

**ECONOMIC ANALYSIS OF SUGARCANE BASED AND
ALTERNATE CROPPING SYSTEMS IN IRRIGATED
SUGARCANE BELTS OF BELAGAVI DISTRICT**

BINDU B. R.

**DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE, DHARWAD
UNIVERSITY OF AGRICULTURAL SCIENCES,
DHARWAD-580 005**

JUNE, 2017

**ECONOMIC ANALYSIS OF SUGARCANE BASED AND
ALTERNATE CROPPING SYSTEMS IN IRRIGATED
SUGARCANE BELTS OF BELAGAVI DISTRICT**

Thesis submitted to the
University of Agricultural Sciences, Dharwad
in partial fulfillment of the requirements for the
Degree of

Master of Science (Agriculture)
in
AGRICULTURAL ECONOMICS

By
BINDU B.R.

**DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE, DHARWAD
UNIVERSITY OF AGRICULTURAL SCIENCES,
DHARWAD-580 005**

JUNE, 2017

**DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE, DHARWAD
UNIVERSITY OF AGRICULTURAL SCIENCES, DHARWAD**

CERTIFICATE

This is to certify that the thesis entitled “**ECONOMIC ANALYSIS OF SUGARCANE BASED AND ALTERNATE CROPPING SYSTEMS IN IRRIGATED SUGARCANE BELTS OF BELAGAVI DISTRICT**” submitted by **Miss BINDU B.R.** for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ECONOMICS** to the University of Agricultural Sciences, Dharwad is a record of research work carried out by her during the period of her study in this university, under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

**DHARWAD
JUNE, 2017**

**(S. M. MUNDINAMANI)
CHAIRMAN**

Approved by :

Chairman :

(S. M. MUNDINAMANI)

Members :

1. _____
(R. S. PODDAR)

2. _____
(H. B. BABALAD)

ACKNOWLEDGEMENT

Gratitude takes three forms, “A feeling from the heart, an expression in words and a giving in return.....”

At last, the moment has come to look into the deeper layers of my heart which is filled with the feeling of togetherness and loveliness; consolation and satisfaction. Some are permanent and some are momentary but both involve a number of persons to whom I acknowledge my warm regards.

First and foremost I humbly bow my head before the Almighty for the un-merited blessings through various hands. I submit this small venture before God with full satisfaction and pleasure from my heart.

I wish to express my deep sense of reverence to **Dr. S. M. MUNDINAMANI**, Professor and University Head, Department of Agricultural Economics, University of Agricultural Sciences, Dharwad and the esteemed chairman of my advisory committee. I am profoundly thankful to him for suggesting need based research, thought provoking discussion, invaluable inspiring guidance, sustained interest, personal affection and constructive criticism during the course of investigation.

It is with great respect and devotion I place on record, my deep sense of gratitude and indebtedness to my advisory committee members **Dr. R.S. PODDAR**, Professor, Department of Agricultural Economics, Dharwad and Head, Project Planning Monitoring Cell (PPMC), UAS Dharwad. **Dr. H. B. BABALAD**, Professor, Department of Agronomy, University of Agricultural Sciences, Dharwad for their sustained and valuable guidance, constructive suggestions, unflinching patience, friendly approach, constant support and encouragement throughout the period of my research work.

I am extremely delighted to place on record my profound sense of gratitude to Dr. B. L. Patil, Professor and Head, Department of Agricultural Economics, Dr. G. N. Kulkarni, Dr. Jayashree A. Handigol and Dr. H. Basavaraja, Dr. B.R. Jamakhandi and Dr. M. T. Sharma for their unstinted support, critical comments and valuable suggestions during the study and research work.

I accord my sincere thanks to the Heads of the District Statistical Office and Joint Director of Agriculture and the agricultural officers of the Belagavi District. I have visited, for helping me during my research work by providing secondary data. I am also thankful to farmers of all the villages which I surveyed, for their cooperation during the interviews.

With much love and affection, I record my respectful indebtedness and gratitude to my father **Shri Ravi B.M.** and my mother **Smt. Rathnamma N.G.** whose love and affection have

always been a source of inspiration and encouragement to me in all walks of my life. I feel inadequacy of diction to express my deep sense of gratitude and heartfelt thanks to my sisters **Jyothi, Sujatha, Ranjitha**, brother-in-law **Sangmesh**, brother **Siddesh** and sweet baby **Vaishu** for their boundless love and unshakeable confidence which inspired me in pursuing the study and responsible for what I am today. I dedicate this piece of work for their love and sacrifice.

I express my heartfelt thanks to my dearest friend Miss. Gayatri Beeligi who was with me in my endeavour for; her constant help during work and helped me to pursue my research work with precision. I am grateful to my seniors Miss. Radhika V.S., Shilpa P.C., and Priyadarshini for their valuable advises during the degree programme.

I would like to take this opportunity to thank my beloved friends, classmates seniors and juniors; vidyashree, Geetha, Karuna, Mangala, Shaziya, Bharthi, Akshata, Mahesh, Rakesh, Sampath, Sunil, Akbar, Manju, Asma, Pavitra and Gowri for their direct and indirect encouragement, support and wishes.

I will never forget the enormous and timely help rendered by Mr. Anup (Anup Computers) for their patience, precise delivery and meticulous typing of the manuscript.

Finally, I thank GOD for bestowing me with divine spirit, essential strength and necessary succor to find my way towards a glorious carrer amidst several hurdles and struggles.

.....omission of any names doesn't mean the lack of gratitude.

**DHARWAD
JUNE, 2017**

(BINDU B. R.)

CONTENTS

Sl. No.	Chapter Particulars	Page No.
	CERTIFICATE	iii
	ACKNOWLEDGEMENT	iv
	LIST OF ABBREVIATIONS	viii
	LIST OF TABLES	ix
	LIST OF FIGURES	xi
	LIST OF APPENDICES	xii
1.	INTRODUCTION	1-8
2.	REVIEW OF LITERATURE	9-24
	2.1 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	9
	2.2 Cost and returns in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	12
	2.3 Resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	17
	2.4 Constraints in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	21
3.	METHODOLOGY	25-40
	3.1 Description of the study area	25
	3.2 Sampling procedure	33
	3.3 Nature and sources of data	33
	3.4 Analytical tools and techniques	33
	3.5 Definitions and Concepts	37
4.	RESULTS	41-90
	4.1 Socio-economic profile of sample respondents in the study area	41
	4.2 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems of sample farmers in the study area	43
	4.3 Cropping pattern followed by the sample farmers in sugarcane mono-cropping, sugarcane based intercropping systems	47
	4.4 Cropping pattern followed by the sample farmers in alternate cropping systems	54
	4.5 Operation wise labour utilisation pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	57
	4.6 Input utilization pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	61

Contd.....

Sl. No.	Chapter Particulars	Page No.
	4.7 Cost of cultivation in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	63
	4.8 Returns from sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	74
	4.9 Resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	77
	4.10 Allocative efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	83
	4.11 Constraints faced by sample respondents in sugarcane mono-cropping, sugarcane based intercropping systems	85
	4.12 Constraints faced by sample respondents in alternate cropping systems	88
5.	DISCUSSION	91-106
	5.1 Socio-economic profile of sample respondents in the study area	91
	5.2 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems of sample farmers in the study area	92
	5.3 Cropping pattern followed by the sample farmers in sugarcane mono-cropping, sugarcane based intercropping systems	93
	5.4 Cropping pattern followed by the sample farmers in alternate cropping systems	94
	5.5 Operation wise labour utilisation pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	95
	5.6 Input utilization pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	97
	5.7 Cost of cultivation in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	98
	5.8 Returns from sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	99
	5.9 Resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	100
	5.10 Allocative efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	102
	5.11 Constraints faced by sample respondents in sugarcane mono-cropping, sugarcane based intercropping systems	104
	5.12 Constraints faced by sample respondents in alternate cropping systems	105
6.	SUMMARY AND POLICY IMPLICATIONS	107-111
	REFERENCES	112-117
	APPENDICES	118-122

LIST OF ABBREVIATIONS

Sl. No	Abbreviations	
1	mm	Millimeter/s
2	kg	Kilogram/s
3	t	Tonne/s
4	ha	Hectare/s
5	q	Quintal/s
6	%	Percentage
7	mt	Million tonne/s
8	mha	Million hectare/s
9	md	Man days
10	pd	Pair days
11	hr	Hour/s
12	l	Litre/s
13	FYM	Farm yard manure
14	DAP	Di ammonium phosphate
15	MOP	Murate of potash
16	₹	Rupees
17	lakh t	Lakh tonne/s
18	lakh ha	Lakh hectare/s
19	sq. km	Square kilometer/s
20	°C	Centigrade

LIST OF TABLES

Table No.	Title	Page No.
3.1	Land utilization pattern in the study area	28
3.2	Demographic features of the study area	30
3.3	Taluk-wise area Irrigated by different sources in Belagavi district (2015-16)	31
3.4	Area under different crops in the Belagavi district	32
4.1	Socio-economic profile of the sample respondents	42
4.2	Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems of sample farmers in the study area	45
4.3	Major cropping systems identified under sugarcane based and alternate cropping systems in the study area	46
4.4	Land holding pattern of the farmers in the identified major cropping systems in the study area	48
4.5	Source of irrigation in the identified major cropping systems in the study area	49
4.6	Cropping pattern of sugarcane mono-cropping farmers (CS-I)	50
4.7	Cropping pattern of sugarcane based intercropping systems farmers (CS-II)	52
4.8	Cropping pattern of sugarcane based intercropping systems farmers (CS-III)	53
4.9	Cropping pattern of alternate cropping systems farmers (CS-IV)	55
4.10	Cropping pattern of alternate cropping systems farmers (CS-V)	56
4.11	Operation wise labour utilisation pattern in sugarcane mono-cropping	58
4.12	Operation wise labour utilisation pattern in sugarcane based intercropping systems	60
4.13	Operation wise labour utilisation pattern in alternate cropping systems	62
4.14	Input utilization pattern in sugarcane mono-cropping	64
4.15	Input utilization pattern in sugarcane based intercropping systems	65
4.16	Input utilization pattern in alternate cropping systems	66
4.17	Cost of cultivation in sugarcane mono-cropping	69
4.18	Cost of cultivation in sugarcane based intercropping systems	70

Contd.....

Table No.	Title	Page No.
4.19	Cost of cultivation in alternate cropping systems	72
4.20	Returns from sugarcane mono-cropping	75
4.21	Returns from sugarcane based intercropping systems	76
4.22	Returns from alternate cropping systems	78
4.23	Comparative costs and returns structures under sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	79
4.24	Resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	8
4.25	Allocative efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	84
4.26	Constraints faced by sample respondents in sugarcane based cropping systems	87
4.27	Constraints faced by sample respondents in Alternate cropping systems	89

LIST OF FIGURES

Figure No.	Title	Page No.
1	Map of the study area	26
2	Sampling design	34
3	Variable cost components under sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	67
4	Share of different cost under sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	73
5	Costs and returns structures in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems	80

LIST OF APPENDICES

Appendix No.	Title	Page No.
I	Schedule	118

Introduction

1. INTRODUCTION

Agriculture is the backbone of Indian economy and about 65 per cent of Indian population depends directly upon agriculture. It has to support almost 17 per cent of world population from 2.3 per cent of world geographical area and 4.2 per cent of world's water resources (Pandey, 2009). Indian agriculture is characterized by small farm holdings. The average farm size is only 1.57 ha. Around 93 per cent of farmers have land holdings smaller than 4 ha and they cultivate nearly 55 per cent of the arable land. The latest statistics claim that, out of the total GDP and the exports of India, one-fifth and 10 per cent, respectively is contributed by agriculture. Agriculture is the basic means of attaining raw material for the other sectors. Hence, directly as well as indirectly it plays a major role in the growth of the economy.

Problems of mono-cropping:

In the changing agricultural scenario in the world as a result of globalization, agriculture in India has to face new challenges to compete at the global level in many agricultural commodities. Indian agriculture is now facing second generation problems like severe water scarcity, nutrient imbalance, soil degradation, salinity alkalinity, resurgence of pests and diseases, environmental pollution and decline in farm income. Crop diversification shows lot of promise in alleviating these problems through fulfilling the basic needs and regulating farm income, withstanding weather aberrations, controlling price fluctuation, ensuring balanced food supply, conserving natural resources, reducing the chemical fertilizer and pesticide loads, environmental safety and creating employment opportunity.

Need for crop diversification:

Crop diversification has been recognized as an effective strategy for achieving the objectives of food security, nutrition security, income growth, poverty alleviation, employment generation, judicious use of land and water resources, sustainable agricultural development and environmental improvement. Crop diversification may be adopted as a strategy for profit maximization through reaping the gains of complementary and supplementary relationships or in equating substitution and price for competitive products. It also acts as a powerful tool to minimize risks in farming (Gupta and Tewari, 2005). Crop diversification in India is generally viewed as a shift from traditionally grown less

remunerative crops to more remunerative crops. Market infrastructure development and price related supports also induce crop shift. Higher profitability and also the resilience/stability in production also induce crop diversification. The crop shift also takes place due to governmental policies and thrust on some crops over a given time. For example, Technology Mission on Oilseeds (TMO) was created to give thrust on oilseeds production as a national need for the country's requirement for less dependency on imports (Kalaiselvi, 2012). Market infrastructure development and certain other price related supports also induce crop shift. Crop diversification and also the growing of large number of crops are practiced in rain-fed lands to reduce the risk factor of crop failure due to drought or less rain and due to pest and diseases. Crop substitution and shift are also taking place in the areas with distinct soil problems. However in recent years a growing mono-cropping system especially in irrigated command areas has created challenges. Heavy water guzzling crops like sugarcane and paddy are taken under as mono-cropping systems. These systems have led to declining soil productivity, low water use efficiency and land degradation etc.

Sugarcane scenario:

Sugarcane (*Saccharum officinarum* L.) is one of the most important commercial crops of the tropics. It is an energy source for human beings and is the main source of sugar in the world. Sugarcane belongs to family *Poaceae* and genus *Saccharum* and the cultivation of sugarcane was practiced in all the tropical and sub-tropical regions. Portuguese and Spaniards took it to the New World early in the 16th century. It was introduced to the United States of America (Louisiana) around 1741.

India is considered as homeland of sugarcane and has been cultivated from the historic times over the years and a major commercial crop next to cotton in India, since Indian agro-climatic conditions are favourable for the production of this crop. It is most important source of sugar and also plays a pivotal role in the agro-industrial economy of India.

At present Brazil, India, China, Thailand, Pakistan, Mexico and Indonesia are the leading producers of sugarcane. Globally, sugarcane is cultivated over an area of 26.11 mha with a production of 1936.60 mt and productivity of 68.58 t/ha (FAO, 2015-16). Sugarcane area and productivity differ widely from country to country. Brazil has the highest area (9.8 mha) and production (739.267 mt), while Colombia has the highest productivity (94.75 t/ha). The six largest exporters of sugar during 2015-16 were Brazil (26.7 mt), Thailand (7 mt),

Australia (3.1 mt), Mexico (2.1 mt), Guatemala (1.9 mt) and India (2.79 mt) and were expected to supply approximately 80 per cent of all the world free market exports. India is currently ranked as the sixth largest exporter of sugar to the world market (World Sugar Stat, 2016).

After Brazil, India ranked second among the sugarcane growing countries in the world in terms of both area and production. The area under sugarcane cultivation during 2015-16 was 50.12 mha with a production 352.10 mt and productivity of 69.84 t/ha. Leading states in production of sugarcane in India are Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh. The annual consumption of sugar in India is estimated to be 23 mt. The per capita annual consumption of white sugar is 18.9 kg and that of gur and Khandsari is 3.7 kg.

India had exported 27.91 lakh t of sugar during 2015-16. The major raw sugar importing countries from India are China, Indonesia and Gulf countries while, white sugar is being shipped to countries like East and South-East Asia, Western Africa, Iran, Iraq, Egypt, Sri Lanka and Afghanistan. Sugar import accounted for 11.21 lakh t (World Sugar stat, 2015-16).

Karnataka is one among the major sugarcane and sugar-producing states in the country. Sugarcane is being cultivated in large areas since many years for manufacture of jaggery, khandsari and white sugar. It is also a major provider of livelihood to millions of agricultural families and their dependents particularly in rural areas. In Karnataka, the sugarcane is cultivated over an area of 6.90 lakh ha with a production 39.14 mt and productivity of 98.50 t/ha (Anon., Karnataka state agriculture profile 2015-16). Belagavi, Bagalkot, Mandya, Vijaypur and Bidar are the leading sugarcane growing districts in the state.

In recent years, continuous growing of mono-crop of sugarcane in irrigated belts is creating problems of resource degradation and depletion of water table. To conserve soil fertility, to save water and to hold degradation processes, the need for crop diversification has been reported (Gill and Ahlawat, 2013). Hence, diversification is necessary from sugarcane mono-cropping systems to alternate cropping systems.

Major alternate crops to sugarcane:

Turmeric (*Curcuma longa* L.) an important spice crop with its brilliant yellow colour has been used as dye, medicine and flavouring since 600 B.C. According to Bureau of Indian

Standards (BIS) 63 spices are grown in India. The spices are grown throughout the country from tropical to temperate climate. The spice turmeric or haldi constitutes boiled, dried, cleaned and polished rhizomes (the underground swollen stem of plant). It is one of the multi-use products which have many valuable properties and uses, which is extensively used in food, textile, medicine and cosmetic industries.

Turmeric can be cultivated in tropical and subtropical countries. It is grown throughout the world particularly in the tropical countries. India is the largest producer, consumer and exporter of turmeric. Other producers in Asia include Bangladesh, Pakistan, Sri Lanka, Burma, Taiwan and Indonesia. Major importers are the Middle East and North African countries, Iran, Japan and Sri Lanka. These importing countries represent 75 per cent of the turmeric world trade and are mostly supplied by the Asian producing countries. Europe and North America represent the remaining 15 per cent and are supplied by India and Central and Latin American countries (FAO, 2016).

India has 18.53 lakh ha under turmeric cultivation with a total production of 70.17 mt. Andhra Pradesh topped both in area and production with 7.39 m ha and 37.58 lakh t, respectively followed by Tamil Nadu with an area of 3.3 m ha and production 15.86 mt (India stat 2015-16). Productivity was highest in Tamil Nadu (6118 kg/ ha). Turmeric is seasonal product which is available in the market mainly in two seasons, commencing in mid-February to May and second season is mid-August to October.

Karnataka ranks third among the turmeric growing states in the country after Andhra Pradesh and Tamil Nadu with an area and production of 24,912 ha and 2.50 lakh t (Anon., Karnataka state agriculture profile 2015-16), with a share of 8.5 per cent of India's total production. In Karnataka the area and production of turmeric is grown at the rate of five and six per cent per annum. The major districts which are producing turmeric in the states are Chamarajnagar, Mysore, Bagalkot, Belagavi and Bidar.

Maize (*Zea mays* L.) is one of the most important cereal crops of the world and provides more human food than any other cereals. Maize provides for humans and animals and serves as basic raw materials for the production of starch, oil and protein, alcoholic beverages and food sweeteners. Maize is the most widely distributed crops of the world. It is cultivated in the tropics, sub-tropics and temperate regions.

Maize ranks third position next to wheat and rice in the world with respect to area, while its productivity surpasses all other cereal crops. Maize is grown in 70 countries of the world. The major maize growing countries are USA, China, Brazil, Mexico, France, India, Argentina and Indonesia. During 2015-16, Maize was cultivated in 168 mha with a production of 854.67 mt globally. The countries like USA, China, Brazil, Mexico, Argentina and India together accounted for 75 per cent of the world maize production. USA occupies the first position with an area of 34.151 mha and production of 317.44 mt followed by China with an area of 33 mha and production of 178 mt.

In India, Maize is the most important food crops after rice and wheat. Currently in India maize is grown on an area of 8.17 mha with production and productivity being 19.73 mt and 2.4 t/ha, respectively (2015-16). India ranks sixth in global maize production, contributing to 2.4 per cent of the world production with almost 5 per cent share in world harvested area. The predominant maize growing states that account for more than 80 per cent of the total maize production are Andhra Pradesh, Karnataka , Rajasthan, Maharashtra, Bihar, Uttar Pradesh, Madhya Pradesh and Himachal Pradesh.

Karnataka produced 4.4 mt of maize with an area of 1.3 mha during 2015-16. The major maize growing districts in the states are Davangere, Belagavi, Haveri, Bagalkot, Bellary and Chitradurga.

Chickpea (*Cicer arietinum* L.) is known in India since ancient times. It is said to be one of the oldest pulses known and cultivated in Asia and Europe. According to Aykroid and Doughty (1964), the centre of origin of chickpea is stated to be eastern Mediterranean region, but its probable place of origin lies in South Western Asia, *i.e.* countries lying to North-West of India such as Afghanistan.

Chickpea is the third most important pulse crop, after dry bean and peas, produced in the world. It accounts for 20 per cent of the world pulses production. Major producers include India, Pakistan and Mexico. South and Southeast Asia region contributes about 81 per cent to the global chickpea production, with India as the principal chickpea producing country (84% share in the region). Six countries including India, Australia, Turkey, Myanmar, Pakistan and Ethiopia accounts for 90 per cent of world chickpea production (FAO, 2016).

India occupies the first position in the world in terms of chickpea area (7.8 mha) and production (8.8 mt) during 2015-16, accounting for 30.91 per cent and 39.92 per cent of total

pulses area and production. The largest chickpea producing state in the country is Madhya Pradesh followed by Uttar Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Rajasthan and Haryana (India stat, 2015-16)

Karnataka is fourth largest chickpea growing state in the country next to Madhya Pradesh and Maharashtra. Total area under chickpea in Karnataka was 9.7 lakh ha with a production of 5.7 lakh t (Anon., Karnataka state agriculture profile 2015-16). The medium rainfall, dry and healthy weather are considered to be the ideal condition for chickpea cultivation.

Groundnut (*Arachis hypogaea* L.) is one of the important cash crops in the semiarid tropical regions like India. It is one of the main sources of edible oil and protein in the country. India ranks first in groundnut production in the world with about 30 per cent share in the global production. Groundnut ranks third in terms of area and production among the other oilseeds in the country. In India, the total production of oilseeds was 29.75 mt and production of oil was 8.64 mt (Indiastat 2015-16).

Groundnut production which occupies over 6292 thousand ha in the country and contributes over 31 per cent in edible oil seed output and 30 per cent in edible oil production. Groundnut oil is main cooking oil in the country. Besides, groundnut is also used in roasted form as dry nuts and for other table preparation.

Karnataka is one the important groundnut growing states in the country. Groundnut covered largest area among oilseed crops in state. It is annually grown in an area about 9.08 lakh ha producing 7.33 lakh t with an average productivity of 8.07 q/ha (Anon., Karnataka state agriculture profile 2015-16) and constitutes 14.43 per cent of the area and 8.04 per cent of production of groundnut in the country.

Significance of the study

In recent years, the continuous growing of sugarcane in irrigated belts of Belagavi district is creating problems of resource degradation like reduction in yield, decline in soil productivity, soil salinity, land degradation, more susceptible to pest and diseases, processing constraint in the peak production period and depletion of water table. To conserve soil fertility and save water, there is a need for crop diversification.

In this context the present study was taken up to analyse the economics of alternate cropping systems over sugarcane and sugarcane based inter cropping systems with the following specific objectives.

Specific objectives of the study

1. To identify sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.
2. To estimate cost and returns under sugarcane mono-cropping, major sugarcane based intercropping and alternate cropping systems.
3. To analyse resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.
4. To analyse the constraints in adoption of sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems and suggest appropriate policy options.

Hypotheses

1. Majority of the farmers are following sugarcane mono-cropping and sugarcane based intercropping systems.
2. Alternate cropping systems and sugarcane based inter-cropping systems are more profitable than sugarcane mono-cropping.
3. Resource use efficiency is more in sugarcane mono-cropping than sugarcane based intercropping systems and alternate cropping systems.
4. Many constraints are faced by the farmers in adopting sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.

Limitation of the study

Since, data were collected by survey method, the inherent lacunae associated with this type of enquiry may have crept into the study. Since, estimates were provided by recalling the memory by respondents because of the non-maintenance of the farm records, efforts were made to elicit the accurate information by cross questioning. However, the degree of discrepancy, if any, would be negligible as the estimates presented are on averages.

Presentation of the study

The study has been presented in six chapters as indicated below,

Introduction: In the introductory chapter, nature and importance of the research problem, specific objectives and hypotheses of the study have been presented.

Review of literature: It deals with review of the relevant past studies related to the present study.

Methodology: This chapter gives an over view of the study area, the nature and sources from where relevant data have been collected and the analytical tools employed for evaluating objectives of the study.

Results: Summarized the results under appropriate heads consistent with the objectives of the study.

Discussion: Provided the explanation for the casual relationship between certain variables and the outcomes, which they produced.

Summary and Policy Implications: Brief summary of the main findings of the study along with policy implications drawn from the findings have been presented.

References: The list of referred books and journals are presented in this section.

Review of Literature

2. REVIEW OF LITERATURE

A review of the past research helps in identifying the conceptual and methodological issues relevant to the study. This would enable the researcher to collect information and subject to sound reasoning and meaningful interpretation. A brief review of the earlier work related to the present study is presented in this chapter. Keeping in view, the objectives of the study, the reviews are presented under the following headings.

- 2.1 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.
- 2.2 Cost and returns in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.
- 2.3 Resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.
- 2.4 Constraints in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.

2.1 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

Bullar *et al.* (2006) a field studies were conducted to evaluate relative profitability of intercropping spring-planted sugarcane with greengram, blackgram and okra in 1:1 ratio as compared to its sole cultivation and to assess the efficiency in these intercropping systems at Sugarcane Research Station, Jalandhar .These were tested in randomized block design (RBD) with three replications. The data of 3 years showed that intercropping of okra reduced the cane yield by 8.1 per cent compared with sole sugarcane. However, this intercropping system recorded the highest mean cane-equivalent yield (74.2 t/ha) as well as net returns (₹ 37,461/ha) among the cropping systems. The net returns under sole sugarcane were ₹ 24,950/ha.

Kumar *et al.* (2006) conducted a field experiment to study the effect of dual-purpose legume intercropping with spring sugarcane at the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar. All intercrops, except Sesbania reduced the cane yield significantly. The reduction in cane yield was 14.0, 8.9 and 11.4 per cent with cowpea, mungbean and urdbean intercropping respectively. Sugarcane intercropped with Sesbania

yielded similar to that of sole sugarcane. Sugarcane + cowpea gave 17.2, 15.8, 19.0 and 26.5 per cent higher mean cane-equivalent yield (118.4 t/ha) than sole sugarcane, sugarcane + mungbean, sugarcane + urdbean and sugarcane + *Sesbania* intercropping respectively. Sugarcane + cowpea also gave the highest net return of ₹ 57,772 compared to ₹41,449 with urdbean and ₹ 48,330 with sole sugarcane. Respective B:C ratio was 2.06, 1.78 and 2.01.

Rana *et al.* (2006) conducted a field experiment to study the feasibility of various intercrops with autumn sugarcane in Pantnagar, Uttaranchal. Treatments comprising 12 combinations, 6 cropping systems, *viz.*, sole sugarcane, sugarcane + lentil/ mustard / maize/ rajmash /rapeseed, as intercrop were tested in randomized block design. All the intercrops except maize, reduced cane yield attributed to decline in number of mill-able canes. Mean reduction in cane yield was 8.7 per cent with lentil, 14.8 per cent with mustard, 13.3 per cent with rajmash and 8.7 per cent with rapeseed. Sugarcane + maize gave the highest mean cane-equivalent yield (200.6 t/ha) being 52.5, 45.4, 55.7, 50.0 and 48.6 per cent higher than sole sugarcane and its intercropping with lentil, mustard, rajmash and rapeseed respectively. Sugarcane intercropped with maize gave highest net return of ₹1,24,874/ha followed by sugarcane alone (₹71145) as against ₹ 62,104; 65,067; 67,138 and 69,040 with intercropping of mustard, rajmash, rapeseed and lentil respectively.

