugarcane crop. There was no individual farmer who attained a 100 per cent technical efficiency. This is an indication that with all available resources farmers can still improve their efficiency. The average allocative efficiency was 61.5 per cent with a minimum of 15.6 per cent and a maximum of 83.2 per cent. This indicated that there was still room to improve allocative efficiency of the small-scale sugarcane farmers by 38.5 per cent if they operate on the frontier. This means that the small-scale farmers could assign the resources to their best alternative uses and prices as well as allow them to execute their allocative functions through input use. The cost efficiency of the small-scale sugarcane farmers ranges from 11.4 to 53.6 with a mean of 41.8 per cent. This demonstrates the available potential that the small-scale sugarcane farmers in the study area can exploit to enhance the productivity and profitability through the use of available technology and resources.

Sihlongonyane *et al.* (2014) indicated technical efficiency of maize in Switzerland was 64.7 per cent suggesting that farmers could still improve the technical efficiency by 35.3 per cent. While, allocative efficiency was 99.52 per cent, suggesting that farmers were able to use minimum costs to get a given level of output. In terms of economic efficiency, farmers were 64.3 per cent efficient. They were able to use minimum inputs and at minimum costs for a given level of output. However, farmers could still increase their economic efficiency by 35.7 per cent.

Karthick *et al.* (2013) study on resource use efficacy and technical efficiency of turmeric production. Results revealed that the technical efficiency of about 69 per cent of sample farmers has been found more than 80 per cent,

which indicated the possibility of increasing the yield of turmeric by adopting better technology. Non-availability of labour has been reported the major production constraint by the turmeric growers.

The results of Trujillo and Iglesias (2013) showed that the group of farmers had an average technical efficiency of 76 per cent, which varies in the range of 11 to 95 per cent. About one fourth of the sample was below the average estimated technical efficiency. In this respect, it could be still possible for small-scale farmers to reallocate these inputs to improve their technical efficiency.

Al-Feel and AL-Basheer (2012) study results showed that the mean technical efficiency of wheat production in Gezira scheme was 63 per cent which means that wheat production could have been increased by 37 per cent at the same level of inputs, had resources efficiently utilized.

Ali and Yousif (2012) results showed that the mean technical efficiencies of wheat in Sudan were 0.75 and 0.66 in Dongola and Ed-abba, respectively, while for faba bean they were 0.65 and 0.71, the overall mean allocative efficiencies of wheat in the two localities were 0.72 and 0.68, whereas, they were 0.86, 0.84 for faba bean. The predicated overall mean of economic efficiencies that estimated as the inverse of their cost efficiencies of wheat were 0.41 and 0.45 in the two localities, while in faba bean production they were 0.57 and 0.62 in Dongola and Ed-abba, respectively. That means farmers who cultivated faba bean were more economically efficient than farmers who cultivated wheat in the two localities and their allocative efficiencies were sources of gain.

Hota and Pradhan (2012) conducted an analysis on the economic efficiency of rice production through the DEA and the results concluded that the resource use in rice cultivation in the study area leaves ample scope for improvement for all size groups in all the villages. Further, the medium and large farmers may be advised to achieve the resource-use efficiency effectively so as to raise their technical efficiency for realizing better output.

Khan (2012) study on tomato farms in North Pakistan found that technical efficiency indices varied significantly, with technical efficiency index averaging at 65 per cent. The indices of allocative efficiency also varied widely, with an average of 56 per cent. There was a wide gap between the highest and lowest economic efficiency indices, with a mean economic efficiency of 35 per cent.

Wosor and Nimoh (2012) showed that the farmers were in the stage two of production function, indicated by the elasticities of the various inputs. This was because all inputs demonstrate positive coefficient but diminishing returns throughout, and this is the characteristic of the stage two of the production function. However, considering the allocative efficiency, the farmers were found not to be efficient in allocating the resources in the study area. This is because the ratio between the marginal value product (MVP) and the marginal factor cost (MFC) was identified as less than unity for all the inputs, except labour and organic manure.

Huq and Arshad (2010) in their study revealed that the cultivation of chili is highly profitable. The net return against cultivating of chili was Tk. 73,164 ha⁻¹, while the Benefit Cost Ratio (BCR) was 1.93. However, all the farmers were not very close to the maximum frontier outputs (efficiency levels varying from 11 to 96 per cent and their mean efficiency was 77 per cent).

Narala and Zala (2010) study on technical efficiency of rice in Central Gujarat revealed that the farm-specific technical efficiencies ranged from 71.39 per cent to 99.82 per cent, with the mean of 72.78 per cent, which indicated that on average, the realized output can be raised by 27 per cent in the region with the available technology and resources, without any additional resources.

Dipeolu and Akinbode (2008) results on pepper production in South-West Nigeria revealed average technical, allocative and economic efficiencies of 0.737, 0.893 and 0.658 respectively. These imply that given the present efficiency levels, there is room for the average farmer to increase pepper output or save costs without the need to change existing technology.

Goyal *et al.* (2006) results revealed that, the technical efficiency showed wide variations across sample farms ranging from 0.24 to 0.99 in the year 1998-99. The results also showed that the farm specific technical efficiencies estimated were time varying and tend to decline over time. The mean technical efficiency declined from 0.80 in first year to 0.72 in the last year, which indicated that average technical efficiency regressed/deteriorated through years in paddy production. Although there were high relative frequencies of the technical efficiency of above 0.90, there were also some farmers who were quite poor in their technical efficiency performance. The mean level of technical efficiency over the years ranged from 0.35 to 0.99, with overall mean technical efficiency being 0.77.

Suresh and Reddy (2006) results showed that the allocative efficiency had indicated that marginal return per one rupee increase under these heads would be Rs. 2.83, Rs. 1.57 and Rs. 1.17, respectively.

Anupama *et al.* (2005) conducted analysis on Technical efficiency of maize production in Madhya Pradesh and the results highlighted that, the minimum technical efficiency was found 42 per cent and the mean technical efficiency was 77 per cent. The maximum number of farms came under the category of 80-90 per cent technical efficiency. The study implied that the maize output of the “average farmer” could be increased by 23 per cent by adopting the technology followed by the “best practice” farmers.

Chen *et al.* (2001) results showed that labour was the most important factor in pineapple production following by capital and land. The technical inefficiency of farms was between 1.59 per cent and 65.13 per cent, which suggested pineapple production still has space for improvement.

Rahman *et al.* (2000) in their analysis showed that the mean economic efficiencies estimated from Translog cost frontiers for *Boro*, *Aus*, and *Aman* rice were respectively 80 per cent, 60 per cent and 74 per cent. The study also revealed that without change of output the production cost of *Boro*, *Aus* and *Ainan* could be reduced by 20 per cent, 40 per cent and 26 per cent, respectively.

2.3 FACTORS AFFECTING THE TECHNICAL EFFICIENCY OF PRODUCTION

Hossain (2016) in his study revealed that the age and education was showed as negatively significant at 5 per cent level of significance.

The Results highlights of Chepngetich *et al.* (2015) showed that the technical efficiency was influenced positively by formal education level of the household, experience in sorghum farming, membership in farmers associations, use of hired labour, production advice, and use of manure. Surprisingly household size, meant to enhance labour, had a negative influence. To increase technical efficiency, efforts should focus on improving information flows on agronomic practices. Farmers should also be encouraged to form and actively participate in various farmers associations, which enhance learning and pooling of labour resources, hence improving technical efficiency.

Mohammed *et al.* (2015) recommended that timely and adequate supply of fertilizer should be made available to farmers at an affordable price in order to enhance chilli pepper production.

Thabethe *et al.* (2014) study concluded that age, the level of education and gender were significant determinants of technical efficiency. On the other hand, the level of education, off-farm income, land size, and experience are significant determinants of allocative efficiency. As far as cost efficiency is concerned; the significant determinants were a level of education, land size and experience in sugarcane farming.

Karthick *et al.* (2013) revealed that planting material, nitrogen, potash, harvesting and curing cost, machine hours and irrigation have a positive and significant influence on turmeric yield. Economic efficiency of these variables, except harvesting and curing cost, was more than one, indicating that these resources were being used at sub-optimum levels and there existed the possibility of enhancing the yield of turmeric by increasing their use.

The results of Trujillo and Iglesias (2013) showed that the variables used as the determinants of technical inefficiency indicate that an increase in acreage does not improve the technical efficiency of these small pineapple farmers. Moreover, the results show that this group of farmers still lack the levels of education and experience that are sufficient to approach optimal levels of productive efficiency.

Al-Feel and AL-Basheer (2012) showed that the main socio-economic factors determining the farmer's technical efficiency of wheat in Sudan appeared to be: the timing of the different agricultural operations, irrigation and land ownership. To improve wheat production technical efficiency, the study recommended usage of wheat improved varieties and application of the different agricultural operations, particularly land preparation and irrigation, at the optimum timing.

Khan (2012) study found that the farmer education, extension visits, age and access to credit contributed significantly and positively to productive efficiencies.

Kyei *et al.* (2011) analysis showed that the input factors of cocoa cultivation in Ghana region studied included labour, quantity of fertilizer, pesticides, modern equipments, age of trees and farm sizes. Out of the above, labour and age of trees were not significant. Also, the estimate of inefficiency component showed that, with the exception of the age of farmers, most of the specific characteristics were not significant. It was recommended that the ability to use and adjust properly, factors such as labour, capital and age of farms would lead to increase in output. Also, inefficiency would decrease drastically if variables such as educational level, farming experience and family size of the farmer were increased.

Narala and Zala (2010) study found that factors like operational area, experience, education and distance of field from canal structure were the most influential determinants of technical efficiency, while the variable, number of working family members, showed significant but negative relationship with technical efficiency. By adopting good management practices and proper

allocation of the existing resources and technology, along with sound extension programmes, the potential that existed for improving the productivity of rice in the state, could be exploited.

Murthy *et al.* (2009) concluded that most of the tomato farms irrespective of size of holding have shown technical inefficiency problems. The medium farmers have been observed with best measures of technical efficiency, which has been explained by factors such as the land and labour productivity and education. Though medium farmers have been found efficient, with higher yields, it is the small farmers who have emerged as price-efficient producers in terms of lower cost on production (Rs. 1.72/kg compared to Rs. 2.01 in medium farms and Rs. 1.85 in large farms) and higher unit profit. Most of the farms have been observed to have potential to expand production and productivity, increasing technical efficiency as majority has been performing with increasing returns to scale.

Dipeolu and Akinbode (2008) results on pepper production in South-West Nigeria revealed extension contact, gender, indigeneship status, age and household size have significant effect on technical inefficiency. The study recommended, among others intensive extension services which focus more on native, older and female farmers and are geared towards raising technical knowledge of pepper farmers in order to improve output significantly.

Goyal *et al.* (2006) in their study indicated that there was scope to improve the productivity of the crop with the given level of inputs use and technology. If the efficiency is improved, farmers will gain considerably in terms of higher profits. Further, the technical inefficiencies of production of farmers are significantly related to age and year of observation. However, the inefficiencies of paddy production are not significantly related to schooling and land. There are certain other variables such as rainfall data, extension services, access to credit, research and development, farmers' training, etc., which may be important to be included in the inefficiency effects model. But, because of lack of information/data, these variables have not been modelled in inefficiency effects which could have provided an insight into the policy framework.

Suresh and Reddy (2006) results showed that the average technical efficiency of the paddy farmers in the command area has been found as 66.8 per cent. Education of the farmer and supplementary irrigation provided during the water-stress days were identified as the factors which could enhance the technical efficiency.

Anupama *et al.* (2005) results showed that, the economic efficiency of the maize growers in the state of Madhya Pradesh could be improved by increasing the adoption level of the improved package of practices. This can be made possible by providing good quality seeds of improved maize cultivars and easy and cheap credit for the purchase of critical inputs like fertilizers, plant protection chemicals, *etc.*

Chen *et al.* (2001) results showed that, the capital, area, and varieties (such as Tainung No.6, Tainung No.11, Tainung No.13 and others) might significantly enhanced the technical efficiency in pineapple production. Hence, increasing investment, raising labour quality, and adopting right variety may enhance the technical efficiency in pineapple production.

2.4 CONSTRAINTS IN PRODUCTION

Geetha and Selvarani (2017) in their study on major constraints in chilli production identified unfavorable system of processing was the major problem in production of chilli.

Khan *et al.* (2017) results showed that, unstable prices, less extension services, disease attack and impure inputs were main problems in chilli production.

Sarker (2016) in his study revealed that, the major constraints are ignorant about improved seeds and cultivation practices, chemicals with doses and method of application, scientific method of storage, *etc.* The major economic and physical constraints are the high cost of the seed of improved cultivars and non-availability of funds.

Sharma (2016) analysed the constraints in Naga King chilli production was constrained by several factors *viz*; lack of warehouse / go down for proper storage of Naga King chilli, lack of market information, problem of credit facilities and lack of transportation facilities. Further lack of scientific training about Naga King chilli cultivation and high price fluctuation in market were also perceived as sources of market risks, but on a lower scale.

Shelke *et al.* (2016) analysed the constraints of organic and inorganic tomato farmers in the frequency and per cent methods were calculated. It was observed that one of the most important problem faced by organic and inorganic tomato growers was scarcity of water because, of unseasonal rains, shrinking of ground water level the farmers were facing the problem which was predominant about 77.00 per cent in case of both the farmers. The next important problem faced by the farmers was timely unavailability of labourers and fluctuation of market price which was reported in organic tomato growers as 60.41 per cent and 39.58 per cent, respectively. Whereas in case of inorganic tomato growers it was found to be about 79.16 and 62.50, respectively. Another important constraint which was faced by inorganic tomato growers was high cost of fertilizers which was about 60.41 per cent.

Dangore *et al.* (2015) conducted an analysis on constraints faced by the chilli growers in production and marketing of dry chilli. Total sample of 90 farmers were selected randomly and the results shown that, the lack of technical knowledge was major problem in production which was expressed by 81 farmers. Lack of financial facility was expressed by 79 dry chilli growers and lack of drying space for red chilli was expressed by 78 farmers.

Patel *et al.* (2015) results showed that, the problem of insect- pest and diseases, lack of soil testing facilities and scarcity of labour were some major problems which were faced by the farmers during the production of chilli crop in Raigarh district of Chattishgarh state.

Pandit and Basak (2014) selected ten characteristics and of which, level of education, family size, farm size, extension media contact, knowledge on vegetable production and cosmopolitaness showed significant negative correlation and family subsistence pressure showed significant positive correlation with farmers' constraints in commercial cultivation of vegetables. Stepwise multiple regressions showed that extension media contact, cosmopolitaness and knowledge on vegetable production had greater influence on farmers' constraints.

Patil *et al.* (2014) results showed that, under production related constraints all the respondents expressed the problem of lack of research support in providing scientific rationality of practices and non-availability of labourers to carry out organic farm practices. The problem of limited and irregular power supply (97.86%) and no documentation of organic farming practices (95.71%) and lack of organic practices to control pest and diseases (95.71%) were also highlighted by more than 90 per cent of farmers. Similarly, majority of the respondents expressed the problems of non-availability of organic manures (85.00%) and lack of awareness about biofertilizers and biopesticides use (80.71%), respectively.

The results of Trujillo and Iglesias (2013) showed that only acreage, education, and experience were statistically significant influencing technical efficiency in pineapple in Colombia. Nevertheless, variables such as off-farm income, technical assistance and access to credit did contribute positively to the levels of technical efficiency, but they were not statistically significant.

Biradar and Chandrgi (2013) findings revealed that majority (78.33%) of the farmers expressed problem of price fluctuation followed by inadequate irrigation (62.50%) and same per cent of them expressed the non availability of labourers at critical stages and high wages, non availability of good quality inputs at proper price at right time (59.17%). The major suggestions made by the respondents were minimum support price should be fixed for chilli (86.67%), followed by market should be nearer, (65.83%), should provide good quality of inputs at right time at proper price (54.16%).

Karthick *et al.* (2013) study revealed that the non-availability of labour has been reported the major production constraint by the turmeric growers.

Jat *et al.* (2012) analysed the constraints in tomato cultivation, the major constraints in improved tomato production technology as perceived by tomato growers were high cost of high yielding varieties, high cost of fertilizers and chemicals, lack of knowledge of disease resistant varieties, lack of knowledge about proper application methods of chemical fertilizers, lower price at harvesting time, unavailability of fertilizers in the local market at the time of sowing, minimum support price is not fixed by the government, lack of knowledge of seed treatment and lack of knowledge and skills about proper method of tomato production. The financial constraints were most perceived by the tomato growers followed by technical constraints and educational constraints, whereas the marketing constraints and input constraints were perceived least by the tomato growers.

Rama Rao (2012) analysed the constraints in sugarcane by using the Response Priority Index (RPI) method. The highest value of RPI was for 'labour shortage', therefore most important constraint in sugarcane cultivation in the North Coastal Zone was difficulty in getting labour during period of important operations. The other constraints were shortage of irrigation water, not getting remunerative prices, high cost of machines, difficulty in getting good quality seed material and infestation by pests and diseases.

Rama rao (2011) revealed that the most important constraint in SRI cultivation of rice had been identified as 'nursery management'. The SRI method being more skill oriented, the study had observed that yields can be made sustainable if constraints were addressed on war-footing basis.

Sharma and Gupta (2010) revealed that the major constraints expressed by chilli growers were heavy price fluctuation of the produce, no support price of chilli, lack of knowledge of raising nursery, low price at peak time and high cost of hybrid seeds. The major constraints expressed by ex-chilli growers were, comparatively decreased production of chilli, intensive requirement of labour at picking and low price at peak time.

Chapter III

MATERIAL AND METHODS

The chapter on “material and methods” provides information about the sampling design employed, method of data collection used for obtaining information from the sample farmers and the statistical tools and techniques which are used for the analysis of the data related to objectives of the present study. The basic terms and concepts involved in the study are also mentioned in the chapter as outlined hereunder.

- 3.1. Sampling design
- 3.2. Data collection
- 3.3. Techniques of analysis
- 3.4. Concepts and terms

3.1 SAMPLING DESIGN

Multistage purposive and sampling technique was followed for selection of state, district, mandal and villages and thereafter random sampling is employed for selection of farmers. The steps considered while selecting sample have been described below.

3.1.1. Selection of state

In India chilli is cultivated in Andhra Pradesh, West Bengal, Maharashtra, Orissa and Madhya Pradesh. Andhra Pradesh has the highest area and production of chilli in India with 7.39 lakh tonnes of production and 1.35 lakh hectares of area, hence selected for study purposively.

3.1.2 Selection of district

In Andhra Pradesh, chilli is predominantly grown in Guntur, Prakasam, Kurnool and Krishna districts. Guntur district has the highest area and production of chilli with 4.08 lakh tonnes of production and 0.63 lakh hectares of the area for the year 2014-15, hence selected for the study purposively.

3.1.3 Selection of mandal

In Guntur district, according to the data of CPO (Chief Planning Office), out of fifty-seven mandals, four mandals with a maximum area under chilli crop were selected, which included Veldurthi, Sattenapalle, Bollapalle and Medikonduru (Table 3.1).

3.1. Area under chilli in selected mandals during 2014-15

S.No.	Mandal	Chilli area (ha.)
1	Veldurthi	4320 (6.83)
2	Sattenapalle	4187 (6.62)
3	Bollapalle	3960 (6.26)
4	Medikonduru	3375 (5.34)
	Guntur	63218 (100)

Note: Figures in parentheses indicate percentage to the total

Source: Chief Planning Office (CPO), Guntur.

3.1.4 Selection of villages

Three villages from each of the four selected mandals were selected based on the highest area under chilli cultivation (Table 3.2).

Table 3.2 Area of chilli in selected villages during the year 2014-15

S. No.	Mandal	Village	Area (ha.)
1	Veldurthi	Gottipalla	741 (17.15)
		Veldurthi	704 (16.29)
		Srigiripadu	614 (14.21)
	Veldurthi Total area		4320 (100)
2	Sattenapalle	Panidem	459.51 (10.97)
		Gudipudi	354.25 (8.46)
		Bhrugubanda	329.96 (7.88)
	Sattenapalle Total area		4187 (100)
3	Bollapalle	Perurupadu	435.72 (11.00)
		Mellavagu	395 (9.97)
		Ravulapuram	375.62 (9.49)
	Bollapalle Total area		3960 (100)
4	Medikonduru	Sripuram	505 (14.96)
		Paladugu	445 (13.18)
		Medikonduru	424 (12.56)
	Medikonduru Total area		3375 (100)
	Guntur total chilli area		63,218

Note: Figures in parentheses indicate per cent to total chilli area under respective mandals

Source: Chief Planning Office (CPO), Guntur.

3.1.5 Selection of respondents

Ten farmers from each selected village were selected randomly making a total sample of 120 farmers and these farmers were post-stratified into small, medium and large farmers based on the total operated farm holdings.

Table 3.3 Selection of respondents in sample area

S. No	Size classification	Farm holding (ha.)	Number of farmers
1	Small farmers	Below 2	48
2	Medium farmers	2 - 4	39
3	Large farmers	Above 4	33

Thus out of total 120 farmers, 48 small farmers with below 2 hectares of farm holding, 39 medium farmers with the farm holding size of 2 hectares - 4 hectares and 33 large farmers holding size of above 4 hectares were selected from the selected villages randomly.

3.2 DATA COLLECTION

The data collection included both primary data and secondary data from different sources.

3.2.1 Primary data

Primary data on cost of cultivation and other relevant socio-economic factors influencing chilli production were collected from the farmers in the selected villages of the study area through interview method with the help of a pre-tested schedule. It included family details like age, education, farming experience, land holding of farmers, cropping pattern, asset position, input use, costs and returns of chilli production and constraints faced by the farmers in chilli production.

3.2.2 Secondary data

The data regarding the agro economic features of the study area and area under chilli crop were collected from the Chief Planning Office (CPO), Guntur district and officials of Department of Agriculture, GOAP and other agencies in village level.

3.2.3 Period of the study

The field survey was taken up during February and March 2017. The data and the information collected from final sample farmers was related to the Agricultural Year 2015-2016. The secondary data was related to different periods viz., population census data in the year 2011, 19th livestock census in the year 2012 and agro-economic features for Guntur district and selected mandals during 2014-15 year.

3.3 TECHNIQUES OF ANALYSIS

3.3.1 Tabular analysis

Conventional tabular analysis was used to compute the socio- economic profile of the sample farmers, costs-returns structure of chilli and the constraints of chilli farmers in the study area.

3.3.2 Cost concepts

Various cost concepts were developed by different economists to assess the extent of the cost of cultivation. The cost concepts classification adopted by CACP (Commission on Agricultural Costs and Prices), New Delhi was used in the present study for estimating the cost of cultivation of chilli.

Cost A_1 = Value of hired human labour

- + Value of bullock labour (both hired and owned)
- + Value of machinery power (both hired and owned)
- + Value of seeds (purchased)
- + Value of insecticides, pesticides and weedicides
- + Value of manure (both owned and purchased)
- + Value of fertilizers
- + Value of irrigation charges
- + Depreciation and maintenance of implements and farm buildings
- + Miscellaneous expenses (electricity charges, fuel, gunny bags *etc.*)
- + Land revenue/cess and other taxes
- + Interest on working capital

Cost $A_2 = \text{Cost } A_1 + \text{Rent paid for leased in land}$

Cost $B_1 = \text{Cost } A_1 + \text{Interest on fixed capital (excluding land)}$

Cost $B_2 = \text{Cost } B_1 + \text{Rental value of owned land}$

Cost $C_1 = \text{Cost } B_1 + \text{Imputed value of family labour}$

Cost $C_2 = \text{Cost } B_2 + \text{Imputed value of family labour}$

Cost $C_3 = \text{Cost } C_2 + 10 \text{ per cent of cost } C_2$

Measures of farm income

Farm business income = Gross income - Cost A_1

Family labour income = Gross income - Cost B_2

Farm investment income = Farm business income – imputed value of family labour

3.3.3 Economic efficiency

In order to estimate the economic efficiency, various methods have been developed and classified as parametric and non-parametric approaches. Farm efficiency was measured in terms of technical efficiency, allocative or price efficiency and cost efficiency or economic efficiency. Technical efficiency is the ability of a firm to achieve maximum possible output with the available resources, while allocative efficiency refers to the ability to contrive an optimum allocation of given resources. Economic efficiency is a product of technical and allocative or price efficiencies (Farrell, 1957).

In this study, Data Envelopment Analysis (DEA), a non-parametric approach is employed, which can handle multiple outputs and inputs and does not require a prior specific functional form for the production frontier. DEA also has the advantage that it does not require the distributional assumptions of the inefficiency term, and it is also possible to identify the best practice for every farm.

