ECONOMIC ANALYSIS OF FARMING SYSTEMS IN SOUTH KONKAN REGION

BY

SUDARSHAN TANAJI GORE
M.Sc. (Agri.)

DEPARTMENT OF AGRICULTURAL ECONOMICS
FACULTY OF AGRICULTURE
DR.BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI- 415 712,
Dist. Ratnagiri (M.S.)

May, 2016

ECONOMIC ANALYSIS OF FARMING SYSTEMS IN SOUTH KONKAN REGION

A thesis submitted to the
FACULTY OF AGRICULTURE

DR.BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH,
(Agricultural University)
Dapoli, Dist. Ratnagiri (M.S.)

In partial fulfilment of the requirements for the degree of

Doctor of Philosophy (Agriculture)

in

AGRICULTURAL ECONOMICS

by

SUDARSHAN TANAJI GORE
M.Sc. (Agri.)

DEPARTMENT OF AGRICULTURAL ECONOMICS
FACULTY OF AGRICULTURE,
DR.BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI- 415712,
DIST. RATNAGIRI (M.S.)

May, 2016

ECONOMIC ANALYSIS OF FARMING SYSTEMS IN SOUTH KONKAN REGION

A thesis submitted to the

FACULTY OF AGRICULTURE

DR.BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH,

(Agricultural University)

Dapoli, Dist. Ratnagiri (M. S.), India

In partial fulfilment of the requirements for the degree of

Doctor of Philosophy (Agriculture)

in

AGRICULTURAL ECONOMICS

by

SUDARSHAN TANAJI GORE

M.Sc. (Agri.)

APPROVED BY THE ADVISORY COMMITTEE

Chairman and Research Guide

(S.S.Wadkar)
Associate Professor,
Department of Agril. Economics,
College of Agriculture, Dapoli

:Members:

(J.M. Talathi)
Head,
Department of Agril. Economics,
Dr. B. S. K. K. V. Dapoli.

.

(V.G. Patil)
Professor,
Department of Extension Education,
College of Agriculture, Dapoli

(J. S. Dhekale)
Associate Professor (Statistics)
Department of Agril. Economics,
College of Agriculture, Dapoli.

(A.C. Deorukhakar)
Associate Professor, ,
Department of Agril. Economics,
College of Agriculture, Dapoli.

Dr. S.S. WADKAR
M.Sc. (Agri.) Ph.D.
Associate Professor,
Department of Agricultural Economics,
College of Agriculture, Dapoli
Dist. Ratnagiri (M.S.)

CERTIFICATE

This is to certify that the thesis entitled**, "ECONOMIC ANALYSIS OF FARMING SYSTEMS IN SOUTH KONKAN REGION "** submitted to the Faculty of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra State, in partial fulfilment of the requirements for the degree of **Doctor of Philosophy (Agriculture) in Agricultural Economics,** embodies the results of the piece of bona-fide research work carried out by **SUDARSHAN TANAJI GORE** under my guidance and supervision and that no part of this thesis has been submitted for any other degree or diploma. All the assistance and help received during the course of investigation and the sources of literature have been duly acknowledged by him.

Place: Dapoli

Dated:

(Dr. S.S.WADKAR)
Chairman
Advisory Committee and
Research Guide

ACKNOWLEDGEMENT

"PRAISE TO LORD GANESHA"

While I stand at the cups of completion of my research work numerous memories gush through my mind which are full of gratitude to those who stood with me at various stages of my research work. I seize this opportunity to express my deepest sense of gratitude and thankfulness.

It is moment of great pleasure in recording my fervent sense of gratitude and heartfelt thanks. I express my gratefulness to my Research Guide and Chairman of Advisory Committee **Dr. S. S. WADKAR,** Associate professor, Department of Agricultural Economics, College of Agriculture, Dapoli, whose valuable guidance, constant encouragement, profound interest in research, constructive suggestions, unfailing co-operation, hard work and helping mind throughout the course of my Ph.D.study, gave me this unique experience of planning, conducting and presenting the research.

It gives me great pleasure to express my profound gratitude and heartfelt respect to my Advisory Committee members, **Dr. J. M. Talathi,** Head, Department of Agricultural Economics, Dr. B. S. K. K. V., Dapoli, **Dr. V. G. Patil,** Professor, Department of Extension Education, College of Agriculture, Dapoli and **Dr. A. C. Deorukhakar,** Associate Professor ,Department of Agricultural Economics, College of Agriculture, Dapoli for giving me valuable guidance and timely help during the course of my post graduation studies.

I feel gratified in acknowledging **Dr. J.S. Dhekale**, Associate Professor (Statistics) Department of Agricultural Economics, College of Agriculture, Dapoli for his generous help in Statistical Analysis, valuable guidance, and profound interest in research.

I extend my cordial thanks to Dr. V. G. Naik, Associate Professor, Dr. S. R. Torane, Deputy Director of Research (Ag. Econ), Dr. V. A. Thorat, Dr. P.

J. Kshirsagar, Dr. R. M. Joshi, Dr. D. B. Malve, Dr. S. S. Bhosale, Prof. Mrs. S. M. Kulkarni, all Assistant Professors and other staff members of the Department of Agricultural Economics for the help rendered during my stay at Dapoli.

I place on record my cordial thanks to, Hon'ble **Dr. Tapas Bhattacharya,** Vice Chancellor, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, **Dr. R. G. Burte**, Dean, Faculty of Agriculture and **Dr. S. A. Chavan** Associate Dean, college of Agriculture, Dapoli for their valuable guidance and provision of necessary facilities for conducting this study.

Most importantly, none of this would have been possible without the love and patience of my family. My immediate family, to whom this dissertation is dedicated to, has been a constant source of love, concern, support and strength all these years. I would like to express my heart-felt gratitude to my family. I have to give a special mention for the support given by my beloved father, **Shri. Tanaji Namdev Gore** who has enlightened me to believe in the beauty of dreams. Mother, **Sau. Anusaya** who has been an inexhaustible source of inspiration throughout my life. Their blessings, love and affection has brought the desired dream to reality. Parents teach us to dream, to try, with our feet on the ground and sights on the sky.

I take this opportunity to express my affection and obligation to my loving Brothers **Samadhan** and **Pravin**, sister- in –laws **Sau. Manjusha** and **Sau. Priya** for their encouragement, love, care, support and assistance in building my educational career. I also wish to mention my sweet little nephews **Parth** and **Shreyas.**

I owe thanks from bottom of my heart to my Ph.D. batchmates, Rushikesh, Yogesh, Manisha, my senior Dr. Digmbar Perke, Dr. Rakesh Kawale, Dr. Kavita Khade, Navdeep Mhatre, junior Ph.D scholars, Nikhil, Sonal, Mansing,

Surajkumar, Somnath, Dnyandeo Gaurish, and M.sc Friends Balaji, Balkrushna, Pooja, Vrushali, Savita, Dhanaji, Pankaj and Late. Rahul Surwase for their excellent company during the Ph.D. study.

A friend is who comes and enjoys in happy days and also gives moral support and confidence in bad day. I thankfully acknowledge the contribution of my special friends from Dept. of Extnension Education, Radhika, Bhagyashree, Sonam, Swapnil (Mittu), Ramesh, Pankaj, Deva, Pramod, Radha, Sevak, Ganesh, Suraj, Bhartesh, Ramehwar, Santosh, Vijay, Nishikant, Neha, Yogita and Sapana.

I would like to thank all my friends Sachin Patil (PSI), Raviraj Lawand, Krushnahari Sapkal (PSI), Kiran Gawade, Dnyaneshwar, Sachin, Suraj, Pradip, Nitin, Omkar, Vishal, Dagdu patil, Shoyeb, Suvarna, Neeta, Megha, Deepika, Deepali, Poonam A, Tejashree and Poonam D for their loving wishes for completing the study.

I also wish to express my deepest thanks to all non-teaching staff of Department of Agricultural Economics, College of Agriculture, Dapoli and farmers selected for the collection of data during research work. Without their benevolence and active support it is impossible for me to succeed.

Once again, I would like to thank each and every person who helped me directly or indirectly to turn this dream comes true. Lastly, I am very thankful to Mr. Sudhakar Bhoye, Vakratund graphics for timely completing this manuscript.

Place: Dapoli
Date: (Sudarshan Tanaji Gore)

APPENDIX II

Per hectare cost and returns of crop grown in farming systems in cluster I

FS-I										
			Paddy		Mango		Cashewnut		Paddy	
			Av. Size	0.69	Av. Size	0.83	Av. Size	0.89	Av. Size	0.71
Sr. No.	Particulars	Unit	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value(Rs.)	Quantity	Value (Rs
1	Hired human labour									
	a. Male	Days	46	6900	49	7350	55	8250	44	6600
	b. Female	Days	39	3900	27	2700	39	3900	30	3000
2	Bullock labour	Pair/days	23	6900	0	0	0	0	12	3600
3	Seed material	kg.	52	1040	0	0	0	0	52	1040
4	FYM/Compost	qt.	49	9800	10	2500	7	1400	45	9000
5	Fertilizers	kg.	175	2100	445	5340	350	3500	180	1800
6	Rab material	qt.	19	760	0	0	0	0	20	800
7	PPC	Lit.	0	0	4	3600	3.5	3325	0	0
	Total			31400		21490		20375		25840
8	Depreciation on charges			260		1035		325		295
9	Land revenue and other cesses			60		65		60		60
10	Interest on working capital			1884		1289		1223		1550
	Cost A			33604		23879		21983		27745
11	Interest on fixed capital			2500		3254		3554		1620
12	Rental value of land			9083		16667		20500		7333
	Cost B			45187		43800		46037		36699
13	Family labour									
	a. Male	Days	32	4800	50	7500	50	7500	39	5850
	b. Female	Days	26	2600	31	3100	38	3800	27	2700
	Cost C			52587		54400		57337		45249
14	Production									
	a. Main produce	qt.	26	39000	50	100000	15	123000	24	36000
	b. By produce	qt.	50	10000	0	0	0	0	40	8000
	Total			49000		100000		123000		44000
15	**Net Returns**			-3587		45600		65664		-1249
16	**Input Output ratio**			0.93		1.84		2.15		0.97

FS-II							FS-III			
			Coconut		Arecanut		Paddy		Nagli	
			Av. Size	0.69	Av. Size	0.83	Av. Size	0.55	Av. Size	0.24
Sr. No.	Particulars	Unit	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)
1	Hired human labour									
	a. Male	Days	35	5250	42	6300	28	2800	29	4350
	b. Female	Days	16	1600	25	2500	55	2750	20	2000
2	Bullock labour	Pair/days	0	0	0	0	28	7000	18	5400
3	Seed material	kg.	0	0	0	0	46	690	8	160
4	FYM/Compost	qt.	14	3500	8	2000	56	11200	5	1250
5	Fertilizers	kg.	653	7836	70	840	106	1060	80	960
6	Rab material	qt.	0	520	0	0	19	760	0	0
7	PPC	Lit.	0	0	1.4	1260	0	0	0	0
	Total			18706		12900		25500		14120
8	Depreciation on charges			890		450		247		330
9	Land revenue and other cesses			60		60		60		60
10	Interest on working capital			1122		774		765		847.2
	Cost A			20778		14184		26572		15357
11	Interest on fixed capital			3354		3150		2297		2356
12	Rental value of land			14050		10933		5493		4417
	Cost B			38182		28267		34362		22130
13	Family labour									
	a. Male	Days	34	5100	40	6000	32	3200	23	3450
	b. Female	Days	17	1700	26	2600	68	3400	20	2000
	Cost C			44982		36867		40962		27580
14	Production									
	a. Main produce	qt.	8430	84300	8	65600	22	30800	17	25500
	b. By produce	qt.	0	0	0		18	2520	10	1000
	Total			84300		65600		33320		26500
15	Net Returns			39318		28733		-7642		-1080
16	Input Output ratio			1.87		1.78		0.81		0.96

FS-III										
			Vari		Cowpea		Wal		Pawata	
			Av. Size	0.21	Av. Size	0.23	Av. Size	0.19	Av. Size	0.25
Sr. No.	Particulars	Unit	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)
1	Hired human labour									
	a. Male	Days	42	6300	26	3900	30	4500	21	3150
	b. Female	Days	23	2300	50	5000	40	4000	35	3500
2	Bullock labour	Pair/days	6	1800	20	6000	18	5400	15	4500
3	Seed material	kg.	7	84	24	960	36	5400	20	1600
4	FYM/Compost	qt.	10	2500	15	3750	8	2000	13	3250
5	Fertilizers	kg.	50	600	60	720	55	660	50	600
6	Rab material	qt.	0	0	0	0	0	0	0	0
7	PPC	Lit.	0	0	1.5	1350	0	0	1	900
	Total			13584		21680		21960		17500
8	Depreciation on charges			210		275		370		370
9	Land revenue and other cesses			60		60		60		60
10	Interest on working capital			815.04		1300.8		1317.6		1050
	Cost A			13854		23315.8		23707.6		18920
11	Interest on fixed capital			1250		2150		2500		2563
12	Rental value of land			2767		13000		12000		9333
	Cost B			17871		38466		38208		30816
13	Family labour									
	a. Male	Days	20	3000	30	4500	27	4050	24	3600
	b. Female	Days	15	1500	45	4500	51	5100	38	3800
	Cost C			22371		47466		47358		38216
14	Production									
	a. Main produce	qt.	17	15300	13	78000	8	72000	7	56000
	b. By produce	qt.	13	1300	0	0	0	0	0	0
	Total			16600		78000		72000		56000

CONTENTS

LIST OF TABLES

LIST OF FIGURES

FS-IV										
			Mango		Cashewnut		Ladyfinger		Snakegaurd	
			Av. Size	0.77	Av. Size	0.80	Av. Size	0.40	Av. Size	0.24
Sr. No.	Particulars	Unit	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)
1	Hired human labour									
	a. Male	Days	52	7800	55	8250	127	19050	69	10350
	b. Female	Days	29	2900	39	3900	85	8500	45	4500
2	Bullock labour	Pair/ days	0	0	0	0	15	4500	25	7500
3	Seed material	kg.	0	0	0	0	19	4750	10	8500
4	FYM/Compost	qt.	9	2250	10	2500	15	3750	14	3500
5	Fertilizers	kg.	450	5400	368	4416	685	8220	523	6276
6	Rab material	qt.	0	0	0	0	0	0	0	0
7	PPC	Lit.	3	2700	0	0	7	6300	3	2700
	Total			21050		19066		55070		43326
8	Depreciation on charges			486		298		654		546
9	Land revenue and other cesses			65		60		60		60
10	Interest on working capital			1263		1144		3304.2		2600
	Cost A			22864		20568		59088.2		46532
11	Interest on fixed capital			4125		3658		1256		2154
12	Rental value of land			16667		17767		48417		20533
	Cost B			43656		41993		108761		69219
13	Familylabour									
	a. Male	Days	49	7350	51	7650	98	14700	38	5700
	b. Female	Days	35	3500	35	3500	79	7900	52	5200
	Cost C			54506		53143		131361		80119
14	Production									
	a. Main produce	qt.	50	100000	13	106600	83	290500	56	123200
	b. By produce	qt.	0	0	0	0	0	0	0	0

	Total			100000		106600		290500		123200
16	Net Returns			45494		53457		159139		43081
17	Input Output ratio			1.83		2.01		2.21		1.54

	FS-IV					
			Ghewada		Watermelon	
			Av. Size	0.22	Av.Size	0.50
Sr. No.	Particulars	Unit	Quantity	Value (Rs.)	Quantity	Value (Rs.)
1	Hired human labour					
	a. Male	Days	82	12300	90	13500
	b. Female	Days	95	9500	46	4600
2	Bullock labour	Pair/days	16	4800	13	3900
3	Seed material	kg.	32	9600	3.5	8750
4	FYM/Compost	qt.	16	4000	16	4000
5	Fertilizers	kg.	569	6828	510	6120
6	Rab material	qt.	0	0	0	0
7	PPC	Lit.	1.5	1350	1.5	1350
	Total			48378		42220
8	Depreciation on charges			593		596
9	Land revenue and other cesses			60		60
10	Interest on working capital			2902.68		2533.2
	Cost A			51933.68		45409.2
11	Interest on fixed capital			2356		2568
12	Rental value of land			26000		23690
	Cost B			80289.68		71667.2
13	Familylabour					
	a. Male	Days	60	9000	56	8400
	b. Female	Days	63	6300	43	4300
	Cost C			95589.68		84367.2
14	Production					
	a. Main produce	qt.	52	156000	95	142500
	b. By produce	qt.	0	0	0	0
	Total			156000		142500
15	Cost per quintal					
16	Net Returns			60410.32		58132.8
17	Input Output ratio			1.63		1.69

APPENDIX IV

Per hectare cost and returns of crop grown in farming systems in cluster II

	FS-I	

			Paddy		Mango		Cashewnut		Arecanut	
			Av. Size	0.65	Av. Size	0.69	Av. Size	0.82	Av. Size	0.30
Sr. No.	Particulars	Unit	Quantity	Value	Quantity	Value	Quantity	Value (Rs.)	Quantity	Value
1	Hired human labour									
	a. Male	Days	47	7050	45	6750	51	7650	40	6000
	b. Female	Days	37	3700	32	3200	45	4500	30	3000
2	Bullock labour	Pair/ days	21	6300	0	0	0	0	0	0
3	Seed material	kg.	50	1000	0	0	0	0	0	0
4	FYM/Compost	qt.	52	13000	9	2250	9	2250	9	2250
5	Fertilizers	kg.	170	2040	485	5820	495	5940	60	720
6	Rab material	qt.	20	800	0	0	0	0	0	0
7	PPC	Lit.	0	0	5	4500	3	2700	1.5	1350
	Total			33890		22520		23040		13320
8	Depreciation on charges			279		1123		346		570
9	Land revenue and other cesses			60		60		60		60
10	Interest on working capital			2033		1351		1382.		799
	Cost A			36262		25054		24828		14749
11	Interest on fixed capital			2645		3345		3615		3012
12	Rental value of land			8500		19250		19133		9917
	Cost B			47407		47649		47577		27678
13	Family labour									
	a. Male	Days	36	5400	45	6750	50	7500	45	6750
	b. Female	Days	30	3000	23	2300	35	3500	26	2600
	Cost C			55807		56699		58577		37028
14	Production									
	a. Main produce	qt.	28	40600	55	115500	14	114800	7	59500
	b. By produce	qt.	52	10400	0	0	0	0	0	0
	Total			51000		115500		114800		59500
15	Net Returns			-480		58801		56223		22472

				7						
16	Input Output ratio			0.91		2.04		1.96		1.61

FS-I					FS-II					
			Coconut		Paddy		Mango		Cashewnut	
			Av. Size	0.45	Av. Size	0.50	Av. Size	0.62	Av. Size	0.70
Sr. No.	Particulars	Unit	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1	Hired human labour									7500
	a. Male	Days	60	9000	49	7350	42	6300	50	4100
	b. Female	Days	21	2100	34	3400	36	3600	41	0
2	Bullock labour	Pair/ days	0	0	19	5700	0	0	0	0
3	Seed material	kg.	0	0	52	1040	0	0	0	0
4	FYM/Compost	qt.	14	3500	60	15000	12	3000	0	1600
5	Fertilizers	kg.	630	7560	168	2016	510	6120	8	3060
6	Rab material	qt.	0	960	18	720	0	0	306	0
7	PPC	Lit.	0	0	0	0	4.5	4050	4	3800
	Total			23120		35226		23070		20060
8	Depreciation on charges			900		291		1250		360
9	Land revenue and other cesses			60		60		60		60
10	Interest on working capital			1387		2113.56		1384.2		1203.6
	Cost A			25467		376900.56		25764.2		21683.6
11	Interest on fixed capital			3160		2594		3451		3646
12	Rental value of land			16333		8117		17667		16673
	Cost B			44960		484001		46882		42003
13	Family labour									
	a. Male	Days	42	6300	29	4350	41	6150	49	7350
	b. Female	Days	33	3300	42	4200	29	2900	42	4200
	Cost C			54561		56951		55932		53553
14	Production									
	a. Main produce	qt.	9800	98000	26	37700	53	106000	12.2	100040
	b. By produce	qt.	0	980	55	1100	0	0	0	0

				00		0				
	Total					48700		106000		100040
15	Net Returns			43439		-8251		50068		46487
16	Input Output ratio			1.80		0.85		1.90		1.87

FS-II										
			Ladyfinger		Snakegaurd		Brinjal		Green chilli	
			Av. Size	0.30	Av. Size	0.23	Av. Size	0.23	Av. Size	0.24
Sr. No.	Particulars	Unit	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)
1	Hired human labour									
	a. Male	Days	121	18150	75	11250	75	11250	90	13500
	b. Female	Days	92	9200	50	5000	68	6800	81	8100
2	Bullock labour	Pair/ days	14	4200	23	6900	15	4500	17	5100
3	Seed material	kg.	20	5000	11	9350	0.8	320	1.5	1500
4	FYM/Compost	qt.	14	3500	14	3500	15	3750	25	6250
5	Fertilizers	kg.	654	7848	550	6600	410	4920	410	4920
6	Rab material	qt.	0	0	0	0	0	0	0	0
7	PPC	Lit.	6	5400	3.5	3150	2	1800	1.5	1275
	Total			53298		45750		33340		40645
8	Depreciation on charges			596		546		320		657
9	Land revenue and other cesses			60		60		60		60
10	Interest on working capital			3198		2745		2000		2439
	Cost A			57152		49101		35720		43801
11	Interest on fixed capital			1315		2154		1845		2635
12	Rental value of land			40833		18700		21667		32083

	Cost B			99300		69955		59232		78519
13	Familylabour									
	a. Male	Days	105	15750	41	6150	56	8400	95	14250
	b. Female	Days	85	8500	52	5200	67	6700	96	9600
	Cost C			123550		81305		74332		102369
14	Production									
	a. Main produce	qt.	70	245000	51	112200	65	130000	55	192500
	b. By produce	qt.		0		0		0		0
	Total			245000		112200		130000		192500
16	Net Returns			121450		30895		55668		90131
17	Input Output ratio			1.98		1.38		1.75		1.88

FS-III										
			Arecanut		**Coconut**		**Cowpea**		**Wal**	
			Av. Size	**0.60**	**Av. Size**	**0.62**	**Av. Size**	**0.21**	**Av. Size**	**0.19**
Sr. No.	**Particulars**	**Unit**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**
1	Hired human labour									
	a. Male	Days	39	5850	29	4350	28	4200	32	4800
	b. Female	Days	30	3000	19	1900	65	6500	34	3400
2	Bullock labour	Pair/ days	0	0	0	0	25	7500	16	4800
3	Seed material	kg.	0	0	0	0	26	1040	40	6000
4	FYM/Compost	qt.	10	2500	12	3000	13	3250	9	2250

5	Fertilizers	kg.	83	996	610	7320	75	900	64	768
6	Rab material	qt.	0	0	0	520	0	0	0	0
7	PPC	Lit.	1.5	1350	0	0	4	3600	0	0
	Total			13696		17090		26990		22018
8	Depreciation on charges			450		1060		310		520
9	Land revenue and other cesses			60		60		60		60
10	Interest on working capital			822		1025		1619		1321
	Cost A			15028		19235		28979		23919
11	Interest on fixed capital			3150		3354		3251		2865
12	Rental value of land			11617		12917		14667		12750
	Cost B			29794		35506		46897		39534
13	Family labour									
	a. Male	Days	39	5850	29	4350	23	3450	31	4650
	b. Female	Days	34	3400	18	18000	21	2100	28	2800
	Cost C			39044		41		52447		46984

						656				
14	Production									
	a. Main produce	qt.	8.5	69700	7750	775000	16	88000	8.5	76500
	b. By produce	qt.		0	0	0		0		0
	Total			69700		775000		88000		76500
16	Net Returns			30656		35844		35553		29516
17	Input Output ratio			1.79		1.86		1.68		1.63

			FS-III		FS-IV							
			Pawata		Paddy		Summer Paddy		Nagli		Groundnut	
			Av. Size	0.23	Av. Size	0.63	Av. Size	0.27	Av. Size	0.21	Av. Size	0.21
Sr. No.	Particulars	Unit	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)
1	Hired human labour											
	a. Male	Days	35	5250	41	6150	62	9300	25	3750	80	120000
	b. Female	Days	45	4500	32	3200	55	5500	29	2900	55	55000
2	Bullock labour	Pair/ days	18	5400	14	4200	19	5700	17	5100	18	54000
3	Seed material	kg.	27	2160	48	960	42	1050	9	180	80	6400
4	FYM/Compost	qt.	17	4250	65	130000	20	5000	7	1750	16	4000
5	Fertilizers	kg.	65	780	220	22000	490	5880	80	960	362	4344
6	Rab material	qt.	0	0	22	880	15	600	0	0	0	0
7	PPC	Lit.	4	3600	0	0	0	0	0	0	1	900
	Total			25		30		33		14		38

			FS-I		FS-II		FS-III		FS-IV		
				940		590		030		640		544
8	Depreciation on charges			370		325		568		390		654
9	Land revenue and other cesses			60		60		60		60		60
10	Interest on working capital			1556		1835		1982		878		2312
	Cost A			27926		32810		35640		15968		41571
11	Interest on fixed capital			3125		1765		2865		2534		2645
12	Rental value of land			12000		8133		5850		3966		10000
	Cost B			43051		42709		44355		22469		54216
13	Family labour											
	a. Male	Days	26	3900	41	6150	32	4800	19	2850	52	7800
	b. Female	Days	38	3800	25	2500	45	4500	17	1700	68	6800
	Cost C			50751		51359		53655		27019		68815
14	Production											
	a. Main produce	qt.	9	72000	26	39000	26	35100	15	22500	15	60000
	b. By produce	qt.	0	0	49	9800	50	10000	13	1300	30	6000
	Total			72000		48800		45100		23800		66000
16	Net Returns			2124 9		-2559		-8555		-3219		-2816
17	Input Output ratio			1.42		0.95		0.84		0.88		0.95

			FS-I				FS-III		FS-IV	
Sr. No.	**Particulars**	**Unit**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**
1	Hired human labour									
	a. Male	Days	121	18204	103	15459	48	6782.5	214	32166
	b. Female	Days	84	8403	91	9037	68	5590.5	142	14223
2	Bullock labour	Pair/ days	16	4761	9	2556	33	9895	22	6606
3	Seed material	Kg.	36	717.6	37	738.4	46	2165.14	19	10427
4	FYM/Compost	qt.	48	10083	44	9430	42	10384	36	8952.5
5	Fertilizers	Kg.	802	8996.2	510	5865.12	125	1507.6	1421	16354.2
6	Rab material	qt.	13	524.4	14	918	10	418	0	0
7	PPC	Lit.	6	5947.25	1	768.6	1	535.5	7	6192
8	Dry fodder									
	a. Grass	No			4	1750				
	b. Rice Straw	qt			40	6038				
9	Feed	qt			17	25500				
10	Concentrate	Kg			12	22050				
	Total			57636.45		100110		36860.24		94920.7
11	Depreciation on charges			2039		1346		733.99		
12	Land revenue and other cesses			160		119		178.6		1616
13	Interest on working capital			3706.227		2161.3272		1527.906		203
	Cost A			63541.677		42973		39285.736		5695.242
14	Interest on fixed capital			8216		10581		4367.99		102434.942
15	Rental value of land			39445		21013		12974.86333		10099
	Cost B			111202.677		178303		56628.58933		69190
16	Family labour									181723.942
	a. Male	Days	108	16212	95	17029	45	6306.5	168	25207.5
	b. Female	Days	77	7749	121	12087	75	6027	134	13439
	Cost C			135163.677		207419		68962.08933		220370
17	Production									
	a. Main produce	qt.		223220		213280		75769		415500

	b. By produce	qt.		7000		7649		2321.4		0
	Total			230220		220929		78090.4		415500
18	Net Returns			95056.323		13568		9128.310667		195130
19	Input Output ratio			1.70		1.06		1.13		1.89

Cluster-I

$$Z = 19948_{X1} + 7000_{X2} + 8000_{X3} + 26000_{X4} + 20324_{X5} + 23960_{X6} + 110000_{X7} + 57612_{X8} + 143363_{X9} + 123768_{X10} + 46000_{X11} + 57000_{X12} + 12000_{X13} + 35000_{X14}$$

$Area\ Kharif$

$X_1 + X_2 + X_3 \leq 53$ ……(1)

$Area\ (Residual\ Moisture)$

$X_4 + X_5 + X_6 \leq 30$ ……(2)

$Area\ (Irrigated)$

$X_7 + X_8 + X_{10} + X_{14} \leq 21$ ……(3)

$Total\ Area$

$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_9 + X_{10} + X_{14} \leq 104$ ……(4)

$Cereal\ requirement$

$60X_1 + 12X_2 + 12X_3 \geq 1090$ ……(5)

$Pulse\ requirement$

$8X_4 + 10X_5 + 10X_6 \geq 50$ ……(6)

$Vegetable\ requirement$

$100X_7 + 100X_8 + 150X_{10} \geq 400$ ……(7)

$F.Y.M\ requirement$

$8X_1 + 5X_2 + 5X_3 + 5X_4 + 5X_5 + 5X_6 + 15X_7 + 15X_8 + 15X_9 + 15X_{10} + 5X_{14} \geq 0$ ……(8)

$F.Y.M\ Production$

$$2X_{11} + 2.5X_{12} + 1.5X_{13} \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Dry Fodder production

$$8.5X_1 + 5X_2 + 4X_3 + 5X_4 + 5X_5 + 6X_6 + 5X_{14} \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

Dry Fodder requirement

$$9X_{11} + 13X_{12} + 11X_{13} \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

Green Fodder requirement

$$5X_{11} + 8X_{12} + 5X_{13} \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Green Fodder Production

$$450X_{14} \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

Milk requirement

$$1100X_1 + 1200X_2 \geq 35000 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (14)$$

non negative restrictions

$$X_i \geq 0 \qquad i = 1,2, \ldots\ldots\ldots 13 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Cluster -II

$$Z = 22560X_1 + 17419X_2 + 8000X_3 + 25300X_4 + 20919X_5 + 22950X_6 + 123928X_7 + 130427X_8 + 82436X_9 + 110400X_{10} + 15000X_{11} + 43500X_{12} + 63000X_{13} + 12000X_{14} + 40000X_{15}$$

$Area\ (Kharif)$

$$X_1 + X_2 + X_3 \leq 38 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$Area\ (Residual\ moisture)$

$$X_4 + X_5 + X_6 \leq 30 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$Area\ (Irrigated)$

$$X_2 + X_7 + X_8 + X_9 + X_{10} + X_{14} + X_{15} \leq 31 \quad \ldots\ldots\ldots\ldots\ldots (3)$$

$Total\ Area$

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_9 + X_{10} + X_{11} + X_{15} \leq 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$Cereal\ Requirement$

$$50X_1 + 40X_2 + 10X_3 \geq 1012 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$Pulse\ Requirement$

$$10X_4 + 10X_5 + 10X_6 \geq 25 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$Vegetable\ Requirement$

$$100X_7 + 250X_8 + 120X_9 + 150X_{10} \geq 450 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$F.Y.M\ requirement$

$$8X_1 + 8X_2 + 5X_3 + 5X_4 + 5X_5 + 5X_6 + 15X_7 + 15X_8 + 15X_9 + 15X_{10} + 10X_{14} + 5X_{15} \geq 0 \quad \ldots(8)$$

$F.Y.M\ Production$

$$2.5X_{12} + 2.5X_{13} + 2X_{14} \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

$Dry\ fodder\ production$

$$10X_1 + 10X_2 + 4X_3 + 4X_4 + 5X_5 + 3X_6 + 10X_{11} + 10X_{15} \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (10)$$

$Dry\ fodder\ requirement$

$$9X_{12} + 10X_{13} + 10X_{14} \geq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

$Green\ fodder\ requirement$

$5X_{12} + 8X_{13} + 8X_{14}$

≥ 0 …… (12)

$Green\ fodder\ production$

$450X_{15} \geq$

0 …… (13)

$Milk\ requirement$

$1200X_{12} + 1500X_{13} \geq$

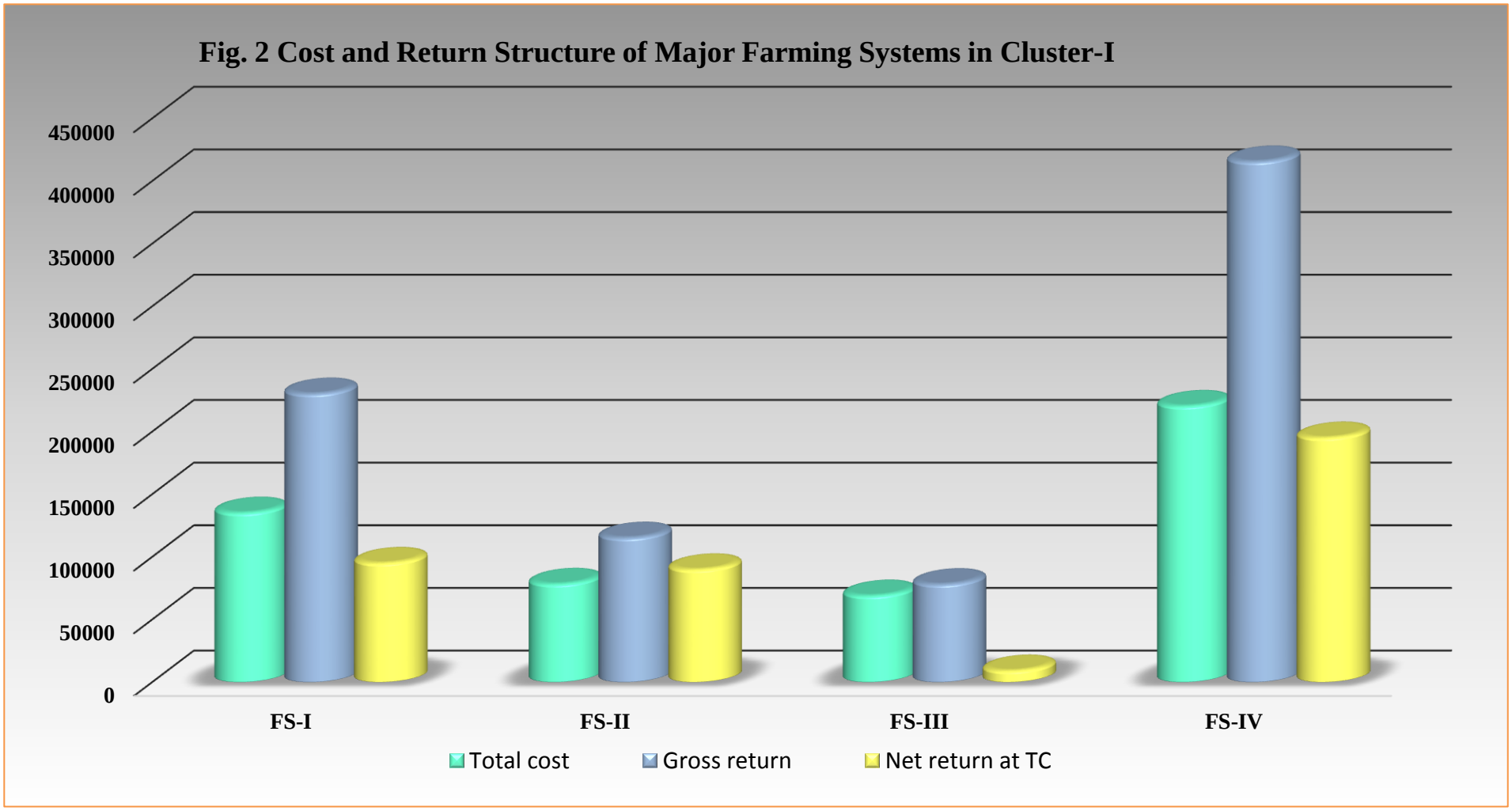
35000 …… (14)

$Non - negative\ restrictions$

$X_i \geq 0$ i

$= 1,2,3$ …… (15)

Fig. 2 Cost and Return Structure of Major Farming Systems in Cluster-I



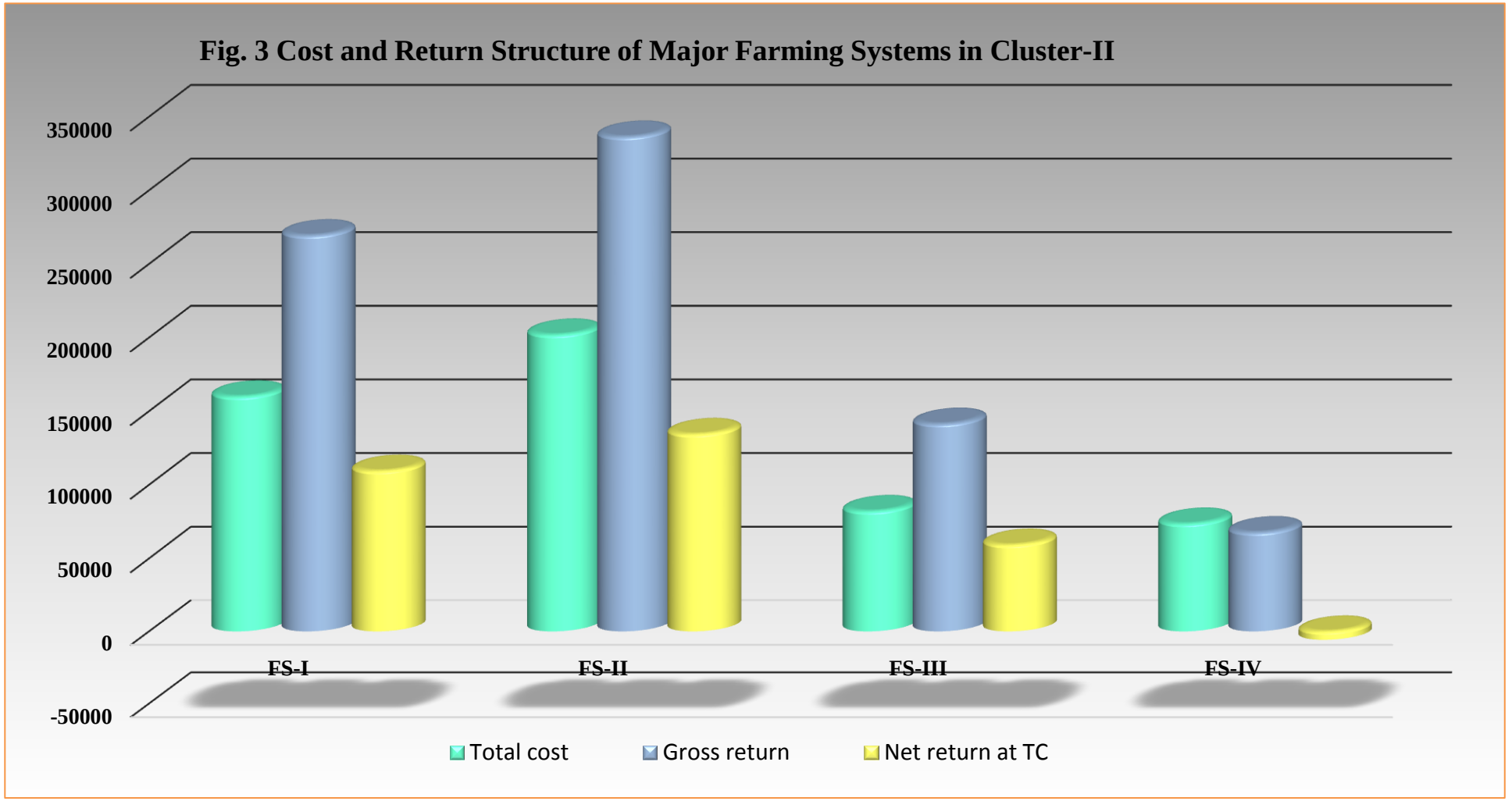


Fig. 3 Cost and Return Structure of Major Farming Systems in Cluster-II
350000
300000
250000
200000
150000
100000
50000
0
-50000
FS-I
FS-II
FS-III
FS-IV
Total cost
Gross return
Net return at TC

APPENDIX I

Department of Agricultural Economics,
College of Agriculture, Dapoli
Dr.BSKKV Dapoli, Dist- Ratnagiri (MH)

SCHEDULE

Economic Analysis of Farming Systems in South Konkan Region.