Singh *et al.* (2007) conducted a field experiment to study the effect of berseem and senji intercropping on growth, yield and quality of winter initiated ratoon of sugarcane in Lucknow. Intercropping of berseem in winter-initiated sugarcane ratoon significantly increased the number of millable canes (117.8 thousand/ha), cane yield (72.4 t/ha), cane-equivalent yield (90.81 t/ha) and commercial cane sugar (8.81 t/ha) compared with sole cropping (7.66 t/ha). The cane yield, cane-equivalent yield and sugar yield increased significantly in sugarcane + berseem and sugarcane + senji intercropping systems. Early-maturing, high sugar variety 'CoS 687' sugarcane yielded higher (63.1 t/ha) under berseem intercropping system than sole cropping (54.7 t/ha). Highest profit of ₹71,570/ha and B:C ratio of 3.13 were recorded under sugarcane ratoon+ berseem intercropping system.

Singh *et al.* (2008) conducted a study to assess the production potential and economic viability of autumn-planted sugarcane based intercropping systems, *viz.*, sugarcane sole and sugarcane intercropped with lentil, rajmash, Indian mustard, rapeseed and maize in lucknow. The intercropping with rajmash had no adverse effect on the number of millable canes (117.6

thousand/ha) and cane yield (83.4 t/ha) compared with sole cane. Intercropping of rajmash and maize for green cobs resulted in highest net profit (₹ 89,883 and 83,815/ha) and B:C ratio (2.53 and 2.34) compared with sole sugarcane (₹ 50,199 /ha). Ratoon sugarcane intercropped with lentil gave higher cane yield (64.2 t/ha) than that from sugarcane sole. Inclusion of short-duration intercrops like rajmash, and maize for green cobs in autumn-planted sugarcane improved the productivity and profitability.

Singh *et al.* (2010) conducted a study to find out the most promising intercropping system in autumn sugarcane in Ludhiana. Sugarcane crop was raised using single bud cane setts placed vertically on wide furrows. On an average, the single bud vertical planting recorded 74.4 per cent higher germination and 34.2 per cent higher cane yield as compared to conventional planting with three budded setts in furrows. The sugarcane intercropped with garlic and metha followed by onion as vegetable produced the highest cane yield. The intercropping system of sugarcane and radish as vegetable followed by as seed crop recorded the highest net returns of ₹1.25 lakh/ha. It was immediately followed by sugarcane + garlic (₹ 1.23 lakh/ha). The intercropping systems of sugarcane with turnip as vegetable followed by seed crop, followed by radish metha and onion as vegetable recorded higher net returns as compared to standard. It is concluded that single bud vertical sett planting saved 25 per cent seed and gave higher autumn cane yield than conventional planting method. The autumn sugarcane planted by this method intercropped with garlic, turnip and radish both for vegetable followed by seed production and metha as vegetable followed by onion recorded the highest productivity and profitability

Kumar *et al.* (2011) conducted a field experiment to study the feasibility of various intercrops with autumn planted cane at G.B. Pant University of Agriculture & Technology, Krishi Vigyan Kendra, Dhakrani, Dehradun. Six treatments formulated with intercropping *i.e.* sugarcane sole, sugarcane+ radish, sugarcane + onion, sugarcane + fenugreek, sugarcane + French bean and sugarcane+ potato in randomized block design. Based on the two years study, onion intercropping was selected as most remunerative in autumn cane with the highest cane equivalent yield (147.9 t/ ha) and net return (₹192340) among all the intercropping systems. Sugarcane + potato intercropping was also found comparable with sugarcane +onion produced cane equivalent yield of 147.0 t/ha and net return (₹188680/ha). Whereas, lowest

cane equivalent yield and net return recorded under sugarcane+ fenugreek intercropping system among the vegetables.

Mohanty *et al.* (2012) conducted a study on banana intercropping under drip irrigation at Soil and Water Management Research Farm, Navsari Agricultural University, Navsari. To explore the possibility of increasing monetary return from banana based intercropping system by optimizing vegetables and planting pattern combination. The economic assessment of the intercropping system indicated that banana with onion was most profitable system under drip irrigation. Which recorded higher banana equivalent yield and net realization while, benefit cost ratio was maximum under banana with garlic.

Sonavane *et al.* (2014) conducted an experiment to evaluate various intercropping options in drip irrigated banana at Soil and Water Management Research Unit, Navsari Agricultural University, Navsari. The treatment A2 (33 per cent area allocation to intercrops) recorded significant increase in growth attributes and number of fingers/plant as compared to A1 (25-27 per cent area allocation to intercrops) and A3 (58-60 area allocation to intercrops). Among the intercrops, the treatment having onion and garlic as intercrop recorded significantly higher growth attributes as compared to cauliflower as intercrop. Allocation of higher area to the intercrop (58-60 per cent) recorded significantly higher banana equivalent yield (106 t/ha) as compared to 25-27 per cent (93 t/ha) and 33 per cent (102 t/ha) areas. Whereas among intercrops the highest banana equivalent yield was recorded under the treatment involving onion (107 t/ha) as intercrop over the rest of the treatments. The highest net realization (₹60,4128) was recorded under treatment combination of A3 with onion. Whereas, the highest B:C ratio (3.19) was recorded under the treatment combination of A2 area with onion as intercrop.

2.2 Cost and returns of sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

Kaligouda (1989) conducted a study on cropping systems in Ghataprabha command area, Karnataka. Results revealed that, sugarcane, *kharif* maize, cotton and chilli were the major crops in *kharif* season, yielding a net income of ₹4,100.00, ₹205.41, ₹296.00 and ₹470.82 per acre respectively. Similarly wheat, khapli, bengalgram and *rabi* maize were the major crops in the *rabi* season with a net income of ₹160.78, ₹153.25, ₹239.88 and ₹540.52 per acre, respectively.

Shetty *et al.* (1990) examined the economics of cropping system at Agricultural Research Station, Siruguppa to find out suitable cropping sequences for Tungabhadra Project Area. Among the various sequences tried, maize-bengalgram produced the highest net return (₹6,370/ha with a BCR 2.50) followed by maize-wheat sequence (₹3,693/ha with a BCR 1.60).

Malik and Singh (2000) conducted a study on cost and returns of sugarcane production in Hardwar district of western Uttar Pradesh. In case of reserve area (< 10 kms from sugar mills) cost A1, A2, B1, B2, C1, C2 and gross income from main product and by product were ₹21,605, ₹21,805, ₹24,724, ₹3,390.8, ₹28,231, ₹37,415, ₹45,002 and ₹4,419 respectively. In far area (>10 kms from sugar mills) the above costs in the same order were ₹21,366, ₹21,866, ₹24,498, ₹33,293, ₹28,009, ₹42,758, and ₹4,416, respectively.

Nagpure *et al.* (2004) conducted a study on economics of sugarcane production in Vidarbha region of Maharashtra estimated the per hectare cost of cultivation in Suru crop at cost A, B and C as ₹35,178.86, ₹53,207.91 and ₹54,011.11, respectively. In the case of ratoon, it was estimated to be ₹25,612.88, ₹42,326.52 and ₹43,162.62, respectively. The net income per hectare of ₹15,766 was found out to be higher in the case of ratoon crop as against ₹11,334 from Suru main crop. The efficiency of per rupee investment in the cultivation of ratoon vis-à-vis sole crop of suru at cost C was estimated to be 1.36 and 1.21, respectively.

Savitha (2004) conducted a study on role of rural women in animal husbandry found that nearly half of the respondents were middle age group (48.80 %), majority of respondents were illiterates (75.50 %), farm labour (61.80 %), nuclear family (54.40 %), low income group (45.50 %) and medium flock size (53.30 %). It was also found that majority were married (91.10 %), landless (62.20 %), medium family size (47.70 %), low institutional participation (58.85 %) and low mass media participation (62.50 %).

Tanveer (2006) conducted a study on comparative economic analysis of paddy based farming systems in Mandya district, Karnataka. He found that, among the four major farming systems identified in the study area, the gross returns in FS-I (crop production and poultry enterprises) was ₹9,40,879.80, while total cost was ₹7,68,945.99 with a net returns of ₹1,71,933.81, which was found to be most profitable, which was due to rearing of poultry birds, followed by FS-III (crop production and sericulture enterprises), FS-IV (only crop

production enterprises) and FS-II (crop production and dairy enterprises), with net returns of ₹83,658.40, ₹57,739.53 and ₹54,720.59, respectively.

Rajkumar (2007) carried out an investigation to study the cost and returns structure of major redgram based cropping systems in the Bidar district. The study revealed that under rain-fed condition, total variable cost was high in CS-V (₹11114.81/ha), followed by CS-III (₹11,056.28/ha) and CS-II (10,960.90/ha). The total fixed cost was high in CS-II (₹9,875.36/ha), followed by CS-III (₹9,729.63/ha) and CS-IV (₹7,643.15/ha). The maximum net returns were found under CS-II (₹18,932.09/ha), followed by CS-I (₹1,333.69/ha), CS-III (₹16,285.46/ha), CS-IV (₹12,961.31/ha) and CS-V (₹5,470.57/ha). Returns per rupee of investment was found to be highest in CS-II (1.91), followed by CS-I, CS-III, CS-IV and CS-V with values of 1.82, 1.78, 1.71 and 1.29, respectively.

Sale and Yadav (2008) conducted a study on economics of sugarcane cultivation with an integrated approach in Kolhapur district of Maharashtra. In this study examined the per hectare resource use structure in organic and inorganic sugarcane farming, calculate the per hectare cost of cultivation in organic and inorganic sugarcane farming and compare the economics of the two farming systems. Results showed that the per hectare cost of suru sugarcane with inorganic and organic farming were ₹66,572.73 and ₹57,275.72, respectively and the per tonne cost of production of sugarcane were estimated as ₹660.83 and ₹712.42 in inorganic and organic farming, respectively.

Shinde *et al.* (2009) conducted a study on profitability analysis of sugarcane based inter cropping systems in Belagavi district of Karnataka. The focus of the present study was on economic evaluation of the intercropping system in Raibag taluk of Belagavi district. A sample size of 120 farmers was selected using random sampling method and the techniques of tabular and functional analysis were employed. CS-I(Sugarcane + Maize),CS-II (Sugarcane + Wheat), CS-III (Sugarcane + Chickpea) and CS-IV (Sugarcane sole) were the four important sugarcane based cropping systems followed in the study area under irrigated conditions, it was found that, per hectare total cost of cultivation was found be high in CS-I (₹73718.25/ha) followed by CS-II (₹71,171.95/ha) and CS-III (69,707.20/ha) and CS-IV (₹65,692.00/ha). The maximum net returns were found under CS-I (₹45,828.05/ha) followed by CS-III, CS-II and CS-IV (₹27,471.97, ₹24,840.55 and ₹13,287.17/ha, respectively). Returns per rupee of investment was found to be highest in CS-I (1.62), followed by CS-III, CS-II and CS-IV with values of 1.39, 1.35 and 1.20 respectively.

Singh and Grover (2010) made a comparative economic analysis of wheat based cropping sequences in different agro-climatic areas of Punjab, observed that variable costs of wheat-paddy sequence were higher (₹2,027.35/ha) than wheat-cotton (₹2,002.13/ha), wheat-maize (₹1,887.35/ha) and wheat-potato (₹1,503/ha) sequences. However, returns over variable costs were higher in wheat-maize sequence (₹2,023.56/ha), followed by wheat-paddy (₹1823/ha), wheat cotton (₹1,248.65/ha) and wheat-potato (₹857.35/ha) sequences.

Baliyan *et al.* (2011) studied the cost and return on costs and returns structure of sugarcane production in Muzaffarnagar district, Western Uttar Pradesh. The study revealed that estimated cost of cultivation in sugarcane (planted) per hectare was ₹9,118, ₹19,681 and ₹20,229 on small, medium and large farms respectively. The major components of cost of cultivation were operational cost, rental value of land and material cost. The major components of operational cost were transportation, harvesting and intercultural operations in all the three size of farms with 40 per cent share in total cost of production. The major components of the material cost were manure and fertilizers, seed and irrigation on all the three size group of farms (18.32 per cent to 2.44 per cent respectively in total cost of production).

Rithesh (2013) studied the cost and returns structure of sugarcane processed for sugar and jaggery. The study revealed that the cost incurred by the sample farmers in cultivating sugarcane for sugar and jaggery preparation was ₹56,723.60 per acre and ₹55,942.26 per acre respectively. It was also noticed that the expenditure on variable cost was higher (₹46,058.72 per acre) for farmers growing sugarcane for sugar production and also for farmers growing sugarcane for jaggery preparation (₹45,277.38 per acre). The share of the fixed cost in total cost of cultivation was ₹10,664.88 per acre accounting for 18.80 per cent for farmers growing sugarcane for sugar production whereas the share of the fixed cost in total cost of cultivation was ₹10,554.44 per acre accounting for 18.90 per cent for farmers growing sugarcane for jaggery preparation. In case of sugarcane grown for sugar purpose, the gross returns and net returns were found to be ₹1,18,750.00 and ₹62,026.44 per acre respectively where as in case of sugarcane grown for purpose of jaggery, the gross returns and net returns were found to be ₹2,92,980.00 and ₹1,42,095.30 per acre, respectively.

Papang and Tripathi (2014) studied the costs and returns structure of turmeric and constraints faced by producers in Jaintia hills district of Meghalaya, India. The study revealed

that, the share of variable cost was about 98 per cent of the total cost. The total costs of cultivation (cost C₂) for turmeric was estimated ₹77,012 per ha, whereas the net income was worked out to be ₹6,475 per ha for fresh turmeric and ₹28,109 per ha for dried turmeric. About ₹12,719 per ha of additional expenditure was incurred on post-harvest management of turmeric. It is observed that a higher net income was obtained when the farmers disposed of the product after drying which also gives the farmers the capacity to hold/store their product to avoid distress sale. The cost of production of turmeric was ₹15.68 per kg, ₹60.93 per kg and ₹70.17 per kg for fresh, semi-processed and processed (powdered) form, respectively. Lack of Knowledge about pest management is the major constraint faced by farmers in production whereas the fluctuation in disposal price of turmeric ranks first among the marketing constraints faced by farmers.

Kant *et al.* (2015) studied the comparative profitability of sugarcane production under different size group of farms in Meerut district of Uttar Pradesh. From the purposively selected district and block on the basis of highest area under the crop. Four villages were selected randomly from the selected block, a complete list of the farmers were prepared and then categorized into four categories *i.e.* marginal, small, medium and large. From the total sugarcane growers, 100 respondents were selected in probability proportion to their population, for the collection of data, returns over various cost concepts were used. The overall average of cost of cultivation, net return, cost of production and profit margins were ₹1,72,679, ₹-13,973, ₹286 and ₹-34 respectively.

Shreeshail and Mundinamani (2016) conducted a study on impact of micro irrigation on sugarcane productivity and profitability over the conventional method of irrigation in northern Karnataka. 120 farmers practicing drip irrigation and 120 farmers practicing conventional method of irrigation in cultivation of sugarcane were selected purposively for the study and thus the total sample size was 240. Purposive multistage random sampling procedure was followed for the selection of two samples. The results of the study revealed that the highest yield was obtained in case of drip irrigated farms (164.77 t/ha) compared to conventional irrigated farms 130.27 t/ha). Among the two methods of irrigation, the total cost incurred in case of conventional method of irrigation was highest (₹1,80,304.07/ha) as compared to cost incurred in cultivation of sugarcane under drip irrigation (₹ 1,46,007.96/ha). Thus the cultivation of sugarcane crop in the study area was found to be highly profitable

under drip irrigation as also supported by a high magnitude of returns per rupee investment (2.04) compared to sugarcane cultivation under conventional method of irrigation (1.28).

2.3 Resource use efficiency in sugarcane based and alternate cropping systems

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

Shivanand (2002) analysed the resource use efficiency of banana crop in northern Karnataka. He employed Cobb-Douglas type of production function, where banana yield as dependent and land, labour, FYM, bullock labour, fertilizers plant protection chemicals as independent variables. The study shown that land, labour and plant protection chemicals were significantly influenced the production of banana as indicated by their significant regression coefficients of 0.672, 0.472, and 0.172 respectively in the study area. The MVP to MFC ratio were positive and more than one for land (7.890), labour (5.321) and FYM (1.34) , whereas it was less than one in case of fertilizers (0.871), bullock labour (-4.012) and plant protection chemicals (0.73).

Sunanda and Narender (2003) examined resource productivity of Mesta farms in Srikakulam district of Andhra Pradesh. Results of the study indicated that Mesta fibre accounts for 70 per cent of raw jute. The cultivation involves intensive human labour in addition to manures and fertilizers, seeds and cattle labour. The Cobb-Douglas production function analysis for these variables indicated constant returns to scale on all farm size groups. The marginal value product to opportunity cost ratios for all farm size groups indicated resource use efficiency and revealed the scope of adjustments and reorganisation of resources, so as to obtain higher returns in Mesta cultivation.

Yadav *et al.* (2004) made comparative study of resource use efficiencies and resource productivities of traditional and tissue culture banana production in Maharashtra state. The regression co-efficient of area, FYM and potash were positive and significant at 10 per cent level, indicating scope to increase level of those inputs to step up the productivity. The sum of elasticities of production was equal to unity; revealing that constant returns to scale in traditional method of banana production. In tissue culture banana, the functional analysis revealed that, the regression co-efficient of plantlet was highly significant, there by indicating

scope to increase the level of plantlet. The sum of elasticities of production was equal to unity showing constant returns to scale. MVP/MFC ratio for inputs, namely sucker nitrogen and bullock labour was greater than unity referring that efficient use of these resources.

Rajeshwari (2004) conducted a study on resource use efficiency for coconut based farming systems in Tumkur district of Karnataka, using Cobb-Douglas production function. She observed that the capital and feed in Farming System-I (coconut + greengram followed by ragi + dairy) number of cows in Farming System-II, (coconut + greengram + groundnut followed by ragi + dairy) labour in Farming System-III, (coconut + paddy + greengram followed by ragi + dairy) land, labour, feed and number of sheep in Farming System-IV (coconut + greengram followed by ragi + dairy + sheep) and land and number of cows in Farming System-V (coconut + arecnut + ragi + dairy) had positive and significant influence on gross returns.

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

Rajkumar (2007) examined resource use efficiency for Redgram based cropping systems in Bidar district of Karnataka, using Cobb-Douglas production function. CS-I (Redgram + jowar), CS-II (Redgram + Blackgram), CS-III (Redgram + Soybean), CS-IV (Redgram + Greengram) and CS-V (Redgram sole) were the five important Redgram based cropping systems followed in the study area. The result of the Cobb-Douglas production function analysis revealed that in the majority of the cases, present farm income from different cropping systems were ₹22,217.81, ₹27,514.63, ₹25,405.323, ₹22,639.10 and ₹8,971.74 in CS-I, CS-II, CS-III, CS-IV and CS-V respectively. The ratio of MVP to MFC was greater than one for human labour, seed, nitrogen, potash and plant protection chemicals indicating the scope for using additional units of these inputs to increase gross income.

Singh (2007) conducted a study to examine the technical efficiency of wheat cultivation in Haryana. The study revealed that the high degree of technical inefficiency in

wheat farming was attributed to the low level of education of farmers, poor extension services and gross distortion in the price of inputs like agro-chemicals and labour. The study also revealed that the perceived in-efficiency is due to farmers own decision. The estimates of technical efficiency indicated that the small size farmers are more efficient than medium and large farmers.

Taru *et al.* (2008) analysed economic efficiency of resource use in groundnut production in Adamawa State of Nigeria. Primary data were basically used with the aid of structured questionnaires administered on 143 farmers using a simple random technique. The regression analysis indicated that the Cobb- Douglas function gave the best fit. The R^2 (0.78) was highly significant at one per cent level. Three out of the eight independent variables were significant at one per cent level, these were farm size, seeds and labour input, they were positively affected the groundnut production. Economic efficiency of resource used showed, the seeds and labour were underutilized, while fertilizers and agrochemicals were over utilized.

Arti and Jyoti (2009) examined resource use efficiency and sustainability of Maize cultivation in Jammu and Kashmir region. Multistage random sampling was adopted for selection of 120 sample farmers. Cobb Douglas production function was employed for analysis. Study revealed that seeds, urea, potash, FYM, human labour and capital were included in the model which explained 51 per cent variation in the Maize production, and maximum sample farmers were used local seeds and only 22 per cent of the farmers used purchased hybrid seeds in the study area.

Kaur *et al.* (2010) analysed technical efficiency of wheat production in Punjab. The sample farmers were selected using the three-stage random sampling technique. The data were analysed by using frontier production function. The result signifies that, the farmers of the central region don't have much scope to increase productivity of wheat through technical efficiency improvement under the existing conditions of input use and technology. In the semi hilly and south-western regions, the yield of wheat can be improved to the extent of 13 per cent and 15 per cent respectively through adoption of better practices of technology.

Kiresur and Ichangi (2011) studied the socio-economic impact of Bt Cotton in Karnataka. Multistage random sampling technique was employed to select 60 sample farmers. Cobb-Douglas production function was fitted to assess the resource use efficiency. Results of

the study revealed that average expenditure on seed was higher in Bt Cotton than non-Bt Cotton. Quantity of organic manure used in Bt (6.5/ha) and non Bt (6.7/ha) farmers was almost same. But cost incurred on chemical fertilizers and organic manures was higher in non-Bt than Bt farmers. The use of labour was more on non-Bt than Bt farmers. It was due to more number of sprays for pest management on non-Bt Cotton, adding to the cost on human labour.

Ahmad *et al.* (2012) examined the resource use efficiency in almond cultivation in Kunduz Province, Afghanistan. 21 farmers were selected from small, 24 from medium and 15 from large category, making a total sample of 60 farmers. The production elasticities for all the variables namely land, labour, manures, fertilizers and plant protection expenditure were found to be positively significant. One per cent increase in land and labour would increase gross returns by 0.388 and 0.289 per cent. One per cent increase in the level of all the included variables would bring about 1.03 per cent increased in the gross returns, indicating that there is possibility of increasing returns by increasing the inputs. The above results imply that one unit increase in land, labour, plant protection cost, fertilizer cost would result in 0.38, 0.28, 0.15 and 0.15 units of increase in yields respectively.

Rao (2012) concluded a study entitled efficiency, yield gap and constraints analysis in irrigated vis-à-vis rain-fed sugarcane in north coastal zone of Andhra Pradesh. The economics of yield gap in irrigated and rain-fed sugarcane cultivation have been studied in North Coastal Zone of Andhra Pradesh for the period 2008–09 by collecting data on various aspects of costs and returns. Budgeting techniques, cost concepts, benefit cost ratio (BCR), yield gap analysis and response priority index have been used for the analysis. The study has shown that the value of BCR is higher for plant crop in irrigated (1.49 %) than in rain fed (1.43 %) regions. The yield gap between irrigated and rain fed regions has been found to be 67.00 per cent, in which input usage had a higher (41.86 %) effect than cultural practices (25.93 %).

Girei and Giroh (2013) conducted a study on productivity and resource use efficiency in sugarcane production in Numa, Adamawa State, Nigeria. The study revealed that the coefficient of multiple determinations (R^2) was 0.797 this means that about 79.70 % of variation in the dependent variable was explained by variations in the explanatory variables. Farm size and sett were statistically significant at 5 % and 1 % probability level. Sugarcane production was in stage one of the production frontier (irrational zone of production) as

evidenced by elasticity of production (1.147) implying either under or over utilization of resources among farmers.

Karthick *et al.* (2014) analysed resource use efficiency and technical efficiency of turmeric production in Tamil Nadu. The resource-use efficiency and technical efficiency of turmeric production were computed using primary data collected from 90 turmeric growers spread over three blocks in Dharmapuri district of Tamil Nadu. The study has 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, is more than one, indicating that these resources are being used at sub-optimum levels and there exists the possibility of enhancing the yield of turmeric by increasing their use. The technical efficiency of about 69 per cent of sample farmers has been found more than 80 per cent, which indicates the possibility of increasing the yield of turmeric by adopting better technology.

Agarwal and Singh (2015) conducted a study on economic analysis of soybean cultivation in Narsinghpur district of Madhya Pradesh, India. The study has revealed that the average cost of cultivation was observed highest on medium farm as compared to large and small farms. Average per hectare gross return from soybean for overall farmers was found to be 43179.59. Cost of production per quintal of soybean was 1354.92 on overall farms. The benefit-cost ratio was similar in case of medium and large farmers with 1.74 and slightly higher in case of small farmers 1.76. None of the soybean growers was applying potashic fertilizers to soybean crops, but it plays vital role in nodule formation and in enzyme activities. Therefore, it is required that farmers should apply potashic fertilizer to the soybean crop.

2.4 Constraints in sugarcane based and alternate cropping system

Rajkumar and Singh (2002) identified the problem faced by the farmers in production of vegetables. The problems reported were, poor quality seeds (42.2 %), insufficient availability of seed (40 %), high cost of seed (31 %) and non-availability of seed at appropriate time (12.2 %). The other problems noticed were high cost of fertilizer, poor state of fertilizer and plant protection delivery system in the district.

Basavaraj and Kunnal (2002) conducted a study to know the constraints in production, marketing and processing of soybean in Belagavi district. It was observed that severe

problems faced by growers were rust disease leading to heavy loss, high labour wages and non-availability of quality seeds in the production front. In marketing, farmers experienced problem of price fluctuation, low price for the produce, problem of transportation and delayed payment of sale. The other problems were, inadequate power supply and non-availability of labour.

Nain *et al.* (2002) studied the irregularity in the distribution of sugarcane purchase indent, delay in payment of sugarcane to the farmers, delay in unloading, lack of transportation facilities etc., and were the major problems reported by the selected respondents in marketing of sugarcane to the sugar mills.

Wadear (2003) conducted a study to know the problems faced by the sample farmers in production of different crops in selected zones of northern Karnataka. He observed that problems like price fluctuation, lack of storage facility and incidence of pests and diseases were reported as severe problems under Farming System-I (greengram, jowar, tur, blackgram, paddy, sunflower, and groundnut in *Kharif*; bengalgram and jowar in *rabi* and sugarcane and dairy animals) in Zone-I. Lack of knowledge about source of availability of seeds and incidence of pests and diseases were the severe constraints in sunflower production under Farming System-I, in Zone-II, constraints in bengal gram production, followed by the non-availability of seeds in time under both the farming systems in both Zone-I and Zone-II, which need immediate attention.

Anjugam *et al.* (2006) conducted a study on economics of usage of bio-inputs in sugarcane to identify the determinants of adoption of bio-inputs and suggest alternate measures for their increased use in sugarcane cultivation in the western zone of Tamil Nadu. The results revealed that access to bio-inputs, adequate information from the sugar mill and non-health hazards had significant positive influence on profitability of adoption of bio-inputs usage in sugarcane.

Tanveer (2006) identified the constraints faced by the paddy growers in Mandya district of Karnataka. He opined that major constraints as expressed by the farmer-respondents in the study area were high cost of inputs, fluctuation in the prices of the produce, shortage of organic manures/FYM, lack of transportation, marketing facilities and scarcity of funds.

Vorghes (2008) conducted a study to know the problems of coconut growers in Tamil Nadu. The study revealed that majority coconut growers faced the marketing as well as

production constraints like small size of holdings, decline in proportion of bearing palms, prevalence of root disease, lack of irrigation, use of low productive hybrid varieties etc. Marketing problems like low price for produce, price fluctuation, irregularity of payments, lack of market information, lack of transportation facilities *etc.*

Kumar (2010) identified the reasons for shifting from inorganic to organic cultivation of vegetables. The study revealed that the main reasons for shifting from inorganic to organic cultivation of vegetables were increasing returns from organic vegetables, followed by reason of quality of organic vegetables, soil health oriented motives, increasing cost of inorganic chemicals, environmental concern, motivation by neighbouring organic farmers and motivation by media.

Menasinahal (2011) studied the performance of cotton in traditional paddy fields of Uttar-kannada district, Karnataka. Multistage sampling technique was used to select 30 cotton and 30 paddy growers from each taluk. The data on performance of cotton cultivation in traditional paddy fields was collected from the selected sample respondents through personal interview method. Data were analysed using growth rate analysis and budgeting technique method. The results indicated that growth in area, production and productivity of paddy were negatively significant, Whereas for cotton positively significant and the change in temperature, change in rainfall pattern and high gross income from cotton were the major reasons for shifting from paddy to cotton cultivation.