The DEA technique adopted by Charnes *et al.* (1978) was adopted in the present study. If there are K inputs and M outputs on each of the N firms or Decision making units (DMUs), then $K \times N$ input matrix, X , and $M \times N$ output matrix, Y , represent the data pertaining to all N DMUs. For the i^{th} DMU, inputs and outputs were represented in terms of X_i and Y_i vectors, respectively. Then for the i^{th} DMU, first a ratio measure $\mu' Y_i / v' X_i$ was obtained where μ and v are output and input weights, respectively. The optimal weights are given by the following mathematical programming problem.

$$\max_{\mu, v} (\mu'Y_i / v'X_i)$$

subject to

$$\begin{aligned} (\mu'Y_j / v'X_j) &\leq 1 & j = 1, 2, \dots, N \\ \mu, v &\geq 0 \end{aligned}$$

Imposing the constraint $v'X_i = 1$ to avoid an infinite number of solutions to the above mentioned equation and considering the dual problem, the DEA model can be rewritten as:

$$\min_{\theta, \lambda} \theta$$

subject to

$$\begin{aligned} -y_i + Y\lambda &\geq 0, \\ \theta x_i - X\lambda &\geq 0, \\ \lambda &\geq 0 \end{aligned}$$

Where, θ is a scalar and λ is a $N \times I$ vector of optimal weights attached to each of the efficient DMUs. θ represents Technical Efficiency (TE) score of the i^{th} DMU. The criterion used by Ferreira (2005) and Murthy *et. al* (2009) was used in the present study to decide the cut-off score for efficient farmers. Farmers that operated at 0.90 or more score were considered as 'efficient farmers'. The explanation for this flexibility, according to Ferreira (2005) and Murthy *et. al* (2009), is to avoid compromising the analysis through a farm that stands out as being an outlier rather than for its true relative efficiency. Data recording errors and external factors were attributed for this flexibility. Solving the linear programming problem given by below equation for N times yields the efficiency index for each of the N DMUs.

$$\frac{\delta C}{\delta P_i} = X_i(P, Q)$$

Substituting a firm's input prices (P_i) and output quantity (Q) into the demand system. the economically efficient input vector (X_i) was obtained. The ratio of cost of economically efficient inputs to actual cost yields a measure of economic efficiency, and the ratio of economic efficiency to technical efficiency provides a measure of allocative efficiency. The efficiency score obtained from the above model corresponds to Constant Returns to Scale (CRS).

The DEA methodology has been extended and applied to a wide range of issues during the past decades. One useful extension was the cost minimizing DEA model, which was used to estimate the economic (or cost) efficiency.

This model can be expressed as:

$$\min x_i^*, \lambda W_i' X_i^*$$

subject to

$$- y_i + Y \lambda \geq 0,$$

$$x_i^* - X \lambda \geq 0,$$

$$\lambda \geq 0$$

Where, x_i^* is the cost-minimizing or economically efficient input vector for the i^{th} DMU, given its input price vector, W_i , and the output vector Y_i . The Economic (or cost) Efficiency index for the i^{th} DMU can then be computed as:

$$EE_i = W_i' X_i^* / W_i' X_i$$

which is the ratio of the minimum cost to the actual cost. The Allocative Efficiency (AE) index is derived as the ratio between EE and TE.

In this study, cost efficiency DEA model was used to calculate the technical efficiency, allocative efficiency and economic efficiency of the i^{th} sample farm in each production system can be expressed separately for three size groups of farmers as given below:

For small farmers

$$\min_{\theta, \lambda} \theta_i$$

subject to

$$\lambda_1 Y_1 + \lambda_2 Y_2 + \dots + \lambda_{48} Y_{48} \geq Y_i$$

$$\lambda_1 X_{1,1} + \lambda_2 X_{1,2} + \dots + \lambda_{48} X_{1,48} \geq \theta_i X_{1,i}$$

$$\lambda_1 X_{2,1} + \lambda_2 X_{2,2} + \dots + \lambda_{48} X_{2,48} \geq \theta_i X_{2,i}$$

$$\lambda_1 X_{3,1} + \lambda_2 X_{3,2} + \dots + \lambda_{48} X_{3,48} \geq \theta_i X_{3,i}$$

$$\lambda_1 X_{4,1} + \lambda_2 X_{4,2} + \dots + \lambda_{48} X_{4,48} \geq \theta_i X_{4,i}$$

$$\lambda_1 X_{5,1} + \lambda_2 X_{5,2} + \dots + \lambda_{48} X_{5,48} \geq \theta_i X_{5,i}$$

$$\lambda_1 X_{6,1} + \lambda_2 X_{6,2} + \dots + \lambda_{48} X_{6,48} \geq \theta_i X_{6,i}$$

$$\lambda'(\lambda_1, \lambda_2, \dots, \lambda_{48}) \geq 0$$

In case of small farmers, since there are 48 farmers in the sample, the linear programming problem was solved 48 times.

For medium farmer

$$\min_{\theta, \lambda} \theta_i$$

subject to

$$\begin{aligned} \lambda_1 Y_1 + \lambda_2 Y_2 + \dots + \lambda_{39} Y_{39} &\geq Y_i \\ \lambda_1 X_{1,1} + \lambda_2 X_{1,2} + \dots + \lambda_{39} X_{1,39} &\geq \theta_i X_{1,i} \\ \lambda_1 X_{2,1} + \lambda_2 X_{2,2} + \dots + \lambda_{39} X_{2,39} &\geq \theta_i X_{2,i} \\ \lambda_1 X_{3,1} + \lambda_2 X_{3,2} + \dots + \lambda_{39} X_{3,39} &\geq \theta_i X_{3,i} \\ \lambda_1 X_{4,1} + \lambda_2 X_{4,2} + \dots + \lambda_{39} X_{4,39} &\geq \theta_i X_{4,i} \\ \lambda_1 X_{5,1} + \lambda_2 X_{5,2} + \dots + \lambda_{39} X_{5,39} &\geq \theta_i X_{5,i} \\ \lambda_1 X_{6,1} + \lambda_2 X_{6,2} + \dots + \lambda_{39} X_{6,39} &\geq \theta_i X_{6,i} \\ \lambda'(\lambda_1, \lambda_2, \dots, \lambda_{39}) &\geq 0 \end{aligned}$$

In case of medium farmers, since there are 39 farmers in the sample, the linear programming problem was solved 39 times.

For large farmers

$$\min_{\theta, \lambda} \theta_i$$

subject to

$$\begin{aligned} \lambda_1 Y_1 + \lambda_2 Y_2 + \dots + \lambda_{33} Y_{33} &\geq Y_i \\ \lambda_1 X_{1,1} + \lambda_2 X_{1,2} + \dots + \lambda_{33} X_{1,33} &\geq \theta_i X_{1,i} \\ \lambda_1 X_{2,1} + \lambda_2 X_{2,2} + \dots + \lambda_{33} X_{2,33} &\geq \theta_i X_{2,i} \\ \lambda_1 X_{3,1} + \lambda_2 X_{3,2} + \dots + \lambda_{33} X_{3,33} &\geq \theta_i X_{3,i} \\ \lambda_1 X_{4,1} + \lambda_2 X_{4,2} + \dots + \lambda_{33} X_{4,33} &\geq \theta_i X_{4,i} \\ \lambda_1 X_{5,1} + \lambda_2 X_{5,2} + \dots + \lambda_{33} X_{5,33} &\geq \theta_i X_{5,i} \\ \lambda_1 X_{6,1} + \lambda_2 X_{6,2} + \dots + \lambda_{33} X_{6,33} &\geq \theta_i X_{6,i} \\ \lambda'(\lambda_1, \lambda_2, \dots, \lambda_{33}) &\geq 0 \end{aligned}$$

In case of large farmers, since there are 33 farmers in the sample, the linear programming problem was solved 33 times.

For Pooled farmers

$$\min_{\theta, \lambda} \theta_i$$

subject to

$$\lambda_1 Y_1 + \lambda_2 Y_2 + \dots + \lambda_{120} Y_{120} \geq Y_i$$

$$\lambda_1 X_{1,1} + \lambda_2 X_{1,2} + \dots + \lambda_{120} X_{1,120} \geq \theta_i X_{1,i}$$

$$\lambda_1 X_{2,1} + \lambda_2 X_{2,2} + \dots + \lambda_{120} X_{2,120} \geq \theta_i X_{2,i}$$

$$\lambda_1 X_{3,1} + \lambda_2 X_{3,2} + \dots + \lambda_{120} X_{3,120} \geq \theta_i X_{3,i}$$

$$\lambda_1 X_{4,1} + \lambda_2 X_{4,2} + \dots + \lambda_{120} X_{4,120} \geq \theta_i X_{4,i}$$

$$\lambda_1 X_{5,1} + \lambda_2 X_{5,2} + \dots + \lambda_{120} X_{5,120} \geq \theta_i X_{5,i}$$

$$\lambda_1 X_{6,1} + \lambda_2 X_{6,2} + \dots + \lambda_{120} X_{6,120} \geq \theta_i X_{6,i}$$

$$\lambda'(\lambda_1, \lambda_2, \dots, \lambda_{120}) \geq 0$$

In case of large farmers, since there are 120 farmers in the sample, the linear programming problem was solved 120 times.

Y = Yield of chilli (q ha⁻¹)

X₁ = Machine labour (hours ha⁻¹)

X₂ = Human labour (man days ha⁻¹)

X₃ = Quantity of seeds (grams ha⁻¹)

X₄ = Chemical fertilizers (kg ha⁻¹)

X₅ = Irrigation (hours ha⁻¹)

X₆ = Plant protection chemicals (litres ha⁻¹)

The solution to this problem yields technical efficiency (θ) and optimal weights (λ) for the i^{th} farm in the sample. Solving the linear programming problem for small, medium and large farmers 48, 39 and 33 times respectively, gave the technical efficiency of all the farms. In this cost efficiency DEA model, along with the input data on labor, fertilizer, pesticides, seed, the input price data was also used to obtain the allocative and cost efficiencies. In the present study DEA was carried out using DEAP version 2.1 (Coelli,1996) which generates the technical, economic and allocative efficiencies as well as optimum input levels for the small, medium and large farmers in the study area.

3.3.4 Multiple linear regression analysis:

Multiple Linear Regression (MLR) was used to study factors affecting the technical efficiency of chilli growing farmers in Guntur district of Andhra Pradesh. The following multiple linear regression equation was fitted for the present study.

$$Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8 + b_9 X_9 + b_{10} X_{10} + e_t$$

Where,

Y = Technical efficiency

X₁ = Age of the farmer (years)

X₂ = Educational level (number of years of schooling)

X₃ = Family labour(number)

X₄ = Farming Experience (years)

X₅ = Chilli cultivated area (ha.)

X₆ = Cost of production (Rs. q⁻¹)

X₇ = Human labour (man days ha⁻¹)

X₈ = Irrigation (hours ha⁻¹)

X₉ = Machine power (hours ha⁻¹)

X₁₀ = Training programmes attended (No.)

a = Intercept

b₁ – b₁₀ = Regression coefficients

e_t = Error term

The regression coefficients b_i's were tested for their significance by using the following formula

$$t = \frac{|b_i|}{\text{SE of } b_i} \sim (n-k-1)df$$

Where,

n = Number of observations

k = Number of independent variables

S.E.	=	Standard Error
b_i	=	Regression coefficients
t	=	Test for significance
df	=	Degrees of freedom

3.3.5 Responses priority index (RPI):

In the quantification of constraints expressed by the farmer, there was a problem whether to give more emphasis for a number of responses to a particular priority or to the highest number of responses to a constraint in first priority. as both lead to different conclusions. To resolve this Responses-Priority Index (RPI) as a product of Proportion of Responses (PR) and Priority Estimate (PE) (Rama Rao, 2012) was adopted. The PR for the i^{th} constraint will give the ratio of number responses for a particular constraint to the total responses as given below:

$$(\text{RPI})_i = \frac{\sum_{j=1}^k f_{ij} \cdot X_{[(k+1)-j]}}{\sum_{i=1}^I \sum_{j=1}^k f_{ij}}$$

Where,

$(\text{RPI})_i$	=	Response priority index for i^{th} constraint.
$\sum_{j=1}^k f_{ij}$	=	Total number of responses for the i^{th} constraint.
f_{ij}	=	Number of responses for the j^{th} priority of i^{th} constraint ($i=1,2,3,\dots,I$; $j=1,2,3,\dots,k$).
$X_{[(k+1)-j]}$	=	Scores for j^{th} priority.
$\sum_{i=1}^I \sum_{j=1}^k f_{ij}$	=	Total number of responses to all constraints.
k	=	Number of priorities.

The larger the RPI, the higher the importance for the particular constraint.

3.4 CONCEPTS AND TERMS

3.4.1 Allocative efficiency

Allocative efficiency is a state of the economy in which production represents consumer preferences; in particular, every good or service is produced up to the point where the last unit provides a marginal benefit to consumers equal to the marginal cost of producing it.

3.4.2 Technical efficiency

Technical efficiency is the effectiveness with which a given set of inputs is used to produce an output. A farmer is said to be technically efficient if a farmer is producing the maximum output from the minimum quantity of inputs, such as labour, capital and technology.

3.4.3 Economic efficiency

It is the expression of technical efficiency in monetary value by attaching prices. In other words, the ratio of the value of output to the value of the input is called economic efficiency. It is the maximization of price per unit of input.

3.4.4 Interest on working capital

The interest on working capital was charged at the rate of 7 per cent for half of the crop period.

3.4.5 Interest on fixed capital

Interest on the present value of fixed assets (excluding land) such as farm buildings, implements and machinery, irrigation structures and equipment was charged at the rate of 10 per cent per annum.

3.4.6 Rental value of owned land

The total rental value of owned land was taken as equal to the lease amount for similar farm prevailed in the study area.

3.4.7 Rent paid for leased-in land

The rent paid for the leased-in land was taken as the actual lease amount paid for that particular land. The value of both rental value of owned land and rent paid for leased in land are same.

3.4.8 Input costs

All the inputs were valued at current market prices.

3.4.9 Human labour

There are three types of human labour *viz.*, family labour, permanent labour and casual hired labour. The family labour is imputed at the general wage rate prevailing for the casual labourers in the locality. In the case of permanent labour payment made in kinds like grain, meals and other perquisites are evaluated at market rates, besides payments made in cash are added. The daily wage rate has been taken into consideration for payment to hired labourer, which varies with the type of operation.

3.4.10 Bullock labour

To evaluate the cattle labour of both owned and hired, prevailing hire rate was considered (in case of hired bullock labour no separate charge is made for the person engaged in the operation. To avoid further complexity, bullock labour is considered as bullock team).

3.4.11 Machine labour

In case of owners, the net cost of maintenance per hour was adopted, whereas the actual hired rate was taken in case of those who hired the tractor machinery.

3.4.12 Land revenue

The actual amount paid by the farmer towards land revenue was taken into account.

3.4.13 Operational holding

The total land area held under a single management for the purpose of cultivation. It excludes any land leased out to another person.

3.4.14 Irrigation

The water charges paid by the cultivator for availing the canal water and the actual expenses on fuel and electricity were taken into consideration and evaluated as irrigation charges for the crop period.

3.4.15 Manures and fertilizers

The farm produced manures were charged at the prevailing rates of the locality. Fertilizers and manures purchased were charged at the rate actually paid.

3.4.16 Plant protection chemicals

Actual prices paid for the plant protection chemicals by the borrower were considered.

3.4.17 Seed cost

The amount actually paid for purchasing seeds or seedlings were charged at the prevailing rates of the locality.

3.4.18 Transport costs

In case of own transportation, the wages for the human and cattle labour used were considered. Otherwise, the actual costs paid for transportation were included.

3.4.19 Farm assets

The physical property owned by the farmer such as farm buildings, livestock, machinery and implements, excluding land were included under farm assets.

3.4.20 Depreciation

The depreciation was worked out for the items like farm machinery and implements, farm buildings and wells and the other farm equipment. Depreciation was calculated by using below formula.

$$\text{Depreciation} = \frac{\text{Original cost of the asset} - \text{Junk value}}{\text{Useful life of the asset}}$$

3.4.21 Fixed cost

Fixed costs are costs that are independent of output. These remain constant throughout the relevant range and are usually considered sunk for the relevant range (not relevant to output decisions). Fixed costs often include rent, buildings, machinery, etc.

3.4.22 Variable costs

Costs associated with the using of variable resources *viz.*, seeds fertilizers, FYM, plant protection chemicals, human and bullock labour and interest on working capital.

3.4.23 Small farmer

Farmers having less than 2 hectares of operational land holding are grouped as small farmers.

3.4.24 Medium farmer

Farmers having 2-4 hectares of operational land holding are grouped as medium farmers.

3.4.25 Large farmer

Farmers having more than 4 hectares of operational land holding are grouped as large farmers.

3.4.26 Cost of cultivation

The cost of various inputs and input services used for raising a crop in a unit area is the cost of cultivation.

3.4.27 Cost of production

The expenditure incurred in producing a unit quantity of output is called cost of production *i.e.* costs in Rs. per quintal.

3.4.28 Gross returns

Gross returns referred to the total value of the crop produced on the farm during the year valued at the market price.

3.4.29 Net returns

Net returns was estimated on the basis of total cost of cultivation

$$\text{Net returns} = \text{Gross returns} - \text{Total cost}$$

3.4.30 Rate of return

Rate of return is the ratio between the net returns to total cost

$$\text{Rate of return} = \frac{\text{Net returns}}{\text{Total cost}}$$

3.4.31 Constraint

It is an external factor, which influences on the production of chilli crop.

Chapter V

RESULTS AND DISCUSSION

In this chapter, an attempt is made to discuss critically the analytical results obtained from the study. The results of the study are presented and discussed under the following sections:

- 5.1 Socio-economic profile of sample farmers
- 5.2 Cost of cultivation and cost of production of chilli
- 5.3 Economic efficiency of chilli production
- 5.4 Factors affecting technical efficiency of chilli production
- 5.5 Constraints in chilli production

5.1 SOCIO-ECONOMIC PROFILE OF SAMPLE FARMERS

A comprehensive understanding of the composition of a farm family, land holding, educational qualification, asset structure and experience in farming practice *etc.*, of the sample farmers serves as bases in presenting and interpreting the results of the analysis. Hence, the major socio-economic characters of sample farmers are presented here under.

5.1.1 Family composition and family labour composition

It is observed from Table 5.1 that, the family size on an average varies from 4.02 members on small farmers and 3.63 members on medium farmers to 4.13 members on large farmers with an overall average of 3.93 members. The composition of a family with respect to males was larger than children and females in all the selected farms. The average number of family members working on the farm was 2.04, 1.88, 1.87 and 1.94 in the case of small, medium, large and pooled farmers respectively. The composition of farm family workers with respect to males was higher than females in all the selected farms.

Table 5.1. Family composition and family labour composition on selected farms

S.No.	Particulars	Small	Medium	Large	Pooled
I	Family Composition				
	a. Male	1.87 (46.52)	1.69 (46.56)	1.87 (45.28)	1.81 (46.06)
	b. Female	1.47 (36.57)	1.41 (38.84)	1.39 (33.66)	1.43 (36.39)
	c. Children	0.68 (16.92)	0.53 (14.60)	0.87 (21.07)	0.69 (17.56)
	Total	4.02 (100)	3.63 (100)	4.13 (100)	3.93 (100)
II	Family labour composition				
	a. Male	1.29 (63.24)	1.17 (62.23)	1.24 (66.31)	1.24 (63.92)
	b. Female	0.75 (36.76)	0.71 (37.77)	0.63 (33.69)	0.70 (36.08)
	Total	2.04 (100)	1.88 (100)	1.87 (100)	1.94 (100)

Note: Figures in parentheses indicate percentages to the respective totals.

Thus, the larger family size was observed in large group farmers (4.13), followed by small group (4.02) and medium group (3.63). But the contribution of total farm family labour was high in small group (2.04), followed by medium group (1.88) and large group (1.87) but with a low difference.

5.1.2 Age

It is observed from Table 5.2 that, the number of sample farmers for small farmers group was maximum in the age group of 31-40 with 45.83 per cent followed by age group of 41-50 with 22.92 per cent, age group of 51-60 with 20.83 per cent, age group of below 30 with 6.25 per cent and age group of 61-70 with 4.17 per cent. In the medium farmers group was maximum number of farmers were in the age group of 31-40 with 41.03 per cent, followed by age group of 41-50 with 25.64 per cent, age group of 51-60 with 17.95 per cent, age group of 61-70 with 10.26 per cent and age group of below 30 with 5.13 per cent. In the large farmers group was maximum in the age group of 41-50 with 45.45 per cent followed by age group of 31-40 with 27.27 per cent, age group of 51-60

with 15.15 per cent, age group of 61-70 with 9.09 per cent and age group of below 30 with 3.03 per cent. In pooled farmers the same was maximum in the age group of 31-40 with 39.17 per cent followed by age group of 41-50 with 30 per cent, age group of 51-60 with 18.33 per cent, age group of 61-70 with 7.50 per cent and age group of below 30 with 5 per cent.

Table 5.2 Particulars of age of sample farmers

S.No.	Age group	Small	Medium	Large	Pooled
1	Below 30	3 (6.25)	2 (5.13)	1 (3.03)	6 (5)
2	31 - 40	22 (45.83)	16 (41.03)	9 (27.27)	47 (39.17)
3	41 - 50	11 (22.92)	10 (25.64)	15 (45.45)	36 (30)
4	51 - 60	10 (20.83)	7 (17.95)	5 (15.15)	22 (18.33)
5	61 - 70	2 (4.17)	4 (10.26)	3 (9.09)	9 (7.50)
	Total	48 (100)	39 (100)	33 (100)	120 (100)

Note: Figures in parentheses indicate percentages to the respective column totals.

It could be concluded that the highest number of sample farmers were in the age groups of 31 years to 40 years both in small group and medium group categories, while same was highest in 41 years to 50 years category in large group of farmers

5.1.3 Literacy level

The literacy level of sample farmers is given in Table 5.3. It can be noted from the table that in case of small farmers 33.33 per cent had primary level of education, followed by illiterates (29.17%), secondary level of education (20.83 %), higher education (10.42 %) and degree (6.25 %). In medium farmers, 48.72 per cent farmers had primary education, followed by illiterates (30.77%), secondary level of education (15.38%), higher education and degree was 2.56 and 2.56 per cent respectively. In large farmers 36.36 per cent had primary level of education, followed by illiterates (33.33%), secondary level of education (15.15%), higher education (12.12%) and degree (3.03%). In pooled farmers 39.17 per cent had primary level of education, followed by illiterates (30.83%), secondary level of education (17.50%), higher education (8.33%) and degree (4.17%).

Table 5.3. Literacy level of sample farmers

S.No.	Particulars	Small	Medium	Large	Pooled
1	Illiterates	14 (29.17)	12 (30.77)	11 (33.33)	37 (30.83)
2	Primary (upto 5 th standard)	16 (33.33)	19 (48.72)	12 (36.36)	47 (39.17)
3	Secondary (6-10)	10 (20.83)	6 (15.38)	5 (15.15)	21 (17.50)
4	Higher (10+2)	5 (10.42)	1 (2.56)	4 (12.12)	10 (8.33)
5	Degree	3 (6.25)	1 (2.56)	1 (3.03)	5 (4.17)
	Total	48 (100)	39 (100)	33 (100)	120 (100)

Note: Figures in parentheses indicate percentages to the respective column totals

Hence, it is inferred that, majority of the sample farmers were educated only upto primary level, followed by the higher per cent of illiterates in all the three age groups of farmers.

5.1.4 Average size of land holding of sample farmers

A close perusal of data in Table 5.4 indicates that, the average size of holding varied from 1.11 ha. on small farmers, 2.97 ha. on medium farmers and 6.53 ha. on large farmers with an overall average of 3.20 ha. for the pooled farmers. Of the total operated area the chilli cultivated area comes under irrigated land.

It is further observed that the area under chilli crop had revealed a direct relationship with the farm size. It was of the order of 0.69, 1.47, 3.37 and 1.68 hectares on small, medium, large and pooled farmers respectively. But the per cent area under chillies to total operational farm holding area was more in small farmers. It ranged from 51.60 per cent on large farms to 62.16 per cent on small farms with an overall average of 52.50 per cent for the sample as a whole. The same on medium farms was 49.49 per cent. This clearly shows that small farms are not lagging behind to allocate more proportion of the total operational area under cash crops like chillies.

In the study area, some farmers are taken the land as leased-in land. The average leased-in land was 0.02 for small farmers, 0.30 for medium farmers, 2.18 for large farmers and 0.70 for the pooled farmers. In the study area none of the sample farmers had leased-out their land.

Table 5.4. Average size of land holding of sample farmers

S.No.	Particulars	Small	Medium	Large	Pooled
1	No. of farmers	48	39	33	120
2	Owned land (ha.)	1.08	2.66	4.35	2.49
3	Leased- in land (ha.)	0.02	0.30	2.18	0.70
4	Leased-out land (ha.)	0	0	0	0
5	Total operational holding (ha.)	53.42	115.94	215.70	385.06
6	Total chilli area (ha.)	33.18	57.47	111.29	201.94
7	Average operational farm holding (ha.)	1.11	2.97	6.53	3.20
8	Average area under chilli (ha.)	0.69	1.47	3.37	1.68
9	Area under chillies to operational holding (%)	62.11	49.49	51.60	52.50

Thus, it shows that small farmers were interested in chilli cultivation, with 62.16 per cent area under chilli, followed by large farmer (51.06%) and medium farmer (49.49%).