Name: Gore Sudarshan Tanaji **Discipline:** Agricultural Economics
Degree: Ph.D **Regd.No:** 161
Year: 2014-2015

1) **General information of farmer:**

1	Name:	2	Age:
3	Education:	4	Village
5	Taluka:	6	District:
7	Occupation:		
a	Main:	b	Subsidiary:

2) **Family size and composition:**

Sr. No	Particulars	Total Members			Working on Farm		
		Male	Female	Total	Male	Female	Total
1	Below 14 years						
2	Above 14 years						
3	Old age (above 65 years)						
4	Earning Member						
5	Total						

3) Land Resources:

Sr.No	Particulars	Area (acres)	Land Rent paid /received	
			Irrigated	Unirrigated
1	Owned		----------	----------
2	Land leased in			
3	Land leased out			
4	Total operational holding			

4) Land Utilization:

Sr.No	Category	Area (ha/Acres)
i)	**Cultivated area**	
	• Irrigated	
	• Unirrigated	
	• Total	
ii)	**Fallow land**	
	• Current	
	• Permanent fallow	
iii)	**Grazing land**	
	Total land holding	

5) Cess paid on specific crops:

Sr.No	Crops	Cess paid (Rs)
1		
2		
3		
4		
5		

6) Cropping pattern:

Sr.No	Season	Area (Acres)	Yield (Q)		Rate (Rs.)/Qt	
			Main	By Produce	Main	By Produce
I	**Kharif:**					
	i)					
	ii)					
	iii)					
	iv)					
	v)					
II	**Rabi**					
	i)					
	ii)					
	iii)					
	iv)					
	v)					
III	**Perennial crops:**					
	i)					
	ii)					
	iii)					
	iv)					
	v)					

7) Resource Inventory:

Sr. No	Available resource/ Input	Unit	Qty	Price	From where it is purchased (Place of purchase)		Distance in Km
					Own village	Other place	

8) Capital Availability

Sr.No	Enterprise	Own capital	Loan taken if any		Loan disbursement	Amount to repay
			Source	Amount		

9) Detailed cost of crop production: (separate for each crop)

Name of crop: i) variety: Area (ha):

Sr. No	Operation	Human labour						Bullock labour Days/hr	Material	
		Family			Hired				Qty /No	Amount (Rs)
		M	F	C	M	F	C			
1	Collection of rab material									
2	Preparatory tillage									
a	Repairs of bunds									
b	Ploughing									
c	Planking									
d	Any other									
3	Applying F.Y.M									
4	Sowing/raising seedling									
5	Transplanting/gap filling									
6	Interculture									
	a)weeding									
	b)hoeing									
7	Applying Fertilizer									
8	Irrigation									
9	Spraying/dusting									
10	Threshing and cleaning									
11	Harvesting and transport									
12	Drying and bagging									
13	Any other operation									
	Total									

10) Farm assets:

A) Machineries and Implements:

Sr.No	Particulars	No	Year of purchase	Purchase price (Rs)	Present value (Rs)	Repairs (Rs)
1	**Machinery**					
a	Tractor					
b	Power tiller					
c	Oil engine with pump set					
d	Electric Motor					
2	**Implements:**					
a	Iron plough					
b	Wooden plough					
c	Paddy thresher					
d	Sprayer/ duster					
e	Harrow					
f	Hoe					
3	**Hand Tools**					
a	Sickles					
b	Koyata					
c	Pick axe					
d	Spade					
e	Iron basket					
f	Other					
4	**Vehicles**					
a	Bullock cart					
b	Tempo:					
c	Other:					

B) Farm building

Sr No	Particulars	No	Area	Year of Construction	Cost of Construction	Present value	Repairs
1	Farm House						
2	Cattle Shed						
3	Godown						
4	Irrigation shed						

C) Irrigation structure:

Sr. No	Particulars	No.	Year of construction	Purchase price (Rs)	Present Value	Repairs
1	**Well**					
	a) Open well					
	b) Bore well					
	c) Open + Bore well					
2	**Pump set**					
	a) Electric motor					
	b) Oil engine					

3	Pipe line					
4	Sprinkler set					
5	Drip irrigation set					
7	Other					

11) Livestock:

Sr. No	Particulars	No	Age (years)	Year of purchase	Purchase price (Rs)	Present value (Rs)
1	**Drought animals:**					
	a)Bullock					
	b) He-buffalo					
2	**Milch animals**					
	a)Crossbreed cows					
	b) Local cattle					
	c) Buffalo					
3	**Breeding bull**					
4	**Heifers (< 3 years)**					
5	**Goats**					
6	**Sheep**					
7	**Poultry birds**					

12) Detail information of orchard:

Sr.No	Name of plant	Age	Area (ha)	No. of palms/trees		Spacing	Variety	Intercrops in garden	
				bearing	Non bearing			Bearing	Non bearing
1	**Mango**								
	Orchard I								
	Orchard II								
	Orchard II								
2	**Cashewnut**								
	Orchard I								
	Orchard II								
	Orchard II								
3	**Coconut**								
	Orchard I								
	Orchard II								
	Orchard II								
4	**Arecanut**								
	Orchard I								
	Orchard II								
	Orchard II								
5	**Other**								

13) Input Utilization for maintenance of orchard:

Sr.No	Name of plant	INPUTS				Plant protn.	Other
		F.Y.M	Fertilizers (Qt)				
			N	P	K		
1	**Mango**						
	Orchard I						
	Orchard II						
	Orchard II						
2	**Cashewnut**						
	Orchard I						
	Orchard II						
	Orchard II						
3	**Coconut**						
	Orchard I						
	Orchard II						
	Orchard II						
4	**Arecanut**						
	Orchard I						
	Orchard II						
	Orchard II						
5	**Other**						
	Orchard I						

14) Operation wise labour utilized for maintenance of orchard:
(Separate for each orchard)

Sr.No	Name of operation	Family labour (days)		Hired labour (days)		Machinery (hours)
		Male	Female	Male	Female	
1	Cleaning of orchard repairing fence					
2	Application of manures (No.of doses..)					
3	Application of fertilizers (No.of doses)					
4	Application of plant protection measures					
5	Preparation of channels and basins for irrigation					
6	Giving irrigation a)winter------days b)summer--------days					
7	Harvesting (No. of harvesting)					
8	Transporting/ storage					
9	Other operation					

15) Operation wise labour required for maintenance of livestock:

Sr.No	Type of work	Family labour (days)			Hired labour (days)		
1	**Dairy**	M	F	C	M	F	C
	i)Feeding and care						
	ii)Tending cattle						
	iii)Milking and distribution						
2	**Poultry**						
	i)Feeding and care						
	ii) Any other						
3	Other						

16) Running expenses for livestock maintenance (for one year)

Sr.No	Particulars	Qty/No	Price/unit (Rs)	Amount (Rs)
1	**Dairy**			
	i)Feeds			
	a) Owned			
	b) purchased			
	ii)Concentrates			
	a)purchased			
	iii)Dry fodder			
	a)Owned			
	b)purchased			
	iv)Green fodder			
	a)Owned			
	b)purchased			
	v)veterinary aid			
	vi)Any other			
2	**Poultry**			
	i)Feeds			
	a)Owned			
	b)purchased			
	c)Veterinary aid			
	d)Any other			

17) Receipts from Crop production:

Sr.No	Crop	Production		Rate/unit		Total value (Rs)
	Sole/mixed/intercrop	**Main Product (Qt)**	**By Product (Qt)**	**Main Product (Qt)**	**By Product (Qt)**	

18) Receipts from livestock:

Sr.No	Product	Production qt/No	Disposal			Rate (Rs)	Amount (Rs)
			Home Consumption qt/No	Sold qt/No	Any other qt/No		
1	Dairy						
	a)Milk						
	i)cow						
	ii)buffalo						
	b)F.Y.M (C.L)						
	e)Any other						
2	Poultry						
	a)Eggs						
	b)Birds						
	c)Poultry manure (C.L)						
3	Any other						

19) Details about price prevailed in the village:

Sr No	Operation/Name of input	Male		Female		Child (Rs)	Rate (Rs/kg)
		Cash (Rs)	Kind	Cash (Rs)	Kind		
1	Peak season						
	a)Sowing						
	b)Harvesting						
2	Off season						
3	Permanent labour						
	a)Monthly						
	b)Yearly						
4	Manures (C.L)						
5	Seed						
6	Fertilizers (kg)						
	i)						
	ii)						
	iii)						
	iv)						
7	Insecticides/pesticides						
	i)						

	ii)						

20) Constraints:

1) Regarding labour : a) Non availability when actually need b) Wages are high c) Shortage of labour d) Other 2) Regarding manures/ fertilizers : a) Not available in village itself b) Shortage of F.Y.M/ manures c) High cost of manures d) High cost of fertilizers e) Others 3) Regarding irrigation: a) Shortage of water in summer b) Failure of electricity supply c) High cost of electricity d) Other	4) Regarding marketing of produce: a) Do not fetch market price b) No adequate demand in nearby area c) Transport is costly d) High marketing cost. 5) Regarding input: a) Non-availability of quality input b) High cost of input c) Others 6) Regarding return: a) Low price b) Price fluctuation d) High cost of production e) Other

7) Fragmentation and subdivision of the land holding. Yes / No.
8) Scarcity of owned fund, credit problems. Yes / No.
9) Non availability of technical assistance. Yes / No.

Abstract

Introduction and Research Objectives

Appendices

Implications

Summary and Conclusions

Results and Discussion

Methodology

Review of Literature

SYNOPSIS OF RESEARCH WORK

ECONOMIC ANALYSIS OF FARMING SYSTEMS IN SOUTH KONKAN REGION

Submitted by:

SUDARSHAN TANAJI GORE

Ph.D (Ag.)

Regd. No. 161

Submitted to:

DEPARTMENT OF AGRICULTURAL ECONOMICS,

COLLEGE OF AGRICULTURE, DAPOLI.

DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH,

DAPOLI, DIST: RATNAGIRI

Introduction

In farming system approach, the farm is viewed in holistic manner. The farmers are confronted with many socio-economic, biological, institutional, administrative and technological constraints. The farming system conceptually is a set of elements or components, which are interrelated and interact among themselves. At the Centre of interaction is the farmer himself, exercising control and choice regarding the type and results of interaction.

Recently research on farming system has been gaining momentum and the scientists and research scholars are developing tools and techniques to discover the more practicable methods to improve the farming. This study is an attempt in this direction covering different aspects of farming system with respect to agricultural development in South Konkan region of Maharashtra State.

Indian agriculture is characterised by mixed farming involving a system of combining crop production with one or more of the livestock enterprises like rearing of cattle, sheep, goat, pigs and poultry as well as fishery, bee-keeping, sericulture, etc. Although in India farming is not commercialized to a large extent, it remains that farmer has to make decisions regarding his business of farming, with a view to attaining maximum welfare. The welfare may not be maximization of net profit in the usual sense, but it can be assumed that he would like to maximize farm income by which he can maintain himself and his family. The decision of enterprise mix on a farm will be conditioned by overall welfare of the family. In describing Farming Systems and their characteristics, we start therefore with the assumption that they did not come about by chance and that there is always a reason why farming in a specific case is carried out in one way rather than another.

Farming is a complex human activity consisting of farm enterprises which are interrelated and interact for the available resources and environment. It also involves application of highly sophisticated technology on one side and the physical, social and economic factor on other. Hence, successful attainment of total agricultural development depends on the farming system approach to a large extent. Many experts have also opined that there is need to understand and analyze the existing farming systems in order to quicken the pace of agricultural development. Failure to understand the existing farming systems and the proposed

improved technology might often lead to failure of the new technology. It was therefore, felt necessary that study on farming systems be taken up. Present study was undertaken to examine the farming systems in South Konkan region with the following specific objectives

1) To identify the existing farming systems in the study area.
2) To work out the cost, returns and profitability of major farming systems.
3) To study the resource use efficiencies and productivities of major farming systems.
4) To assess the possibilities of optimization of profit in major farming systems.
5) To identify the constraints faced by the farmers in the existing farming systems and suggest remedial measures.

Hypotheses

1) In existing farming systems there is higher proportion of dryland horticulture.
2) In existing farming systems various resource allocation and resource levels are not properly organised.
3) There is scope for optimum use of existing resources.

Methodology

In present study the multistage sampling procedure was followed in the present study. The South Konkan region has varied agro climatic conditions. Hence, it was felt necessary to delineate the region in to sub regions. The secondary data on various aspects were collected from the district statistical abstracts and Joint Director of Agriculture, Thane for both districts *viz.*, Ratnagiri and Sindhudurg.

Primary data on various aspects of farming were collected from head of each household with the help of a set of pre-tested comprehensive questionnaire designed for the study. Primary data so collected pertained to 100 samples from each region. In all, 200 farmers were selected to elicit information for study.

The present study made use of different statistical techniques such as percentages, ratios, correlations, different cost concepts and higher analytical techniques, such as cluster analysis, production function analysis and linear programming etc. The cluster analysis was carried out by using hierarchical agglomerative method. Cobb-Douglas type of production functions were formed

separately for crop and other enterprises to study the resource use efficiency. The deterministic linear programming model was used for studying the optimum farming systems. The two types of optimum solutions simulated were: a) optimum farming system at existing resource level (optimum plan M-I) and b) optimum farming system at enhanced resource level (optimum plan M-II).

Results and discussion

The important outcomes with reference to objectives referred for the study are presented in following paragraphs

The cluster analysis delineated the study area in to two distinct clusters. The first cluster included 9 tahsils namely Mandangad, Dapoli, Khed, Chiplun, Sangameshwar, Lanja, Rajapur, Ratnagiri, Guhagar. The second cluster consisted of 8 tahsils namely Devgad, Vaibhavwadi, Kankavli, Sawantwadi, Vengurle, Dodamarg, Kudal, Malvan.. The average age of the farmers was 49.84 years with 86.00 per cent literacy. The average family size was 6.34. As regards to occupation at overall level, the majority of the farmers (74.00 %) have their main occupation as agriculture.

In study area 8 existing major farming systems were identified. In cluster I, 4 major farming systems were identified namely 1) Paddy + Rainfed plantations (FS-I), 2) Paddy + Irrigated plantations+ Dairy (FS-II), 3) Paddy + Other cereals pulses (FS-III), 4) Rainfed plantations+ Vegetables (FS-IV).

The major farming systems in cluster II region were 1) Paddy + Rainfed plantations+ Irrigated plantations (FS-I), 2) Paddy + Rainfed plantations+ Vegetables (FS-II), 3) Irrigated plantations+ Pulses + Dairy (FS-III), 4) Paddy + Other cereals +Oilseed (FS-IV).

The land holding pattern across all the farming systems adopted in cluster I regions indicated that per farm land holding was ranging from 1.75 hectares in FS-III to 3.17 hectares in FS-IV. In cluster II, the operational holding was ranging from 1.71 hectares in FS-IV to 3.35 hectares in FS-I.

In the study area the crops grown and enterprises followed had a large variation not only between farming systems and also in different regions. The important crops grown in the study area were Paddy, Finger millet (Nagli), Mango,

Cashewnut, Coconut, Arecanut. The pulses and vegetables crops included Lady's finger, Brinjal, Cowpea, *Pawata, Wal,* Snake gourd, Chilli, Watermelon etc.

The gross cultivated per holding area in cluster I was ranging from 1 hectares in FS-III to 2.92 hectare in FS-IV. However, cropping intensity was less at 167 per cent in farming system III. In cluster II, the gross cropped area was ranging from 0.84 hectare in FS-IV to 2.91 hectares in FS-I. Cropping intensity I was found to highest in FS-III (167%) and cropping intensity II was ranging from 167 per cent to 242.73 per cent in cluster I. In cluster-II, on the area and crop duration basis cropping intensity II was ranging from 165.47 per cent to 255 per cent. The cropping intensity I was highest (165.47%) in FS-IV in cluster II

In South Konkan region it was observed that, in case of paddy the per hectare gross returns were maximum in FS-I (Rs.49000) followed by in FS- II (Rs 44000) in cluster I. The per hectare total cost of cultivation of paddy was maximum in FS-I Rs.52587.

In case of mango production per hectare net returns over total cost were Rs.45600 and Rs.45495 in in FS-I and FS-IV respectively (cluster- I). The per hectare gross returns worked out to Rs.100000 in both the farming systems. The per hectare net returns were ranging from Rs.50068 (FS-II) to Rs.58801 (FS-I) in cluster- II. Similar observation were also recorded by Swami (2004) and Bhuwad (2012) while studying farming systems in Ratnagiri district of Maharashtra.

The per hectare gross returns in Lady's finger, brinjal and snake gourd were Rs.245000, Rs.130000 and Rs.112200 respectively. The per animal total maintenance cost in dairy enterprise was Rs.43404, whereas the maximum gross returns were Rs.48700 in FS-III in cluster- II.

In case of watermelon the total cost and total gross returns were Rs. 84367 and Rs.142500 (cluster-I). Among the pulse crops per hectare gross returns (Rs. 78000) and net returns over total cost (Rs. 47466) were maximum in cowpea. The per hectare total cost and total returns in lady's fingure were Rs.131361 and Rs.290500 (cluster-I) which revealed that lady's fingure was most remunerative crop of the region.

In case of Cashewnut per hectare gross returns and total cost were Rs.114800 and Rs.58577 (FS-I). The returns on each rupee invested were ranging from Rs.1.87 in FS-II to Rs.1.96 in FS-I (Cluster-II)

In case of coconut per hectare gross returns were maximum in FS-I (Rs.98000) followed by in FS-III (Rs.77500). The per hectare net returns at total cost were ranging from Rs.35844 in FS-III to Rs.43439 in FS-I. . The returns on per rupee invested by the farmers were ranging from Rs.1.80 in FS-I to Rs.1.86 in FS-III (Cluster-II). Swami (2004) in his study in Ratnagiri district also found that the input output ratio in coconut was 1.85

In case of Cluster-I region, among the farming systems followed in the region, maximum per farm labour used was in FS – IV (658 man days). The per farm net returns over total cost were maximum in FS-IV which amounted to Rs.195130 followed by FS - I (Rs.95056). The maximum returns on per rupee invested at total cost worked out to Rs.1.89 in FS – IV.

As regards Cluster-II region, among all farming systems followed, FS-IV required maximum labour (613 man days). The per farm gross returns were maximum in FS-II (Rs.336396) followed by FS-I (Rs.109472). The net returns over total cost were maximum in FS–II (Rs.134427).

The per farm total cost (Rs.220370) and gross returns (Rs.415500) were maximum in Rainfed plantations + Vegetables farming system in cluster-I region. However, in this system the returns on per rupee invested was maximum (Rs.1.89). In Paddy + Rainfed plantations + Vegetables farming system followed in Cluster-II region, the per farm total cost and gross returns were Rs.201969 and Rs.336396, respectively. The returns per rupee invested were Rs.1.67 in this system. Similar results were found in Naik (2002) and Veerkar (2002)

In South Konkan region the 8 farming systems were found to be major farming systems followed by the farmers. The per farm total human labour required was maximum (658 man days) in Rainfed plantations + Vegetables farming system. It can be concluded that the Paddy + Rainfed plantations + Vegetabless was most remunerative system for income and employment generation in the study area.

The findings of the present study are in conformity with the findings of, Kandasamy, G. S., (1998), Gumaste, A. K.*et.al* (2000), Swami K. S. (2004), Bhuwad, S.S (2012). **The results of the present investigation lead to accept the hypothesis that, in existing farming systems there was higher proportion of income from dryland horticulture**

The total income of the farm families in cluster-I was Rs. 288413, Rs. 219686, Rs. 125102 & Rs. 485875 in faming system I, II, III & IV respectively. The income from other sources worked out to Rs. 58195 which contributed 20.18 percent of the total income. In farming system II, it was observed that out of the total income 38.23 percent income came from horticulture production, while 27.50 percent was from dairy enterprise. In case of Farming system IV, 86.60 percent income was from farm business income, while other than farm business activity (wages and business / service) contribution 14.40 percent of the total income.

In case of cluster-II. the total income from farming system IV was very less as compared to other farming systems. While, in farming system I, more than 50 per cent income was derived from horticultural production. The income derived from dairy activity was equivalent to the crop production income in farming system III. Farmers have best alternative to go for livestock activity which also gave better profit.

In cluster-I, the expenditure on crop production was major expenditure in FS-IV, while expenditure on horticulture crop was major expenditure in FS-I. The total expenditure was found to be Rs. 28648, Rs.44880, Rs. 48058 and Rs.67910 in FS-I, FS-II, FS-III and FS-IV respectively.

In case of cluster-II, the family expenditure of sample farms were Rs. 34676, Rs.50230, Rs.59442 and Rs. 35805 in farming system I, II, III and IV respectively. In farming system II, also crop production activity shared 50.69 per cent. The expenditure on livestock activity in farming system III was found to be 23.85 per cent.

The sustainable farm income of farming systems I, II, III, IV were Rs.66409, Rs.1717, Rs. -38930 and Rs. 127220 respectively in cluster-I. The farming system I, II and IV have an economic surplus. It means farming system I, II and IV were having sustainable farm income. But farming system III could not meet their requirements on the basis of their farm business income. The income from other sources (wages, services and business etc.) was the only factor which helped them to sustain. In FS-I, II and IV, the sustainable income came to Rs. 124602, Rs. 45778 and RS. 197595 respectively. Similar results were found in Dorge (2012)

In cluster-II, the sustainable farm income of farming system I and II were Rs. 74797 and Rs. 84201 respectively. These farming systems seemed to have more

economic surplus. The sustainable income in farming system I, II, III and IV were, 141589, Rs. 150979. Rs. 58150 and Rs. 16474 respectively. It was observed that, farming system II have more sustainable income as compared to the other farming systems.

In cluster-I and cluster-II, farming systems were ranked on the basis of sustainable farm income. In case of cluster-I, FS-IV was ranked I (First) in producing sustainable farm income while, in cluster II, FS-II was ranked I (First) which gives highest sustainable farm income as compared to other farming systems

The results of resource use efficiency in paddy indicated that, seed, nitrogen and phosphorous were positive and influencing factors on production. The sum of regression coefficients indicated increasing returns to scale.

As regards mango cultivation, nitrogen, potash and plant protection chemicals were positive and significant inputs. In cashewnut production, the increasing returns to scale was observed whereas, nitrogrn, phosphorus and potash were significantly contributing to the production and their use was more than the desired level. Similar observation were also recorded by Swami (2004) and Bhuwad (2012) and Pawar (2006)

In case of arecanut, nitrogen, male labour and female labour were contributing to the production positively and significantly. The nitrogen, male labour female labour and were excessively used than the desired level.

As regards dairy enterprise, green fodder and concentrates, male labour and female labour were positive and significant, while the green fodder and concentrate, male labour and female labour were utilized at less extent than the required quantity. It was concluded that there is need to have proper mix of these inputs in milk production.

As regards paddy production, F.Y.M, nitrogen and potash were most influencing variables along with seed in FS-I, whereas phosphorus had shown negative influence in FS-V.

In mango production, F.Y.M., phosphorous, potash and male labour were contributing positively and significantly. F.Y.M and phosphorous were less utilized than desired level whereas, use of potash and male labour was more than the desired

level. The increasing returns to scale was observed in mango production. Similar results were found in Wagale (2007)

As regards cashewnut, the inputs such as F.Y.M., phosphorous and plant protection chemicals were contributing positively. The extent of use of phosphorus was less than the desired level where as F.Y.M. and plant protection chemicals were utilized more than the desired level. The decreasing returns to scale was observed in Cashewnut production. In brinjal cultivation, seed was most influencing input positively on the production along with nitrogen and plant protection chemicals. Seed was utilized more than the optimum level whereas, plant protection chemicals were utilized less than the desired level. The decreasing returns to scale was observed in brinjal production.

Dairy enterprise was found to be influenced positively and significantly by male labour, female labour and veterinary expenses, out of which male labour was utilized more than optimum level and female labour and veterinary expenses were utilized less than the desired level. Similar observations were found in Borude (2002)

The findings of the present study are in conformity with the findings of Kalara, B. S. *et al.* (2007), Mudasir Iqbal *et.al* (2010), Makadia, J. J. *et.al* (2014)

The results of the present investigation lead to accept the hypothesis that, in existing farming systems various resource allocation and resource levels are not properly organized.

The alternative plan suggested increase in area under nagli whereas paddy area was decreased. In alternative plan, area under paddy was decreased and the number of dairy animals was increased. It was observed that, the area under *vari* was slightly reduced while area under vegetables crops was increased. In alternative plan, the area under pawata was unchanged and additional resources were utilized for dairy enterprise. In case of fodder maize, 4.12 ha area was diverted in alternative plan. The number of dairy animals was also increased in the alternative plan.

In existing plan, the cereal requirement was 1090 qt and production was 990 qt. The alternate plan gave surplus production of 1466 qt from cereal crops which fulfiled the cereal requirement. The net returns observed in alternate plan for paddy, *nagli* and *vari* were Rs 797920, Rs 70000 and Rs 24000 respectively over existing

plan. The net returns for bhendi, ghewada and snake gourd were observed to be Rs. 550000, Rs 108546 and Rs 618840 respectively over existing plan. In alternate plan it was observed that, the production of vegetable was 1330 qt and requirement was 400 qt. The surplus production (1788 qt) of vegetables can gives more net returns and benefit to the farmers by selling the surplus production. Similar results were found in Srinivasa (2005)

In alternative plan, the area under paddy was unchanged. However, the area under brinjal was increased from 6.00 per cent to 8.00 per cent. The number of dairy animals were also found to be increased in alternative plans. As regards, the area under pulses (wal, pawata and cowpea) was decreased and diverted to the fodder maize cultivation. The number of dairy animals were also increased due to area allocated to the fodder maize for the fulfilling the green fodder requirement of the dairy animals.

In alternate plan, the production of vegetables was observed to be 3600 qt. The additional production of vegetables concludes competitive crop and high profitability of vegetable crops in cluster-II. The net returns were found to be Rs 789600, Rs 69676 and Rs 16000 from paddy, summer paddy and *vari* respectively. Regarding pulses, it was observed that, the requirement was 25 quintals and surplus production of 195 qt after fulfilment of pulse requirement. The protein requirement might be fulfilled by consumption of fish and fish products, because rice and fish are the major items of the staple food of the study area. Similar observations were recorded in Behera (2014)

It was indicated that, the net were maximized in all the crops which were followed under major farming systems in the study area It was concluded that in both the regions, reallocation of existing resources and adoption of recommended technologies had shown a higher returns than those from the existing plans. Hence, it was imperative to reallocate, rearrange the existing resources in all the farming systems and in both the regions. Thus, it was revealed that, the resource optimization has good potential to enhance the income through resource mobilization and allocation.

The findings of the present study are in conformity with the findings of, Ganesh, K., 2000, Dhole, V. V.*et.al* (2011), Behera, U. K. *et al*. (2014)

The results of the present investigation accept the hypothesis that, there is scope for optimum use of existing resources

The study of production constraints in South Konkan region, revealed that, the constraints faced by the farmers were shortage of labour (76.24%), high wage rates (71.00%), non-availability of inputs in time (62.54%) and in village, less knowledge of integrated farming system (58.10%), inadequate know how about pest control (41.25%), high cost of fertilizers (51.34%), shortage of water in summer (20.00%), and fragmentation of holding (16.58%),

The problems faced by the farmers in South Konkan region indicate difference between sub regions. However, the above mentioned problems indicate in general the situation that farmers were facing. It can be concluded that the major problems of study area in production aspects were high cost of fertilizers, non-availability of inputs, and inadequate knowledge about pest control, integrated farming system, high wage rates, shortage of water in summer and fragmentation of holding etc.

As regards marketing problems the major problems observed in South Konkan region were price fluctuation and inadequate transport, storage and warehousing facilities. In case of financial problems too much documentation and no easy access to credit and high interest rates were found to be the major problems.

It was revealed from the results that, the suggestions from the farmers from both the were different. But in general in South Konkan region, the measures to facilitate the farmers in adoption of the farming systems were demonstrations on control of Eryophite mite (60.58%), demonstrations on farming system models (50.00%) and the training on processing of fruit products (41.00%). So that the farmers will replace seed regularly and productivity can be improved. These were found to be major measures in South Konkan region.

In case of marketing, warehousing facility (65.38%), improvement in transport (45.35%), regulation of prices in general of agricultural products (40.58%), particularly fruits were marketing measures suggested by the farmers in the study area.

In case of financial aspects the reduction in the interest rates and the easy procedure for loan were the two measures suggested by the farmers. Recently, Government of Maharashtra had taken a decision to give loans to women self-help

groups at the rate of four per cent. This decision may help the farmers in study area to avail credit at cheaper rate and to invest in agriculture.

Conclusions.

1) In study area eight major farming systems were followed by the farmers. The farming systems in cluster I were 1) Paddy + Rainfed plantations 2) Paddy + Irrigated plantations+ Dairy 3) Paddy + Other cereals + pulses 4) Rainfed plantations+ Vegetables. In cluster II, 1) Paddy + Rainfed plantations+ Irrigated plantations 2) Paddy + Rainfed plantations+ Vegetables 3) Irrigated plantations+ Pulses + Dairy 4) Paddy + Other cereals +Oilseed
2) In case of crop enterprises, crops were grouped as a system component or crop group enterprises such as rainfed plantation, irrigated plantation, other cereal, pulses, (excluding paddy). Paddy crop was considered as a separate enterprise because it is a main staple food crop of the region and cultivated on large scale. The non-crop farm enterprise undertaken by sample respondents was dairy.
3) Among both the clusters in South Konkan region, the farming systems namely 1) Paddy + Rainfed Plantation, 2) Rainfed Plantation + Vegetables, 3) Irrigated Plantation + Pulses + Dairy, 4) Paddy + Rainfed Plantation + Irrigated Plantation, 5) Paddy + Rainfed Plantation + Vegetables were found to be highly profitable farming systems among the major farming systems (8) identified in the study area.
4) The horticulture plantations plays a very dominant role in profitability of the farming systems. Which underline its importance and need to concentrate on these enterprises for making farming systems more profitable. Thus the proper balance between livestock enterprises and crop enterprises need to be encouraged to bring remaining farming systems more profitable.
5) The total income of the farming system-IV in cluster-I was maximum as compared to other farming systems. Indicated that, other farming systems needs to depend more in other farm business activity as compared to farming system IV.
6) The farmers of all the farming systems of both the regions were having sustainable farm income except FS-III (cluster-I) and FS-IV (cluster-II)

7) The cobb-Douglas production function analysis in different farming systems has shown that more than 90 per cent variation in gross returns were contributed by seed , FYM and fertilizers,

8) The crop enterprises such as paddy, coconut, mango, ,arecanut, cashewnut, vegetables and other enterprises such as dairy had shown their influence and competitiveness in the alternative plans

9) Optimization exercise suggested that, there is great scope for reallocation or rearrangement of the existing resources and also it is possible to increase the net income supported by proper allocation at increased resource level and adoption of package of practices with recommended technology.

10) The problems faced by the farmers in this study area are shortage of labour, less knowledge of integrated farming system, high incidence of pest, high cost of fertilizer, electricity failure or irregular supply, less knowledge about pest control, low prices for produce, high marketing cost, lengthy process in sanction of loan, no easy access for credit and high interest rates

Policy implications:

On the basis of study on farming systems the following suggestions and policy implications are made.

1) The region wise specific farming systems needs to be focused/promoted such as

    a) In cluster-I, 1) Paddy + Other Cereals + Pulses, 2) Paddy + Irrigated Plantation + Dairy are suggested for implementation on larger area.
    b) In cluster-II, 1) Paddy + Other Cereals + Oilseed suggested for implementation on extended area.

2) In study area it is found that the farming systems followed by the farmers are of varied nature and training on integrated farming systems will be helpful for making the farming systems more profitable.

3) Rice is the pre-dominant crop of the study area but existing yield level was very low as compared to the recommended technology. Effort need to be taken to motivate the farmers for adopting modern technologies.

4) The awareness among the farmers is needed to follow packages of practices for various crops. The human labour should be used judiciously so that it would be cost effective.

5) The allocation of resources and rearrangement of enterprises has greater scope in majority of the farming systems. The rearrangement in existing perennial crops is difficult but in case of establishment of new plantations it can be easily implemented

DEPARTMENT OF AGRICULTURAL ECONOMICS
COLLEGE OF AGRICULTURE, DAPOLI

Title of Thesis	**:**	Economic Analysis of Farming Systems in South Konkan region.
Name of Student	**:**	Mr. Gore Sudarshan Tanaji
Regd. No.	**:**	161
Name of Research Guide:	**:**	Dr. S. S. Wadkar
Degree	**:**	Ph.D. (Agri.)
Major Subject	**:**	Agricultural Economics

THESIS ABSTRACT

The present study entitled, "Economic Analysis of Farming Systems in South Konkan region" was undertaken with specific objectives viz., to identify different farming systems in study area, cost returns, and profitability of major farming systems, resource use efficiencies, possibilities of optimization of profit and the problem faced by the farmers. A cross-sectional sample of 200 farmers was selected

randomly through cluster analysis in the study area. The primary data required for the study was collected during year 2014-15 from selected farmers by adopting personal interview method with the help of specially designed schedule. The present study made use of different statistical techniques such as percentages, ratios, correlations, different cost concepts and higher analytical techniques, such as production function analysis and linear programming.

In the study area in all, eight major farming systems were identified in both the cluster viz., The farming systems followed in cluster-I region were 1) Paddy + Rainfed plantations (FS-I), 2) Paddy + Irrigated plantations+ Dairy (FS-II), 3) Paddy + Other cereals pulses (FS-III), 4) Rainfed plantations+ Vegetables (FS-IV). The farming systems followed in cluster-II region were named 1) Paddy + Rainfed plantations+ Irrigated plantations (FS-I), 2) Paddy + Rainfed plantations+ Vegetables (FS-II), 3) Irrigated plantations+ Pulses + Dairy (FS-III), 4) Paddy + Other cereals +Oilseed (FS-IV).

As regards Paddy + Rainfed plantations farming system, it was revealed that the profitability of this system was also higher in Cluster-I region. The per farm gross returns, total cost and per farm net returns over total cost in this farming system were (Rs.230220), (Rs.135164), (Rs. 95056.) respectively. The returns on per rupee invested at total cost was Rs.1.70. The Irrigated plantations + Pulses + Dairy farming system was more remunerative in Cluster-II region. Return on per rupee invested in this farming system was Rs.1.72. It was also observed that, the total variable cost (Rs.130172) and total cost (Rs.201969) incurred were maximum in FS-II (Paddy + Rainfed Plantation + Vegetables) in Cluster-II.

Among all clusters in South Konkan region, the farming systems namely 1) Paddy + Rainfed Plantation, 2) Rainfed Plantation + Vegetables, 3) Irrigated Plantation + Pulses + Dairy, 4) Paddy + Rainfed Plantation + Irrigated Plantation, 5) Paddy + Rainfed Plantation + Vegetables were found to be highly profitable among the major farming systems (8) identified in the study area. In other words, these farming systems are having sustainable farm income, which underline its importance and need to concentrate on these enterprises for making farming systems more profitable and sustainable. On the contrary, proper balance between livestock enterprises and crop enterprises need to be encouraged to bring remaining farming systems more profitable one. In case of cluster-I, FS-IV was ranked I (First) in

producing sustainable farm income while, in cluster II, FS-II was ranked I (First) which gives highest sustainable farm income as compared to other farming systems.

The resource use efficiency in paddy indicated that, seed, nitrogen and phosphorous were positive and influencing factors on production. The sum of regression coefficients indicated increasing returns to scale. As regards mango cultivation, nitrogen, potash and plant protection chemicals were positive and significant inputs. In cashewnut production, the increasing returns to scale was observed whereas, nitrogen, phosphorus and potash were significantly contributing to the production and their use was more than the desired level. Dairy enterprise was found to be influenced positively and significantly by male labour, female labour and veterinary expenses, out of which male labour was utilized more than optimum level and female labour and veterinary expenses were utilized less than the desired level.

Optimization exercise suggested that, there is great scope for reallocation or rearrangement of the existing resources and also it is possible to increase the net income supported by proper allocation at increased resource level and adoption of package of practices with recommended technology. The problems faced by the farmers in this study area were shortage of labour, shortage of water in summer, less knowledge of integrated farming system, fragmentations and sub-division of landholdings, high incidence of pest, high cost of fertilizer, electricity failure or irregular supply and less knowledge about pest control. Training on farming system models, processing of fruit products, need for regulations of wage rates and supply of the good quality seed were some of the measures suggested by sample farmers.

CHAPTER I
INTRODUCTION

Agricultural progress is normally regarded as a prerequisite of economic development. It is true that economic development in modern times has to be associated with industrialization, nevertheless, it is generally accepted that industrialization can follow only on the sound heels of agriculture or, to turn the metaphor, agriculture is the foundation on which the entire superstructure of the growth of industrial sector and other sectors of the economy has to stand.

Agriculture throughout the world is still single most important human activity. Despite all the advances of high technology, it is still the only reliable source of food and an important source of fibres and other products, whose synthetic substitutes are often not as good as the natural products or more costly to produce. In many third world countries, it is main or the only source of livelihood for over 50 per cent of population and contributes roughly the same proportion to the national income.

Agriculture forms the backbone of Indian economy. Despite concerted industrialization in the last five decades, agriculture occupied a pride of place in the Indian economy. The improved technology, progressiveness, innovative nature and entrepreneurial ability of the farmers could result in increased production in seventies and eighties. But the same tempo could not be maintained now since continuous input use resulted only in disproportionate returns to individual crops or cropping systems. A vast majority of available land is under dry land agriculture whose potential is not yet fully exploited. For a sustained agricultural development, the minimisation of risk in agricultural production is essential. Diversification of agriculture is the best alternative to realise this end objective. Farming systems approach fits well into the funnel of diversified agriculture.

The green revolution has helped, to a great extent, achieve self-sufficiency in food grains and improve the productivity of resources in agriculture. The new technology raised the profitability of investment. This encouraged the farmers to make sizable investment in agriculture and farming is considered as business in the recent years.

The per capita availability of land has declined to as low as 0.48 hectare. With the decline in farm size, it would be increasingly difficult to produce enough food for the family. Only 25 to 30 per cent of the modern agricultural technology have reached the farmers. This modern technology however has been restricted to favourable farming situations, since there is no further scope for horizontal expansion of land for cultivation. The only alternative left is for vertical expansion and that too through diversification of the farming system.

It is generally believed that farmers in developing agriculture fail to exploit fully the potential of technologies and/or make allocative errors with the result that yields show wider variation, usually reflecting a corresponding variation in the management capacitates of the farmers. This shows that considerable scope exists for raising productivity and income of the farmers by improving their efficiency.

Indian agriculture is characterised by mixed farming involving a system of combining crop production with one or more of the livestock enterprises like rearing of cattle, sheep, goat, pigs and poultry as well as fishery, bee-keeping, sericulture, etc. Although in India farming is not commercialized to a large extent, it remains that

farmer has to make decisions regarding his business of farming, with a view to attaining maximum welfare. The welfare may not be maximization of net profit in the usual sense, but it can be assumed that he would like to maximize farm income by which he can maintain himself and his family. The decision of enterprise mix on a farm will be conditioned by overall welfare of the family. In describing Farming Systems and their characteristics, we start therefore with the assumption that they did not come about by chance and that there is always a reason why farming in a specific case is carried out in one way rather than another.

1.1 Farming system

Farming system represents integration of farm enterprises such as cropping systems, animal husbandry, fisheries, forestry, etc. for optimal utilization of resources bringing prosperity to the farmer.

Farming system approach introduces a change in farming techniques for higher production from the farm as whole with the integration of all enterprises. The farm products other than the economic products, for which the crops are grown, can be better utilized for productive purpose in the farming system approach. A judicious mix of cropping system with allied enterprises like dairy, poultry, piggery, fishery, sericulture, etc. suited to the given agro climatic conditions and socio-economic status of farmers would bring prosperity to the farmers.

1.2 Farming system research

In its broadest sense the term farming systems research is any research that views the farm in a holistic manner and considers interacting factors in the system. A farming system is a complex interrelated matrix of soils, plants, animals, implements, labour, capital and other inputs controlled in the past by farming families and influenced to varying degrees by political, economic, institutional and social forces that operate at any levels . Research on farming system has various objectives ranging from increasing the body of knowledge about farming systems to solving different problems of farming system. The farm is viewed in holistic manner. The farmers are subjected to many socio-economic, biophysical, institutional, administrative and technological constraints. The farming system conceptually is a set of elements or components that are interrelated which interact among themselves. At the centre of

interaction is the farmer exercising control and choice regarding the type and results of interaction.

The Farming System Research (FSR) originates from recognizing the interdependence and inter-relationships of natural environment within the farming system. In FSR, the farmers by participating in the research process help in the identification of the research problem as well as take part in testing the possible solution. Farmer's participation in farming system research means that the system itself can be incorporated in the experiment and realistic results can be obtained through farmer managed trials.

1.3 Components of farming System

Farming enterprise includes crop, livestock, poultry, fish, sericulture vermicompost, dairy, goat, etc. A combination of one or more enterprises with cropping, when carefully chosen, planned and executed, gives greater dividends than single enterprise especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of enterprises to be combined with crop production activity. Judicious mix of one or more of these enterprises with agronomic crop should complement the farm income and help in recycling the farm residue. The selection of enterprise must be based on the cardinal principle of minimizing the competition and maximizing the complementarity between the enterprises.

1.4 Need for Study

So far, studies conducted on farming systems in the south Konkan region of Maharashtra state are few, and farming system approach in analysing the problems of agriculture is gaining lot of importance in recent years. Such study will throw light on the problems associated with different farming systems and enable the academicians and policy makers to issue, instead of blanket recommendations, a region specific, appropriate and tailor-made recommendations and policy can be implemented for overall agricultural development in south Konkan region of Maharashtra.

The present study is a modest attempt to study farming systems in south Konkan region with following specific objectives.

6) To identify the existing farming systems in the study area.

7) To work out the cost, returns and profitability of major farming systems.
8) To study the resource use efficiencies and productivities of major farming systems.
9) To assess the possibilities of optimization of profit in major farming systems.
10) To identify the constraints faced by the farmers in the existing farming systems and suggest remedial measures.

1.5 Hypotheses

1) In existing farming systems there is higher proportion of dryland horticulture.
2) In existing farming systems various resource allocation and resource levels are not properly organised.
3) There is scope for optimum use of existing resources.