Ramarao (2012) in his study on- Efficiency, yield gap and constraints analysis in irrigated Vis-à-vis rain-fed sugarcane in North Coastal zone of Andhra Pradesh. Multistage sampling technique was adopted for selecting 120 sample farmers out of which 60 irrigated farmers and 60 rain-fed farmers. Apart from budgeting technique and cost concepts, benefit-cost ratio, decomposition of sources of yield gaps and response priority index were employed for the analysis. The study has showed that BCR is higher for irrigated (1.49) than rain-fed (1.43) crop. Yield gap was found to be 67.8 per cent, in which input usage had a higher (41.86 %) effect than cultural practices (25.93 %). The most important constraint in sugarcane cultivation is shortage of labour. Therefore, irrigated sugarcane is more remunerative and yields can be sustainable if constraints are addressed and proper package of practices is followed.

Mundinamani *et al.* (2013) examined the problems and prospects for mechanical harvesting of chickpea in Gulbarga and Dharwad districts of Karnataka by selecting 120

chickpea growers (sixty from each district). The study revealed that the major constraints in adoption of mechanical harvesting of chickpea were non-availability of suitable varieties and machines.

Kerketta *et al.* (2015) conducted a study to know the constraints faced by chickpea growers in adoption of IPM practices in Durg district of Chhattisgarh by selecting 120 chickpea growers. The study revealed that the majority (91.66 %) of the respondents reported, non-availability of bio-agents (NPV, parasites etc.), followed by Non-availability of inputs at a time (bio-pesticides, traps, herbicides etc.) (90.00 %), lack of proper training conduct for IPM practices by extension agent or agencies (80.83 %) are considered as major constraints. As regards to suggestions of chickpea growers for minimizing the constraints, majority of the chickpea growers said that availability of inputs at proper time, training by extension agencies about IPM practices and Technical information & knowledge to the farmers about IPM practices should be provided by RAEO at village level.

Narayan *et al.* (2015) identified the constraints in area, production and productivity of pulses. The study indicates that growth rate of area-0.09, -0.60 and 1.62 and production 1.52, 0.59 and 3.35 during 1980s, 1990s and 2000s decades, which affect the net per capita per day availability of pulses, has declined sharply from 61 gms to 32 gms from 1951 to 2010. Therefore, the gap of domestic demand and supply widen sharply. The study revealed that major constraints in production of pulses were technology inadequacy as well as policy reform and non-availability essential inputs i.e. quality seed, life saving irrigation, fertilizers and nutrients, price policy implication and marketing to be reoriented to bring it in tune with the emerging demand and supply of pulses in India.

Methodology

3. METHODOLOGY

An economic investigation depends critically on the selection of a representative sample and elicitation of accurate data and use of appropriate analytical tools and models. The methodology adopted for the present study including the selection of the study area and its description, the nature and sources of data and the analytical tools employed are outlined in this chapter under the following heads:

3.1 Description of the study area

3.2 Sampling procedure

3.3 Nature and sources of data

3.4 Analytical tools and techniques employed

3.5 Definition of terms and concepts

3.1 Description of the study area

An assessment of any development activity can be made only with a detailed understanding of the physical, natural characteristics and socio-economic status of the region. Hence, an attempt has been made to describe the physical, natural and socio-economic features of Belagavi district of Karnataka (Fig.1).

3.1.1 Karnataka state

Karnataka state is situated in West Central part of the peninsular India. It consists of a narrow elongated belt between the *Arabian Sea* and Western Ghats and enhancing coastline of about 400 km. The state has an area of 1,19,257 sq. km and is situated between 115°19' North latitude and 74°78' East longitudes. The state is bounded by Maharashtra on the north and by Goa and *Arabian Sea* on the west. It has a common border with Andhra Pradesh on the east and Tamil Nadu and Kerala on the south. The average rainfall of the state is 1139 mm. The state receives rainfall both from southwest and northeast monsoons. The mean temperature ranges from 21.5°C to 31.7°C.

3.1.2 Belagavi district, location and area

The present study was conducted in Belagavi district of Northern part of Karnataka which comes under Northern transitional zone. Belagavi district consists of ten taluks namely, Athani, Bailhongal, Belagavi, Chikkodi, Gokak, Hukkeri, Khanapur, Raibag, Ramdurg and

Saudatti. Belagavi district is located at North–West region of Karnataka state between 15-23° to 16-58° N' latitude and 74.05° to 75.28°E longitude. It is surrounded by Vijayapur, Bagalkot, Dharwad and Uttar Kannda Districts of Karnataka and Sangli, Kolhapur, Ratnagiri districts of Maharashtra.

3.1.3 Agro-Climate features

The total geographical area of the district is 13,415 square kilometres which stands in first place with respect to area in the state. The major rivers flowing in the district are Krishna, Malaprabha and Ghataprabha. The main irrigation sources for the district are canals followed by wells, bore-wells and lift irrigation.

3.1.4 Soils

Geographically the district is divided into three regions, *i.e.*, 1.Hilly zone, 2. Northern transition zone, 3.Northern dry zone. The Khanapur taluk lies under Hilly zone, Chikkodi, Hukkeri, Bailhongal and Belagavi taluks fall under Northern transition zone, while Athani, Raibag, Gokak, Ramdurg and Saudatti taluks fall under the northern dry zone. The major soils of these regions are medium to deep black, reddish sandy and red sandy loam.

3.1.5 Climate

The climate is generally dry and healthy, except during the monsoon season. The hot season begins by March with the maximum temperature of 40⁰C and minimum temperature of 14⁰C during December, which is generally the coldest month.

3.1.6 Rainfall

The district receives an average annual rainfall of 808.3 mm which is uncertain, as well as erratically distributed and Gokak taluk receives an average annual rainfall of 507.6 mm. whereas Chikkodi and Soudatti receives an average annual rainfall of 678.6 and 503.6 mm. In the district, Raibag taluk receives a lowest average annual rainfall of 491.7 mm and Khanapur taluk receives the highest average annual rainfall of 1859.1 mm (2015-16).

3.1.7 Land utilization pattern

The land utilization pattern of the Belagavi district during the year 2015-16 is presented in the Table 3.1. Out of the total geographical area of the district (13.44 lakh ha) the area under forest is 1.9 lakh ha, with net sown area of 7.28 lakh ha and fallow land is 2.73 lakh ha. Area which is not available for cultivation is 0.38 lakh ha.

Table 3.1 Land utilization pattern in the study area

SI. No	Particulars	Belagavi district		Gokak taluk		Chikkodi taluk		Soudatti taluk	
		Area (lakh ha)	%	Area (lakh ha)	%	Area (lakh ha)	%	Area (lakh ha)	%
1	Total geographical area	13.44	100	1.54	100	1.26	100	1.58	100
2	Area under forest	1.9	14.16	0.22	14.29	0.005	0.4	0.26	16.46
3	Area not available for cultivation	1.13	8.44	0.38	24.68	0.12	9.52	0.32	20.25
4	Other uncultivated land excluding fallow land	0.38	2.88	0.017	1.10	0.045	3.57	0.043	2.72
5	Fallow land	2.73	20.33	0.24	15.58	0.24	19.05	0.25	15.82
6	Net area sown	7.28	54.19	0.74	48.05	0.85	67.46	0.55	34.81

Source: District at a glance 2015-16, District statistical office, Belagavi

Gokak, Chikkodi and Soudatti taluks contribute 1.54 ,1.26 and 1.58 lakh ha to the total geographical area of the district respectively. The area under forest is 0.22, 0.005 and 0.013 lakh ha in Gokak, Chikkodi and Soudatti respectively. The net area sown is 0.74, 0.85 and 0.31 lakh ha in Gokak, Chikkodi and Soudatti respectively. The fallow land is 0.44, 0.24 and 0.12 lakh ha in Gokak, Chikkodi and Soudatti respectively. Area not available for cultivation accounts for 0.38, 0.12, and 0.13 lakh ha in Gokak, Chikkodi and Soudatti respectively.

3.1.8 Demographic features of study area

Table 3.2 indicates that, as per the 2011 census, the population of Belagavi district was 4778439 with literacy rate of 64.57 per cent, out of which male literacy was 72.19 per cent and female literacy was 56.70 per cent.

The Table 3.2, also revealed that, the population of Gokak, Chikkodi and Soudatti taluks were 5.26, 5.67 and 3.11 lakh respectively. Literacy rate of Gokak, Chikkodi and Soudatti is 55.90, 42.29, 56.68 per cent respectively, out of which male literacy was 68.70, 80.56 and 70.65 per cent and female literacy was 42.84, 56.63 and 56.68 per cent respectively (2001, census).

3.1.9 Source of irrigation

The area under irrigation is presented in Table 3.3, the main sources of irrigation in Belagavi district were canals (96,914 ha), followed by wells (75,238 ha), Bore wells (61,947 ha), lift irrigation (34,156 ha), other sources (66,348 ha). The total area irrigated in the Belagavi district is 55,089 ha. The major source of irrigation in Gokak, Chikkodi and Soudatti were canal (17,143 ha), bore wells (11,820 ha) and lift irrigation (24,264 ha), respectively.

3.1.10 Cropping pattern

The cropping pattern (Table 3.4) in the study area during 2015-16 indicated that out of the gross cropped area, cereals formed the important component with 41.07 per cent followed by, commercial crops (31.55 %), oil seeds (13.59 %), pulses (11.29 %), fruits and vegetables (4.96 %) and total spices (1.52%). Major cereal crops grown in the Belagavi district were maize, paddy, sorghum, wheat and bajra. Major pulse crops were pigeonpea, horse gram, black gram and chickpea. Major oil seeds were soybean groundnut, sunflower and sesame. Major commercial crops were sugarcane, cotton and tobacco.

Table 3.2 Demographic features of the study area

SI. No	Particulars	Belagavi district	Gokak taluk	Chikkodi taluk	Soudatti taluk
1	Geographical area (lakh ha)	13.44	1.54	1.26	1.58
2	Population (lakh no.)				
	Male	21.50	2.66	2.90	1.58
	Female	20.64	2.59	2.76	1.53
	Total	42.14	5.26	5.67	3.11
3	Literacy rate (%)				
	Male	75.70	68.70	80.56	70.65
	Female	52.30	42.84	56.63	42.29
	Total	64.20	55.90	42.29	56.68
4	Net sown area (ha)	7,28,473	74,138	84,587	31,703
5	Net area irrigated sources (ha)				
	Canal	96,914	17,143	4,810	15,931
	Open-well	4,002	21,814	14,710	8,601
	Bore-well	75,258	17,820	7,342	11,397
	Lift-irrigation	61,947	548	502	26,264
	Others	66,348	6,190	5,143	0
	Total	3,38,605	51,990	38,032	60,896
6	Annual rainfall (mm)	769.1	507.6	678.6	503.6

Source: District at a glance 2015-16, District statistical office, Belagavi

Table 3.3 Taluk-wise area irrigated by different sources in Belagavi district (2015-16)
(Area in ha)

Sl. No	Taluk	Canals		Dugwells		Lift irrigation		Borewells		Other sources		Total	
		Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage
1	Athani	2,796	4.43	18,481	16.91	24,652	46.20	7,043	9.17	10,926	18.02	72,898	19.57
2	Bailhongal	0	0.00	317	0.29	457	0.86	7,858	10.23	1,267	2.09	9,899	2.66
3	Belagavi	0	0.00	7,394	6.76	0	0.00	1,318	1.72	0	0.00	8,712	2.34
4	Chikkodi	4,810	7.61	14,710	13.46	502	0.94	17,820	23.20	6,190	10.21	38,032	10.21
5	Gokak	17,143	27.14	21,814	19.95	548	1.03	7,342	9.56	5,143	8.48	51,990	13.96
6	Hukkeri	4,785	7.57	6,887	6.30	787	1.47	986	1.28	4,212	6.95	17,657	4.74
7	Khanapur	0	0.00	1,063	0.97	5	0.01	6,860	8.93	2,513	4.15	11,059	2.97
8	Ramdurg	5,621	8.90	2,399	2.19	146	0.27	4,369	5.69	13,496	22.26	26,923	7.23
9	Raybag	12,085	19.13	27,656	25.30	0	0.00	11,811	15.38	16,880	27.84	74,432	19.98
10	Saudatti	15,931	25.22	8,601	7.87	26,264	49.22	11,397	14.84	0	0.00	60,896	16.35
	Total district	63,171	100.00	10,9322	100.00	53,361	100.00	76,804	100.00	60,627	100.00	3,72,497	100.00

Source: District at a glance 2015-16, District statistical office, Belagavi

Table 3.4 Area under different crops in the Belagavi district

Sl. No	Crops	Area	Percentage
I	Cereals		
1	Paddy	59,938	6.16
2	Sorghum	1,24,105	12.77
3	Maize	1,56,718	16.12
4	Wheat	46,789	4.81
5	Bajra	9,256	0.95
6	Others	2,332	0.24
	Total cereals	3,99,138	41.07
II	Pulses		
1	Chickpea	78,642	8.09
2	Greengram	25,913	2.66
3	Pigeonpea	2,869	0.29
4	Others	2,357	0.24
	Total pulses	1,09,781	11.29
III	Commercial Crops		
1	Sugarcane	2,66,247	27.40
2	Cotton	40,310	4.14
	Total commercial crops	3,06,557	31.55
IV	Spices crops		
1	Turmeric	1,695	0.17
	Total spices	9,025	1.51
V	Oilseeds		
1	Soybean	74,314	3.88
2	Groundnut	37,725	1.59
3	Sunflower	15,450	7.64
	Others	4,293	0.44
	Total oilseeds crops	1,32,097	13.59
VI	Fruits and Vegetables	19,054	4.96
VII	Gross cropped area	9,71,652	100

Source: District at a glance 2015-16, District statistical office, Belagavi

3.2 Sampling procedure

3.2.1 Selection of the study area and farmer respondents

Multistage sampling procedure was adopted for selection of the farmers for the study. In the first stage, Belagavi district was selected as it has highest area, production and productivity of sugarcane in Northern Karnataka. In the second stage, out of ten taluks in Belagavi district, three taluks were selected based on each taluk having highest area under irrigation through canals, borewells and lift irrigation. In the third stage, two villages from each selected taluk having highest area under canals, borewells and lift irrigation were selected. Finally from each selected village, ten sugarcane mono-crop growing farmers, five sugarcane based intercrops growing farmers and five farmers growing alternate crops to sugarcane were chosen from each of these selected villages randomly. Thus, the total sample size selected for the present study was totaled to 120. The detailed sampling design is presented in Fig.2.

3.3 Nature and sources of data

For evaluating the specific objectives designed for the study, both primary and secondary data were collected. Primary data was collected from randomly selected sample farmers by personal interview method with the help of pre-tested schedule. The data so collected from the respondents includes, general information, size of holdings, cropping pattern followed, inputs used, input prices, output obtained and opinions regarding various problems faced by the farmers in production of selected cropping systems.

Secondary data for the study was collected from taluk headquarters, District at a glance and Karnataka state agriculture profile (2015-16).

3.4 Analytical tools and techniques employed

For assessing quantitatively the objectives and hypotheses outlined for the purpose of the present study, following analytical tools and techniques were employed.

3.4.1 Tabular analysis

3.4.2 Budgeting technique

3.4.3 Cobb-Douglas production function

3.4.4 Garrett's ranking technique

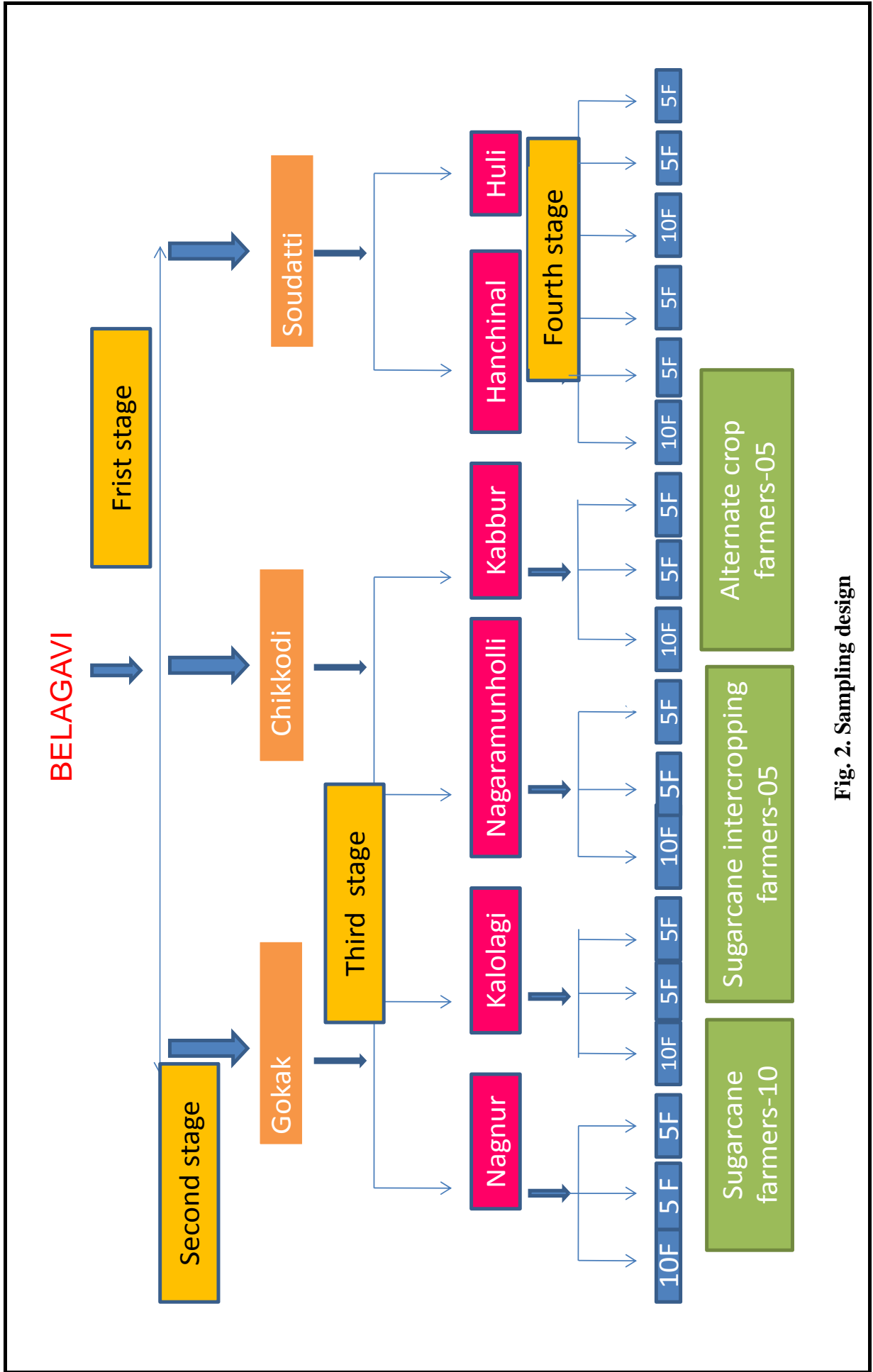


Fig. 2. Sampling design

3.4.1 Tabular presentation method

Tabular analysis involving the computation of means, percentages etc., were employed to present the data regarding demographic features, socio-economic profile, cropping systems and constraints expressed by the farmers.

3.4.3 Budgeting technique

In order to compute the costs and returns in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems, budgeting technique was employed.

3.4.4 Cobb-Douglas production function

To study the resource productivity and allocative efficiency in different cropping systems, a modified Cobb-Douglas type of production function was fitted. This was used with a view to determine the extent to which the important resources that have been quantified, explain the variability in the gross returns of the cropping systems and to determine whether the resources were optimally used in these cropping systems.

The general form of the Cobb Douglas function is $Y = aX_i b^i$ where, 'Xi' is the variable resource measure, 'Y' is the output, 'a' is a constant and 'bi' estimates the extent of relationship between X_i and Y and when X_i is at different magnitudes. The 'b' coefficient also represents the elasticity of production in the Cobb-Douglas production function analysis.

The form of Cobb-Douglas production function used in the present study is as follows.

$$Y = a X_1 b^1 \cdot X_2 b^2 \cdot X_3 b^3 \dots \dots \dots X_n^{bn} \quad (1)$$

On linearization, it becomes

$$\text{Log } Y = \text{log } a + b_1 \text{log } X_1 + b_2 \text{log } X_2 + b_3 \text{log } X_3 + \dots \dots \dots + b_n \text{log } X_n \quad (2)$$

Production function employed for cropping system as a whole is given below.

$$\text{Log } (Y) = \text{log } (a) + b_1 \text{log } (X_1) + b_2 \text{log } (X_2) + b_3 \text{log } (X_3) + b_4 \text{log } (X_4) + b_5 \text{log } (X_5) + b_6 \text{log } (X_6) + b_7 \text{log } (X_7) + e$$

Where,

Y = Gross returns in rupees/ha

a = Intercept

X_1 = Seedlings/Setts cost (₹/ha)

X_2 = FYM cost (₹/ha)

X_3 = Chemical fertilizers cost (₹/ha)

X_4 = Plant protection chemicals cost (₹/ha)

X_5 = Human labour cost (₹/ha)

X_6 = Bullock labour cost (₹/ha)

X_7 = Machine labour cost (₹/ha)

e_u = Random error term

b_i = Elasticities of production ($i = 1, 2...7$)

Returns to scale

The returns to scale were estimated directly by getting the sum of 'bi' coefficients. The returns will be increasing, constant or diminishing based on whether value of summation of 'bi' is greater, equal or less than unity, respectively.

3.4.4 Allocative efficiency

Given the technology, allocative efficiency exists when resources are allocated within the farm according to market prices and it implies the proper level of input use in production. To decide whether a particular input is used rationally or irrationally, its marginal value products would be computed. If the marginal value product of an input just covers its acquisition cost it is said that is used efficiently.

The Marginal Value Products (MVP) was calculated at the geometric mean levels of variables by using the following formula.

$$\text{MVP } i^{\text{th}} \text{ resource} = b_i \frac{\bar{y}}{\bar{x}_i}$$

\bar{y} = Geometric mean of the output

\bar{x}_i = Geometric mean of i^{th} independent variable

b_i = The regression coefficient of the i^{th} independent variable

In order to determine, the efficiency of allocation of the resources or price efficiency, the value of the marginal product obtained by multiplying the marginal product (b_i) by the price of the product was compared with its marginal cost. A ratio of the value of marginal product to the factor price more than unity implied that the resources were advantageously employed. If the ratio was less than one, it suggested that resource was over utilized.

The criterion for determining optimality of resource use was,

MVP/MFC > 1 underutilization of resources

MVP/MFC = 1 optimal use of resources

MVP/MFC < 1 excess use of resources.

3.5.4 Garrett's ranking technique

This technique was used to evaluate the problems encountered in sugarcane cultivation and marketing. In this method, the farmers were asked to rank the given problem according to the magnitude of the problem. The orders of merit given by respondents were converted into ranks by using the following formula.

$$\text{Percentage Position} = \frac{100 (R_{ij} - 0.5)}{N_j} \quad (1)$$

Where,

R_{ij} = Rank given for i^{th} item by j^{th} individual

N_j = Number of items ranked by j^{th} individual

The percentage position of each rank thus obtained was converted into scores by referring to the table given by Garrett. Then for each factor the scores of individual respondents were added together and divided by total number of respondents for whom the scores were added. These mean scores of all the factors were arranged in the order of their ranks and inferences were drawn.

3.5 Concepts used in the study

Different concepts used in the study are discussed in this section.

3.5.1 Terms and concepts related to identification of cropping system

Cropping system: The kind and sequence of crops grown on an area of land over a period of one year was considered as cropping system.

Cropping pattern: The allocation of the area under various crops at a point of time (*kharif*, *rabi* and summer) represented the cropping pattern.

Inter-cropping: Growing two or more crops simultaneously on the same piece of land with definite row arrangement or in a fixed ratio is called intercropping.

3.5.2 Concepts related to evaluation of cropping system

The total costs were divided into two broad concepts

A. Variable or operational costs

B. Fixed costs

The method adopted for computing the different cost items are described below:

A. Variable or operational costs

These were the costs incurred by the farmers for the sugarcane growing which were productive. Broadly these were the actual costs along with incidental charges incurred towards seeds, manures and fertilizers, plant protection chemicals, labour charges and miscellaneous charges.

Seeds: The cost of purchased seeds was based on the actual amount paid by the respondents. The farm-produced seeds were imputed based on the prices, which prevailed at the time of sowing.

Farm Yard Manure (FYM): The value of FYM generated on their farm was imputed by considering the rates prevailing in the locality for per tractor load at the time of its application.

Fertilizers and Plant Protection Chemicals (PPC): The cost of fertilizers and plant protection chemicals was based on the actual prices paid by the sample respondents including the cost of transportation and other incidental charges, if any.

Human labour: The cost of hired labour was calculated at the prevailing wage rates paid per day (Eight hours) in the study area for men and women during the study period. The same wage rates were imputed for family labour. While expressing labour in man days, women days were converted into man days by taking 1.33 women days equal to one man days. Woman labour was converted into male equivalents. The formula used for conversion was Male equivalents of female labour = $0.65 \times$ total number of female labour days Conversion factor 0.65 was taken based on the ratio of wage paid to the men labour V/s women labour.

Machine labour: The cost of machine labour both hired and owned was calculated for differential rates for deferent type of operation prevailed in study area.

Bullock labour: It is measured in pair days. Here one pair day means eight hours of work by a pair of bullock may be treated as one bullock labour day.

Interest on working capital: This was calculated at the rate of 7 per cent for the six months on the total value of the seeds, manures, fertilizers, plant protection chemicals, human labour, bullock labour, machine labour and materials (based on the interest rates charged by financial institutions).

B. Fixed costs: The fixed cost includes depreciation on farm implements and machinery, interest on fixed capital, land revenue and rental value of land.

Depreciation charges: Depreciation rates, life span and junk value for various agricultural implements and consequently, the depreciation was calculated using the straight-line method.

$$\text{Depreciation} = \frac{\text{Purchase value} - \text{Junk value}}{\text{life span}}$$

The depreciation charges were allocated to different crops cultivated during the year in proportion to the area under each crop.

Interest on fixed capital: Interest on fixed capital was calculated at the rate of 12 per cent, as the fixed deposits in commercial banks and private banks would fetch this rate of interest. The items considered under fixed capital were implements and machinery. Interest was considered on the value of these assets after deducting the depreciation for the year. No interest was charged on the land value since the rental value of owned land was considered. Then the amount so calculated was apportioned to the crop acreage based on duration of the crop.

Land revenue: Land revenue was taken at the rates levied by the government (30 /ha).

Rental value of land: Rental value of land was calculated at the prevailing rate per acre per annum in the study area and was apportioned to the respective crop.

Total cost of cultivation: The total cost included the cost of human labour, bullock labour, tractor power, FYM, fertilizers, plant protection chemicals, seeds and other fixed cost.

3.5.2.4 Income concepts

Gross income: Gross income were computed on the basis of actual prices at which individual farmers sold their main products and by-products, *i.e.* value of main product plus by-product is called gross income.

Net income: This was defined as the difference between gross income and total cost incurred by farmers.

Benefit cost (B:C) ratio: It is the ratio of total cost of cultivation to the gross returns multiplied by 100 *i.e.* returns per rupee of expenditure.

Cropping Intensity (CI)

Cropping intensity was computed as the ratio of the gross cropped area to the net sown area and expressed in percentage.

$$\text{Cropping intensity} = \frac{\text{Gross cropped area}}{\text{Net cropped area}} \times 100$$

Results

4. RESULTS

The results that emerged from analysis of data collected for achieving the set objectives of the study are presented in this chapter under following heads.