5.1.5 Asset structure of sample farmers

The study of the farm assets reveals the economic background of the farmers. The risk bearing ability of the farmers largely depends on the value of the assets owned. The value of farm assets according to different size groups was presented in Table 5.5. It was observed that, the per hectare value of assets ranged from Rs. 43,17,367.30 on small farms, Rs. 43,48,800.43 on medium farms to Rs. 45,10,165.98 on large farms with an average of Rs. 43,79,054.89 on pooled farms. Further, it was noticed that land, the basic resource which supports the production of all farm commodities was the single most valuable asset on the sample farms. The land value per hectare was maximum for medium farms (Rs. 43,45,131.69) followed by small farms (Rs. 43,15,209.76) and large farms (Rs. 42,66,293.81). The same was Rs 43,09,962.48 for pooled farms.

The value of assets per hectare excluding land value had a direct relationship with farm size, as it was Rs. 2,157.54 on small farms, Rs. 3,668.30 on medium farms and Rs. 2,43,872.17 on large farms.

Table 5.5. Average asset structure of sample farmers (Rs. ha⁻¹)

S. No.	Items	Small	Medium	Large	Pooled
1	No. of farmers	48	39	33	120
2	Land (Rs. ha ⁻¹)	4315209.76	4345131.69	4266293.818	4309962.48
3	Pump house (Rs. ha ⁻¹)	56.41	78.56	1518.18	460.83
3	Tractor (Rs. ha ⁻¹)	0	0	211818.18	58250
4	Cultivator (Rs. ha ⁻¹)	0	0	9909.09	2725.00
5	Pump set (Rs. ha ⁻¹)	641.02	754.23	12090.99	3795.83
6	Spades (Rs. ha ⁻¹)	197.7	244.1	228.48	221.25
7	Sickles (Rs. ha ⁻¹)	139.74	155.64	176.96	156.16
8	Sprayers (Rs. ha ⁻¹)	725.24	1948.71	7893.93	3094.17
9	Cattle shed (Rs. ha ⁻¹)	397.43	487.5	236.36	389.17
10	Value of Total Assets				
	a. Without Land Value (Rs. ha ⁻¹)	2157.54	3668.30	243872.17	69092.41
	b. With Land Value (Rs. ha ⁻¹)	4317367.30	4348800.43	4510165.98	4379054.89

It could be concluded that magnitude and pattern of value of assets excluding land, the investments on implements and machinery was more in large farmers. Large farmers are having high asset value when compared to small, medium and pooled farmers.

5.1.6 Farming experience

The process of gaining knowledge and skill is termed as experience. It is a measure of the period an individual farmer was involved in chilli production. The more the number of years of production by chilli farmers, the more knowledge

and skills gained. Farming experience influences individual perceptions and understanding of the management requirements and it is also an important factor determining both the productivity and production level in chilli cultivation.

Farming experience of the farmers is presented in Table 5.6. Majority of the small, medium, large and pooled farmers comes under the group of having 11 to 20 years of experience, which constitute to 40.83 percent in pooled group. In small farmers majorly, having 11-20 years of experience occupied first place, which constituted 47.42 per cent, followed by 21-30 years with 27.08 per cent, 31-40 years with 16.67 per cent, 1-10 years with 10.42 per cent and 41-50 years with 4.17 per cent. In medium farmers majorly having 11-20 years of experience occupied first place, which constitute 43.59 per cent, followed by 21-30 years with 28.21 per cent, 31-40 years with 12.82 per cent, 1-10 years with 10.26 per cent and 40-50 years with 5.13 per cent. In large farmers majorly having 21-30 years of experience occupied first place, which constitute 36.36 per cent, followed by 11-20 years with 27.27 per cent, 31-40 years with 21.21 per cent, 41-50 years with 9.09 per cent and 1-10 years with 6.06 per cent. In pooled farmers majorly having 11-20 years of experience occupied first place, which constitute 40.83 per cent, followed by 21-30 years with 27.50 per cent, 31-40 years with 16.67 per cent, 1-10 years with 9.17 per cent and 41-50 years with 5.83 per cent. These results indicated that most of the chilli farmers are categorized in the classes of 11years -20 years of experience in chilli farming.

Table 5.6. Years of experience of chilli farmers

S.No.	Framing Experience (Years)	Small (No.)	Medium (No.)	Large (No.)	Pooled (No.)
1	1 - 10	5 (10.42)	4 (10.26)	2 (6.06)	11 (9.17)
2	11- 20	23 (47.42)	17 (43.59)	9 (27.27)	49 (40.83)
3	21 - 30	10 (20.83)	11 (28.21)	12 (36.36)	32 (27.50)
4	31 - 40	8 (16.67)	5 (12.82)	7 (21.21)	21 (16.67)
5	41 - 50	2 (4.17)	2 (5.13)	3 (9.09)	7 (5.83)
	Total	48 (100)	39 (100)	33 (100)	120 (100)

Note: Figures in parentheses indicate percentages to the respective column totals

The farming experience could be related to the age group of different groups of farmers. As most of small and medium farmers belong to 31 years to 40 years age group, they are having lesser farming experience of 10 years to 20 years, while large farmers were high in number in the age group of 41 years to 50 years and hence had larger farming experience of 21 years to 30 years.

5.2 COST OF CULTIVATION OF CHILLI

To facilitate discussion and comparison of economics of chilli cultivation, an attempt has been made to project, the results of the study on a comparative basis according to farm size.

5.2.1 Labour utilization

Labour is an important input in the production process. The labour employed on the farm depends on the nature of operation, size of the farm, type of the crop and availability of the labour.

5.2.1.1 Human labour utilization

Human labour is one of the important input services influencing the cost structure. Successful completion of every farm operation requires some amount of human labour. The use of this input service depends on the type and size of the enterprise. The operation wise human labour utilization in chilli production is presented in Table 5.7.

A close scrutiny of Table 5.7, Fig.1, Fig. 2, Fig. 3 and Fig. 4 revealed that, on an average, human labour employed was 344.84 man days per hectare in chilli production in which the family labour contribution was 71.55 man days (20.75%) and the rest 273.29 man days (79.25%) by hired labour. The total human labour utilized per hectare of chilli was 299.98, 331.62 and 364.51 man days for small, medium and large farmers respectively. Thus, the human labour utilization had a direct relationship with farm size. The family labour utilization was 76.57 man days (25.42%) on small farmers, 72.07 man days (21.73%) on medium farmers and 70.62 man days (19.37%) on large farmers. The hired

human labour utilization in chilli cultivation was 223.43 man days on small farmers, 259.54 man days and 293.89 man days for medium and large farmers respectively which showed a direct relationship with farm size.

It is also clear from the Table 5.7 that, among all the operations, harvesting involved more human labour (196.75 man days per hectare) followed by irrigation (56.12 man days per hectare), plant protection chemicals application (29.20 man days per hectare) and transplanting (23.31 man days per hectare). Other operations where human labour was employed were weeding, fertilizer application, drying and grading, manuring, bund formation, packing and nursery bed preparation accounted for 10.7, 9.56, 7.41, 4.89, 3.83, 2.46 and 0.61 per cent respectively of the total human labour utilization. More or less same trend persisted in all the size groups with reference to human labour utilization.

Table 5.7. Operation wise human labour utilization in chillies according to farm size**(Man days ha⁻¹)**

S.No.	Particulars	Small farmers	Medium farmers	Large farmers	Pooled farmers
1	Manuring	5.22 (1.74)	5.01 (1.51)	5.8 (1.59)	4.89 (1.42)
2	Nursery bed preparation	0 (0)	0.05 (0.02)	1.08 (0.30)	0.61 (0.18)
3	Transplanting	21 (7.00)	24.19 (7.29)	23.37 (6.41)	23.31 (6.76)
4	Bund formation	4.18 (1.39)	3.51 (1.06)	4.26 (1.17)	3.83 (1.11)
5	Weeding	12.84 (4.28)	11.83 (3.57)	9.65 (2.65))	10.7 (3.10)
6	Fertilizer application	9.64 (3.21)	10.67 (3.22)	9.72 (2.37)	9.56 (2.77)
7	Plant protection chemicals applying	26.93 (8.98)	30.29 (9.13)	29.31 (8.04)	29.2 (8.47)
8	Irrigation	45.74 (15.25)	51.73 (15.60)	59.67 (16.37)	56.12 (16.27)
9	Picking / Harvesting	163.13 (54.38)	183.61 (55.37)	212.64 (58.34)	196.75 (57.06)
10	Drying and grading	8.86 (2.95)	8.28 (2.50)	6.53 (1.79)	7.41 (2.15))
11	Packing	2.44 (0.81)	2.45 (0.74)	2.48 (0.68)	2.46 (0.71)
	Total	299.98 (100)	331.62 (100)	364.51 (100)	344.84 (100)
	Owned labour	76.57 (25.42)	72.07 (21.73)	70.62 (19.37)	71.55 (20.75)
	Hired labour	223.43 (75.48)	259.54 (78.27)	293.89 (80.62)	273.29 (79.25)

Note: Figures in parentheses indicate percentages to the respective column totals

It is inferred from table 5.7 that total human labour utilization in chilli was high in large farmer group followed by the medium farmer and small farmer. However, the family labour component was high both in terms percentage and units in small farmer category, followed by medium farmer and large farmer.

Of all the operations harvesting consumed more than 50 per cent of total labour utilization in all the groups.

5.2.1.2 Machine power utilization

The analytical findings of Table 5.8 reveal that, the machinery use was highest at 36.70 hours per hectare on large farmers followed by 34.51 hours on medium farmers and 32.31 hours on small farmers, while it was 35.49 hours on pooled farmers. Machinery use showed a positive relationship with the size of holding indicating a greater degree of mechanization on large farms. Among different farm operations, higher use of machinery (tractor) power was with reference to ploughing recorded 18.17 hours of tractor use followed by inter cultivation with 16.11 hours and line marking with 1.21 hours which accounted for 51.20 per cent, 45.39 per cent and 3.41 per cent of the total tractor use respectively on pooled farms. The same trend was noticed on small and large farmers. But, in medium farmers inter cultivation consumed higher machinery power 17.12 hours of tractor use followed by ploughing with 16.28 hours and marking with 1.11 which accounted for 49.21 per cent, 47.17 per cent and 3.22 per cent respectively.

Table 5.8. Operation wise machine power utilization in chilli Cultivation (Hrs. ha⁻¹)

S.No.	Particulars	Small farms	Medium farms	Large farmers	Pooled farmers
1	Ploughing	15.66 (48.47)	16.28 (47.17)	19.54 (53.24)	18.17 (51.20)
2	Line Marking	1.38 (4.27)	1.11 (3.22)	1.22 (3.32)	1.21 (3.41)
3	Inter cultivation	15.27 (47.26)	17.12 (49.61)	15.94 (43.43)	16.11 (45.39)
	Total	32.31 (100)	34.51 (100)	36.7 (100)	35.49 (100)

Note: Figures in parentheses indicate percentages to the respective column totals

5.2.1.3 Bullock labour utilization

The bullock labour utilization was very much less when compared to machine labour utilization in chilli cultivation in sampled area. Chilli farmers are not utilizing bullock labour frequently because of non-availability of work cattle population in the study area and also because the same work can be done by machine labour effectively with in less time.

5.2.2 Material inputs

Production of farm commodities not only require input services *viz.*, human labour, cattle labour and machinery services, but also require material inputs like manures, seedlings, chemical fertilizers and plant protection chemicals *etc.*, Table 5.9. shows the details on material inputs used in chilli cultivation per hectare on different size groups.

The manures used by the small, medium, large and pooled farmers was 7.45, 8.34, 8.62 and 8.36 respectively. The seedlings used by the farmers was more in medium farmers (25,645.25) when compared to small farmers (23,434.56) and large farmers (24,424.61).

Table 5.9. Material inputs used in chilli cultivation per hectare

S.No.	Particulars	Size group			
		Small	Medium	Large	Pooled
1	Manures (Tonnes)	7.45	8.34	8.62	8.36
2	Seedlings (No.)	23434.56	25645.25	24424.61	23863.7
3	Chemical fertilizers (Kgs)				
	Nitrogen	534.32	570.61	590.42	557.28
	Phosphorous	66.53	76.25	75.84	70.27
	Potassium	134.41	143.46	160.75	145.18
4	Plant protection chemicals (lts)				
	Liquids	14.74	17.88	21.04	19.11

The chemical fertilizers used by the all size groups was more than the recommended dose for hybrid chilli cultivation (500 N- 60 P – 120 K) which is total of 680 kg per hectare. Large farmers are occupied first place in utilizing the chemical fertilizers with 827.07 kg per ha. followed by medium farmers (790.32), pooled farmers (772.73) and small farmers (735.26)

The plant protection chemical application was highly applying in the study area, large farmers are occupied first place in utilizing the plant protection chemicals with 21.04 liters per hectare followed by pooled farmers was 19.11 lts per ha., medium farmers was 17.88 lts per ha. and small farmers was 14.74 lts per ha.

5.2.3 Cost of cultivation of chilli

The profitability of any enterprise depends upon costs and returns. Generally, costs in any economic study are discussed under two heads *viz.*, variable costs and fixed costs. In general, variable costs alone are reckoned as the cost of cultivation by the farmers and profit and loss are worked out ignoring the fixed costs. But, in the economic analysis of any business enterprise, the fixed costs are also taken into account to arrive at total costs and compute net profits.

The variable costs of chilli farmers included costs on seeds, land preparation, manure, nursery bed preparation, bund formation, marking, transplanting, inter-cultivation, weeding, fertilizer application, spraying of plant protection chemicals, irrigation, picking/ harvesting, packing and interest on working capital. The fixed costs include the land revenue, depreciation charges, rental value of owned land and interest on fixed capital. The particulars of the cost of cultivation of chilli and share of different operational costs and total fixed costs per hectare for small, medium, large and pooled farmers are presented in Table 5.10.

The total cost of cultivation (TCOC) of chilli was worked out to be Rs. 3,93,872.67 per hectare for pooled farmers. The average per hectare TCOC cost of cultivation increase with the increase in the size of the holdings from Rs. 3,53,443.07 on small farmers, Rs. 3,90,393.17 on medium farmers to

Rs. 4,10,188.71 on large farmers indicating a direct relationship with the size of the holding. This was due to intensive use of inputs by large farmers. These results are consistent with Reddy *et al.* (2011).

It was found that the variable costs accounted for a major share in the TCOC on all categories of farms (Fig. 5.9). The total per hectare operational costs ranged from Rs. 3,07,831.87 (87.10%) on small farmers, Rs. 3,40,858.62 (87.31%) on medium farmers to Rs 3,57,266.15 (87.10%) on large farmers, with an overall average of Rs 3,43,863.98 (87.30%) on pooled farms these results are in-line with Patel *et al.* (2015) and Reddy *et al.* (2011)

It is evident from Table 5.10 and Fig 5.8 that, the cost of human labour was the major cost component among variable costs with an amount of Rs. 1,17,137.69 per hectare accounting for 29.74 per cent of TCOC on pooled farmers. The same was Rs. 1,01,895.32 on small farmers, Rs. 1,12,226.51 on medium farmers and Rs. 1,24,218.65 on large farmers accounting for 28.83, 28.75 and 30.28 per cents of their respective TCOC (Fig. 5.5, Fig. 5.6 and Fig. 5.7 and Fig. 5.8).

Thus, from the stand point of human labour utilization, it is seen that harvesting, irrigation, weeding and application of plant protection chemicals were the important operations which require large quantum of human labour.

The next important item of operational cost was irrigation charges which accounted to an amount of Rs. 86,707.83 on pooled farmers accounting for 22.01 per cent. The same was Rs. 78951.46 (22.34%) on small farmers, Rs. 83735.57 (21.45%) on medium farmers and Rs. 90,555.41 (22.08%) on large farmers. The other items of expenditure in the order of importance were plant protection chemical costs (10.29%), fertilizers costs (8.00%), Machine labour cost (7.05%), seed cost (5.47%), manure (2.12%), interest on working capital (1.75%), miscellaneous expenses (0.83%) and bullock labour (0.03%) respectively for pooled farms. More or less same trend was followed across all the size groups, which was almost similar with the study of Rajur *et al.* (2008).

Fixed costs per hectare were estimated at Rs. 45,611.21, Rs. 49,534.45, Rs. 52,922.55 and Rs. 50,008.68 accounting for 12.90 per cent, 12.69 per cent, 12.90 per cent and 12.70 per cent of TCOC on small, medium, large and pooled farmers respectively as shown in Table 5.10. The rental value of owned land was the major cost item among the fixed costs which accounted for 12.58, 12.34, 11.12 and 11.64 per cents on small, medium, large and pooled farmers. Depreciation and interest on fixed capital were other fixed cost items accounting for 0.03 and 0.89 per cents respectively on pooled farms as the farm asset position was very low in all the three groups of farmers.

The seedlings was used by the all of the small and most of the medium farmers. In large farmers majorly they go for growing of chilli nursery. So, the cost incurred on the seeds was less when compared to small and large farmers.

The overall analysis of TCOC of chilli crop revealed that, the large farmers incurred higher costs than small farmers and medium farmers. This was mainly because of intensive use of human labour, number of irrigations and pesticides used by the large farmers compared to small and medium farmers.

The above findings indicated that chilli crop in general was high labour intensive crop besides higher requirement of Irrigation. This finding was in conformity with the results obtained by Srikala *et al.* (2016) in their study revealed that the cost of human labour constitutes 40 per cent of total cost of cultivation. Rajur *et al.* (2008) and Shukla (2010) revealed that the labour costs occupies more than 36 per cent in the total cost of cultivation.

Table 5.10. Item wise cost of cultivation of chilli farmers in sample area

(Rs. ha⁻¹)

S. No.	Particulars	Size groups			
		Small	Medium	Large	Pooled
A.	Variable costs				
i	Seeds / seedlings	24812.9 (7.02)	27781.83 (7.13)	17372.07 (4.24)	21557.11 (5.47)
ii	Human labour	101895.32 (28.83)	112226.51 (28.75)	124218.65 (30.28)	117137.69 (29.74)
	a. hired labour	74030.27 (20.95)	87013.61 (22.29)	98691.87 (24.06)	91315.98 (23.18)
	b. family labour	27865.04 (7.88)	25212.90 (6.46)	25526.78 (6.22)	25821.70 (6.56)
iii	Bullock labour	195.87 (0.06)	208.82 (0.05)	71.88 (0.02)	131.23 (0.03)
iv	Machine labour	24875.74 (7.04)	27111.39 (6.94)	28960.12 (7.06)	27762.85 (7.05)
v	Insecticides, pesticides and herbicides	32051.97 (9.07)	40066.36 (10.26)	44357.42 (10.81)	40516.74 (10.29)
vi	Manure	7518.46 (2.13)	8352.67 (2.14)	8626.03 (2.10)	8366.24 (2.12)
vii	Fertilizers	28637.59 (8.10)	31480.95 (8.06)	32401.82 (7.90)	31521.2 (8.00)
viii	Irrigation charges	78951.46 (22.34)	83735.57 (21.45)	90555.41 (22.08)	86707.83 (22.01)
ix	Miscellaneous expenses	2733.41 (0.77)	3074.56 (0.79)	3554.50 (0.87)	3282.99 (0.83)
x	Interest on working capital	6159.15 (1.74)	6819.95 (1.75)	7148.24 (1.74)	6880.08 (1.75)
	Total variable cost	307831.87 (87.10)	340858.62 (87.31)	357266.15 (87.10)	343863.98 (87.30)
B.	Fixed costs				
i.	Depreciation	175.39 (0.05)	87.41 (0.02)	470.1 (0.11)	136.64 (0.03)
ii.	Land revenue/ cesses and other taxes	500 (0.14)	500 (0.13)	500 (0.12)	500 (0.13)
iii.	Rental value of owned land	44478.26 (12.58)	48184.50 (12.34)	45619.6 (11.12)	45860.15 (11.64)
iv.	Interest on fixed capital	457.56 (0.13)	762.54 (0.20)	6332.85 (1.54)	3511.89 (0.89)
	Total fixed cost	45611.21 (12.90)	49534.45 (12.69)	52922.55 (12.90)	50008.68 (12.70)
C.	Total cost (A+B)	353443.07 (100)	390393.17 (100)	410188.71 (100)	393872.67 (100)

Note: Figures in parentheses indicate percentages to the respective column totals.

Though the variable costs, fixed costs and total costs were varying in the three groups of farmers, the per cent contribution of variable costs and fixed costs to total costs remind same in all the three groups. The large farmers were including high cost of cultivation, followed by medium and small group of farmers, inferring that the total cost of cultivation was varying directly with the farm size.

5.2.4 Cost concepts in chilli cultivation

The cost of cultivation of a crop is not uniquely defined on account of the fact that various components of cost differ in their economic significance and therefore, it becomes necessary to work out aggregate costs differing in composition. Hence, the cost of production of chillies was also dealt by adopting the cost concepts, which were worked out as suggested by CACP. The cost concepts Cost A₁, Cost A₂, Cost B₁, Cost B₂, Cost C₁, Cost C₂ and Cost C₃ were worked out in the study.

Of all the cost concepts, cost C₂ is the most comprehensive cost as it covers all the variable costs and fixed costs. The TCOC of chilli according to cost concepts was worked out and presented in Table 5.11 and Fig. 5.10. In the study area, the rent paid for leased-in land and rent for owned land were same.

On an average, the cost C₂ (TCOC) of chilli per hectare was Rs. 3,93,872.65 on pooled farmers. It was highest on large farmers (Rs. 4,10,188.71) as compared to small farmers (Rs. 3,53,443.07) and medium farmers (Rs. 3,90,393.17) indicating a direct relationship with farm size. These findings were consistent with the Rajur *et. al* (2008) and Olayiwola (2014) in their analysis cost of cultivation was more in large farmers and less in small farmers. The Same trend was showed in Cost C₁ and Cost C₃.

It is found from the data, that Cost A₁ ranged between Rs.2,80,642.21 on small farms to Rs.3,32,709.47 on large farms with an average of Rs.3,18,678.91 per hectare. The high value of cost A₁ on large farmers was due to higher expenditure incurred on items like hired human labour, Irrigation, fertilizers, plant protection and machine power. Cost A₂ was minimum (Rs.3,25,120.47) on small farms and increased with the increase in farm size. It was Rs.3,64,539.06 per hectare for the pooled farmers.

Cost B_1 was of the order of Rs. 2,81,099.77, Rs. 3,16,995.77 and Rs. 3,39,042.32 on small, medium and large farmers respectively, with an average of Rs. 3,22,190.80 per hectare for the pooled farmers. Cost B_2 was Rs. 3,25,578.03, Rs. 3,65, Rs. 180.27, 3,84,661.93 and Rs. 3,68,050.95 on small, medium, large and pooled farmers respectively.

Table 5.11. Cost of cultivation of chillies as per cost concepts

(Rs. ha⁻¹)

S.No.	Particulars	Size groups				
		Small	Medium	Large	Pooled	
1	Cost A₁: Cultivation costs					
	i	Seeds / seedlings	24812.90 (6.38)	27781.83 (6.47)	17372.07 (3.85)	21557.11 (4.98)
	ii	Hired human labour	74030.27 (19.04)	87013.61 (20.26)	98691.86 (21.87)	91315.98 (21.08)
	iii	Bullock labour	195.87 (0.05)	208.82 (0.05)	71.88 (0.02)	131.22 (0.03)
	iv	Machine labour	24875.74 (6.40)	27111.39 (6.31)	28960.12 (6.42)	27762.85 (6.41)
	v	Plant protection chemicals	32051.97 (8.24)	40066.36 (9.33)	44357.42 (9.83)	40516.75 (9.35)
	vi	Manure	7518.46 (1.93)	8352.67 (1.95)	8626.03 (1.91)	8366.24 (1.93)
	vii	Fertilizers	28637.59 (7.37)	31480.95 (7.33)	32401.82 (7.18)	31521.20 (7.28)
	viii	Irrigation charges	78951.46 (20.31)	83735.57 (19.50)	90555.41 (20.07)	86707.84 (20.01)
	ix	Depreciation	175.39 (0.05)	87.41 (0.02)	470.11 (0.10)	136.64 (0.03)
	xii	Land revenue	500 (0.13)	500 (0.12)	500 (0.11)	500 (0.12)
	xii	Interest on working capital	6159.15 (1.58)	6819.96 (1.59)	7148.24 (1.58)	6880.09 (1.59)
	ix	Miscellaneous expenses	2733.41 (0.70)	3074.56 (0.72)	3554.50 (0.79)	3282.99 (0.76)
	Cost A₁		280642.21 (72.18)	316233.13 (73.64)	332709.47 (73.74)	318678.91 (73.55)
2	Cost A₂		325120.47 (83.62)	364417.63 (84.86)	378329.07 (83.85)	364539.06 (84.14)
3	Cost B₁		281099.77 (72.30)	316995.77 (73.82)	339042.32 (75.14)	322190.80 (74.36)
4	Cost B₂		325578.03 (83.74)	365180.27 (85.04)	384661.93 (85.25)	368050.95 (84.95)
5	Cost C₁		308964.81 (79.47)	342208.67 (79.69)	364569.10 (80.81)	348012.50 (80.32)
6	Cost C₂		353443.07 (90.91)	390393.17 (90.91)	410188.71 (90.91)	393872.65 (90.91)
7	Cost C₃		388787.38 (100)	429432.49 (100)	451207.57 (100)	433259.92 (100)

Note: Figures in parentheses indicate percentages to the respective column totals.