1.6 Scope of Study

The outcome of the present investigation will be of immense importance to evolve, develop and implement the location specific farming systems, in the study area, as well as the area with similar situations elsewhere. It will help farmers, academicians and policy makers to decide the strategies which will lead to overall development of agriculture in the region.

1.7 Limitations of Study

The present study was based on primary as well as secondary data. There were limitations to classify the study area across villages or revenue circles due to paucity of village wise, or revenue circle wise secondary data on agro climatic parameters. Hence the study was carried out with the tahsils wise data. Due to some limitations of software integer programming was not performed which has more relevance in dairy and poultry enterprises.

In farming system studies risk efficient farming system should be included, however due to high quantum of study this aspect was not considered. The primary data were based on the memory recall of the sample respondents as farmers seldom keep records.

CHAPTER-II
REVIEW OF LITERATURE

The farming system specifically refers to crop combination or enterprise mix in which the product and the by-products of one enterprise serve as the input for the production of other enterprise. It takes into account the consumption need of the family, the economic factor like relative profitability, technical feasibility of enterprise, availability of farm resources and availability of infrastructure facilities. The purpose and profitability of different crop and livestock combinations vary from region to region and even within the region.

Review of research work done by various research workers in the past is not only useful to plan and organize research work on proper line but also provide an opportunity to improve the inadequacies in research work. It also provides a general

orientation about the topic of investigation by creating an insight and sense of integration about present study is reviewed in this chapter.

The literature reviewed in the present study is broadly grouped into following categories.

2.1 Identify different farming systems.

2.2 Costs, returns and profitability.

2.3 Resource use efficiency.

2.4 Linear programming

2.5 Constraints faced by the farmers

2.1 Identify different farming systems.

Naik *et al*. (1991) examined the economics of farming system in Sindhudurg district. A sample of 120 cultivators were selected and four enterprise combinations namely only crop, crop + dairy, crop + poultry and crop + poultry + dairy were identified. It was observed that per farm business income increased with the additions to dairy and poultry or both to crop production. Among the enterprise combinations the highest employment (248 days) was provided by the crop + dairy + poultry enterprise combination.

Sain (1991) commented that study of farming systems is important not only from the view point of planners but from the view point of farmers also. The planners are mainly concerned with the framing of policies in the national interest while the farmers are interested in maximizing their profit. Sound resources base and unmatched development in technical breakthrough are obvious reasons behind the efficiency of any farming systems.

Singh *et al* (1991) conducted a study for developing most remunerative farming system in relation to the agro socio-economic conditions of Western Haryana. The study revealed that mixed farming system with three milch animals was always better than arable farming in all aspects.

Rangaswamy *et al.* (1995) studied rice based farming system. A model was developed for a holding of 0.4 hectare to suit the small and marginal farmers of Tamil Nadu Agricultural University, Coimbatore from 1987-1992. The study revealed that

the total net income under rice-poultry-fish-mushroom integrated farming system was Rs. 12025 and the net income for conventional cropping system was only Rs. 6334 per year from 0.4 hectare area. Practicing integrated farming system gave an additional net income of Rs. 5091 per year over conventional cropping system.

Senthivel *et al.* (2002) studied the farming system approach for sustainable yield and income under rainfed vertisole in Tamil-Nadu. The study concluded that with adoption of an integrated farming system with cropping, rainfed fruit trees and goat rearing on dry land, there would be a considerable increase in income for small and marginal farmers.

Swami (2004) studied the economics of farming system in Ratnagiri district of Maharashtra state. Study revealed that the crops + dairy, crops + goat, crops + poultry enterprise was most profitable farming systems giving farmer a net income at Rs.41373, Rs.37903, Rs.37710., respectively which can provide supplementary income to the farmers.

Saikumar (2005) studied on farming systems in the tank commands in north eastern Karnataka – an economic analysis of jala samvardhane yojana sangha managed tanks. The study revealed that, the three major farming systems identified in each district dairy enterprise was found to be most common as a complimentary enterprise. The net returns was highest under FS-I (Rs. 53,404.59/ha) in Bidar district, FS-III (Rs. 19,828.02/ha) in Bellary district and FS-II (Rs. 23,844.63/ha) in Raichur District. Production function analysis revealed that, inputs such as feed + concentrates was over utilized, where as number of cows and seeds were under utilized in Bidar district. The resources like land, number of cows, fertilizer+FYM were over utilized and labour, PPC + veternary charges were underutilized in Bellary district. Where as in Raichur district fertilizer+FYM, labour were under utilized. Hence there is scope for deployment of resources. In OFD and FFS plots returns were increased over control plots due to reduced cost of cultivation and increased yield. Non-availability of adequate water and alternative source of irrigation, high cost of inputs, lack of awareness of recommended cropping sequences and technical guidance were major production problems. Among marketing problems, lack of market information and storage facility were the major once. These problems can be minimized by providing adequate and timely credit, market.

Rajkumar (2007) studied the economics of red gram based cropping systems in Bidar district. The study has revealed that the ratio of MVP to MFC was greater than one for human labour, seed, nitrogen, potash and plant protection chemicals under different Cropping Systems, indicating further scope for using additional units of these inputs to increase gross income. With respect to employment generation, CS-II generated higher employment (64.91 man days/ha), as it required more labour, followed by CS-I (55.87 man days/ha) and CS-ill (55.11 man days/ha). Majority of farmers faced the problems of exogenous factors, high wages, scarcity of own fund, price fluctuation and lack of market information, which lead to uncertainty of income to the farmers.

Mandeep and Joshi (2008) studied crop production and dairy farming on marginal and small farms in Panjab. It has been found that a majority of the farm households are not able to meet their requirements from their income from crops and dairy farming. Further dairy farming has emerged as a major allied enterprise for supplementing the income of marginal and small farmers in Punjab. The study has suggested to further exploit the potential of off-farm sources towards meeting the domestic expenditure. Also, the technical efficiency of crops and dairy farming should be improved to provide more income to farmers.

Korikanthimath (2009) analyzed integrated farming systems for sustainability in agricultural production. He revealed that rice - brinjal + mushroom + poultry as best one interns of rice equivalent yield (21.49 t/ha), employment generation (392 man days), energy efficiency and economics. In coconut gardens, integration of fodders (napier bajra hybrid + Centrosema) for supporting dairy unit proved the best based on above criteria used in rice based IFS. Similarly integration of cardamom in arecanut gardens, arable crops and livestock in cashewnut, and poultry/duck-fish IFS were found more profitable and sustainable.

Nedunchezhian and Thirunavukkarasu (2009) studied on economics of livestock enterprises in different farming systems identified that, viz. I) Crop+dairy, II). Crop+dairy+goat, III). Crop+dairy+sheep, IV). Crop+goat+sheep, V). Dairy, VI). Dairy+goat and VII). Dairy+sheep. Cost of production per cattle unit was the highest in farming system I (Rs. 3401.55), while it was less in farming systems in which sheep and / or goat were the components. Farming system VII obtained highest contribution from dairy animals (45.3 per cent). The contribution from goats under

farming system VI (26.1 per cent) was found to be highest, while farming system VII received maximum contribution (23.3 per cent) from sheep.

Torane (2009) conducted an econometric analysis of farming systems in North Konkan region of Maharashtra. Revealed that the necessity of promoting region specific farming systems such as Paddy + Irrigated plantations + Dairy, Paddy + Irrigated plantations + Flowers and Irrigated plantations + Dairy in north coastal plains; Paddy + Other cereals + Rainfed plantation + Dairy and Paddy + Vegetables + Poultry in northern central plains and hills, Paddy + Vegetables + Dairy, Paddy + Pulses + Dairy + Poultry and Paddy + Rainfed plantations + Dairy in southern central plains and hills. Paddy + Rainfed plantation + Dairy, Paddy + Irrigated plantations + Rainfed plantation + Dairy and Paddy + Irrigated plantations + Vegetables + Dairy in southern coastal plains regions. Balanced use of fertilizers and judicious use of labour is required so that it would be cost effective. The use of FYM and organic fertilizers should be increased.

Regeena (2009) studied a case study of a successful farm in Kollam district in the South zone of Kerala. Economic analysis of the integrated system thus developed has revealed that all the indicators of economic efficiency, viz., benefit cost ratio, and monetary equivalent ratio and efficiency are higher than in the earlier system. There has been a perceptible change in the social status of the farmers. The study has revealed that the homestead farmers of Kerala could be successfully re-modeled giving emphasis on cash generation and retaining their subsistence orientation through diversification of crops and enterprises.

Bhuwad (2012) studied the economics of farming system in Ratnagiri district. It was observed that, in study area six major farming systems were evaluated,1) Paddy + Pulses + Dairy 2) Paddy + Pulses + Irrigated plantation 3) Paddy + Irrigated plantation 4) Paddy + Other Cereal + Irrigated Plantation 5)Paddy + Dairy 6)Paddy + Rainfed Plantation. It was observed that, total cost was maximum in FS-1(Rs.109617) while it was minimum in FS-IV(Rs.68436).The per farm gross return were maximum in FS-III(Rs.148377) followed by FS-II (Rs.128837)FS-I (126304), FS-VI (Rs.115794) ,FS-IV (Rs.87787) and FS-V (Rs.76876), which indicated that higher return in farming system in which rainfed plantation were undertaken. The farm net returns were maximum in FS-III (Rs.53374) followed by FS-II (Rs.47835), FS-VI (Rs.45638), FS-IV (Rs.19351), FS-I (Rs.16587) and FS-V (Rs.4019).

Sachinkumar *et. al*. (2012) Studied the economics of farming systems on northern transitional zone of Karnataka, it was observed that the net return were highest in the system involving crops and dairy (Rs.33533). in rural area of Dharwad , the net return were highest in the system involving crops, dairy and plantation (Rs.57285).Whereas in case of Belgaum peri-urban area the net returns were highest in system involving crops, vegetables, dairy and poultry (rs.11142).In rural area the farming systems consisting of crops. Dairy, goat performed much better (Rs.31668). The dairy was most common non-crop component include in all most all the farming systems and it was found profitable in all the farming systems in Dharwad area.

2.2 Cost, return and profitability.

Koppad and Khan (1996) made a comparative economic analysis of two farming systems *viz*., maize-wheat and maize-sunflower on large farms in Malaprabha Command Area, Karnataka. A comparison of resource use pattern showed that human labour and bullock labour were higher in the maize-sunflower system, while use of fertilizer was higher in maize-wheat system.

Kandasamy (1998) analyzed economics of Integrated Farming Systems at Pariyar in Tamil Nadu. He reported that among the different farming system practices, dairy-based system was found to be more profitable than others. The next best system was dairy cum poultry based mixed farming with a mean annual net income of Rs. 5,899 per ha with per day income of Rs.16.16. Poultry based mixed farming system observed net income of Rs. 2,287 with per day income of Rs. 6.27 over pure cropping system which recorded mean annual net income of Rs. 2,219 with per day income of Rs. 6.08. Farmers method of sole cropping could give the least mean annual net income of Rs. 1,902 and Rs. 5.21 of per day income.

Gumaste and Borude (2000) studied the profitability of dairy enterprise in Konkan region of Maharashtra State. The study indicated that fixed capital requirement for the crop was higher than dairy enterprise, while working capital requirement of dairy enterprise was higher than crop enterprise. However, profitability worked out on the basis of farm business income, the dairy enterprise showed its dominance over crop enterprise.

Naik *et al*. (2002) studied the economics of farming systems in South Konkan coastal region of Maharashtra State. It was observed that in sole cropping, 100 per

cent income was contributed by the crops. In mixed farming (crop + dairy), 34.40 per cent income was contributed by dairy enterprise and remaining by crops. Regarding crop + poultry, 16.17 per cent of income was contributed by poultry enterprise and remaining by crops. In crop + dairy + poultry farming system, 30.44 per cent income was contributed by dairy, 11.25 per cent by poultry enterprise and remaining 58.33 per cent income was contributed by crop production. It was also revealed that only crop provide 197.58 man- days employment, whereas crop + dairy farming system had provided 203.18 man- days employment and crop + dairy + poultry farming system provided total employment of 248.09 man-days.

Veerkar and Kamble (2002) studied the economics of crop + dairy farming in Chiplun block of Ratnagiri district. The result of the study indicated that the crop production activity sustained loss on small and medium farm to the extent of Rs. 2268 and Rs. 3500 per farm. Dairy enterprise realized per farm net profit, which ranged from Rs. 2596 on small farms to Rs. 4026 on large farms with overall profit of Rs. 3211. The combination of crop + dairy enterprise gave net profit ranging from Rs. 328 on small farms to Rs 7525 on large farms with overall per farm net profit of Rs. 1999.

Wadkar *et al*. (2002) studied the economics of farming system in Thane district of Maharashtra State. The study indicated that the farm business income from crop + dairy enterprise was maximum (Rs. 6284.31) followed by crop + poultry (Rs. 5367.37) and only crops (Rs. 5367.37). Per farm employment generated was maximum in crop + dairy enterprise, followed by crop + poultry enterprise. It was concluded that in case of perennial crops, coconut + sapota and coconut + arecanut were more profitable and regarding enterprise combinations crop + dairy was economically more variable.

Chandel and Malhotra (2006) studied livestock systems in poor endowment of India. Study revealed that seven major systems were prevalent in semi-arid region of country. Vast differences have been observed in existing average and exploitable potential in milk productivity, a high milk productivity in buffalo based livestock system has been traced.

Ganesh Kumar and Rai (2006) studied economic status of poultry farming enterprises in Andaman and Nicobar Island. Study revealed that, at overall level out

of total investment 45.18 per cent investment was on land while 51.06 per cent it was on building. Among the various cost involved for maintenance of broiler poultry farm, the total variable cost constituted 95.85 per cent (Rs. 90682). The net return per bird was Rs. 14.13 at overall level and benefit cost ratio was ranging from 1.13 to 1.24 among different size groups.

Swami *et al.* (2007) A study on the economics of farming systems was undertaken with specific objectives of analyzing the different farming systems, input use, cost and profitability, income and employment generation, intention in adoption of specific farming system and adoption of modern farm technologies undertaken by farmers. In Ratnagiri district, Maharashtra, India, four farming systems were evaluated, with only crops, crops+dairy, crops+poultry and crops+goat adopted by 56 (46.66%), 31 (25.83%), 25 (20.83%) and 8 cultivators (6.68%), respectively. The net return earned was highest from crops+dairy, recording Rs. 41 373.21. This was followed by crops+goat which earned 37 902.95, crops+poultry which earned Rs. 37 710.24, while only crops earned Rs. 36 414.81 revealing that crops+dairy enterprise was more profitable than other enterprises. Per farm income was increased with the addition of dairy or poultry. Among the enterprise combinations, the highest employment of 123 days was provided for crops+goat enterprise. The main purposes of keeping animals were production of FYM and utilization of farm byproducts. Keeping dairy, poultry and goat was made to meet family requirement of eggs, milk and meat.

Vichare (2007) studied different rice based cropping systems in North Konkan of Maharashtra. It was observed that, rice-vegetable cropping systems gave maximum net returns (Rs. 31493 per ha.) followed by rice-pulses (Rs.9485 per ha.) and rice (Rs. 9964 per ha.).

Ram Suresh and Singh (2008) The study was conducted in Gonda District of Uttar Pradesh during 2005-06. It may be observed that from sugarcane production the highest income was Rs. 25065 on small farms than in all categories. The family labour income was Rs. 29710 on small farms and Rs. 24566 on large farms and family labour income was highest for the small farm in all categories. The sugarcane-buffaloes-cow based farming systems was a highest family labour income on small farm. Relatively higher net income Rs. 4441 on large farms for buffaloes and Rs. 1798 on medium farms for cow could be higher productivity of buffaloes as compared

to that of cow. However, sugarcane-buffaloes were found to be relatively better dairy animals to provide income and employment opportunities in the study area.

Singh (2008) studied economics of sugarcane-based farming system in Western Uttar Pradesh. Sugarcane-livestock-cereals-fodder has been found the major system being followed by a majority of the farmers. It has been found that sugarcane farmer keeps in general tow dairy animals, largely for household milk consumption. The major income source of farmers in the area has been found sugarcane (58 per cent), followed by livestock and cereal crops. The study has observed that a family worker earns Rs 41,270 per year in the study area, which is much lower than that in Punjab (Rs 74,080/year). The study has suggested that a combination of technology, policy and institutional innovations is needed for improvement in productivity and profitability of crops and livestock in the area.

Srivastava *et al*. (2010) studied the diagnosis of pulses performance of India. India is the largest producer and consumer of pulses in the world accounting for about 25 per cent of global production, 27 per cent of global consumption and about 33 per cent of the world's area under pulses. However, compared to cereals like wheat and paddy, the growth rate of area and production of pulses is negligible and there exists wide variability in their yield in different states of country. The study has explored the growth and dynamics of production and consumption of major pulses in different states of India and has made a comparative evaluation of key economic factors affecting their production. Pulses have exhibited a grim picture in their production performance both spatially and temporally. Area substitution coupled with the biased revenue terms of trade has shown preference of cereals and oilseeds over pulses. However, pulses have been found to be preferred over coarse grains. Further, a structural shift in production performance of pulses-producing states not only validates the lack of spatial and temporal stability in their production performance but also throws light on the hidden potential of minor states in pulses production for long-term sustainability of pulse production.

Singh (2010) studied the technical efficiency of dairy farmers who are actively engaged in cooperative value chain and who remain apart from the supply chain dairy farmers can gain considerable higher profits just by increasing the efficiency in their operations. The possession of hybrid animals, permanent labourers for better supervision, medicare and institutional finance effect efficiency positively.

Dikshit and Birthal (2010) estimated the feed consumption rates for the different livestock species by age-group, sex and function at the national level, and based on that the paper has generated demand for different types of feed by the year 2020. The estimates of demand for different feed will help the policy makers of the country in designing trade strategy to maximize benefits from livestock production.

Torane (2011) studied the farming systems diversification in North Konkan region of Maharashtra-An economic analysis. The location-specific existing farming systems have been studied for their profitability and extent of diversification in the North Konkan region of Maharashtra. The study area has been delineated into different clusters/sub- regions using hierarchical agglomerative method. The farming in North Konkan region has been found highly varied in nature. The farm economy has also depicted a wide variation as per-farm income has been found to range from Rs. 1135 to Rs. 218015 across different farming systems. The most profitable farming systems in study area are: (i) Paddy + Irrigated plantation + Betel vines (B:C ratio, 2.02), (ii) Paddy + Pulses + Dairying + Poultry (B:C ratio, 1.74), (iii) Paddy + Vegetables + Dairying (B:C ratio, 1.62), (iv) Paddy + Irrigated plantations + Rainfed plantation + Dairying (B:C ratio,1.57), (v) Irrigated plantations + Dairying (B:C ratio,1.56), and (vi) Paddy + Irrigated plantations + Flowers (B:C ratio,1.42). The diversification has shown a positive co-relation with profitability which underlines the importance of combination of enterprises.

Baba *et al*. (2011) the study has emphasized on an appropriate livestock mix and increasing animal productivity through scientific management for the overall social benefits from this sector. In addition, budgetary allocations to research in this sector should be enhanced to evolve innovative production technologies leading to improved animal production efficiency.

Prasanth (2012) A study was conducted to understand existing livestock based farming systems, to assess constraints in the farm environment, to find out most accepted farming system and to develop economically viable and efficient integrated farming system in Pariyaram panchayat. Sixty farmers were interviewed. Eighty percentages of livestock farmers are above 50 years of age. Thirty five percentage of farmers treat livestock farming as their main income source. A downtrend towards rice cultivation was noticed among dairy farmers. Forty percentage of livestock farmers had three or more cattle. Fifteen percentage of farmers have 10 or more

number of cattle. Sixty percentage of the farmers were getting 10 liters of milk per animal per day. Only 15 percentage of farmers are cultivating fodder in their premises. All livestock farmers have at least a few coconut trees as a subsidiary income. Most of the respondents' children are well educated. Most of the farmers are economically and socially sound. Increased feeding cost is the major problem being faced by livestock farmers. Ninteen combinations of livestock based farming systems were identified in Pariyaram panchayat. From this study it could be inferred that farming system which mainly contains livestock, coconut and rice with added options of fodder, biogas, vegetables and poultry is the most sustainable livestock based farming system in Pariyaram panchayat. For reducing the feed cost, fodder cultivation and rice cultivation should be encouraged. For increasing the profit from livestock farming, biogas plant has to be installed. Selling products as value added ones will increase profit. Proper awareness programmes are needed for attracting youngsters to this sector.

Rai *et al* (2013) The present study was conducted to evaluate profitability of various models in existing and intervened integrated farming system (IFS) along with acceptance of farmers in northern plains of Uttar Pradesh, India. Twenty farmers from each district viz. Barabanki and Raebareli, were monitored with all accessible records. Various interventions in their farming system were made which included new technology of rural poultry production (Model-1), infertility control, vegetable production using our bio-enhancer (CSR-BIO), gladiolus, banana (G-9 variety), guava (semi-intensive), goat and awareness about improved composting and quality seeds. The pre-dominant farming system with 16 families was paddy-wheat-fallow with benefit:cost (B:C) ratio of 1.83. This was followed by paddy-wheat-green gram-bovines in 7 families with B:C ratio of 1.66. The highest B:C ratio of 4.78 was observed in model-R i.e. vegetables cultivations on river bank due to varietal and CSRBIO interventions. The lowest B:C ratio (2.09) in post intervention period was observed in model-O (guava-bovine-vegetables) due to no return from guava in first 2 years. The family annual income in the survey increased significantly. The IFS models, if introduced, are highly useful and uniform acceptance of the components takes time. From the present study, it clearly emerged that IFS gives higher B:C ratio than the existing cropping/farming system.

Sudheer (2013) To tackle the challenge of food grain production and food security, chemical agriculture advocates call for the continuing or higher use of chemical fertilizers and synthetic pesticides. The present study compared the economics of organic farmers (N=350) and chemical farmers (N=200) for three crops, paddy, redgram, and groundnuts, in the state of Andhra Pradesh, a south eastern coastal state of India. It was found that organic farmers are earning a gross income of 5%, 10% and 7% more compared to the chemical farmers of paddy, redgram and groundnut, respectively, and with lower input costs the profits earned by the organic farmers are higher by 37%, 33% and 59% for the selected crops respectively. Organic farming is generally more profitable in terms of financial costs and returns than chemical farming, irrespective of the crop or the size of farm (the exceptions being small redgram farms and large goundnut farms). An analysis of the farmers' perception of organic farming reveals that electronic media (television) is the prime motivator for farmers to adopt organic practices. Farmers believed that organic farming improves soil fertility and their profits in the long run.

Chakraborty and Bera (2014) Present study based on primary data collected from North 24-Parganas district of West Bengal reveals that organic rice yield is 5.57 and 0.50% below the average of conventional and purely inorganic system respectively. Total returns are recorded to be 13.04 and 16.53% above its counter parts in the same order. Although sample farmers incur 15.15 and 18.70% more prime cost of cultivation, they earn 9.83 and 13.22% higher net return over two competing systems respectively due to presence of higher premium prices which consumers are ready to pay realizing the beneficial effects of organic products of human health and harmful impact on environment and soil fertility. So, lower physical yield of organic rice apparently seems a threat to future food security of the nation, but this sustainable alternative system of crop production will be able to feed every people of India when sustainability of this form of eco-friendly crop production system considering the instability associated with the existing crop production practices popularly known as "Green Revolution" technology.

Kumar Parveen and Slathia (2014) The study was carried out in the subtropical *Kandi* belt of the Jammu region. The study revealed that the total cost of cultivation per household for horticulture trees worked out to be rupees 3877.57. Of the total cost the variable cost accounted for rupees 2169.10 and the fixed costs

accounted for rupees 1708.47. The gross returns and the net returns were rupees 8168.99 and 4410.70 respectively. The average benefit cost ratio was 1:2.11.

Makadia *et al* (2014) Rice being a staple food of most Indians occupies largest area and second largest production in the world. Operational holding is shrinking and land, water resources are getting degraded. Henceforth, the evaluation of innovative production practices is needed to meet the growing demand of rice. Under such a scenario, System of Rice Intensification (SRI) has emerged as an important technology to increase rice productivity. For this study 120 farmers (60 SRI+60 Traditional) were selected. Cost-C2 for SRI and traditional method was found to 43790 and 40985 per ha, respectively. Average per hectare yield of SRI and traditional method was reported to 51.25 and 41.25 qtl, respectively. The return per hectare over operating cost-A for SRI and traditional method was to the tune of 49758 and 33865, respectively. In SRI method, resource use efficiency of human labour contributed positive and significant while for traditional method manure and fertilizer found positive and significant towards paddy production.

Reddy and Mundinamani (2014). The present study aims to analyse the cost and returns of major identified organic farming systems *viz.* organic farming system-I: Green gram+Sorghum+Dairy, organic farming System-II: Groundnut+Maize+Dairy and organic farming system-III: Cotton+Chilli+Onion+Mango in Gadag district of Karnataka State by collecting primary data from 95 organic growers for the period 2011-12. The analysis of cost and returns in major identified organic farming systems in the study area revealed that, the net returns realized by the farmers was found to be maximum in organic farming system-III (Rs.97437) as compared to other farming systems identified in the study area. In addition to crop enterprises, Horticulture enterprise, Mango cultivation was found to be one of the important associated enterprises along with dairy enterprise practised by the sample farmers and major income source in the study area. The analysis also revealed that the share of dairy alone in the major organic farming system-I and II contributed 38.83 per cent and 34.77 per cent to the gross returns, respectively. Among six identified farming systems in the study area FS-III of Gadag was found to be profitable based on the net returns obtained from the farming systems as whole enterprise. Thus, the study suggests that efforts should be made through Raitha Samparka Kendra (RSK) and

Krishi Vigyana Kendra (KVK) to popularize these farming systems in the study area to utilize farm resources efficiently to enhance productivity and profitability.

Saharia *et al* (2014) A study was carried out under NAIP component-3 sub-project in Gosaigaon area of Kokrajhar district which involved integration of 2(two) indigenous sows and 1(one) Hampshire male pig to 450 m2 water surface area. Two months old piglets were reared for six months. Thus two batches of pigs were reared in integration with one crop of fish in a year. Fertilized pond water enriched with blue-green algae was used for irrigating horticultural crops i.e. okra in Kharif season and cabbage in the Rabi season cultivated at marginal area measuring 1000 m2 on the bank of the pond. Fish species like catla, rohu, mrigal, grass carp and silver carp were released in the ponds @8,888 per ha. The field trial revealed a 5000 kg fish per ha per year. The average yield of fish was 2.11 quintal after one year in a 450 m2 pond area. An average of 2.4 and 2.87 quintal of cabbage and okra respectively was harvested in an area of 1000 m2 each. Income from 2 batches of 3 pigs each was raised from 19,000.00 to Rs. 65,750.00 at the end of the year. The benefit cost ratio (BCR) of integrated farming over traditional system was calculated to be 3.29:1 vs 1.4:1. Further the system helped complete recycling of pig sludge and there is a continuous horizontal extension of pig breed improvement activity among the pig farmers

Shivanaikar *et al* (2014) The present study was undertaken with objective of assessing cost and returns involved in organic and inorganic sugarcane cultivation in Bagalkot district of Karnataka. Multistage sampling design was used for drawing samples and tabular analysis was employed to analyse collected data. The results showed that, the per acre cost of sugarcane cultivation on organic farms (Rs. 45,974.50) was less when compared to that on inorganic farms (Rs.54, 331.82). This marginal difference was due to the higher cost incurred on chemical fertilizers, cost on more quantity of setts used as less spacing and more human labour used by inorganic sugarcane farmers. The return structure in sugarcane clearly revealed that the per acre gross returns was higher (Rs. 82,328) on organic farms compared to that of inorganic farms (Rs. 81,360) with a positive net return on both the categories of the farms. The net return on organic farm was Rs. 36,353.90 and was Rs. 27,028.18 on inorganic farms. The B: C ratio was also higher on organic farms (1.79) compared to inorganic farms (1.50). Hence, cultivation of sugarcane in organic is better compared inorganic and it will improve soil health and farmers income.

Vijaykumar *et al* (2014) the present study was conducted during 2010-11 in Latur district of Maharashtra. About 32 soybean growers were randomly selected from eight villages of Udgir tehsil of Latur district. Data were collected by personal interview method by using pretested schedule. In existing farm plan, total expenditure on all crops in the form of cost-C was Rs. 134517.47, gross return was Rs. 214568.50, and net profit on cost-C was Rs. 80051.03. Total expenditure of livestock enterprise was Rs. 48215.38, gross return was Rs. 58276.93 and net profit was Rs. 10061.55. With regard to farm as a whole was found to be Rs. 182732.85, gross return was observed to be Rs. 272845.43 and net profit was Rs. 90112.58. In regard to alternative farm plan total expenditure on all crops in the form of cost-C was Rs. 131218.99. Gross return from all crops was found to be Rs. 216617.97, and net profit was Rs. 85398.96. Total expenditure of livestock enterprise was Rs. 48011.35, gross return was Rs. 58381.82 and net profit was Rs. 10370.45. With respect to farm as a whole total expenditure on farms as a whole was Rs. 179230.34, gross return was Rs. 274999.79 and net profit was Rs. 95769.41.

Alves *et al* (2015) This work reports an analysis of the main components of costs and revenues of an agroforestry system with coffee and banana, as well as an analysis of its economic performance through indicators: net present value, equivalent period benefit (or cost), family labor revenue and a sensitivity analysis of net present value. The main cost components in the system are the human labor and mineral and organic fertilizers applied in coffee, and the costs for the production of coffee outweigh the costs of banana production. The monthly income from the production of bananas balances the costs of coffee production, generating a positive cash flow in the studied period. Financial indicators showed positive values, demonstrating the economic viability of the system with coffee and banana. The agroforestry system is economically feasible, even with variations of ±20% in production costs and selling prices of their products.

Jawanjal *et al* (2015) In suru sugarcane group per hectare cost 'A' was Rs. 75,423, cost 'B' was Rs. 1,15,600 and cost 'C' was Rs. 1,43,664 while in ratoon sugarcane group per hectare cost 'A' was Rs. 48,228, cost 'B' was Rs. 71,693 and cost 'C' was Rs. 88,873, respectively. The net returns in suru sugarcane group were Rs. 1,63,286, Rs. 1,23,109 and Rs. 95,045 at cost 'A', 'B' and 'C', respectively while in ratoon sugarcane group net returns were Rs. 91,339, Rs. 67,874 and Rs. 50,694 at cost

'A', 'B' and 'C', respectively. The analysis of per hectare profitability of suru sugarcane and ratoon sugarcane crop indicated that cultivation of both type of sugarcane were profitable at all the levels of cost, as indicated by into benefit-cost ratio of suru sugarcane 1.66 and ratoon sugarcane 1.57. In suru sugarcane group per hectare main produce was 102.45 tonne and by produce was 20.49 tonne while in ratoon sugarcane group main produce was 59.90 tonne and by produce was 11.98 tonne.

Surwase *et al* (2015) The present study was conducted during 2013-14 in Thane district of Maharashtra. The cultivation of sapota of Dahanu and Palghar tahsils is concentrated near and away from the sea shore. Therefore, a cross sectional sample of 120 sapota growers was randomly selected and stratified in to two categories *i.e.* near the sea shore (Group I) and away from sea shore (Group II). The data were collected by personal interview method with the help of pretested schedule. The result revealed, at overall level per hectare total cost of maintenance (cost-C) of sapota orchard was worked out to Rs. 120138. The per hectare total cost of maintenance (cost C) of sapota orchard in group I was worked out to Rs. 125336 and Rs. 114452 in group II. The per hectare gross returns received at overall level of sapota orchard was Rs. 180572 and profit at different cost levels such as cost A, cost B and cost C were Rs. 127408, Rs. 69350 and Rs. 60434, respectively. The per hectare gross return was Rs.201260 in group I and Rs. 155901 in group II observed. It was observed that, at overall level net profit received at different cost levels such as cost A, cost B and cost C were Rs.145338, Rs.84644 and Rs.75924, respectively. Input-output ratio was 1.50 at overall level.

Dorge *et al* (2015) The present study, comparative economics of various farming systems have been workout for ascertaining the sustainability of most profitable one. Three widely adopted farming systems were selected for the study *viz* I) Crops only, II) Crops + Livestock, III) Crops + Livestock + Horticulture crops. The two districts *Viz*. Ahmednagar and Solapur were selected purposively. Two tahsils from each district were selected. The per farm income pattern indicated that, the total income in FS-II was double than FS-I. The item wise income indicated that, the more than 50 per cent income was derived from crop production in FS-I and FS-II. In expenditure pattern, out of total expenditure more than 70 per cent was the farm expenditure in all the FS. The region wise sustainable farm income indicted that, FS-II and FS-III, were having sustainable farm incomes in both the regions. But FS-I

could not meet their requirements on the basis of their farm business income. It means farmers of FS-I were not having sustainable farm income. After adding the income from other sources, farmers in FS-I, had sustainable farm income, in both the regions. Therefore, the income from other sources (wages, services and business etc) was the only factor, which helped them to become sustainable.

2.3 Resource use efficiency.

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

Sharma and Singh (1993) in their study on resource use productivity and resource allocation efficiency used a Cobb-Douglas type of production function. The results of the study indicated that the feed concentrate was the most important input affecting milk production. The regression co-efficient of this input was positive and statistically significant in all the equations fitted, indicating that the farmers could increase their milk production by feeding more of concentrates to the animals. The regression coefficients of green fodder and dry fodder were also positive.

Vishweshwar (1994) employed Cobb-Douglas type of production function to measure the efficiency of inputs used in the production of cotton by IPM and non-IPM adopted farmers in Malaprabha command area in Karnataka. The study indicated that the ratio of MVP to MFC for land was greater than one. While it was less than one for labour and it was negative for seed, fertilizers and pesticides in conventional farmers. In case of IPM adopted farmers, the MVP to MFC ratio for land, labour seed and fertilizers were greater than one and it was negative for fertilizers.

Nagraj *et al.* (1996) in their study to evaluate the economics of maize-sunflower farming system at different size group of farmers of Tungabhadra command area, concluded that the variation in the gross returns explained by the variables included in the production function analysis was to the extent of 89.49 per cent and 99.03 per cent in maize and sunflower, respectively. The resource use efficiency indicated that land, manures and fertilizers together had maximum

influence on gross returns of maize and in case of sunflower after maize, land was the single most factor that greatly influenced the gross returns.

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

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 a significant effect on the gross returns.

Mythilli and Shanmugam (2000) studied technical efficiency of rice growers in Tamil Nadu by using stochastic frontier production function approach. Study was based on panel data. The model was estimated by the maximum likelihood method. The estimated mean technical efficiency was 82 per cent indicating that on an average, the sample farms in Tamil Nadu state tend to realize only 82 per cent of their technical abilities. It meant that approximately 18 per cent potential was not realized. However the technical efficiency was ranging from 46.5 to 96.7 per cent among the various farms.

Mahesh *et al*. (2002) made an attempt to measure the technical efficiency in tea industry on farmer owned as well as corporate farms in west Bengal. The maximum likelihood estimates were calculated and stochastic frontier production function was used to estimate the technical efficiency in production. The stochastic frontier Production function of the Cobb-Douglas type was specified for the study. It was observed that in farmers group mean technical efficiency was 68.72 per cent. Whereas in corporate units, mean technical efficiency was 84.68 per cent. The most efficient farms in farmers group were 11.67 per cent. In short run it is possible to increase the yield by 31.28 per cent in case of farmers and 15.32 per cent in case of corporate farms by using better management practices.

Verma (2002) employed Cobb-Douglas production function for evaluating resource use efficiency in onion. The marginal value product of seed, manures and fertilizers, human labour and machine power were positive on small farms while it had negative value of bullock labour, plant protection and irrigation were

negative. This implies that the small farms were underutilizing seed, manures and fertilizers, human labour and machine power while bullock labour, plant protection and irrigation were excessively used on the farms. In case of large farms, marginal value product of seed, manures and fertilizers, human labour, bullock labour and plant protection were positive while it had negative value of machine power and irrigation

Sunanda and Narender. (2003) studied resource productivity of mesta farms in Srikakulam District of Andhra Pradesh. The cobb-douglas production function was used for study. The coefficient of multiple determination R^2 ranging from 0.86 to 0.95 in different farm size groups. The production elasticities indicated that one percent increase in human labour in small and medium farms would increase the grows output by 0.45 and 0.23 per cent, respectively. Similarly one per cent increase in cattle labour in small and medium farms would increase the gross output by 0.37 and 0.87 per cent, respectively. However negative sign to the co-efficient of input, seed indicated its excessive use it was also revealed study that ratio of MVP to opportunity cost in all farm were less than acquisition costs (1.00) indicating, seed, manners, and fertilizers, human labour, cattle labour were used inefficiently in all size group of farms, This showed that there was scope for reorganization of resources to achieve higher profits..

Singh (2004) fitted the Cob-Douglas production function to analyse the resource use efficiency in vegetable crops and it was found to explain nearly 87 per cent to 98 per cent of the variation in the dependent variable. The elasticity of production of rental value of land (X_1) was found to be more than one indicating increasing returns for tomato and onion. Remaining variables for okra, brinjal and potato vegetable crops were found less than one indicating decreasing returns to scale. The sum of regression coefficients of variables (Σbi) turned out to be less than one for onion, okra and potato vegetable crops and more for tomato and brinjal crops indicating gross value of these vegetable crops increased proportionally with an increase in the variable factors and vice-versa.

Rajashekharappa *et al.* (2004) made a critical study on technical efficiency in arecanut production. The data envelopment analysis programme DEAP- a non-parametric linear programming approach was used for estimating technical efficiency scores. The extent of overall economic efficiency has been expressed

in terms of cost inefficiency. Allocative efficiency was calculated by using cost minimization data envelope analysis. Considering the behavioral objective of cost minimization or revenue maximization. Study revealed that mean efficiency has been found to vary widely from 69 to 90 per cent among the sample farms and across regions, which indicates that on an average, the realized output could be raised by 10 to 31 percent without any additional resources. The results also showed that through proper use of existing technology, there was a huge potential in improving productivity of arecanut which can be exploited.

Vagdevi *et al* (2004) Production function analysis was used to examine the resource productivity and resource use efficiency of vegetable farms in the Krishna District of Andhra Pradesh, India. Analysis showed the predominant position of diminishing factor returns and diminishing returns to scale. The marginal value products to opportunity cost ratios showed the inefficient use of resources at different magnitudes.

Pawar and Pawar (2005) An investigation was carried out to study the marginal productivity, economic efficiency and optimum resource use in NCS 145 cotton production in Parbhani district of Maharasthra, India, during 2003-04. Results revealed that the regression coefficient of hired human labour (0.182) was highly significant at 1% level while the regression coefficients of area of NCS 145 cotton (0.221), family human labour (0.137) and manure (0.077) were positive and statistically significant at 5% level. Thus, it was inferred that these resources were underutilized and there was scope to increase them in cotton production. In terms of resource use efficiency, a rupee of investment on each of the resources, namely, hired human labour, manure, family human labour and area of NCS-145 cotton, was highly profitable. The optimum use of each of the resources was higher than the existing specific resources except bullock labour and potash.

Haque (2006) This paper analyses resource use efficiency in crop production in India, as reflected by changes in factor productivity/profitability over time. It also discusses sustainable use of land and water resources and identifies some required policy interventions.

Nikam *et al* (2006) This study was conducted to examine the profitability and resource use efficiency in cropping systems at the command area of Natuwadi

Irrigation Project in Ratnigiri District, Maharashtra, India. The data were gathered by interviewing 90 farmers during 2003-04. Male labour days and seed exerted significant influence on output in rice-fallow and rice-rice cropping system, while fertilizer exerted significant influence on output in rice-groundnut system. The ratios of marginal value product to marginal factor cost were greater than one in case of male labour days for rice-fallow and rice-rice systems. In case of rice-groundnut system, the use of fertilizer and irrigation showed greater than one ratio between marginal value products to marginal factor costs.

Pawar and Pawar (2006) An investigation was carried out during 2003-04 to study resource productivity, resource use efficiency and optimum resource use in rainfed pearl millet (*Pennisetum americanum* [*P. glaucum*]) production in Maharashtra, India. Results showed that a one percent increase in the use of hired labour, nitrogen manure and family human labour, increased the production of pearl millet grain by 0.262, 0.074, 0.068 and 0.148%, respectively. The use of manure was the most profitable followed by hired human labour and use of nitrogen. The existing size of rainfed pearl millet farm was 0.83 ha while the optimum size of the farm was 0.06 ha.

Rohile *et al* (2006) This study was conducted to determine the resource use efficiency in banana (*Musa paradisiaca*) production in Sindhudurg District, Dapoli, and Maharashtra, India. The banana growers (n=90) were classified into two groups based on the type of banana orchards, viz., mixed cropping and sole cropping. Out of 90 growers, 67 growers practised mixed cropping and 23 growers employed sole cropping. The average area devoted to banana was 0.40 ha in mixed cropping and 1.08 ha in sole cropping. The variation in yield due to various input used in banana cultivation was 99% in both groups. In mixed cropping, planting material and fertilizers were significant variables, while in sole cropping, planting material, male labour, fertilizers and irrigation charges were statistically significant. The ratio of marginal value product to FC [fixed costs] of chemical fertilizers in mixed cropping and planting material, female labour and plant protection in sole cropping was less than one, which indicates excess utilization of these resources. It is suggested that the banana growers must reallocate and judiciously use input resources to maximize production at lower cost.