- 4.1 Socio-economic profile of sample farmers in the study area
- 4.2 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems of sample farmers in the study area
- 4.3 Cropping pattern followed by the sample farmers in sugarcane mono-cropping, sugarcane based intercropping systems
- 4.4 Cropping pattern followed by the sample farmers in alternate cropping systems
- 4.5 Operation wise labour utilisation pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 4.6 Input utilization pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 4.7 Cost of cultivation in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 4.8 Returns from sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 4.9 Resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 4.10 Allocative efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 4.11 Constraints faced by sample respondents in sugarcane mono-cropping, sugarcane based intercropping systems
- 4.12 Constraints faced by sample respondents in alternate cropping systems

4.1 Socio-economic profile of sample respondents in the study area

An understanding of general characteristics of the sample farmers is expected to provide a bird's eye view of the general features prevailing in the study area. Therefore, an attempt has been made in the study to analyse some of the important characteristics of sample farmers and the same are presented in Table 4.1. The study covered 120 farmers, of which 60 farmers are following sugarcane mono-cropping, 30 farmers each were practicing sugarcane

Table 4.1 Socio-economic profile of the sample respondents

Sl. No.	Particulars	Units	Sugarcane mono-cropping (n=60)	Sugarcane based intercropping systems (n=30)	Alternate cropping systems (n=30)
1	Age	Years	45.6	43.2	46.41
2	Education				
a.	Illiterate	Nos.	5 (8.33)	5 (16.67)	6 (20.00)
b.	Primary	Nos.	19 (31.67)	6 (20.00)	8 (26.67)
c.	High school	Nos.	18 (30.00)	8 (26.67)	9 (30.00)
d.	PUC	Nos.	10 (16.67)	7 (23.33)	4 (13.33)
e.	Degree	Nos.	8 (13.33)	4 (13.33)	3 (10.00)
3	Family size				
a.	Male	Nos.	2.34 (45.70)	2.16 (40.45)	1.85 (42.14)
b.	Female	Nos.	1.56 (30.47)	1.93 (36.14)	1.42 (32.35)
c.	Children	Nos.	1.22 (23.83)	1.25 (23.41)	1.12 (25.51)
	Total		5.12 (100.00)	5.34 (100.00)	4.39 (100)
4	Occupation				
a.	Agriculture as a main occupation	Nos.	57 (95.00)	28 (93.33)	27 (90.00)
b.	Agriculture as a subsidiary occupation	Nos.	3 (5.00)	2 (6.67)	3 (10.00)
	Total		60 (100.00)	30 (100.00)	30 (100.00)
5	Land holding pattern				
a.	Rainfed	ha	0.45 (11.11)	0.6 (17.39)	1.04 (32.30)
b.	Irrigated	ha	3.6 (88.89)	2.85 (82.61)	2.18 (67.70)
	Total	ha	4.05 (100.00)	3.45 (100.00)	3.22 (100.00)

Note: Figures in the parentheses indicate percentage to total

based intercropping and alternate cropping systems were selected from two villages of three taluks viz., Gokak, Chikkodi and Soudatti of Belagavi district.

The average age of the farmers was 45.60, 43.20 and 46.41 years in sugarcane mono-cropping, sugarcane based intercropping systems and alternate cropping systems, respectively. It could be further observed that, majority of the sample farmers were literate and having their education ranging from primary to college level in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems. In case of sugarcane mono-cropping, among the sample farmers 31.67 per cent had primary school education, 30 per cent had high school education, 16.67 per cent had pre-university education and 8 per cent had degree education. In case of sugarcane based intercropping systems, out of 83.33 per cent of the literate farmers, 20.00 per cent of them studied up to primary school, 26.67 per cent studied up to high school level, 23.33 and 13.33 per cent had completed PUC and degree education, respectively. Whereas in case of alternate cropping systems, the proportion of primary, high school, PUC and degree education level of the farmers were 20.00, 26.67, 30.00, 13.33 and 10.00 per cent, respectively.

The family composition of sample farmers in the study area revealed that the proportion of male per family was more constituting 45.70, 40.45 and 42.14 per cent in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems, respectively. Average family size was 5.12, 5.34 and 4.21 per cent, respectively in the cropping systems studied in that order.

As far as occupation is concerned, in all the three systems, the main occupation of sample respondents was agriculture, which is about 95.00, 93.33 and 90.00 per cent in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems, respectively. The average size of agricultural land holding in these systems in that order was 4.05, 3.45 and 3.22 ha.

4.2 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems of sample farmers in the study area

In the study area, 60 farmers were selected under sugarcane monocropping, 30 farmers each were selected under sugarcane based intercropping systems and alternate cropping systems. In sugarcane based intercropping systems, totally 6 sugarcane based intercropping

systems were observed and presented in Table 4.2. Among these 36.67 per cent of the sample farmers practised sugarcane + fodder maize intercropping system, 30 per cent followed sugarcane + soybean intercropping system, 13.33 per cent practised sugarcane + onion intercropping system, 10 per cent of the sample farmers followed sugarcane + greengram intercropping system, 6.67 per cent followed sugarcane + tomato and 3.33 per cent followed sugarcane + blackgram intercropping system.

In alternate cropping system, five alternate cropping systems were identified and presented in the Table 4.2. Out of these cropping systems, turmeric sole-crop accounted for 40 per cent followed by maize-chickpea-groundnut, soybean-wheat-vegetables, cotton-groundnut and greengram-sorghum-groundnut with 36.67, 10.00, 6.67 and 6.67 per cent, respectively.

4.2.1 Major cropping systems identified under sugarcane based intercropping and alternate cropping systems in the study area

In the study area, major cropping systems practiced by the sample farmers are presented in the Table 4.3, 60 farmers were following sugarcane mono-cropping; they were growing sugarcane with a variety of CO-86032, CO-8011, and CO-675.

Under sugarcane based intercropping systems, two major cropping systems were identified which accounted for about 66.67 per cent, out of the total sugarcane based intercropping systems observed in the study area. Among these two sugarcane based intercropping systems, 36.67 per cent of sample farmers practised sugarcane + fodder maize intercrop, sugarcane (Variety CO-86032, CO-8011 and CO-675) and fodder maize (Variety Ganga). 30 per cent of sample farmers followed sugarcane + soybean intercrop, sugarcane (Variety CO-86032, CO-8011 and CO-675) and soybean (Variety JSS- 355).

In alternate cropping systems, two major cropping systems were identified which accounted for 76.67 per cent of the total alternate cropping systems observed in the study area. Among these two alternate cropping systems, 40.00 per cent of sample farmers were growing turmeric sole crop with a variety of Suvarna and 36.67 per cent of sample farmers were growing maize-chickpea-groundnut in *kharif*, *rabi* and summer seasons, respectively. (Maize variety NK-6240, kaveri and pioneer; Chickpea variety JG-11 and JAKI-921 and groundnut variety GPBD- 4, TNV-2 and JL-24).

Table 4.2 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems of sample farmers in the study area

Sl. No.	Components	No of farmers	Percentage
I. Sugarcane mono-cropping			
1	Sugarcane mono-crop	60	100
II. Sugarcane based intercropping systems			
1	Sugarcane + Fodder maize	11	36.67
2	Sugarcane + Soybean	9	30.00
3	Sugarcane + Onion	4	13.33
4	Sugarcane + Greengram	3	10.00
5	Sugarcane + Tomato	2	6.67
6	Sugarcane + Blackgram	1	3.33
	Total	30	100.00
III. Alternate cropping systems to sugarcane			
1	Turmeric-sole	12	40.00
2	Maize-Chickpea-Groundnut	11	36.67
3	Soybean-Wheat-Vegetables	3	10.00
4	Cotton-Groundnut	2	6.67
5	Greengram-Sorghum-Groundnut	2	6.67
	Total	30	100.00

Table 4.3 Major cropping systems identified under sugarcane based and alternate cropping systems in the study area

Particulars		Variety		No. of farmers	%
1. Sugarcane mono-cropping					
Cropping system-I	Sugarcane mono-crop	Sugarcane Co-86032, Co-8011		60	100
2. Sugarcane based intercropping systems					
Cropping system-II	Sugarcane + Fodder maize	Sugarcane Co-86032, Co-8011, Co-675	Maize Ganga	11	36.67
Cropping system-III	Sugarcane + Soybean	Sugarcane Co-86032, Co-8011, Co-675	Soybean JSS-355	9	30.00
3. Alternate cropping systems					
Cropping system – IV	Turmeric sole	Turmeric Suvarna		12	40.00
Cropping system – V	Maize-Chickpea- Groundnut	Maize Nk-6240 Kaveri Poineer	Chickpea JG-11 JAKI-9218	11	36.67
			Groundnut GPBD-4 TMV-2 JL-24		

4.2.2 Land holding size of the sample farmers in the identified major cropping systems in the study area

The average farm size in the identified cropping systems was given in Table 4.4 revealed that, the maximum farm size was observed in case of CS-I (4.05 ha) followed by CS-II (3.52 ha), CS-III (3.39 ha), CS-IV (3.48 ha) and CS-V (2.98 ha). Out of the total agricultural land holding in CS-I, CS-II, CS-III, CS-IV and CS-V, average area under irrigated condition was 3.6, 2.99, 2.72, 2.59 and 1.78 ha, respectively and remaining 0.45, 0.53, 0.67, 0.89 and 1.20 ha was under rain-fed condition, respectively.

4.2.3 Source of irrigation in the identified major cropping systems in the study area

From the Table 4.5, it could be seen that all the farmers were having irrigation facility from different sources such as canals, bore wells and lift irrigation. In case of CS-I, it was observed that 36.67 per cent farmers irrigated their farm through canals, 33.33 per cent from lift irrigation and 30.00 per cent from bore wells irrigation facility.

In case of CS-II, it was observed that majority of the farmers irrigated their farm through canals (45.45 %) followed by bore wells (36.36 %) and lift irrigation facility (18.18 %).

In case of CS-III, it could be seen that 44.44 per cent of the farmers irrigated their farm through canals followed by bore wells (33.33 %) and lift irrigation facility (22.22 %).

In case of CS-IV, it was observed that majority of the farmers irrigated their farm through bore wells (41.67 %) followed by canals (33.33 %) and lift irrigation facility (25 %).

In case of CS-V, it was observed that 36.36 per cent farmers irrigated their farm through canals, followed by bore wells (27.27 %) and lift irrigation facility (36.36 %).

4.3 Cropping pattern followed by the sample farmers in sugarcane mono-cropping, sugarcane based intercropping systems

4.3.1 Cropping pattern of sugarcane mono-cropping farmers (CS-I)

The cropping pattern followed by the sample farmers in CS-I (Sugarcane mono-cropping) was calculated and presented in Table 4.6.

It is evident from table that, out of the average gross cropped area of 9.80 ha, 41.33 per cent was cultivated in *kharif*, 32.24 per cent was cultivated in *rabi* and 26.43 per cent was

Table 4.4 Land holding pattern of the farmers in the identified major cropping systems in the study area

Sl. No.	Particulars	Rainfed	Irrigated	Total
		Area	Area	Area
1	Sugarcane mono-cropping			
a.	CS-I (n=60)	0.45 (11.11)	3.6 (88.89)	4.05 (100.00)
2	Sugarcane based intercropping systems			
a.	CS-II (n=11)	0.53 (15.06)	2.99 (84.94)	3.52 (100.00)
b.	CS-III (n=9)	0.67 (19.76)	2.72 (80.24)	3.39 (100.00)
3	Alternate cropping systems			
a.	CS-IV (n=12)	0.89 (25.57)	2.59 (74.43)	3.48 (100.00)
b.	CS-V (n=11)	1.2 (40.27)	1.78 (59.73)	2.98 (100.00)

Note: Figures in the parentheses indicate percentage to total.

Note: CS-I : Sugarcane mono-crop
 CS-II : Sugarcane + Fodder maize
 CS-III : Sugarcane + Soybean
 CS-IV : Turmeric sole
 CS-V : Maize-Chickpea-Groundnut

Table 4.5 Source of irrigation in the identified major cropping systems in the study area

Sl. No.	Particulars	Canals	Bore wells	Lift irrigation	Total
		No. of farmers	No. of farmers	No. of farmers	No. of farmers
1	Sugarcane mono-cropping				
a.	CS-I (n=60)	22 (36.67)	18 (30.00)	20 (33.33)	60 (100.00)
2	Sugarcane based intercropping systems				
a.	CS-II (n=11)	5 (45.45)	4 (36.36)	2 (18.18)	11 (100.00)
b.	CS-III (n=9)	4 (44.44)	3 (33.33)	2 (22.22)	9 (100.00)
3	Alternate cropping systems				
a.	CS-IV (n=12)	4 (33.33)	5 (41.67)	3 (25.00)	12 (100.00)
b.	CS-V (n=11)	4 (36.36)	3 (27.27)	4 (36.36)	11 (100.00)

Note: Figures in the parentheses indicate percentage to total.

Note: CS-I : Sugarcane mono-crop
 CS-II : Sugarcane + Fodder maize
 CS-III : Sugarcane + Soybean
 CS-IV : Turmeric sole
 CS-V : Maize-Chickpea-Groundnut

Table 4.6 Cropping pattern of sugarcane mono-cropping farmers (CS-I)

n=60 (Area in ha)			
Sl. No.	Crops	Area	Percentage
a.	<i>Kharif</i>		
1	Sugarcane	1.58	16.12
2	Maize	0.63	6.43
3	Soybean	0.55	5.61
4	Cotton	0.41	4.18
5	Greengram	0.37	3.78
6	Turmeric + Chilli	0.35	3.57
7	Cabbage	0.16	1.63
I	Sub total	4.05	41.33
b.	<i>Rabi</i>		
1	Sugarcane	1.58	16.12
2	Chickpea	0.64	6.53
3	Wheat	0.52	5.31
4	Sorghum	0.42	4.29
II	Sub total	3.16	32.24
C	Summer		
1	Sugarcane	1.58	16.12
2	Maize	0.65	6.63
3	Tomato + Chilli	0.36	3.67
III	Sub total	2.59	26.43
IV	Gross cropped area	9.8	100.00
V	Net cropped area	4.05	
	Cropping intensity (%)	241.98	

Note:- CS-I: Sugarcane mono-crop

cultivated in summer. It could be further observed that, sugarcane occupied a major proportion of area (1.58 ha) in *kharif* which worked out to 16.12 per cent of gross cropped area followed by maize (0.63 ha), soybean (0.55 ha), cotton (0.41 ha), greengram (0.37 ha), blackgram (0.35 ha) and cabbage (0.16 ha).which accounted for 6.43, 5.61, 4.18, 3.78, 3.57 and 1.63 per cent of the gross cropped area, respectively.

In *rabi* season also, sugarcane occupied a major proportion of the gross cropped area which was 16.12 per cent followed by chickpea, wheat and sorghum which were 6.53, 5.31 and 4.29 per cent, respectively. In the summer season also, sugarcane occupied a major proportion of the gross cropped area which was 16.12 per cent followed by maize and tomato + chilli which were 6.63 and 3.67 per cent, respectively The net sown area, on an average of the sample farmers was 4.05 ha and cropping intensity was 241.98 per cent.

4.3.2 Cropping pattern of sugarcane based intercropping systems farmers (CS-II)

The cropping pattern followed by the sample farmers in CS-II (Sugarcane + fodder maize) was calculated and presented in Table 4.7. Results revealed that, during *kharif* season sugarcane + fodder maize intercropping system dominated the cropping pattern accounting for the largest proportion of average gross cropped area (1.21 ha) followed by maize (0.51 ha), soybean (0.46 ha), cotton (0.41 ha), greengram (0.33 ha), blackgram (0.31 ha) and cabbage (0.29 ha), respectively.

Area under sugarcane + fodder maize as the highest area and continued in *rabi* season as sugarcane sole crop followed by chickpea, wheat and sorghum which were 7.49, 5.65 and 4.18 per cent, respectively.

Table 4.7 also revealed that, area under sugarcane continued to be same even during summer season followed by maize and tomato + brinjal which were 7.13 and 2.58 per cent, respectively. The net sown area on an average of the sample farmers was 3.52 ha and cropping intensity was 231.25 per cent.

4.3.3 Cropping pattern of sugarcane based intercropping systems farmers (CS-III)

The cropping pattern followed by the sample farmers in C-III (Sugarcane + Soybean) was calculated and presented in Table 4.8. Results revealed that, during *kharif* season sugarcane + soybean intercropping system dominated the cropping pattern accounted for the largest proportion of average gross cropped area (1.09 ha) followed by maize (0.54 ha),

Table 4.7 Cropping pattern of sugarcane based intercropping systems farmers (CS-II)

(n=11) (Area in ha)

Sl. No.	Crops	Area	Percentage
a.	<i>Kharif</i>		
1	Sugarcane + Maize	1.21	14.86
2	Maize	0.51	6.27
3	Soybean	0.46	5.65
4	Cotton	0.41	5.04
5	Greengram	0.33	4.05
6	Turmeric	0.31	3.81
7	Cabbage	0.29	3.56
I.	Sub total	3.52	43.24
b.	<i>Rabi</i>		
1	Sugarcane	1.21	14.86
2	Chickpea	0.61	7.49
3	Wheat	0.46	5.65
4	Sorghum	0.34	4.18
II.	Sub total	2.62	32.19
C.	Summer		
1	Sugarcane	1.21	14.86
2	Maize	0.58	7.13
3	Tomato + Brinjal	0.21	2.58
III	Sub total	2.00	24.57
IV	Gross cropped area	8.14	100.00
V	Net cropped area	3.52	
VI	Cropping intensity (%)	231.25	

Note:- CS-II : Sugarcane + Fodder maize

Table 4.8 Cropping pattern of sugarcane based intercropping systems farmers (CS-III)

(n=9) (Area in ha)			
Sl. No.	Crops	Area	Percentage
a.	<i>Kharif</i>		
1	Sugarcane + Soybean	1.09	13.16
2	Maize	0.54	6.52
3	Soybean	0.49	5.92
4	Cotton	0.42	5.07
5	Greengram	0.38	4.59
6	Turmeric	0.28	3.38
7	Cabbage	0.19	2.29
I.	Sub total	3.39	40.94
b.	<i>Rabi</i>		
1	Sugarcane	1.09	13.16
2	Chickpea	0.59	7.13
3	Wheat	0.48	5.80
4	Sorghum	0.36	4.35
II.	Sub total	2.52	30.43
C.	Summer		
1	Sugarcane	1.39	16.79
2	Maize	0.62	7.49
3	Tomato + Brinjal	0.36	4.35
III	Sub total	2.37	28.62
IV	Gross cropped area	8.28	100.00
V	Net cropped area	3.39	
VI	Cropping intensity (%)	244.25	

Note:- CS-III: Sugarcane + Soybean

soybean (0.49 ha), cotton (0.42 ha), greengram (0.38 ha), blackgram (0.28 ha) and cabbage (0.19 ha), respectively.

In *rabi* season also, area under sugarcane + maize was continued to be same followed by chickpea (0.59 ha), wheat (0.48 ha) and sorghum (0.36 ha).

Table 4.8 also revealed that, area under sugarcane continued even during summer season followed by maize (0.62 ha) and tomato + brinjal (0.36 ha).

4.4 Cropping pattern followed by the sample farmers in alternate cropping systems

4.4.1 Cropping pattern of alternate cropping systems farmers (CS-IV)

The cropping pattern followed by the sample farmers in CS-IV (Turmeric sole) was calculated and presented in Table 4.9. It is evident from the table that, out of the average gross cropped area of 8.6 ha, 40.47 per cent was cultivated in *kharif*, 30.93 per cent was cultivated in *rabi* and 28.60 per cent was cultivated in summer season. It could be further observed that, turmeric occupied a major proportion of area (1.12 ha) in *kharif* which worked out to 13.02 per cent of gross cropped area followed by maize (0.69 ha), soybean (0.55 ha), cotton + chilli (0.45 ha), maize + mustard (0.39 ha) and tomato + chilli (0.28 ha) which accounted for 8.02, 6.40, 5.23, 4.53 and 3.26 per cent of the gross cropped area, respectively.

In *rabi* season also, turmeric occupied a major proportion of the gross cropped area which was 13.02 per cent followed by chickpea, wheat and sorghum which were 8.02, 5.12 and 4.77 per cent, respectively.

In the summer season also, turmeric occupied a major proportion of the gross cropped area which was 13.02 per cent followed by maize and groundnut + cowpea and tomato + brinjal which were 6.28, 5.12 and 4.19 per cent, respectively. The net sown area on an average of the sample farmers was 3.48 ha and cropping intensity was 247.13 per cent.

4.4.2 Cropping pattern of alternate cropping systems farmers (CS-V)

The cropping pattern followed by the sample farmers in CS-IV (Maize-Chickpea-Groundnut) was calculated and presented in Table 4.10. It is evident from the table that out of the average gross cropped area of 7.99 ha, 37.30 per cent was cultivated in *kharif*, 35.92 per cent was cultivated in *rabi* and 26.78 per cent was cultivated in summer.

Table 4.9 Cropping pattern of alternate cropping systems farmers (CS-IV)

(n=12) (Area in ha)

Sl. No.	Crops	Area	Percentage
a.	<i>Kharif</i>		
1	Turmeric	1.12	13.02
2	Maize	0.69	8.02
3	Soybean	0.55	6.40
4	Cotton + chilli	0.45	5.23
5	Maize + mustard	0.39	4.53
6	Tomato + chilli	0.28	3.26
I	Sub total	3.48	40.47
b.	<i>Rabi</i>		
1	Turmeric	1.12	13.02
2	Chickpea	0.69	8.02
3	Wheat	0.44	5.12
4	Sorghum	0.41	4.77
II	Sub total	2.66	30.93
C.	Summer		
1	Turmeric	1.12	13.02
2	Maize	0.54	6.28
3	Groundnut + Cowpea	0.44	5.12
4	Tomato + Brinjal	0.36	4.19
III	Sub total	2.46	28.60
IV	Gross cropped area	8.6	100.00
V	Net cropped area	3.48	
VI	Cropping intensity (%)	247.13	

Note:- CS-IV: Turmeric sole

Table 4.10 Cropping pattern of alternate cropping systems farmers (CS-V)

(n=11) (Area in ha)

Sl. No.	Crops	Area	Percentage
a.	<i>Kharif</i>		
1	Maize	1.48	18.52
2	Soybean	0.63	7.88
3	Cotton + chilli	0.44	5.51
4	Maize + Mustard	0.24	3.00
5	Tomato + chilli	0.19	2.38
I	Sub total	2.98	37.30
b.	<i>Rabi</i>		
1	Chickpea	1.18	14.77
2	Wheat	0.51	6.38
3	Sorghum	0.44	5.51
4	Wheat + safflower	0.41	5.13
5	Chickpea + Sorghum	0.33	4.13
II	Sub total	2.87	35.92
c.	Summer		
1	Groundnut	0.96	12.02
2	Maize	0.51	6.38
3	Groundnut + Cowpea	0.38	4.76
4	Chilli + coriander	0.29	3.63
III	Sub total	2.14	26.78
IV	Gross cropped area	7.99	100.00
V	Net cropped area	2.98	
VI	Cropping intensity (%)	268.12	

Note:- CS-V: Maize-Chickpea-Groundnut

It could be further observed that, maize occupied a major proportion of area (1.48 ha) in *kharif* which worked out to 18.52 per cent of gross cropped area followed by soybean (0.63 ha), cotton + chilli (0.44 ha), maize + mustard (0.24 ha) and tomato + chilli (0.19 ha) which accounted for 7.88, 5.51, 3.00, and 2.38 per cent of the gross cropped area, respectively.

In *rabi* season, chickpea occupied a major proportion of the gross cropped area which was 14.77 per cent followed by wheat, sorghum, wheat + safflower and chickpea + sorghum which were 6.38, 5.51, 5.13 and 4.13 per cent, respectively.

In summer season, groundnut occupied a major proportion of the gross cropped area which was 12.02 per cent followed by Maize, groundnut + cowpea and chilli + coriander which were 6.38, 4.76 and 3.63 per cent, respectively. The net sown area on an average of the sample farmers was 2.98 ha and cropping intensity was 268.12 per cent.

4.5 Operation wise labour utilisation pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

4.5.1 Operation wise labour utilisation pattern in CS-I under sugarcane mono-cropping

The labour utilisation pattern in cultivation of CS-I (sugarcane mono-cropping) was calculated and presented in Table 4.11 and Fig.3.

In case of CS-I, total human labour engaged per ha was 207.02 md and that of bullock labour was 4.37 pd and machine labour was 9.97 hr. The use of human labour was highest in irrigation (68.35 md) followed by weeding (44.05 md), harvesting (37.50 md), planting (21.15 md), fertiliser application (9.08 md), transporting of farmyard manure (6.08 md), sett bed preparation (3.34 md), application of plant protection chemicals (4.12 md), harrowing (3.8 md), spreading of farmyard manure (3.45 md), ploughing (3.20 md) and inter cultivation (2.90 md). The use of bullock labour was highest in inter cultivation (2.25 pd), followed by sett bed preparation (2.12 pd) and about 3.25, 3.26 and 3.46 hr of machine labour were used for ploughing, transportation of farmyard manure and harrowing, respectively.

4.5.2 Operation wise labour utilisation pattern in CS-II under sugarcane based intercropping systems

The labour utilisation pattern in cultivation of CS-II (sugarcane + fodder maize) was calculated and presented in Table 4.12 and Fig.3.

Table 4.11 Operation wise labour utilisation pattern in sugarcane mono-cropping

(Per ha)

Sl. No	Particulars	CS-I (n=60)		
		Human labour (md)	Bullock labour (pd)	Machine labour (hr)
1	Ploughing	3.2	-	3.25
2	Transportation of FYM	6.08	-	3.26
3	Harrowing	3.8	-	3.46
4	Spreading of FYM	3.45	-	-
5	Sett bed/seed preparation	3.34	2.25	-
6	Planting /Sowing	21.15	-	-
7	Inter cultivation	2.9	2.12	-
8	Fertilizer application	9.08	-	-
9	Weeding	44.05	-	-
10	Irrigation	68.35	-	-
11	Application of PPC	4.12	-	-
12	Harvesting	37.5	-	-
	Total	207.02	4.37	9.97

Note:- CS-I : Sugarcane mono-crop

In case of CS-II, the sample farmers used 224.03 md of human labour, 9.59 hr of machine labour, 7.84 pd of bullock labour. In which about 3.60, 3.48 and 2.51 hr of machine labour were used for ploughing, harrowing and transportation of farmyard manure, respectively. The highest bullock labour was used for sowing operation (2.86 pd) followed by inter cultivation (2.39 pd) and set bed preparation (2.59 pd). Among the human labour used for different operations, the highest human labour was used for irrigation (74.13 md) followed by harvesting (46.73 md), weeding (40.20 md), planting and sowing (26.75 md), fertiliser application (10.36 md), transportation of farmyard manure (6.95 md), sett bed preparation (4.86 md), application of plant protection chemicals (3.42 md), ploughing (3.45 md), spreading of farmyard manure (2.55 md) harrowing(2.39 md) and inter-cultivation (2.24 md).

4.5.3 Operation wise labour utilisation pattern in CS-III under sugarcane based intercropping systems

The labour utilisation pattern in cultivation of CS-III (sugarcane + soybean) was calculated and presented in Table 4.12 and Fig.3.

In case of CS-III, total human labour, bullock labour and machine labour used by sample farmers were 134.06 md, 6.46 pd and 9.83 hr, respectively. The human labour used for different operations, the highest human labour was used for irrigation (78.69 md) followed by harvesting (51.70 md), weeding (42.95 md), planting and sowing (28.60 md), fertiliser application (9.49 md), transportation of farmyard manure (6.33 md), application of plant protection chemicals (3.29 md), sett bed preparation (5.49 md), ploughing(3.66 md), spreading of farmyard manure (2.43 md), harrowing(2.39 md) and inter cultivation(2.18 md). The highest bullock labour was used for sowing operation (2.84 pd) followed by inter cultivation (2.24 pd) and sett bed preparation (2.14 pd). The machine labour used was 3.20, 3.69 and 2.42 hr for ploughing, transportation of farmyard manure and harrowing, respectively.

4.5.4 Operation wise labour utilisation pattern in CS-IV under alternate cropping systems

The labour utilisation pattern in cultivation of CS-IV (Turmeric sole) was calculated and presented in Table 4.13 and Fig.3.