5.2.5 Output and returns from chilli production

From the Table 5.12, It is clear that, the large farmers recorded higher yield of 42.29 quintals of chilli compared to small farmers (32.75) and medium farmers (36.97) per hectare, which accounted to 36.75 quintals on pooled farmers. High yields on large farmers was due to the efficient usage of the fertilizers and number of irrigations in a critical period of the crop cultivation of chilli. The gross returns obtained by small, medium, large and pooled farmers were Rs. 4,04,535.53, Rs. 4,59,363.37, Rs. 5,27,023.05 and Rs. 4,56,150.56 respectively. The net returns obtained by small, medium, large and pooled farmers were Rs. 51,092.46, Rs. 68,970.17, Rs. 1,16,834.34 and Rs. 62,277.91 respectively. Thus the gross and net returns from chilli crop were higher on large farmers compared to small and medium farmers (Fig 5.9) and accordingly rate of return per rupee spent was also higher on large farmers (0.28) followed by medium (0.18) and small (0.14). At pooled level, the rate of return was 0.16. Thus, the rate of return increases with increase in farm size and in terms of cost, the cost of production decreases with increase in farm size as shown in Table 5.12 under economies of large scale production.

Table 5.12. Output and returns of chilli farms per hectare

S.No	Particulars	Small farmers	Medium farmers	Large farmers	Pooled farmers
1	Yield (q ha-1)	32.75	36.97	42.29	36.75
2	Price per quintal	12352.23	12425.30	12462.12	12412.26
3	Gross returns (Rs ha-1)	404535.53	459363.34	527023.05	456150.56
4	Total costs (Rs ha-1)	353443.07	390393.17	410188.71	393872.65
5	Net returns (Rs ha-1)	51092.46	68970.17	116832.34	62277.91
6	Rate of return (%)	0.14	0.18	0.28	0.16
7	Cost of production (Rs. q ⁻¹)	10792	10560	9699	10718

It could be inferred that though the cost of cultivation was increasing with farm size group, the cost of production was decreasing with increasing farm size, indicating that operation of economics of size. Thus in chilli production large farmers are more benefited than the other two groups. It was also confirmed with the higher rate of return in large farmer, followed by medium group and small group of farmers.

5.2.6 Measures of farm income

An important aspect of farm business management and decision making relates to the manner in which the available resources are allocated. A measuring rod is necessary to evaluate the optimal use of resources. To achieve this objective, various farm efficiency measures *viz.*, gross income, net income, farm business income, family labour income, farm investment income and rate of returns were computed and are presented in Table 5.13.

Gross income exhibited a direct relationship with the farm size and it was of the order of Rs. 4,04,535.53, Rs. 4,59,363.34, Rs. 5,27,023.05 and Rs. 4,56,150.56 on small, medium, large and pooled farmers respectively. The gross income was more on large farmers due to highest productivity compared to other categories of farmers. Though the gross income is a measure to assess the efficiency of the farm business, it alone does not help us to gauge the success of the farm business. Therefore, another measure namely net income, which represents a surplus of gross income over total costs was estimated. The net income showed a direct relationship with the farm size. Large farmers recorded a net income of Rs. 1,16,832.34 against Rs. 51,092.46 and Rs. 68,970.17 on small farms and medium farmers respectively. The same was Rs. 62,227.91 on pooled farmers.

Farm business income, which indicates returns on owned resources like land, labour and capital was also more on large farmers (Rs. 1,94,313.58) as compared to small farmers (Rs. 1,23,893.32) and medium farmers (Rs. 1,43,130.21), which means the large farmers were superior to small and medium farmers in effective usage of these resources.

Family labour income is another measure of farm efficiency representing the returns from farmer's own labour and family labour. Large farmers derived family labour income amounting to Rs. 1,42,361.12, while it was Rs. 78,957.50 and Rs. 94183.07 on small and medium farmers respectively. The same on pooled farms was Rs. 88,099.61.

Table 5.13. Measures of farm income in chilli production (Rs. ha⁻¹)

S.No.	Particulars	Small farmers	Medium farmers	Large farmers	Pooled farmers
1	Gross income	404535.53	459363.34	527023.05	456150.56
2	Net income	51092.46	68970.29	116832.34	62277.91
3	Farm business income	123893.32	143130.21	194313.58	137471.65
4	Family labour income	78957.50	94183.07	142361.12	88099.61
5	Farm investment income	96028.28	117917.21	168786.79	111649.95

Farm investment income, a measure of returns to fixed capital was Rs. 96,028.28, Rs. 1,17,917.31, Rs. 1,68,786.80 and Rs. 1,11,649.95 on small, medium large and pooled farms respectively. Thus, all the farm income measures were increasing with farm size in chilli production.

5.3 ECONOMIC EFFICIENCY OF CHILLI PRODUCTION

Knowing price or the unit cost for the actual amount of resources combinations helps to estimate the economic efficiency. The estimated and distribution of technical, allocative and economic efficiency levels using the CRS-DEA model is presented here under for the different farm size groups.

5.3.1 Small farmers

The results of the efficiency scores for small farmers in Technical efficiency (TE), Allocative efficiency (AE) and Economic efficiency (EE) among chilli farmers are indicated in Table 5.14. The mean TE was found to be 84.70 per cent. Similarly, the mean AE and EE of sample farmers were 83.10 per cent and 70.30 per cent, respectively. The model output indicates that sample small farmers in the study area were relatively good in TE than AE and EE.

It was observed that only about 27.08 per cent of farms under constant returns to scale performed with technical efficiency level equal to 0.90 or greater, *i.e.* 13 of the total 48 farmers. The mean efficiency score was 0.847. Based on this, it could be inferred that remaining 35 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 15.30 per cent and maintain the same level of chilli production as achieved by 27.08 per cent of the farmers.

It was observed that only about 18.75 per cent of farmers performed with technical efficiency level equal to 0.90 or greater are efficient, *i.e.* 9 of the total 48 farmers. The average efficiency score was 0.831. Based on this, it could be inferred that remaining 39 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 16.90 per cent and maintain the same level of chilli production as achieved by 18.75 per cent of the farmers.

The mean economic efficiency level (70.30%) indicated that farmers could reduce the current average cost of production by 29.70 per cent to achieve the potential minimum cost level without reducing output levels. It was observed that only about 14.58 per cent of farmers are efficient, *i.e.* 7 of the total 48 farmers. It can be inferred that if small farmers in the study area were to achieve 100 per cent economic efficiency, they would experience substantial production cost saving of 29.70 per cent.

The level of TE among the small households was presented in Table 5.14. The small farmers had ranges of 68.40 per cent to 100 per cent, which showed that the majority of the sample households had TE score of 80 per cent to 90 per cent. But there are also 18 sample households which contributed about 37.50 per cent, whose TE levels were limited to the range of 60 per cent to 80 per cent. Sample farmers in this group had room to enhance their chilli production at least by 20 per cent, on an average.

According to the results showed in Table 5.14, the AE distribution scores indicate that the largest efficiency group of chilli producers (35.42%) operated between 80 per cent and 90 per cent. Farmers in this group could save at least 10 per cent of their current cost of inputs by behaving in a cost-minimizing way.

Table 5.14. Frequency distribution of TE, AE and EE of small farmers

Efficiency categories	Technical efficiency		Allocative efficiency		Economic efficiency	
	Freq.	Percentage	Freq.	Percentage	Freq.	Percentage
$E < 0.1$	0	0	0	0	0	0
$0.1 < E \leq 0.2$	0	0	0	0	0	0
$0.2 < E \leq 0.3$	0	0	0	0	0	0
$0.3 < E \leq 0.4$	0	0	0	0	0	0
$0.4 < E \leq 0.5$	0	0	0	0	3	6.25
$0.5 < E \leq 0.6$	0	0	6	12.50	2	4.17
$0.6 < E \leq 0.7$	6	12.5	4	8.33	13	27.08
$0.7 < E \leq 0.8$	11	22.92	12	25.00	14	29.16
$0.8 < E \leq 0.9$	18	37.50	17	35.42	9	18.75
$0.9 < E \leq 1.0$	13	27.08	9	18.75	7	14.58
Efficient	13	27.08	9	18.75	7	14.58
Inefficient	35	72.92	39	81.25	41	85.42
Total	48	100.00	48	100.00	48	100.00
Maximum	1		1		1	
Minimum	0.684		0.591		0.487	
Mean score	0.847		0.831		0.703	

Note: E = Efficiency ; Freq = Frequency

The distribution of EE scores implied that about 29.16 per cent of the farmers were operating between the economic efficiency levels of 70 per cent and 80 per cent. The small group farmers could save at least 20 per cent of their current cost of inputs by behaving in a cost-minimizing way. The low level of EE was the total effect of both technical and allocative inefficiencies.

5.3.2 Medium farmers

The results of the efficiency scores in Technical efficiency (TE), Allocative efficiency (AE) and Economic efficiency (EE) among chilli farmers are indicated in Table 5.15. The mean TE was found to be 87.20 per cent. Similarly, the mean AE and EE of sample farmers were 85.90 per cent and 74.90 per cent, respectively. The model output indicates that sample medium farmers in the study area were relatively good in TE than AE and EE.

It was observed that only about 28.21 per cent of farms under constant returns to scale performed with technical efficiency level equal to 0.90 or greater, *i.e.* 11 of the total 39 farmers. The mean efficiency score was 0.872. Based on this, it could be inferred that remaining 26 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 12.80 per cent and maintain the same level of chilli production as achieved by 28.21 per cent of the farmers.

The mean score of AE was 85.90 per cent. The results indicates that on average sample farmers in the study area could increase chilli output by 14.10 per cent. In other words, cost of production could be reduced by 14.10 per cent had farmers used the right inputs and low input costs.

Farmer with mean economic efficiency level could reduce the current average cost of production by 25.10 per cent to achieve the potential minimum cost level without reducing output levels. It can be inferred that if farmers in the study area were to achieve 100 per cent economic efficiency, they would experience substantial production cost saving of 25.10 per cent.

It was observed that only about 15.38 per cent of farms *i.e.* six of the total 39 farmers under constant returns to scale performed with economic efficiency level equal to 0.90 or greater. The mean efficiency score was 0.749. Based on this, it could be inferred that remaining 33 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 25.10 per cent and maintain the same level of chilli production as achieved by 15.38 per cent of the farmers.

The level of TE among the sample households was presented in Table 5.15. The medium farmers had ranges of 57.20 per cent to 100 per cent, and the result showed that the majority of the sample households had TE score of 70 per cent to 80 per cent which constituted to 41.03 per cent. But there are also 10 sample households accounted to 25.64 per cent whose TE levels were limited to the range of 40 per cent to 70 only. Sample farmers in this group have room to enhance their chilli production at least by 30 per cent, on average. Out of the

total sample farmers, 15.38 per cent of the farmers had TE of greater than 90 per cent. This implies that around 71.80 per cent of the sample farmers could increase their production to reach maximum efficiency.

According to the results showed in Table 5.15, the AE distribution scores indicated that the largest efficiency group of chilli producers (38.46%) operated between 70 per cent and 80 per cent. Farmers in this group could save at least 20 per cent of their current cost of inputs by behaving in a cost-minimizing way. Only 20.52 per cent of the total sample farmers had an AE score that ranged between 91 per cent and 100 per cent. This showed that majority of chilli producing farmers (79.49%) could reduce their current input cost by reallocation of resources in a cost minimizing way.

Table 5.15. Frequency distribution of TE, AE and EE of medium farmers

Efficiency categories	Technical efficiency		Allocative efficiency		Economic efficiency	
	Freq.	Percentage	Freq.	Percentage	Freq.	Percentage
$E < 0.1$	0	0	0	0	0	0
$0.1 < E \leq 0.2$	0	0	0	0	0	0
$0.2 < E \leq 0.3$	0	0	0	0	0	0
$0.3 < E \leq 0.4$	0	0	0	0	0	0
$0.4 < E \leq 0.5$	0	0	1	2.56	1	2.56
$0.5 < E \leq 0.6$	2	5.12	3	7.69	2	5.13
$0.6 < E \leq 0.7$	4	10.25	8	21.51	7	17.95
$0.7 < E \leq 0.8$	8	20.51	15	38.46	16	41.03
$0.8 < E \leq 0.9$	14	35.90	4	10.26	7	17.95
$0.9 < E \leq 1.0$	11	28.21	8	21.52	6	15.38
Efficient	11	28.21	8	21.52	6	15.38
Inefficient	28	71.79	31	79.48	33	84.61
Total	39	100.00	39	100.00	39	100.00
Maximum	1		1		1	
Minimum	0.572		0.523		0.478	
Mean score	0.872		0.859		0.749	

Note: E = Efficiency ; Freq = Frequency

The distribution of EE scores implied that about 41.03 per cent of the farmers were operating between the economic efficiency levels of 70 per cent and 80 per cent. The medium group farmers could save at least 20 per cent of their current cost of inputs by behaving in a cost-minimizing way. The low level of EE was the total effect of both technical and allocative inefficiencies.

5.3.3 Large farmers

The results of the efficiency scores for large farmers in Technical efficiency (TE), Allocative efficiency (AE) and Economic efficiency (EE) among chilli farmers are indicated in Table 5.16. The mean TE was found to be 92.60 per cent. Similarly, the mean AE and EE of sample farmers were 86.90 per cent and 80.40 per cent, respectively. The model output indicates that sample large farmers in the study area were relatively good in TE than AE and EE.

It was observed that only about 27.27 per cent of farms under constant returns to scale performed with technical efficiency level equal to 0.90 or greater, *i.e.* 9 of the total 33 farmers. The mean efficiency score was 0.926. Based on this, it could be inferred that remaining 24 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 7.40 per cent and maintain the same level of chilli production as achieved by 27.27 per cent of the farmers.

The mean score of AE was 86.90 per cent. The results indicated that on an average large farmers in the study area could increase chilli output by 13.10 per cent or cost of production could be reduced by 13.10 per cent had farmers used the right inputs and outputs mix relative to input costs and output prices.

Farmer with an average economic efficiency level could reduce the current average cost of production by 19.60 per cent to achieve the potential minimum cost level without reducing output levels. It could be inferred that if farmers in the study area were to achieve 100 per cent economic efficiency, they would experience substantial production cost saving of 19.60 per cent.

It was observed that only about 18.18 per cent of farms *i.e.* six of the total 33 farmers under constant returns to scale performed with economic efficiency level equal to 0.90 or greater. The mean efficiency score was 0.804. Based on this, it could be inferred that remaining 27 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 19.60 per cent and maintain the same level of chilli production as achieved by 18.18 per cent of the farmers.

The level of TE among the large sample households was presented in Table 5.16. The sample farmers had ranges of 57.80 per cent to 100 per cent, the result showed that the majority of the sample households have TE score of 80 per cent to 90 per cent. However, there are also sample 16 households which contributed about 48.33 per cent, whose TE levels were limited to the range of 50 per cent to 80 per cent. Sample farmers in this group had room to enhance their chilli production at least by 20 per cent, on average. Out of the total sample farmers, 27.27 per cent of the farmers have TE of greater than 90 per cent. This implies that around 78.79 per cent of the sample farmers could increase their production to reach maximum efficiency.

According to the results showed in Table 5.16, the AE distribution scores indicate that the largest efficiency group of chilli producers (36.36%) operated between 80 per cent and 90 per cent. Farmers in this group could save at least 10 per cent of their current cost of inputs by behaving in a cost-minimizing way. Only 18.18 per cent of the total sample farmers had an AE score that ranged between 91 per cent and 100 per cent. This shows that almost chilli producing farmers (81.82%) could reduce their current input cost by reallocation of resources in cost minimizing way.

Table 5.16. Frequency distribution of TE, AE and EE of large farmers

Efficiency categories	Technical efficiency		Allocative efficiency		Economic efficiency	
	Freq.	Percentage	Freq.	Percentage	Freq.	Percentage
$E < 0.1$	0	0	0	0	0	0
$0.1 < E \leq 0.2$	0	0	0	0	0	0
$0.2 < E \leq 0.3$	0	0	0	0	0	0
$0.3 < E \leq 0.4$	0	0	0	0	0	0
$0.4 < E \leq 0.5$	0	0	0	0	0	0
$0.5 < E \leq 0.6$	5	15.15	0	0	2	6.06
$0.6 < E \leq 0.7$	2	6.06	10	30.30	5	15.15
$0.7 < E \leq 0.8$	6	18.18	5	15.15	9	27.27
$0.8 < E \leq 0.9$	11	33.33	12	36.36	11	33.33
$0.9 < E \leq 1.0$	9	27.27	6	18.18	6	18.18
Efficient	9	27.27	6	18.18	6	18.18
Inefficient	24	72.73	27	81.82	27	81.82
Total	33	100.00	33	100.00	33	100.00
Maximum	1		1		1	
Minimum	0.528		0.684		0.578	
Mean score	0.926		0.869		0.804	

Note: E = Efficiency ; Freq = Frequency

The distribution of EE scores implied that about 33.33 per cent of the farmers were operated between 80 per cent and 90 per cent. The farmers in large group could save at least 10 per cent of their current cost of inputs by behaving in a cost-minimizing way.

5.3.4 Pooled farmers

The results of the efficiency scores of pooled farmers indicated that there were wide ranges of differences in Technical efficiency (TE), Allocative efficiency (AE) and Economic efficiency (EE) among chilli farmers which was indicated in Table 5.17. The mean TE was found to be 84.10 per cent. Similarly, the mean AE and EE of sample farmers were 75.20 per cent and 63.20 per cent, respectively. The model output indicated that sample farmers in the study area were relatively good in TE than AE and EE.

It was observed that only about 25.83 per cent of farms under assumption of constant returns to scale performed with technical efficiency level equal to 0.90 or greater, *i.e.* 31 of the total 120 farmers. The mean efficiency score was 0.841. Based on this, it could be inferred that remaining 89 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 15.90 per cent and maintain the same level of chilli production as achieved by 25.83 per cent of the farmers.

The mean score of AE was 75.20 per cent. The result indicated that on an average pooled sample farmers in the study area could increase chilli output by 24.80 per cent, On other hand, cost of production could be reduced by 24.80 per cent had farmers used the right inputs and low input costs.

Farmer with an average economic efficiency level could reduce current average cost of production by 36.80 per cent to achieve the potential minimum cost level without reducing output levels. It could be inferred that if farmers in the study area were to achieve 100 per cent economic efficiency, they would experience substantial production cost saving of 36.80 per cent.

It was observed that only about ten per cent of farms *i.e.* twelve of the total 120 farmers under constant returns to scale performed with economic efficiency level equal to 0.90 or greater. The mean efficiency score was 0.632. Based on this, it could be inferred that remaining farmers, which did not operate at the maximum efficiency level, could reduce the input level by 36.80 per cent and maintain the same level of chilli production as achieved by ten per cent of the farmers.

The level of TE among the sample households operate is also presented in Table 5.17. The sample farmers had ranges of 52.40 per cent to 100 per cent of TE and the result showed that the majority of the sample households have TE score of 80 per cent to 90 per cent. But there were also 43 pooled households which accounted to 35.83 per cent, whose TE levels were limited to the range of 50 per cent to 80 per cent. Sample farmers in this group had room to enhance their chilli production at least by 20 per cent, on an average. Out of the total

sample farmers, 25.83 per cent of the farmers had TE of greater than 90 per cent. This implies that around 74.17 per cent of the sample farmers could increase their production at least by 10 per cent.

According to the results showed in Table 5.16, the AE distribution scores indicated that the largest efficiency group of chilli producers (46.67%) operated between 60 per cent and 70 per cent. Farmers in this group could save at least 30 per cent of their current cost of inputs by behaving in a cost-minimizing way. Only 23.33 per cent of the total sample farmers had an AE score that ranged between 91 per cent and 100 per cent. This showed that almost chilli producing farmers (76.67%) could save their current input cost by reallocation of resources in a cost minimizing way.

Table 5.17. Frequency distribution of TE, AE and EE of Pooled farmers

Efficiency categories	Technical efficiency		Allocative efficiency		Economic efficiency	
	Freq.	Percentage	Freq.	Percentage	Freq.	Percentage
$E < 0.1$	0	0	0	0	0	0
$0.1 < E \leq 0.2$	0	0	0	0	0	0
$0.2 < E \leq 0.3$	0	0	0	0	0	0
$0.3 < E \leq 0.4$	0	0	0	0	13	10.83
$0.4 < E \leq 0.5$	0	0	1	0.83	18	15.00
$0.5 < E \leq 0.6$	5	4.17	18	15.00	16	13.33
$0.6 < E \leq 0.7$	22	18.33	56	46.67	36	30.00
$0.7 < E \leq 0.8$	16	13.33	12	10.00	11	9.17
$0.8 < E \leq 0.9$	46	38.33	5	4.17	14	11.67
$0.9 < E \leq 1.0$	31	25.83	28	23.33	12	10.00
Efficient	31	25.83	28	23.33	12	10.00
Inefficient	89	74.17	92	76.67	108	90.00
Total	120	100.00	120	100.00	120	100.00
Maximum	1		1		1	
Minimum	0.524		0.438		0.336	
Mean score	0.841		0.752		0.632	

Note: E = Efficiency ; Freq = Frequency

The EE scores for pooled farmers was 63.20 per cent, which was less than small, medium and large farmer groups. About 30 per cent of the farmers were operated between 60 per cent and 70 per cent. The farmers in pooled group could save at least 30 per cent of their current cost of inputs by behaving in a cost-minimizing way.

The results from table 5.14 to 5.17 revealed that TE was more than AE and EE in all groups of farmers. Further, all the three types of efficiency measures *viz.*, TE, AE and EE were more in large farmers, followed by medium and small farmers. The results indicated that both the input usage and input allocation indicating the price efficiency of inputs was more in large farmers over the other two groups. Thus, there is a great scope of ranging resources to get maximum production in small group of farmers followed by medium and large groups.

The above findings are similar with the Lubis *et al.* (2014) was in their study revealed that technical efficiency is more than allocative efficiency and economic efficiency.

5.4 FACTORS AFFECTING TECHNICAL EFFICIENCY OF PRODUCTION

Generally, the technical efficiency is influenced by several factors *i.e.* technical, socio-economic and demographic factors like age, education, farming experience, family labour, input quantities, cost of production, *etc.*

The output in CRS - DEA model individual farmer technical efficiency scores was used in this analysis to study the influence of identified factors on technical efficiency of chilli was studied through multiple regression analysis and the results are shown in Table 5.18.

The Multiple Linear regression equations are given here under for chilli farmers for different farm size groups of farmers.

a) Small farmers:

$$TE_S = 0.5358 + 0.0028 X_1 + 0.0035^{**} X_2 + 0.0090 X_3 + 0.0038 X_4 + 0.0182^* X_5 - 0.0058^* X_6 - 0.0024^* X_7 - 0.0019^* X_8 - 0.0012 X_9 + 0.0016^* X_{10}$$

b) Medium farmers:

$$TE_M = 1.5773^* + 0.0055^{**} X_1 + 0.0019 X_2 + 0.0084 X_3 + 0.0049^{**} X_4 + 0.0115^{**} X_5 - 0.0013^{**} X_6 - 0.0016^{**} X_7 - 0.0017^* X_8 - 0.0011 X_9 + 0.0047^{**} X_{10}$$

c) Large farmers:

$$TE_L = 1.5435^* + 0.0026 X_1 + 0.0034^{**} X_2 + 0.0140^* X_3 + 0.0016^{**} X_4 + 0.0260^{**} X_5 - 0.0019 X_6 - 0.0023^* X_7 - 0.0016^* X_8 - 0.0023^{**} X_9 + 0.0009^* X_{10}$$

d) Pooled farmers:

$$TE_P = 0.2432 + 0.0007 X_1 + 0.0013^{**} X_2 + 0.0101^{**} X_3 + 0.0003 X_4 + 0.0066^{**} X_5 - 0.0024^{**} X_6 - 0.0008^* X_7 - 0.0016^* X_8 + 0.0032 X_9 + 0.0023^{**} X_{10}$$

The intercept values as indicated in the above equation and Table 5.17 for small, medium, large and pooled farmers were 0.5358, 1.5773, 1.5435 and 0.2432 respectively, which indicates that if the all values of the variables were zero the expected mean value of TE was the intercept value.