Shanmugam and Venkataramani (2006) studied technical efficiency in agricultural production and its determinants. A district level data for different states for the year 1990-91 was used for the study. A stochastic frontier production function applied and maximum likelihood estimates were used to estimate the production function. Secondly determinants of technical efficiency were estimated by regressing various socio-economic variables against technical efficiency values obtained. The mean technical efficiency in the sample was found to be roughly 79 per cent, which means sample districts on an average, could increase their output by 21 per cent without additional resources through proper use of existing inputs and technology. Across the entire sample, technical efficiency ranges from a low value of 41.69 per cent (Jaisalmer in Rajasthan) to 92.67 per cent (Kodagu in Karnataka). The most states viz; Madhya Pradesh, Rajasthan have the most districts centered below the mean technical efficiency value. The study has shown that health, education and infrastructure could be the powerful drivers of technical efficiency.

Kalara and Singh (2007) This study examines the cultivation practices and resource use patterns of rice farmers in Bulandshahr district, Uttar Pradesh, India. The efficiency of irrigation water use from different sources (canal, electric tube well and diesel pumps) is examined, as well as the profitability of rice production under these different water sources. It is shown that higher output and income can be obtained by managing the resources efficiently. Measures to optimize total returns and resource utilization under irrigated agriculture are explored.

Pawar and Pawar. (2007) An investigation was conducted to determine resource productivity, resource use efficiency and optimum resource allocation in JKCH-66 cotton (*Gossypium hirsutum*) production in Maharashtra, India, during 2003-04. Data were gathered by interviewing 48 cotton growers using a pre-tested interview schedule. Results revealed that regression coefficients of manure (0.141) and hired human labour (0.172) were highly significant at 1% level, while regression coefficients of phosphorus (0.062), area of JKCH-66 cotton (0.184) and bullock labour (0.142) were positive and statistically significant at 5% level. Thus, it was inferred that these resources were underutilized and there was scope to increase them in cotton production. The ratios of marginal value product to price with respect to the

resources were high. It is suggested that as long as specific return is more than the added cost, production must be pushed until marginal cost and return are equal.

Wagale *et al* (2007) This study was conducted to explore resource use efficiency in mango (*Mangifera indica* cv. Alphonso) production, and specifically to: determine inputs utilization across different farm size; examine size productivity relationship in mango production; and analyse the constraints faced by mango growers during production. Data were gathered from 120 mango growers from eight villages in Sindhudurg District, Maharashtra, India, during 2003-04. The average size of holding of the respondents was 2.54 ha. Moreover, the average respondents using different inputs in mango production were: 61.67% growers use manure, 70.83% use fertilizers and 76.67% use plant protection chemicals. The per hectare cost of cultivation was Rs. 43 198.00, Rs. 44 310.00 and Rs. 48 103.00 in small, medium and large farms, respectively. The net return was Rs. 13 594.00, Rs. 16 747.00 and Rs. 18 879 in small, medium, and large farms, respectively. Further, the cost benefit ratio at total cost of production was 1.26, 1.31 and 1.33 in small, medium, and large farms, respectively. The constraints encountered by mango growers were marketing of mango to commission agents (47.50%), lack of technical knowledge (42.50%) and unavailability of cold storage facility (29.17%).

Jyoti *et al* (2008) This study examines the technical efficiency of rice under the Jammu district in India and identifies the factors influencing technical efficiency in rice production. The present study was carried out during the year 2006 in Jammu district of the Jammu and Kashmir state among 100 farmers. The data collected were subjected to analysis for examining the technical efficiency, resource use efficiency, cost and returns and factors influencing the technical efficiency in rice production. The stochastic frontier production function was used to estimate technical efficiency. The estimates of the stochastic frontier shows that the estimated values of the coefficients of the seed and land were positive; therefore seed and land were productive inputs for successive production of paddy crop. The estimated values of the coefficient of labour, fertilizer and irrigation were negative but significant indicating overuse of these factors in producing the paddy crop. Statistically significant and positive values of estimated coefficients indicated that farmers could increase per hectare yield by implying more units of these inputs.

Debnath *et al* (2009) The nature of resources available and how they are combined and utilized in aquaculture largely determine its economic viability and social profitability. Using a novel Resource Cost Ratio (RCR), this study analyzes resource use efficiency and social profitability of an integrated aqua farm located in Tripura, India. RCR, a variant of the Domestic Resource Cost Ratio (DRCR), is the ratio of the net cost of non-marketable resources and the net value addition by using marketable resources. The RCR for the integrated farm was found to be -0.24. The negative value of RCR shows positive profitability for the integrated farm. The corresponding value for a specialized farm was found to be 0.52. The difference is the greater resource use efficiency of the integrated approach. Private and social profits per unit cost for the integrated farm (0.26 and 0.08, respectively) were higher than for the specialized farm (0.11 and 0.04, respectively).

Singh *et al* (2009) Results are presented of a study examining the resource use efficiency in agriculture in Ghazipur, Uttar Pradesh, India, during 2004-05, using the Cobb-Douglas production function. A set of 4 village was selected randomly and 30 cultivators from each village were selected randomly. The major crops selected for the study were wheat, sugarcane, potato and paddy. The resource use efficiency was determined by comparing the estimated marginal value productivity of various inputs (seed, manure/fertilizer, irrigation, human labour, plant protection) with their respective factor costs. It appears that the cultivators have not been able to allocate their inputs efficiently and there seems to be considerable scope for argumenting profit by optimum use of inputs.

Satpute *et al* (2009) this study examines the economic feasibility of soybean grown under organic and inorganic farming. A survey was conducted on 120 organic and inorganic growers during the *kharif* season of 2006-2007 at the Parbhani district of Maharashtra in India. Results revealed that the per hectare production of organic and inorganic soybean was 18.15 quintal and 21.08 quintal, respectively. The per hectare gross return was Rs. 39,506 and Rs.36, 785 for organic and inorganic soybean production, respectively. The per hectare net profit of organic soybean farming was higher than inorganic soybean farming. The per hectare total cost required for organic soybean production was Rs. 18, 024.70. The price of organic soybean was higher than inorganic soybean. The correlation of organic soybean farming seed and vermicompost was statistically significant at a 1% level of probability. The correlation

of phosphorus and plant protection was statistically significant at a 1% level of probability for inorganic soybean farming. The net return and benefit cost ratio for organic soybean was higher than for inorganic soybean. Organic soybean production was more beneficial than inorganic soybean production

Landge *et al* (2010) Banana (Musa paradisica L.) is one of the most important fruit crops in the world. It ranks next to mango in both area and production in India. About 48 drip irrigated banana growers were randomly selected for the study. Cross sectional data were collected from the banana growers with the help of pretested schedule by personal interview method. The study was conducted to know the resource productivity, resource use efficiency and optimum resource use in banana production. Cobb-Douglas production function was fitted to the data. The results revealed that the regression coefficient of machine labour, irrigation and area under banana was 0.054, 0.203 and 0.213, respectively which were positive and significant. Marginal productivity with respect to area, bullock labour and machine labour was 51.291, 2.759 and 2.746 quintals, respectively. It inferred that if area is increased by one hectare, bullock labour increased by one pair and machine labour increased by one hour, it would lead to increase banana production by 51.291, 2.759 and 2.746 quintals, respectively. The sum of the production elasticities (Σbi) was 0.576 which indicated decreasing return to scale.

Iqbal and Kachroo (2010) The present investigation was conducted in Jammu district of Jammu and Kashmir state during the year 2008. Two blocks were selected from Jammu district having the highest area under mango fruit. Cobb-Douglus function was used to study the relationship between output and various inputs. Coefficient of variation was calculated in order to analyze the instability in cropped area, yield and net returns. The study on per hectare costs of mango indicated that on an average the cost A, cost B and cost C were Rs. 1523.95, Rs. 4456.20 and Rs. 12910.80, respectively. The benefit cost ratio with respect to cost A was 9.31, 3.28 with respect to cost B and 1.10 with respect to cost C. Human labour was significant and underutilized in mango in all groups except in 20-24th year group where it was non-significant and over utilized. Manures+fertilizers, plant protection and pruning and training over utilized in 10-14th year group while as in other groups these inputs were underutilized in all groups except pruning+training in the overall group where it was over utilized. The pruning+training were over utilized upto 14th year and from

15th year onwards it was underutilized. The instability was found higher in case of area as compared to yield and net returns.

Kakade *et al* (2011) In all 32 grape winery owners were selected from Pune, Nasik and Sangli districts of Maharashtra. Data were collected from 32 grape winery owners by personal interview method for the year 2009-2010. Cobb-Douglas production function was fitted to the data. The results revealed that the regression coefficients of hired human labour, raw grape, potassium metabisulphate, water quantity and KH_2PO_4 were 0.011, 0.494, 0.116, 0.005 and 0.267, respectively which were positive and significant. Marginal productivity with respect to hired human labour, raw grape, potassium metabisulphate, KH_2PO_4 and glycol was 9.321, 3.163, 597.674, 1034.330 and 208.293 litres, respectively. It inferred that if hired human labour increased by one person, raw grape by one quintal, potassium metabisulphate by one kg, KH_2PO_4 by one kg and glycol by one litre that would lead to increase grape wine production by 9.321, 3.163, 597.674, 1034.330 and 208.293 litres, respectively. The sum of the production elasticities (bi) was found to be 0.655 which indicated decreasing return to scale.

Jaya Tiwari and More (2012) The present study entitled cost and returns of soybean cultivation in Indore district of Madhya Pradesh was undertaken to study the costs and returns aspects of soybean. The study covered two blocks and four villages with 80 farmers growing soybean. The sample farmers were stratified in to small (up to 2 hectares) and large (more than 2 hectares). The data pertained to 2009-2010 were collected through survey method with the help of pretested schedules. Conventional and functional analysis was used to analyze the data and to arrive at valid conclusions. The per hectare cost of cultivation of soybean was estimated at Rs.30,740.85, Rs.28,466.26 and Rs.29,58.7.43 on small, large and pooled farms, respectively and thus exhibiting inverse relationship with the size of the farm. The cost of producing a quintal of soybean showed direct relationship with the size of the holding as it was Rs. 1,727 on small farms, Rs. 1,848.45 on large farms and Rs. 1,793.20 on pooled farms. The net income decreased from Rs.13,342.47 on small farms to Rs.8,986.56 on large farms. The same on pooled farms was Rs.10,999.42.

Mane *et al* (2012) Investigation was carried out during the year 2010-11. About 60 sericultural producers were randomly selected from ten villages of two tehsils of Osmanabad district of Maharashtra. Cross sectional data were collected

from sericultural producers with the help of pretested schedule by personal interview method. The study was conducted to know the elasticity of production, resource productivity and resource use efficiency in cocoon production. Cobb-Douglas production function was fitted to the data. The results revealed that regression co-efficient of disease free layings (0.042) and disinfecting material (0.229) were positive and significant. Regression co-efficient with respect to batches under cocoon production was 0.048 followed by that of hired human labour (0.105), family human labour (0.170), mulberry leaves (0.257) and electricity (0.025) which were positive but non-significant. The sum of production elasticities (Σbi) was 0.876 which indicated decreasing return to scale.

Menasinahal *et al* (2012) The study was under taken in Uttara Kannada district of Karnataka state. The two major Taluks *viz.*, Mundagod and Haliyal where paddy has been largely replaced by cotton were selected. From each Taluk, 30 farmers growing paddy and 30 farmers growing cotton were selected randomly for the study. In paddy cultivation fanners used 46.90 man days of human labour, 13.76 pair days of bullock labour and 4.28 hours of machine labour, 3.92 tonnes of FYM. 138.8 kg of nitrogenous, 69.7 kg of phosphorus and 59.61 kg of potassium fertilizers kg per hectare. The seed rate used was 78.8 kgs per hectare. In cultivation of cotton the sample farmers used 59.41 man days of human labour, 20.67 pair days of bullock labour and 1.19 hours of machine labour per hectare, 5.32 tonnes of FYM. 140.9 kg of nitrogenous and 71.2 kg of phosphorus and 68.3 kg of potassium fertilizer per hectare. The seed rate used was 2.87 kg per hectare. In cultivation of paddy FYM, chemical fertilizers and bullock labour were underutilized whereas seeds and FYM were underutilized where was chemical fertilizers, human labour and bullock labour were over utilized.

Pawar and Vijaykumar (2012) Investigation was carried out during the year 2010-2011. About 32 soybean growers were randomly selected from eight villages of Udgir tehsil of Latur district of Maharashtra. Cross sectional data were collected from soybean growers with the help of pretested schedule by personal interview method. Data were related to soybean output and inputs like area under soybean, hired human labour bullock labour machine labour, seed, manure and use of nitrogen, phosphorus, potash and family labour as resources. Cobb Douglas production function was fitted to the data. The results revealed that, regression co-efficient of human labour was

(0.129) followed by machine labour (0.024) which were positive and highly significant at 1 per cent level. Regression co-efficients of bullock labour (0.067) and plant protection (0.011) were positive and significant at 5 per cent level. Regression co-efficients of seed, manure, nitrogen and phosphorus were also positive but non-significant. Marginal product of area under soybean was 10.803 q followed by machine labour (0.274 q), bullock labour (0.231 q) and so on. MVP to price ratio with respect to phosphorus was 3.01 followed by that of nitrogen (2.98). Hence, preference might be given to increase the use of phosphorus on priority basis in soybean production.

Shetye *et al* (2012) From the production function analysis it was revealed that, in case of inorganic cashew orchard the elasticity coefficient for area (X_1) was positive and found statistically significant at 1 per cent level of probability. Whereas, the elasticity coefficients for K(X_7) and N(X_5) were positive and found statistically significant at 5 per cent and 10 per cent level of probability, respectively the value of coefficient of multiple determination (R^2) was 0.972 indicating that 97.20 per cent variation in cashew production was explained by variables included in the function. The return to scale was found constant ($\Sigma bi=1.003$). In case of organic cashew orchard, the elasticity coefficient for area (X_1) was positive and found statistically significant at 1 per cent level of probability. The value of coefficient of multiple determination (R^2) was 0.934 indicating that 93.40 per cent variation in cashew production was explained by variables included in the function. The applied 't' test indicated that the value of Σbi (1.306) was significant at 5 per cent level. It showed that increasing returns to scale have prevailed in organic cashew orchard. Allocative resource use efficiency across inorganic and organic cashew orchards of cashew revealed that cashew growers have to be given adequate technical knowledge for resource management and proper use of resources mainly critical inputs.

Singh *et al* (2012) The present study was undertaken in Varanasi districts of Uttar Pradesh to study resource use efficiency in milk production on sample households. Varanasi district consisted of eight blocks. Two blocks were selected at random. Two villages from each block were randomly selected. A sample of 100 milk producing households comprising of 15 landless, 33 marginal, 22 small, 17 medium and 13 large were selected randomly from these four villages. The average quantity of green fodder, dry fodder and concentrate fed to the milking buffaloes of all categories

were found to be 17.85 Kg, 8.39 Kg. and 3.22 Kg. per day per animal respectively. Linear and Cobb-Douglas milk production functions were tried to study resource use efficiency. The linear was found best fit keeping in view sign, significance of regression co-efficient and value of R^2. The regression coefficient of green fodder, dry fodder and concentrate were found significant. It was observed that green fodder, dry fodder and concentrate were underutilized indicating that feeding of more quantity of green fodder, dry fodder and concentrate will further increase the productivity of milch buffaloes in the study area.

Hota and Debapriya (2013) The agricultural productivity and production of paddy continue to be at low level despite the use of critical inputs may be due to the resource-use inefficiency in the paddy farms. Keeping this in view the paper seeks to estimate the resource productivity, resource-use efficiency, technical efficiency and returns to scale across the farm sizes (small, medium and big) in villages (irrigated, tailed-irrigated and non-irrigated) under study in Bargarh district of Orissa by using Cob-Douglas production function and Data Envelopment Analysis (DEA). The study shows that the productivity is often affected by the resource-use and technical inefficiencies of farms even though small farms were comparatively found to be less technically inefficient. Decreasing return to scale is observed as a predominant feature in the area under study in this context. Hence, a prudent mix of resources is suggested for productivity improvement with focus on strategic and timely intervention.

Karthick *et al* (2013) The resource-use efficiency and technical efficiency of turmeric production have been 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. Non-availability of labour has been reported the major production constraint by the turmeric growers. The study has suggested some measures to increase productivity and income of farmers in the study area.

Pandian *et al* (2013) The Study was under taken to analyze the Productivity of Resource in Milk Production in urban areas of Tamil Nadu. A Total Sample Size of 90 dairy farmers was selected from three urban milk shed areas of Tamil Nadu namely Chennai (Tambaram), Erode and Vellore for the present Study. To estimate the productivity of resources in milk production, Cobb Douglas Production Function was used. The co-efficient of multiple determinations (adjusted R^2) was 0.912, indicating that the five variables selected for the analysis had explained 91.2 percent variation in total milk production. The Results of Cobb- Douglas Production Function revealed that concentrate, green fodder and labour had Positive and highly significant ($P<0.01$) influence on Milk Production. The result of allocative efficiency of Resources in milk production revealed that concentrates, labour and veterinary charges were under-utilized, whereas green fodder and dry fodder were over-utilized.

Pawar and Haral (2013). The results revealed that, regression co-efficient of economic life of custard apple garden was 0.630 followed by area under custard apple garden (0.194), manure (0.021) and bullock labour (0.015) which were positive and significant at 1 per cent level. Regression co-efficient of hired human labour, nitrogen, phosphorous and potash were positive but non-significant. On the contrary, regression coefficient of plant protection was -0.018 which was negative and significant at 1 per cent level. Marginal product of area under custard apple garden was 15.507 quintals followed by that of economic life of custard apple garden (2.804 q), bullock labour (1.465 q) and manure (0.156 q) and so on. MVP to price of ratio with respect to bullock labour was 11.78 followed by potash (4.09), manure (3.20), nitrogen (2.93), phosphorus (2.71), area under custard apple (1.15), hired human labour (1.22) and economic life of custard apple garden (0.89). Hence, preference might be given to bullock labour on priority basis in custard apple production.

Sunny Kumar *et al* (2013) The present study assesses the economics and resource use efficiency of important vegetables (potatoes, peas, chillies, and cauliflowers) in Punjab, India. Thirty farmers were selected for each vegetable, for a total sample of 120 vegetable growers. The total cost of cultivation on per hectare basis among the selected vegetables was found to vary between Rs. 112 954.79 for cauliflowers to Rs. 80 866.50 for potatoes. Gross returns and net returns were highest among the cauliflower crop, which were Rs. 165 669.60 and Rs. 52 714.81, respectively, and least among the potato crop with corresponding figures of Rs.

86 058.30 and Rs. 5191.80, respectively. Fertilizer was found be a significant variable affecting the productivity of potatoes and chillies, while expenses on insecticides turned out to be significant for the potato and cauliflower crops. Labour in the case of peas and cauliflowers and fertilizers in the case of potatoes and chillies were found to be underutilized. The study emphasized the need to curtail the overuse of irrigation in the case of peas and chilli crops, and insecticides in the case of cauliflowers.

Takale (2013) This study examined the production elasticities, resource-use efficiency and returns to scale of sugarcane cultivation in Parbhani district, Maharashtra, India. Primary data for the year 2009-10 were collected from a sample of 100 farms. The study found diminishing returns to scale in sugarcane cultivation for all farm sizes because of the excessive use of human labour, machine charges and insecticides. Analysis of resource-use efficiency revealed that none of the inputs was efficiently allocated for all size groups of cultivators. The analysis of production elasticities in sugarcane cultivation, according to farm size, revealed that the coefficient of irrigation and seeds was positively significant except for large farms, while the production elasticities of machine charges, human labour, and insecticides (except for small farms) were negative.

Jagtap *et al* (2014) The study was conducted in Achalpur tahsil of Amravati district of Maharashtra with a sample of 80 farmers selected randomly from four villages with twenty farmers from each village. Data used were pertaining to the period 2009-10. Production function analysis of data indicated that, among various resources selected, human labour, bullock labour and machine power in small farmers, seed, bullock labour and fertilizers and manures in medium farmers and the fertilizers and manures in large farmers were statistically significant. The ratio of marginal value product to its acquisition cost per unit was found to be greater than unity for the variables plant protection chemicals and fertilizers and manures in small farmers, variables human labour and fertilizers and manures in medium farmers and the variables seed, human labour and fertilizers and manures in large farmers. Also economic analysis of data indicated that majority of farm produce was routed through two marketing channels, Channel-I (Producer-commission agent-retailer-consumer) and Channel-II (Producer-commission agent-Wholesaler-retailer-consumer). Producer's share in consumer's rupee was found to be 56.31%, 40.59% and price spread was Rs. 655.35 Rs. 891 q^{-1} for Channel-I and Channel-II respectively.

Makadia *et al* (2014) Rice being a staple food of most Indians occupies largest area and second largest production in the world. Operational holding is shrinking and land, water resources are getting degraded. Henceforth, the evaluation of innovative production practices is needed to meet the growing demand of rice. Under such a scenario, System of Rice Intensification (SRI) has emerged as an important technology to increase rice productivity. For this study 120 farmers (60 SRI+60 Traditional) were selected. Cost-C2 for SRI and traditional method was found to 43790 and 40985 per ha, respectively. Average per hectare yield of SRI and traditional method was reported to 51.25 and 41.25 qtl, respectively. The return per hectare over operating cost-A for SRI and traditional method was to the tune of 49758 and 33865, respectively. In SRI method, resource use efficiency of human labour contributed positive and significant while for traditional method manure and fertilizer found positive and significant towards paddy production

Pawar *et al* (2014) Investigation was carried out during the year 2011-12. About 96 groundnut growers were randomly selected from eight villages of Sengaon tehsil of Hingoli district of Maharashtra. Cross sectional data were collected from groundnut growers with the help of pre-tested schedule by personal interview method. Data were related to TAG-24 groundnut output and inputs like hired human labour, family human labour, bullock labour, machine labour, fertilizer, plant protection and irrigation as resources. Cobb-Douglas production function was fitted to the data. The results revealed that, regression co-efficient of area under groundnut was 0.382 followed by that of hired human labour (0.229), nitrogen (0.041), and irrigation (0.220) which were positively significant at five per cent level. Regression co-efficient of phosphorus was found significant at one per cent level. On the contrary, the regression co-efficient of family human labour, bullock labour, machine labour, potash and plant protection were negative and non-significant. Marginal product of area under groundnut was 11.20 quintals followed by that of hired human labour (0.063 q), nitrogen (0.023 q) and phosphorus (0.28 q) and so on. MVP to price ratio with respect to area under groundnut was 2.34 followed by that of phosphorus (6.71), nitrogen (5.28) and hired human labour (2.63). Hence, preference might be given to increase the area on priority basis in groundnut production. Optimum use of area under groundnut was found to be 2.18 hectares.

Reddy and Munadinamani .(2014) The efficiency measures have been developed to express technical or allocative efficiency in various farm enterprises and to relate these to the financial success. The present study aims to analyze the resource use efficiency using production function for organic farming systems I of Gadag district in Karnataka. The results revealed that the regression coefficients of all the resources were positive except for seed (-0.07), bio-pesticide (-0.05), green fodder (-1.51) and concentrates (-0.16). The variables included in the function explained 95 per cent variation in the dependent variable as indicated by value of coefficient of multiple determination (R^2) was 0.95. In case of organic Farming System-III, The ratios of MVP to MFC were less than unity for biopesticide, organic manure and dry fodder showing that these resources were over utilized.

Suresh Kumar *et al* (2014) present study was designed to measure input use, cost structure, return and resource use efficiency in wheat production of South Gujarat division of Gujarat, India. In present investigation The sample of 240 Wheat farmers were selected from study area which input-output data collected based on rabi cropping season with a view to examine the input use, cost structure and returns in production and marketing of wheat and the resource use efficiency of wheat growers in year 2013-14. We was used the log linear type Cobb-Douglas production function. The results of study revealed that the average total cost of cultivation of wheat was ' 45784.31. It was the highest on large farms followed by 45720.79 on medium farms, and 39016.69 on small farms. Higher costs on large farms are associated with intensive use of Human labour, bullock labour, manures & fertilizers and irrigation charges. The overall input-output ratio was 1:1.44 on the basis of total cost of cultivation. It was the highest (1: 1.48) on large farms, followed by medium farms (1:1.43), and small farms (1:1.35). The average cost of production per quintal of wheat was about ' 1285.86 which was lower than the market price of wheat ranging from ' 1600 to ' 1950 per quintal. Functional analysis of wheat crop revealed that seed, N fertilizer, irrigation, human labour, No. of weeding, P fertilizer F.Y.M, bullock labors, and No. of spray i.e. 0.511,0.371, 0.288, 0.188, 0.171, 0.148, 0.059, 0.029, and 0.020 respectively. This is positive and statistically significant, indicated which indicated that if expenses made on these resources, then it will be gives profitable returns.

Vasanthi and Chandrasekaran (2014)The present study undertaken in Cauvery delta zone and Southern zone in the state of Tamil Nadu has estimated the resource use efficiency in rice production and has assessed the effect of farm specific socio economic factors affecting the technical efficiency. A stochastic frontier production function was estimated to determine technical efficiency of individual farms. The data were collected for two years from the Cost of Cultivation Scheme of Tamil Nadu Centre. The results of Cobb-Douglas stochastic production function indicated that the estimated parameters for seed (positive), labour hours (negative) and value of pesticides (negative) are significant and hence, playing a major role in influencing rice production under canal irrigation. But in the case of tank irrigation system the estimated parameters for fertilizers, labour hours, machine hours are significantly and positively influenced the yield of paddy. Moreover the marginal value product to input price ratios for the variables influencing significantly revealed that it will be profitable to increase the use of seeds in canal irrigation and fertilizer and human labour in tank irrigation system. The Z test results indicated that there is a significant difference between the average technical efficiency estimates between canal and tank irrigation systems.

Ibitoye *et al* (2015) The study was on resource use efficiency among tomato farmers in Kogi State, Nigeria. The data were collected from 240 tomato farmers through purposive sampling in 2014. Questionnaire design was the instrument used for data collection. Data collected were analysed through the use of simple descriptive statistics, OLS regression analysis and efficiency ratio. The result of the study showed that majority of tomato farmers in the State were married males with an average family size of 7 members. Farmers' educational status, farming experience, contact with extension workers, and farm size were positively related and significant at 1% in influencing the output of tomato produced in the State. Resources such as pesticide, labour, years spent in school, quantity of seed and farm size were positively and significantly related to tomato output in Kogi State. Quantity of pesticide, seed and fertilizer were over utilized while labour and farm size were underutilized. It is recommended that government should implement policies that will facilitate the efficient utilization of agricultural resources among tomato farmers in Kogi State.

Jawanjal *et al* (2015) The functional analysis was carried out to know the contribution of independent variables in yield of sugarcane. From the estimated Cobb-

Douglas production function (log linear production function), it was observed that, in suru sugarcane co-efficient of determination (R^2) was 0.9113 indicating 91 per cent of variation and in ratoon sugarcane co-efficient of determination (R^2) was 0.9344 indicating that, 93 per cent of the variation in the yield was explained by the identified input variables included in the function e.g. expenditure on manures, plant protection, potassium and nitrogen in suru sugarcane cultivation, and plant protection and manures to be curtailed considering their excess utilization in ratoon sugarcane cultivation. Whereas, MVP to FC ratios was more than unity for phosphorus and nitrogen, human labour, irrigation indicated under-utilization of these resources in sugarcane cultivation which underlines scope of expanding the use of these inputs

Ravikumar *et al* (2015) The study was carried out to analyze the cost and returns in pomegranate cultivation and efficiency of marketing channels in Chitradurga district, Karnataka State, India. The study utilized the primary data collected from a sample of 120 farmers spread across 14 villages of two taluks in Chitradurga district. Further, a sample of 10 each of preharvest contractors and retailers were also selected for enumerating the data on marketing costs and margins. Tabular analysis and Cobb-Douglas production function were used for data analyses. The results revealed that expenditure on labour and manures and fertilizers were found to have positive influence on production and were significant at 1 and 5% level, respectively. The ratio of marginal value product and marginal factor cost were positive and more than unity for the resource fertilizer and manures for both Challakere and Hiriyur taluks. The ratio of marginal value product and marginal factor cost was negative and more than unity for the resource PPC whereas negative below unity for the resource labour for sample farmers of both Challakere and Hiriyur taluks indicating that resources were in excessive use. The cost of marketing incurred by the growers who sold at the market for a quintal of fruits amounted to Rs. 442.31 and Rs. 439.12, respectively for Challakere and Hiriyur taluks. The commission charges, transportation costs and cost of packing material were major components of marketing cost. The net profit of retailer was 1.93 and 1.31% (Rs. 164 and 110 per quintal) and profit of pre harvest contractors was Rs. 895 and Rs. 876 per quintal (10.53 and 10.41%) and the price spread was 70.07 and 69.73% in Challakere and Hiriyur taluk, respectively. The producer's share in consumer's rupee was less in Channel-II compared to Channel-I i.e., 29.93 and 30.27%.

Sulaiman *et al* (2015) the aim of the study is twofold; to determine how the resource inputs were efficiently used and describe how socio-economic characteristics of sugarcane farmers affected the efficiency of sugarcane producers in Kaduna state. Study Design: Primary data were collected for this study from sugarcane farmers through the use of well-structured questionnaires. Place and Duration of Study: This study was carried out in Maigana Agricultural Zone of Kaduna state, Nigeria between September and December 2014 cropping season. Methodology: Multistage-stage sampling technique was employed for data collection. Results: A total of 330 respondents were randomly selected and interviewed. The analysis revealed that the coefficients of the resource inputs farm size, cutting (*sett*), fertilizer, labour and agrochemical had positive sign, thus conformed to the *a priori* expectation. The average practice technical efficiency was found to be 89% Conclusion: These resource inputs were found to be inelastic and not intensively being utilized. Hence, the farmers should increase the rate of inputs used in order to optimize efficiency in sugarcane production in the study area.

Surwase *et al* (2015) The study aimed to analyze the resource use efficiency of sapota in Thane district which has high concentration of area under sapota. The multistage random sampling procedure was adopted to choose 120 sample farmers from Dahanu and Palghar tahsils of Thane district which are concentrated near and away from the sea shore, therefore the Villages in Dahanu and Palghar tahsils is divided in to two categories *i.e.* near the sea shore (Group I) and away from sea shore (Group II). The results of the Cobb-Douglas production revealed that the regression co-efficient for area was found to be significant in case of all the sapota farmers and the co-efficient of multiple determination was (R_2) 57 per cent, 49 per cent, and 44 per cent in case of group I, group II and at overall level, respectively. At near sea shore farms (Group I) the ratio of MVP/MFC is greater than unity in case of male labour, female labour, fertilizer and plant protection indicated that these resources were underutilized which underlines the scope of expanding the use of these inputs. However, in case of away from sea shore (Group II) farms the ratio of MVP/MFC is greater than unity in case of male labour, manures and fertilizer

Tirlapur and Mundinamani (2015) The present study was under taken in Dharwad district to analyse the resource use efficiency of major crops. Major crops grown in the district such as chickpea, cotton, paddy, soybean, maize and chilli were

selected for the study. Multistage random sampling was adopted for selection of sample respondents. Cobb-Douglas production technique was employed. Results of the study revealed that seed, fertilizers, PPC and machine labour were over utilized and human labour and bullock labour were underutilized by the chickpea farmers. Cobb-Douglas production function for cotton under rainfed condition revealed that seed, PPC, human labour and bullock labour were over utilized and FYM, fertilizer and machine labour were underutilized. During production of paddy seed, fertilizers, FYM, bullock labour and machine labour were over utilized and human labour and PPC were underutilized by the farmers. FYM and PPC were underutilized and seed, fertilizers, human labour, bullock labour and machine labour were underutilized by farmers in cultivation of soybean. Resource use efficiency under rainfed chilli production revealed that seed, PPC, bullock labour and machine labour were over utilized and FYM, fertilizer and human labour were underutilized by the farmers.

Waghmode *et al* (2015) This paper presents the results of field studies conducted in Maharashtra, India, to determine the resource productivity and resource use efficiency in sugarcane production in the area. It was shown that irrigation, nitrogen fertilizers, human labour and farmyard manure were the resources most important in increasing the sugarcane productivity in the study area.

The literature reviewed so far under this heading indicated that, majority of researchers have used Cobb- Douglas production function to study the resource efficiency. Among the various inputs human labour, fertilizer were excessively used, whereas plant protection, irrigation, were underutilized in most of the studies.

2.4 Linear Programming Analysis

Mathematical programming has been considered an efficient way of obtaining optimum production plans when numerous competing activities are associated with a large number of resources and restrictions of various kinds and magnitude. In India, budgeting techniques was used as a tool for farm planning in the beginning, while in recent years linear programming technique is being used for complex farm planning purposes.

Sankhayan *et al* (1977) An attempt is made to point out the fallacies in the use of maximization linear programming models in Indian farming conditions in regard to

(1) the use of prices associated with the variables, (2) items of variable expenses treated as working capital, (3) use of synthetic farm situations, especially those where even crop activities are also averaged for a given sample of farms and (4) classification of land. It is pointed out that the prices associated with capital borrowing activity should correspond to the rate of interest when the objective function is to maximize the returns to fixed farm resources. Items on variable expenses (working capital) must also include the imputed value for home produced seed. Charges for hired labour for a particular activity should not be accounted for in the working capital expenses if intermediate labour hiring activities and labour constraints were provided in the LP model. As far as possible, indiscriminate averaging of activities in a sample of farms should be avoided as it would introduce a bias in the results, most probably underestimating the optimum value of the objective function. Land should not be classified according to land use capability but according to the quality of land.

Nanaja Reddy (1980) used linear programming technique to examine the income and employment potential of small farmers in Channapatna Block, Bangalore district. He found that the existing cropping pattern was oriented towards subsistence farming with a large proportion of the cropped area allotted under food crops. Relatively less capital intensive crops were accorded priority in land allocation over more capital intensive and profitable crops. The land use and resource allocation was found to be sub-optimal and there existed a scope for increasing profits through reallocation of resources.

Sirohi *et al*. (1980) used linear programming for a sample of 72 farm households in the Union Territory of Delhi and examined the possibilities of increasing income and employment through introduction of dairy and poultry into the existing crop farming system. On optimization with liberal credit facilities, the new enterprise system (crop + dairy + poultry) was found to increase employment besides augmenting the income on small and marginal farms.

Thorve and Galagalikar (1985) used linear programming to study the impact of dairy enterprise on the cost and returns in various farming situations of Akola district of Maharashtra. They concluded that mixed farming with dairy had a positive effect on the income of the farmers of all the size groups.

Singh *et al* (1988) employed linear programming to integrate improved technology of crop and milk production for increasing income and employment. They concluded that the optimization of resources under different farm plans resulted in increased income on all the categories (marginal, small, medium and large farms). Adoption of improved technology of crop and milk production increased the income of the farmers by 116 per cent (small) to 232 per cent (marginal) as compared to the existing plan.

Salam *et al* (1991) Mixed farming is a common practice on small farms in Kerala, India. This article describes the methodology and results of a study, conducted at the Kerala Agricultural University NARP Special Station, Kottarakkara, to develop a homestead model suitable for a 0.20-ha holding in the coastal uplands of South Kerala under rainfed conditions. The technique of linear programming was used for this purpose. A coconut-based mixed farming system involving 14 activities and integrating the crop and livestock systems was found to be the best. The structural and functional diversity of the components of the model ensure a high level of resource-use efficiency, meeting the multiple demands (food, fodder, fuel and timber) of the home. The model also provides for a net return of Rs 12 628 with a benefit-cost ratio of 1.64. The crop-livestock components selected in the model interact synergistically to increase the productivity and to generate higher net returns. The model developed is capable of maintaining soil health and ensuring environmental safety. Hence, it is economically efficient, ecologically sound and biologically sustainable.3

Sankhayan and Cheema (1991) in an expository analysis using linear programming models for generating optimum farm plans, opined that it is indeed a very powerful technique which could efficiently handle a large number of linear constraints and variables (activities) simultaneously. They concluded that it was essential in all the models not to include the cost of those inputs in the working capital coefficients for which separate buying activities are provided in the model. It was optimal to use interest as a component of individual working capital coefficient provided the form of the model used was consistent with such a situation.

Goswamy and Meenakshi sundaram (1992) revealed from their study conducted in West Garo hills district of Meghalaya, that by a mere reallocation of existing resources, farmers could increase their net income from Rs. 1,807 to Rs. 2,854 per hectare, an increase of 57.83 per cent. Further, by relaxing the capital

constraint, the level of present income could be pushed further to Rs. 4,416, with an increase of 144.41 per cent.

Gautam, T. (1993) Analysis using a linear programming model showed that a combination of rice, wheat, mustard and livestock could increase net income by 49%, 26% and 13% on small, medium and large farms, respectively. These net incomes for all farm sizes would be possible by increasing the winter area under crops and reducing the livestock unit. The area devoted to pulses and linseed could be devoted to mustard and the irrigated area could be allocated to wheat. The livestock unit needs to be reduced sharply to divert labour to the optimal crop combination. The animal power available should remain sufficient for the changed farming system.

Sastry (1993) In his study to determine the optimum farm plans for the farmers in Chittoor district of Andhra Pradesh used linear programming technique. A total of twenty-four optimum plans were developed for small and large farmers of Chittur, Tirupati and Madanapalli revenue divisions. Rational use of existing technology enabled to realize higher net farm incomes compared to the existing crop and livestock mix and adequate borrowing with recommended technology led to still higher net farm returns. Shadow prices of labour revealed that it was profitable for large farmers to hire male and female labours in both the seasons. The shadow prices of labour on small farms indicated surplus availability of labour. The judicious use of resources were indicated by optimum models for small and large farmers, besides increasing the net farm returns, also facilitated complete repayment of loans in *rabi* season itself.

Ramesh Kumar (1993) undertook a study for developing risk efficient farming system for the development of Eastern Dry Zone of Karnataka. He employed a deterministic linear programming technique to work out the optimal plans for land utilisation, farm returns and labour employment under existing and recommended levels of technology with limited and unlimited availability of capital. Parametric risk programming was used to obtain risk efficient plans. These plans were obtained for small and large farms of watershed area and non-watershed area separately. He concluded that a wide gap existed between the returns of existing and recommended practices. The judicious use of resources as indicated by optimum plans for small and large farms of both watershed area and non-watershed area, besides increasing the net farm returns would be helpful for fuller payment of loans.

Goswami (1997) attempted to develop optimum farm plans for the Garo hill areas where shifting cultivation was practiced for augmenting the incomes of the hill farmers by eliminating shifting cultivation. He used linear programming model to maximise farm business income under the prevailing level of resources, with capital borrowing and simultaneous hiring of capital and human labour. He indicated the systematic farm planning was a paying proposition under the existing technology and with the existing resource base on the hill farms.

Kiresur et.al. (2004) used linear programming to study the optimum plans for sustainable farming systems in northern eastern dry zone in Karnataka. The sample farmers were post classified into various farming system viz., field crops + Dairy animals (FS I) and field crops + Dairy Animals + Draught Animals (FS II). In farming system II the area under sunflower during Kharif was increased by 77.27 per cent in model – I and 89.78 per cent in model – II. In Rabi season area under bengal gram increased from 0.1 ha to 0.96 ha (model – II) while area under sourghum declined by 87.65 per cent. The cropping intensity was increased from 159.12 per cent in existing plan to 189.78 per cent in optimum plan.In large farms the area of Kharif sunflower was increased by 56.51 per cent. It was concluded that FS-I was found to be more sustainable than FS-II.

Veerkar (2004) employed linear programming to formulate optimum plans. The optimum plans suggested that, in sole cropping of coconut plant population should be reduced by 18 per cent. In system III the optimal plan which accommodated 136 coconut palms along with 600 arecanut palm and 733 black pepper vines per hectare could generate about 24 per cent excess income and 33 per cent more employment

Srinivasa *et al.* (2005) studied optimum cropping pattern for sericulture dominant farms in southern dry zone of Karnataka.The deterministic linear programming technique was used for obtaining optimal combination for different enterprises followed by the sample farmers. The model also suggested maintaining of one crossbred caw and two buffaloes. The model suggested shifting of cropping pattern from subsistence dominated crop like ragi to commercial crop like bivoltine sericulture in Kolar area and cross bred sericulture in Mysore area.

Shalander Kumar et.al (2006) studied farming system in water scarce region of Uttar Pradesh. Optimum farming systems were formulated by incorporating linear programming technique. Integer values for livestock enterprise whereas, non-integer values for other enterprises were used. Wheat-mustard based and potato based farming systems were identified as a major farming systems. Among the optimum farm plans highest increase in farm income over existing farm situation was 60 per cent in small farms with goat units. It was concluded that increase in net returns due to optimum allocation of resources has been higher on small farms than large farms. The livestock rearing especially buffalo keeping has been highly profitable even under water scarce situation.

Mahendran *et al.* (2006) used Linear Programming techniques to evolve optimal cropping pattern in groundwater overexploited region of perambalur district of Tamil Nadu. Among the constraints imposed, land, capital and irrigation were major constraints. The capital was declined from Rs. 62248 per ha Rs. to 61123 per ha. In optimal crop plan the use of majority of inputs were declined as compared to the existing situation indicating the proper use of input could reduce the cost, to obtain the same amount of income.