In case of CS-IV, the sample farmers used 286.21 md of human labour, 11.50 hr of machine labour, 5.37 pd of bullock labour. In which about 3.15, 2.81 and 2.26 hr of machine labour were used for ploughing, transportation of farmyard manure and harrowing,

Table 4.12 Operation wise labour utilisation pattern in sugarcane based intercropping systems

(Per ha)

Sl. No	Particulars	CS-II (n=11)			CS-III (n=9)		
		Human labour (md)	Bullock labour (pd)	Machine labour (hr)	Human labour (md)	Bullock labour (pd)	Machine labour (hr)
1	Ploughing	3.45	-	3.60	3.66	-	3.2
2	Transportation of FYM	6.95	-	3.48	6.33	-	3.69
3	Harrowing	2.39	-	2.51	2.39	-	2.42
4	Spreading of FYM	2.55	-	-	2.43	-	-
5	Sett bed/seed preparation	4.86	2.59	-	5.49	2.89	-
6	Planting /Sowing	26.75	2.86	-	28.6	2.14	-
7	Inter cultivation	2.24	2.39	-	2.18	2.24	-
8	Fertilizer application	10.36	-	-	9.49	-	-
9	Weeding	40.20	-	-	42.95	-	-
10	Irrigation	74.13	-	-	78.69	-	-
11	Application of PPC	3.42	-	-	3.29	-	-
12	Harvesting	46.73	-	-	51.7	-	-
	Total	224.03	7.84	9.59	237.2	7.27	9.32

Note:- CS-II : Sugarcane + Fodder maize
CS-III : Sugarcane + Soybean

respectively. The highest pair days of bullock labour was used for inter cultivation (3.62 pd), followed by ploughing (1.52 pd). Among the human labour used for different operations, the highest human labour was used for irrigation (51.25 md) followed by harvesting (38.25 md), weeding (30.95 md), planting (26.69 md), fertiliser application (7.58 md), transportation of farmyard manure (5.20 md), spreading of farmyard manure (4.28 md), Rhizome treatment (3.48 md), application of plant protection chemicals (3.39 md), inter cultivation (2.90 md), ploughing (2.57 md) and harrowing (2.31 md).

4.5.5 Operation wise Labour utilisation pattern in CS-V under alternate cropping systems

The labour utilisation pattern in cultivation of CS-V (Maize-chickpea-groundnut) was calculated and presented in Table 4.13 and Fig.3.

In case of CS-V, total human labour, bullock labour and machine labour used by sample farmers were 134.06 md, 6.46 pd and 9.83 hr , respectively. The highest pair days of bullock labour was used for sowing operation (3.87 pd), followed by inter cultivation (2.59 pd). The machine labour used for operations like ploughing (3.88 hr), harrowing (3.28 hr) and transportation of farmyard manure (2.67 hr). Among the human labour used for different operations, the highest human labour was used for harvesting (34.25 md) followed by planting (24.23 md), weeding (21.58 md), irrigation (15.25 md), fertiliser application (10.38 md), transportation of farmyard manure (6.89 md), application of plant protection chemicals (7.88 md), ploughing (4.59 md), harrowing (4.35 md), seed treatment (3.20 md), spreading of farmyard manure (3.31 md) inter cultivation (3.16 md) and application of plant protection chemicals (2.88 md).

4.6 Input utilization pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

4.6.1 Inputs used in CS-I under sugarcane mono-cropping

Inputs used in cultivation of CS-I (Sugarcane mono-crop) are presented in Table 4.14 and Fig.3.

In case of CS-I, the sample farmers used 7.88 t of setts as planting material for establishing sugarcane crop on a ha of land. For meeting out plant nutrients requirements on a ha of land, 10.48 t of FYM and 6.16, 2.86, 4.58 q of urea, DAP and MOP were used,

Table 4.13 Operation wise labour utilisation pattern in alternate cropping systems

(Per ha)

Sl. No	Particulars	CS – IV (n=12)			CS – V (n=11)		
		Human labour (md)	Bullock labour (pd)	Machine labour (hr)	Human labour (md)	Bullock labour (pd)	Machine labour (hr)
1	Ploughing	2.57	1.52	3.15	4.59	-	3.28
2	Transportation of FYM	5.2	-	2.81	6.89	-	2.67
3	Harrowing	2.31	-	2.26	4.35	-	3.88
4	Spreading of FYM	4.28	-	-	3.31	-	-
5	Rhizome/ Seed treatment	3.48	-	-	3.20	-	-
6	Planting / Sowing	26.69	-	-	24.23	3.87	-
7	Inter cultivation	2.9	3.62	-	3.16	2.59	-
8	Fertilizer application	7.58	-	-	10.38	-	-
9	Weeding	30.95	-	-	21.58	-	-
10	Irrigation	51.25	-	-	15.25	-	-
11	Application of PPC	3.39	-	-	2.88	-	-
12	Harvesting	38.25	-	-	34.25	-	-
	Total	178.85	5.14	8.22	134.06	6.46	9.83

Note:- CS-IV : Turmeric sole
 CS-V : Maize + Chickpea + Groundnut

Table 4.14 Input utilization pattern in sugarcane mono-cropping**(per ha)**

SI. No	Particulars	Units	CS-I (n=60)
1	Setts		
a.	Sugarcane	t	7.88
2	Farm Yard Manure	t	10.48
3	Chemical fertilizers		
a.	Urea	q	6.16
b.	DAP	q	2.86
c.	MOP	q	4.58
	Total	q	13.60
4	Plant protection chemicals		
a.	Pesticides	l	2.14
b.	Herbicides	l	1.24
	Total	l	3.38

Note:- CS-I : Sugarcane mono-crop

respectively. Further the average quantity of plant protection chemicals used was 2.14 l of pesticides and 1.24 l of herbicides.

4.6.2 Inputs used in CS-II and CS-III under sugarcane based intercropping systems

Inputs used in cultivation of CS-II (Sugarcane + fodder Maize) and CS-III (Sugarcane + soybean) are presented in Table 4.15 and Fig.3.

In case of CS-II, the inputs utilization per ha indicated that, requirement of sugarcane setts was (6.90 t), seeds of fodder maize (25.36 kg), FYM (11.38 t), chemical fertilizers (15.45 q), plant protection chemicals (2.28 l). Whereas in case of CS-III, requirement of sugarcane setts was (6.73 t), seeds of soybean (58.15 kg), FYM (11.86 t), chemical fertilizers (17.53 q), plant protection chemicals (2.73 l).

4.6.3 Inputs used in CS-IV and CS-V under alternate cropping systems

Input utilization pattern in cultivation of CS-IV (Turmeric sole) and CS-V (Maize-Chickpea-Groundnut) are presented in Table 4.16 and Fig.3.

In case of CS-IV, the sample farmers used 16.58 q of rhizome for turmeric cultivation on ha of land. For nutrients, the average quantity of FYM applied amounted to 8.23 t and the average quantity of chemical fertilizers used were 4.51, 3.25 and 5.85 q of urea, DAP and MOP, respectively. Further the average quantity of plant protection chemicals used was 1.15 l of pesticides and 0.42 l of herbicides.

Whereas in case of CS-V, the sample farmers used 13.75 kg of seeds for maize, 51.12 kg of seed for chickpea and 136.25 kg of seeds for groundnut on a ha of land. For nutrients the average quantity of FYM applied amounted to 6.18 t and the average quantity of chemical fertilizers used were 5.21, 3.25 and 2.49 q of urea, DAP and MOP, respectively. Further the average quantity of plant protection chemicals used was 0.96 l of pesticides and 0.65 l of herbicides.

4.7 Cost of cultivation in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

4.7.1 Cost of cultivation in CS-I under sugarcane mono-cropping

The details of variable cost, fixed cost and total cost incurred per ha in case of CS-I were calculated and presented in the Table 4.17 and Fig.4.

Table 4.15 Input utilization pattern in sugarcane based intercropping systems

(Per ha)

Sl. No.	Particulars	Units	CS-II (n=11)	CS-III (n=9)
1	Setts/Seeds			
a.	Sugarcane	t	6.90	6.73
b.	Fodder maize	kg	25.36	-
c.	Soybean	kg	-	58.15
2	Farm Yard Manure	t	11.38	11.86
3	Chemical fertilizers			
a.	Urea	q	6.95	7.45
b.	DAP	q	3.38	4.12
c.	MOP	q	5.12	5.96
	Total	q	15.45	17.53
4	Plant protection chemicals			
a.	Pesticides	l	1.46	1.82
b.	Herbicides	l	0.82	0.91
	Total	l	2.28	2.73

Note:- CS-II : Sugarcane + Fodder maize
 CS-III : Sugarcane + Soybean

Table 4.16 Input utilization pattern in alternate cropping systems

(Per ha)

SI. No.	Particulars	Units	CS-IV (n=12)	CS-V (n=11)
1	Rhizome/seeds			
a.	Turmeric	Q	16.58	-
b.	Maize	Kg	-	13.75
c.	Chickpea	Kg	-	51.12
d.	Groundnut	Kg	-	136.25
2	Farm Yard Manure	T	8.23	6.18
3	Chemical fertilizers			
a.	Urea	Q	4.51	5.21
b.	DAP	Q	3.25	3.25
c.	MOP	Q	5.85	2.49
	Total	Q	13.61	10.95
4	Plant protection chemicals			
a.	Pesticides	L	1.15	0.96
b.	Herbicides	L	0.42	0.65
	Total	L	1.57	1.61

Note:- CS-IV : Turmeric sole
 CS-V : Maize + Chickpea + Groundnut

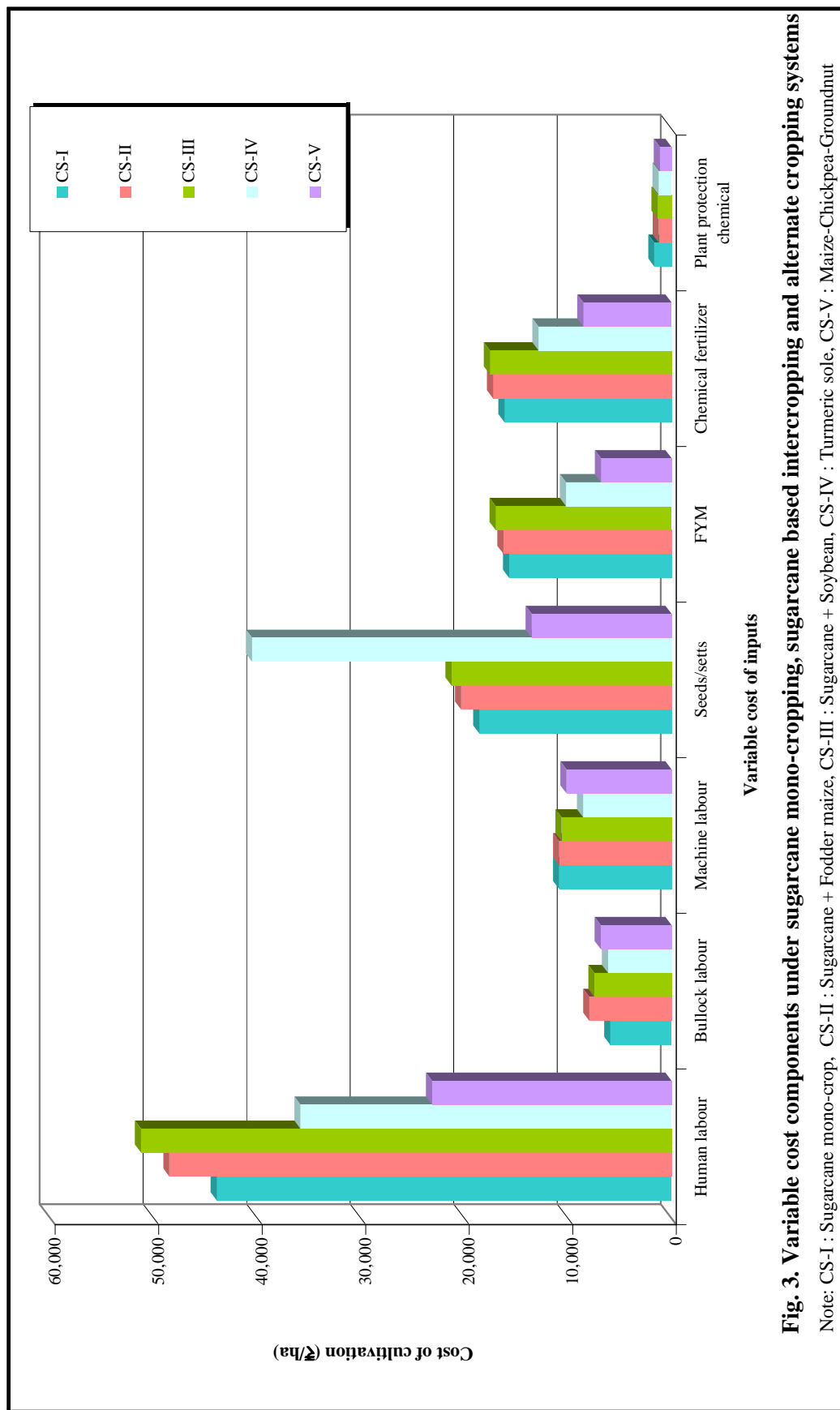


Fig. 3. Variable cost components under sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
 Note: CS-I : Sugarcane mono-crop, CS-II : Sugarcane + Fodder maize, CS-III : Sugarcane + Soybean, CS-IV : Turmeric sole, CS-V : Maize-Chickpea-Groundnut

It was observed that, the total cost of cultivation was ₹1,45,075.19 per ha, out of which 83.16 per cent was variable cost and remaining 16.84 per cent was fixed cost. The distribution pattern of variable cost on various inputs revealed that, human labour shared the highest which was 30.29 per cent of the total cost followed by setts which was 12.79 per cent and chemical fertilizers 11.12 per cent. The share of FYM, machine labour, bullock labour and plant protection chemicals was 10.81, 7.48, 4.08 and 1.14 per cent, respectively and interest on working capital was ₹7,892.42 accounting for 5.44 per cent.

On the other hand, the items included under fixed cost namely, rental value of land, land revenue, depreciation and the interest on fixed capital shares in the total cost of cultivation amounted to 13.79, 0.02, 1.23 and 1.80 per cent, respectively.

4.7.2 Cost of cultivation in CS-II under sugarcane based intercropping systems

The per ha total cost incurred under CS-II (sugarcane + fodder maize) were calculated and presented in Table 4.18 and Fig.4.

Results revealed that, the per ha total cost of cultivation was ₹1,56,538.71, out of which 83.63 per cent was variable cost and remaining 16.37 per cent was fixed cost. The distribution pattern of variable cost on various inputs revealed that, human labour shared the highest which was 30.99 per cent of the total cost followed by setts/seeds which was 12.98 per cent and chemical fertilizers 11.01 per cent. The share of FYM, machine labour, bullock labour and plant protection chemicals was 10.38, 6.93, 5.08 and 0.78 per cent, respectively and interest on working capital was ₹8,563.95 accounting for 5.47 per cent.

On the other hand, the items included under fixed cost namely, rental value of land, land revenue, depreciation and the interest on fixed capital shares in the total cost of cultivation amounted to 12.78, 0.02, 1.82 and 1.75 per cent, respectively.

4.7.3 Cost of cultivation in CS-III under sugarcane based intercropping systems

The per ha total cost incurred from CS-III (sugarcane + soybean) were calculated and presented in Table 4.18 and Fig.4.

It could be seen that, the total cost incurred by the sample farmers was ₹1,60,061.09 per ha out of which 84.53 per cent was variable cost and remaining 15.47 per cent was fixed cost. The distribution pattern of variable cost on various inputs revealed that, human labour shared the highest which was 32.02 per cent of the total cost followed by setts/seeds and chemical fertilizers which was 13.27 and 10.95 per cent. The share of FYM, machine labour,

Table 4.17 Cost of cultivation in sugarcane mono-cropping

(₹/ha)

Sl. No.	Particulars	CS-I (n=11)	
		Cost	Percentage
A	Variable cost		
1	Human labour	43,936.25	30.29
2	Bullock labour	5,920.25	4.08
3	Machine labour	10,858.68	7.48
4	Seeds/setts	18,562.34	12.79
5	FYM	15,680.23	10.81
6	Chemical fertilizers	16,132.18	11.12
7	Plant protection chemicals	1,658.87	1.14
8	Interest on working capital (7 %)	7,892.42	5.44
I	Sub-total	1,20,641.22	83.16
B	Fixed cost		
	Rental value of land	20,000	13.79
	Land revenue	30	0.02
	Depreciation	1,786.05	1.23
	Interest on fixed capital (12 %)	2,617.926	1.80
II	Sub total	24,433.98	16.84
Total cost of cultivation (I+II)		1,45,075.19	100.00

Note:- CS-I : Sugarcane mono-crop

Table 4.18 Cost of cultivation in sugarcane based intercropping systems

₹/ha)

Sl. No.	Particulars	CS-II (n=11)		CS-III (n=9)	
		Cost	Percentage	Cost	Percentage
A	Variable cost				
1	Human labour	48,516.27	30.99	51,256.41	32.02
2	Bullock labour	7,950.32	5.08	7,450.58	4.65
3	Machine labour	10,850.31	6.93	10,623.20	6.64
4	Seeds/setts	20,326.20	12.98	21,247.41	13.27
5	FYM	16,241.23	10.38	16,982.34	10.61
6	Chemical fertilizer	17,232.56	11.01	17,532.16	10.95
7	Plant protection chemical	1,225.34	0.78	1,351.23	0.84
8	Interest on working capital (7 %)	8,563.9561	5.47	8,851.0331	5.53
I	Sub-total	1,30,906.19	83.63	1,35,294.36	84.53
B	Fixed cost				
1	Rental value of land	20,000	12.78	20,000	12.50
2	Land revenue	30	0.02	30	0.02
3	Depreciation	2,856.18	1.82	2,083.15	1.30
4	Interest on fixed capital (12 %)	2,746.3416	1.75	2,653.578	1.66
II	Sub total	25,632.52	16.37	24,766.72	15.47
Total cost of cultivation (I+II)		1,56,538.71	100.00	1,60,061.09	100.00

Note:- CS-II : Sugarcane + Fodder maize
CS-III : Sugarcane + Soybean

bullock labour and plant protection chemicals was 10.61, 6.64, 4.65 and 0.84 per cent, respectively and interest on working capital was ₹8,851.03 accounting for 5.53 per cent.

On the other hand, the items included under fixed cost namely, rental value of land, land revenue, depreciation and the interest on fixed capital shares in the total cost of cultivation amounted to 12.50, 0.02, 1.30 and 1.66 per cent, respectively.

4.7.4 Cost of cultivation in CS-IV under alternate cropping systems

The details regarding per ha total cost under CS-IV (Turmeric-sole) were calculated and presented in Table 4.19 and Fig.4.

Results revealed that, per ha total cost of cultivation was ₹1,42,575.07, out of which 86.58 per cent was variable cost and remaining 13.42 per cent was fixed cost. The distribution pattern of variable cost on various inputs revealed that, Rhizome/seed cost shared the highest which was 28.42 per cent of the total cost followed by human labour which was 25.15 per cent and chemical fertilizers 9.02 per cent. The share of FYM, machine labour, bullock labour and plant protection chemicals was 7.15, 5.99, 4.31 and 0.88 per cent, respectively and interest on working capital was ₹8,075.42 accounting for 5.66 per cent.

On the other hand, the items included under fixed cost namely rental value of land, land revenue, depreciation and the interest on fixed capital shares in the total cost of cultivation amounted to 10.66, 0.02, 0.30 and 1.44 per cent, respectively.

4.7.5 Cost of cultivation in CS-V under alternate cropping systems to sugarcane

The average per ha cost incurred from CS-V (Maize + Chickpea + Groundnut) were calculated and presented in Table 4.19 and Fig.4.

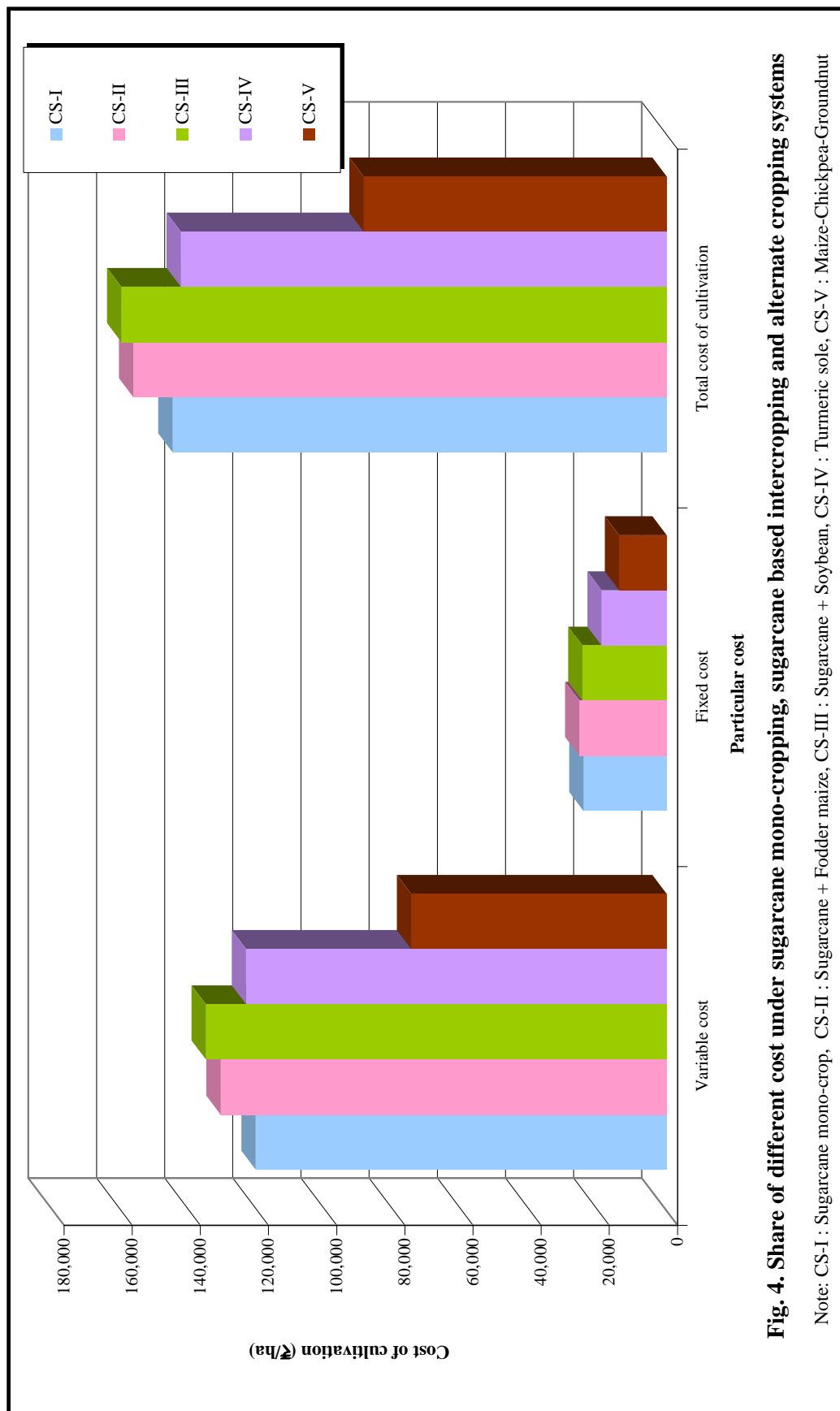
It was observed that, the total cost of cultivation was ₹88,966.06 per ha, out of which 84.30 per cent was variable cost and remaining 15.70 per cent was fixed cost. The distribution pattern of variable cost on various inputs revealed that, human labour shared the highest which was 26.00 per cent of the total cost followed by seeds cost which was 15.18 per cent. The share of chemical fertilizer, FYM and plant protection chemicals was 9.58, 7.67 and 1.26 per cent, respectively, and interest on working capital was ₹4,906.35 accounting for 5.51 per cent.

On the other hand, the items included under fixed cost namely rental value of land, land revenue, depreciation and the interest on fixed capital shares in the total cost of cultivation amounted to 12.14, 0.03, 1.85 and 1.68 per cent, respectively.

Table 4.19 Cost of cultivation in alternate cropping systems

(₹/ha)					
Sl. No.	Particulars	CS-IV (n=12)		CS-V (n=11)	
		Cost	Percentage	Cost	Percentage
A	Variable cost				
1	Human labour	35,853.54	25.15	23,131.12	26.00
2	Bullock labour	6,141.23	4.31	6,841.28	7.69
3	Machine labour	8,542.58	5.99	10,148.26	11.41
4	Rhizome/Seeds	40,520.23	28.42	13,504.70	15.18
5	FYM	10,193.12	7.15	6,819.26	7.67
6	Chemical fertilizer	12,856.25	9.02	8,523.12	9.58
7	Plant protection chemical	1,256.13	0.88	1,123.1	1.26
8	Interest on working capital (7 %)	8,075.42	5.66	4,906.35	5.51
I	Sub-total	1,23,438.50	86.58	74,997.19	84.30
B	Fixed cost				
1	Rental value of land	15,200	10.66	10,800	12.14
2	Land revenue	30	0.02	30	0.03
3	Depreciation	1,856.23	1.30	1,642.2	1.85
4	Interest on fixed capital (12 %)	2,050.34	1.44	1,496.66	1.68
II	Sub total	19,136.57	13.42	13,968.86	15.70
Total cost of cultivation (I+II)		1,42,575.07	100.00	88,966.06	100.00

Note:- CS-IV : Turmeric sole
 CS-V : Maize + Chickpea + Groundnut



4.8 Returns from sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

4.8.1 Returns from sugarcane mono-cropping and sugarcane based intercropping systems

The average yield level and net returns realized under CS-I (Sugarcane mono-crop), CS-II (Sugarcane + fodder maize) and CS-III (Sugarcane + soybean) are presented in Table 4.20 and 4.21 and Fig.5.

The results showed that per ha sugarcane yield was highest in case of CS-III (104.14 t/ha), followed by CS-II (98.63 t/ha) and least was found in the case of CS-I (86.56 t/ha) with an average market price of ₹ 2,310.23, ₹ 2,350.45 and ₹ 2,345.56 /t in case of CS-I, CS-II and CS-III, respectively.

With respect to the per ha sugarcane intercrop yield, it was found to be maximum in CS-III (soybean) of 14.25 q with an average market of ₹ 2,180 /q. In case of CS-II average by-product of fodder maize was 3.45 t/ha and the average market price was ₹ 900.00 /t. Where as in case of CS-III average by-product of soybean was 0.65 t/ha and the average market price was ₹ 400 /t.

The results pertaining to the per ha gross returns from different cropping systems indicated that higher gross return of ₹ 2,67,896.62 was realized in case of CS-III followed by CS-II of ₹ 2,34,929.88 and least was found in case of CS-I of ₹ 19,9973.51.

The corresponding per ha net return was found to be highest in case of CS-III (₹ 10,7835.53), followed by CS-II (₹ 78,391.17) and CS-I (₹ 54,898.32). The B:C ratio was found to be highest in case of CS-III (1.67) followed by CS-II (1.48) and CS-I (1.38).

4.8.2 Returns from alternate cropping systems

The average yield level and net returns under CS-IV (Turmeric-sole) and CS-V (Maize – chickpea- groundnut) are presented in Table 4.22 and Fig.5.

The results showed that in case of CS-IV per ha turmeric yield was 39.63 q, in case of CS-V maize yield under *kharif* season, chickpea yield under *rabi* season and groundnut yield under summer season was 46.25, 11.25 and 10.53 q, respectively and average market price of turmeric, maize, chickpea and groundnut was ₹ 7,136.23, ₹ 1,220.23, ₹ 5,136.21 and ₹ 5,121.11 /q, respectively.