The explanatory power of the model R^2 was 0.64, 0.68, 0.77 and 0.63 in small, medium, large and pooled farmers respectively. This implied that all explanatory variables together were explaining 64 per cent of variation, 68 per cent variation, 77 per cent variation and 63 per cent variation in technical efficiency of small, medium, large and pooled farmers respectively.

Age of the medium farmers for TE was positive and significant at 5 per cent level of significance. This implied that age contributed positively to TE, which was similar to the finding of Trujillo and Iglesias (2013), Thabethe *et al.* (2014), Goyal *et al.* (2006) and Khan (2012). The estimated coefficient of age for

technical efficiency indicated the importance of greater knowledge and skill that gathered over time, which increases the capacity of households for producing optimal output and optimal allocation of resources and technology. In small, large and pooled farmers, the age was positive but was not significantly influencing on the technical efficiency.

Education of small, large and pooled farmers had a significant effect on TE. It was positive and significant at 5 per cent level of significance. The significant effect of education on TE confirmed the importance of education in increasing the efficiency of chilli production. In other words, educated households had relatively better capacity for optimal allocation of inputs. which is in line with the study done by Thabethe *et al.* (2014), Trujillo and Iglesias (2013), Murthy *et al.* (2009), Narala and Zala (2010) and Khan (2012). For the medium farmers, education had a positive effect on TE but at non-significant level.

Family labour in large and pooled farmers was positive and significant at 1 per cent and 5 per cent level of significance respectively. It represents the increase in family labor in cultivation practices will reduce the hired labour cost, as majorly chilli requires more number of human labour. For the small and medium farmers family labour has positive effect on TE but at non-significant level.

Farming experience has positive and significant effect on TE in medium and large farmers at 5 per cent level of significance. It indicated that with the accumulated experiences gathered over time, they become skillful as they get older and may have an interest in the use of new methods of production. For small and pooled farmers the farming experience showed positive impact on TE but at non-significant level.

Chilli cultivated area has positively significant effect on TE in small, medium and pooled farmers at 1 per cent level of significance and large farmers at 5 per cent level of significance. It revealed that the increase in cultivated area significantly influenced more on the technical efficiency because of the proper utilization of the input quantities and low inputs costs. This result was in conformity with the findings of Narala and Zala (2010) and Chen *et al.* (2001)

Cost of production was negatively significant on TE in small at 1 per cent level of significance and medium, large and pooled farmers at 5 per cent level of significance. It could taken that an increase in unit of cost of production will decreases by 0.0058, 0.0013, 0.0019 and 0.0024 units of technical efficiency in small, medium, large and pooled farmers respectively. So, farmers need to decrease the input costs thereby cost of cultivation will be minimized and rate of return would be increased.

Human labour used in the total period of chilli cultivation has showed the negative impact on the TE. Human labour utilization was recorded negatively significant in small, large and pooled farmers at 1 per cent level of significance and in medium farmers at 5 per cent level of significance. It entails that the unit increase in human labour would decreases the technical efficiency by 0.0024, 0.0016, 0.0023 and 0.0008 units in small, medium, large and pooled groups respectively. It revealed that the human labour utilization in the production practices was more, so, farmers had to rethink about the allocation of human labour in the farming practices.

Irrigation had showed negative significance in all farm size groups at 1 per cent level of significance. It indicates that the unit increase in irrigation would decrease the TE by 0.0019, 0.0017, 0.0016, 0.0016 units in small, medium, large and pooled farmers group respectively. These results are contrast with Al-Feel and AL-Basheer (2012).

Machine labour had showed positively significant in small farmers at 1 per cent level of significance and medium, large and pooled farm size groups was showed as positive effect but at non-significant level. It intend that unit increase in machine labour will increase the TE by 0.0014, 0.0001, 0.0023 and 0.0032 units in small, medium, large and pooled farmers group respectively.

Number of training programmes attend by the farmer has shown positively significant effect on TE in small, large, pooled farmers at 5 percent level of significance. If the training programmes increased in the sample area, the technical efficiency could be increased.

In small farmers, educational level was showed positively significant on TE at 5 per cent level of significance. Chilli cultivated area, machine hours and training programmes attended was showed positively significant on TE at 1 per cent level of significance and cost of production, human labour and irrigation was showed as negatively significant on TE at 1 per cent level of significance.

In medium farmers, chilli cultivated area showed as positively significant on TE at 1 per cent level of significance. Age of the farmer, farming experience and no. of training programmes attended was shown as positively significant on TE at 5 per cent level of significance. Cost of production, human labour and machine labour was showed as negatively significant on TE at 5 per cent level of significance. Irrigation was showed the negatively significant on TE at 1 per cent level of significance.

In large farmers, educational level, farming experience, chilli cultivated area and no. of training programmes attended was showed as positively significant on TE at 5 per cent and family labour showed positive significance on TE at 1 per cent level of significance. Cost of production and machine power was showed as negatively significant at 5 per cent level of significance but human labour used and irrigation hours showed at 1 per cent level of significance.

In pooled farmers, educational level, farming experience and no. of training programmes attended was showed as positively significant at 5 per cent and chilli cultivated area was showed as positively significant at 1 per cent level of significance. Human labour and Irrigation hours showed negative significance on TE at 1 per cent level of significance and cost of production showed as negatively significant at 5 per cent level of significance.

Table 5.18. Factors influencing technical efficiency of farmers in chilli cultivation

S.No.	Particulars	Small farmers		Medium farmers		Large farmers		Pooled farmers	
		b	SE	b	SE	b	SE	b	SE
1	Intercept (a)	0.5358	0.3851	1.5773*	0.2971	1.5435*	0.4338	0.2432	0.1973
2	Age of the farmer (years) (X ₁)	0.0028	0.0034	0.0055**	0.0024	0.0026	0.0022	0.0007	0.0022
3	Educational level (number of years of schooling) (X ₂)	0.0035**	0.0017	0.0019	0.0026	0.0034**	0.0016	0.0013**	0.0006
4	Family labour (number) (X ₃)	0.009	0.0063	0.0084	0.0071	0.0140*	0.0043	0.0101**	0.0049
5	Farming Experience (years) (X ₄)	0.0038	0.0025	0.0049**	0.0022	0.0016**	0.0007	0.0003	0.0016
6	Chilli cultivated area (ha.) (X ₅)	0.0182*	0.0044	0.0115*	0.0024	0.0260**	0.0107	0.0066*	0.0019
7	Cost of production (Rs./q) (X ₆)	-0.0058*	0.0019	-0.0013**	0.0006	-0.0019**	0.0009	-0.0024**	0.0011
8	Human labour (man days ha ⁻¹) (X ₇)	-0.0024*	0.0009	-0.0016**	0.0007	-0.0023*	0.0008	-0.0008*	0.0003
9	Irrigation (hours ha ⁻¹) (X ₈)	-0.0019*	0.0007	-0.0017*	0.0006	-0.0016*	0.0003	-0.0016*	0.0005
10	Machine power (hours ha ⁻¹) (X ₉)	0.0014*	0.0006	0.0011	0.0027	-0.0023**	0.0011	0.0032	0.0019
11	Training programmes attended (No.) (X ₁₀)	0.0016**	0.0007	0.0047**	0.0012	0.0009**	0.0004	0.0023**	0.0011
	F test	6.12*		3.52*		6.74*		13.89*	
	R ²	0.64		0.68		0.77		0.63	

Note: b = Coefficient, SE = Standard Error

* and ** denote that the coefficients are significant at 1 per cent and 5 per cent level of significance respectively.

5.5 CONSTRAINTS IN CHILLI PRODUCTION

The sample farmers were enquired to elicit the problems faced by them during production of chilli in Guntur district. Response priority index technique was employed to prioritize the problems faced by the farmers and the results are presented in Table 5.19.

Table 5.19. Response priority index of prioritization of problems pertaining to chilli production

S.No.	Constraints	RPI	Rank
1	High cost of human labour	0.98	I
2	High Irrigation costs	0.89	II
3	Pest and disease management	0.80	III
4	Price fluctuations	0.62	IV
5	Lack of extension services	0.60	V
6	Educational Level of Farmers	0.35	VI
7	Lack of input subsidies	0.33	VII
8	Nursery Management	0.25	VIII
9	Nearness to market	0.19	IX

Note: RPI = Response priority index

The sample farmers faced various problems like, high irrigation costs, problem with nursery management, educational level of farmers, marketing, nearness to market, Pest and disease management, high cost of human labour during production, Lack of input subsidies, price fluctuations in chilli, lack of extension services *etc.* They prioritized high cost of human labour during production as the major constraint for the production of chilli with a score of 0.98 followed by high cost of irrigation (0.89) and pest and disease management (0.80), price fluctuations (0.62), lack of extension services (0.60), educational level of farmers (0.35), lack of input subsidies (0.33), nursery management (0.25) and nearness to market.

Chapter VI

SUMMARY AND CONCLUSIONS

Chilli is one of the important cash crops in India. It comes under the category of spices and condiments. It is grown in all parts of India. Both green and ripe varieties are used to impart pungency to food. Hence, it has gained importance as an inevitable condiment and vegetable. It is used in pickles, sauces, ketchup, essences, oleoresins and it is an inevitable ingredient in Indian dishes. An alkaloid capsaicin is extracted from chilli, which has medicinal value. Chilli is also rich in Vitamin C.

Scarcity of resources has led the production economists to think about the reallocation of existing resources to have more output with given level of input combinations or to produce a prescribed level of output with the minimum cost without changing the production technology. Thus, the measurement of the production efficiency in agricultural production is an important issue because it gives pertinent information for making sound management decision in resource allocation. Hence the present study on “Economic efficiency of chilli production in Guntur district of Andhra Pradesh” has been selected with the following objectives.

6.1 OBJECTIVES

1. To study the cost of cultivation of chilli in Guntur district of Andhra Pradesh
2. To estimate the economic efficiency of chilli production
3. To identify the factors affecting the technical efficiency of chill production
4. To analyse the constraints in chilli production

6.2 SAMPLING DESIGN

The multistage purposive and random sampling technique was adopted in designing sampling frame for the study. In the first stage Guntur district was selected based on the highest area under chilli cultivation in Andhra Pradesh. In

the second stage, four mandals *viz.*, Veldurthi, Sattenapalle, Bollapalle, Medikonduru were selected based on the highest area under chilli in the selected district. Similarly, in third stage, three villages were selected based on highest area under chilli in each mandal and ten farmers from each selected village of the mandal were selected at random, in view of spread of chilli growers in villages. Finally, the sample size constituting 120 farmers was post-stratified into small, medium and large farmers comprising 48, 39 and 33 respectively for the study. The primary data from sample farmers were collected by personal interview method by using pre-tested structured questionnaire. The primary data on cultivation of chilli from farmers pertained to 2015-16 agricultural year.

6.3 TOOLS AND TECHNIQUES OF ANALYSIS

Socio economic profile of the farmers along with the costs and returns of chilli were collected through a pre tested questionnaire and analysed through conventional analysis. General tabular method of analysis was used to analyse the data on costs and returns. Cost of production by cost concepts approach adopted by CACP was also attempted. Besides, Data envelopment analysis was employed to study the economic efficiency of chilli farmers. Factors influencing technical efficiency of chilli farmers was analysed through multiple regression model and Response priority index was used to find out the constraints in chilli production.

6.4 SOCIO-ECONOMIC PROFILE

The larger family size was observed in large group farmers (4.13), followed by small group (4.02) and medium group (3.63). But the contribution of total farm family labour was high in small group (2.04), followed by medium group (1.88) and large group (1.87) but with a low difference.

The highest number of sample farmers were in the age groups of 31 years to 40 years both in small group and medium group categories, while same was highest in 41 years to 50 years category in large group of farmers

Educational level of farmers in pooled sample as a whole was observed that 39.17 per cent having primary level of education, followed by illiterates (30.83%), secondary level of education (17.50%), higher education (8.33%) and degree (4.17%).

The average size of holding varied from 1.11 ha. for small farmers, 2.97 ha. for medium farmers to 6.53 ha. for large farmers with an overall average of 3.20 ha. for the pooled farmers. Of the total operated area, the chilli cultivated area comes under irrigated land.

Large farmers were having high number of assets when compared to small, medium and pooled farmers.

The farming experience of total sample was majority were having 11-20 years of experience occupying the first place, which constituted to 40.83 per cent, followed by 21-30 years with 27.50 per cent, 31-40 years with 16.67 per cent, 1-10 years with 9.17 per cent and 41-50 years with 5.83 per cent. These results concluded that most chilli farmers were having 11-20 years of experience in chilli farming.

6.5 COST OF CULTIVATION OF CHILLI

The per hectare human labour utilization showed a direct relationship with farm size indicating labour intensive nature of large farmers. The human labour utilization was of the order of 299.98, 331.62, 364.51 and 344.84 man-days of eight hours on small, medium, large and pooled farms respectively. On an average more than 50 per cent of total labour was utilized for harvesting alone and it had indicated a direct relationship with farm size as the labour for harvesting was related to the productivity of the farm. Weeding and inter cultivation, plant protection and manuring and fertilization were the other important operations which utilized large quanta of human labour on all farm size groups.

The average cost of cultivation per ha of chilli was Rs. 3,53,443.07, Rs. 3,90,393.17, Rs. 4,10,188.71 and Rs. 3,93,872.67 for small, medium, large and pooled farmers in the study area. Of the total cost, variable costs accounted for a major share of cultivation of chilli in all size groups of farmers.

The share of variable costs in total cost showed a direct relationship with farm size. The proportion of variable cost was Rs. 3,07,831.87, Rs. 3,40,858.62, Rs. 3,57,266.15 and Rs. 3,43,863.98, which accounted for 87.10 per cent, 87.31 per cent, 97.10 and 87.30 per cent of the total cost of cultivation of chilli for small, medium, large and pooled farmers respectively. Among the different variable costs, human labour occupied the major share of total cost of cultivation with 28.83 per cent, 28.75 per cent, 30.28 per cent and 29.74 per cent in small, medium, large and pooled farmers respectively.

Cost of cultivation according to cost concepts revealed that costs, A_1 , A_2 , B_1 , B_2 , C_1 , C_2 , C_3 have exhibited direct relationship with farm size. On an average, the cost C_2 (TCOC) of chilli per hectare was Rs. 3,93,872.65 on pooled farmers. It was highest on large farmers (Rs. 4,10,188.71) as compared to small farmers (Rs. 3,53,443.07) and medium farmers (Rs. 3,90,393.17) indicating a direct relationship with farm size.

The gross returns varied from Rs.4,04,535.53 on small farms to Rs.5,27,023.05 on large farms with an overall average of Rs.4,56,150.56 per hectare for the pooled farmers. The same for medium farms was Rs.4,59,363.34. The net returns per hectare were of the order of Rs. 51,092.46, Rs. 68,970.17, Rs.1,16,832.34 and Rs.62,277.91 on small, medium, large and pooled farmers respectively.

6.6 ECONOMIC EFFICIENCY OF CHILLI PRODUCTION

The results of the efficiency scores for small farmers in Technical efficiency (TE), Allocative efficiency (AE) and Economic efficiency (EE) among chilli farmers are indicated that, the mean TE was found to be 84.70 per cent. Similarly, the mean AE and EE of sample farmers were 83.10 per cent and 70.30 per cent, respectively.

The distribution of EE scores implied that about 29.16 per cent of the farmers were operating between the economic efficiency levels of 70 per cent and 80 per cent. The small group farmers could save at least 20 per cent of their current cost of inputs by behaving in a cost-minimizing way. The low level of EE was the total effect of both technical and allocative inefficiencies.

It was observed that only about 14.58 per cent of farms under assumption of constant returns to scale performed with economic efficiency level equal to 0.90 or greater, *i.e.* 7 of the total 48 farmers. The mean efficiency score was 0.703. Based on this, it could be inferred that remaining 41 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 29.70 per cent and maintain the same level of chilli production as achieved by 14.58 per cent of the farmers.

The results of the efficiency scores in Technical efficiency (TE), Allocative efficiency (AE) and Economic efficiency (EE) among chilli farmers are indicated that, the mean TE was found to be 87.20 per cent. Similarly, the mean AE and EE of sample farmers were 85.90 per cent and 74.90 per cent, respectively.

The distribution of EE scores implied that about 41.03 per cent of the farmers were operating between the economic efficiency levels of 70 per cent and 80 per cent. The medium group farmers could save at least 20 per cent of their current cost of inputs by behaving in a cost-minimizing way. The low level of EE was the total effect of both technical and allocative inefficiencies.

It was observed that only about 17.95 per cent of farms under assumption of constant returns to scale performed with economic efficiency level equal to 0.90 or greater, *i.e.* 7 of the total 39 farmers. The mean efficiency score was 0.749. Based on this, it could be inferred that remaining 32 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 25.10 per cent and maintain the same level of chilli production as achieved by 17.95 per cent of the farmers.

The results of the efficiency scores for large farmers in Technical efficiency (TE), Allocative efficiency (AE) and Economic efficiency (EE). The mean TE was found to be 92.60 per cent. Similarly, the mean AE and EE of sample farmers were 86.90 per cent and 80.40 per cent, respectively. The model output indicates that sample large farmers in the study area were relatively good in TE than AE and EE.

The distribution of EE scores implied that about 33.33 per cent of the farmers were operated between 80 per cent and 90 per cent. The farmers in large group could save at least 10 per cent of their current cost of inputs by behaving in a cost-minimizing way.

It was observed that only about 21.22 per cent of farms under assumption of constant returns to scale performed with economic efficiency level equal to 0.90 or greater, *i.e.* 7 of the total 33 farmers. The mean efficiency score was 0.804. Based on this, it could be inferred that remaining 26 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 19.60 per cent and maintain the same level of chilli production as achieved by 21.22 per cent of the farmers.

The results of the efficiency scores of pooled farmers indicated that there were wide ranges of differences in Technical efficiency (TE), Allocative efficiency (AE) and Economic efficiency (EE). The mean TE was found to be 84.10 per cent. Similarly, the mean AE and EE of sample farmers were 75.20 per cent and 63.20 per cent, respectively. The model output indicated that sample farmers in the study area were relatively good in TE than AE and EE.

The EE scores of the farmers about 30 per cent of the farmers were operated between 60 per cent and 70 per cent. The farmers in pooled group could save at least 30 per cent of their current cost of inputs by behaving in a cost-minimizing way.

It was observed that only about 10 per cent of farms under assumption of constant returns to scale performed with economic efficiency level equal to 0.90 or greater, *i.e.* 12 of the total 120 farmers. The mean efficiency score was 0.632. Based on this, it could be inferred that remaining 108 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 36.80 per cent and maintain the same level of chilli production as achieved by 10 per cent of the farmers.

When we compare the technical efficiency, allocative efficiency and economic efficiency results with the constraints faced by the chilli farmers, we can infer that the high cost of human labour, high irrigation charges and pest and disease management are the major constraints. So, if the farmers could decrease the inputs costs, they would be benefited and the efficiency of the farmers will be increased.

6.7 FACTORS AFFECTING TECHNICAL EFFICIENCY OF PRODUCTION

In small farmers, educational level was showed positively significant at 5 per cent level of significance. Chilli cultivated area, machine hours and training programmes attended was showed positively significant at 1 per cent level of significance and cost of production, human labour and irrigation was showed as negatively significant at 1 per cent level of significance.

In medium farmers, chilli cultivated area showed as positively significant at 1 per cent level of significance. Age of the farmer, farming experience and no. of training programmes attended was shown as positively significant at 5 per cent level of significance. Cost of production, human labour and machine labour was showed as negatively significant at 5 per cent level of significance. Irrigation was shows the negatively significant at 1 per cent level of significance.

In large farmers educational level, farming experience, chilli cultivated area and no. of training programmes attended was showed as positively significant at 5 per cent but family labour showed at 1 per cent level of significance. Cost of production and machine power used was showed as negatively significant at 5 per cent level of significance but human labour used and irrigation hours showed at 1 per cent level of significance.

In pooled farmers, educational level, farming experience and no. of training programmes attended was showed as positively significant at 5 per cent and chilli cultivated area was showed as positively significant at 1 per cent level of significance. Human labour and Irrigation hours showed negative significance on TE at 1 per cent level of significance and cost of production showed as negatively significant at 5 per cent level of significance.

6.8 CONSTRAINTS IN CHILLI PRODUCTION

The sample farmers faced various problems like, high irrigation costs, problem with nursery management, educational level of farmers, marketing, nearness to market, Pest and disease management, high cost of human labour during production, Lack of input subsidies, price fluctuations in chilli *etc.* They prioritized high cost of human labour during production as the major constraint for the production of chilli with a score of 0.98 followed by high cost of irrigation (0.89) and pest and disease management (0.80).

6.9 CONCLUSIONS

- The highest number of sample farmers were in the age groups of 31 years to 40 years both in small group and medium group categories, while same was highest in 41 years to 50 years category in large group of farmers
- The value of assets per hectare excluding land value had a direct relationship with farm size, as it was Rs. 2,157.54 on small farms, Rs. 3,668.30 on medium farms and Rs. 2,43,872.17 on large farms. It could be concluded that magnitude and pattern of value of assets excluding land, the investments on implements and machinery was more in large farmers. Large farmers are having high asset value when compared to small and medium farmers.
- Total human labour utilization in chilli was high in large farmer group followed by the medium farmer and small farmer. However, the family labour component was high both in terms percentage and units in small farmer category, followed by medium farmer and large farmer. Of all the operations harvesting consumed more than 50 per cent of total labour utilization in all the groups including pooled farmers.
- Variable costs, fixed costs and total costs were varying in the three groups of farmers, the per cent contribution of variable costs and fixed costs to total costs remind same in all the three groups. The large farmers were including high cost of cultivation, followed by medium and small group of farmers, inferring that the total cost of cultivation was varying directly with the farm size.

- The cost of cultivation was increasing with farm size group, the cost of production was decreasing with increasing farm size, indicating that operation of economics of scale. Thus in chilli production large farmers are more benefited than the other two groups. It was also confirmed with the higher rate of return in large farmer, followed by medium group and small group of farmers.
- Farm investment income, a measure of returns to fixed capital and all farm income measures were increasing with farm size in chilli production.
- The results of economic efficiency of pooled sample indicated that, chilli farmer could decrease current input by 15.90 per cent to produce the same amount of output. The result for mean allocative efficiency also suggests that cost of production could be reduced by 24.80 per cent had farmers used the right inputs and low costs. On the other hand, it was observed that only about 10 per cent of farms under assumption of constant returns to scale performed with economic efficiency level equal to 0.90 or greater, *i.e.* 12 of the total 120 farmers. The mean efficiency score was 0.632. Based on this, it could be inferred that remaining 108 farmers, which did not operate at the maximum efficiency level, could reduce the input level by 36.80 per cent and maintain the same level of chilli production as achieved by 10 per cent of the farmers.
- The results of regression equation fitted to identify the determinants of Technical efficiency indicated that among the significant variables, human labour and irrigation had a greater influence on technical efficiency of chilli in all farm sizes, followed by the cost of production.
- The sample farmers prioritized the high cost of human labour during production as the major constraint for the production of chilli with a score of 0.98 followed by high cost of irrigation (0.89) and pest and disease management (0.80).

6.10 POLICY IMPLICATIONS

- Agriculture department should act as a catalyst in providing knowledge regarding improved varieties and production technologies (pre and post harvesting technologies like storage) to farmers.
- Agriculture department should conduct the training programmes on input usage so that the farmers will be knowing the good package of practices in chilli cultivation there by fertilizer and pesticide usage will be reduced.

- The problem of high labour costs during harvesting, inter cultivation and weeding warrants the use of chemical weedicides. This involves strengthening of the Research and Development in developing good post emergence herbicides, so as to reduce the number of inter cultivation operations in chilli cultivation.
- As the small farmers are having no fixed assets *viz.*, farm equipment and machinery there is a greater need to set up Agro-Service Centers at the village level to provide the plant protection equipment and other machinery on no-profit-no-loss basis so that the small farmers can go ahead with the farm operations in time.
- There is need for introduction of Drip Irrigation systems in the area of study as irrigation charges are high.
- It is necessary to avoid the implementation of NREGS during the periods of sowing and harvesting of chilli crop and facilitate the chilli growing farmers to get hired labour during that period or entitle the agricultural operations may be included in NREGS programme so that the farmers may get rid of the hired human labour cost and thus increasing their net returns.

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Note: The literature is cited as per the “Thesis Guide Lines” prescribed by Acharya N. G. Ranga Agricultural University, Guntur.

Chapter IV

AGRO ECONOMIC FEATURES

The success of any agricultural economy mainly depends upon the agro climatic and socio-economic conditions of that region such as climate, rainfall, soil type, infrastructural facilities, irrigation facilities, land utilization pattern, credit facilities etc., Since the present study is confined to Guntur district and its mandals, general view of agro-climatic features are presented in brief with the objective of providing necessary background information for understanding district profile, problem formulation and results of the study.