Dhole *et al* (2011) Three models were developed by using Linear programming with the objective of production, net benefit and labor employment maximization. The methodology and models developed were applied to command area of the Left Main Canal (LMC) and Right Main Canal (RMC) of the Som-Kagdar Irrigation Project. These models were applied for various levels of surface water availability *i.e.* number of canal running days in a season (70, 80, 90, 100, 110 and 120 days). The optimal cropping pattern has been derived using multi objective analysis. The optimal cropping pattern derived for 120 days canal running indicated that the net benefit, production and labor employment were increased by 18.75, 16.53, 16.58 percent respectively compared to existing cropping pattern. Similarly, optimal cropping pattern derived for 80 days of canal running for conjunctive use of surface water and ground water indicated that production, net benefit and labor utilization were increased by 12.73, 10.36 and 13.06 percent respectively compared to existing cropping pattern.

Behera and Rana (2013). In the present study, Fuzzy Linear Programming (FLP) is used for developing suitable compromise integrated farming system models

for farmers in north Indian situations under multi-objective environment. Based on the socio-economic survey, three objectives, capital requirement (CR), labour employment (LE) and farm income (FI) are considered for development of model. All three objective functions are represented by linear membership functions in fuzzy multi-objective framework. It is observed from compromise solution obtained by FLP that capital requirement, labour employment, farm income are Rs 493 071, 897 man-days, Rs 604 860, respectively with degree of satisfaction (λ) 0.462. Analysis of compromise solution in multi-objective environment also indicated that capital requirement, labour employment and farm income have differed considerably as compared to individual optimal solutions obtained by solving linear programming individually for each objective function. Sensitivity analysis studies indicated that effect of linear/nonlinear membership functions is having significant effect on degree of satisfaction.

Budiasa *et al* (2013) The objective of this study is to develop the optimal solution model for food production technology of integrated farming system (SIMANTRI) to support sustainable agriculture in Bali. Primary data under survey method towards 20 farmers of the SIMANTRI 068 in Buleleng Regency and secondary data from appropriate sources were used to specify parameters of the model. Linear programming approach was used to analyze constrained optimization problem of the model by using BLPX88 package program. A small farming system with farm scale of 0.58 hectare, which integrates food and horticulture crops and bali cattle, was optimally operated by farmer. It is indicated by optimal solution of the model which conforms to observed behavior. The maximum farming system' income that was generated from the optimal model was Rp21, 658,160 per annum. The integrated farming system (SIMANTRI 068) is potentially sustainable since it can fulfil sustainability criteria: economically viable, environmentally sound, socially acceptable, technically and culturally appropriate.

Behera and Rana (2014) In the present study, the farmers' problem and their multi-objectives were incorporated in the model by considering a case study under north Indian situations. A generalized farm problem with respect to various physical and socioeconomic constraints under irrigated ecosystem of north India was used for designing the integrated farming systems through goal programming-constraint method of modeling techniques. Maximization of farm income is selected as the main

objective of the constraint method of multi-objective optimization and other two objectives, viz. capital requirement and labour employment were used as the additional constraints in the constraint set. Thirty three non-dominated set of alternatives/strategies were formulated by parametrically changing the values of additional constraints. The study revealed that the maximum farm net return of Rs 6,59,623 was obtained, while the other two objectives, capital requirement and labour requirement were fixed as constraints at Rs 5,24,926 and 966 man days, respectively. Goal programming can be used as tool for designing individual integrated farming system on scientific basis considering the resource availability at the farm level. The single objective IFS models were developed using linear programming technique for marginal, small and medium farm situations, which proved potential to replace existing rice (*Oryza sativa* L.)-wheat [*Triticum aestivum* (L.) emend. Fiori & Paol] system with higher profitability.

Hagel *et al* (2014) Construction of the Itaparica dam and reservoir induced changes in the agricultural production systems of the Itaparica micro-region, at the lower-middle São Francisco river basin. Extensive traditional systems were replaced by e.g. irrigated fruit production. However, over twenty years after the dam construction, many farmers are still facing income insecurity. A survey, consisting of expert interviews and structured on-farm interviews, has been conducted to analyze current production systems. A Linear Programming farm optimization model was applied to determine optimal land allocation considering changing production conditions. Income depended strongly on low wages for day laborers, free irrigation water, and stable prices of the main crop, coconut. Diversification of production and improved market access can help to improve farmers' income situation. Moderate water pricing can raise the awareness of water scarcity and lead to implementation of water saving production methods.

Ponnusamy *et al* (2015) Study on horticulture + crop + dairy + poultry (H+C+D+P) and horticulture + crop + dairy + poultry + sheep/goat (H+C+D+P+S/G) farming systems was conducted in Tiruvallur and Thanjavur districts of Tamil Nadu, India to understand the contribution of horticulture-based farming system in providing sustainable livelihood and influencing techno-socio-economic characteristics of farm families. A Sustainable Livelihood Index (SLI) was developed. The H+C+D+P was not only perceived to be eco-friendly but also ensured high level of food security

(76.92%) than H+C+D+P+S/G (66.67%). However, both the systems had low level of input recycling and permanent asset creation. The H+C+D+P+S/G was more profitable (60.00%) than H+C+D+P (46.15%). The livelihood sustainability was positively influenced by education, decision making pattern and communication behaviour. The study suggests that livelihood of poor farm families in developing countries would be improved better, if they are appropriately sensitized on horticulture-based farming systems.

In view of above findings the profit maximization approach using linear programming technique has been adopted in these studies. The earlier researchers felt that since agriculture is a complex sector, its planning is most difficult, but not impossible. Economic factors like investment, output, prices, market environment and Government policies and programmes; institutional factors like land tenure, size of holdings, cooperation; personal factors like attitude, receptibility, caste, literacy and other factors like management and infrastructure play a vital role in any farming ventures. However, the constraints identified and opportunities proposed are location specific and may not be applicable to other areas. However, the techniques used are worth for developing suitable methodology for study area.

2.5 Constraints faced by the farmers.

Rangaswamy (1986) pointed out the constraints for dry land farming areas namely availability of quality seeds, fertilizers and pesticides. He revealed that the farmers were uncertain about the outcome of crops and farmers felt that they would loose less by investing less. He stressed the need for developing suitable strategies to stabilize the farm income in dry areas.

Chitinis and Bhikgaonkar (1987) investigated the major constraints that caused technological gaps in the process of adoption of dry farming technology. Four types of constraints were identified namely (i) technology, (ii) credit and economic service and (iii) supply and (iv) information transfer. They firmly advocated the adequate supply of inputs, timely advice and training through demonstrations.

Chandrashekhar (2001) listed production constraints faced by growers in order of importance. They were lack of technical guidance, more pest and disease, high cost of fertilizers, high cost of plant protection chemicals, non-availability of seed materials and non-availability of fertilizer in time.

Gavisiddappa (2001) identified the problems in Gherkin production and trade in Haveri district of Karnataka. The sample farmers were unanimous and cent per cent in their opinion with respect to non-availability of seeds, unawareness potentiality of crop, lack of irrigation facilities, pest and diseases, lack of cheap labour, no market in India and no storage facilities of refrigerated rooms. Irregular payment made by the company (30%) and lack of research support regarding the crop (34 %) were some other problems.

Veerkar *et al.* (2002) studied the constraints in goat farming in Ratnagiri district of Konkan region (M.S.). Analysis of the study revealed that non-availability of unproved breed was the main problem in all groups. Inadequate owns funds were the second major problem as reported by 50.84 per cent goat keepers from small group. Non availability of feed, lack of veterinary, grazing scarcity and fear of wild animals, were the problems of goat keepers.

Wagh *et al*. (2002) studied the constraints in adoption of dairy technology in Sirpur taluka of Dhule district of Maharashtra. The study has revealed that the important economic constraint were non-availability of loan (100per cent), lack of capital (81 per cent). Among the constraints related to input supply, non-supply of

improved breeds and feeds (100 per cent), lack of knowledge of improved fodder and non-availability of veterinary aid center (67.00 per cent).

Hirala and Verma (2004) conducted a study to know the constraints faced by the growers. They observed that high cost of chemicals, lack of technical guidance, shortage of labour when needed, high labour charge, non availability of paddy weeder and non availability of chemicals in local market.

Gireeshayya Udagatti (2005) studied an economic analysis of farming systems in tank commands of Northern Karnataka. It was observed that, Farming System-I of Koppal district exhibited by highest net returns (Rs.35, 645/ha) followed by Farming System-I of Bagalkot district (Rs.31, 238/ha). Production function analysis revealed that, inputs such as labour, seeds, fertilizers + FYM and PPC + veterinary charges were under utilized in Bagalkot district. The resources like labour, feed and concentrates and seeds were underutilized in Koppal and Haveri districts. Hence, there is scope for deployment of these resources. In OFD and FFS plots returns were increased over control plots due to reduced cost of cultivation and increased yield. It was also observed that, the Constraints like non-availability of quality seeds, lack of awareness of recommended cropping sequences, high cost of inputs, lack of credit facility, scarcity of owned funds, low price for the produce and lack of storage facility were most severe in crop production. Hence, there is need to strengthen institutional support for provision of credit, infrastructure facility and formulate appropriate policies for safe guarding the interest of the farmers.

Singh *et al*. (2009) studied the economics of farming systems in Uttar Pradesh. The study has indicated that cross-bred breeding programme has not become popular due to low demand for milk of cross-bred cows. Credit has significant impact on farm income and credit requirement of about 86 per cent farmers is met by the institutional sources. Fragmentations and sub-divisions of landholdings, scarcity of labour, low yield of crops, less reliable markets, scarcity of owned-fund, depleting natural resources, non-availability of good quality seeds and sheds for poultry, etc. have been identified as the major constraints to promote integrated farming system in this area.

Amarnath (2009) identified the diversification of agriculture for sustainability and its impact on farm income through the linear programming technique. The constraints specified in the model include minimum land for paddy and fodder crops.

The optimal plan has suggested raising of paddy I, fodder sorghum I, sorghum II and maize II along with 50 per cent increased application of inputs form the present level. Also, raising of paddy I, fodder sorghum I and maize I along with dairy activity has been suggested. Thus, the farmers could adopt combination of crops along with increased application of inputs and carrying dairy activity for higher farm income and sustainability.

Reddy and Reddy (2010) studied supply side constraints in production of pulses in India: A case study of lentil. The study has found that the lentil based cropping systems are profitable and also have high water productivity, hence are suitable for mostly un- exploited rice fallows under water-deficit conditions. Even though marketed surplus ratios have increased in recent years, there is a post-harvest loss to the extent of 7 percent of production which needs to be curtailed to increase overall supply for final consumption. There is a case for larger institutional and policy support for pulse crops, keeping visible effects of pulse crops in increasing yield of subsequent crops in crop rotations.

Biswas (2010) conducted a study on farming system approach to improve IUE, employment and income in eastern India reported that farm size is too small to employ the family labour force year around if they grow mono crop. Therefore, they resort to integration of various types of farming systems namely cropping, livestock, fishery, piggery, goat keeping, horticulture (fruit, vegetables, flower, apiculture, plantation) etc. This results in higher use efficiency of inputs (IUE) including fertilizers, reduction of risks, and generation of employment opportunities in culminating higher farm income.

Suresh (2010) studied the economic analysis of cropping systems under tank irrigation in Northern Karnataka. The study has revealed that the constraints like, poor maintenance of tanks, siltation of tank bed, misutilization of allocated funds and improper cropping pattern were reported by the respondents. Organizational constraints included inadequate funds, staff, and lack of political will. Hence, there is a need to strengthen institutional support for provision of credit, infrastructure facility and formulate appropriate polices for safe guarding the interest of the farmers.

Rao and Rama (2011) the most important constraint in SRI cultivation has been identified as ‘nursery management’. The SRI method being more skill oriented,

the study has observed that yields can be made sustainable if constraints are addressed on war-footing basis.

Patr *et al* (2014) Survey was conducted with designed questionnaire in selected villages of five different districts namely, Dimapur, Kohima, Peren, Wokha and Mon based on their geographical location. A total of 200 respondents were interviewed on different aspects of socio-economic condition, routine management, health care practices and market linkages associated with pig husbandry.. The major constraint faced by the farmers include high cost of concentrate feed (81.08%), non-availability of proper veterinary health care (72.97%), high cost of initial inputs and lack of quality piglet (60.36%), frequent outbreak of diseases (46.85%), lack of availability good breeding boar (45.95%), lack of market linkages (45.04%) etc. Scientific interventions in utilization of non-conventional feed resources, capacity building in health care services, adoption of scientific breeding, use of artificial insemination and developing suitable entrepreneur for medium to large scale production and proper use of pig by-products could transform the traditional subsistence pig farming to a profitable enterprise.

CHAPTER III

SOCIO-ECONOMIC BACKGROUND OF SOUTH KONKAN REGION

This chapter is devoted to give the socio-economic background information about the area under study. The study of background information is necessary to understand the economic implications of the physical conditions under which production is carried out. The various factors like topography, location, climate, rainfall, soil, irrigation, marketing, and communication facilities decide the stability of particular enterprise in the area. Therefore a brief account of socio-economic conditions prevailing in the selected area (South Konkan Region) is given so as to have better understanding of the region and the interpretation and implications of findings of the study.

3.1 Location

The South Konkan coastal zone of the Konkan region comprises districts namely Ratnagiri and Sindhudurg. The zone lies in between $16^0$30' to $18^0$04' North and $73^0$19' and $74^0$18'East longitudes. The zone is along narrow strip of measuring 260 km. In length and width ranges from 15-60 km. The total area of south Konkan region is 13,415 sq. km., which accounts for 4.37 per cent of total area of Maharashtra.

3.2 Boundaries

The region is formed by a narrow belt, running north to south along western coast of India and lies in between the Sahyadri hills in the east and Arabian Sea in the west. Beyond the Sahyadri hills, there are Satara and Kolhapur districts, Raigad district to the north and Goa state to the south.

3.3 Topography

The zone has an undulating topography with hills and rocky plains alternating. The whole of eastern and northern parts of the zone are covered with hills which are continuation of the main Sahyadri ranges. About 85 per cent of the land surfaces in the zone are hilly. The important parent rock information of the districts is Deccan trap, granites and laterites. The laterites have the largest extent in zone. South Konkan can be divided into three parts on the basis of physical features *viz*; a) hilly area of

Sahyadri and its offshoots, b) the plateau surface on which cereal crops like Rice and Nagli are grown and c) coastal plains where coconut and arecanut gardens and fishing are the main sources of earning livelihood. The rivers of South Konkan; *viz* Savitri, Vashisthi, Shastri, Tillari and Terekhol flow from east – west and join Arabian Sea.

3.4 Soil

Lateritic soil is the predominant type of soil in this zone. Along the seacoast in a narrow belt coastal saline and coastal alluvial soil occur. The pH of the soil ranges from 5.5 to 6.5, calcium carbonate is completely absent and the soil is poor in phosphorus content. The lateritic soil is rich in organic matter and consequently in nitrogen content. However, the peculiar climate in the region and acidity of soil lower down the mineralization rate of nitrogen from the organic matter, as a result, these soils are found to be responsive to the application of nitrogenous fertilizers. The soils are fairly supplied with potassium.

In the immediate vicinity of the coast or creeks, the soils are highly saline and do not supports any crop except the halophytic bush type vegetation. The coastal saline soils have more than 3 per cent of total soluble salt and pH of 7.5 to 8.0. The coastal alluvial soils are clay loamy in texture having pH of 7.0 to 7.5 and total soluble salt 0.1 to 0.2 per cent. They have good fertility and support garden crops like coconut, arecanut banana etc. The hilly high lying terrain has '*varkas*' type soil which is suitable for cultivation of millets like Ragi, *Vari* and Oilseed crop like niger and sesamum. The soils are found in several grades *viz*; a) soil useful for rice cultivation b) *varkas* soils useful for cashewnut, mango and nagli and c) coastal alluvial soils useful for coconut and arecanut gardens and d) salty land locally known as *Khar* or *Khajan* land.

3.5 Climate

Since the pattern of agricultural development is determined by the combined effect of rainfall, temperature and humidity, the characteristics in this respect should be analysed in detail. The zone has three seasons *viz*; i) Summer from March to May, ii) Rainy seasons from June to October, iii) Winter season from November to February.

3.6 Rainfall

Rainfall in the zone is mainly due to south-west monsoon. Winter rains from north-east monsoon are negligible or rare, although rainfall is spread over from middle or last week of May to November, the important months of rainfall are only four i.e. June, July, August and September and 97 per cent of the rainfall receives during these months. The maximum rainfall (33.37%) and intensity (49.4 mm/hr) are noticed in the month of July. The variability of the south-west monsoon is 25 per cent. The total rainfall ranges from 2500 mm to 5000mm distributed in 90 to 120 days in different parts. The maximum dry spells are observed in the month of September followed by June.

3.7 Temperature

Warm and humid climate is characteristic feature of the coastal belt. The mean daily temperature is above 20^0C throughout the year. May, generally the hottest month with mean maximum temperature around 22^0C. High humidity in association with warm temperature from April to October renders the weather uncomfortable in the absence of wind. Temperature after May till August is about 4 to 5^0C the diurnal range in temperature is small during April to October being less than 7^0C due to maritime influence. It however, increases by 10 to 11^0C during November to march under the influence of northerly dry winds of land origin. The mean annual range of temperature i.e. variation in mean daily temperature throughout the year is only 5^0C.

3.8 Humidity

During rainy season, the humidity is as high as 90-98 per cent. It is least during winter afternoon when it comes down to 60 per cent.

3.9 Area and population

The total geographical area of the two districts is 13336.30sq. kms. This is about 4.40 per cent of the total area of Maharashtra state. The region having average east-west expansion of about 64 km. the average North-south length of South Konkan region is about 300 km. According to 2011 Population Census the total population of South Konkan is 24, 62,602 and Density of population per sq. km is 179.5. In the total population, the proportion of female was higher (52.19%) than male (47.81%). The sex ratio of the region (female per 1000 male) was 1085. In the region, high literacy percentage was observed. It was 82.43 per cent in Ratnagiri and 86.54 per cent in Sindhudurg district.

3.10 Land utilization

The land use pattern of South Konkan is given in the Table 3.1. It is observed from the table that out of the total geographical area of 13,204 ha, 99 hectares were under forest like the land put to non-agril uses, barren and unsuitable land for cultivation, etc. was about 2190 hectares area, 2382 hectares land was cultivated waste. The current fallow and other fallow land together contributes 2049 hectares (20.81%), the area sown more than once was only 755 hectares (2.90%) and the gross cropped area was 4684 hectares.

Table 3.1: Land utilization in South Konkan region.

(Area in ha)

Sr.No.	Land use category	Ratnagiri	Sindhudurg	South Konkan region
1	Total geographical area	8164 (100.00)	5040 (100.00)	13204 (100.00)
2	Area under forest	60 (0.74)	39 (0.77)	99 (3.35)
3	Land put to non agricultural uses	210 (2.57)	122 (2.42)	332 (10.82)
4	Barren land and land unsuitable for cultivation	1980 (24.25)	210 (4.17)	2190 (13.6)
5	Permanent pastures and other grazing land	280 (3.43)	100 (2.00)	380 (2.20)
6	Land under miscellaneous tree crop and grooves	492 (6.02)	352 (6.98)	844 (6.40)
7	Cultivable waste land	1382 (16.93)	1000 (19.84)	2382 (15.41)
8	Current fallows	510 (6.25)	203 (4.02)	713 (5.40)
9	Other fallows	680 (8.33)	656 (13.02)	1336 (10.12)
10	Net area sown	2578 (31.60)	1351 (26.81)	3929 (29.80)
11	Area sown more than once	335 (12.98)	420 (8.33)	755 (2.90)
12	Gross cropped area	2913	1771	4684

(Figures in parentheses indicate percentages to total geographical area.)

Source: Socio- Economic Review and District Statistical Abstract of Ratnagiri and Sindhudurg districts 2012-13.

From the Table 3.1 it can be concluded that there is a good scope for increasing area under cultivation by bringing the cultivable waste and other fallow land under cultivation, which is 20.81 per cent of total geographical area. Particularly, on this area, mango and Cashewnut cultivation should be taken up with the help of

Employment Guarantee Scheme under Horticultural Development programme. The proportion of area under forest is also very low 3.35 per cent which need to be increased. As a result, high proportion of cultivable waste land as well as barren and uncultivable land and fallow land the proportion of net area sown to total geographical area was very low (29.80%).

3.11 Cropping pattern

The area under different crops in South Konkan region is given in Table 3.2.

Table 3.2: Cropping pattern of South Konkan region

(Figures in 00' ha)

Sr. No.	Crop	Ratnagiri	Sindhudurg	South Konkan region
1	Rice	811 (31.46)	799 (59.14)	1610 (40.80)
2	Other cereals	301 (11.68)	900 (66.62)	1201 (30.70)
3	Total cereals	1112 (43.13)	1699 (125.75)	2811 (71.54)
4	Total pulses	40 (1.55)	19 (1.41)	59 (1.50)
5	Total foodgrains (cereals + pulses)	1152 (44.69)	918 (67.95)	2070 (52.70)
6	Fruits and vegetables	297 (11.52)	365 (27.02)	662 (16.85)
7	Species and condiments	9 (0.35)	9 (0.70)	18 (0.46)
8	Total food crop	1458 (56.55)	1292 (95.63)	2750 (69.99)
9	Total oil seed crops	71 (2.75)	126 (9.33)	197 (5.01)
10	Total non-food crops	1455 (56.43)	204 (15.09)	3495 (88.95)
11	Area cropped more than once	335 (12.98)	420 (31.08)	755 (19.22)
12	Gross cropped area	2578 (100.00	1351 (100.00)	3929 (100.00)

(Figures in parentheses indicate percentages to total gross cropped area.)

Source: Socio- Economic Review and District Statistical Abstract of Ratnagiri and Sindhudurg districts 2012-13.

It is seen from Table 3.2 that cereal crops dominate the cropping pattern of South Konkan region. Among the cereal crops, rice is a predominating crop during kharif accounting for 161000 ha. (40.80%) on a limited area, where water is available, the rice is grown in rabi-hot weather season, usually the mono cropping of rice is

practiced. The proportion of pulses in the total area is only 1.50 per cent. The spices and condiments are grown on 1800 ha. (0.45%), fruits and vegetables are grown on 66200 ha. (16.85%). Fruit crops mainly consist of mango and cashew.

Looking to the cropping pattern, it was observed that cropping pattern of South Konkan region was directed towards cash crops like mango, cashewnut, coconut, spices and condiments which results into the higher returns per hectare to the cultivators of this region.

Source: Socio- Economic Review and District Statistical Abstract of Ratnagiri and Sindhudurg Districts 2012-13.

3.12 Irrigation

In South Konkan region gross cropped area is 468400 ha, out of which total irrigated area are 36440 ha.

The percentage of gross irrigated area to the gross cropped area is only 9.18 per cent. The main source of irrigation is well.

Table 3.3: Irrigated area in South Konkan region

Sr. No.	District	Gross cropped area	Gross irrigated area (GIA)	
			Area (ha)	Percentages to GCA
1	Ratnagiri	291300	2530	0.98
2	Sindhudurg	177100	33910	24.34
	South Konkan region	**468400**	**36440**	**9.18**

Source: Socio-Economic Review and District Statistical Abstract of Ratnagiri and Sindhudurg districts 2012-13.

3.13 Horticulture

Development of Horticulture is the hope of this region. The agro-climatic conditions of this region are favourable for cultivation of mango, cashew, coconut, and arecanut and also spices. In fact, some farmers have made the good beginning by taking large-scale plantation of mango and cashew. From the year 1990-91, the Government of Maharashtra has undertaken massive programme of plantation of horticulture crops under Employment Guarantee Scheme since then large area of this region has been covered under horticultural plantations, which is otherwise being wasted. Up to the year 2009-10. About 2.80 lakh hectares area was came under

horticultural plantation out of which 1,07,000 ha. under mango, 1,43,000 ha under cashewnut and about 21,000 ha under coconut. Considering the export potential of Alphonso mango, recently Government has declared this region as Agri-Export Zone for Alphonso mango.

3.14 Agro-industries

The main agricultural products in South Konkan region are paddy, nagli mango, cashewnut, kokum, jackfruit and arecanut. These products are of great economic importance. In addition to these major forest products like bamboo, timber wood, catechu (katha), grass and some plants of medicinal value are found in the region.

The South Konkan region is famous for production of best quality Alphonso Mango and also for cashew, coconut and arecanut. Alphonso mango and cashew gives seasonal employment to local peoples for operations such as harvesting, grading, assembling and distribution of mangoes, drying of cashew nut, separation of apples and nuts, preparation of wooden boxes for mango packaging, marketing and transportation, cashew processing etc. Cashew processing units not only help in employment generation in this region but also, help in dispersal of units in the rural areas to prevent the migration of rural masses to urban areas. There are nine cashew processing factories and 78 household level cashew processing units in this region. Cashewnut from these districts fetches a substantial foreign exchange. Kokum fruit are also collected in the season, processed and sold in the form of *kokum syrup* and Amsul, *kokum oil* is also extracted from seeds. This has good demand in cosmetics industry. Paddy straw is useful for manufacturing paper and paperboard, there are some units operating in the region.

3.15 Livestock

Livestock makes substantial contribution to the economy by providing subsidiary occupation and income to the rural population, food to human population and employment to small farmers and landless labour.

The livestock population in South Konkan region as per livestock census 2010-11 is given in table 3.4. It is seen from table 3.4 that total cattle population in South Konkan region was 2224115 lakh heads of which 45.33 per cent was bovine

population, cattle and buffalo population was 36.37 per cent and 6.69 per cent respectively of the total livestock population.

The conditions in the zone are ideally suited for grassland development and cattle production. As per the report of nutrition expert's per capita consumption of milk meagre in the zone, this needs boosting. The increase in the milk production can be achieved through increase in number of productive animals, growing of grasses on waste lands, setting up of veterinary aid centres and encouragement to manufacture concentrated feeds. The unproductive animals and menaces as stray cattle for which Grampanchayat act needs to be enforced vigorously.

Table 3.4: Livestock population of South Konkan region.

(Figures in number)

Sr. No.	Category of livestock	Ratnagiri	Sindhudurg	Per cent
1	Cattle	580552	228271	808823 (36.37)
2	Buffalo	43862	104826	148688 (6.69)
3	Total Bovine	675072	333097	1008169 (45.33)
4	Sheep	47	214	261 (0.01)
5	Goat	60381	36291	96672 (4.35)
6	Poultry	69100	46932	116032 (5.21)
7	Other livestock	42722	2748	45470 (2.04)
	Total livestock	**1471736**	**752379**	**2224115 (100.00)**

(Figures in parenthesis indicate percentage to total reported area.)

Source: Socio- Economic Review and District Statistical Abstract of Ratnagiri and Sindhudurg Districts 2012-13.

3.16 Transport and communication.

The only National Highway (NH-17), Mumbai to Goa, runs from north to south is the major source of road transport. All the tahsil places and big villages in the region are well connected to this highway to facilitate smooth transport service. The total road length of region is 10541 km., of which length of National Highway is 385 km. The region is having only one railway tract (Konkan Railway) running from north to south with total length of 297.47 km. with this transport facility, the region is now

well connected with southern and northern part of the country. At present, transporting of agricultural goods, truck/tempo services are being used because of their easy access. The rail transport is presently used only for journey purpose. However, in coming future, the Konkan railway will definitely provide better transport facility for transportation of valuable agricultural commodities of this region in distant market of the country.

For better and early transmission of messages, the region is having 654 post offices and 52221 telephone connections in Ratnagiri district and 371 post offices and 24326 telephone connections in Sindhudurg district. Recently the mobile facility is made available at many places to facilitate quick communication.

3.17 Marketing of Agricultural Produce

There are number of Co-operative Societies functioning in this region which cater the needs of market. However, long distance from major market like Mumbai, Pune and other big cities, hilly undulating terrain hamper the transportation of goods produced in the region. Inadequate transport facilities and lack of ready market are major bottlenecks in the production of certain commodities. Most of the mangoes sent to Mumbai market and some quantities are marketed in Pune, Nagpur, Kolhapur and other cities in the state. Sometimes, mangoes are also sent to Ahamedabad, Indore, Rajkot, New Delhi, but the quantity is very meagre.

There is no surplus food grain production in the region and hence, marketing of food grain is not developed. Area under groundnut is increasing where the irrigation facilities are available and hence, few oil mills/ ghanis are in operation.

3.18 Co-operative and Banking sector

Co-operative and Banking sector covers various aspects of agricultural needs, such as extension of agricultural credit and supply of agricultural inputs through co-operative societies. Upto the end of March 2010, there were 2394 co-operative societies (1565 in Ratnagiri + 829 in Sindhudurg), of which, 607 (25.36%) were Primary Agricultural Co-operative Societies. In addition to this various commercial, schedule and co-operative bank branches were in operation in this region and the total number of the bank branches was 298. As compared to Maharashtra, the percentage share of PACS's in region was only 1.50 and the proportionate credit disbursement

was only 0.80 per cent (up to 2009-2010). This showed that co-operative and banking sector is not well developed in study area as compared to rest of Maharashtra.

Source: Socio-Economic Review and District Statistical Abstract of Ratnagiri and Sindhudurg district (2012-2013).

CHAPTER IV
METHODOLOGY

The present study has been an attempt to examine some important aspects of the farming systems, such as cost, return and profitability, input use efficiencies and optimization of profit in these systems and problems faced by the farmer respondents. In this chapter details of methodology followed are discussed under the following headings.

4.1 Sampling procedure

4.2 Nature and source of data

4.3 Cost concepts used in the study

4.4 Analytical techniques employed

4.1 Sampling procedure

Data required for the present study were obtained both from primary and secondary sources. Primary data were collected from farmers by direct interview method with well structured, pre tested schedule prepared exclusively for this study. Multistage sampling method was used to select sample households. The district level data were obtained from District Socio Economic Review and District Statistical Abstract for Ratnagiri and Sindhudurg districts and also from Office of Joint Director of Agriculture, Thane.

4.1.1 Selection of Districts

The Konkan region comprising of five coastal districts of Maharashtra falls under West Cost Plains and Ghat region according to Agro-climatic regions of India. These districts are classified into two zones viz. South Konkan coastal zone comprising of Sindhudurg and Ratnagiri districts and North Konkan coastal zone comprising of Thane and Raigad districts. The research on farming system has been carried out in North Konkan region. No exhaustive research has been conducted in south Konkan coastal zone Hence, to fulfil the objectives of the study the South Konkan region was selected purposively, which consist of two districts.

1) Ratnagiri.
2) Sindhudurg

4.1.2 Selection of Clusters.

The data regarding area under different crops such as cereals, pulses, plantation crops, forest, rainfall, livestock animal's, poultry birds etc., were collected for all 16 tahsils of both the districts. Based on these parameters the tahsils were subjected to cluster analysis. Within the tahsils there was distinct variation in agro climatic factors. So also, among the districts there was distinct variation.

Table 4.1 Distribution of group wise sample households from different clusters

Cluster No.	Tahsil	Proportionate weightage of the tahsil (%)	Sample households
I.	Mandangad	5.28	5
	Dapoli	10.66	11
	Khed	11.65	12
	Chiplun	16.39	16
	Guhagar	7.68	8
	Ratnagiri	10.38	10
	Sangameshwar	15.79	16
	Lanja	8.60	8
	Rajapur	13.56	14
	Total	100.00	100
II.	Deogad	15.17	15
	Vaibhavwadi	7.92	8
	Kankavali	16.42	16
	Malvan	14.16	14
	Vengurale	9.66	10
	Kudal	18.77	19
	Sawantwadi	10.66	11
	Dodamarg	7.23	7
	Total	100.00	100
	Grand Total	**--**	**200**

4.1.3 Cluster analysis

Cluster analysis is a multivariate statistical procedure that starts with data set containing information about a sample of entities and attempts to reorganize these entities into relatively homogeneous groups or groups of highly similar entities, called as "clusters". Among the different methods of cluster analysis, Hierarchical

agglomerative method was used in present study. A jump statistical software was used to carry out the analysis. The data for the different variables used for each tahsil was standardized between range of 0 to 1. In hierarchical agglomerative method the analysis was made in two steps, firstly the proximity matrix was formed, and then the clustering was done.

Table 4.2: Distribution of Tahsilwise villages and sample households selected for study

Cluster I			Cluster II		
Tahsil	**Village**	**No. of Holdings**	**Tahsil**	**Village**	**No. of Holdings**
Mandangad	Kumble	5	Devgad	Dabhole	5
Dapoli	Mhalunge	6		Jamsande	5
	Ladghar	5		Sangane	5
			Vaibhavwadi	Sangulwadi	4
Khed	Udhale	6		Narkarwadi	4
	Sanas	6	Kankavli	Bordave	5
				Khorpavan	5
Chiplun	Kherdi	5		Osargoan	6
	Sawarde	5	Vengurle	Ubhadanda	5
	Kumbharwadi	6		Math	5
Guhagar	Shrungartali	4	Malvan	Salel	5
	Deoghar	4		Chauke	5
Ratnagiri	Someshwar	5		Katwad	4
	Pawas	5	Kudal	Pawashi	6
Sangameshwar	Dhamani	5		Kupawade	6
	Navadi	5		Kumbhavli	7
	Kalambaste	6			
			Sawantwadi	Charathe	5
Lanja	Adavali	4		Majgaon	6
	Asage	4	Dodamarg	Adali	4
Rajapur	Kharavate	5		Sasoli	3
	Kondavali	5			
	Oni	4			
Total		**100**			**100**

Based on these parameters a cluster analysis was carried out. From the results it was observed that, all the tahsils of each district were selected in respective cluster. (Table 4.1) The total number of villages were decided proportionally on the basis of contribution of particular tahsil in respective cluster based on extent components of farming systems such as area under different crops, number of animals, poultry birds etc. The technique and procedure of cluster analysis is described later in this chapter.

Required number of sample household was selected from randomly selected villages of each tahsils as per requirement of proportionate weightage of each tahsil (Table 4.2). Farmers were selected randomly for collecting information regarding their various enterprises they undertaken. From each cluster 100 farmers were randomly selected.

4.2 Nature and source of data

Data required for the present study were obtained both from primary and secondary sources. Primary data was collected from farmers by direct interview method with well structured, pre tested schedule prepared exclusively for this study. Multistage sampling method was used to select sample households. The district level data was obtained from District Socio Economic Review and District Statistical Abstract for Ratnagiri and Sindhudurg districts and also from Office of Joint Directors of Agriculture, Thane.

4.3 Cost concepts used in the study

Economics of individual crop and crop combination /crop rotation was worked out. The standard cost concepts used in farm management studies are as follows.

Cost A :

1) Value of hired human labour
2) Value of hired bullock labour
3) Value of owned bullock labour
4) Hired machinery charged
5) Value of seed
6) Value of insecticides and pesticides
7) Value of manure
8) Value of fertilizer
9) Depreciation on implements, machinery and farm buildings.
10) Irrigation charges.
11) Land revenue and other ceases.
12) Interest on working capital.
13) Miscellaneous expenses.

Cost B :

Cost A + Imputed rental value of land + Imputed interest on fixed capital.

Cost C :

Cost B + Imputed value of family labour.

Output input ratio

Benefit cost or input output ratio was calculated by using following formula

$$\text{Output input Ratio} = \frac{\text{Gross Returns (Rs.)}}{\text{Total Cost (Rs.)}}$$

4.3.1 Costs and Returns in Field Crop Enterprise

The total costs were divided into two broad classes.

1. Variable or operational costs

2. Fixed costs

Variable costs include costs incurred on seed, manures and fertilizers, plant protection chemicals, labour charges and miscellaneous charges.

Fixed costs include land revenue, depreciation on farm implements and interest on fixed capital investment.

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

4.3.1.1 Variable or Operational Costs

a. Seed: Farm-produced seed has been valued at the prices prevalent at the time of sowing and purchased seeds have been considered at actual rates paid by the sample farmers.

b. Farm yard manure and vermicomposting: Farm yard manure was valued at the price prevailing in village. Thus, quantity of farm yard manure, vermicompost, purchased by farmer was valued at actual price paid by sample farmer.

c. Labour: The hired male and female labour was charged at the prevailing wage rates paid per day (eight hours) in the study area. The bullock labour was charged as per hiring rates prevailed in village. For family labour the wages were imputed at the same rates as those paid to hired human labour.

d. Fertilizer and plant protection chemicals: The cost of fertilizers and plant protection chemicals were considered on par with the amounts actually paid by the sample farmers.

e. Miscellaneous costs: Miscellaneous costs include repair charges, cost of Rabing operation in paddy, paddy husk/straw, and in the case of poultry, cost of vermicompost, etc. as per rates actually paid by the sample farmers.

4.3.1.2. Fixed Costs

a. Land revenue: Land revenue was calculated at the rates levied by the Government.

b. Rental Value of Land: Rental value of land was calculated as 1/6th of the gross value of produce.

c. Depreciation charges: Depreciation on machinery and equipment's, farm buildings and sheds was calculated by using straight-line method, and charged to specific crops for which the article was used. In case of articles used for more no of crops, the cost was apportioned on the basis of area.

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

d. Interest on fixed capital: Interest on fixed capital was calculated at the rate of 10 per cent on the book value of the machinery, equipment's and buildings.

e. Interest on variable costs: Interest on variable cost was calculated at the rate of 12 per cent. The cost was charged for a crop as interest on working capital for a period of crop cultivation.

f. Cropping Intensity Index: The cropping intensity was calculated with the help of index.

$$\text{CII} = \frac{\text{Gross cropped area}}{\text{Net area}} \text{ X } 100$$

This concept of cropping intensity discounts the relative importance of long duration or perennial crops because of short duration crops it reflects a higher cropping intensity weightage while for long duration perennial crops like fruit crops it shows a lower intensity weightage. Hence in this study for annual/ perennial crops (Fruit crops) which occupied the field throughout the year, the cropped area was considered as equivalent to 3 times the net sown area. If area under Mango is one hectare it is considered as equivalent to three crops and hence the gross cropped area is treated as equivalent to three hectare for th e entire year in calculating the cropping intensity.

Gross cropped area – Area under various crops in a year for different seasons

Net area – Area available for cultivation

4.3.1.3 Returns

The gross returns were calculated by taking the actual output prices obtained by the farmer in the market or at prevailing rates in the village. The same was used for imputing the value of the produce retained for home consumption. Gross returns include values of both the main product and by-product. Net returns were calculated by deducting the total cost of cultivation from gross returns.

4.3.2 Cost and Returns in Other Farm Enterprises

The other farm enterprises included the non-crop farm enterprises such as, Poultry, Dairy, Goat keeping etc.

4.3.2.1 Costs

The cost includes fixed costs and variable costs. Fixed costs includes depreciation Charges on building, machinery, equipment and other permanent fixtures. In the case of dairy animals, draught animals and goat and the purchase value of animals was also included in fixed cost component as imputed value of animal. The present market value was considered for value of animal born on the farm. Each one of these items was divided by the average expected life of them to arrive at annuities. Variable costs include cost of feed, dry fodder, green fodder, veterinary charges, poultry feed, chicks, husk/straw used (tus) for poultry.

4.3.2.2 Returns

The value received by farmers for farm produced milk, hiring charges of draught animal, were used to calculate gross returns accordingly. The valuation of by-products, manure in the case of dairy, poultry, and goat keeping were added to the total returns. In dairy enterprise, local cows, cross breed cows and buffaloes were clubbed on the basis of their present value, to work out per animal costs and returns for the whole herd of the household.

4.3.2.3 Local Names and Terms Used in Study

a. Rabbing: It is a pre-tillage operation followed by the farmers in paddy cultivation. In this operation the twigs, leaves, cowdung, paddy straw etc. are spread over nursery bed and it is burnt. This practice is generally done in the month of April or May in morning or evening hours.

Local names
Nagli – Finger millet
Vari – Proso millet
Wal – Long yard bean (*Lablab purpureus*)

4.3.2.4 Sustainable Income

Economic sustainability depends on profitable enterprises, family saving and family debt. Therefore, the sustainable farm income means the annual income from farm activities which meets the annual expenditure of farm and family and remains surplus to the farm family for saving or repayment of debt. Therefore, for sustainable farm income, the farm expenditure were deducted from the total farm business income.

4.4 Analytical Techniques

4.4.1 Tabular Analysis

This provides the simplest and most intelligible tool to analyze the existing level of farming. This technique was employed to analyze the demographic features, land use pattern, cropping pattern, input use pattern, livestock production, and cost of production, gross returns and net returns from different farm products. The data were analyzed using averages, percentages and ratios. The cropping intensity was worked out to examine the extent of multiple cropping.

4.4.2 Cluster Analysis

Cluster analysis is a multivariate statistical procedure that starts with data set containing information about a sample of entities and attempts to reorganize these entities into relatively homogeneous groups or groups of highly similar entities, called as "clusters". Among the different methods of cluster analysis, Hierarchical agglomerative method was used in present study.