Table 4.20 Returns from sugarcane mono-cropping

Sl. No.	Particulars	Units	CS-I
I	Yield		
1	Main product		
a.	Sugarcane	t/ha	86.56
2	By product	t/ha	-
II	Market price		
1	Main product		
a.	Sugarcane*	₹/t	2310.23
b.	Intercrop	₹/t	-
2	By product	₹/t	-
III	Gross returns	₹/ha	1,99,973.51
IV	Total cost	₹/ha	1,45,075.19
V	Net return	₹/ha	54,898.32
VI	B:C Ratio	-	1.38

*Procurement price of sugar factory

Note:- CS-I : Sugarcane mono-crop

Table 4.21 Returns from sugarcane based intercropping systems

Sl. No.	Particulars	Units	CS-II (n=11)	CS-III (n=9)
I	Yield			
1	Main product			
a.	Sugarcane	t/ha	98.63	104.14
b.	Intercrop	t/ha	-	10.25
2	By product	t/ha	3.45	0.65
II	Market price			
1	Main product			
a.	Sugarcane*	₹/t	2,350.45	2,345.56
b.	Intercrop	₹/t		2,280.00
2	By product	₹/ha	900.00	400.00
III	Gross returns	₹/ha	2,34,929.88	2,67,896.62
IV	Total cost	₹/ha	1,56,538.71	1,60,061.09
V	Net return	₹/ha	78,391.17	1,07,835.53
VI	B:C Ratio	-	1.50	1.67

*Procurement price of sugar factory

Note:- CS-II : Sugarcane + Fodder maize

CS-III : Sugarcane + Soybean

The results pertaining to the per ha gross returns was found to be highest in case of CS-IV (₹2,82,773.11) followed by CS-V (₹1,71,252.68). The corresponding per ha net return was found to be highest in CS-IV (₹1,40,198.04) followed by CS-V (₹84,793.06). The returns per rupee expenditure were highest in case of CS-IV (1.98) followed by CS-V (1.92).

4.8.3 Comparative costs and returns structures under sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

The total cost incurred, gross returns generated and net returns realized in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems were computed and presented in Table 4.23 and Fig.5. The maximum total cost per ha was observed in case of CS-III (₹1,60,061.09) and least cost in case of CS-V (₹88,966.06). The share of total variable cost in total cost was found to be the highest in case of CS-IV (86.58%) followed by CS-III (84.53 %), CS-V (84.30 %), CS-II (83.63 %) and CS-I (83.16 %). Whereas, the share of total fixed cost in the total cost was found to be the highest in case of CS-I (16.84 %) followed by CS-II (16.37 %) and least was in case of CS-IV (13.42 %). The gross returns were found to be highest in the case of CS-IV (₹2,82,773.11), followed by CS-III (₹2,67,896.62), CS-II (₹2,34,929.88), CS-I (₹1,99,973.51) and CS-V (₹1,71,252.68)

With respect to the net returns per ha, the net returns over total variable cost and total cost were found to be the highest in case of CS-IV (₹1,40,198.04) followed by CS-III (₹1,07,835.52), CS-V (₹84,793.06), CS-II (₹78,391.17) and CS-I (₹54,898.31). The B:C ratio was found to be highest in case of CS-IV (1.98) followed by CS-V (1.92), CS-III (1.67), CS-II (1.50) and CS-I (1.38).

4.9 Resource use efficiency in sugarcane mono-cropping and sugarcane based intercropping and alternate cropping systems

4.9.1 Resource use efficiency in CS-I under sugarcane mono-cropping

The estimated production function fitted to the data for CS-I are presented in Table 4.24. From the results, it was found that, the regression co-efficient of all resources used by the farmers were positive, except for chemical fertilizers (-0.074) and human labour (-0.013). In this system, the output elasticity of irrigation (0.294) was found to be significant at one per cent level. The output elasticity of FYM (0.147) and human labour (-0.013) was statistically significant at five per cent level.

Table 4.22 Returns from alternate cropping systems

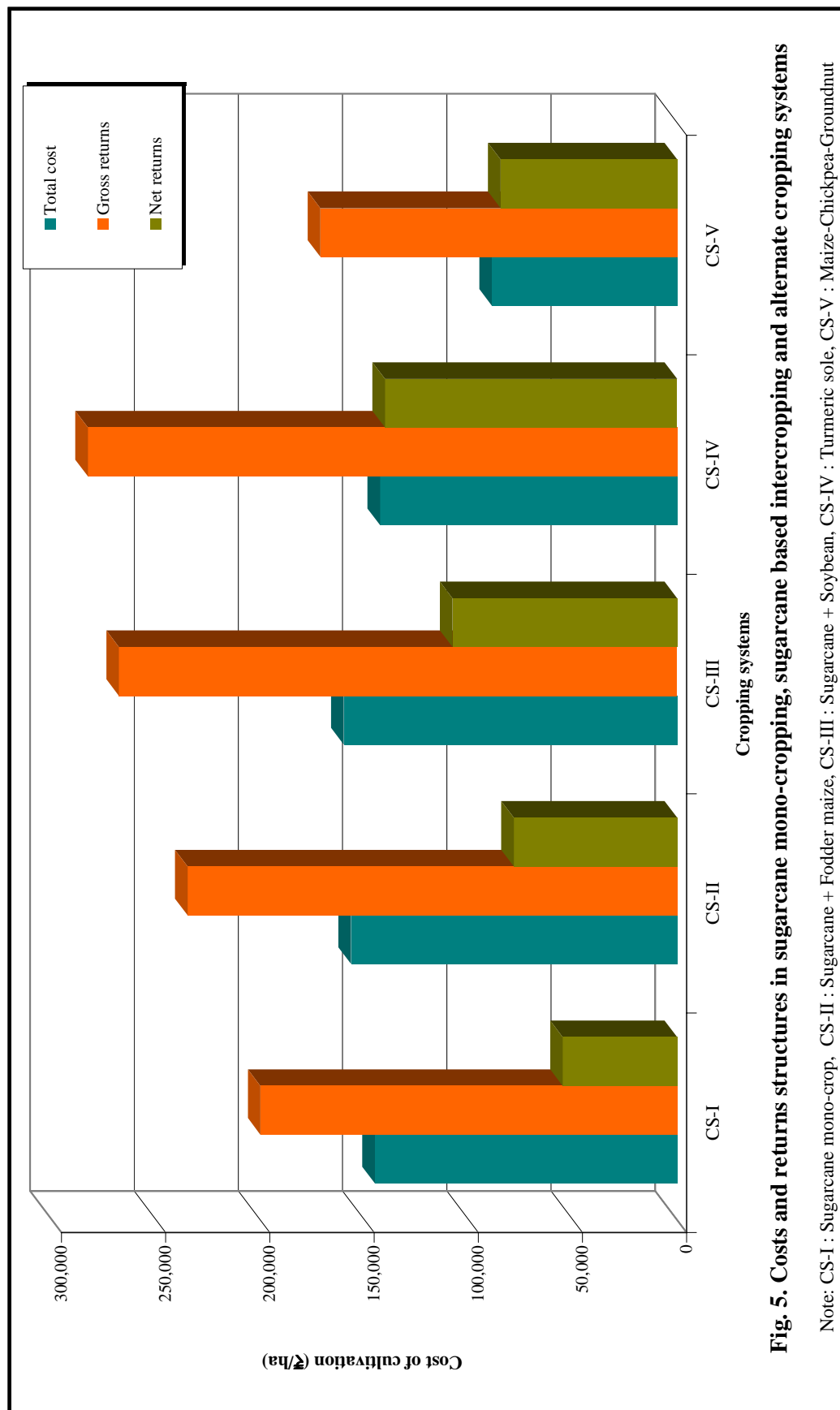
Sl. No.	Particulars	Units	CS-IV (n=12)	CS-V (n=11)
I	Yield			
1	Main product			
	a. Turmeric	q/ha	39.63	-
	b. Maize	q/ha	-	46.25
	c. Chickpea	q/ha	-	11.25
	d. Groundnut	q/ha	-	10.53
2	By product	t/ha	-	2.85
II	Market price			
1	Main product			
	a. Turmeric	₹/q	7,136.23	
	b. Maize	₹/q		1,220.23
	c. Chickpea	₹/q		5,136.21
	d. Groundnut	₹/q		5,121.11
2	By product	₹/t	-	1,100.00
III	Gross returns	₹/ha	2,82,773.11	1,71,252.68
IV	Total cost	₹/ha	1,42,575.07	88,966.06
V	Net return	₹/ha	1,40,198.04	84,793.06
VI	B:C ratio	-	1.98	1.92

Note:- CS-IV : Turmeric sole
CS-V : Maize + Chickpea + Groundnut

Table 4.23 Comparative costs and returns structures under sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

Sl. No.	Particulars	CS-I	CS-II	CS-III	CS-IV	CS-V
A	Costs					
1	Total variable cost	1,20,641.22	1,30,906.19	1,35,294.36	1,27,718.50	75,104.19
2	Total fixed cost	24,433.98	25,632.52	24,766.73	19,136.57	13,968.86
3	Total cost	1,45,075.19	1,56,538.71	1,60,061.09	1,42,575.07	88,966.06
B	Returns					
1	Gross returns	1,99,973.51	2,34,929.88	2,67,896.62	2,82,773.11	1,71,252.68
2	Net returns	54,898.31	78,391.17	1,07,835.52	1,40,198.04	84,793.06
3	B:C Ratio	1.38	1.50	1.67	1.98	1.92

Note:- CS-I : Sugarcane mono-crop
 CS-II : Sugarcane + Fodder maize
 CS-III : Sugarcane + Soybean
 CS-IV : Turmeric sole
 CS-V : Maize-Chickpea-Groundnut



The output elasticity of setts (0.059), chemical fertilizer (-0.074), plant protection chemicals (0.065), machine labour (0.016) and bullock labour (0.179) were found to be non-significant.

The co-efficient of multiple determination (R²) for CS-I was 0.88. This indicated that the variables included in the function explained 88 per cent of the variation in the gross returns from CS-I.

4.9.2 Resource use efficiency in CS-II under sugarcane based intercropping systems

The estimated production function fitted to the data for CS-II are presented in Table 4.24. From the results it was found that, the regression co-efficient of all resources used by the farmers were positive, except for plant protection chemicals (-0.055). Under this system the output elasticity of setts/seeds (0.494) was statistically significant at one per cent level. The output elasticity of chemical fertilizer (0.113) and bullock labour (0.028) were found to be significant at five per cent level and for all others, the resource coefficients were non-significant.

The co-efficient of multiple determination (R²) for CS-II was 0.90 indicating good fit of the model.

4.9.3 Resource use efficiency in CS-III under sugarcane based intercropping systems

The estimated production function fitted to the data for CS-III are presented in Table 4.24. From the results, it was found that the regression co-efficient of all resources used by the farmers were positive except for bullock labour (-0.053). In this system, the output elasticity of human labour (0.699) was significant at one per cent level. The output elasticity of setts/seeds (0.135) and irrigation (0.354) were significant at five per cent level and for all others, the resource coefficients were non-significant.

The co-efficient of multiple determinations (R²) was 0.89 indicating good fit of the model.

4.9.4 Resource use efficiency in CS-IV under alternate cropping systems

The estimated production functions fitted to the data for CS-IV are presented in Table 4.24. From the results, it was found that the regression co-efficient of all resources used by the

Table 4.24 Resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

Sl. No.	Particulars	Parameter	Sugarcane mono-cropping	Sugarcane based intercropping		Alternate cropping systems	
			CS-I (n=60)	CS-II (n=11)	CS-III (n=9)	CS-IV (n=12)	CS-V (n=11)
1	Intercept	A	5.741	3.457	7.087	6.254	8.254
2	Setts / Seeds/ Rhizome	X ₁	0.059	0.494***	0.135**	0.748***	0.299**
3	FYM	X ₂	0.147**	0.347	0.268	0.269**	0.084
4	Chemical fertilizers	X ₃	-0.074	0.113**	0.169	0.073	-0.041
5	Plant protection chemicals	X ₄	0.065	-0.055	0.058	0.031	0.061
6	Human labour	X ₅	-0.013**	0.352	0.699***	0.533***	0.145
7	Bullock labour	X ₆	0.179	0.028**	-0.053	-0.029	0.131
8	Machine labour	X ₇	0.016	0.024	0.121	0.069	0.321***
9	Irrigation	X ₈	0.294***	0.446	0.354**	0.217**	0.168
Coefficient of multiple determination (R ²)			0.883	0.904	0.891	0.884	0.871

Note: *** Significant at 1 % level

** Significant at 5 % level

CS-I : Sugarcane mono-crop

CS-II : Sugarcane + Fodder maize

CS-III : Sugarcane + Soybean

CS-IV : Turmeric sole

CS-V : Maize-Chickpea-Groundnut

farmers were positive except for bullock labour (-0.029). In this system, the output elasticity of rhizome (0.748) and human labour (0.533) were found to be significant at one per cent level. The output elasticity of FYM (0.269) and irrigation (0.217) were statistically significant at five per cent level and for all others the resource coefficients were non-significant.

The co-efficient of multiple determinations (R²) was 0.88 indicating good fit of the model.

4.9.5 Resource use efficiency in CS-V under alternate cropping systems

The estimated production function fitted to the data for CS-V are presented in Table 4.24. From the results, it was found that the regression co-efficient of all resources used by the farmers were positive, except for chemical fertilizers (-0.041). Under this system, the output elasticity of machine labour (0.321) was significant at one per cent level. The output elasticity of seeds (0.299) was significant at five per cent level and for all others the resource coefficients were non-significant.

The co-efficient of multiple determinations (R²) was 0.87 indicating good fit of the model.

4.10 Allocative efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

4.10.1 Allocative efficiency in CS-I under sugarcane mono-cropping

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratios of resources in CS-I are presented in Table 4.25.

The ratio of MVP to MFC was greater than unity for FYM (2.58), bullock labour (2.89) and machine labour (4.19). The MVP to MFC ratio shows negative values for the resource chemical fertilizers (-0.89) and the ratio of MVP to MFC was less than unity for setts (0.51), plant protection chemicals (0.58), human labour (0.81) and irrigation (0.79).

4.10.2 Allocative efficiency in CS-II under sugarcane based intercropping systems

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratios of resources in CS-II are presented in Table 4.25.

Table 4.25 Allocative efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

Sl. No.	Particulars	MVP/MFC				
		Sugarcane mono-cropping	Sugarcane based intercropping systems		Alternate cropping systems	
		CS-I (n=60)	CS-II (n=11)	CS-III (n=12)	CS-IV (n=12)	CS-V (n=11)
1	Seedlings / Setts	0.51	6.24	4.13	9.76	3.80
2	FYM	2.58	3.25	2.19	4.23	1.72
3	Chemical fertilizer	-0.89	0.09	0.81	0.14	-0.29
4	Plant protection chemicals	0.58	-0.45	0.74	0.61	1.43
5	Human labour	0.81	5.81	8.94	6.13	2.19
6	Bullock labour	2.89	0.92	-0.61	-0.34	2.42
7	Machine labour	4.19	-0.29	2.56	1.29	0.13
8	Irrigation	0.79	0.31	1.16	4.59	2.16

Note:- CS-I : Sugarcane mono-crop
 CS-II : Sugarcane + Fodder maize
 CS-III : Sugarcane + Soybean
 CS-IV : Turmeric sole
 CS-V : Maize-Chickpea-Groundnut

The ratio of MVP to MFC was greater than unity for setts/seeds (6.24), FYM (3.25) and human labour (5.81). The MVP to MFC ratio shows negative values for the resources like plant protection chemicals (-0.45) and machine labour (-0.29) and the MVP to MFC ratio was less than unity for chemical fertilizers (0.09), plant protection chemicals (-0.45), bullock labour (0.92), machine labour (-0.29) and irrigation (0.31).

4.10.3 Allocative efficiency in CS-III under sugarcane based intercropping systems

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratios of resources in CS-III are presented in Table 4.25.

The ratio of MVP to MFC was greater than unity for setts/seeds (4.13), FYM (2.19), human labour (8.94) and machine labour (2.56). The ratio of MVP to MFC shows less than unity for chemical fertilizers (0.81), plant protection chemicals (0.74) and irrigation (0.19).

4.10.4 Allocative efficiency in CS-IV under alternate cropping systems

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratios of resources in CS-IV are presented in Table 4.25.

The ratio of MVP to MFC was greater than unity for rhizome (9.76), FYM (4.23), human labour (6.13), machine labour (1.29) and irrigation (4.59). The ratio of MVP to MFC was negative for bullock labour (-0.34) and the MVP to MFC ratio was less than unity for chemical fertilizers (0.14) and plant protection chemicals (0.61).

4.10.5 Allocative efficiency in CS-V under alternate cropping systems

The Marginal Value Product (MVP) to Marginal Factor Cost (MFC) ratios of resources in CS-V are presented in Table 4.25.

The ratio of MVP to MFC was greater than unity for inputs such as seeds (3.80), FYM (1.72), plant protection chemicals (1.43), human labour (2.19), bullock labour (2.42) and irrigation (2.16). The MVP to MFC ratio shows negative values for chemical fertilizers (-0.29) and the MVP to MFC ratio was less than unity for machine labour (0.13).

4.11 Constraints faced by sample respondents in sugarcane mono-cropping, sugarcane based intercropping systems

The problems associated with farmers under different cropping systems in the study area (Table 4.26) have been depicted under the sub-headings of production constraints, financial constraints and marketing constraints.

4.11.1 Production constraints

In the case of CS-I, it was observed that lower yield ranked I, which recorded a mean score of 86.99 followed by excess and injudicious use of water(II), high soil salinity(III), high wage rate (IV), low soil salinity (V), high insect and pest incidence (VI), non-availability of labour (VII), non-availability of inputs like quality seeds/setts(VIII), limited and irregular power supply (IX) and lack of adoption of modern technology (X) with mean scores of 84.03, 72.12, 68.03, 55.71, 42.29, 39.03, 31.15, 28.27 and 19.16, respectively.

In the case of CS-II, it is observed that uncertainty of rains ranked I, which recorded a mean score of 91.69 followed by non-availability of water for irrigation(II), high soil salinity(III), high wage rate (IV), low soil salinity (V), high insect and pest incidence (VI), non-availability of labour (VII), non-availability of inputs like quality seeds/setts(VIII), limited and irregular power supply (IX) and lack of adoption of modern technology (X) with mean scores of 86.64, 81.12, 79.16, 64.15, 56.13, 46.23, 34.09, 30.29 and 29.17, respectively.

In the case of CS-III, it was observed that uncertainty of rains ranked I, which recorded a mean score of 85.26 followed by non-availability of water for irrigation(II), high soil salinity(III), high wage rate (IV), low soil salinity (V), high insect and pest incidence (VI), non-availability of labour (VII), non-availability of inputs like quality seeds/setts(VIII), limited and irregular power supply (IX) and lack of adoption of modern technology (X) with mean scores of 80.12, 76.15, 70.12, 66.58, 59.41, 44.27, 39.48, 28.16 and 21.28, respectively.

4.11.2 Financial constraints

In the case of CS-I, it was observed that non-availability of timely credit ranked I, which recorded a mean score of 81.82 followed by high cost of cultivation (II), delay in getting credit (III) and high rate of interest (IV) with mean scores of 76.17, 64.87 and 46.12, respectively.

In the case of CS-II, it was observed that non-availability of timely credit ranked I, which recorded a mean score of 84.19 followed by high cost of cultivation (II) and delay in getting credit (III) with mean scores 69.19 and 41.19.

In the case of CS-III, it was observed that non-availability of timely credit ranked I, which recorded a mean score of 80.39 followed by high cost of cultivation (II), delay in

Table 4.26 Constraints faced by sample respondents in sugarcane based cropping systems

Sl. No.	Particulars	Sugarcane mono-cropping		Sugarcane based intercropping systems			
		CS-I (n=60)		CS-II (n=11)		CS-III (n=9)	
		Garett score	Rank	Garrett score	Rank	Garett score	Rank
a)	Production constraints						
1	Lower yield	86.99	I	91.69	I	85.26	I
2	Excess and injudicious use of water	84.03	II	86.64	VIII	80.12	VIII
3	High soil salinity	72.12	III	81.12	II	76.15	II
4	High wage rate	68.03	IV	79.16	IV	70.12	IV
5	Low soil fertility	55.71	VII	64.15	VII	66.58	VII
6	High insect and pest incidence	42.29	IX	56.13	IX	59.41	IX
7	Non-availability of labour	39.03	III	46.23	III	44.27	III
8	Non-availability of inputs like quality seeds/sets	31.15	V	34.09	V	39.48	V
9	Limited and irregular power supply	28.27	VI	30.29	VI	28.16	VI
10	Lack of adoption modern technology	19.16	X	29.17	X	21.28	X
b)	Financial constraints						
1	Non-availability of timely credit	81.82	I	84.19	I	80.39	I
2	High cost of cultivation	76.17	II	69.19	II	71.19	II
3	Delay in getting credit	64.87	III	41.19	III	56.03	III
4	High rate of interest	46.12	IV	39.16	IV	40.19	IV
c)	Marketing constraints						
1	Lack of market information	78.19	I	82.13	I	84.13	I
2	Price-fluctuations	70.09	II	76.74	II	75.13	II
3	Lack of crop-cutting order from sugar factory	65.12	III	51.23	III	63.19	III
4	Delay in payment	41.12	IV	45.14	IV	42.19	IV

Note:- CS-I : Sugarcane mono-crop
CS-III : Sugarcane + Soybean

CS-II : Sugarcane + Fodder maize

getting credit (III) and high rate of interest (IV) with mean scores 71.19, 56.03 and 40.19, respectively.

4.11.3 Marketing constraints

In the case of CS-I, it was observed that lack of market information ranked I, which recorded a mean score of 78.19 followed by price -fluctuations (II), lack of crop-cutting under from sugar factory (III) and delay in payment (IV) with mean scores of 70.09, 65.12 and 41.12, respectively.

In the case of CS-II, it was observed that, lack of market information ranked I, which recorded a mean score of 82.13 followed by price -fluctuations (II), lack of crop-cutting under from sugar factory (III) and delay in payment (IV) with mean scores of 76.74, 51.23 and 45.14, respectively.

In the case of CS-III, it was observed that lack of market information ranked I, which recorded a mean score of 84.13 followed by price -fluctuations (II), lack of crop-cutting under from sugar factory (III) and delay in payment (IV) with mean scores of 75.13, 63.19 and 42.19, respectively.

4.12 Constraints faced by sample respondents in alternate cropping systems

The constraints associated with different cropping systems in the study area are grouped under three heads, namely, production constraints, financial constraints and marketing constraints and depicted in Table 4.27.

4.12.1 Production constraints

In the case of CS-IV, it was observed that Delay in onset of monsoon ranked I, which recorded a mean score of 86.12 followed by uncertainty of rains (II), non-availability of water for irrigation (III), high wage rate (IV), non-availability of inputs like quality seeds (V), high insect and pest incidence (VI), low soil fertility (VII) and non-availability of labour (VIII) with mean scores of 79.19, 75.19, 66.27, 53.84, 45.62, 39.19 and 30.15, respectively.

In the case of CS-V, it was observed that delay in onset of monsoon ranked I, which recorded a mean score of 81.79 followed by uncertainty of rains (II), non-availability of water for irrigation (III), high wage rate (IV), non-availability of inputs like quality seeds (V), high insect and pest incidence (VI), low soil fertility (VII) and non-availability of labour (VIII) with mean scores of 76.19, 71.25, 65.19, 61.98, 54.13, 42.53 and 36.47, respectively.

Table 4.27 Constraints faced by sample respondents in Alternate cropping systems

Sl. No.	Particulars	Alternate cropping systems to sugarcane			
		CS-IV (n=12)		CS-V (n=11)	
		Garettte score	Rank	Garettte score	Rank
a)	Production constraints				
1	Delay in onset of monsoon	86.12	I	81.79	I
2	Uncertainty of rains	79.19	II	76.19	II
3	Non availability of water for irrigation	75.19	III	71.25	III
4	High wage rate	66.27	IV	65.19	IV
5	Non-availability of inputs like quality seeds	53.84	V	61.98	V
6	High insect incidence	45.62	VI	54.13	VI
7	Low soil fertility	39.19	VII	42.53	VII
8	Non-availability of labour	30.15	VIII	36.47	VIII
b)	Financial constraints				
1	High cost of cultivation	75.15	I	81.36	I
2	Non-availability of timely credit	69.79	II	75.95	II
3	High rate of interest	54.61	III	54.89	III
4	Delay in getting credit	35.48	IV	41.23	IV
c)	Marketing constraints				
1	Non-availability of market information	85.19	I	81.69	I
2	Price-fluctuations	74.23	II	76.13	II
3	Faulty weighment	66.75	III	68.12	III
4	Lack of storage facility	55.74	IV	59.63	IV
5	Low price in local market	45.08	V	51.23	V
6	Lack of transport facility	35.19	VI	36.19	VI
7	High cost of transportation	21.50	VII	19.10	VII

Note: CS-IV: Turmeric sole CS-V: Maize-Chickpea-Groundnut

4.12.2 Financial constraints

In the case of CS-IV, it was observed that high cost of cultivation ranked I , which recorded a mean score of 75.15 followed by non-availability of timely credit (II), high rate of interest (III) and delay in getting credit (IV) with mean scores of 69.79, 54.61 and 35.48, respectively.

In the case of CS-V, it was observed that high cost of cultivation ranked I, which recorded a mean score of 81.36 followed by non-availability of timely credit (II), high rate of interest (III) and delay in getting credit (IV) with mean scores of 75.95, 54.89 and 41.23, respectively.

4.12.3 Marketing constraints

In the case of CS-IV, it was observed that non-availability of market information ranked I, which recorded a mean score of 85.19 followed by price-fluctuations (II), faulty weighment (III), lack of storage facility (IV), low price in local market (V), lack of transport facility (VI) and high cost of transportation (VII) with mean scores of 74.23, 66.75, 55.74, 45.08, 35.19 and 21.50, respectively.

In the case of CS-V, it was observed that non-availability of market information ranked I which recorded a mean score of 81.69 followed by price-fluctuations (II), faulty weighment (III), lack of storage facility (IV), low price in local market (V), lack of transport facility (VI) and high cost of transportation (VII) with mean scores of 76.13, 68.12, 59.63, 51.23, 36.19 and 19.10, respectively.

Discussion

5. DISCUSSION

The present chapter elaborates the results of the investigation presented in the results chapter. Keeping the objectives of the study in view, the results are discussed under the following heads.

- 5.1 Socio-economic profile of Sample respondents in the study area
- 5.2 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems of sample farmers in the study area
- 5.3 Cropping pattern followed by the sample farmers in sugarcane mono-cropping, sugarcane based intercropping systems
- 5.4 Cropping pattern followed by the sample farmers in alternate cropping systems
- 5.5 Operation wise labour utilisation pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 5.6 Input utilization pattern in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 5.7 Cost of cultivation in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 5.8 Returns from sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 5.9 Resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 5.10 Allocative efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems
- 5.11 Constraints faced by sample respondents in sugarcane mono-cropping, sugarcane based intercropping systems
- 5.12 Constraints faced by sample respondents in alternate cropping systems

5.1 Socio-economic profile of the sample respondents

Age, education level, family size, family type and occupational pattern were the variables considered to assess the socio-economic status of the sample respondents (Table 4.1).

With respect to the age of the sample farmers, it was observed that most of the sample farmers were of middle age group in all the cropping systems. The probable reason for this

might be in a position to that the middle aged men shares responsibility of family and think of improving economic status of the family. Moreover, he has the experience in these activities and he can manage better than any other family members (Savitha, 2004).

With regard to education level of the sample respondents, it was noticed that on an average 15 per cent of the farmers were illiterate. Among literates, education level of sample respondents ranged from primary to college level. There was a higher literacy level in the study area.

The family composition of sample farmers revealed that, the proportion of adult per family was high in all the cropping systems, followed by the proportion of female and children in the family composition.

Occupational pattern of the sample respondents revealed that, the main occupation of them was agriculture in all cropping systems. The pattern of land holding revealed that 80 per cent farmers land was under irrigated condition.