4.1 GUNTUR DISTRICT

Guntur district was formed on 01-10-1904 with Head Quarters at Guntur after bifurcating Krishna and Nellore districts. In 1904 Guntur district was constituted into a separate independent district with the areas of the taluka of Tenali, Bapatla, Guntur, Sattenapalli, Narasaraopet, Vinukonda and Palnadu of old Krishna district and Ongole taluk from Nellore district. Tenali taluk split on 1-7-1909 into two taluks namely Tenali and Repalle. This district formed in 1904 was retained intact till February, 1970. In February, 1970, while forming a new district with Ongole as its Head Quarters, parts of Bapatla and Narasaraopet taluks and whole Ongole taluk were taken to Prakasam district leaving Guntur district with only eight taluks namely Guntur, Sattenapalli, Tenali, Repalle, Bapatla, Narasaraopet, Vinukonda and Palanadu. The Guntur district has 57 mandals, which came into existence with effect from 25-5-1985 in the place of erstwhile taluks and firkhas.

4.1.1 Administrative setup

The district consists of 57 mandals with 729 villages out of which 706 are revenue villages with 1036 villages as hamlets. The district is divided into three revenue divisions *viz.*, Guntur, Narsaraopet and Tenali. The particulars of the overall picture of the administrative divisions are furnished in Table 4.1

Table 4.1. Administrative divisions of Guntur

S.No.	Revenue Division	No. of Mandals	No. of Villages	No. of Gram Panchayats
1	Narsaraopet	20	252	355
2	Guntur	19	253	317
3	Tenali	18	224	348
	TOTAL	57	729	1020

Source: *Hand Book of Statistics 2015. Chief Planning Office, Guntur.*

4.1.2 Location

Guntur district is a part of Krishna delta. The district extends approximately between 15⁰ 18' and 16⁰ 50' of North latitude and 79⁰ 10' and 80⁰ 55' of East longitudes. It is bounded on the North by Krishna and Nalgonda Districts, on the West by Prakasam and Mahboobnagar districts, on the South by Prakasam district, on the East by Krishna district and Bay of Bengal.

Guntur district occupies an area of 11391 sq. km, constituting 7.11 per cent of total area of 1,60,205 sq. km of newly formed Andhra Pradesh. The district got a coastal line of 42 km in Repalle, Nizampatnam, Nagaram and Bapatla mandals. The river Krishna traverses about 250 km from North to South West in an umbrella shape forming the northern boundary of the district.

4.1.3 Demographic particulars

The population as per 2011 census has been presented in Table 4.2. The total population of the district was 48,87,813. It accounts for 5.86 per cent of the total population of the state. The female population of the district was 24,47,292 and this forms 50.06 per cent of the district population.

Table 4.2. Population statistics of Guntur district (2011 census)

S.No.	Item	Unit	Population
1	Total population	Lakhs	48.87813 (100)
2	Male population	Lakhs	24.40521 (43.93)
3	Female population	Lakhs	24.47292 (50.06)
4	Density of population	Per sq.km.	429
5	Females per thousands of males	No.	997
6	Rural population	Lakhs	32.35075 (66.18)
7	Urban population	Lakhs	16.52738 (33.82)
8	a) Total literates	Lakhs	29.60441 (60.57)
	b) Males	Lakhs	16.34726 (33.44)
	c) Females	Lakhs	13.35569 (27.32)
9	a) Average literacy	Per centage	67.40
	b) Male literacy	Per centage	74.79
	c) Female literacy	Per centage	60.09
9	Main workers	Lakhs	21.06326 (43.09)
10	Marginal farmers	Lakhs	2.75298 (5.63)
11	Non-workers	Lakhs	25.06189 (51.27)
12	Cultivators	Lakhs	2.89829 (5.93)
13	Agricultural labour	Lakhs	10.35569 (21.18)

Note: Figures in parentheses indicate percentage to the total

Source: *Hand Book of Statistics 2015, Chief Planning Office, Guntur.*

The rural population of the district was 32, 35,075 and it constituted to 66.18 per cent of the district population and 5.74 per cent to that of state rural population. Similarly, the urban population of the district was 16,52,738 spread over in 12 towns forming 33.82 per cent of the district population and 5.82 per cent of the state population. The decennial growth of population in the district

from 2001 census to 2011 census was + 0.78 per cent. The density of population was 429 per sq.km as against the state 307 per sq.km. The sex ratio of the district was 997 females per 1000 males as against 992 of the state. The literacy rate of the district is 67.40 per cent which is higher than the state literacy rate of 67.02 per cent. The number of main workers in Guntur district was 21,06,326 forming 43.09 per cent of total population.

4.1.4 Physiographic particulars

4.1.4.1 Rivers

The important rivers and rivulets in the district are the Krishna, the Naguleru, the Chandravanka and Gundlakamma. The river Krishna travels about 250 km, through the district along the Northern boundary of the district.

4.1.4.2 Soils

In general soils in Guntur district are very fertile and they are broadly classified as black cotton, red loamy, sandy loamy and alluvial soils. Majority (72%) of the soils are found to be black soils in Guntur district. (Table 4.3)

Table 4.3. Distribution of types of soils in Guntur district

S.No.	Type of soil	Percentage
1	Black cotton soils	72%
2	Red soils	17%
3	Coastal sandy soils	9%
4	Alluvial soils	2%

Source: Agriculture Action Plan (2013-14), Dept. of Agriculture, Govt. of A.P.

4.1.5 Climate

The agro-climatic conditions are very important in the cultivation of field crops. The study area is in tropical zone experiencing more or less extremes of hot summer and cold winter. Since, the area is located nearer to coast where the atmospheric humidity is high, April to June months is the hottest period and the temperature runs very high in the month of May.

Month wise rainfall for Guntur district is presented in Table 4.4 for 2014-15 Agricultural year along with the extent of departure from the normal.

Table 4.4. Rainfall particulars of Guntur district during 2014-15

S.No.	Month	Rainfall (mm)	
		Normal	Actual
1	June	12.30 (14.25)	12.30 (14.25)
2	July	95.40 (67.14)	95.40 (67.14)
3	August	78.10 (51.38)	78.10 (51.38)
4	September	121.80 (83.77)	121.80 (83.77)
South-West Monsoon (Kharif) Total		525.8 (61.64)	307.60 (58.50)
5	October	103.00 (78.93)	103.00 (78.93)
6	November	47.70 (58.17)	47.70 (58.17)
7	December	0.70 (4.27)	0.70 (4.27)
North-East Monsoon (Rabi) Total		228.9 (26.83)	151.40 (66.14)
8	January	1.20 (13.04)	1.20 (13.04)
9	February	0.10 (1.09)	0.10 (1.09)
Winter Total		18.4 (2.16)	1.30 (7.07)
10	March	2.90 (33.33)	2.90 (33.33)
11	April	22.20 (194.74)	22.20 (194.74)
12	May	12.20 (20.40)	12.20 (20.40)
Hot Weather Period Total		79.9 (9.37)	37.30 (46.68)
Grand Total		853 (100.00)	497.6 (58.34)

Note: Figures in parentheses indicate percentage to the total in normal rainfall

Figures in parentheses of actual indicate percentage to the respective row normal rainfall

Source: *Hand Book of Statistics 2015. Chief Planning Office, Guntur.*

The annual normal rainfall of Guntur district was 853 mm. Normal rainfall of South-West monsoon was 525.8 mm i.e., 61.64 per cent of the annual normal rainfall which is vital for the crops during *kharif* season. Normal rainfall of North-East monsoon is 228.9 mm i.e., 26.83 per cent of annual normal rainfall. Generally in Krishna Western Delta areas, the rainfall ranges from 750 mm to 1000 mm whereas in uplands, it ranges from 650 to 1000 mm.

4.1.6 Land utilization

The land utilization particulars of Guntur district are given in Table 4.5

Table 4.5. Land utilization pattern of Guntur district during 2014-15

S. No.	Classification of the area	Area (ha.)
1	Forests	161941 (14.22)
2	Barren and uncultivated waste	31612 (2.78)
3	Land put to non-agricultural use	161134 (14.15)
4	Cultivable waste	26677 (2.34)
5	Permanent pastures and other grazing lands	16450 (1.44)
6	Land put under miscellaneous trees	24180 (2.12)
7	Current fallows	43208 (3.79)
8	Other fallows	50144 (4.40)
9	Net area sown	618398 (54.29)
10	Fish & prawn culture	5356 (0.47)
11	Total geographical area	1139100 (100.00)

Note: Figures in parentheses indicate percentage to the total

Source: *Hand Book of Statistics 2015. Chief Planning Office, Guntur.*

During the year 2014-15, the area covered by forests is 1, 61,941 hectares which forms 14.22 per cent to the total geographical area (11,39,100 ha.). The net cropped area of the district was 6,18,398 hectares which accounted to 54.29 per cent of the total geographical area.

4.1.7 Agriculture and irrigation

4.1.7.1 Land holdings

As per census 2011 (Table 4.6), there are 7,60,648 farm holdings with an operated area of 17,31,861.51 hectares in the district. Marginal and small farmers accounted for maximum share in total operational area with 35.38 per cent and 29.80 per cent respectively. Marginal and small farmers together accounted for 90 per cent with an operating 65 per cent of the total area

Table 4.6. Land holdings in Guntur district**(2011 census)**

S.No.	Type of farmer	Number	Area (ha.)
1	Marginal farmers (below 1 ha)	536458 (70.53)	612654.32 (35.38)
2	Small farmers (1-2 ha)	150845 (19.83)	516069.65 (29.80)
	Sub total	687303 (90.35)	1128723.96 (65.17)
3	Semi medium farmers (2-4 ha)	58319 (7.67)	384278.90 (22.19)
4	Medium farmers (4-10 ha)	14408 (1.89)	188766.98 (10.90)
5	Large farmers (above 10 ha)	618 (0.08)	30091.64 (1.74)
	Grand Total	760648 (100)	1731861.51 (100)

Note: Figures in parentheses indicate percentage to the total

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.1.7.2 Irrigation

Irrigation plays a vital role in agricultural production. Any yield increasing practice can be exploited fully when they are practiced along with this resource. In view of this, area irrigated by different sources in the district for the 2014-15 year is formulated in the Table 4.7.

Table 4.7. Area under different irrigation sources of agriculture in Guntur district during 2014-15

Source	Gross area (ha.)		
	Kharif	Rabi	Total
Surface irrigation			
Canals	312272	44553	356825 (678.32)
Tanks	8729	602	9331 (1.76)
Lift irrigation	12183	8467	20650 (3.90)
Sub total	333184	53622	386806 (72.97)
Ground water			
Tube wells	72099	65781	137880 (26.01)
Dug Wells	2842	1486	4328 (0.82)
Sub total	74941	67267	142208 (26.83)
Other Sources	987	76	1063 (0.20)
Total gross area irrigated	409112	120965	530077 (100.00)
Area irrigated more than once	417	92987	93404 (17.62)
Net area irrigated	408695	27978	436673 (82.38)

Note: Figures in parentheses indicate percentage to the total gross area irrigated

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

In Guntur district, out of 5,30,077 ha. of gross irrigated area 26.83 per cent area accounts to ground water source and 72.97 per cent of area accounts to surface water irrigation during 2014-15. The area irrigated more than once was 93,404 ha. of which more area was irrigated during *Rabi* (92,987 ha.) in the particular area.

4.1.7.3 Area under different crops in Guntur district

Table 4.8 shows the cropping pattern in Guntur district for the year 2014-15.

Table 4.8. Area under different crops in Guntur district during 2014-15

Crop	Area (ha.)		
	Kharif	Rabi	Total
Rice	255607	29695	285302
Jowar	32	21907	21939
Maize	367	63701	64068
Green gram	177	47589	47766
Black gram	1057	30401	31458
Red gram	8861	193	9054
Other pulses	0	5945	5945
Total pulses	10103	84128	94231
Total food grains	266798	199893	466691
Chillies	61140	2078	63218
Turmeric	4854	0	4854
Total condiments and spices	66069	2078	68147
Total fresh and dry fruits	11867	2677	14544
Total vegetables	7948	3380	11328
Total food crops	353152	208282	561434
Total cotton	206374	22	206396
Groundnut	804	3839	4643
Gingelly	1483	1380	2863
Coconut	114	0	114
Total oil seeds	3570	5650	9220
Total tobacco	0	4991	4991
Total fodder crops	6486	9472	15958
Total aromatic plants and flowers	1100	672	1772
Total non food crops	227411	20829	248240
Gross area sown	580563	229111	809674
Net area sown	577254	41144	618398

Source: *Hand Book of Statistics 2015. Chief Planning Office, Guntur.*

The cropping pattern particulars of Guntur district from the table 4.8 shows that total food crops (5,61,434 ha.) occupied major share in the total cropped area followed by total food grains (4,66,691 ha.), rice (2,85,302 ha.), total non food crops (2,48,240 ha.), cotton (2,06,396 ha.), Total pulses (94,231 ha.), total condiments and spices (68,147 ha.), maize (64,068 ha.) and chilli (63218 ha.)

4.1.8 Animal husbandry

According to 19th livestock census (2012), total livestock population in Andhra Pradesh was 56.09 million. Total livestock population in Guntur accounts to 20,62,950 with poultry accounting to 68,77,200.

Table 4.9. Number of households owning animals/poultry birds in Guntur district

S. No.	Particulars	Number
1	Cattle	41986
2	Buffaloes	280751
3	Goats	10123
4	Sheeps	12823
5	Backyard poultry	129930
6	Poultry farm & Hatcheries	113626
	Total	589239

Source: Dept. of Animal Husbandry, dairying and fisheries. 19th livestock census

Table 4.9 shows that the number of households owning animals/poultry birds is more for buffaloes (2,80,751) followed by backyard poultry (1,29,930) and poultry farm and hatcheries (1,13,626) respectively.

Table 4.10. Livestock and poultry population

S.No.	Particulars	Number
1	Cattle (Total)	111230 (5.392)
2	Buffaloes (Total)	1021444 (49.514)
3	Sheep	643419 (31.189)
4	Goats	252750 (12.252)
5	Horses and Ponies	44 (0.002)
6	Donkeys	152 (0.07)
7	Pigs	9182 (0.445)
8	Other Livestock	24729 (1.199)
9	Total Livestock	2062950 (100)
10	Total Poultry	6877200

Source: Dept. of Animal Husbandry, dairying and fisheries. 19th livestock census

Table 4.10 shows the total livestock and total poultry population in Guntur district. Total livestock population buffaloes (10,21,444) occupied the first position followed by sheep (6,43,419), goat (2,52,750) and cattle (11,230). Total poultry in Guntur district was 68,77,200.

Table 4.11. Animal population per thousand households in Guntur district

S.No.	Particulars	Number
1	Cattle	102
2	Buffaloes	935
3	Sheep	576
4	Goats	198
	Total	1811

Source: Dept. of Animal Husbandry, dairying and fisheries. 19th livestock census

The number per thousand households is more in the case of buffaloes (935) followed by sheep (576) and goats (198) respectively which is represented in Table 4.10. It shows that buffaloes population is more than others showing that there are good chances of increasing dairy sector as an allied enterprise to agriculture in the district.

4.1.9 Infrastructure facilities

4.1.9.1 Medical

The district has one general hospital, 3 hospitals for special treatments and 85 PHCs / SHCs apart from other related wings in allopathy. As many as 2,635 beds also exist. All the allopathy institutions are managed by 420 doctors. In other disciplines of ayurvedic, unani and homeopathy, there are as many as 57 hospitals and dispensaries.

4.1.9.2 Transport

Guntur district having good transport facilities and 10,770.40 km length of roads it includes different types like cement concrete, black top, metalled (WBM) and unmetalled (Murrum). The total length of road includes national highways (NH), state highways, major district roads and Zilla parish roads *etc.*. Total number of buses were running on road was 1,248 and it composed of 1,015 A.P.S.R.T.C. and remaining 233 private travels. On an average 40,861.39 lakh passengers used the A.P.S.R.T.C. bus services per year. Guntur district having total number of broad gauge railway stations are 56 with the length of 410.14 km.

4.1.9.3 Educational institutions

There are 4,862 schools (including elementary schools, upper primary schools and high schools), 323 junior colleges and 39 degree colleges exist in the district.

4.2 SCHEMES IMPLEMENTED BY THE DEPARTMENT OF AGRICULTURE, GOVT. OF A.P. IN GUNTUR DISTRICT

The Department of Agriculture has been created mainly to provide Agricultural Extension services to farmers and to transfer the latest technical knowledge to the farming community, introduction of high yielding varieties, laying demonstrations, imparting training to farmers to improve skills & knowledge to boost up the agricultural Production and productivity.

The other objectives of the Department are to assess requirements of agriculture inputs well in advance and to regulate their production and monitor timely supply of seeds, fertilizers and pesticides, implements, credit etc., to farmers.

The Department also performs the statutory functions under various acts and regulations (*i.e.*, quality control) to ensure supply of quality inputs *i.e.*, Seeds, Fertilizers and Pesticides to farmers and implementation of Dangerous Machines Regulation Act.

The Department also carries out certain other facilitating functions such as 1) Action plan for management of BPT 5204, 2) Agricultural Technology Management Agency (ATMA), 3) Agril credit & pavalavaddi, 4) APMIP - Micro irrigation - Drip & Sprinkler irrigation, 5) Collection of soil samples, 6) Distribution of green manure seed, 7) Supply of zinc sulphate, 8) Farm mechanization, 9) Fertilizer supply, 10) Green manure seed distribution, 11) Intensive Cotton Development Programme (ICDP), 12) ISO POM- Oil seeds production programme, 13) National Food Security Mission (NFSM) - Rice & Pules, 14) Polam pilusthondhi, 15) Polambadi, 16) Rythu chaithanya yatralu and rythu sadasulu, 17) Seed village programme, 18) Supply of gypsum, 19) Supply of seeds on subsidy, 20) Soil health management (vermicompost unit), 21) SRI cultivation, etc.,

4.3 SELECTED MANDALS

4.3.1 Veldurthi mandal

4.3.1.1 Demographic information

As per 2011 census (Table 4.12), total population of Veldurthi mandal stood at 49,054, with male population of 24,608, female population of 24,446 and total number of households of 12,166. Density of population per sq. km was 85, sex ratio (females per thousand males) was 993.

Table 4.12. Population particulars of Veldurthi mandal (2011 census)

S.No.	Particulars	Persons	Percentage to total
1	Male	24608	50.17
2	Female	24446	49.83
3	Total	49054	100.00

Source: *Hand Book of Statistics 2015. Chief Planning Office, Guntur.*

4.3.1.2 Literacy rate

As given in Table 4.13, Veldurthi mandal has low literacy rate which might be due to the availability of minimum educational facilities. The literacy rate of the mandal was 47.02 per cent which is lower than district average literacy rate of 67.40 per cent.

Table 4.13. Level of literacy in Veldurthi mandal (2011 census)

Particulars	Literates	Literacy Rate
Male	11993	56.64
Female	8007	37.49
Total	20000	47.02

Source: *Hand Book of Statistics 2015. Chief Planning Office, Guntur*

4.3.1.3 Occupation pattern

The details of occupation particulars of Veldurthi mandal are presented in Table 4.14.

Table 4.14. Occupation pattern in Veldurthi mandal (2011 census)

S.No.	Particulars	Veldurthi
	Total Workers	29130 (59.38)
1	Total Main Workers	25522 (52.03)
	a) Cultivators	7257 (14.79)
	b) Agricultural Labourers	19775 (40.31)
	c) House hold Industry	3 (0.37)
	d) Other workers	1917 (3.91)
2	Marginal workers	3608 (7.36)
3	Total non-workers	19924 (40.62)
4	Total population	49054 (100.00)

Note: Figures in parentheses indicate percentage to the total.

Source: *Hand Book of Statistics 2015. Chief Planning Office, Guntur.*

Total number of workers in Veldurthi mandal were found to be 29,130, which accounted to 59.38 per cent of the total population. The total agricultural labour accounted for around 40 per cent of the total population and the total marginal workers accounted to 7.36 per cent of the total population. The total non-workers was 40.62 per cent to the total population.

4.3.1.4 Category wise land holdings

There were 12,204 land holdings with an operated area of 41,283.45 hectares in the district during the year 2010-11. It is evident from Table 4.15 that on marginal and small farmers accounted for maximum share in total operational area with 21.11 per cent and 35.43 percent respectively.

Table 4.15. Land holding of Veldurthi mandal (2011 census)

S.No.	Type of farmer	Number	Area (ha.)
1	Marginal farmers (below 1 ha)	5669 (46.45)	8716.14 (21.11)
2	Small farmers (1-2 ha)	4184 (34.28)	14626.84 (35.43.)
	Total	9853 (80.73)	23342.98 (56.54)
3	Semi medium farmers (2-4 ha)	1965 (16.10)	13101.24 (31.73)
4	Medium farmers (4-10 ha)	383 (3.14)	4734.79 (11.47)
5	Large farmers (above 10 ha)	3 (0.02)	104.44 (0.25)
	Total	12204 (100.00)	41283.45 (100.00)

Note: Figures in parentheses indicate percentage to the total

Source: *Hand Book of Statistics 2015. Chief Planning Office, Guntur.*

4.3.1.5 Irrigation sources

The Table 4.16 shows that in Veldurthi mandal of Guntur district, there are no surface water irrigation sources and total irrigated area comes under tube wells (12,816 ha) and the total irrigated area was 12,816 ha.

Table 4.16. Irrigation sources of Veldurthi mandal

Source	Gross area irrigated in 2015 (ha.)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Surface irrigation	0	0	0
Ground water			
Tube wells	12793	23	12816
Dug wells	0	0	0
Other sources	0	0	0
Sub total	12793	23	12816
Total area irrigated	12793	23	12816

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.1.6 Cropping pattern

Table 4.17 shows the cropping pattern in Veldurthi mandal, Guntur district for the year 2014-2015.

Table 4.17. Cropping pattern in Veldurthi mandal

Crop	Area (ha.)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Rice	88	0	88
Maize	0	6	6
Green gram	0	49	49
Red gram	42	0	42
Total pulses	42	49	91
Total food grains	130	55	185
Chillies	3670	0	3670
Total condiments and spices	3670	0	3670
Total fresh and dry fruits	176	0	176
Total vegetables	15	2	17
Total food crops	3991	57	4048
Total cotton	13252	0	13252
Groundnut	0	15	15
Total oil seeds	0	15	15
Total tobacco	0	0	0
Total fodder crops	45	0	45
Total non food crops	13297	15	13312
Gross area sown	17288	72	17360
Net area sown	17288	72	17360

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

The cropping pattern particulars of Veldurthi mandal from the Table 4.16 shows that total non food crops (13,312 ha.) occupied major share in the total cropped area followed by cotton (13,252 ha.), total food crops (4,048 ha.) and chillies (3,670 ha.)

4.3.1.7 Agricultural implements

The list and number of various agricultural implements and farm equipment in Veldurthi mandal are presented in Table 4.18.

From the Table 4.18, it can be observed that Veldurthi mandal consisted of a maximum number of steel ploughs (2189) and wooden ploughs (796) followed by cultivators (616).

Table 4.18. Particulars of agricultural implements in Veldurthi

(2011 census)

S.No.	Particulars	Number
1	Wooden ploughs	796
2	Steel ploughs	2189
3	Cultivators	616
4	Seed- cum-fertilizers drill/Seed drill	133
5	Sugarcane crushers	0
6	Manually operated sprayers/ dusters	0
7	Power operated sprayer/duster	0

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.2 SATTENAPALLE MANDAL

4.3.2.1 Demographic information

As per 2011 census (Table 4.19), total population of Sattenapalle mandal stood at 1,30,608 with male population of 64,764, female population of 65,844 and total number of households of 34,030. The density of population per sq. km is 673 and sex ratio (females per thousand males) was 1,017.

Table 4.19. Population particulars of Sattenapalle mandal (2011 census)

S.No.	Particulars	Persons	Percentage to total
1	Male	64764	49.59
2	Female	65844	50.41
3	Total	130608	100.00

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.2.2 Literacy rate

As given in Table 4.20, the literacy rate of Sattenapalli mandal was 63.43 per cent which is lower than district average literacy rate of 67.40 per cent.

Table 4.20. Level of literacy in Sattenapalle mandal (2011 census)

S.No.	Particulars	Literates	Literacy Rate
1	Male	41217	71.33
2	Female	33074	55.74
3	Total	74291	63.43

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.2.3 Occupation pattern

The details of occupation pattern are were presented in Table 4.21.

Table 4.21. Occupation pattern in Sattenapalle Mandal (2011 census)

S.No.	Particulars	Sattenapalle
	Total Workers	68413 (52.38)
1	Total Main Workers	63883 (48.91)
	Cultivators	3 (8.28)
	Agricultural Labourers	38818 (29.72)
	House hold Industry	908 (0.70)
	Other workers	17879 (13.69)
2	Marginal workers	4530 (3.47)
3	Non -workers	62195 (47.62)
4	Total population	130608 (100.00)

Note: Figures in parentheses indicate percentage to the total.

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

Total number of workers in Sattenapalle mandal were found to be 68,413 and which accounts to 52.38 per cent of the total population. The total agricultural labour accounted for around 30 per cent of the total population and the total marginal workers accounted to 3.47 per cent of the total population. The total non-workers were 47.62 per cent of the total population.