4.4.3 Production Function Analysis

Production function technique was used to examine the effect of different factors namely farmyard manure (FYM), seed, nitrogen (N), phosphorous (P), potash (K), plant protection chemicals (PPC), human labour, bullock labour on crop production. Cobb-Douglas type of production function of the following form was fitted to the data

4.4.3.1 Crops Enterprises

$$Y = a.\ x_1^{b1}\ x_2^{b2}\ x_3^{b3}\ x_4^{b4} \cdot x_4^{4} \ldots\ldots\ldots\ldots\ldots x_9\ b^{9} \cdot u$$

Where,

Y = Yield (q/ha)

x_1 = Farm yard manure (q/ha)

x_2 = Seed (kg/ha)
x_3 = Nitrogen (kg/ha)
x_4 = Phosphorous (kg/ha)
x_5 = Potash (kg/ha)
x_6 = Plant protection chemicals (kg/ha)
x_7 = Male labour (day/ha)
x_8 = Female labour (day/ha)
x_9 = Bullock labour (pair days/ha)
u = Random error term
a = Intercept
b1, b2, b3 ……. b_9 = Regression coefficient or production elasticities.

4.4.3.2 Dairy Enterprises

Production function technique was used to examine the effect of different factors namely dry fodder, green fodder, concentrates, human labour, veterinary expenditure, etc. on income. Cobb-Douglas type of production function of the following form was fitted to the data.

$$Y_2 = a.\ x_1^{b1}.x_2^{b2}.x_3^{b3}\ x_4^{b4}.x_4^{4} \ldots\ldots\ldots\ldots\ldots x_6\, b^6\ .\ u$$

Where,

Y_2 = Total income (Rs/animal)
x_1 = Dry fodder (Rs/animal)
x_2 = Green fodder (Rs/animal)
x_3 = Concentrates (Rs/animal)
x_4 = Male labour (Rs/animal)
x_5 = Female labour (Rs/animal)
x_6 = Veterinary expenditure (Rs/animal)
u = Random error term
a = Intercept

b1, b2, b3 ……. b_6 = Regression coefficients or production elasticities

4.4.3.3 Estimation of marginal physical product

Marginal product of respective farm inputs was calculated by taking first order partial derivatives of output Y with respect to concern input appearing in estimated production function.

$$Y = ax_1^{b1}x_2^{b2}x_3^{b3}x_4^{b4}x_5^{b5}x_6^{6}x_7^{b7}e^{u}$$

$$\frac{dy}{dx} = ab_1x_1^{b1-1}x_2^{b2}x_3^{b3}x_4^{b4}x_5^{b5}x_6^{6}x_7^{b7}e^{u}$$

$$= \frac{\bar{Y}}{\bar{X}} b_i$$

Where,

b_i= Production elasticity of X_i

$\bar{Y}$ = Geometric mean of Y_i, $\bar{X}$ =Geometric mean of X_i

4.4.3.4 Estimation of marginal value product

1. Marginal value product (MVP)

   MVP= MPP× Price per unit of output

2. Marginal cost

   MC =Price per unit of input

3. Input use efficiency

   I. MVP/FC =1 Optimum use of input

   II. MVP/FC <1 Excess utilization of input

   III. MVP/FC >1 Underutilization of input

These forms of the Cobb-Douglas type of production functions were used in general for assessing resource use efficiency of crops as well as other enterprises followed in major farming systems. However, only those inputs were used for particular enterprise were retained in particular function. Inputs which were not used by majority of farmers in particular enterprise were removed from the production function model fitted to the data.

4.4.4 Linear Programming Analysis

The deterministic linear programming technique was employed to work out the maximum attainable returns by the optimum allocation of various available resources. Optimum allocation of resources was defined as one, which gives physical, technical and resource conditions, showed what activities to be undertaken and how much of each resource to be allocated to each activity so that the net farm returns are maximized in a year. Linear programming technique was chosen because among the various analytical tools available for allocation of available limited farm resources among alternative enterprises, it was the most powerful and efficient tool of analysis. The traditional tool of budgeting become less efficient when the number of constraints and real variables are large and unique solutions are desired.

4.4.4.1 Mathematical Formulation of the Model

In linear programming analysis, a linear function of a number of variables to be maximized subject to a number of constraints in the form of linear equalities and inequalities was adopted. In mathematical form, one-year (two seasons) linear programming model can be expressed in the following way:

Maximize:

$$Z = \sum_{j=1}^{n} Cj\ Xj \quad \text{(objective function)}$$

Subject to

1) $$\sum_{j=1}^{n} Cij\ Xij \geq bi \quad (i=1 \ldots\ldots k)$$

2) $$\sum_{j=1}^{n} aij\ Xij \leq bi \quad (i=k+1 \ldots\ldots m)$$

3) $$\sum_{j=1}^{n} aij\ Xij = bi \quad (i=m+n \ldots\ldots n)$$

4) $$\sum_{j=1}^{n} Xj \geq 0$$

Where,

Z = Net returns from all crop activities included in the model

Cj= Net returns from jth activity, measured in rupees per unit of jth activity

Xj = Level of jth activity

aij = The quantity of ith resource/input required per unit of jth activity

bi = Total availability of ith resource on the farm

Simplex method was used to derive optimum plans. Programming was done for each zone separately.

4.4.4.2 Selection Process of Activities

On the basis of primary data collected it was observed that, the sample farmers were found to follow crop, dairy and draught animal's enterprises. The crop activities undertaken by them were in following order.

In *Kharif* season, farmers were found to have grown cereal crops namely, paddy, nagli, prosomillet. The pulse crops such as wal, pawata and cowpea grown on available moisture in Rabi season. Vegetable crops namely lady's finger, ghewada, watermelon, Brinjal, chilli and snake gourd were also grown in *Rabi* season. In summer season paddy, fodder maize and groundnut was mainly observed to be grown in cluster – II.

4.4.4.3 Activities Used in the Model

Selection of crops was necessary to arrive at an optimum programme. So, the crops those were more popular and recommended by the local agricultural department, Agricultural University were considered. The selection was also based on the various other important factors like feasibility of growing them in particular type of soil, input availability, market facilities, farmer's requirement and profitability. The activities in the model can be classified as real and disposal activities.

The real activities also known as production activities constituted the principal alternatives of farming system and individual crop-livestock rotation being followed in a particular zone was considered as an activity. Thus different crop/livestock rotations followed by different size groups of farmers of each zone constituted the activities of the model. Two types of activities were included in the model. The first group indicated existing package of practices that is being followed by the farmers whereas the other group, activities represented the package of practices that are recommended and at expected yield level. The information regarding the crop and livestock activities with existing technology was obtained from sample farmers in the study area. Whereas information regarding recommended technology was obtained from university diary/ publication.

The disposal activities were the derived activities to take care of the inequalities of the model. These were needed to convert the inequalities into equalities for the solution of the problem. However, these activities were automatically generated by the computer under QSB Programming Model.

4.4.4.4 Technological Matrix

The input-output information on various production activities taken on the farm is very important for constructing the technological matrix for the linear programming model. The input coefficients included in this study referred to land, labour and capital. Land was classified into *kharif* land, *rabi* land and summer land. Labour included both family and hired as well as both human and bullock labour. Capital referred to funds required to meet the cost of seeds, fertilizers, farm yard manure, plant protection chemicals, irrigation charges, dry fodder, green folder, concentrates, veterinary expenses, insurance charges, marketing expenses and wages of hired human, bullock and machinery labour.

The average prices that the sample farmers paid and received were considered as the input-output prices in this study. The input-output coefficients in the model referred to per hectare in the case of crops or per animal in the cases of dairy.

4.4.4.5 Resource Constraints

Linear programming problem lies on the fact that at least some of the resources are limited in supply. In the area under study the most restricting resources identified were as below.

a) Land Constraint

Size of the operational holding is an important constraint to the maximization of farm income. The operational holding of the farmer was the total land holding of the farmer, as none of the farmer leased in any land. In the study area mainly two types of land observed viz, rainfed and irrigated. However, rainfed land was cultivated in Kharif and rabi. Thus the whole land was classified as Kharif land, rabi land and summer land.

b) Irrigated land constraint

Irrigated land was identified as another crucial factor which was greatly influencing the area under the specific crop in the study area. The water for irrigation was dependent on rainfall and run off water stored in dams. The groundwater resources were restrictive, abundant during rainy season and dried up in the rest of the months. Depending on the storage capacity of dams, method of releasing water

and location of farm, few farmers were able to raise three crops, while most of the farmers were able to take up only two crops or a single crop alone.

c) Food Requirement

Food requirement was estimated by using the standard norms for total farm families in the sample. Food requirement of cereals, pulses and vegetables was considered as a minimum production for the group of the families. The minimum restrictions in the model included the preference of the farmer to patronize certain farming systems to meet out the subsistence needs of the farm families. The minimum restrictions were imposed on activities which were highly profitable.

4.4.4.6 Resource availability

Having estimated the resource requirements and identified the restricting resources, it was necessary to assess the resource availability. For compiling the resource availability, the resources available on the farms were estimated from the survey data and were taken into account.

4.4.4.7 Net Value Product

For each crop the net value product was worked out by considering the price of the product, yield and operational expenses of cultivation.

4.4.4.8 Formulation of problem

The Formulated problem for two groups (Cluster I and Cluster II) is given separately.

4.4.4.9 Optimum Plans

The linear programming was employed to develop optimum farming systems under different situations. To accomplish the objectives of the study, a few variations in the basic models were incorporated. The following alternative plans were developed.

Existing Plan

These models comprised the existing crop alternatives with existing cultivation practices and the available resources to the farmers.

Alternate plan I

This plan was similar to existing plan except that recommended technologies are incorporated in place of existing technologies. The result of this plan indicated that, the income increasing possibilities by a switch over to the recommended technologies even at the existing level of resources. Each of the plan was designed for two groups (Cluster-I and Cluster-II) in the study area.

CHAPTER V
RESULTS AND DISCUSSION

The data collected from the selected farmers with the help of designed schedule were analyzed as per specific objectives by using different tools and techniques described in the methodology chapter. The results that emerged from analysis for achieving the set objectives of the study are presented in this chapter under following heads.

5.1 Delineation of study area

5.2 General characteristics of sample respondents

5.3 Existing farming systems

5.4 Per hectare profitability of enterprises followed in study area

5.5 Cost and returns structure of farming systems

5.6 Resource use efficiency of enterprises followed under major farming systems

5.7 Optimum farming systems

5.8 Constraints faced by farmers and measures to overcome them

5.1 Delineation of Study Area

The cluster analysis was carried out to bring together the tahsils based on their association among themselves with respect to different indicative variables. A 'Hierarchical agglomerative method' was followed to identify the tahsils of South Konkan region that have similar farming systems. The variables were based on the set of 23 characteristics relating to crop enterprises consisting of annual crops such as paddy, other cereals, pulses, oilseeds, and perennial crops, such as mango, cashew, arecanut, coconut, and forest area, rainfall, livestock etc. The result of cluster analysis is given in Table 5.1.

The analysis has classified all 17 tahsils of South Konkan region into two distinct clusters. The first cluster included 9 tahsils namely Mandangad, Dapoli, Khed, Chiplun, Sangameshwar, Lanja, Rajapur, Ratnagiri, Guhagar. The second cluster consisted of 8 tahsils namely Devgad, Vaibhavwadi, Kankavli, Sawantwadi, Vengurle, Dodamarg, Kudal, Malvan.

Table 5.1 Delineation of Study Area on the Basis of Agro-climatic Parameters.

Cluster No.	Name of Cluster	Tahsils in respective clusters
1.	Cluster - I	Mandangad, Dapoli, Khed, Chiplun, Sangameshwar, Lanja, Rajapur, Ratnagiri, Guhagar.
2.	Cluster - II	Deogad, Vaibhavwadi, Kankavli, Sawantwadi, Vengurle, Dodamarg, Kudal, Malvan.

5.2 General Characteristics of Sample Respondents

The general characteristic features of sample respondents are presented in Table 5.2

5.2.1 Age group

Age is one of the important factor influencing enterprising attitude of a farmer. It is observed that, at overall level, the average age of farmers was 49.84 years. The average age was ranging from 49.41 years in cluster – I to 50.27 years in cluster–II. The majority of farmers in study area were middle aged group which indicated the need of to promoting young generation involvement in farming.

5.2.2 Education

Education is another important factor influencing skill, managerial ability and technical knowledge. Table 5.2 indicate that, at overall level 86.00 per cent farmers were literate, out of which 33.50 per cent farmers have completed primary education while 45.00 per cent farmers have a high school level education.

It is revealed from Table 5.2 that, at overall level the literacy percentage of farmers in study area was high (86.00%) and the overall educational score was 9.86 which indicated that the farmers were adequately educated. The literacy rate in cluster – I was found to be lower (84.00%) as compared to cluster-II (88.00%).

5.2.3 Occupational distribution

Occupation is also important factor directly affecting the income of the family. The main occupations identified were farming, business and service. The distribution of the cultivators according to occupation is given in Table 5.2.

It is observed from the Table 5.2 that, at overall level, out of 200 sample farmers, majority (74.00%) had farming as their main occupation followed by service (13.50%) and business (12.50 %). The farmers having agriculture as their sole occupation were ranging from 71.00 per cent to 76.00 per cent among the clusters studied.

As regards subsidiary occupation, out of 200 cultivators an important subsidiary occupation was agricultural labour (40.50%) followed by farming (26.00%), no occupation (21.50%) and business (11.50%).

Table 5.2. General Information of Sample Respondents in the Study Area

Sr. No.	Particulars	Cluster I (N = 100)	Cluster II (N = 100)	Overall
1	**Age (years)**	49.41	50.27	49.84
2	**Education score**	9.44	9.88	9.86
	i) Illiterate	16 (16.00)	12 (12.00)	28 (14.00)
	ii) Literate	84 (84.00)	88 (88.00)	172 (86.00)
	a) Primary	35 (35.00)	32 (32.00)	67 (33.50)
	b) High school	41 (41.00)	49 (49.00)	90 (45.00)
	c) College	08 (08.00)	07 (07.00)	15 (07.50)
	Total	100 (100)	100 (100)	200
3	**Occupation**			
	a)Main			
	i)Farming	72 (72.00)	76 (76.00)	148 (74.00)
	ii) Business	13 (13.00)	12 (12.00)	25 (12.50)
	iii) Service	15 (15.00)	12 (15.00)	27 (13.50)
	Total	100 (100)	100 (100)	200 (100)
	b)Subsidiary			
	i)Farming	23 (23.00)	29 (29.00)	52 (26.00)
	iii)Business	10 (10.00)	13 (13.00)	23 (11.50)
	iv)Agricultural Labour	41 (41.00)	41 (41.00)	82 (40.50)
	vi)No Occupation	26 (26.00)	17 (17.00)	43 (21.50)
	Total	100 (100)	100 (100)	200 (100)

(Figures in the parentheses are percentages to total)

Table 5.3: Size of the family

Sl. No.	Particulars	Cluster I (N=100)	Cluster II (N=100)	Overall (200)
1.	Family size (No.)			
a)	**Up to 14 years**			
	i) Male	1.13 (17.73)	1.12 (17.72)	1.12 (17.66)
	ii) Female	0.87 (13.65)	0.84 (13.29)	0.85 (13.40)
	Subtotal (a)	2.00 (31.39)	1.96 (31.01)	1.98 (31.23)
b)	**Above 14 years**			
	i) Male	2.68 (42.07)	2.46 (38.92)	2.57 (40.53)
	ii) Female	1.81 (28.41)	1.90 (30.06)	1.85 (29.17)
	Subtotal (b)	4.37 (68.60)	4.36 (68.98)	4.36 (68.76)
	Total (a+b)	6.37 (100.00)	6.32 (100.00)	6.34 (100.00)

(Figures in the parentheses are percentages to total)

It is revealed from the Table 5.2 that, at overall level, farming was dominant occupation of farmers as 74.00 per cent farmers have reported farming as their main occupation and 26.00 per cent farmers have reported farming as a subsidiary occupations, therefore the majority of farmers 200 (100.00%) have engaged in farming indicated the importance of agriculture as an occupation in their livelihood.

5.2.4 Size of the family

Size of the family is the factor directly affecting both consumption needs of the farm family and supply of labours in the farm business. It also affect the income generating capacity of farm family.

The total labour engaged on a farm, a substantial portion comes from farmers own family. The labour available from the family, the size of the family and members working on farms are studied and results are presented in Table 5.3.

It was observed from the Table 5.3 that the average size of the family for the sample farmers at overall level was 6.34. The family members were classified agewise (up to 14 years, above 14 years) and sexwise (male and female).

It was observed that out of total family members, 1.98 (31.23 %) were below 14 years, 4.36 (68.76%) were above 14 years. Which indicated that the majority of the family members were of middle aged. At overall level, sexwise classification showed that, out of family members, 1.12 (17.66%) were males and 0.85 (13.40%) were females in up to 14 years age group and 2.57(40.53%) were males, 1.85 (29.17%) were females in above 14 years age group.

5.3 Existing Farming Systems

Data collected from sample households were post classified into various farming systems. Each cluster (region) was considered as a separate spatial unit and further analysis was carried out independently. The farming systems were formed by considering the criteria, such as purpose of undertaking a particular enterprise, similarity between various crop enterprises, homogeneity within a farming system and heterogeneity between any two farming systems.

In case of crop enterprises, crops were grouped as a system component or group crop enterprises such as rainfed plantations, irrigated plantations, oil seeds, other cereals, (excluding paddy). Paddy crop was considered as a separate enterprise

Table 5.4 : Existing Farming Systems in South Konkan Region

Cluster	Farming System	No. of farmers		Area		Name
	No.	No.	%	ha	%	
Cluster – I	**FS–I**	**29**	**29**	**70.21**	32.00	**Paddy + Rainfed plantations**
	FS–II	**22**	**22**	**40.61**	18.51	**Paddy + Irrigated plantations+ Dairy**
	FS-III	**16**	**16**	**26.33**	12.00	**Paddy + Other cereals + pulses**
	FS-IV	**12**	**12**	**35.05**	15.97	**Rainfed plantations+ Vegetables**
	FS-V	8	8	16.25	7.41	Paddy + Vegetables + Poultry
	FS-VI	6	6	12.68	5.78	Paddy + Dairy+ Poultry
	FS-VII	3	3	9.68	4.41	Paddy + Other cereals + Pulses + Vegetables
	FS–VIII	2	2	4.68	2.13	Paddy + Other cereals + Rainfed Plantation
	FS-IX	2	2	3.94	1.80	Paddy + Pulses + Goat rearing
	Total	100	100.00	219.43	100	
Cluster – II	**FS–I**	**24**	**24**	**69.87**	31.93	**Paddy + Rainfed plantations+ Irrigated plantations**
	FS-II	**20**	**20**	**55.10**	25.18	**Paddy + Rainfed plantations+ Vegetables**
	FS-III	**17**	**17**	**31.45**	14.37	**Irrigated plantations+ Pulses + Dairy**
	FS-IV	**14**	**14**	**19.50**	8.91	**Paddy + Other cereals +Oilseed**
	FS-V	8	8	14.38	6.57	Paddy + Other Cereals + Vegetables
	FS-VI	8	8	13.84	6.32	Paddy + Dairy+ Poultry
	FS-VII	5	5	8.26	3.77	Paddy + Goat rearing
	FS-VIII	4	4	6.45	2.95	Paddy + Poultry
	Total	100	100.00	218.85	100.00	

because it is a staple food crop, cultivated largely in the study area. The non-crop farm enterprises (other enterprises) undertaken by sample respondents were dairy, poultry, goat rearing and draught animals rearing.

Out of total farming systems identified, 8 farming systems were found to be the major farming systems. A particular farming system followed by at least 10 per cent farmers or more in a cluster was considered to be the major farming system and remaining farming systems were not considered for further analysis. The existing farming systems followed in study area are presented in Table 5.4

The cost, returns, resource use efficiency and optimality studies are presented only for the major farming systems. Hence farming systems discussed in the later part are major farming systems in study area.

5.3.1 Farming Systems in Cluster-I

It was observed from Table 5.4 that in this region four farming systems were followed by the farmers. The farming systems followed in this region were 1) Paddy + Rainfed plantations (FS-I), 2) Paddy + Irrigated plantations+ Dairy (FS-II), 3) Paddy + Other cereals pulses (FS-III), 4) Rainfed plantations+ Vegetables (FS-IV).

It was revealed from Table 5.4 that, farmers in this region have followed four major farming systems. The paddy enterprise was observed to be followed in all farming systems except FS-IV. In addition to paddy and irrigated plantations, farmers have followed dairy and vegetables, indicating awareness among the farmers to implement the market oriented agribusiness practices in this region.

5.3.2 Farming Systems in Cluster-II

The farming systems followed in this region were named 1) Paddy + Rainfed plantations+ Irrigated plantations (FS-I), 2) Paddy + Rainfed plantations+ Vegetables (FS-II), 3) Irrigated plantations+ Pulses + Dairy (FS-III), 4) Paddy + Other cereals +Oilseed (FS-IV). The irrigated plantations and rainfed plantations were main enterprises followed in addition to paddy in this region due to a suitable agro-climatic situation for this crop. Paddy was grown in all farming systems except FS-III. Paddy was grown in *Kharif* as well as in *Rabi* season, in farming system IV indicating availability of irrigation facility in the region. The pulses were grown under FS-III, while dairy was undertaken in FS-IV.

Table 5.5: Land holding under selected major Farming systems

Sl. No	Particulars	Cluster –I				Cluster –II			
		FS-I	FS-II	FS-III	FS-IV	FS-I	FS-II	FS-III	FS-IV
I	Owned Land								
	A) Cultivated land								
	a) Unirrigated land	2.42	0.71	1.67	1.57	2.16	1.81	0.63	0.84
	b) Irrigated land	-	1.13	-	1.35	0.75	0.97	1.22	0.55
	B) Current Fallow	0.2	0.27	-	0.05	0.12	-	0.19	-
	C) Permanent Fallow	0.14	0.25	0.08	0.2	0.42	0.15	0.11	0.32
	Total owned land	2.76	2.36	1.75	3.17	3.45	2.93	2.15	1.71
II	Land leased in	-	-	0.08	-	-	-	0.04	-
III	Land leased out	-	0.15	-	-	0.1	-	-	-
IV	Operational holding	2.76	2.21	1.83	3.17	3.35	2.93	2.19	1.71

(area in ha.)

5.3.3 Land holding Under Existing Farming Systems.

The size of the operational holding has a profound influence on different economic aspects of farming business such as scale of production, intensity of resources used, ultimately effective levels of expenditure and credit requirement. Land holding and land utilization includes land use pattern according to different land use categories. It included cultivated land (irrigated and unirrigated), fallow land, grazing land, and cultivable waste land. The land holding and land utilization pattern of sample farmers is presented in Table 5.5.

It is observed from Table 5.5 that, per farm total owned land in cluster-I was ranging from 1.75 hectares in FS-III to 3.17 hectares in FS-IV. The irrigated area in FS-II and FS-IV was observed to be 1.13 hectare and 1.35 hectare respectively.

In case of cluster-II, per farm total owned land was maximum (3.45 ha) in FS-I. The per farm irrigated land was maximum in FS-III (1.22 ha). The per farm permanent fallow land was found to be maximum (0.42 h.) in FS-I. The operational holding was ranging from 1.71 hectares in FS-IV to 3.35 hectares in FS-I.

5.3.4 Cropping Patterns Followed on Sample Farms

The area under different crop in different seasons i.e. cropping pattern is another important factor influencing the level of total annual expenses in the farm as well as returns from the farm business. The information on cropping pattern adopted by the sample farmers under different farming systems is presented in Table 5.6 and Table 5.7.

5.3.4.1 Cropping Pattern in Cluster –I

The cropping pattern followed in this region is presented in Table 5.6.

It was observed from the Table 5.6 that, the net cultivated area was ranging from 1 hectares in FS-III to 2.92 hectare in FS-IV. In the case of FS-I, the area under paddy was 28.63%.The maximum area was under rainfed plantation i.e. Cashewnut 36.92% per cent and mango 34.43% per cent, respectively. In FS-II, the maximum area was under paddy (38.37%) followed by coconut (32.97%) and arecanut (28.10%).

Table 5.6: Cropping Pattern of Sample Farms in Cluster I

Sr. No.	Particulars	FS – I	FS – II	FS – III	FS – IV
I	***Kharif* season**				
1.	Paddy	0.69 (28.63)	0.71 (38.37)	0.55 (32.93)	
2.	Nagli			0.24 (14.37)	
3.	Prosomillet (vari)			0.21 (12.57)	
	Sub Total	0.69 (28.63)	0.71 (38.37)	1 (59.87)	--
II	***Rabi* Season**				
1.	Cowpea			0.23 (13.78)	
2.	Wal			0.19 (11.38)	
3.	Pawata			0.25 (14.97)	
4.	Lady's finger				0.40 (13.69)
5.	Snakegaurd				0.24 (8.21)
6.	Ghewada				0.22 (7.53)
7	Watermelon				0.50 (17.12)
	Sub Total	--	--	0.67 (40.14)	1.35 (46.55)
III	**Perennial crops**				
1.	Mango	0.83 (34.43)			0.77 (26.36)
2.	Cashewnut	0.89 (36.92)			0.80 (27.39)
3.	Arecanut		0.52 (28.10)		
4.	Coconut		0.61 (32.97)		
	Sub Total	1.72 (71.35)	1.13 (61.07)		1.57 (53.75)
	Gross cropped area	5.85 (100.00)	4.1 (100.00)	1.67 (100.00)	6.06 (100.00)
	Net cropped area	2.41	1.85	1	2.92
	Cropping intensity –I (%)	100%	100%	167%	100%
	Cropping intensity –II (%)	242.73%	221.62%	167%	207.53%

(Figures in parentheses indicate percentage to gross cropped area)

Sr. No.	Particulars	FS – I	FS – II	FS – III	FS – IV

Table 5.7: Cropping Pattern of Sample Farms in Cluster II

I	***Kharif* season**				
1.	Paddy	0.65 (22.33)	0.50 (17.92)		0.63 (45.32)
2.	Nagli				0.21 (0.15)
3.	Prosomillet (vari)				
	Sub Total	0.65 (22.33)	0.50 (17.92)		0.84 (60.43)
II	***Rabi* Season**				
1.	Paddy				0.27 (19.42)
2.	Cowpea			0.21 (11.35)	
3.	Wal			0.19 (10.27)	
4.	Pawata			0.23 (12.43)	
5.	Lady's finger		0.30 (10.75)		
6.	Snakegaurd		0.23 (8.24)		
7	Brinjal		0.24 (8.60)		
8	Green Chilli		0.21 (7.52)		
9	Groundnut				0.28 (20.14)
	Sub Total	--	0.98 (35.12)	0.63 (34.05)	0.55 (39.56)
III	**Perennial crops**				
1.	Mango	0.69 (23.71)	0.62 (22.22)		
2.	Cashewnut	0.82 (28.17)	0.70 (25.08)		
3.	Arecanut	0.30 (10.30)		0.60 (32.43)	
4.	Coconut	0.45 (15.46)		0.62 (33.51)	
	Sub Total	2.26 (77.66)	1.32 (61.07)	1.22 (65.94)	----
	Gross cropped area	7.43 (100.00)	5.44 (100.00)	4.29 (100.00)	1.39 (100.00)
	Net cropped area	2.91	1.82	1.85	0.84
	Cropping intensity-I (%)	100%	153.84%	100%	165.47%
	Cropping intensity-II (%)	255%	245%	231.89%	165.47%

(Figures in the parentheses indicate percentages to gross cropped area)

Regarding FS-III, area under paddy, nagli and vari was 32.93 per cent, 14.37 per cent and 12.57 per cent respectively. The area under pulse crop was 40.14 per cent. In FS-IV the maximum area was under Cashewnut that is 0.80 hectare (27.39%) followed by arecanut 0.77 hectare (26.36%). It was observed that in FS-IV the area under vegetable crops was 46.55 per cent. The cropping intensity index as defined in methodology (Chapter-IV) that, it was ranging from 167 per cent to 242.73 per cent. The cropping intensity was lower in FS-III.

5.3.4.2 Cropping Pattern in Cluster –II

The cropping pattern followed in this region is presented in Table 5.7.

It was revealed that net cultivated area among the different farming systems was ranging from 0.84 hectare in FS-IV to 2.91 hectares in FS-I. In FS-I substantial area was under Cashewnut (28.17%) followed by mango (23.71%) and paddy (22.33%). In FS-II, the area, under Cashewnut was maximum, *i.e.* 0.70 hectares (25.08%). The area under vegetable crops was 0.98 hectares (35.12%) in FS-II.

Out of total cultivated area, the area under irrigated plantations that is coconut and arecanut in FS-III was 0.62 hectare (33.51%) and 0.60 hectare (32.43%) respectively. However, in FS-III 0.63 hectares (34.05%) of area was observed in *rabi* season under pulse crops. In FS-IV mainly summer paddy was grown due to availability of irrigation facility. However, area under oilseed crop i.e. groundnut in FS-IV worked out to be 20.14 per cent of gross cropped area. The area under cereal crops was found to be 0.84 hectares (60.43%) in FS-IV. The cropping intensity index in this region was ranging from 165.47 per cent to 298.90 per cent. In case of FS-II, cropping intensity index was fond to be higher.

5.4 Profitability of Enterprises Followed under Major Farming Systems

The farming system-wise per hectare cost, returns and profitability of crops and per unit cost, returns and profitability non-crop farm enterprises were calculated for each cluster separately. The unit for dairy enterprise was per animal. The per unit profitability of enterprises followed in the study area are presented in Table 5.8 and 5.9.

5.4.1 Profitability of Enterprises in Cluster-I.

The results of per hectare and per unit profitability in Cluster – I are presented in Table 5.8.

a) Paddy: It was observed from Table 5.8, that paddy crop was grown under all the farming systems in the study area except FS-IV. The per hectare gross returns were maximum in FS-I (Rs.49000) followed by in FS- II (Rs 44000) and FS-III (Rs.33320). The per hectare gross returns were minimum in FS-III (33320).However, per hectare cost was also less in FS-III (Rs.40962) indicating that less use of inputs. The per hectare total cost of cultivation of paddy was maximum in FS-I Rs.52587. The input-output ratios were ranging from Rs.0.81 in FS-III to Rs. 0.97 in FS-II indicating need to increase adoption of high yielding varieties and also proper utilization of resources. Similar observation were also recorded by Swami (2004) and Bhuwad (2012) while studying farming systems in Ratnagiri district of Maharashtra.

b) Mango: As indicated in results (Table 5.8) mango was grown under FS-I and FS-VI. The per hectare total cost in FS-I and FS-VI was Rs.54400 and Rs.54506 respectively. The per hectare gross return worked out to Rs.100000 in both the farming systems, resulting into per hectare net returns at total cost Rs.45600 and Rs.45495 in in FS-I and FS-IV respectively. The input output ratio were found to be 1.84 and 1.83 in FS-I and FS-IV, which indicated the suitability and economic importance of this crop in the study area.

c) Cashewnut: Cashewnut was also grown only under FS-I and FS-VI, (Table 5.8) as an important enterprise in rainfed condition along with mango. The per hectare total cost was highest (Rs. 57337) in FS-I. The per hectare gross returns amounted to Rs. 123000 and per hectare net returns over total cost were Rs.65664 and input output ratio was Rs.2.15 in FS-I. In FS-IV, per hectare total variable cost and total fixed were amounted to Rs.31360 and Rs.21783, respectively. The per hectare gross returns was Rs.106600, resulting into net returns at total cost to Rs.53457 and input output ratio was found to be 2.01. Similar observation were also recorded by Swami (2004) and Bhuwad (2012) while studying farming systems in Ratnagiri district of Maharashtra. It could be concluded that cashew was comparatively high income

Table 5.8: Per hectare profitability of crops grown and other enterprises profitability in major farming systems in cluster I (Rs./ha.)

Sr. No.	Particulars	FS-I			FS-II				FS-III	
		Paddy	Mango	Cashewnut	Paddy	Coconut	Arecanut	Dairy	Paddy	Nagali
1	Total Variable Cost (TVC)	40684	33379	32898	35940	26628	22274	45833	32865	20417
2	Total Fixed Cost (TFC)	11903	21021	24439	9308	18354	14593	3750	8097	7163
3	Total Cost (TC)	52587	54400	57337	45249	44982	36867	49583	40962	27580
4	Gross Returns	49000	100000	123000	44000	84300	65600	60405	33320	26500
5	Net income over TVC	8316	66621	90103	8060	57672	43326	14572	455	6083
6	Net income over TC	-3587	45600	65664	-1249	39318	28733	10822	-7642	-1080
7	Benefit-Cost Ratio	0.93	1.84	2.15	0.97	1.87	1.78	1.22	0.81	0.96

Table 5.8: Continued….

Sr.	Particulars		FS-IV

No.		Vari	Cowpea	Wal	Pawata	Mango	Cashewnut	Lady's finger	Snake guard	Ghewada	Watermelon
1	**Total Variable Cost (TVC)**	18899	31981	32428	25950	33163	31360	80974	56826	66581	57453
2	**Total Fixed Cost (TFC)**	4287	15485	14930	12326	21343	21783	50387	23293	29009	26914
3	**Total Cost (TC)**	23186	47466	47358	38276	54506	53143	131361	80119	95590	84367
4	**Gross Returns**	16600	78000	72000	56000	100000	106600	290500	123200	156000	142500
5	**Net income over TVC**	-2299	46019	39572	30050	66837	75240	209526	66374	89419	85046
6	**Net income over TC**	-6586	30534	24642	17724	45494	53457	159139	43081	60410	58133
7	**Benefit-Cost Ratio**	0.72	1.64	1.52	1.46	1.83	2.01	2.21	1.54	1.63	1.69

earning crop and required less care and inputs and thus it could be included in the farming system under rainfed conditions.

d) Coconut: The coconut was observed to be grown only under FS-II. The total cost in coconut worked out to Rs.44982. The per hectare gross returns and net returns were Rs.84300 and Rs. 39318.The input-output ratio was 1.87, indicating suitability of crop to agro-climatic situation and its high profitability. Similar observation were also recorded by Swami (2004)

e) Arecanut: As indicated in results (Table 5.8), the per hectare total cost and gross returns for crop grown under FS-II were Rs.36867 and Rs.65600 respectively. Which lead to net returns per hectare at Rs.28733.The returns per rupee invested was Rs. 1.78, which indicated high profitability of crop.

f) Wal: The per hectare gross returns and total cost in FS – III amounted to Rs.7200 and Rs 47358, respectively resulting into net returns at total cost to the tune of Rs.24642.

g) Cowpea: The per hectare gross returns from cowpea under FS-III was estimated at Rs.78000. The per hectare total cost worked out to Rs.47466, and return on per rupee invested at total cost was Rs.1.64.

h) Pawata: The per hectare gross returns from Pawata cultivation under FS-III was worked out to Rs.56000. The total cost of cultivation was Rs.38276. The per hectare net return over total cost was Rs.17724. The input-output ratio was found to be1.46. Similar observations were recorded by Torane (2009)

i) Lady's Finger: The per hectare total cost of cultivation and per hectare gross returns under FS-III for lady's finger worked out to Rs.131361 and Rs.290500, respectively. The per hectare net returns over total cost Rs.159139.

j) Snake gourd: Snake gourd was another important vegetable crop grown under FS-IV. The per hectare total variable cost and total fixed cost were Rs.56826 and Rs.23293, respectively. The per hectare gross returns were Rs.123200. The return on per rupee invested at total cost was worked out to Rs.1.54.

k) Ghewada: It was observed from Table 5.8 that, the total cost of cultivation of Ghewada in FS-IV worked out to Rs.95590 and per hectare gross return was

Rs.156000. The returns per rupee invested was Rs.1.63, which indicated high profitability of crop.

l) Watermelon: Watermelon was found to be grown (FS-IV) in this region. The per hectare gross returns was Rs.142500 and total cost was Rs.84367. The per hectare net returns at total cost was Rs.58133. The return on per rupee invested at total cost was Rs.1.69. Swami (2004) in his study in Ratnagiri district also found that the input output ratio in coconut was 1.70

m) Nagali: In case of Finger millet the per hectare gross returns worked out to Rs.26500 in FS-III. The total cost of cultivation was Rs.27580. The returns per rupee invested at total cost were Rs. 0.96. Swami (2004) in his study in Ratnagiri district also found that the input output ratio in nagli was 0.77. The results indicated the need for proper farm management practices in nagli crop as the crop is being grown in less fertile and eroded lands.

n) Vari: It was observed from Table 5.8 that, per hectare total variable cost and total fixed were amounted to Rs.18899 and Rs.4287, respectively. The per hectare gross returns was Rs.16600, resulting into net returns at total cost to Rs.-6586.

o) Dairy: The dairy enterprise was followed by the farmers in FS-II. It was observed from the table 5.8 that, per animal gross return was Rs.60405. The per animal total cost of maintenance was minimum Rs.49583. The return per rupee invested at total cost was Rs.1.22 indicating the profitability of enterprise and also supported the farm earnings substantially and supplied F.Y.M. to other crops, leading to indirect saving to the farmers. Similar observations were recorded by Borude (2002)

5.4.1 Profitability of Enterprises in Cluster-II.

The results of per hectare and per unit profitability in Cluster – I are presented in Table 5.9.

a) Paddy: Paddy was found to be one of the major crop enterprises followed in this region. Paddy was cultivated in *kharif* as well as in *Rabi* season. In *kharif* paddy, the per hectare gross returns was maximum in FS-I, (Rs.51000) and minimum (Rs.48700) in FS-II. The per hectare total cost of cultivation of *Kharif* paddy was maximum (Rs.56951) in FS-II and minimum (Rs.51359) in FS-IV. The returns on per rupee invested at total cost was negative in all farming systems. In case of *rabi* paddy, the per hectare gross returns in FS-IV, was estimated at Rs.45100. The total cost of

Table 5.9: Per hectare profitability of crops grown and other enterprises profitability in major farming systems in cluster II (Rs. /ha.)

Sr. No.	Particulars	FS-I					FS-II				
		Paddy	Mango	Cashew nut	Arecanut	Coconut	Paddy	Mango	Cashewnut	Lady's finger	Snakeguard
1	**Total Variable Cost (TVC)**	44323	32921	35422	23469	34107	45890	33504	32814	80746	59845
2	**Total Fixed Cost (TFC)**	11484	23778	23154	13559	20453	11062	22428	20739	42804	21460
3	**Total Cost (TC)**	55807	56699	58577	37028	54561	56951	55932	53553	123550	81305
4	**Gross Returns**	51000	115500	114800	59500	98000	48700	106000	100040	245000	112200
5	**Net income over TVC**	11484	82579	79378	36031	63893	2810	72496	67226	164254	52355
6	**Net income over TC**	-4807	58801	56223	22472	43439	-8251	50068	46487	121450	30895
7	**Benefit-Cost Ratio**	0.91	2.04	1.96	1.61	1.80	0.86	1.90	1.87	1.98	1.38

Table 5.9: Continued…….

Sr. No.	Particulars			FS-III					
		Brinjal	Green chilli	Arecanut	coconut	Cow pea	Wal	Pawata	Dairy

1	**Total Variable Cost (TVC)**	50440	66934	23768	24265	34159	30789	35196	39954
2	**Total Fixed Cost (TFC)**	23892	35435	15277	17391	18288	16195	15555	3450
3	**Total Cost (TC)**	74332	102369	39044	41656	52447	46984	50751	43404
4	**Gross Returns**	130000	192500	69700	77500	88000	76500	72000	48700
5	**Net income over TVC**	79560	125566	45932	53235	53841	45711	36804	8746
6	**Net income over TC**	55668	90131	30656	35844	35553	29516	21249	5296
7	**Benefit-Cost Ratio**	1.75	1.88	1.79	1.86	1.68	1.63	1.42	1.12

Table 5.9: Continued…….