5.2 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems of sample farmers in the study area

In the study area, 60 farmers were following sugarcane mono-cropping, 30 farmers each were following sugarcane based intercropping systems and alternate cropping systems. Among the different cropping systems (Table 4.2), two major cropping systems were observed in sugarcane based intercropping and alternate cropping systems and were practiced by 66.67 and 76.67 per cent of the farmers, respectively. Among the two major sugarcane based intercropping systems, 36.67 per cent of sample farmers growing sugarcane + fodder maize intercrop and 30.00 per cent of sample farmers growing sugarcane + soybean intercrop. In alternate cropping systems, among the two major cropping systems 40.00 per cent of sample farmers growing turmeric sole and 36.67 per cent of sample farmers growing maize-chickpea-ground nut in *kharif*, *rabi* and summer season, respectively. These cropping systems showed the diversification nature of farmers in the study area. They had components of commercial crops, spices and field crops.

5.2.1 Average farm size and source of irrigation in the identified sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

It can be observed (Table 4.4) from results that, the larger farm size was observed in case of CS-I (4.05 ha) followed by CS-II (3.52 ha), CS-III (3.39 ha), CS-IV (3.48 ha) and CS-

V (2.98 ha). Major source of irrigation observed (Table 4.5) in the study area were canal (36.67 %) followed by lift irrigation (33.33 %) and bore well irrigation (30.00 %).

5.3 Cropping pattern followed in sugarcane mono-cropping, sugarcane based intercropping systems in study area

5.3.1 Cropping pattern of sugarcane mono-cropping farmers (CS-I)

For identifying the cropping pattern practised by the sample farmers under sugarcane mono-cropping in the study area, the crops were divided into *kharif*, *rabi* and summer crops.

It could be observed (Table 4.6) that, most commonly grown crops in the study area were sugarcane followed by maize, soybean, cotton, green gram, turmeric and cabbage.

The area under sugarcane was continued to be the same in *rabi* season, as sugarcane is perennial crop followed by chickpea, wheat and sorghum.

The area under sugarcane was continued to be same in summer season, followed by maize and tomato + chilli. The cropping intensity found to be high (241.98) in the study area. It is because of majority of the sample farmers concentrates much on cultivation of sugarcane sole crop in all the seasons, due to congenial climate and other facilities like irrigation for sugarcane in the study area.

Sugarcane provides considerable scope for intercropping with short duration crops. It was concluded that intercropping of sugarcane having higher cane productivity as compared to sole sugarcane crop and also provides additional mid-season income to the sugarcane producing farmers.

5.2.2 Cropping pattern of sugarcane based intercropping systems farmers (CS-II)

For identifying the sugarcane based intercropping systems practiced by the farmers in the study area, the crops were divided into *kharif*, *rabi* and summer crops. It could be observed (Table 4.7) that most commonly practised intercrops in the study area were sugarcane + maize intercrop followed by maize, soybean, cotton, green gram, turmeric and cabbage.

The area under sugarcane was continued to be the same in *rabi* season, as sugarcane is perennial crop followed by chickpea, wheat and sorghum.

The area under sugarcane was continued to be same in summer season, followed by maize and tomato + chilli. The cropping intensity found to be (231.98) in the study area as sugarcane is commercial crop and bestowed with irrigation facility around the year.

Sugarcane provides considerable scope for intercropping with short duration crops. It was concluded that intercropping of sugarcane having higher cane productivity as compared to sole sugarcane crop and also provides additional mid-season income to the sugarcane producing farmers.

5.2.3 Cropping pattern of sugarcane based intercropping systems farmers (CS-III)

It can be observed from Table 4.8 that, majority of sample farmers had grown sugarcane + soybean intercrop in the study area. Most commonly observed pattern in the study area in *kharif* season was sugarcane + soybean intercrop followed by maize, soybean, cotton, green gram, turmeric and cabbage.

The area under sugarcane was continued to be the same in *rabi* season, as sugarcane is perennial crop followed by chickpea, wheat and sorghum.

The area under sugarcane was continued to be same in summer season, followed by maize and tomato + chilli. With respect to cropping intensity it was found to be (244.25) in the study area as sugarcane is commercial crop and bestowed with irrigation facility around the year.

Sugarcane provides considerable scope for intercropping with short duration crops. It was concluded that intercropping of sugarcane having higher cane productivity as compared to sole sugarcane crop and also provides additional mid-season income to the sugarcane producing farmer.

5.4 Cropping pattern followed by the sample farmers in alternate cropping systems

5.4.1 Cropping pattern of alternate cropping systems farmers (CS-IV)

It can be observed from Table 4.9 that, majority of sample farmers had grown turmeric-sole as well as other crops in the study area. Most commonly observed pattern in the study area in *kharif* season was turmeric-sole followed by maize, soybean, cotton + chilli, maize + mustard and tomato + chilli.

The area under turmeric was continued to be the same in *rabi* season, followed by chickpea, wheat and sorghum.

The area under turmeric was continued to be same in summer season, followed by maize, groundnut and tomato + brinjal. With respect to cropping intensity it was found to be high (247.13) in the study area as it was bestowed with irrigation facility around the year.

5.4.2 Cropping pattern of alternate cropping systems farmers (CS-V)

It can be observed from (Table 4.10) from results that, Most commonly observed pattern in the study area was maize followed by soybean, cotton + chilli, maize + mustard and tomato + chilli.

In *rabi* season, observed pattern was chickpea followed by wheat, sorghum, wheat + safflower, chickpea + sorghum.

In summer season, observed pattern was groundnut followed by maize, groundnut + cowpea and chilli + coriander. With respect to cropping intensity it was found to be (268.12) in the study area as it was bestowed with irrigation facility around the year.

5.5 Operation wise labour utilisation pattern in sugarcane, sugarcane based intercropping and alternate cropping systems

5.5.1 Operation wise labour utilisation pattern in CS-I under sugarcane mono-cropping

The table 4.11 revealed that, in case of CS-I, about 3.25, 3.26 and 3.46 hr of machine labour were used for ploughing, transportation of farmyard manure and harrowing respectively. The highest pd of bullock labour was used for inter-cultivation (2.25 pd), followed by sett bed preparation (2.12 pd). Among the human labour used for different operations, the highest human labour was used for irrigation (68.35 md) followed by weeding (44.05 md), harvesting (37.50 md), planting (21.15 md), fertiliser application (9.08 md), transporting of farmyard manure (6.08 md), sett bed preparation (3.34 md), application of plant protection chemicals (4.12 md), harrowing (3.8 md), spreading of farmyard manure (3.45 md), ploughing (3.20 md) and inter cultivation (2.90 md).

5.5.2 Operation wise labour utilisation pattern in CS-II under sugarcane based intercropping systems

The table 4.12 showed that, in case of CS-II, about 3.60, 3.48 and 2.51 hr of machine labour were used for ploughing, harrowing and transportation of farmyard manure, respectively. The highest bullock labour was used for sowing operation (2.86 pd) followed by inter-cultivation (2.39 pd) and set bed preparation (2.59 pd). Among the human labour used

for different operations, the highest human labour was used for irrigation (74.13 md) followed by harvesting (46.73 md), weeding (40.20 md), planting and sowing (26.75 md), fertiliser application (10.36 md), transportation of farmyard manure (6.95 md), sett bed preparation (4.86 md), application of plant protection chemicals (3.42 md), ploughing (3.45 md), spreading of farmyard manure (2.55 md) harrowing (2.39 md) and inter-cultivation (2.24 md).

5.5.3 Operation wise labour utilisation pattern in CS-III under sugarcane based intercropping systems

It was observed (Table 4.12) from results that, in case of CS-III, about 3.20, 3.69 and 2.42 hr of machine labour were used for ploughing, transportation of farmyard manure and harrowing, respectively. The highest bullock labour was used for sowing operation (2.84 pd) followed by inter cultivation (2.24 pd) and set bed preparation (2.14 pd). Among the human labour used for different operations, the highest human labour was used for irrigation (78.69 md) followed by harvesting (51.70 md), weeding (42.95 md), planting and sowing (28.60 md), fertiliser application (9.49 md), transportation of farmyard manure (6.33 md), application of plant protection chemicals (3.29 md), set bed preparation (5.49 md), ploughing(3.66 md), spreading of farmyard manure (2.43 md), harrowing (2.39 md) and inter-cultivation (2.18 md).

5.5.4 Operation wise labour utilisation pattern in CS-IV under alternate cropping systems

The results given in Table 4.13 showed that, in case of CS-IV, about 3.15, 2.81 and 2.26 hr of machine labour were used for ploughing, transportation of farmyard manure and harrowing, respectively. The highest bullock labour was used for inter cultivation (3.62 pd), followed by ploughing (1.52 pd). Among the human labour used for different operations, the highest human labour was used for irrigation (51.25 md) followed by harvesting (38.25 md),weeding (30.95 md), planting (26.69 md), fertiliser application (7.58 md), transportation of farmyard manure (5.20 md), spreading of farmyard manure (4.28 md), rhizome treatment (3.48 md), application of plant protection chemicals (3.39 md), inter cultivation (2.90 md), ploughing (2.57 md) and harrowing (2.31 md).

5.5.5 Operation wise labour utilisation pattern in CS-V under alternate cropping systems

It was observed (Table 4.13) from results that, in case of CS-V, about 3.88, 3.28 and 2.67 hr of machine labour were used for ploughing, harrowing and transportation of farmyard

manure, respectively. The highest bullock labour was used for sowing operation (3.87 pd), followed by inter cultivation (2.59 pd). Among the human labour used for different operations, the highest human labour was used for harvesting (34.25 md) followed by planting (24.23 md), weeding (21.58 md), irrigation (15.25 md), fertiliser application (10.38 md), transportation of farmyard manure (6.89 md), application of plant protection chemicals (7.88 md), ploughing (4.59 md), harrowing (4.35 md), seed treatment (3.20 md), spreading of farmyard manure (3.31 md) inter cultivation (3.16 md) and application of plant protection chemicals (2.88 md).

It was observed that, among the five cropping systems, total human labour engaged per ha was highest in case of CS-III(237.20 md) followed by CS-II, CS-I, CS-IV and CS-V with human labour of 224.03, 207.02, 178.85 and 149.06 md, respectively. Due to the large amount of human labour required for hand weeding, harvesting and irrigation. Utilization of bullock labour was highest in case of CS-II (7.84 pd) followed by CS-III, CS-V, CS-IV and CS-I with bullock labour of 7.27, 6.46, 5.14 and 4.37 pd, respectively, Which were mainly used in sowing and inter-cultivation. With respect to machine labour utilization, not much difference observed among all the cropping systems.

5.6 Input utilization pattern in sugarcane, sugarcane based intercropping and alternate cropping systems

5.6.1 Input utilization pattern in sugarcane mono-cropping and sugarcane based intercropping systems

The inputs used per ha (Table 4.14) revealed that, in case of CS-I, the sample farmers used 7.88 t of setts as planting material for establishing sugarcane crop on ha of land. For meeting out plant nutrients requirements on a ha of land, 10.48 t of FYM, 6.16, 2.86, 4.58 q of urea, DAP and MOP were used respectively. Further the average quantity of plant protection chemicals used was 2.14 l of pesticides and 1.24 l of herbicides.

It was observed (Table 4.15) from results that, in case of CS-II, the inputs utilization of setts of sugarcane (6.90 t), seeds of fodder maize (25.36 kg), FYM (11.38 t), chemical fertilizers (15.45 q), plant protection chemicals (2.28 l). Whereas in case of CS-III, requirement of sugarcane setts was (6.73 t), seeds of soybean (58.15 kg), FYM (11.86 t), chemical fertilizers (17.53 q), plant protection chemicals (2.73 l).

Sugarcane cultivation under CS-III and CS-II requires less quantity of setts due to maintaining of more spacing (120x 60) between the rows at the time of planting as compared to CS-I (90x30). Utilization of FYM is high in case of CS-III and CS-II as compared to CS-I due to additional requirement of FYM for intercrops.

5.6.2 Input utilization pattern in alternate cropping systems

The results (Table 4.16) showed that, in case of CS-IV, seed rate used by sample farmers per ha in turmeric cultivation was 16.58 q as against recommended seed rate of 20 q. This was mainly because of high cost of rhizomes. Farmers used FYM of 8.23 t/ha as against the recommended dose 20 t/ha. This is mainly because of lack of availability and high price of FYM. Chemical fertilizers like urea, DAP, MOP of 4.51, 3.25 and 5.85 q used per ha as against recommended dose of chemical fertilizers like urea, DAP and MOP of 3.50, 2.5 and 5.00 q/ha, respectively.

Where as in case of CS-V, seed rate used by the sample farmers in maize, chickpea and groundnut cultivation was 13.75, 51.12, 62.50 kg/ha as against the recommended seed rate of 20.00, 62.5, 75.00 kg/ha, respectively. This is mainly because of lack of awareness among farmers about recommended seed rate for crop production and high price of seeds. Farmers used FYM of 6.18 t/ha as against recommended dose of 10 t/ha. This is mainly because of lack of availability and high price of FYM. chemical fertilizers like urea, DAP and MOP of 5.21, 3.25 and 2.49 q used per ha as against recommended dose of chemical fertilizers like urea, DAP and MOP of 4.00, 2.00 and 2.5 q/ha, respectively.

5.7 Cost of cultivation in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

5.7.1 Cost of cultivation in sugarcane mono-cropping, sugarcane based intercropping systems

The results on cost structure (Table 4.17 and 4.18) revealed that, the per ha total cost incurred by the farmers in growing sugarcane intercrop as well as mono- crop found to be higher in CS-III (₹1,60,061.09) as compared to CS-II (₹1,56,538.71) and CS-I (₹1,45,075.19)

The per ha variable cost of was higher in case of CS-III (₹135294.36) as compared to CS-II (₹13,0906.19) and CS-I (₹1,20,641.22) was mainly due to high cost of human labour.

The per ha fixed costs was marginally higher in case of CS-II (₹25,632.52) as compared to CS-III (₹24,766.72) and CS-I (₹24,433.98). The cost incurred on land revenue and land rents were similar in all the three cropping systems

The cost of human labour in case of all three systems was high which was mainly due to the reason of higher labour requirement for irrigation, hand weeding and harvesting.

5.7.2 Cost of cultivation in alternate cropping systems

The results on cost structure (Table 4.19) revealed that, the per ha total cost incurred by the sample farmers under CS-IV was higher ₹1,42,575.07 as compared to CS-V of ₹88,966.06.

The per ha variable cost was higher in case of CS-IV (₹1,23,438.50) as compared to CS-V (₹74,997.19) mainly due to high cost of human labour and seeds.

The per ha fixed costs was marginally higher in case of CS-IV (₹19,136.57) as compared to CS-V (₹13,968.86). The cost incurred on land revenue was similar in the above two cropping systems

The cost of human labour was high in case of CS-IV as compared to CS-V was mainly due to the reason of higher labour requirement for hand weeding, irrigation and harvesting.

5.8 Returns from sugarcane, sugarcane based intercropping and alternate cropping systems

5.8.1 Returns from sugarcane, sugarcane based intercropping systems

From the Table 4.20 and 4.21 it was evident that, the per ha average yield of sugarcane was comparatively higher in case of CS-III (104.14 t) followed by CS-II (98.63 t) and least in case of CS-I (86.56 t) was mainly due to intercropping followed in sugarcane, as sugarcane was intercropped with soybean increases the yield and enables the crops more effectively to utilize nutrients, to improve soil fertility and field ecological condition.

The results pertaining to the per ha returns from sugarcane as well as sugarcane intercrop indicated that higher gross return of ₹2,67,896.62 was realized from CS-III followed by CS-II of ₹2,34,929.88 and lesser gross return of ₹1,94,412.00 was realized under CS-I. The corresponding per ha net return under CS-III, CS-II and CS-I were observed to be ₹1,07,835.53, ₹7,8391.17 and ₹49,336.81 respectively. The B:C ratio was highest in case of CS-III (1.67) followed by CS-II (1.48) and CS-I (1.34).

5.8.2 Returns from alternate cropping systems

From the Table 4.22 it was evident that, the per ha average yield in case of CS-IV was 39.63 q, whereas in case of CS-V the average yield of maize, chickpea and groundnut was 46.25, 11.25 and 10.53 q, respectively.

The results on return structure (Table 4.17) revealed that, higher gross return of ₹2,82,773.11 was realized from CS-IV as compared to the gross return of ₹1,71,252.68 from CS-V. The corresponding per ha net return under CS-IV and CS-V were observed to be ₹1,40,198.04 and ₹84,793.06 respectively. The B:C ratio for CS-IV and CS-V is 1.98 and 1.86, respectively.

5.8.3 Comparative costs and returns structures under sugarcane, sugarcane based intercropping and alternate cropping systems

The total cost incurred, gross returns generated and net returns realized in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems were computed and presented in Table 4.23. The maximum total cost per ha was observed in case of CS-III (₹1,60,061.09) and least cost was in case of CS-V (₹88,966.06). The share of total variable cost in total cost was found to be the highest in case of CS-IV (86.58 %) followed by CS-III (84.53 %), CS-V (84.30 %), CS-II (83.63 %) and CS-I (83.16 %). Whereas the share of total fixed cost in the total cost was found to be the highest in case of CS-I (16.84 %) followed by CS-II (16.37 %) and least was in case of CS-IV (13.42 %). The gross returns were found to be highest in the case of CS-IV (₹2,82,773.11), followed by CS-III (₹2,67,896.62), CS-II (₹2,34,929.88), CS-I (₹1,99,973.51) and CS-V (₹1,71,252.68)

With respect to the net returns per ha, the net returns over total variable cost and total cost were found to be the highest in CS-IV (₹1,40,198.04), followed by CS-III (₹1,07,835.52), CS-V (₹84,793.06), CS-II (₹78,391.17) and CS-I (₹54,898.31). The B:C ratio was found to be the highest in CS-IV (1.98) followed by CS-V (1.92), CS-III (1.67), CS-II (1.50) and it was the least in case of CS-I (1.38).

5.9 Resource use efficiency in sugarcane mono-cropping and sugarcane based intercropping and alternate cropping systems

5.9.1 Resource use efficiency in CS-I under sugarcane mono-cropping

The production function analysis of CS-I, for different resources (Table 4.24) indicated that, the output elasticity of irrigation was significant at one per cent level *i.e.* every

one per cent increase in the irrigation would increase the gross returns by 0.29 per cent. The human labour had negative coefficient but was significant at five per cent level, indicating the decrease in the gross income for the increased use of this resource.

The output elasticity of setts, chemical fertilizers, plant protection chemicals and bullock labour were non-significant, they did not affect the gross returns significantly.

The output elasticity of chemical fertilizer showed a negative increment in the gross returns but not significantly. The co-efficient of multiple determination (R^2) indicated that 88 per cent of the variation in gross income was explained by the variables included in the production function.

5.9.2 Resource use efficiency in CS-II under sugarcane based intercropping systems

The production function analysis for CS-II showed that (Table 4.24), about 90 per cent of the variation in gross returns was explained by the 8 variables included in the production function. The output elasticity of setts/seeds was significant at one per cent level *i.e.* every one per cent increase in the setts/ seeds would increase the gross returns by 0.49 per cent. The output elasticity of chemical fertilizer and bullock labour was significant at five per cent level *i.e.* every one per cent increase in the chemical fertilizers and bullock labour would increase the gross returns to the tune of 0.113 and 0.028 per cent, respectively.

The output elasticity of FYM, human labour and irrigation were non-significant, they did not affect the gross returns significantly.

The output elasticity of plant protection chemicals and irrigation were negative, indicating over-utilization of these resources; increased use of this resource would further decrease the gross returns.

5.9.3 Resource use efficiency in CS-III under sugarcane based intercropping systems

The production function analysis of CS-III, for different resources (Table 4.24) indicated that, the output elasticity of human labour was significant at one per cent level. The output elasticity of seeds/setts and irrigation was significant at five per cent level. One per cent increase in human labour would increase total returns to the tune of 0.69 per cent and five per cent increment in setts/ seeds and irrigation would increase total returns to the tune of about 0.13 and 0.35 per cent, respectively.

The output elasticity of chemical fertilizers, plant protection chemicals, bullock labour and machine labour were non-significant, they did not affect the gross returns significantly.

The output elasticity of bullock labour was negative, indicating over-utilization of these resources; increased use of this resource would further decrease the gross returns

The co-efficient of multiple determination (R^2) indicated that 89 per cent of the variation in gross income was explained by the variables included in the production function.

5.9.4 Resource use efficiency in CS-IV under alternate cropping systems

The production function analysis for CS-IV showed that (Table 4.22), about 83 per cent of the variation in gross returns was explained by the 8 variables included in the production function. It was observed that, the output elasticity of rhizome and human labour was significant at one per cent level *i.e.* every one per cent increase in the rhizome and human labour increases the returns by 0.74 and 0.53 per cent, respectively. The output elasticity of FYM and irrigation was significant at five per cent level *i.e.* every one per cent increase in the FYM and irrigation increases the returns by 0.26 and 0.21 per cent, respectively. The increase in resource like plant protection chemicals and machine labour has increased the gross returns positively but not significantly. The increase in bullock labour showed a negative increment in the gross returns but not significantly.

5.9.5 Resource use efficiency in CS-V under alternate cropping systems

The production function analysis of CS-V, for different resources (Table 4.25) indicated that The output elasticity of machine labour was significant at one per cent level *i.e.* every one per cent increase in the machine labour would increase the gross returns by 0.32 per cent. The output elasticity of seeds was significant at five per cent level *i.e.* every one per cent increase in the seeds would increase the gross returns by 0.29 per cent. The resources viz., FYM, human labour, bullock labour also had positive effect indicating that gross returns can be increased by using increasing quantity of any of these resources.

The co-efficient of multiple determination (R^2) indicated that 87 per cent of the variation in gross income was explained by the variables included in the production function.

5.10 Allocative efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

5.10.1 Allocative efficiency in CS-I under sugarcane mono-cropping

From the Table 4.7 it was evident that, in case of CS-I, the MVP to MFC ratio was greater than unity for FYM, bullock labour, machine labour indicating the greater scope for

using additional units of these resources to increase gross income. The MVP to MFC ratio was less than unity for setts, chemical fertilizers, plant protection chemicals, human labour and irrigation indicating excessive use of these inputs. Thus, FYM, bullock labour, machine labour were under-utilized while setts, chemical fertilizer, plant protection chemicals, human labour and irrigation were over-utilized in CS-I.

5.10.2 Allocative efficiency in CS-II under sugarcane based intercropping systems

A comparison of ratio of MVP to MFC for selected variables (Table 4.25) indicated that, in case of CS-II, the MVP to MFC ratio was greater than unity for setts/seeds, FYM, chemical fertilizers and human labour indicating the greater scope for using additional units of these resources to increase gross income. The MVP to MFC ratio was less than unity for plant protection chemicals, bullock labour, machine labour and irrigation indicating excessive use of these inputs. Thus, setts/seeds, FYM, chemical fertilizer and human labour were under-utilized while plant protection chemicals, bullock labour, machine labour and irrigation were over-utilized in CS-II.

5.10.3 Allocative efficiency in CS-III under sugarcane based intercropping systems

The results (Table 4.25) showed that, in case of CS-III, the ratio of MVP to MFC was greater than unity for setts/seeds, FYM, human labour and machine labour indicating the greater scope for using additional units of these resources to increase gross income. The MVP to MFC ratio was less than unity for chemical fertilizer, plant protection chemicals, bullock labour and irrigation indicating excessive use of these inputs. Thus, setts/seeds, FYM, human labour and machine labour were under-utilized while chemical fertilizer, plant protection chemicals, bullock labour and irrigation were over-utilized in CS-III.

5.10.4 Allocative efficiency in CS-IV under alternate cropping systems

It was observed (Table 4.25) from results that, in case of CS-IV, The MVP to MFC ratio was greater than unity for rhizome, FYM, human labour, machine labour and irrigation indicating the greater scope for using additional units of these resources to increase gross income. The MVP to MFC ratio was less than unity for chemical fertilizers, plant protection chemicals and bullock labour indicating excessive use of these inputs. Thus, rhizome, FYM, chemical fertilizer, human labour, machine labour and irrigation were under-utilized while plant protection chemicals and bullock labour were over-utilized in CS- IV.

5.10.5 Allocative efficiency in CS-V under alternate cropping systems

The results (Table 4.25) showed that, in case of CS-V, the MVP to MFC ratio was greater than unity for seeds, FYM, plant protection chemicals, human labour, bullock labour and irrigation indicating the greater scope for using additional units of these resources to increase gross income. The MVP to MFC ratio was less than unity for chemical fertilizers and machine labour indicating excessive use of these inputs. Thus, seeds, FYM, plant protection chemicals, human labour, bullock labour and irrigation were under-utilized while chemical fertilizer and machine labour were over-utilized in CS- V.

5.11 Constraints faced by sample respondents in sugarcane, sugarcane based intercropping systems

An informal discussion with the sample farmers revealed that they are facing lot of problems in crop production under different cropping systems in the study area. Opinion survey was conducted to know the major constraints faced by the farmers in crop production and results of opinion survey are presented in the Table 4.24. Constraints grouped under three heads, namely, production constraints, financial constraints and marketing constraints. Garrett's test was applied by giving ranks for constraints.

5.11.1 Production constraints

In the study area, almost all the sample respondents in all the cropping systems encountered lower yield was the major problem because of continuous growing of sugarcane since from many years deteriorate the soil productivity. Excess and injudicious use of water has got II rank; Water will remain a critical input for agriculture. So sample farmers need technical guidance regarding water harvesting techniques and farmers should use water efficiently by giving only life-saving irrigations. High soil salinity has got III rank; because of sugarcane monocropping and conventional method of irrigation.

High wage rate IV rank; labour is one of the basic factor without which production is not at all possible. So agriculture labours, small and marginal farmer's migration to the nearby city for other works like carpentry, factory etc. to meet their basic requirements, educated youths have negative attitude towards agriculture, creating scarcity of agriculture labour, results increasing in wage rate.

Low soil fertility was the V constraint faced by sample farmers. High insect and pest infestation was the VI constraint faced by the farmers which was due to non-availability of quality plant protection chemicals.

Non-availability of labour (VII) was also one of major constraint faced by the farmers. Non-availability of inputs like quality seeds/setts (VIII) influenced negatively on the yield. Limited and irregular power supply and lack of adoption modern technology problem was also faced by majority of the sample farmers in the study area.

5.11.2 Financial constraints

Non-availability of timely credit was I constraint faced by majority of the farmers in the study area. Majority of the farmers were small and marginal with low production capacity land holdings. With lesser propensity to save, creation of owned fund is very difficult. High cost of cultivation has got II rank; indicating higher expenditure on inputs like labour, seeds, fertilizer and FYM. Delay in getting credit (III) and high rate of interest (IV) was also faced by the sample farmers in the study area.

5.11.3 Marketing constraints

Lack of market information was one of the major constraint faced by the farmers in the study area. Price –fluctuations (II), lack of crop-cutting under from sugar factory (III), delay in payment (IV) and high cost of transportation (V) were also the other problems faced by majority of sample farmers in the study area. Similar results were also reported while studying soybean by Basavaraj and Kunnal (2002).

5.12 Constraints faced by sample respondents in alternate cropping systems

An informal discussion with the sample farmers revealed that they are facing lot of problems in crop production under different cropping systems in the study area. Opinion survey was conducted to know the major constraints faced by the farmers in crop production and results of opinion survey are presented in the Table 4.24. Constraints grouped under three heads, namely, production constraints, financial constraints and marketing constraints. Garrett's test was applied by giving ranks for constraints

5.12.1 Production constraints

In the study area, almost all the sample respondents in all the cropping systems encountered delay in onset of monsoon, uncertainty of rain were the major two problems because of prolonged dry spell from the last two years. Non-availability of water for irrigation has got III rank; Water will remain a critical input for agriculture. So sample farmers need technical guidance regarding water harvesting techniques and farmers should use water efficiently by giving only life-saving irrigations.

High wage rate IV rank; labour is one of the basic factor without which production is not at all possible. So agriculture labours, small and marginal farmer's migration to the nearby city for other works like carpentry, factory etc to meet their basic requirements, educated youths have negative attitude towards agriculture, creating scarcity of agriculture labour, results increasing in wage rate.

Non-availability of inputs like quality seeds/setts (V) was also one of major constraint faced by the farmers. High insect and pest infestation was the VI constraint faced by the farmers which was due to non-availability of quality plant protection chemicals.