4.3.2.4 Category wise land holdings

There are 18,990 land holdings with an operated area of 43,362.92 hectares in the district for the year 2010-11. Marginal and small farmers accounted for maximum share in the operational area, as evident from Table 4.22.

Table 4.22. Land holding of Sattenapalle mandal (2011 census)

S.No.	Type of farmer	Number	Area (ha.)
1	Marginal farmers (below 1 ha)	13560 (71.41)	15621.06 (36.02)
2	Small farmers (1-2 ha)	3525 (18.56)	12075.84 (27.85)
	Total	17085 (90.39)	27696.9 (63.67)
3	Semi medium farmers (2-4 ha)	1423 (7.49)	9424.56 (21.73)
4	Medium farmers (4-10 ha)	472 (2.49)	5892.45 (13.59)
5	Large farmers (above 10 ha)	10 (0.05)	349.01 (0.80)
	Total	18990 (100.00)	43362.92 (100.00)

Note: Figures in parentheses indicate percentage to the total

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.2.5 Irrigation sources

For the Sattenapalle mandal of Guntur district, it is clear from Table 4.23 that, main irrigation sources are surface irrigation, which accounted to a total 9,642 ha. area cultivated. In the surface irrigation majorly 8966 ha. was cultivated under the canals. Total irrigated area was 9,490 ha.

Table 4.23. Irrigation sources of Sattenapalle mandal

Source	Gross area irrigated in 2015 (ha.)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Surface irrigation			
Canals	8813	153	8966
Tanks	243	2	245
Lift irrigation	415	16	431
Sub total	9471	171	9642
Ground water			
Tube wells	0	3	3
Dug wells	19	17	36
Other sources	0	0	0
Sub total	19	20	39
Total area irrigated	9490	191	9681

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.2.6 Cropping pattern

Table 4.24 shows the cropping pattern in Sattenapalle mandal, Guntur district for the year 2015.

Table 4.24. Cropping pattern in Sattenapalle mandal

Crop	Area (ha.)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Rice	5001	110	5111
Maize	0	60	60
Black gram	0	8	8
Red gram	31	1	32
Other pulses	0	7	7
Total pulses	31	16	47
Total food grains	5032	186	5218
Chillies	4292	0	4292
Turmeric	102	0	102
Total condiments and spices	4394	0	4394
Total fresh and dry fruits	39	0	39
Total vegetables	52	20	72
Total food crops	9517	206	9723
Total cotton	7645	0	7645
Total tobacco	0	1	1
Total fodder crops	92	45	137
Total aromatic plants and flowers	4	0	4
Total non food crops	7783	46	7829
Gross area sown	17300	252	17552
Net area sown	17300	0	17300

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

The cropping pattern particulars of Sattenapalle mandal from the table 4.24 shows that total food crops (9,723 ha.) occupied major share in the total cropped area followed by total non food (7,829 ha.), cotton (7,645 ha.), total food grains (5,218 ha.), Rice (5,111 ha.), total condiments (4,394 ha.) and chillies (4,292 ha.)

4.3.2.7 Agricultural implements

The list and number of various agricultural implements and farm equipment in Sattenapalle mandal are presented in Table 4.25.

From the Table 4.25, it can be observed that Sattenapalle mandal consists of a maximum number of cultivators (1040) and steel ploughs (814) followed by wooden ploughs (727).

Table 4.25. Particulars of agricultural implements of Sattenapalle mandal (2011 census)

S.No	Particulars	Number
1	Wooden ploughs	727
2	Steel ploughs	814
3	Cultivators	1040
4	Seed- cum-fertilizers drill/Seed drill	317
5	Sugarcane crushers	0
6	Manually operated sprayers/ dusters	22
7	Power operated sprayer/duster	0

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.3 BOLLAPALLE MANDAL

4.3.3.1 Demographical information

As per 2011 censuses (Table 4.26), the total population of Bollapalle mandal stood at 58,086 with male population of 29,245, female population of 28,841 and total number of households of 14,764. Density of population per sq. km was 376 and the sex ratio (females per thousand males) was 986.

Table 4.26. Population particulars of Bollapalle mandal (2011 census)

S.No.	Particulars	Persons	Percentage to total
1	Male	29245	50.35
2	Female	28841	49.65
3	Total	58086	100.00

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.3.2 Literacy rate

As given in Table 4.27, Bollapalle mandal has minimum educational facilities. The literacy rate of the mandal was 40.72 per cent which is lower than district literacy rate of 67.40 per cent.

Table 4.27. Level of literacy in Bollapalle mandal (2011 census)

S.No.	Particulars	Literates	Literacy Rate
1	Male	13179	52.45
2	Female	7247	28.95
3	Total	20426	40.72

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.3.3 Occupation pattern

The details of the occupation particulars in Bollapalle mandal are presented in the Table 4.28.

Table 4.28. Occupation pattern in Bollapalle mandal (2011 census)

S.No.	Particulars	Bollapalle
	Total Workers	34695 (59.73)
1	Total Main Workers	29343 (50.52)
	Cultivators	7092 (12.21)
	Agricultural Labourers	25119 (43.24)
	House hold Industry	227 (0.39)
	Other workrs	2257 (3.89)
2	Marginal workers	5352 (9.21)
3	Non -workers	23391 (40.27)
4	Total population	58086 (100.00)

Note : Figures in parentheses indicate percentage to the total.

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

Total number of workers in Bollapalle mandal as given in Table 4.28, were found to be 34,695 and which accounts to 59.73 per cent of the total population. The total agricultural labour accounted for around 43 per cent of the total population and the total marginal workers accounted to 9.21 per cent of the total population. The total non-workers were 40.27 per cent to the total population.

4.3.3.4 Category wise land holdings

There are 13,467 land holdings with an operated area of 43,059.37 hectares in the district for the year 2010-11. Marginal and small farmers accounts for maximum share in operational area that is evident from Table 4.29.

Table 4.29. Land holding of Bollapalle mandal (2011 census)

S.No.	Type of farmer	Number	Extent (ha.)
1	Marginal farmers (below 1 ha)	6913 (51.33)	9354.78 (21.73)
2	Small farmers (1-2 ha)	3961 (29.41)	13830.7 (32.12)
	Total	10874 (80.07)	23185.48 (53.84)
3	Semi medium farmers (2-4 ha)	2182 (16.20)	14237.26 (33.06)
4	Medium farmers (4-10 ha)	401 (2.98)	5296.35 (12.30)
5	Large farmers (above 10 ha)	10 (0.07)	340.28 (0.79)
	Total	13467 (100.00)	43059.37 (100.00)

Note: Figures in parentheses indicate percentage to the total

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.3.5 Irrigation sources

For the Bollapalle mandal of Guntur district, it is clear from the table 4.30 that the mandals is having both irrigation sources i.e. surface irrigation and groundwater. In the surface irrigation majorly 2,909 ha. was cultivated under the canals and in the ground water source, about 6,214 ha. area was covered under tube wells. Total irrigated area during both the seasons was 9,164 ha.

Table 4.30. Irrigation sources of Bollapalle mandal

Source	Gross area irrigated in 2015 (ha.)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Surface irrigation			
Canals	1043	1866	2909
Tanks	0	41	41
Lift irrigation	0	0	0
Sub total	1043	1907	2950
Ground water			
Tube wells	4857	1357	6214
Dug wells	0	0	0
Other sources	0	0	0
Sub total	4857	1357	6214
Total area irrigated	5900	3264	9164

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.3.6 Cropping pattern

Table 4.31 shows the cropping pattern in Sattenapalle mandal, Guntur district for the year 2015.

Table 4.31. Cropping pattern in Bollapalle mandal

Crop	Area (ha.)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Rice	976	1592	2568
Maize	0	42	42
Green gram	12	0	12
Black gram	0	11	11
Red gram	272	0	272
Other pulses	0	0	0
Total pulses	284	11	295
Total food grains	1471	1645	3116

Table 4.31 Contd..

Chillies	2981	359	3340
Total condiments and spices	2981	359	3340
Total fresh and dry fruits	324	0	324
Total vegetables	15	0	15
Total food crops	4791	2004	6795
Total cotton	2965	0	2965
Total oil seeds	68	86	154
Total tobacco	0	1185	1185
Total fodder crops	119	313	432
Total non food crops	4098	1584	5682
Gross area sown	8889	3588	12477
Net area sown	8877	3577	12454

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

The cropping pattern particulars of Bollapalle mandal from the Table 4.26 shows that total food crops (6,794 ha.) occupied major share in the total cropped area followed by total non food crops (5,682 ha.), chillies (3,340 ha.), total condiments and spices (3,340 ha.), total food grains (3,116) and cotton (2,965 ha.).

4.3.3.7 Agricultural implements

The list and number of various agricultural implements and farm equipment in Bollapalle mandal are presented in Table 4.32.

From the table 4.32 it can be observed that Bollapalle mandal consists of a maximum number of wooden ploughs (787) and cultivators (707) followed by steel ploughs (520).

Table 4.32. Particulars of agricultural implements of Bollapalle mandal (2011 census)

S.No.	Particulars	Number
1	Wooden ploughs	787
2	Steel ploughs	520
3	Cultivators	707
4	Seed- cum-fertilizers drill/Seed drill	496
5	Sugarcane crushers	18
6	Manually operated sprayers/ dusters	0
7	Power operated sprayer/duster	0

Source: Hand Book of Statistics 2014-2015, CPO, Guntur district

4.3.4 MEDIKONDURU MANDAL

4.3.4.1 Demographical information

As per 2011 Census (Table 4.33), total population of mandal stood at 60,144 with male population of 30,682, female population of 29,462 and total number of households of 15,909. Density of population per sq. km is 397 and the sex ratio (females per thousand males) was 960.

Table 4.33. Population particulars of Medikonduru mandal (2011 census)

S.No.	Particulars	Persons	Percentage to total
1	Male	30682	51.01
2	Female	29462	48.99
3	Total	60144	100.00

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.4.2 Literacy rate

As given in Table 4.34, The literacy rate of the Medikonduru mandal was 63.35 per cent which is lower than district literacy rate of 67.40 per cent.

Table 4.34. Level of literacy in Medikonduru mandal (2011 census)

S.No.	Particulars	Literates	Literacy Rate
1	Male	19522	71.51
2	Female	14507	54.91
3	Total	34029	63.35

Source: Hand Book of Statistics 2014-2015, CPO, Guntur district

4.3.4.3 Occupation pattern

The details of the occupation pattern of Medikonduru mandal are presented in the table 4.35

Total number of workers in Medikonduru mandal were found to be 33,189 which accounts to 55.18 per cent of the total population. The total agricultural labour accounted for around 36 per cent of the total population and the total marginal workers accounted to 3.96 per cent of the total population. The total number of non-workers was 44.82 per cent to the total population.

Table 4.35. Occupation pattern in Medikonduru Mandal (2011 census)

S.No.	Particulars	Medikonduru
	Total Workers	33189 (55.18)
1	Total Main Workers	30806 (51.22)
	Cultivators	4359 (7.25)
	Agricultural Labourers	21693 (36.07)
	House hold Industry	339 (0.56)
	Other workers	6798 (11.30)
2	Marginal workers	2383 (3.96)
3	Non -workers	26955 (44.82)
4	Total population	60144 (100.00)

Note: Figures in parentheses indicate percentage to the total.

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.4.4 Category wise land holdings

There are 11,828 land holdings with an operated area of 26,844.91 hectares in the district for the year 2010-11. Marginal and small farmers accounted for maximum share in operational area as evident from Table 4.36.

Table 4.36. Land holding of Medikonduru mandal (2011 census)

S.No.	Type of farmer	Number	Extent (ha.)
1	Marginal farmers (below 1 ha)	8560 (72.37)	9750.49 (36.32)
2	Small farmers (1-2 ha)	2171 (18.35)	7420.92 (27.64)
	Sub total	10731 (90.72)	17171.41 (63.96)
3	Semi medium farmers (2-4 ha)	797 (6.74)	5199.21 (19.37)
4	Medium farmers (4-10 ha)	279 (2.36)	3782.17 (14.09)
5	Large farmers (above 10 ha)	21 (0.18)	692.12 (2.58)
	Grand total	11828 (100.00)	26844.91 (100.00)

Note: Figures in parentheses indicate percentage to the total

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.4.5 Irrigation sources

For the Medikonduru mandal of Guntur district, it is clear from the Table 4.37 that, main irrigation sources are surface irrigation, cultivating a total area of 4,485 ha. Total net irrigated area was 4449 ha.

Table 4.37. Irrigation sources of Medikonduru mandal

Source	Gross area irrigated in 2015 (ha.)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Surface irrigation			
Canals	4426	59	4485
Tanks	0	0	0
Lift irrigation	0	0	0

Table 4.37 Contd..

Sub total	4426	59	4485
Ground water			
Tube wells	23		23
Dug wells	0	0	0
Other sources	0	0	0
Sub total	23	0	23
Total area irrigated	4449	59	4508
Area irrigated more than once	0	59	59

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

4.3.4.6 Cropping pattern

Table 4.38 shows the cropping pattern in Medikonduru mandal, Guntur district for the year 2014-15.

Table 4.38. Cropping pattern in Medikonduru mandal

Crop	Area (ha.)		
	<i>Kharif</i>	<i>Rabi</i>	Total
Rice	959	8	967
Maize	0	40	40
Red gram	30	0	30
Other pulses	0	6	6
Total pulses	30	6	36
Total food grains	989	54	1043
Chillies	3296	0	3296
Turmeric	171	0	171
Total condiments and spices	3467	0	3467
Total fresh and dry fruits	22	0	22
Total vegetables	43	7	50
Total food crops	4521	61	4582
Total cotton	6004	0	6004
Coconut	1	0	1

Table 4.38 Contd..

Total oil seeds	1	0	1
Total tobacco	0	4	4
Total fodder crops	120	130	250
Total non food crops	6132	134	6266
Gross area sown	10653	195	10848
Net area sown	10653	0	10653

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

The cropping pattern particulars of Medikonduru mandal from the Table 4.36 shows that total non food crops (6,266 ha.) occupied major share in the total cropped area followed by cotton (6,004 ha.), total food crops (4,582 ha.), total condiments and spices (3,467 ha.) and chillies (3,296 ha.)

4.3.4.7 Agricultural implements

The list and number of various agricultural implements and farm equipment in Medikonduru mandal are presented in Table 4.39.

Table 4.39. Particulars of agricultural implements of Medikonduru mandal (2011 census)

S.No.	Particulars	Number
1	Wooden ploughs	83
2	Steel ploughs	467
3	Cultivators	437
4	Seed- cum-fertilizers drill/Seed drill	451
5	Sugarcane crushers	0
6	Manually operated sprayers/ dusters	0
7	Power operated sprayer/duster	0

Source: Hand Book of Statistics 2015. Chief Planning Office, Guntur.

From the Table 4.39 it can be observed that Medikonduru mandal consists of a maximum number of Steel ploughs (467) and Seed- cum-fertilizers drill/Seed drills (451) followed by cultivators (437).

Guntur district consists of 57 mandals with 729 villages out of which 706 are revenue villages with 1,036 villages as hamlets. District was extending approximately 15° 18' and 16° 50' of north latitude and 79° 10' and 80° 55' of East longitude. Guntur occupies an area of 11,391 sq.km. As per 2011 census total population of the district was 48,87,813 it accounts 5.86 per cent of the total population of the state. Total agriculture labour was 10.35569 lakhs, which constitutes 21.18 per cent in Guntur district. Total annual rainfall of Guntur district was 497.6 mm during 2014-15, which is less than normal.

In Guntur district majority of soils found to be black cotton soils. In total geographical area, 54.29 per cent of land was under net area sown during 2014-15. Marginal and small farmers together accounts for 90 per cent with an operational holding of 65 per cent of the total cultivated area. Out of 5,30,077 ha. of gross irrigated area in Guntur 79.92 per cent land was comes under surface irrigation and remaining comes under ground water sources. Area under different crops in Guntur district. Majorly total food crops occupied first place in cultivated area. In animal husbandry, buffaloes growing households and total buffaloes population was more in all selected mandals. In sample area literacy rate was more in Sattenapalle with 67.43 per cent. Total workers are more in Sattenapalle 68,413 which constitute to 52.38 per cent to their total population. In all mandals majorly marginal and small farmers are occupied more land holdings.

In literacy rate Medikonduru mandal occupied first place with 63.35 per cent of total literacy among selected four mandals followed by Sattenapalle (55.74%), Veldurthi (47.02%) and Bollapalle (40.72%).

In occupational pattern agricultural labour percentage was more in Bollapalle with 43.24 per cent followed by Veldurthi (40.31%), Medikonduru (36.07%) and Sattenapalli (29.72%)

In land utilization pattern the marginal and small farmers are occupied major share in total cultivated land. Medikonduru marginal and small farmers are occupied 90.72 per cent followed by Sattenapalle (90.39%), Veldurthi (80.73%) and Bollapalle (80.07%).

The major crops grown in all selected mandals are condiments and spices cotton, chillies and total food crops occupied major share in the gross area sown. Irrigation sources were good in Sattenapalle mandal compared to other mandals in the sample area. On an average all mandals the total food crops growing area was more than the remaining crops. In all mandals on an average wooden plough and steel plough are high in number.

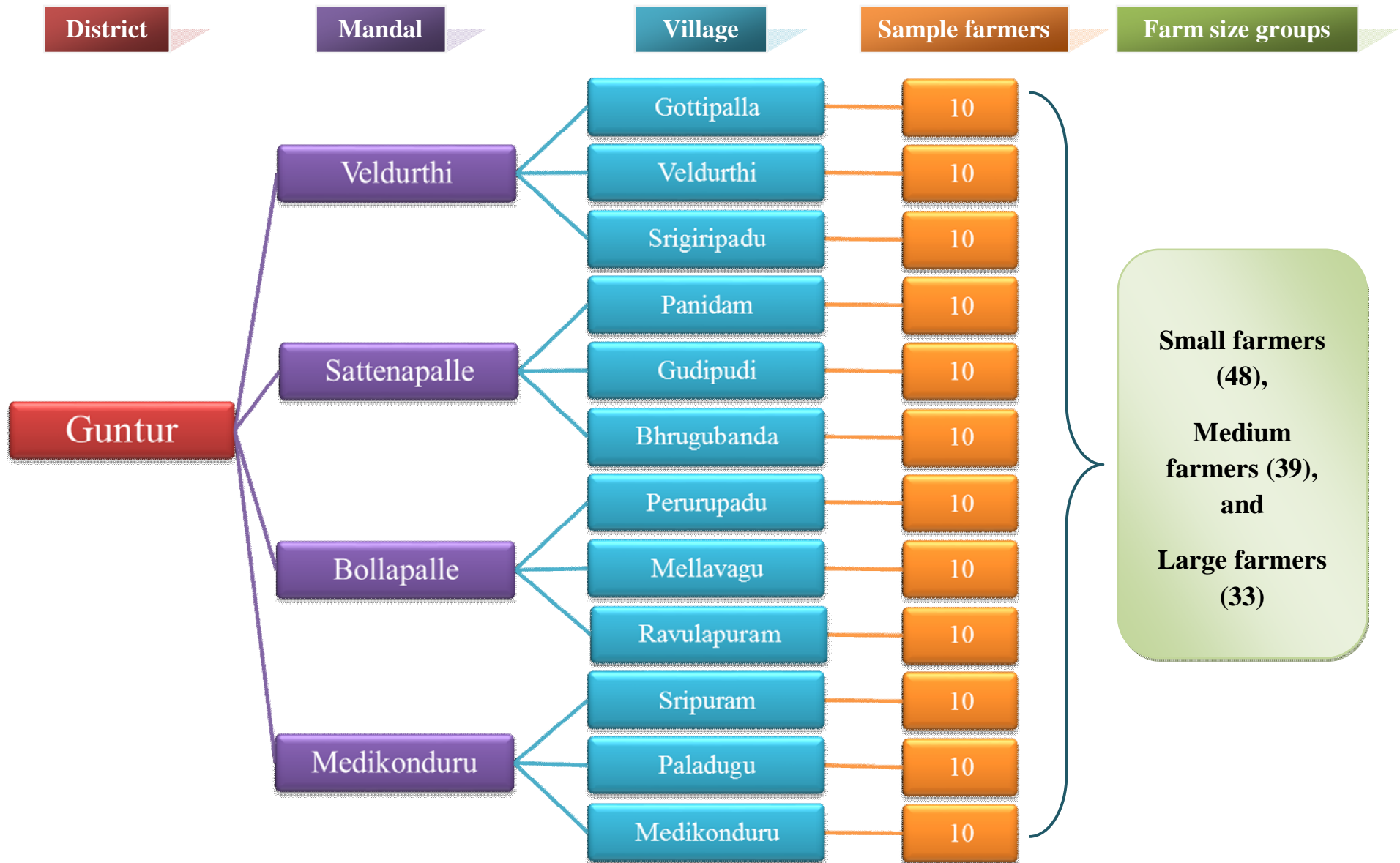


Fig. 3.1 Sampling design regarding selection of villages



Fig. 4.1: Map showing selected mandals in Guntur district of Andhra Pradesh

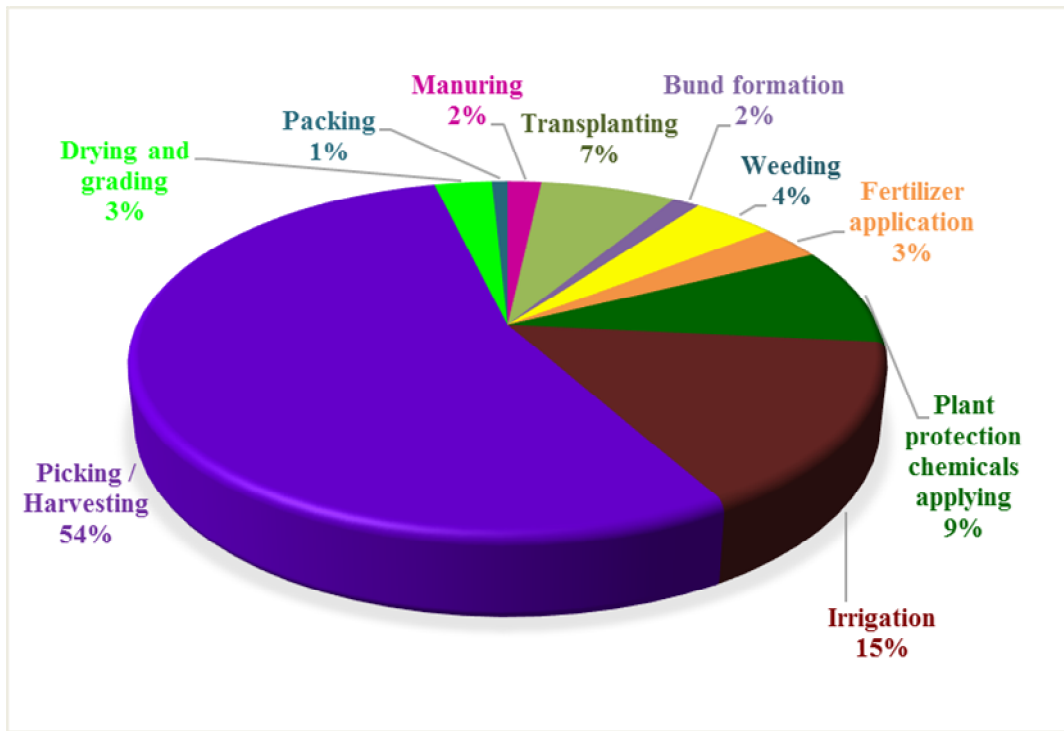


Fig. 5.1 Operation wise human labour utilization in chilli cultivation for small farmers