Sr.No	Particulars	FS-IV			
		Paddy	**Summer paddy**	**Nagli**	**Groundnut**
1	**Total Variable Cost (TVC)**	41075	44312	20068	55457
2	**Total Fixed Cost (TFC)**	10283	9343	6951	13359
3	**Total Cost (TC)**	51359	53655	27019	68816
4	**Gross Returns**	48800	45100	23800	66000
5	**Net income over TVC**	7725	788	3732	10543
6	**Net income over TC**	-2559	-8555	-3219	-2816
7	**Benefit-Cost Ratio**	0.95	0.84	0.88	0.96

cultivation amounted to Rs. 53655, resulting into net returns at total cost to Rs.-8555. The return on per rupee invested at total cost in *Rabi* season was Rs.0.84.

b) Mango: As indicated in the results (Table 5.9) the mango was grown in this region under FS-I and FS-II. It was revealed that, despite the total cost in FS-II being less than FS-I, the return in FS-I was more. The per hectare total cost and gross returns in FS-I worked out to Rs.56699 and Rs.115500, respectively, which may be attributed to proper use of the resources. The per hectare net returns were ranging from Rs.50068 (FS-II) to Rs.58801 (FS-I). The returns per rupee invested in FS-I (2.04) were higher than FS-II (Rs.1.90) indicating high profitability of crop under the farming system. Similar results were found in Naik (2002)

c) Cashewnut: In case of cashewnut, it was observed that from Table 5.9 that, in Cluster –II, cashewnut was grown under FS-I, FS-II. The total cost was minimum in FS-II (Rs.53553) than FS-I (Rs.58577). The per hectare gross returns were observed to be maximum in FS-I (Rs.114800) followed by in FS-II (Rs.100040). The return on each rupee invested was ranging from Rs.1.87 in FS-II to Rs.1.96 in FS-I.

d) Coconut: The total variable cost in coconut worked out to Rs.34107 and Rs.24262, in FS-I and FS-III respectively. The gross returns was maximum in FS-I (Rs.98000) followed by in FS-III (Rs.77500). The per hectare net returns at total cost was ranging from Rs.35844 in FS-III to Rs.43439 in FS-I. The higher gross return in FS-I was not mainly due to the productivity but due to the selling method adopted by the farmers in FS-III. It was revealed that the majority of the farmers following FS-I have sold the coconut on nut basis whereas in other farming systems the coconut is sold on tree basis, in which production from whole tree was sold at a particular price for a year. It was also revealed during the investigation that there was negligence on the part of some farmers with regard to the care and maintenance of the trees, once the price of the tree was negotiated. The return on per rupee invested by the farmers was ranging from Rs.1.80 in FS-I to Rs.1.86 in FS-III indicating suitability of crop to agro-climatic situation and its high profitability. Similar results were found in Naik (2002) and Veerkar (2002)

e) Arecanut: The per hectare gross returns from arecanut was maximum (Rs.69700) in FS-III followed by (Rs.59500) in FS-I. The per hectare total cost of cultivation was ranging from Rs.37028 in FS-I to Rs.39044 in FS-III. The net returns over total cost

worked out to Rs.22472 and Rs.30656 in FS-I and FS-III, respectively. The returns per rupee invested was ranging from Rs. 1.61 in FS-I to Rs. 1.79 in FS-III, which indicated high profitability of crop.

f) Cowpea: It was observed from Table 5.9, that the cowpea was grown under FS-III. The per hectare gross returns from cowpea under FS-III was estimated at Rs.88000. The per hectare total cost worked out to Rs.52447, and return on per rupee invested at total cost was Rs.1.68.

g) Wal: Per hectare total cost and gross returns in wal under FS-III were Rs.46984 and Rs.76500, respectively. The per hectare net returns over total cost was Rs.29516.

h) Pawata: Per hectare total variable cost for pawata under FS-III was Rs.35196. The total cost of cultivation was Rs.50751. The per hectare gross returns was Rs.72000 and net return per rupee invested at total cost was Rs.21249.

i) Lady's finger: It was observed from Table 5.9, that the lady's finger was another important vegetable crop grown under FS-II. The per hectare gross returns was higher Rs.245000 than all other crops included in the system. The per hectare total cost was also higher (Rs.123550). The per hectare net returns and returns per rupee invested were highest in the case of this crop as compared to other crop as well as these from non-crop farm enterprises. The returns per rupee invested was Rs. 1.98, which indicated high profitability of crop.

j) Snake gourd: Snake gourd was one of the remunerative crop grown under FS–III. Per hectare variable cost was estimated at Rs.59845 and per hectare total fixed cost was Rs.21460. The per hectare gross return amounted to Rs.112200, resulting into net returns over total cost to the tune of Rs.30895 and return on per rupee invested at total cost was Rs.1.38.

k) Brinjal : For brinjal grown in *rabi* season under FS-III, the per hectare total cost was Rs.74332 and gross return was Rs.130000. Per hectare net returns over variable cost and total cost were Rs.79560 and Rs.55668, respectively. The returns per rupee invested was high (Rs.1.75) indicating the commercial importance of the crop due to greater demand in the markets.

l) Green Chilli : It was observed from Table 5.9 that, chilli grown under FS-III have also important role in addition to other vegetable crop as it had contributed to farm earning of the farmer following FS-III. The per hectare net returns was more

Rs.90131 and return on each rupee invested was Rs.1.88, indicating high profitability of the crop.

m) Dairy: It was revealed from Table 5.9 that, the dairy enterprise was the main non-crop farm enterprise followed in the region. The dairy was found to be undertaken under farming system FS-III. It was observed that per animal total cost of maintenance was Rs.43404. The per animal gross return was also high (Rs.48700) in FS-III. The return per rupee invested was Rs.1.12. It can be concluded that the dairy enterprise was found to be remunerative under all the farming systems.

n) Finger millet (Nagli): In case of Finger millet the per hectare gross returns worked out to Rs.23800 in FS-IV. The total cost of cultivation was Rs.27019. The returns per rupee invested at total cost was Rs.0.88, indicating the low productive efficiency of the crop. Swami (2004) in his study in Ratnagiri district also found that the input output ratio in nagli was 0.77. The results indicated the need for proper farm management practices in nagli crop as the crop is being grown in less fertile and eroded lands.

o) Groundnut: Smooth gourd was another important oilseed crop grown under FS-IV. The per hectare total variable cost and total fixed cost were Rs.55457 and Rs.13359, respectively. The per hectare gross returns were Rs.66000. The return on per rupee invested at total cost was worked out to Rs0.96.

5.5 Cost and Returns Structure of Major Farming Systems

The per farm cost and return structure in major farming systems followed by farmers were estimated for each region (clusters) independently and they are presented in Table 5.10 and Table 5.11.

5.5.1 Cost and Returns of Major Farming Systems in Cluster-I.

The results of farming system wise per farm cost and returns profile in Cluster-I are presented in Table 5.10

In this region 4 major farming systems were observed. The farming systems in this region were 1) Paddy + Rainfed plantations (FS-I), 2) Paddy + Irrigated plantations+ Dairy (FS-II), 3) Paddy + Other cereals pulses (FS-III), 4) Rainfed plantations+ Vegetables (FS-IV).

Table 5.10 Cost and returns of major farming system in cluster-I. **Rs./farm**

			FS-I		FS-II		FS-III		FS-IV	
Sr. No.	**Particulars**	**Unit**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**	**Quantity**	**Value (Rs.)**
1	Hired human labour									
	a. Male	Days	121	18204	103	15459	48	6782	214	32166
	b. Female	Days	84	8403	91	9037	68	5590	142	14223
2	Bullock labour	Pair/days	16	4761	9	2556	33	9895	22	6606
3	Seed material	Kg.	36	717	37	738	46	2165	19	10427
4	FYM/Compost	qt.	48	10083	44	9430	42	10384	36	8952
5	Fertilizers	Kg.	802	8996	510	5865	125	1507	1421	16354
6	Rab material	qt.	13	524	14	918	10	418	0	0
7	PPC	Lit.	6	5947	1	768	1	535	7	6192
8	Dry fodder									
	a. Grass	No			4	1750				
	b. Rice Straw	qt			40	6038				
9	Feed	qt			17	25500				
10	Concentrate	Kg			12	22050				
	Total			57636		100110		36860		94920
11	Depreciation on charges			2039		1346		733		
12	Land revenue and other cesses			160		119		178		1616
13	Interest on working capital			3706		2161		1527		203
	Cost A			63541		42973		39285		5695
14	Interest on fixed capital			8216		10581		4367		102434
15	Rental value of land			39445		21013		12974		10099
	Cost B			111202		178303		56628		69190
16	Family labour									181723
	a. Male	Days	108	16212	95	17029	45	6306	168	25207
	b. Female	Days	77	7749	121	12087	75	6027	134	13439
	Cost C			135163		207419		68962		220370
17	Production									
	a. Main produce	qt.		223220		213280		75769		415500
	b. By produce	qt.		7000		7649		2321		0
	Total			230220		220929		78090		415500
18	Net Returns			95056		13568		9128		195130
19	Input Output ratio			1.70		1.06		1.13		1.89

The enterprises followed in FS-I were paddy, mango and Cashewnut. Per farm total male and female labour used in this system worked out to 230 man days and 161 man days respectively. The per farm total variable cost was Rs.85304. Total fixed cost was Rs.49860. Per farm total cost and gross returns were Rs. and Rs135163 and Rs.230220, respectively. The net returns over total variable cost was worked out to Rs.144916. The net returns at total cost was Rs.95056, resulting into returns on per rupee invested at total cost to Rs.1.70.

It was observed from Table 5.10 that, the components of FS-II were paddy, coconut, arecanut and dairy. The per farm total variable cost was worked out to Rs.53035. The total cost was Rs.78339. The per farm gross returns was amounted to Rs.115220. The net returns over total cost was just Rs.89916 resulting into returns on per rupee invested at total cost (Rs.1.47).

In case of FS-III enterprises such as paddy, nagli, vari, cowpea, wal and pawata crops were grown. The per farm labour requirement was 236 man days. The per farm total variable cost was amounted to Rs.50722. The total cost was worked out to Rs.68962. The per farm net returns over variable cost and over total cost were Rs.27369 and Rs.9128, respectively. The return on per rupee invested at total cost was Rs.1.13.

The farmers following FS-IV were engaged in cultivation of mango, Cashewnut and five different types of vegetable crops. Per farm total employment generated was 658 man days. The per farm total variable cost was Rs.139262 and total cost was Rs.220370. The per farm gross return was worked out to Rs.415500. The net returns over total cost was amounted to Rs.195130. The return on per rupee invested at total cost was Rs.1.89

Among the farming systems followed in Cluster-I, maximum per farm labour were used in FS -IV (658 man days) followed by FS -II (410 man days) and FS -I (390 man days). The per farm net returns over total cost was maximum in FS-IV (Rs.195130) followed by FS -I (Rs.95056), FS -II (Rs.89916), and FS -III (Rs.9128). The net return per rupee invested at total cost were worked out to Rs.1.89 in FS -IV, followed by Rs.1.70, Rs.1.47 and Rs.1.13 in FS – I, FS-II and FS-III respectively.

It was observed that the farmers have a tendency to grow rainfed and irrigated plantation and also more number of vegetable crops on smaller area for each

vegetables, which indicated the crop diversification followed by farmers for commercial advantage.

It can also be concluded that though the per hectare gross returns and net returns in crops such as paddy, mango, Cashewnut, coconut, arecanut, and vegetables such as ladys finger, snakeguard, ghewada, watermelon and also pulse crops were higher, the per farm actual income earned by farmer was less because of the enterprise mix followed in particular farming system consisting of a vary less area or farm size for each of these enterprise.

5.5.2 Cost and Returns of Major Farming Systems in Cluster-II.

The results of farming system wise per farm cost and returns profile in Cluster-II are presented in Table 5.11

In this region 4 major farming systems were observed. The farming systems in this region were 1) Paddy + Rainfed plantations+ Irrigated plantations (FS-I), 2) Paddy + Rainfed plantations+ Vegetables (FS-II), 3) Irrigated plantations+ Pulses + Dairy (FS-III), 4) Paddy + Other cereals +Oilseed (FS-IV).

It is observed from Table 5.11 that the enterprises followed in FS-I were *Kharif* paddy, finger millet (nagli), mango, cashewnut, pulses, vegetables and dairy. The per farm total labour used in this system were 455 man days. The total variable cost incurred worked out to Rs.102523 and the total fixed cost was Rs.57431. The per farm gross returns obtained from various enterprises amounted to Rs.269426. The returns on per rupee invested at total cost was Rs.1.68.

In FS-II, the enterprises included in this system were *Kharif* paddy, mango, canshewnut, and vegetables. The per farm total human labour used in this system was 613 man days. The total expenditure incurred on all variable items (TVC) worked out to Rs.130172. Per farm total cost and gross returns worked out to Rs.201969 and Rs.336396, respectively, resulting into net returns of Rs.134427. The return on per rupee invested at total cost was Rs.1.67.

FS-III consisted enterprises such as arecanut, coconut, cowpea, wal, pawata and dairy. The per farm total labour used worked out to 377 man days. The per farm total variable cost amounted to Rs.50623 and per farm total cost and gross returns were Rs.82123 and Rs.141415, respectively. The net returns at total cost worked out to Rs.59292 resulting into returns on per rupee invested at total cost to Rs

Table 5.11 Cost and returns of major farming system in cluster-II. **Rs./farm**

Sr. No.	Particulars	Unit	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)
1	Hired human labour									
	a. Male	Days	142	21363	176	26399	84	9261	70	10533
	b. Female	Days	101	10148	140	14045	96	6069	57	5650
2	Bullock labour	Pair/days	14	4095	26	8027	13	3783	23	6768
3	Seed material	Kg.	33	650	35	4562	20	1877	66	2718
4	FYM/Compost	qt.	56	14098	54	14548	22	5490	52	11028
5	Fertilizers	Kg.	1153	13831	913	13457	472	5658	389	4392
6	Rab material	qt.	13	970	223	360	0	350	18	716
7	PPC	Lit.	6	5724	9	8215	3	2430	0.28	252
8	Dry fodder									
	a. Grass	No					5	920		
	b. Rice Straw	qt					28	4161		
9	Feed	qt					13	18396		
10	Concentrate	Kg					9	15768		
	Total			70878		89186		74146		42057
11	Depreciation on charges			1997		3241		1697		879
12	Land revenue and other cesses			198		3297		123		113
13	Interest on working capital			4253		5351		4260		2523
	Cost A			77326		101076		80196		45572
14	Interest on fixed capital			10332		9193		11115		4453
15	Rental value of land			44904		56066		24809		10560
	Cost B			132562		166335		116120		60585
16	Family labour									
	a. Male	Days	125	18720	150	21432	87	13088	53	7953
	b. Female	Days	87	8672	147	14202	110	10589	51	5051
	Cost C			159954		201969		139797		73589
17	Production									
	a. Main produce	qt.		262666		330896		211045		56775
	b. By produce	qt.		6760		5500		1460		10964
	Total			269426		336396		212505		67739
18	Net Returns			109472		134427		72708		-5850
19	Input Output ratio			1.68		1.67		1.52		0.92

In FS-IV, enterprises such as *Kharif* paddy, *rabi* paddy, nagli and groundnut were observed. The total per farm employment created in this farming system was 231 man days. The total variable cost and total fixed cost were amounted to Rs.57584 and Rs.16005, respectively. The gross returns was worked out to Rs.67739. The net returns at total cost were Rs.-5850. The return on per rupee invested was worked out to Rs.0.92.

Among all farming systems followed in the region FS-II required maximum labour (613 man days). The per farm gross returns was maximum in FS-II (Rs.336396) followed by FS-I (Rs.269426), FS-III (Rs.141415) and FS-IV (Rs.67739). The net returns at total cost was maximum in FS–II (Rs.134427) followed by FS-I (Rs.109472).

The returns per rupee invested at total cost were maximum in FS-III (Rs.1.72) followed by FS-I (Rs.1.68). In remaining farming systems it was ranging from Rs.0.92 to Rs.1.67. It can be concluded that, the area under rainfed plantations, number of dairy animals, need to be increased to improve the per farm net returns on different farming systems in this region. It was further concluded that the FS-III and FS-I, were highly profitable farming systems in this region.

5.5.3 Cost and Return Structure of Farming Systems in South Konkan Region

Table 5.12, depicts the birds eye view of economics of farming systems followed in different identified clusters of the study area. However, the profitability as well cost and returns structure cannot be compared between the regions because the enterprises encompassing a farming system of the region do not coincide with the farming systems of other regions.

In South Konkan region, 8 major farming systems were identified which were being followed by the farmers. The per farm total human labour required were maximum (658 man days) in Rainfed plantations + Vegetables farming system in cluster-I

The per farm total variable cost (Rs.130172), total cost (Rs.201969) and gross returns (Rs.336396) were maximum in Paddy + Rainfed plantations + Vegetables farming system (cluster-II). However, the returns on per rupee invested was (Rs.1.67). Whereas, in Paddy + Other Cereals + Oilseed the per farm total variable cost

Table 5.12: Cost and Return Structure of Farming Systems in South Konkan Region

Sr. No	Particulars	FS-1	FS-2	FS-3	FS-4	FS-1	FS-2	FS-3	FS-4
		Cluster- I				Cluster- II			
1	**Total Variable Cost (TVC)**	85304	174360	50722	139262	102523	130172	50623	57584

(Figures in Rs)

2	**Total fixed cost (TFC)**	49860	33059	18255	81108	57431	71797	31467	16005
3	**Total cost**	135164	207419	68962	220370	159954	201969	82123	73589
4	**Gross returns**	230220	220929	78090	415500	269426	336396	141415	67739
5	**Net returns at TVC**	144916	62184	27369	276238	166903	206224	90792	10155
6	**Net returns at TC**	95056	89917	9128	195130	109472	134427	59292	-5850
7	**Returns per rupee at TC**	1.703	1.06	1.13	1.89	1.68	1.67	1.72	0.92

(Rs.57584), total cost (Rs.73529) and gross returns (Rs.67739) were minimum among all the farming system's in both the clusters.

The returns per rupee invested were maximum (Rs.1.89) in Rainfed Plantation + Vegetables system as compared to all farming systems in different regions. Hence, it can be concluded that the Rainfed Plantation + Vegetables was the most remunerative system in the study area.

It was also observed that, the Irrigated plantations + Pulses + Dairy farming system was more remunerative in Cluster-II region. Return on per rupee invested in this farming system was Rs.1.72. It was observed that, the total variable cost (Rs.130172) and total cost (Rs.201969) incurred were maximum in FS-II (Paddy + Rainfed Plantation + Vegetables) in Cluster-II.

As regards Paddy + Rainfed plantations farming system, it was revealed that the profitability of this system was also higher in Cluster-I region. The per farm gross returns, total cost, per farm net returns over total cost in this farming system were (Rs.230220), (Rs.135164), (Rs. 95056.) respectively. The returns on per rupee invested at total cost (Rs.1.70).

Among all clusters in South Konkan region, the farming systems namely 1) Paddy + Rainfed Plantation, 2) Rainfed Plantation + Vegetables, 3) Irrigated Plantation + Pulses + Dairy, 4) Paddy + Rainfed Plantation + Irrigated Plantation, 5) Paddy + Rainfed Plantation + Vegetables were found to be highly profitable farming systems among the major farming systems (8) identified in the study area.

The region wise specific farming systems which need to be promoted are such as in cluster-I, 1) Paddy + Other Cereals + Pulses, 2) Paddy + Irrigated Plantation + Dairy are suggested for implementation on larger area. In cluster-II, 1) Paddy + Other Cereals + Oilseed suggested for implementation on extended area.

The findings of the present study are in conformity with the findings of, Kandasamy, (1998), Gumaste, *et.al* (2000), Swami (2004), Bhuwad (2012). The results of the present investigation lead to accept the hypothesis that, in existing farming systems there was higher proportion of income from dryland horticulture

5.5.4 Income and expenditure pattern of different farming systems

5.5.4.1 Cluster-I

5.5.4.1.1 Income pattern

The details of source-wise income pattern of farm families in different farming systems of both the groups are presented in Table5.13.

It was observed from Table 5.13 that, the total income of the farm families was Rs. 288413, Rs. 219686, Rs. 125102 & Rs. 485875 in faming system I, II, III & IV respectively. In farming system I, 67.77 per cent income was from horticulture production of the total income, 12.04 per cent from crop production. Income from farm business was observed to be Rs. 230220 which contributes 79.82 per cent of the total income. In case of other than farm business income, 10.95 per cent income was from business /service and 9.22 per cent was from wage earning. The income from other sources worked out to Rs. 58195 which contributes 20.18 per cent of the total income. In farming system I, the income from farm business was near about double than income from other source. The 67.77 per cent of farm business income from horticulture production owing to major contribution of plantation crops in the study area (Mango, cashewnut, Arecanut, Coconut).

In farming system II, it was observed that out of the total income 38.23 per cent income came from horticulture production, while 27.50 per cent was from dairy enterprise. The contribution of crop production in total income was found to be 14.22 per cent. It was also observed that 79.95 per cent income was from farm business income. Higher income was from farm business activity owing to combined effect of crop production and non-horticulture prod activity with dairy enterprise. The total income in Farming system II worked out to Rs.2,19,686 out of total income, 79.95 per cent income was from farm business income and 20.65 per cent was from other than farm business i.e. wages and business / service.

Regarding farming system III, 62.42 per cent of the income was from only crop production, because no other enterprise was taken in this farming system. The income derived from wages and business / services was 9.89 per cent and 27.69 per cent respectively. It is indicated that, there is lack of irrigation facility and working capital with farmers. Farmers only have alternative is to go for livestock rearing hence, the more income can be derived from livestock activity. In farming system IV

it was observed that out of total income, 51.66 per cent income was from crop production and 33.94 per cent income from horticulture crops. Thus 86.60 per cent income was from farm business income, while other than farm business activity (wages and business / service) contribution 14.40 percent of the total income.

The difference between faming systems indicated that the total income in faming system IV was double than the total income in faming system I, II, III. The total income from faming system III was very less as compared to farming system I, II, IV. The source wise income indicated that more than 50 per cent income was derived for crop production in all the faming system. While in faming system I, more than 50% income was derived from horticulture production which indicated that, there was more contribution of horticulture crop in present faming systems.

5.5.4.1.2 Expenditure pattern

The per farm annual expenditure of sample farmers is depicted in Table.5.14

The total expenditure of sample farms were Rs.163811, Rs.173908, Rs. 117020 and Rs. 288280 in FS-I, FS-II, FS-III and FS-IV respectively. It was observed that out of total expenditure in FS-I, FS-II, FS-III and FS-IV, more than 50 per cent was the farm expenditure. The expenditure on crop production was major expenditure in FS-IV, while expenditure on horticulture crop was major expenditure in FS-I. The total expenditure was found to be Rs. 28648, Rs.44880, Rs. 48058 and Rs.67910 in FS-I, FS-II, FS-III and FS-IV respectively. In FS-IV, the expenditure on crop production was major and it alone accounted for 47.10 per cent of the total expenditure. In case of FS-I, horticulture production alone shared 59.69 per cent of the total expenditure. It was observed that, in FS-II, the expenditure on livestock activity was found to be Rs.50689 which contributes 29.15 per cent to the total expenditure.

The family expenditure was more in FS-III which contributes 41.07 per cent of the total expenditure. In FS-III, only crop activities were taken, so that, the crop expenditure accounts 58.93 per cent of the total expenditure.

5.5.4.1.2 Sustainable income

Economics sustainability depends on profitable enterprise, family saving and the family debit. Therefore, the sustainable farm income means the annual expenditure of the farm family and remains surplus to the farm family for saving or

Table 5.13: Income pattern of farm families under different farming systems. **(Rs/farm)**

Sr.No	Particulars	Cluster-I				Cluster-II			
		FS-I	**FS-II**	**FS-III**	**FS-IV**	**FS-I**	**FS-II**	**FS-III**	**FS-IV**
1	Crop production	34750 (12.04)	31240 (14.22)	78090 (62.42)	252580 (51.66)	33150 (9.86)	197056 (48.88)	51545 (21.12)	67739 (53.99)
2	Horticulture production	195470 (67.77)	83980 (38.23)	-	165920 (33.94)	236276 (70.27)	139340 (34.56)	89870 (36.83)	-
3	Dairy	-	60405 (27.50)	-	-	-	-	48870 (20.03)	-
	Farm Business Income (A)	230220 (79.82)	175625 (79.95)	78090 (62.42)	415500 (86.60)	269426 (80.13)	336396 (83.440	190115 (77.90)	67739 (53.99)
4	Other Sources								
	a) wages	26607 (9.22)	15746 (7.17)	12372 (9.89)	46389 (9.49)	31511 (9.37)	40444 (10.03)	15330 (6.28)	16183 (12.89)
	b) Business/service	31586 (10.95)	28315 (12.880	34640 (27.69)	23986 (4.91)	35281 (10.49)	26334 (6.53)	38569 (15.80)	41530 (33.10)
	Income from Other Sources (B)	58193 (20.18)	44061 (20.05)	47012 (37.58)	70375 (14.40)	66792 (19.87)	66778 (16.560	53926 (22.10)	57713 (46.00)
6	**Total Income (A+B)**	288413 (100)	219686 (100)	125102 (100)	485875 (100)	336218 (100)	403174 (100)	244041 (100)	125452 (1000

(Figures in parentheses indicates percentage to the total)

Table 5.14: Expenditure pattern of sample farmers under different farming systems (Rs/farm)

Sr.No	Particulars	Cluster-I				Cluster-II			
		FS-I	**FS-II**	**FS-III**	**FS-IV**	**FS-I**	**FS-II**	**FS-III**	**FS-IV**
1	Crop production	37378 (22.82)	32424 (18.64)	68962 (58.93)	135772 (47.10)	36578 (18.79)	127820 (50.69)	32911 (17.70)	73589 (67.27)
2	Horticulture production	97784 (59.69)	45914 (26.40)	-	84597 (29.34)	123375 (63.39)	74145 (29.40)	49209 (26.47)	-
3	Dairy	-	50689 (29.15)	-	-	-	-	44329 (23.85)	-
	Farm expenditure (A)	135163 (82.51)	129028 (14.19)	68962 (58.93)	220369 (76.440	159953 (82.18)	201965 (80.08)	126449 (68.020	73589 (67.27)
4	Other Sources								
	a) Food	8472 (5.17)	13634 (7.84)	11560 (9.88)	14576 (5.60)	12335 (6.34)	16537 (6.58)	19931 (10.72)	14593 (13.34)
	b) Others	20176 (12.32)	31246 (17.97)	36498 (31.19)	53334 (18.50)	22349 (11.48)	33693 (13.36)	39511 (21.25)	21212 (19.39)
5	**Family expenditure (B)**	28648 (17.49)	44880 (25.81)	48058 (41.07)	67910 (23.56)	34676 (17.82)	50230 (19.92)	59442 (31.98)	35805 (32.73)
6	**Total expenditure (Farm + family) (A+B)**	163811 (100)	173908 (100)	117020 (100)	288280 (100)	194629 (100)	252195 (1000	185891 (100)	109394 (100)

(Figures in parentheses indicates percentage to the total)

Table 5.15: Sustainable income of sample farmers under different farming systems. (Rs/farm)

Sr.No	Particulars	Cluster-I				Cluster-II			
		FS-I	FS-II	FS-III	FS-IV	FS-I	FS-II	FS-III	FS-IV
1	Total farm business income	230220	175625	78090	415500	269426	336396	190115	68098
2	Total expenditure (Farm + Family)	163811	173908	117020	288280	194629	252195	185891	109394
3	Sustainable farm income from farm business	66409	1717	-38930	127220	74797	84201	4224	-41296
	a) Sustainable income ranks	II	III	IV	I	II	I	III	IV
4	Income from other sources	58193	44061	47012	70375	66792	66778	53926	57713
5	Sustainable income from total income	124602	45778	8082	197595	141589	150979	58150	16417

repayment of debt. Therefore, for sustainable farm income, the farm expenditure and family expenditure were deducted from the total farm business income. The sustainable income of different farming systems were worked out and presented in table 5.15. Farming systems were ranked on the basis of sustainable farm income. In case of cluster-I, FS-IV was ranked I (First) in producing sustainable farm income

It was observed that, the sustainable farm income of farming systems I, II, III, IV were Rs.66409, Rs.1717, Rs. -38930 and Rs. 127220 respectively. But farming system III could not meet their requirements on the basis of their farm business income i.e income from crop production activity alone. They experienced the deficit of Rs.38930. The farming system I, II and IV have an economic surplus. It means farming system I, II and IV were having sustainable farm income, whereas in Farming system IV sustainable farm income was observed to be higher as compared to the other farming systems. After adding the income from other sources, the non-sustainable farm income of farming system III become sustainable and came to Rs. 8082 and it removed the economic deficit. The income from other sources (wages, services and business etc.) was the only factor which helped them to sustain. In FS-I, II and IV, the sustainable income came to Rs. 124602, Rs. 45778 and RS. 197595 respectively. These farming systems seemed to be have more of an economic surplus. Similar results were found in Dorge (2015)

5.5.4.2 Cluster-II

5.5.4.2.1 Income pattern

The source wise income of farm families in different farming systems is presented in Table 5.13

It was observed from Table 5.13 that, the total income was found to be more in farming system III, which was found to be Rs. 403174. The total income of farm families were, Rs. 336218, Rs. 403174, Rs. 244041 and Rs. 125811 in farming system I, II, III and IV respectively. In farming system IV, the total income form crop activity was Rs. 68098 which contributes 54.13 per cent to the total income. The horticultural production alone contributes 70.27 per cent income in FS-I.

In FS-III, out of total income, 36.83 per cent income was from horticultural production, 21.12 per cent was from crop production and 20.03 per cent from dairy activity i.e, 77.90 per cent income was came from farm business and in case of other

than farm business income, 15.80 per cent from business/ services and 6.28 per cnet from wage earning. It was observed that, in farming system I, out of total income, 70.27 per cent income came from horticultural production and 9.86 per cent from crop production. The 80.13 per cent was from farm business and other than farm business was 19.87 per cent. Higher income was from farm business activity, represents to the effect of crop production activity, horticulture production activity and dairy enterprise. Out of total income in farming system-II, farm business income contributes 83.44 per cent income. The income derived from dairy activity was equivalent to the crop production income in farming system III. Farmers have best alternative to go for livestock activity which also gives better profit.

It is indicated that, the total income from farming system IV was very less as compared to other farming systems. The source wise income indicated that, more than 50 per cent income was derived from crop production in case of farming system IV. While, in farming system I, more than 50 per cent income was derived from horticultural production. It was also observed that, 45 per cent income was derived from other than farm business activity in farming system IV. This is indicated that, farming system IV depends more on other than farm business activity as compared to other farming systems.

5.5.4.2.2 Expenditure pattern

The expenditure pattern of all the farming systems is indicated in Table 5.14.

The total expenditure in farming system II was Rs.252195 which was more as compared to the other farming systems. Out of that, more than 70 per cent was the farm expenditure in farming system II. The expenditure on farm business activity was major contributors in acse of all the farming systems. The family expenditure of sample farms were Rs. 34676, Rs.50230, Rs.59442 and Rs. 35805 in farming system I, II, III and IV respectively. In farming system IV, the expenditure on crop production was major and it alone contributes 67.27 per cent out of total expenditure. In farming system II, also crop production activity shared 50.69 per cent. The expenditure on livestock activity in farming system III was found to be 23.85 per cent.

5.5.4.2.3 Sustainable Income

It is revealed from Table 5.15 that, sustainable farm income of farming system I, II and III were, Rs. 74797, Rs.84201 and Rs. 4224. It was observed that, in case of

farming system IV, they could not meet their requirements on the basis of their farm business income i.e income from crop production activity alone. They had deficit of Rs. 41296. The farmers in farming system I, II and III have an economic surplus. It means farming system I, II and III were having sustainable farm income, whereas more sustainable farm income was observed in farming system IV. After adding income from other sources, the non-sustainable farm income of farming system IV became sustainable and came to Rs. 16417 and it removed the deficit. The income from other sources (wages, business/ services) was the only factor which helped them to sustain. The sustainable farm income of farming system I and II wrwe Rs. 74797 and Rs. 84201 respectively. These farming systems seemed to have more economic surplus. Similar results were found in Dorge (2012). Farming systems were ranked on the basis of sustainable farm income. In case of cluster-II, FS-II was ranked I (First) which gives highest sustainable farm income as compared to other farming systems.

The sustainable income in farming system I, II, III and IV were, 141589, Rs. 150979. Rs. 58150 and Rs. 16474 respectively. It was observed that, farming system II have more sustainable income as compared to the other farming systems.

5.6 Resource Use Efficiency in Major Farming Systems

Resource use efficiency of various crop as well as other (non-crop farm enterprises) was studied in different farming systems in both the clusters.

A Cobb-Douglas type production function was fitted to data to study the resource productivity and allocative efficiency in farming systems, by comparing marginal value product (MVP) and marginal factor cost (MFC) or opportunity cost of respective resources. The production functions were estimated by using log linear model for enterprises in major farming systems. The functions were estimated only for those crops which have got the sufficient samples. The results are presented from Table 5.16 to Table 5.19.

5.6.1 Resource Use Efficiency in Cluster-I

5.6.1.1 Crop Production

The efficiency in the use and allocation of resources for crop enterprises are presented separately for different farming systems in Table 5.16

It could be observed from Table 5.16 that, the Cobb-Douglas production function used to study the resource use efficiency was found to be good fit to the data.

The independent variables considered were F.Y.M. (q), seed (kg.), nitrogen (kg), phosphorus (kg), potash (kg), plant protection chemicals (kg), male labour (days), female labour and bullock labour (days).

The production function estimates are presented in Table 5.16. It was observed from table that, the coefficient of multiple determination (R^2) in case of paddy was ranging from 0.85 in FS-III to 0.97 in FS-I, indicating 85 to 97 per cent of variation in dependent variables was explained by independent variables included in the function. The R^2 value in mango (FS-I), mango (FS-IV), Cashewnut (FS-I), Cashewnut (FS-IV) were 0.96, 0.94, 0.62 and 0.93 respectively. It was revealed that the independent variables have explained the variation in production from 62 per cent to 96 per cent across rainfed plantation in the region. Similar observation were also recorded by Nikam (2006) and Pawar (2006)

In case of paddy in FS-I it was observed that, seed, nitrogen, and phosphorus were found to be positively influencing inputs on paddy production. The regression coefficients of these inputs were 0.11, 0.17 and 0.82, respectively. The seed was significant at 5 per cent while nitrogen and phosphorus were significant at 1 per cent level. The influence of other variables were not significant. MVP to MFC ratio in case of seed, nitrogen and phosphorus were higher than unity. Sum of output elasticities was 1.04 indicating constant returns to scale.

In respect of paddy in FS-II, it was observed that the seed (0.16), F.Y.M. (0.15) and nitrogen (0.65) were influencing production of paddy. Seed was the most contributing factor in paddy production and F.Y.M were positive and significant at 5 per cent level. The returns to scale was increasing as indicated by the sum of output elasticities (1.58). The MVP to MFC ratio in F.Y.M, seed and nitrogen were higher than unity (3.03, 1.43 and 4.30, respectively).

In case of mango crop (FS-I), the nitrogen, potash and plant protection chemicals were contributing positively and significantly to production. While in FS-IV, the F.Y.M, male and female labour chemicals were contributing positively and significantly to production. The regression coefficients of these resources in FS-I and FS-IV were 0.61, 0.15, 0.01 and 0.24, 0.39, 0.22, respectively. In FS-I, the nitrogen and plant protection chemicals were significant at 1 per cent level and potash at 5 per cent level. In case of FS-IV, the F.Y.M, male and female labour chemicals were

Table 5.16: Production Function Estimates for Crops Grown Under Major Farming Systems in Cluster -I.

Sr. No.	Particulars	Parameters	FS – I					
			Paddy		Mango		Cashewnut	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	-0.40	--	-1.08	--	-0.79	
2.	Seed (Kg./ha.)	b_1	0.11** (0.053)	2.02	--		--	--
3.	F.Y.M. (q./ha)	b_2	-0.08 (0.074)	-0.24	0.04 (0.08)	1.95	0.09 (0.22)	3.41
4.	N (Kg./ha)	b_3	0.17* (0.063)	3.03	0.61* (0.44)	2.84	0.50** (0.32)	0.59
5.	P (Kg./ha)	b_4	0.82* (0.12)	9.41	0.17 (0.43)	0.84	0.18** (0.42)	2.85
6.	K (Kg./ha)	b_5	0.02 (0.036)	0.91	0.15** (0.36)	6.74	0.25** (0.31)	1.04
7.	PPC (Kg./ha)	b_6	--	--	0.01* (0.26)	0.19	-0.35 (0.37)	-7.51
8.	Male labour (days/ha)	b_7	0.03 (0.024)	0.05	0.18 (0.24)	0.89	0.16 (0.35)	3.75
9.	Female Labour (days/ha)	b_8	0.01 (0.017)	-0.18	0.25 (0.10)	3.33	0.20 (0.31)	0.72
10.	Bullock labour (days/ha)	b_9	-0.04 (0.061)	2.02	--	--	--	--
11.	Returns to scale	$\sum bi$	1.04		1.42		1.50	
12.	No. of observations	No.	28		28		28	
13.	R square	R^2	0.97		0.96		0.62	

(Figures in the parentheses indicate standard errors of respective variable)

*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.16: Continued……

Sr. No.	Particulars	Parameters	FS - II					
			Paddy		Arecanut		Coconut	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	-0.46	--	0.82	--	2.17	
2.	Seed (Kg./ha.)	b_1	0.16** (0.076)	3.03	--	--	--	--
3.	F.Y.M. (q./ha)	b_2	0.15** (0.060)	1.43	0.01 (0.066)	0.18	0.06 (0.07)	1.05
4.	N (Kg./ha)	b_3	0.65* (0.083)	4.30	0.16* (0.10)	0.98	0.20* (0.10)	3.95
5.	P (Kg./ha)	b_4	0.05 (0.082)	1.28	0.26 (0.16)	3.41	0.02 (0.05)	1.89
6.	K (Kg./ha)	b_5	0.01 (0.025)	0.42	0.07 (0.06)	3.12	0.44* (0.15)	2.28
7.	PPC (Kg./ha)	b_6	--	--	0.20 (0.27)	1.50	--	--
8.	Male labour (days/ha)	b_7	0.31 (0.041)	0.73	0.25* (0.07)	1.25	0.21 (0.14)	1.96
9.	Female Labour (days/ha)	b_8	0.17 (0.030)	0.88	0.15** (0.23)	2.30	0.19* (0.07)	2.93
10.	Bullock labour (days/ha)	b_9	0.08 (0.017)	0.62	--	--	--	--
11.	Returns to scale	$\sum bi$	1.58		1.39		1.09	
12.	No. of observations	No.	21		21		21	
13.	R square	R^2	0.91		0.78		0.78	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.16: Continued……

Sr. No.	Particulars	Parameters	FS - III					
			Paddy		Nagali		Cowpea	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	1.73	--	1.00	--	-2.87	
2.	Seed (Kg./ha.)	b_1	-0.82 (0.50)	-24.76	0.62** (0.55)	2.65	0.18 (0.36)	1.98
3.	F.Y.M. (q./ha)	b_2	0.01 (0..36)	0.19	-0.01 (0.13)	-0.02	0.49** (0.52)	0.17
4.	N (Kg./ha)	b_3	0.37** (0.31)	4.11	0.02 (0.56)	1.11	-0.79 (0.83)	-1.43
5.	P (Kg./ha)	b_4	0.07 (1.41)	1.29	0.02 (0.41)	0.94	0.31* (0.93)	0.61
6.	K (Kg./ha)	b_5	0.43* (0.48)	1.43	--	--	--	--
7.	PPC (Kg./ha)	b_6	--	--	--	--	--	--
8.	Male labour (days/ha)	b_7	0.02 (1.00)	0.13	0.06 (0.401)	0.34	0.09 (0.59)	0.07
9.	Female Labour (days/ha)	b_8	1.03** (0.52)	1.17	0.26* (0.45)	1.74	0.74 (0.54)	0.65
10.	Bullock labour (days/ha)	b_9	0.03 (0.65)	0.25	0.04 (0.08)	0.26	0.16** (0.18)	0.47
11.	Returns to scale	$\sum bi$	1.13		1.01		1.17	
12.	No. of observations	No.	15		15		21	
13.	R square	R^2	0.85		0.95		0.88	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.16: Continued……

Sr. No.	Particulars	Parameters	FS – III		FS - IV			
			Pawata		Mango		Cashewnut	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	0.40	--	0.60	--	5.51	
2.	Seed (Kg./ha.)	b_1	0.17 (0.67)	1.48	--	--	--	--
3.	F.Y.M. (q./ha)	b_2	0.02* (0.40)	0.15	0.24** (0.26)	4.46	0.36* (0.15)	0.49
4.	N (Kg./ha)	b_3	0.40 (0.44)	1.15	-0.07 (0.64)	-3.85	0.44** (2.46)	1.59
5.	P (Kg./ha)	b_4	0.17* (0.43)	0.91	0.23 (0.42)	4.13	0.08 (0.97)	1.08
6.	K (Kg./ha)	b_5			0.039 (0.77)	1.30	0.33* (2.68)	4.43
7.	PPC (Kg./ha)	b_6			0.04 (0.47)	0.32	-0.26 (0.48)	-2.44
8.	Male labour (days/ha)	b_7	-0.01 (0.470	-0.04	0.39** (0.31)	3.55	0.29** (0.69)	0.96
9.	Female Labour (days/ha)	b_8	0.09 (0.32)	0.33	0.22** (0.10)	4.41	0.31 (0.40)	2.54
10.	Bullock labour (days/ha)	b_9	0.31** (0.64)	0.93	--	--	--	--
11.	Returns to scale	$\sum bi$	1.15		1.08		1.54	
12.	No. of observations	No.	15		11		11	
13.	R square	R^2	0.94		0.94		0.93	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.16: Continued……

Sr. No.	Particulars	Parameters	FS - IV			
			Lady's figure		Watermelon	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	-3..47	--	1.40	--
2.	Seed (Kg./ha.)	b_1	-0.22 (0.58)	-8.40	0.37* (0.22)	0.70
3.	F.Y.M. (q./ha)	b_2	0.16* (0.63)	2.16	0.01 (0.04)	0.46
4.	N (Kg./ha)	b_3	0.03 (0.51)	0.12	0.31** (0.37)	2.81
5.	P (Kg./ha)	b_4	0.15 (0.69)	1.24	0.01 (0.05)	0.31
6.	K (Kg./ha)	b_5	0.18** (0.34)	3.81	0.43** (0.15)	1.39
7.	PPC (Kg./ha)	b_6	0.21 (1.60)	0.003	0.08 (0.42)	2.32
8.	Male labour (days/ha)	b_7	0.58** (1.34)	1.14	0.02 (0.18)	0.18
9.	Female Labour (days/ha)	b_8	0.14 (0.74)	0.28	0.35** (0.13)	6.61
10.	Bullock labour (days/ha)	b_9	--	--	--	--
11.	Returns to scale	$\sum bi$	1.23		1.57	
12.	No. of observations	No.	11		11	
13.	R square	R^2	0.91		0.77	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

positively significant at 5 per level. The ratio of MVP to MFC was higher than unity in nitrogen and potash (2.84 and 6.74 respectively), while it was less than unity in plant protection chemicals (0.19) in FS-I. While in case of FS-IV, the ratio of MVP to MFC was greater than unity in all the three significant variables. The sum of output elasticities of mango (FS-I) was 1.42 indicating increasing returns to scale. Where, 1.08 in FS-IV indicating constant returns to scale. It was observed from table that, the coefficient of multiple determination (R^2) in case of mango was ranging from 0.94 in FS-IV to 0.96 in FS-I, indicating 94 to 96 per cent of variation in dependent variables was explained by independent variables included in the function. Similar results were found in Wagale *et al* (2007)

It was observed from Table 5.16 that, in cashewnut production (FS-I), the nitrogen, phosphorous and potash were significantly contributing to yield.. The regression coefficient of nitrogen (0.50), phosphorous (0.18) and potash (0.25) were significant at 5 per cent levels. The sum of elasticities of output (1.50) indicated increasing returns to scale. In respect of cashewnut in FS-IV, it was observed that the F.Y.M (0.44), nitrogen (0.44), potash (0.33) and male labour (0.29) positive and significant at 1 per cent, at 5 per cent, at 1 per cent and at 5 per cent respectively. The coefficient of multiple determination (R^2) in case of cashewnut was ranging from 0.78 in FS-I to 0.93 in FS-IV, indicating 78 to 93 per cent of variation in dependent variables was explained by independent variables included in the function.