Low soil fertility was the VII constraint faced by sample farmers. Non-availability of labour (VIII) was also one of constraint faced by sample farmers in the study area.

5.12.2 Financial constraints

High cost of cultivation has got I rank; indicating higher expenditure on inputs like labour, seeds, fertilizer and FYM. Non-availability of timely credit was II constraint faced by majority of the farmers in the study area. Majority of the farmers were small and marginal with low production capacity land holdings. With lesser propensity to save, creation of owned fund is very difficult. Delay in getting credit (III) and high rate of interest (IV) was also faced by the sample farmers in the study area.

5.12.3 Marketing constraints

Lack of market information was one of the major constraint faced by the farmers in the study area. price –fluctuations (II), faulty weighment (III), lack of storage facility (IV), low price in local market (V), lack of transport facility (VI) and high cost of transportation (VII) were also the other problems faced by majority of sample farmers in the study area.

*Summary and
Policy Implications*

6. SUMMARY AND POLICY IMPLICATIONS

Sustainability of agriculture, food security and profitability are the major issues in future development of agriculture in India. The increasing food needs, due to the bulging population and progressively shrinking per capita agricultural land availability warrant the intensification of cropping system in the country, which is possible mainly through the selection of the suitable and most profitable crops and cropping systems.

Sugarcane is one of the important commercial crops of the country and is the main source of sugar in the world. It provides sugar, besides bio fuel, fibre, fertilizer and by-products. In India, it occupied around 3.8 mha of area with an annual cane production of around 270 mt. In Karnataka, the sugarcane is cultivated over an area of 4.25 lakh ha with production and productivity of 35.73 mt and 84.10 t of sugarcane per ha, respectively. In Karnataka, Belagavi, Bagalkot, Mandya, Vijayapura and Bidar are leading sugarcane growing districts. In recent years, the continuous growing of sugarcane in irrigated belts is creating problems of resource degradation and depletion of water table. To conserve soil fertility and save water, the need for crop diversification has been reported. With this backdrop, the present study attempted to analyse the economics of sugarcane, sugarcane based cropping systems v/s alternate cropping systems in Belagavi district with the following specific objectives.

6.1 Objectives of the study

1. To identify sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.
2. To estimate cost and returns under sugarcane mono-cropping, major sugarcane based intercropping and alternate cropping systems.
3. To analyse resource use efficiency in sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.
4. To analyse the constraints in adoption of sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems and suggest appropriate policy options.

6.2 Methodology

The multistage sampling procedure was adopted for the selection of the sample respondents. In the first stage, Belagavi district was selected based on highest area and production of sugarcane in Northern-Karnataka. In second stage, three taluks namely Gokak, Chikkodi and Soudatti was selected based on each taluk having highest area under irrigation through canals, borewells and lift irrigation. Two villages from each taluk were selected in the third stage. From Gokak taluk (Nagnur and Kalolagi), from Chikkodi taluk (Nagaramunholli and Kabbur) and from Soudatti taluk (Hanchinal and Huli) were selected. Finally, 60 farmers from sugarcane mono-cropping, 30 farmers each from sugarcane based intercropping and alternate cropping systems were selected. Thus, the total sample size chosen for the present study was 120.

The study mainly utilized the primary data associated with required secondary data. The objectives of the study were achieved by using the various statistical and mathematical tools like percentages; ratios, average, and Cobb-Douglass type of production function analysis. Besides, study used Garrets ranking to score problems faced by the farmers in the study area.

6.3 Findings of the study

Major findings of the study are summarised under following heads.

6.3.1 Socio- economic characteristics of sample farmers

The average age of the sample respondents was 45.6, 43.20 and 46.41 years, respectively in sugarcane, sugarcane based intercropping and alternate cropping systems, emphasizing the pre-dominance of middle age group persons in decision-making process. With regard to education level, majority of the sample respondents were literate in all three cropping systems. Occupational pattern of sample respondents revealed that majority of sample farmers were dependent on agriculture for their livelihood. The pattern of land holding revealed that 80 per cent farmers land was under irrigated condition.

6.3.2 Sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

In the study area, among the different cropping systems, two major cropping systems in sugarcane based intercropping (sugarcane+fodder maize and sugarcane+soyabean) and

alternate cropping systems (turmeric-sole and maize-chickpea-groundnut) were practiced by 66.67 and 76.67 per cent of the farmers, respectively.

6.3.3 Average farm size and source of irrigation in the identified sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems

The larger farm size was observed in case of CS-I followed by CS-II, CS-III, CS-IV and CS-V. Major source of irrigation observed in the study were canal, bore well and lift irrigation.

6.3.4 Cropping pattern followed in the study area

The major crops grown in the cropping systems in *kharif* season were sugarcane sole, sugarcane + maize, sugarcane + soybean, turmeric and maize. In *rabi* season, crops like sugarcane and turmeric were continued followed by chickpea, wheat and sorghum. During summer, crops like sugarcane and turmeric were same followed by maize, vegetables like tomato, chilli and brinjal were grown.

6.3.5 Cost and returns structure of sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems.

Results of the study revealed that, total cost incurred by sample farmers found to be highest in CS-III (₹ 1,60,061.09) followed by CS-II (₹ 1,56,538.71), CS-I (₹ 1,45,075.19), CS-IV (₹ 14,25,575.07) and CS-V (₹ 88,966.06).

Gross returns obtained by the farmers were found to be highest in CS-IV (₹ 2,82,773.11) followed by CS-III (₹ 2,67,896.62), CS-II (₹ 2,34,929.88), CS-I (₹ 1,99,973.51) and CS-V (₹ 1,71,252.68). The maximum net return were found to be highest in CS-IV (₹ 1,40,198.04) followed by CS-III, CS-V, CS-II and CS-I with net returns ₹ 1,07,835.52/ha, ₹ 84,793.06/ha, ₹ 7,8391.17/ha and ₹ 54,898.31/ha respectively.

B: C ratio was observed to be highest in CS-IV (1.98) followed by CS-V (1.92), CS-III (1.67), CS-II (1.50) and CS-I (1.38).

6.3.6 Resource use efficiency and allocative efficiency of resources in sugarcane and sugarcane based intercropping and alternate cropping systems

The Cobb-Douglas type of production function was fitted to study the resource use efficiency in identified cropping systems in the study area.

The results of the analysis in CS-I revealed that, the co-efficient of multiple determination (R^2) worked out to be 0.88. Some of the variables like irrigation, human labour and FYM were statistically significant at one and five per cent respectively. The resources *viz.*, chemical fertilizer, human labour, irrigation and plant protection chemicals were over-utilized, whereas FYM, bullock labour and machine labour were under-utilized.

In the case of CS-II, coefficients of seed/setts, chemical fertilizer and bullock labour were statistically significant at one per cent and 5 per cent respectively and exerted positive influence on gross returns. The co-efficient of multiple determination (R^2) was 0.90.

In the case of CS-III the results of MVP to MFC ratio revealed that seeds/setts, FYM, human labour and machine labour and FYM were under- utilized. Whereas, the resources like chemical fertilizers, plant protection chemicals, bullock labour and irrigation were under-utilized. The adjusted co-efficient of multiple determination was 0.89.

With respect to CS-IV, the resources, which had positive and significant influence on gross returns were seeds/rhizome, FYM, human labour and irrigation. The resources like chemical fertilizers, plant protection chemicals and bullock labour were over-utilized while seeds/rhizome, FYM, human labour, machine labour and irrigation were under-utilized. The adjusted co-efficient of multiple determination was 0.88.

With respect to CS-V, the resources like seeds, FYM, plant protection chemicals, human labour, bullock labour and irrigation were under-utilized while chemical fertilizers and machine labour were over-utilized. The adjusted co-efficient of multiple determination was 0.87.

6.3.7 Constraints faced by sample respondents in sugarcane, sugarcane based intercropping and alternate cropping systems

The major constraints faced by the sample farmers were categorized under three heads *viz.*, production, financial and marketing constraints. Among the production constraints lower yield, excess and injudicious use of water, high soil salinity and high wage rate were the major constraints. Low soil fertility, soil compaction, high insect and pest incidence, non-availability of labour, non- availability of inputs like quality seeds/setts, limited and irregular power supply and lack of adoption modern technology were the crucial problems in the study area. In the financial constraints non-availability of timely credit, high cost of cultivation, delay in getting credit and high rate of interest were the major problems. Among the

marketing constraints lack of market information, price-fluctuations, lack of crop-cutting order from sugar factory, low price in local market and delay in payment were observed as severe problems.

6.3.8 Policy implications

Based on the findings of the investigation, the following broad policies can be drawn to improve the cropping systems in order to stabilize the income of the farmers.

1. The cost and return analysis of major cropping systems in the study area revealed that, net returns was found to be maximum in case of alternate cropping system turmeric-sole in CS-IV (₹1,40,198.04) as compared to sugarcane mono-cropping and sugarcane based intercropping systems in sugarcane mono-crop in CS-I (₹54,898.31), sugarcane + fodder maize in CS-II (₹78,391.17) and sugarcane + soybean in CS-III (₹1,07,835.52). Hence, there is a need to wean away the farmers from mono cropping of sugarcane and encourage them to switch for other profitable cropping systems like turmeric, maize-chickpea-groundnut. There is also a need for creating awareness among the farmers about long term deleterious effects of sugarcane mono cropping with the help of large scale crop demonstrations by SAU's, KVK's and NGO's.
2. The resource use efficiency analysis revealed that, the resources are not optimally utilized in the cultivation of sugarcane and sugarcane based intercropping systems. MVP/MFC ratios were less than unity for seeds, chemical fertilizers, plant protection chemicals in case of sugarcane mono cropping whereas, chemical fertilizers, plant protection chemicals and bullock labour in case of sugarcane based intercropping systems, thus indicating their over utilization. Therefore, farmer need to be educated and advised about optimum use of these resources to reduce cost of product, enhance yield and stabilize the farm income.
3. Among the constraints identified in different cropping systems in the study area, majority of the farmers expressed erratic behaviour of rainfall, high soil salinity and high cost of labour were the major ones followed by lack of credit availability and high cost of inputs *etc.* To overcome these problems in the study area, the farmers are to be advised to grow drought resistant varieties/hybrids, adoption of water harvesting and water conservation techniques, partial mechanization, adoption of labour saving techniques and strengthen institutional support for provision of adequate and timely credit.

References

REFERENCES

- Agarwal, P. K. and Singh, O. P., 2015, An economic analysis of soybean cultivation in Narsinghpur district of Madhya Pradesh, India. *Indian J. Agric. Res.*, **48**(3): 185-191.
- Ahmad, T., Suhasini, K., Rao, D. V. S., Bhave, M. H. V., 2012, Resource use efficiency of almond production in Afghanistan – a case study in Kunduz province. *J. Res. ANGRAU*, **40**(1): 75-77.
- Anjugam, M., Jaganmohan, K. R., Padmarani, S. and Sundaresan, R., 2006, A study on organic farming of sugarcane in Western Zone of Tamil Nadu. *Agric. Econ. Res. Rev.*, **19**(2): 233.
- Anonymous, 2001, India Year Book-2001, Ministry of Information and Broadcasting of India, New Delhi, pp.65-69.
- Anonymous, 2015-16, District at a glance, District Statistical Office, Belagavi, pp.45-52.
- Anonymous, 2015-16, Karnataka state agriculture profile, Directorate of Economics and Statistics, Bangalore, pp.19-25.
- Arti, S. and Jyothi, K., 2009, Resource use efficiency and sustainability of maize cultivation in Jammu region of Jammu and Kashmir state. *Agric. Situ. India*, **66**(3): 125 -129.
- Baliyan, S.P., Bhogal, T.S. and Archana, 2011, A study of costs and returns in sugarcane production vis-a-vis its competing crops in Muzaffarnagar district, Western Uttar Pradesh. *Agri. Situ. India*, **55**(4): 209-214.
- Basavaraj, K. and Kunnal, L.B., 2002, Constraints in production, marketing and processing of soybean. *Rural India*, **65** (4): 68-71.
- Bullar, M. S., Kamboj, A. and Singh, G. P., 2006, Weed management in spring planted sugarcane (*Saccharum officinarum*) based intercropping systems. *Indian J. Agron.*, **51**(3): 183-185.
- Ganesh, K., 2000, Evaluation of alternative farming systems in Gazani lands of Karnataka – An economic analysis. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).
- Gill, M.S. and Ahlawat, I.P.S., 2013, Crop diversification-Its role towards sustainability and profitability. *Indian J. Fert.*, **2**(9):125-138.

- Girei, A.A. and Giroh, D.Y., 2013, Productivity and resource use efficiency in sugarcane (*Saccharum officinarum*) production in Numan local government area, Adamawa State, Nigeria. *J. Agric. Soc. Sci.*, **9**(2): 1–5.
- Gupta, R.P. and Tewari, S.K., 2005, Factors affecting crop diversification : A critical analysis *Indian J. Agric. Econ.*, **40**(3):304-309.
- Kalaiselvi, V., 2012, Pattern of crop diversification in Indian scenario. Scholars research library. *Ann. Biol. Res.*, **3**(4): 1914-1918.
- Kaligouda, V.B., 1989, Economics of cropping pattern in Ghataprabha Command Area-A case study. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).
- Kant, K., Tripathi, S. P. and Meena, M., 2015, Comparative profitability of sugarcane production under different size group of farms in Meerut district of Uttar Pradesh. *Agric. Situ. India*, **6**(1):41-48.
- Karthick, V., Alagumani T. and Amarnath J.S., 2014, Resource–use efficiency and technical efficiency of turmeric production in Tamil Nadu - A stochastic frontier approach. *Agric.Econ. Res. Rev.*, **26**(1): 109-114.
- Kaur, M. Mahal, A.K. Sekhon, M.K. and Kings, H.S., 2010, Technical efficiency of wheat production in Punjab: A regional analysis. *Agric. Econ. Res. Rev.*, **23**(1): 173-179.
- Kerketta., Awasthi, H. K. and Yogedra, M., 2015, Constraints faced by chickpea growers in adoption of integrated pest management practices. *Indian J. Agric. Res.*, **15** (2): 1051-1053.
- Kiresur, V. R. and Ichangi, M., 2011, Socio-economic impact of Bt cotton-A case study of Karnataka. *Agric. Econ. Res. Rev.*, **24**(2): 67-81.
- Kumar, S., Rana, N. S., Singh, R. and Singh, A., 2006, Production potential of spring sugarcane as influenced by intercropping of dual purpose legumes under tarai conditions of Uttarakhand. *Indian J. Agron.*, **51**(4): 271-273.
- Kumar, S., Singh, S. S. and Singh, A., 2011, Production potential of winter vegetables as intercrops in autumn planted sugarcane under valley conditions of Uttarakhand. *Progressive Hort.*, **43**(1): 153-154.

- Kumar, V., 2010, Comparative economics of vegetable production under organic and inorganic farming in Belagaum district. *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci. Dharwad, Karnataka (India).
- Mahanty, H. D., Patil, S. J., Bhalerao, P. P., Gaikwad, S. S. and Kotadia, H. R., 2012, Economics and land equivalent ratio of different intercrops in Banana under drip irrigation. *Asian J. Hort.*, **7**(2): 330-332.
- Malik, S. K. and Singh, R. P., 2000, Break-up of costs and returns of sugarcane production in reserve and free areas of sugar mills. *Agric. Situ. India*, **55**(12): 749-751.
- Menasinahal, A. S., 2011, Performance of cotton in traditional paddy fields of utara kannada district, Karnataka-An economic analysis. *M. Sc. (Agri) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).
- Mundinamani, S. M., Kulkarni, G. N., Bhattarai, B. and Upasana, M., 2013, Mechanical harvesting of chickpea in North Karnataka : problems and prospects. *Agric. Econ. Res. Rev.*, **27**(3): 181.
- Nagpure, S. C., Jhakare, A.B., Khandare, A.P. and Patil, R.K., 2004, Economics of sugarcane production in Vidarbha Region of Maharashtra State. *Rural India*, **67** (6-7): 123-125.
- Nain, N., Khatkar, R. K. and Singh, V. K., 2002, Role of sugarcane processing industry and efficiency of processing in Haryana. *Indian J. Agril. Mktg.*, **16**(3): 97-103.
- Narayan, P., and Sandeep, K., 2015, Constraints in area, production and productivity of pulses in India. *Indian J. Agric. Res.*, **49** (2): 114-124.
- Pandey, M. M., 2009, Indian agriculture-An introduction. Fourth session of the technical committee of APCAEM, Chiang Rai, Thailand, pp-85-94.
- Papang, J. S. and Tripathi, A.K., 2014, Costs and returns structure of turmeric (*Curcuma longa* Linn) and constraints faced by producers in Jaintia hills district of Meghalaya, India. *Indian J. Agric. Res.*, **48** (3): 192-198.
- Rajeshwari, Y. G., 2004, An economic analysis of coconut based farming system in Tumkur district of Karnataka. *M.Sc. (Agri.) Thesis*, Uni. Agric. Sci. Dharwad, Karnataka (India).

- Rajkumar, B., 2007, Economics of redgram based cropping systems in Bidar district. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).
- Rajkumar, N. and Singh, H., 2002, Problems in vegetable production in Bharatpur district of Rajasthan. *Rural India*, **65** (2-3): 48-50.
- Ramarao, I. V. Y., 2012, Efficiency, yield gap and constraints analysis in irrigated vis-a vis in rainfed sugarcane in north coastal zone of Andhra Pradesh. *Agric. Econ. Res. Rev.*, **25**(1): 167-171.
- Rana, N. S., Sanjaykumar., Saini, S. K. and Panwar, G. S., 2006, Production potential and profitability of autumn sugarcane-based intercropping systems as influenced by intercrops and row spacing. *Indian J. Agron.*, **51**(1): 31-33.
- Rithesh, S., 2013, Comparative economics of sugarcane processed for sugar and jaggery. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci. Dharwad, Karnataka (India).
- Saikumar, B. C., 2005, Farming Systems in the tank commands in north-eastern Karnataka – An Economic analysis of Jala Samvardhane Yojana Sangha managed tanks. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).
- Sale, Y. C. and Yadav, D. B., 2008, Sugarcane cultivation with an integrated approach in Kolhapur District of Maharashtra. *Cooperative Suga.*, **39**(8): 29-32.
- Savitha, S.S., 2004, Role of rural women in Animal Husbandry. *M.H.Sc. Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).
- Shetty, R.A., Jagannatha, V. and Channabasavanna, A.S., 1990, Suitable cropping sequences area of Tungabhadra Project. *Curr. Res.*, **19** (10): 166-168.
- Shinde, N., Patil, B.L., Murthy, C. and Mamledesai, N.R., 2009, Profitability analysis of sugarcane based intercropping systems in Belagavi district, Karnataka. *Karnataka J. Agric. Sci.*, **22**(4):820-823
- Shivanand, M. and Gangal., 2002, Performance of banana plantations in north Karnataka-An economic analysis. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).

- Shreeshail, R. and Mundinamani, S.M., 2016, Impact of micro irrigation on sugarcane productivity and profitability in northern Karnataka. *Agric. Update*, **11**(3): 181-186.
- Singh, J. and Grover, D.K., 2010, Economics of wheat under different cropping systems. *Prog. Farm.*, **28** (6): 23-26.
- Singh, K., Bhullar, M. S. and Singh, R. S., 2007, Productivity and profitability of autumn sugarcane based intercropping systems in south-western Punjab. *J. Res. Punjab agric. Univ.*, **44**(1): 18-20.
- Singh, K., Singh, A., Gill, M. S., Singh, D., Uppal, S. K. and Bhullar, M. S., 2010, Intercropping in single bud vertical planted sugarcane. *J. Res. Punjab Agric. Univ.*, **47**(4): 138-142.
- Singh, S., 2007, A study on technical efficiency of wheat cultivation in Haryana. *Agric. Econ. Res. Rev.*, **20**: 127-136.
- Sonavane, S. S., Solia, B. M., Gonge, A. P., Patil, S. J., Gajjar, M. M. and Patil, R. G., 2014, Intercropping options in autumn planted banana. *Trends in Biosciences*, **7**(15): 1927-1931.
- Sunanda, N. and Narender, I., 2003, Resource productivity of mesta farms in Srikakulam district of Andhra Pradesh. *The Andhra Agric. J.*, **50** (3-4): 327-331.
- Suryawanshi, M. W., Umate, M. G. and Shaikh, R. M., 2010, Studies on economic returns of sugarcane based intercropping system. *Bioinfolet*, **8**(2): 168-169.
- Tanveer, A., 2006, An economic analysis of paddy based farming systems in southern Karnataka – A case study of Mandya district. *M.Sc (Agri.) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).
- Taru, V. B., Kyagya, I. Z., Mshelia, S. I., and Adebayo, E. F., 2008, Economic efficiency of resource use in groundnut production in Adamawa state in Nigeria. *World J. Agric. Sci.*, **4** (3):896-900.
- Vorghees, P. K., 2008, The problems of coconut growers in Tamil Nadu. *Indian J. Agric. Econ.*, **63**(1): 111-116.

Wadear, P.R., 2003, Animal based farming systems for long-term sustainability innorthern Karnataka – A socio-economic assessment. *Ph. D. Thesis*, Univ. Agric. Sci. Dharwad, Karnataka (India).

www.faostat.com

www.Indiastat.com

www.worldsugarstat.com

Yadav, M.U., Nagure, D.V., Phukse, K.D. and Kalalbandi, B.M., 2004, A Comparative study of resource productivities and resource use efficiencies of traditional and tissue culture banana cultivation in Parbhani district of Maharashtra state. *Karnataka J. Agric. Sci.*, **18**(3): 735-739.

Appendices

APPENDIX

Economic analysis of sugarcane based and alternate cropping systems in irrigated sugarcane belt of Belagavi district

Interview schedule for farmers

Schedule No: _____

Date: _____

1. Type of Farm: Large/Medium/Small

2. General information :

Name : _____ Village: _____ Tq: _____

Age : _____ Education : _____

Occupation : Main : _____ Subsidiary : _____

3. Family composition: Male:_____ Female:_____ Children:_____ Total:_____

4. Land holdings :

Particulars	Dry land (acres)	Irrigated land (acres)	Total (acres)
1) Owned			
2) Leased in			
3) Leased out			
Total			

5. Soil type : Red soil / Black soil / Lateritic soil / Red loamy soil /Alluvial soil

6. Sources of irrigation

Sources	Irrigated area(acres)
1. Canal	
2. Lift irrigation	
3. Bore wells	
4. Wells	
5. Others, if any	

9. Details of cost of cultivation of Sugarcane/sugarcane based/alternate cropping systems

a) Crop: _____ Area: _____

b) Dry / irrigated

if irrigated availability of water : Adequate/ Inadequate

c) Season : *Kharif / Rabi/ Summer*

d) Varieties/ Hybrids : _____ Seed source: owns/KSSC/private company/RSK

10. Input utilization and cost

Sl. No	Inputs	Quantity (Per acre)	Rate (Cost/unit)	Total Cost
1.	FYM			
2.	Seeds			
3.	Organic manures			
4.	Chemical fertilizer a) Urea b) DAP c) SSP d) MOP e) Others i) ii)			
5.	Weedicides/PPC/Growth regulators a) b) c)			
6.	Irrigation charges			
7.	Others a) b) c)			

11. Operation wise utilisation of labour

Sl. No	Operation	Frequency	Hired(No's)		Family(No's)		Bullock pairs	Machine (hr)
			Men	Women	Men	Women		
1.	Ploughing							
2.	Clod crushing							
3.	Harrowing							
4.	FYM application							
	a) FYM							

Sl. No	Operation	Frequency	Hired(No's)		Family(No's)		Bullock pairs	Machine (hr)
			Men	Women	Men	Women		
	transportation							
	b) Spreading							
5.	Marking lines and Sowing							
6.	Gap filling							
7.	Fertilizer application							
8.	Weeding							
9.	Inter cultivation							
10.	PPC application							
11.	Irrigation							
12.	Harvesting							
13.	Threshing							
14.	Packing							
15.	Storage / marketing							

Land revenue: _____

Land rent : _____

Wage rates (Rs/day): Men : _____

women: _____

Bullock (Rs/pair) : _____

Machine (Rs/hr) : _____

12. Yield and returns

Particular	Yield / acre (kg/q/t)	Total production	Value (₹)
Sugarcane			
i. Main product			
ii. By-product			
Sugarcane intercropping			
i.			
ii.			
iii.			
Alternate crops			
i.			
ii.			
iii.			

13. Constraint identified in adoption of sugarcane based cropping system

1. Production factors:

Factors	Rank
1. Uncertainty of rains	
2. Non- availability of labour	
3. Non –availability of water for irrigation	
4. Non –availability of planting material	
5. High wage rates	
6 Delay in onset of monsoon	
7 Early onset of monsoon	
8. Low soil fertility	
9. High insect incidence	
10.Lack of power supply	
11.Non-availability of required inputs	

2. Financial factors:

Factors	Rank
1. Low income from sugarcane crop	
2. High labour requirement for sugarcane crop	
3. High rate of interest	
4. High cost of cultivation of sugarcane crop	
5. Non availability of timely credit	

3. Marketing factors:

Factors	Rank
1. Lack of transport facilities	
2. High cost of transportation	
3. Non –availability of market information:	
4. Price-fluctuations	
5. Lack of crop cutting order from sugar factory	

14. Constraint identified in adoption of alternate cropping systems**1. Production factors:**

Factors	Rank
1. Uncertainty of rains	
2. Non- availability of labour	
3. Non –availability of water for irrigation	
4. Non –availability of planting material	
5. High wage rates	
6. Delay in onset of monsoon	
7. Early onset of monsoon	
8. Low soil fertility	
9. High insect incidence	
10. Limited and irregular power supply	

2. Financial factors:

Factors	Rank
1. Non-availability of timely credit	
2. High rate of interest	
3. High labour requirement	
4. High cost of cultivation	

4. Marketing factors:

Factors	Rank
1. Lack of transport facilities	
2. High cost of transportation	
3. Non –availability of market information:	
4. Price-fluctuations	
5. Faulty weighing	

ECONOMIC ANALYSIS OF SUGARCANE BASED AND ALTERNATE CROPPING SYSTEMS IN IRRIGATED SUGARCANE BELTS OF BELAGAVI DISTRICT

BINDU B. R.

2017

**Dr. S. M. MUNDINAMANI
CHAIRMAN**

ABSTRACT

The study on economic analysis of sugarcane mono-cropping, sugarcane based intercropping and alternate cropping systems was conducted in Belagavi district of north Karnataka. It was based on primary data collected from 120 sample respondents during 2016-17. The sample respondents practiced sugarcane mono-cropping, 6 sugarcane based intercropping and 5 alternate cropping systems to sugarcane. The predominant two sugarcane based inter-cropping and alternate cropping systems were considered.

The Tabular and functional analysis were employed to analyse data. CS-I (Sugarcane mono-crop), CS-II (Sugarcane+ Fodder maize), CS-III (Sugarcane+ Soybean), CS-IV (Turmeric-sole) and CS-V (Maize + Chickpea + Groundnut) were the five major cropping systems identified in the study area. It was found that , per hectare total cost of cultivation was found to be highest in CS-III (₹ 1,60,061.09/ha) followed by CS-II, CS-I, CS-IV and CS-V (₹ 1,56,538.71, ₹ 1,45,075.19, ₹ 1,42,575.07 and ₹ 88,966.06/ha respectively). Maximum net returns per hectare were found under CS-IV (₹ 1,40,198.04), followed by CS-III, CS-V, CS-II and CS-I (₹ 1,07,835.52, ₹ 84,793.06, ₹ 78,391.17 and ₹ 54,898.31/ ha, respectively).

The MVP/MFC ratio for FYM, bullock labour and machine labour in CS-I, setts/seeds, FYM and human labour in CS-II, setts/ seeds, FYM and human labour in CS-III, Rhizome and irrigation in case of CS-IV and seeds, PPC and bullock labour in case of CS-V were greater than unity, indicating further scope for using additional units these inputs to increase gross income. Lower yield in sugarcane, excess and injudicious use of water, low soil fertility and high cost of cultivation were the major constraints faced by the farmers in sugarcane cultivation.