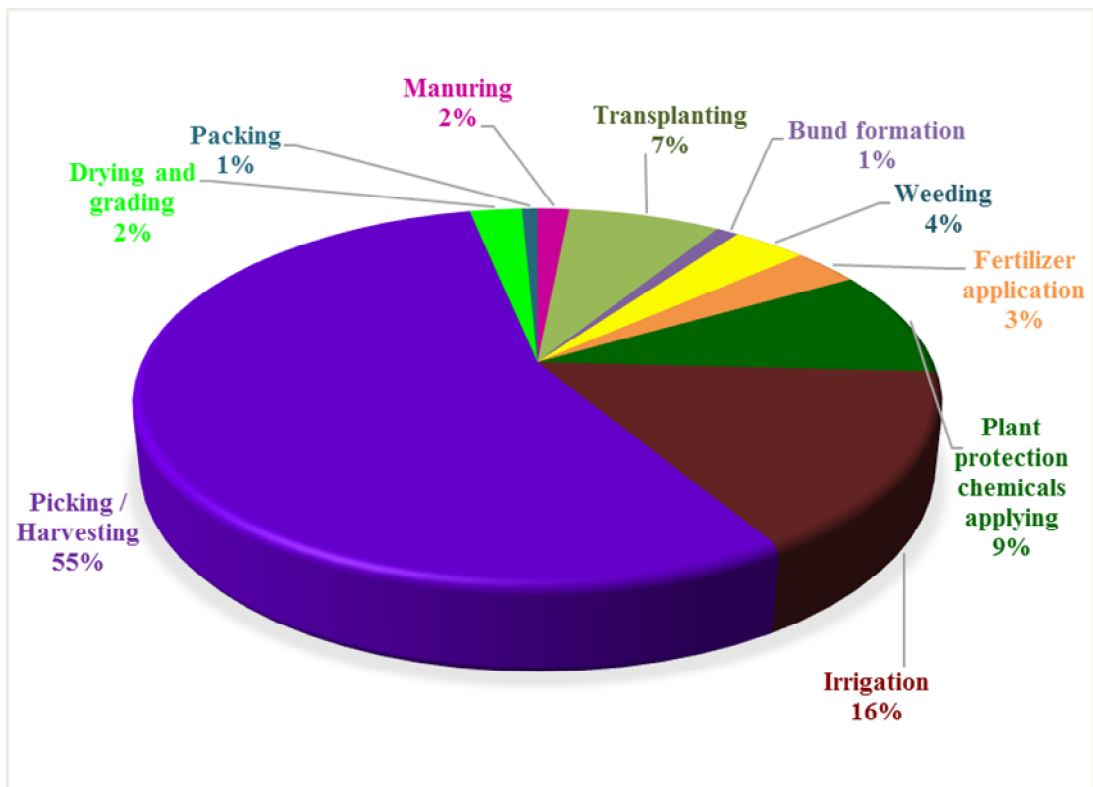


Fig. 5.2 Operation wise human labour utilization in chilli cultivation for medium farmers

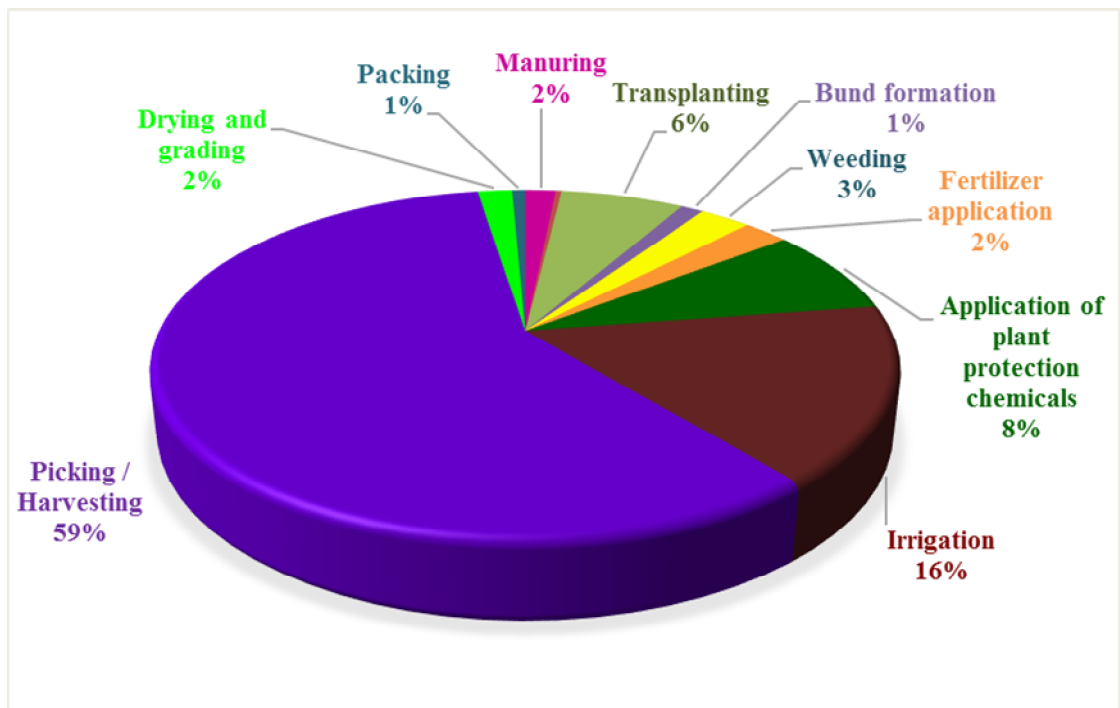


Fig. 5.3 Operation wise human labour utilization in chilli cultivation for large farmers

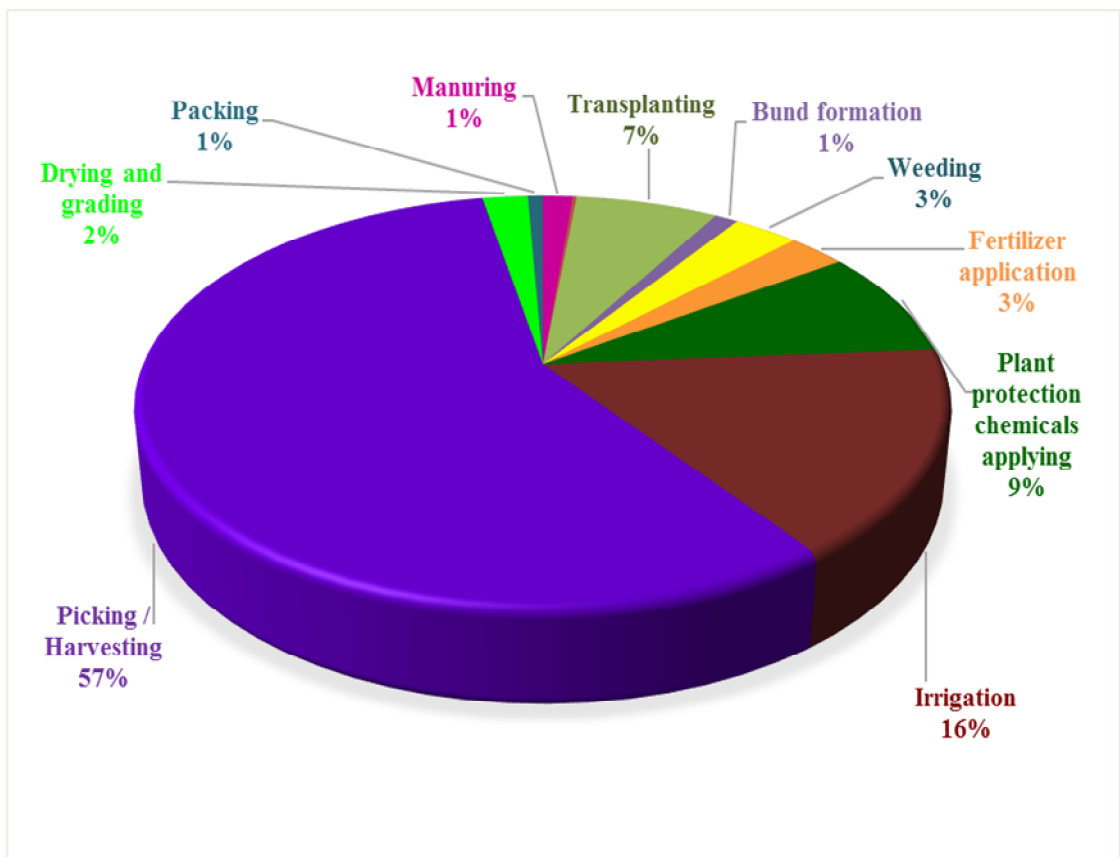


Fig. 5.4 Operation wise human labour utilization in chilli cultivation for pooled farmers

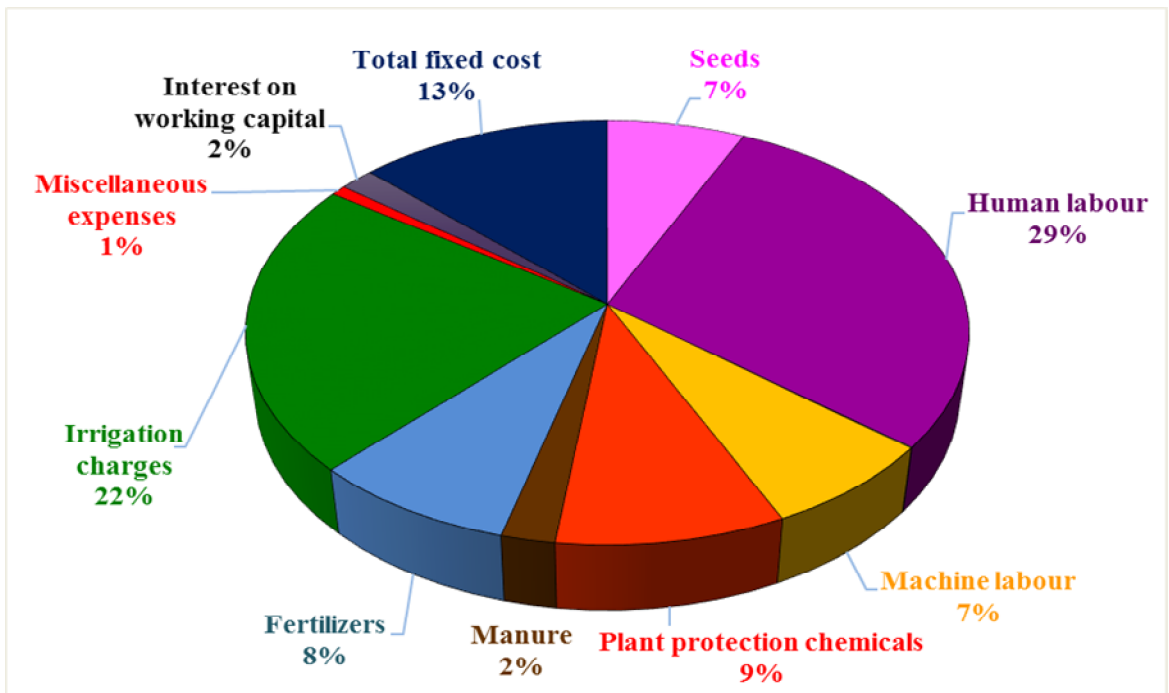


Fig. 5.5 Total cost of cultivation of small farmers in chili

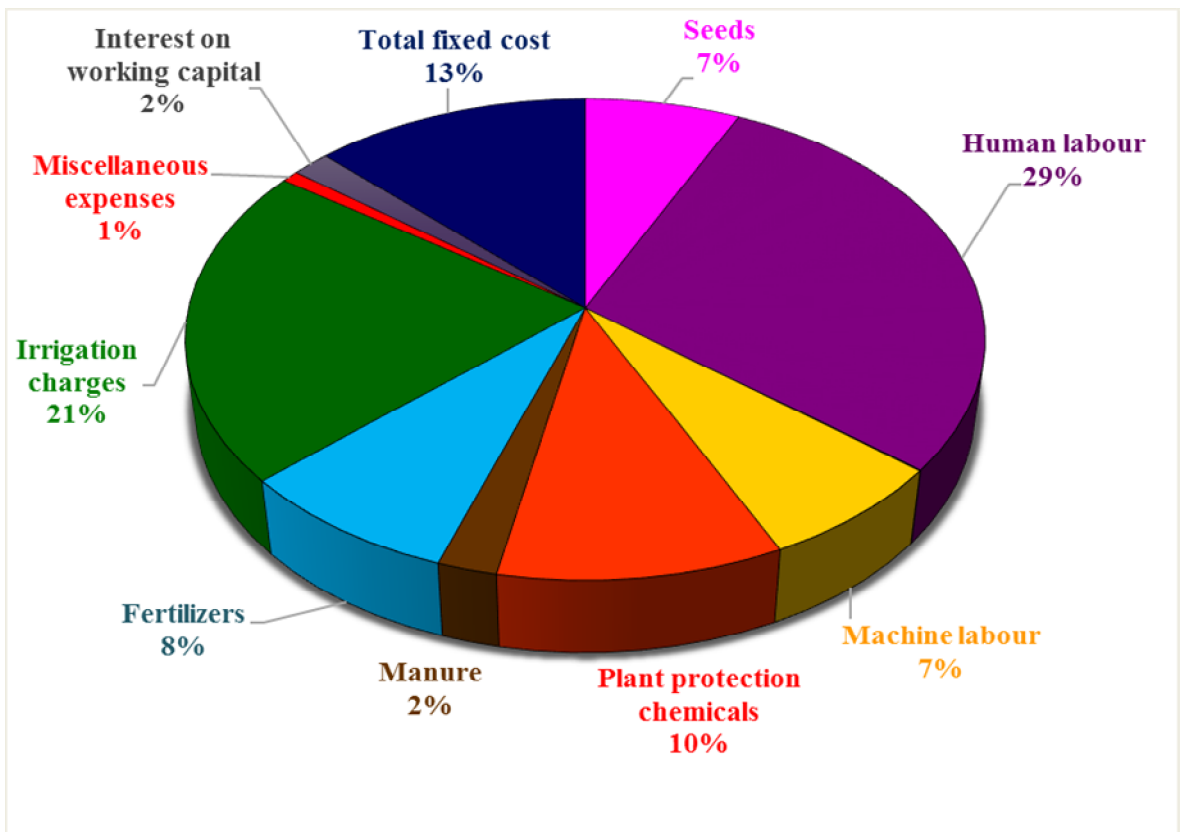


Fig. 5.6 Total cost of cultivation of medium farmers in chili

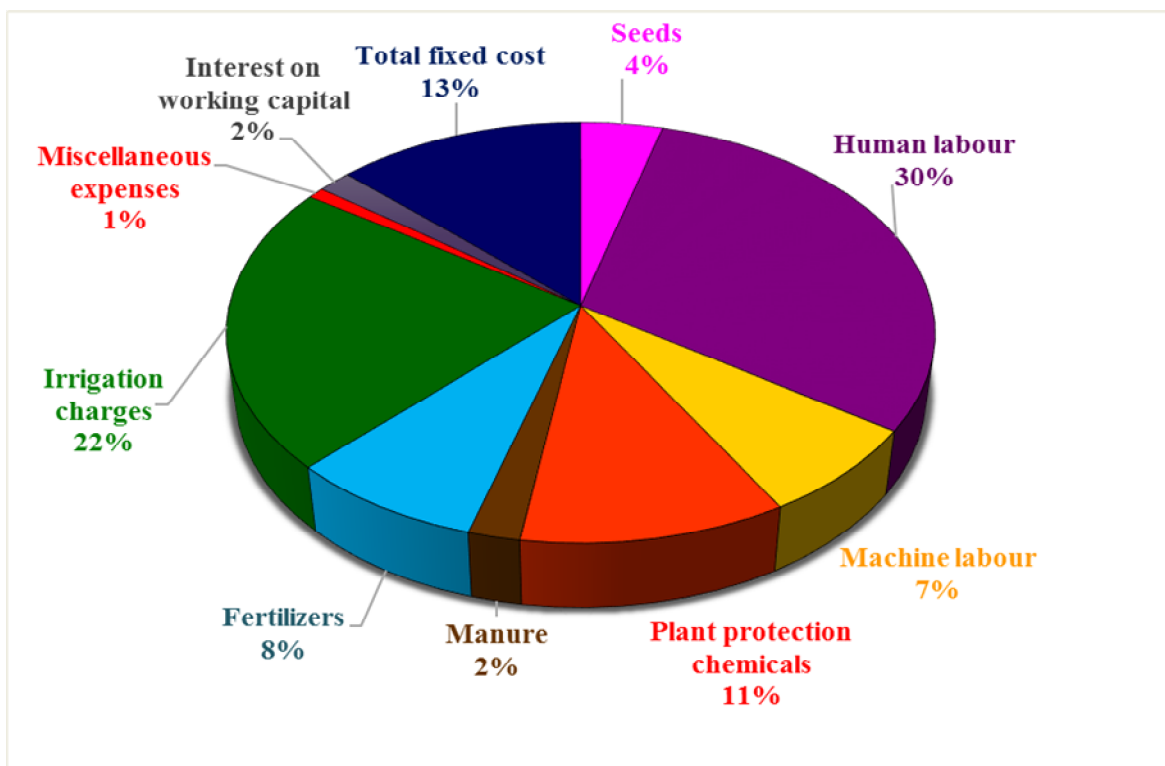


Fig. 5.7 Total cost of cultivation of large farmers in chili

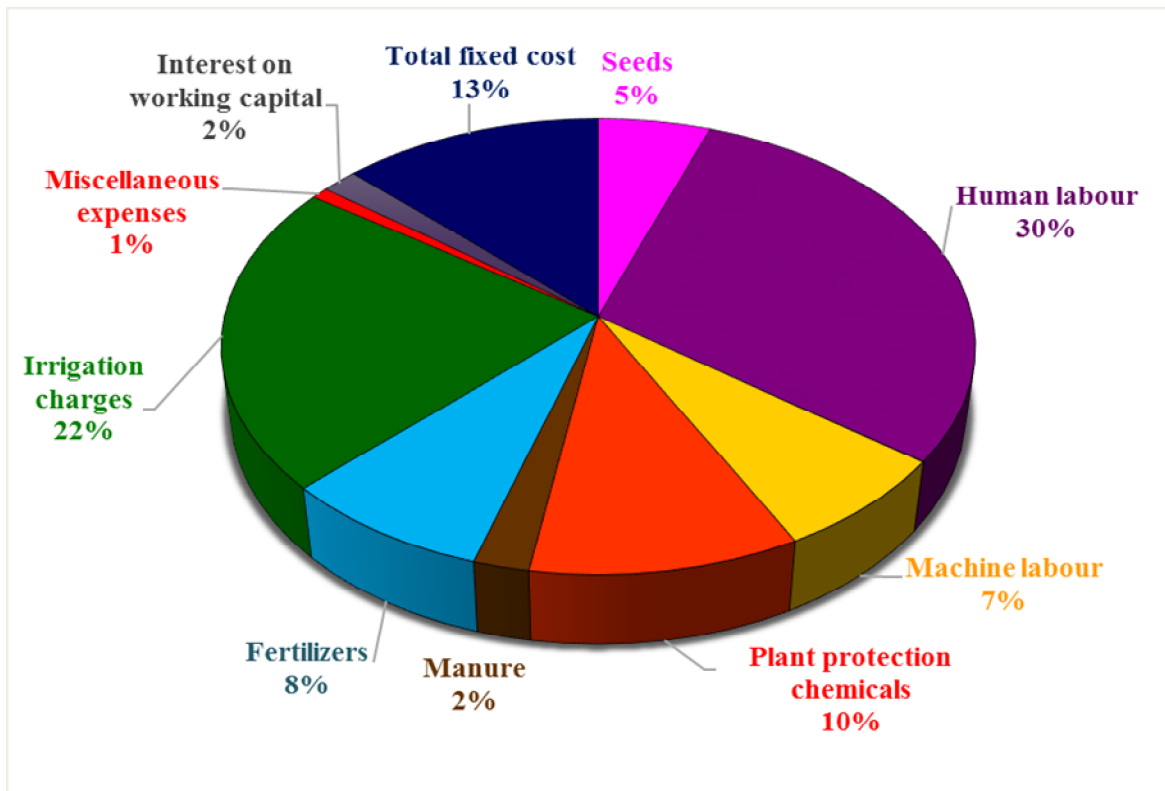


Fig. 5.8 Total cost of cultivation of pooled farmers in chili

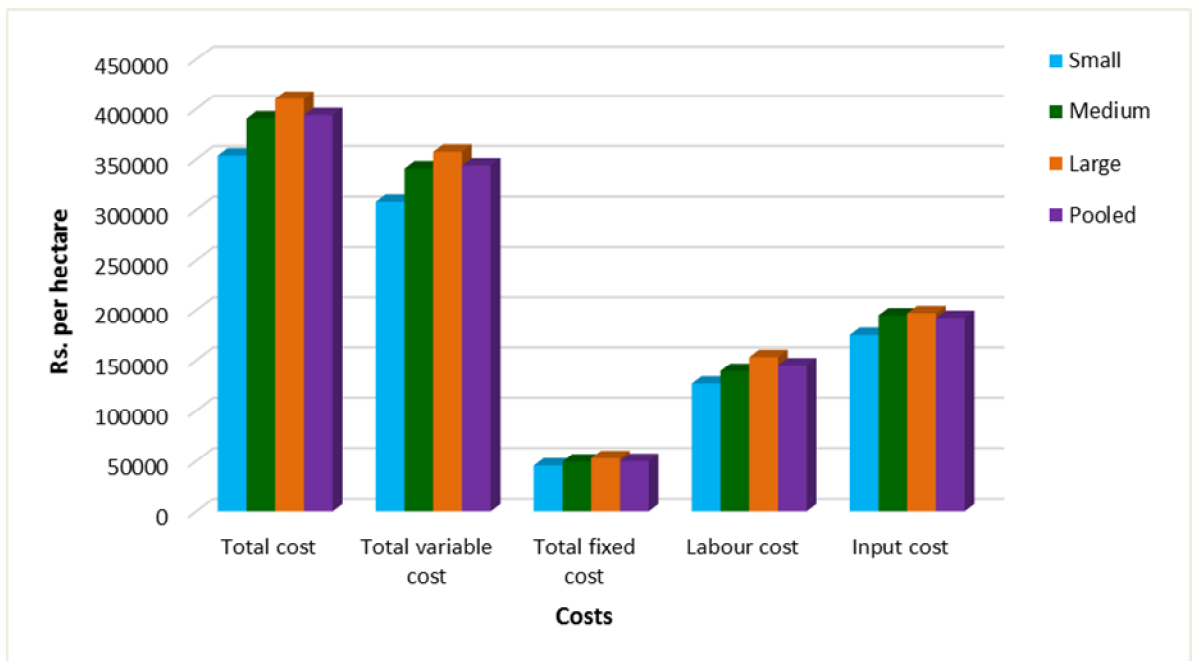


Fig. 5.9 Costs and returns of chilli crop from sample farmers

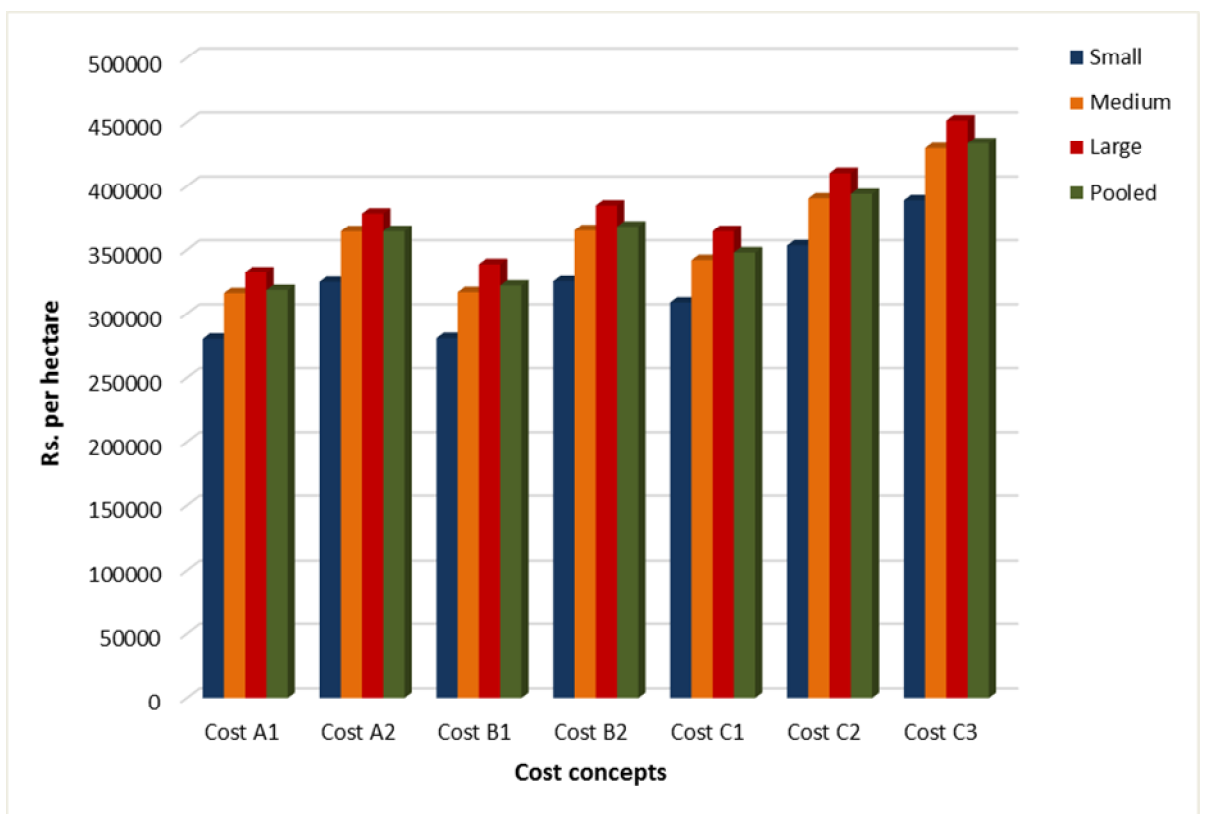


Fig. 5.10 Cost concepts for all farm size groups of small farmers