Regarding resource use efficiency in coconut crop grown under (FS-II), it was observed from Table 5.16 that, the R^2 value was 0.78 indicating 78 per cent variation in dependent variable was explained by independent variables in the function. The variables such as nitrogen, potash and female labour were (0.20, 0.44, and 0.19, respectively) positively and significantly influencing on the production. Among the inputs, potash had high elasticity coefficient, (0.44) implying one per cent increase in nitrogen applied will result in to 0.44 per cent increase in output. The MVP to MFC ratio was found to be higher than unity in case of nitrogen (3.95), potash (2.28) and female labour (2.93) was less than unity. The sum of elasticity was (1.09), which indicated constant returns to scale.

In case of FS-II, the resource use efficiency of arecanut production was positively and significantly influenced by nitrogen, male labour and female labour. The male labour was the most important contributing variable with regression

coefficient of 0.25, and it was significant at 1 per cent. Nitrogen (0.16) and female labour (0.15) were also positive and significant at 1 per cent and at 5 per cent level, respectively. The coefficient of multiple determination was 0.78 indicating 78 per cent of variation in dependent variable is explained by independent variables included in the function. The MVP to MFC ratios were higher than unity for male labour (1.25) and female labour (2.30). The increasing returns to scale was observed as it was revealed from sum of elasticities (1.39) which was higher than one.

In case of ladys fingure crop grown under FS-IV, the R^2 was 0.91 indicating 91 per cent of variation in dependent variable is explained by independent variables included in the function. Among the various variables in the function F.Y.M., potash and male labour have positive and significant influence on ladys fingure production. It was observed from table that, in case of inputs such as F.Y.M. (0.16), potash (0.18), male labour (0.58), the MVP to MFC ratio was greater than one which revealed that these inputs were less used than desired level. The sum of output elasticities was higher than one (1.23) which indicated increasing returns to scale. Similar observation were also recorded by Nikam *et al* (2006) and Pawar *et al* (2006)

The coefficient of multiple determination was 0.77 for watermelon in FS-IV which indicated that 77 per cent of variation in watermelon production was explained by independent variables included in function. Seed, nitrogen, potash and female labour had contributed positively and significantly on watermelon production. The regression coefficients of these inputs were 0.37, 0.31, 0.43 and 0.35 respectively. It was observed that, the seed was more used than the desired level as revealed from MVP to MFC ratio which was less than unity. It was observed from table, that MVP to MFC ratio for nitrogen (2.81), potash (1.39) and female labour (6.61) was more than one which indicated the lesser use of this input than the optimum level. The returns to scale were found to be increasing as it was revealed from sum of regression coefficients which was more than one (1.57).

It was observed from Table 5.16 that, in cowpea production, the F.Y.M., potash and bullock labour were significantly contributing to yield. The regression coefficient of F.Y.M. (0.49), potash (0.31) and bullock labour (0.16) were significant at 5 per cent, 1 per cent and 5 per cent levels, respectively. The sum of elasticities of output (1.17) indicated increasing returns to scale.

In case of *pawata* crop (FS-III), the F.Y.M., potash and bullock labour were contributing positively and significantly to production. The regression coefficients of these resources were 0.02, 0.17 and 0.31, respectively and they were significant at 1 per cent, 1 per cent and 5 per cent level. The ratio of MVP to MFC was less than unity

Table 5.17 Production Function Estimates for dairy Enterprises Followed under Major Farming Systems in Cluster-I

Sr. No.	Particulars	Parameters	FS –II	
			Coefficient	MVP/ MFC
I	Dairy			
1.	Intercept	A	1.34	--
2.	Dry fodder (Rs./Unit)	b_1	0.05 (0.70)	0.131
3.	Green fodder (Rs./Unit)	b_2	0.62* (0.43)	0.372
4.	Concentrates (Rs./Unit)	b_3	0.17* (0.74)	0.004
5.	Male labour (Rs./Unit)	b_4	0.44* (0.24)	0.713
6.	Female labour (Rs./Unit)	b_5	0.29* (0.18)	0.512
7	Veterinary Exp. (Rs./Unit)	b_6	0.02 (0.25)	0.021
8	R square	R^2	0.87	
7.	No. of observations	No.	22	
8.	Returns to scale	∑bi	1.58	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1% and 5% levels, respectively.

in F.Y.M., potash and bullock labour (0.15, 0.91 and 0.93 respectively).The sum of output elasticities was 1.15 indicating increasing returns to scale. Similar results were found in Torane (2009).

In case of *nagli* in FS-III, calculated R^2 was 0.95. The seed and female labour (with regression efficient of (0.62 and 0.26, respectively) were the important variables influencing positively on *nagli* production and they were statistically significant. The ratio of MVP to MFC was higher than unity in both (seed and female labour) the variables (2.65 and 1.74) indicating less use of these inputs than the desired level.

5.6.1.2 Other Enterprises

a) Dairy: To study the resource use efficiency in dairy enterprise the values of independent variables such as dry fodder (Rs.), green fodder (Rs.) concentrates (Rs.), veterinary expenses (Rs.), male labour (Rs.) and female labour (Rs.) were included in the function. The results (Table 5.17) of the regression analysis revealed that the Cobb-douglas production function was found to be good fit to the data. Similar observations were found in Borude (2002)

The R^2 values in FS-II was 0.87 indicating 87 per cent variation in gross returns was explained by independent variables included in the function. In this farming system, green fodder, concentrates, male labour and female labour had positive significant influence on the gross returns. In case of FS-I regression coefficient green fodder, concentrates, male labour and female labour were 0.62, 0.17, 0.44 and 0.29 and they were significant at 1 per cent. The ratio of value of marginal product to marginal factor cost was less than unity in all (reen fodder, concentrates, male labour and female labour) the variables. The sum of elasticities was 1.58 increasing returns to scale.

5.6.2 Resource Use Efficiency in Cluster-II

5.6.2.1 Crop Production

The efficiency in the use and allocation of resources for crop enterprises are presented separately for different farming systems in Table 5.18

To Study the resource use efficiency in Southern central plains and hills region, Cobb-Douglas type production function was found to be good fit to the data. In order to analyse the allocative efficiency of crop enterprises under various farming systems the ratio of marginal value product (MVP) and marginal factor cost (MFC) were worked out and are presented in Table 5.16.

It was observed from Table 5.18 that, the coefficient of multiple determination was 0.58 which indicated that 58 per cent of variation in *kharif* paddy production in FS-I was explained by independent variable included in the function.

F.Y.M, nitrogen, potash and bullock labour were influencing positively and significantly on paddy production. The regression coefficients of F.Y.M, nitrogen, potash and bullock labour were 0.41, 0.14, 0.28 and 0.44, respectively and these inputs were significant at 5 per cent, 5 per cent, 1 per cent and 5 per cent, respectively.

The MVP to MFC ratios in case of F.Y.M (1.42), potash (2.21) and bullock labour (5.11) were higher than unity indicated its use was less than the desired level. The MVP to MFC ratio in case of potash (0.66) was less than unity, indicating more use of this resource. The sum of output elasticities was higher than one (1.44) indicated increasing returns to scale. Similar observations were found in Borude (2002)

The coefficient of multiple determination was 0.94 for *kharif* paddy in FS-II which indicated that 94 per cent of variation in paddy production was explained by independent variables included in function. Seed, F.Y.M, and bullock labour had contributed positively and significantly on paddy production. The regression coefficients of these inputs were 0.39, 0.29 and 0.33 respectively. It was observed from table, that MVP to MFC ratio for Seed (5.14), F.Y.M (1.35) and bullock labour (4.93) was more than one which indicated the lesser use of these inputs than the optimum level. The returns to scale were found to be decreasing as it was revealed from sum of regression coefficients which was less than one (0.94).

In case of *rabi* paddy grown under FS-II, it was observed from the table that, the coefficient of multiple determination (R^2) was 0.82 indicating 82 per cent, variation in dependent variable was explained by independent variables included in the function. The regression coefficient for input such as F.Y.M., and potash were, 0.51 and 0.79, respectively. These inputs have positive influence on paddy production and they were statistically significant at 1 per cent level. The allocative efficiency was observed by MVP to MFC ratio and it was observed from table that, values of MVP to MFC ratio for F.Y.M., and potash were 4.98 and 4.55, respectively. The returns to scale were found to be decreasing as it was revealed from sum of regression coefficients which was less than one (0.90). Similar observations were recorded by Swami (2004)

It was observed from Table 5.18 that, in case of mango (FS-I), the coefficient of multiple determination was 0.87 indicating the about 87 per cent variation in the dependent variable was explained by the independent variables included in the function. It was found that F.Y.M., phosphorus, potash and male labour were contributing positively and significantly to the mango production. The regression coefficients of these variables were 0.11, 0.22, 0.28 and 0.13, respectively and they were significant at 5 per cent, 1 per cent, 5 per cent and 5 per cent levels. The MVP to MFC ratio for F.Y.M. and phosphorus were 0.75 and 0.66 which were found to be

Table 5.18: Production Function Estimates for Crops Grown Under Major Farming Systems in Cluster -II.

Sr. No.	Particulars	Parameters	FS - I					
			Paddy		Mango		Cashewnut	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	1.00	--	-1.71	--	-1.88	--
2.	Seed (Kg./ha.)	b_1	0.10 (0.48)	2.05	--	--	--	--
3.	F.Y.M. (q./ha)	b_2	0.41** (0.62)	1.42	0.11** (0.09)	0.75	-0.03 (0.14)	-1.11
4.	N (Kg./ha)	b_3	0.14** (0.63)	0.66	0.18 (0.61)	0.29	0.50* (0.12)	4.62
5.	P (Kg./ha)	b_4	-0.04 (0.16)	-1.49	0.22* (0.57)	0.66	0.15 (0.14)	1.29
6.	K (Kg./ha)	b_5	0.28* (0.62)	2.21	0.28** (0.34)	1.30	-0.11 (0.21)	-27.09
7.	PPC (Kg./ha)	b_6	--	--	-0.03 (0.26)	-0.63	0.38* (0.27)	0.63
8.	Male labour (days/ha)	b_7	0.12 (1.10)	0.53	0.13** (0.22)	1.43	0.64* (0.20)	2.27
9.	Female Labour (days/ha)	b_8	0.01 (1.07)	0.09	0.29 (0.09)	5.76	-0.05 (0.11)	-3.38
10.	Bullock labour (days/ha)		0.44** (0.56)	5.11	--	--	--	--
11.	Returns to scale	$\sum bi$	1.44		1.17		1.48	
12.	No. of observations	No.	24		24		24	
13.	R square	R^2	0.58		0.87		0.91	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.18: Continued…….

Sr. No.	Particulars	Parameters	FS - I				FS - II	
			Arecanut		Coconut		Paddy	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	-1.03	--	2.02	--	-0.99	--
2.	Seed (Kg./ha.)	b_1	--	2.05	--	--	0.39* (0.67)	5.14
3.	F.Y.M. (q./ha)	b_2	-0.01 (0.03)	-0.19	0.39 (0.13)	6.48	0.29** (0.42)	1.35
4.	N (Kg./ha)	b_3	0.09 (0.39)	0.60	-0.09 (0.08)	-2.01	0.17 (0.53)	1.44
5.	P (Kg./ha)	b_4	0.35* (0.24)	2.57	0.37 (0.15)	5.56	0.07 (2.16)	1.14
6.	K (Kg./ha)	b_5	-0.37 (0.22)	-9.07	0.23 (0.14)	4.93	0.07 (0.80)	3.08
7.	PPC (Kg./ha)	b_6	0.50* (0.36)	0.76	--	--	--	--
8.	Male labour (days/ha)	b_7	0.30 (0.15)	1.94	0.16 (0.12)	0.63	0.05 (0.64)	0.23
9.	Female Labour (days/ha)	b_8	0.35** (0.18)	3.92	0.03 (0.32)	0.18	-0.42 (0.27)	-4.67
10.	Bullock labour (days/ha)		--	--	--	--	0.33**	4.93
11.	Returns to scale	$\sum bi$	1.20		1.17		0.94	
12.	No. of observations	No.	24		24		20	
13.	R square	R^2	0.79		0.89		0.70	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.18: Continued…….

Sr. No.	Particulars	Parameters	FS - II					
			Mango		Cashewnut		Lady's fingure	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	-0.90	--	-3.09	--	-0.92	--
2.	Seed (Kg. /ha.)	b_1	--	--	--	--	0.22* (0.18)	5.75
3.	F.Y.M. (q./ha)	b_2	0.16** (0.16)	1.53	0.18** (0.16)	4.61	0.07 (0.08)	0.87
4.	N (Kg./ha)	b_3	0.02 (0.95)	0.07	0.03 (0.19)	2.24	0.02 (0.31)	0.64
5.	P (Kg./ha)	b_4	0.60* (1.10)	5.72	0.45** (0.29)	0.67	0.42** (0.38)	2.12
6.	K (Kg./ha)	b_5	0.45** (0.63)	4.53	0.05 (0.26)	2.59	0.55** (0.23)	6.87
7.	PPC (Kg./ha)	b_6	-0.04 (0.47)	-0.59	0.18** (0.29)	4.12	0.13* (0.72)	2.76
8.	Male labour (days/ha)	b_7	0.003 (0.29)	0.05	0.51* (0.23)	4.70	0.006 (0.45)	-0.01
9.	Female Labour (days/ha)	b_8	0.22** (0.15)	3.72	0.03 (0.18)	0.92	-0.01 (0.11)	-0.014
10.	Bullock labour (days/ha)		--	--	--	--	--	4.93
11.	Returns to scale	$\sum bi$	1.39		1.43		1.43	
12.	No. of observations	No.	20		20		20	
13.	R square	R^2	0.91		0.93		0.73	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.18: Continued…….

Sr. No.	Particulars	Parameters	FS - II				FS- III	
			Brinjal		Green chilli		Arecanut	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	2.32	--	0.92	--	4.09	--
2.	Seed (Kg. /ha.)	b_1	0.89* (0.20)	1.33	0.34* (0.097)	0.28	--	--
3.	F.Y.M. (q./ha)	b_2	0.08 (0.10)	3.50	0.01 (0.05)	0.19	0.62** (0.25)	1.36
4.	N (Kg./ha)	b_3	0.40* (0.29)	2.66	0.37* (0.13)	2.45	0.17* (7.07)	6.32
5.	P (Kg./ha)	b_4	0.03 (0.36)	2.59	-0.17 (0.11)	-21.13	0.01 (8.26)	0.74
6.	K (Kg./ha)	b_5	-0.11 (0.19)	-64.58	0.28** (0.15)	5.89	0.08 (1.44)	0.71
7.	PPC (Kg./ha)	b_6	0.36* (0.20)	0.92	0.27** (0.12)	6.05	0.45 (2.39)	5.56
8.	Male labour (days/ha)	b_7	0.09 (0.37)	0.80	-0.02 (0.19)	-0.19	-1.00* (4.31)	-47.13
9.	Female Labour (days/ha)	b_8	-0.26 (0.16)	-4.82	-0.0016 (0.05)	-0.03	0.73* (4.48)	1.25
10.	Bullock labour (days/ha)		--	--	--	--	--	--
11.	Returns to scale	$\sum bi$	1.48		1.08		1.05	
12.	No. of observations	No.	20		20		17	
13.	R square	R^2	0.90		0.85		0.89	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.18: Continued…….

Sr. No.	Particulars	Parameters	FS - III			
			Cowpea		Wal	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	-0.49	--	-4.26	--
2.	Seed (Kg. /ha.)	b_1	0.35** (0.14)	4.10	0.39* (0.29)	3.91
3.	F.Y.M. (q./ha)	b_2	-0.001 (0.04)	0.00	0.13** (0.15)	2.06
4.	N (Kg./ha)	b_3	0.87* (0.23)	1.41	0.35** (0.33)	1.75
5.	P (Kg./ha)	b_4	-0.25 (0.19)	-0.60	0.18 (0.54)	0.22
6.	K (Kg./ha)	b_5	--	--	--	--
7.	PPC (Kg./ha)	b_6	--	--	--	--
8.	Male labour (days/ha)	b_7	0.11* (0.07)	0.52	0.27* (0.48)	2.31
9.	Female Labour (days/ha)	b_8	-0.17 (0.17)	-1.05	-0.19 (0.60)	-1.30
10.	Bullock labour (days/ha)		-0.02 (0.03)	-2.34	0.056 (0.13)	0.29
11.	Returns to scale	$\sum bi$	0.89		1.18	
12.	No. of observations	No.	17		17	
13.	R square	R^2	0.75		0.80	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

Table 5.18: Continued…….

Sr. No.	Particulars	Parameters	FS - IV			
			Summer Paddy		Groundnut	
			Coefficient	MVP/ MFC	Coefficient	MVP/ MFC
1.	Intercept	a	1.09	--	-0.54	--
2.	Seed (Kg. /ha.)	b_1	0.05 (0.25)	0.58	0.19** (0.23)	1.39
3.	F.Y.M. (q./ha)	b_2	0.51* (0.31)	4.98	0.39** (0.04)	3.91
4.	N (Kg./ha)	b_3	0.13 (0.90)	0.40	0.0039** (0.45)	0.72
5.	P (Kg./ha)	b_4	-0.13 (0.42)	-2.24	0.014 (0.13)	1.15
6.	K (Kg./ha)	b_5	0.79* (0.90)	4.55	--	--
7.	PPC (Kg./ha)	b_6	--	--	0.15 (0.15))	1.27
8.	Male labour (days/ha)	b_7	-0.39 (0.93)	-0.53	0.22 (0.47)	1.29
9.	Female Labour (days/ha)	b_8	-0.06 (0.87)	-0.22	0.0005 (0.05)	0.01
10.	Bullock labour (days/ha)		--	--	--	--
11.	Returns to scale	$\sum bi$	0.90		0.99	
12.	No. of observations	No.	14		14	
13.	R square	R^2	0.82		0.69	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1%, and 5% levels of probability, respectively

less than unity. While in case of potash (1.30) and male labour (1.43) found to be more than unity which indicated the lesser use of these inputs than the optimum level. The return to scale was found to be increasing as it was revealed from sum of output elasticities (1.17).

In case of mango grown under FS-III, it was observed that coefficient of multiple determination (R^2) was 0.91 indicating 91 per cent variation is explained by the independent variables included in the function. The variables such as F.Y.M. (0.16), phosphorous (0.60), potash (0.45) and female labour (0.22) were contributing to mango production positively and significantly. The MVP to MFC ratio was higher than unity for F.Y.M., phosphorous, potash and female labour the ratios were (1.53, 5.72, 4.53, and 3.72, respectively) indicated the lesser use of these inputs than the optimum level. Similar results were recorded by Kalara, B. S. *et al.* (2007),

It could be observed from Table 5.18 that, in case of Cashewnut (FS I) the R^2 value was 0.91 indicating 91 per cent variation in Cashewnut production was explained by the independent variables. The regression coefficient of nitrogen, plant protection chemicals and male labour were 0.50, 0.38 and 0.64, respectively. These resources were positive and significant at and 1 per cent, while other variables were not significant. The ratios of marginal value product to marginal factor cost were more than one for the resources like nitrogen and male labour (4.62 and 0.27,) which showed that these resources had been used at less than desired level. The sum of output elasticities was higher than one (1.48) indicating increasing returns to scale.

In case of cashewnut in FS-II, calculated R^2 was 0.93 indicating 93 per cent variation in Cashewnut production was explained by the independent variables. The F.Y.M., potash, plant protection chemicals and male labour (with regression efficient of (0.18, 0.45, 0.18 and 0.51, respectively) were the important variables influencing positively on cashewnut production and they were statistically significant. The ratio of MVP to MFC was higher than unity in F.Y.M (4.61), plant protection chemicals (4.12) and male labour (4.70) indicating less use while it was less than unity in potash (0.67) indicating the excessive use of these inputs than the desired level

Regarding resource use efficiency in coconut crop grown under (FS-I), it was observed from Table 5.17 that, the R^2 value was 0.89 indicating 89 per cent variation in dependent variable was explained by independent variables in the function. The

variables such as F.Y.M., phosphorus and potash were (0.39, 0.37, and 0.23, respectively) positively and significantly influencing on the production. Among the inputs, F.Y.M had high elasticity coefficient, (0.39) implying one per cent increase in F.Y.M applied will result in to 0.60 per cent increase in output. The MVP to MFC ratio was found to be higher than unity in case of F.Y.M. (6.48), phosphorus (5.56) and potash (4.93). The sum of elasticity was (1.17), which indicated increasing returns to scale.

Regarding arecanut (FS-I), it was observed from the Table 5.18 that coefficient of multiple determination (R^2) was 0.79, which indicated that the 79 per cent of variation in production were explained by the independent variables included in the function. The phosphorus (0.35), plant protection chemicals (0.50) and female labour (0.35) were positively and significantly influencing the arecanut production. The sum of output elasticities (1.20) was more than one which indicated increasing returns to scale. The MVP to MFC ratio was higher than one for phosphorus (2.57) and female labour (3.92). While in case of plant protection chemicals (0.77), it was less than unity. Similar results were recorded by Mudasir iqbal *et al.* (2010),

In case of FS-III, the resource use efficiency of arecanut production was positively and significantly influenced by F.Y.M., nitrogen, male labour and female labour. The female labour was the most important contributing variable with regression coefficient of 0.73, and it was significant at 1 per cent. F.Y.M (0.62), nitrogen (6.32) and male labour (-47.13) were also positive and significant at 5 per cent, 1 per cent and 1 per cent, respectively The coefficient of multiple determination was 0.89 indicating 89 per cent of variation in dependent variable is explained by independent variables included in the function. The MVP to MFC ratios were higher than unity for F.Y.M. (1.36), nitrogen (6.32) and female labour (1.25). The constant returns to scale was observed as it was revealed from sum of elasticities (1.05) which was higher than one.

In case of lady's fingure in FS-II, calculated R^2 was 0.73 indicating 73 per cent of variation in dependent variable is explained by independent variables included in the function. The seed, phosphorus, potash and plant protection chemicals (with regression efficient of (0.22, 0.42, 0.55 and 0.13, respectively) were the important variables influencing positively on ladys fingure production and they were statistically significant. The ratio of MVP to MFC was higher than unity in seed, phosphorus,

potash and plant protection chemicals (5.75, 2.12, 6.87 and 2.76 respectively) indicating the less use of these inputs than the desired level. The sum of output elasticities (1.43) was more than one which indicated increasing returns to scale.

In case of brinjal crop (FS-II), it was observed from table that, seed was most significantly contributing input to the production of brinjal. The output elasticity of seed was positive (0.89) and it was significant at 1 per cent. The nitrogen and plant protection chemicals were other two inputs which had positive regression coefficients (0.40 and 0.36, respectively) significant at 1 per cent.

The sum of output elasticities (1.48) was more than one indicating the increasing returns to scale. The MVP to MFC ratio were higher than unity in seed (1.33) and nitrogen (2.66). While it was less than unity in plant protection chemicals (0.92) indicating the excess use of input than the desired level.

The coefficient of multiple determination was 0.85 for green chilli in FS-II which indicated that 85 per cent of variation in green chilli production was explained by independent variables included in function. Seed, nitrogen, potash and plant protection had contributed positively and significantly on green chilli production. The regression coefficients of these inputs were 0.34, 0.37, 0.28 and 0.27 respectively. It was observed that, the seed was more used than the desired level as revealed from MVP to MFC ratio which was less than unity (0.28). It was observed from table, that MVP to MFC ratio for nitrogen (2.45), potash (5.89) and plant protection (6.05) was more than one which indicated the lesser use of this input than the optimum level. The returns to scale were found to be constant as it was revealed from sum of regression coefficients which was more than one (1.08). Similar observations were recorded by Torane (2009)

In case of cowpea crop (FS-III), the seed, nitrogen and male labour were contributing positively and significantly to production. The regression coefficients of these resources were 0.35, 0.87, and 0.11, respectively and they were significant at 5 per cent, 1 per cent and l per cent level. The ratio of MVP to MFC was higher than unity in seed and nitrogen (4.10 and 1.41 respectively), while it was less than unity in male labour (0.52). The sum of output elasticities was 0.89 indicating decreasing returns to scale.

It was observed from Table 5.18 that, in *wal* production, the seed, F.Y.M., nitrogen and male labour were significantly contributing to yield. The regression coefficient of seed (0.39), F.Y.M. (0.13), nitrogen (0.35) and male labour (0.27) were significant at 1 per cent, 5 per cent, 5 per cent levels and 1 per cent, respectively.

Table 5.19 Production Function Estimates for Other Enterprises Followed under Major Farming Systems in Cluster-II

Sr. No.	Particulars	Parameters	FS –III	
			Coefficient	MVP/ MFC
I	**Dairy**			
1.	Intercept	a	1.34	--
2.	Dry fodder (Rs./Unit)	b_1	-0.12 (0.55)	-0.29
3.	Green fodder (Rs./Unit)	b_2	0.01 (0.52)	0.03
4.	Concentrates (Rs./Unit)	b_3	0.33 (0.28)	0.08
5.	Male labour (Rs./Unit)	b_4	0.67* (0.19)	1.03
6.	Female labour (Rs./Unit)	b_5	0.34* (0.21)	0.54
7	Veterinary Exp. (Rs./Unit)	b_6	0.26** (0.39)	0.31
8	R square	R^2	0.96	
7.	No. of observations	No.	17	
8.	Returns to scale	∑bi	1.48	

(Figures in the parentheses indicate standard errors of respective variable)
*, **, significant at 1% and 5% levels, respectively.

The sum of elasticities of output (1.18) indicated increasing returns to scale. The coefficient of multiple determination was 0.80 for *wal* in FS-III which indicated that 80 per cent of variation in *wal* production was explained by independent variables included in function. Similar observations were recorded by Torane (2009)

With respect to groundnut grown under FS-IV, it was found that seed, F.Y.M. and nitrogen have positive influence on groundnut production. The regression coefficients of these inputs were 0.19, 0.39 and 0.0039 respectively and they were statistically significant at 5 per cent level. The MVP to MFC ratio in case of seed (1.39) and F.Y.M. (3.91) were more than one which indicated that the farmers following groundnut in FS-IV had used less quantity of these inputs. In case of nitrogen (0.72), it was observed that, this input was excessively used than required

quantity. The decreasing returns to scale was observed as the sum of output elasticities (0.99) was nearer to one.

5.6.2.2 Other Enterprises

a) Dairy: To study the resource use efficiency in dairy enterprise the values of independent variables such as dry fodder (Rs.), green fodder (Rs.) concentrates (Rs.), veterinary expenses (Rs.), male labour (Rs.) and female labour (Rs.) were included in the function. The results (Table 5.19) of the regression analysis revealed that the Cobb-Douglas production function was found to be good fit to the data.

The R^2 values in FS-III was 0.96 indicating 96 per cent variation in gross returns was explained by independent variables included in the function. In this farming system, male labour, female labour and veterinary expenses had positive significant influence on the gross returns. In case of FS-III regression coefficient for male labour, female labour and veterinary expenses were 0.67, 0.34 and 0.26 and they were significant at 1 per cent, 1 per cent and 5 per cent level. The ratio of value of marginal product to marginal factor cost was less than unity in (female labour and veterinary expenses) the variables. The sum of elasticities was 1.48 indicating increasing returns to scale.

The findings of the present study are in conformity with the findings of Kalara *et al.* (2007), Mudasir Iqbal *et.al* (2010), Makadia, *et.al* (2014)

The results of the present investigation lead to accept the hypothesis that, in existing farming systems various resource allocation and resource levels are not properly organized.

5.7 Optimum Plans for Major Farming Systems

In order to study the optimum plans for different farming systems followed by the farmers in the study area two types of models were developed such as a) existing crop alternatives with existing cultivation practices and the available resources b) optimum plans at recommended technologies levels. The optimum plans for each regions were simulated through linear programming technique and the results are presented in Table 5.20 to 5.23

The main aims of this study are to develop cropping pattern, maintenance of soil fertility, efficient use of land and provision of sustained cash income to the

farmers. The scientists and agricultural development officers have to go to the farmers with more than one plan to provide them the opportunity to exercise their own decision with their available resources. Therefore, the attempt has been made to develop alternate plans by employing linear Programming technique to obtain maximum net returns by reallocation of existing resources and recommended technology in both the groups.

5.7.1 The set of activities included in the model.

The model included crop production and livestock production as activities. The set of activities included in the model on the basis of sample observations, have been presented in Table 5.20.

Table 5.20 Activities and numbers allocated by linear programming model

Sr. No	Cluster-I		Cluster-II	
	Activity	**Variable**	**Activity**	**Variable**
1	Rice	X_1	Paddy	X_1
2	Nagali	X_2	Summer Paddy	X_2
3	Wari	X_3	Nagali	X_3
4	Wal	X_4	Wal	X_4
5	Pawata	X_5	Pawata	X_5
6	Cowpea	X_6	Cowpea	X_6
7	Bhendi	X_7	Bhendi	X_7
8	Ghewada	X_8	Brinjal	X_8
9	Water Melon	X_9	Green Chilli	X_9
10	Snake gourd	X_{10}	Snake gourd	X_{10}
11	Cow	X_{11}	Summer Groundnut	X_{11}
12	Buffalo	X_{12}	Cow	X_{12}
13	Bullock	X_{13}	Buffalo	X_{13}
14	Fodder Maize	X_{14}	Bullock	X_{14}
15			Fodder maize	X_{15}

From the Table 5.20, it was observed that total 10 crop activities viz; cereals, pulses and vegetables and from dairy enterprise, cow, buffalo and bollocks in numbers were allocated in cluster –I. Same activities were allocated in cluster II, in addition of summer paddy and summer groundnut were newly observed. Thus total 15 set of activities were observed in cluster-II.

5.7.2 Optimum plans for farming systems in cluster-I

The optimum models-I was obtained for the existing farming systems to explore the possibilities of increasing income through reorganizing the farm resources and presented in Table 5.21.

In case of cluster-I the alternate plan suggested that, the area under *nagli* should be increased from 4 ha (3.85%) to 10 ha (9.62%). It was observed that, area under paddy was decreased from 45 ha. (43.27%) in existing model to 40 ha. (38.46%) in alternate plan. In alternate plan the area under snake gourd and *pawata* were unchanged while number of cow, buffalo and bullocks were increased from 13, 17 and 20 to 25, 27 and 25 respectively resulting into increase in net income earnings over existing.

It was observed that, the area under watermelon and *vari* was slightly reduced by 0.94 per cent and 0.85 per cent respectively. Whereas the area under *wal* was increased from 8 ha (7.69%) to 10 ha (9.62) As indicated above, the area under paddy was decreased in optimum plans due to low productivity of paddy and the more area was allotted to nagli crop. The number of dairy animals were found to be increased in optimum plan. However the dairy enterprise was profitable enterprise in the farming system in optimum plan and plays important supportive role to the system.

It was observed that inspite of decrease in area of different crops, the income was increased due to increase in the number of dairy animals. It indicated that the area under paddy and other crops can be saved and these resources could be diverted to dairy enterprise to increase the profit.

The area under watermelon cultivation was increased from 4 ha to 5 ha, might be due to high profitability under alternate plan. High requirement of labour and working capital under bhendi might have been decreased in alternate plan. In addition to water melon, dairy was found to be competitive enterprise because of number of dairy animals were increased in alternate plan.

It was observed that, the area under fodder maize was incorporated in alternate plan due to increase in dairy animals and profitability of dairy enterprise. The area allocated to under fodder maize was found to be 4.12 ha.

Regarding cowpea, it was observed that, the area under cowpea was decreased from 12 ha to 10 ha. The optimum plan designed at existing level and at

Table 5.21 : Optimum plans for farming systems in South Konkan region.

Particulars	Cluster-I				Cluster-II			
	Existing		Alternate Plan-I		Existing		Alternate Plan-I	
	Area, No	Per cent	Area, No	Per cent	Area, No	Per cent	Area, No	Per cent
Paddy	45	43.27	40	38.46	35	35.00	35	35.00
Nagali	4	3.85	10	9.62	3	3.00	2	2.00
Wari	4	3.85	3	3.00	-	-		0
Wal	8	7.69	10	9.62	10	10.00	5	5.00
Pawata	10	9.62	10	9.62	11	11.00	7	7.00
Cowpea	12	11.54	10	9.62	10	10.00	5	5.00
Bhendi	7	6.73	5	4.81	6	6.00	5	5.0
Ghewada	3	2.88	1.88	1.81	-	-	-	-
Water Melon	4	3.85	5	4.81	-	-	-	-
Snake gourd	5	4.81	5	4.81	4	4.00	5	5.00
Brinjal	-	-	-	-	6	6.00	8	8.00
Green Chilli	-	-	-	-	4	4.00	5	5.00
Summer Paddy	-	-	-	-	4	4.00	4	4.00
Summer Groundnut	-	-	-	-	4	4.00	4	4.00
Fodder Maize	-	-	4.12	3.96	-	-	15	15.00
Total area	**104**	**100**	**104**		**100**	**100**	**100**	
Cow	13		25		12		20	
Buffalo	17		27		15		23	
Bullock	20		25		21		25	

recommended technology level suggested the shift of area from paddy and bhendi to fodder maize which may be because of low cost, low human labour and less working capital requirement in fodder maize as compared to paddy which resulted in to income increasing possibilities by rearing of more number of dairy animals. Which indicated that the importance of supportive role of non-crop farm enterprise in farming systems.

The increase in alternate plan over existing plan indicated that the scope for reallocation of resources.

5.7.3 Optimum plans for farming systems in cluster-II

The optimum plans was designed to study the possibility of increase in net income by reallocating the resources. In case of cluster II, (Table 5.21) the alternate plan suggested that the paddy area should be kept unchanged as in existing plan.

It was observed that, the area under nagli was slightly reduced by 1 per cent. However, the area under Brinjal was increase from 6 ha to 8 ha in alternate plan. It was revealed that the reallocation of existing resources would increase the net income to large extent. Regarding bhendi, it was observed that, the area under bhendi crop was decreased from 6 ha (6.00 %) to 5 ha (5.00%) might be due to high labour requirement and working capital. Whereas the area under green chilli was increased from 4 ha (4.00 %) to 5 ha (5.00%). It was indicated higher profitability of green chilli.

Regarding dairy enterprise, it was observed that, the number of cow and buffalo were increased in numbers from 12 and 15 to 20 and 23 respectively, which indicated indicated the importance of supportive role of non-crop farm enterprise in farming systems. Regarding to summer paddy and summer ground nut, the alternate plan suggested that, are under these crops remain unchanged, it might be due to less availability of irrigation in summer season. The area under snake gourd was found to be increased from 4 ha (4.00%) to 5 ha (5.00%) may be because of profitability of the crop. The area under bhendi was also increased from 6 ha (6.00%) to 8 ha (8.00%) due to reallocation of existing resources and adoption of recommended package of practices.

The area under *wal, pawata* and cowpea was found to be substantially decreased from 10 ha, 11 ha and 10 ha to 5 ha, 7 ha and 5 ha in alternate plan. However, it was also seen that the area under *wal, pawata* and cowpea were decreased

and whole area was diverted to fodder maize because of substantially increase in number of dairy animals which was supportive and profitable enterprise. The area allocated to fodder maize in alternate plan was found to 15 ha (15%) because of fulfillment of green fodder requirement of the animals.

It was concluded that in all the farming systems reallocation of existing resource level have shown higher returns than the existing plans. This indicated greater need to reallocate, rearrange, the resource in all farming system and in both the regions. The optimum plan that alternate plan of existing resource level with recommended technology also suggested to increase the resource level because it indicated higher returns more than these of existing plan. In case of paddy it was observed that the paddy area retained in the optimum plan has a strong relation with the minimum restriction imposed in the model. If this restriction would not have been kept in the analysis, the paddy crop might have been eliminated from the optimum plans which do not suit to the practical situation of the study area as paddy was a staple food crop and despite less returns it is grown over years.

In alternate plan it was observed that the crop enterprises and other enterprises such as dairy, had shown their influence and competitiveness in the optimum plans. It can be inferred from the optimization exercise attempted in the study that there is great scope for reallocation or rearrangement of the existing resources and also it is possible to increase the net income supported by proper allocation at increased resource level and adoption of package of practices with recommended technology.

5.7.4 Net Returns under Optimum Plans for Farming Systems in Study Area

The optimum plan depicted and summarized in order to get a bird's eye view for all farming systems in study area and they are presented in Table 5.22 and 5.23. As presented in Table 5.22 and 5.23, it was revealed that, the allocation of resources and rearrangement of enterprises with adoption of package of practices with recommended technology has greater scope in majority of the farming systems.

5.7.4.1 Cluster-I

It was observed from Table 5.22 that, alternate plan fulfils not only requirement but some additional yield from various crops, namely cereals, pulses, oilseeds and fodder maize. All the crops were contributes surplus production in given alternate plan. The various conditions were given to the FYM requirement and yield

Table 5.22: Net Returns under Optimum Plans for Farming Systems in cluster-I

Cluster-I											
Particulars	**Existing plan**				**Alternate plan**				**Recommended FYM Requirement (tonn)**	**Requirement (qt)**	**Surplus (+)/deficit (-)**
	Area (ha)	**Yield (qt)**	**Production (qt)**	**Net returns (Rs)**	**Area (ha)**	**Yield (qt)**	**Production (qt)**	**Net returns (Rs)**			
Paddy	45	21	945	19948	40	60	2400	797920	8	1090	+2556
Nagali	4	6	24	7000	10	12	120	70000	5		
Wari	4	5	20	8000	3	12	36	24000	5		
Wal	8	6	48	26000	10	10	100	260000	5	50	+250
Pawata	10	7	70	20324	10	10	100	203240	5		
Cowpea	12	6	72	23960	10	10	100	239600	5		
Bhendi	7	80	560	110000	5	100	500	550000	15	400	+1788
Ghewada	3	65	195	57612	1.88	100	188	108546	15		
Snake gourd	5	75	375	123768	5	150	750	618840	15		
Water Melon	4	90	360	143363	5	150	750	716815	15	100	+390
Fodder maize	-	-	-	-	4.12	450	1854	144057	5	180	+1674

levels through the recommended package of practices which were given by Dr.BSKKV, Dapoli.

From the Table 5.22, it was revealed that, in existing plan, the cereal requirement was 1090 qt and production was 990 qt. The alternate plan gives surplus production of 1466 qt from cereal crops which fulfil the cereal requirement. The surplus production gives additional benefit to farmers by selling produce. The net returns observed in alternate plan for paddy, *nagli* and *Var*i were Rs 797920, Rs 70000 and Rs 24000, respectively over existing plan.

It was observed from Table 5.22 that, in existing plan pulse requirement was 50 qt and production was 190 qt. The alternate plan produces 250 qt surplus production after fulfilling the pulse requirement of current population of cluster-I. The less requirement of pulse indicated that, the paddy and fish was staple food in the study area, which fulfils the more than half of the requirement of proteins by consumption of fish and fish products as per the recommendation of ICMR. So, it was concluded that, surplus production of pulses gave additional returns to the farmers. The net returns from *wal*, *pawata* and cowpea was observed to be Rs 260000, Rs 203240 and Rs 139600 respectively. Similar results were found in Srinivasa (2005)

Regarding vegetables, the bhendi, ghewada and snake gourd the area allocated to those crops were 5 ha, 1.88 ha and 5 ha, respectively. The net returns for bhendi, ghewada and snake gourd were observed to be Rs. 550000, Rs 108546 and Rs 618840 respectively over existing plan. In alternate plan it was observed that, the production of vegetable was 1330 qt and requirement was 400 qt. The surplus production (1788 qt) of vegetables can gives more net returns and benefit to the farmers by selling the surplus production.

From Table 5.22 it was observed that, in existing plan the fodder maize was not cultivated. In alternate plan, the conditions for fodder maize was included in model for area allocation to fodder maize which was required for green fodder requirement of dairy animals. In table it was observed that, the area allocated under fodder maize was to be 4.2 ha which gives 1857 qt yield. It was concluded that, the area allocated to fodder maize helps to include the dairy enterprise in the farming systems. Also, the requirement of green fodder was fulfilled by fodder maize production. It was revealed from the table that, all the crops considered in the model

gives surplus production after fulfilling the requirement and also maximize the returns.

5.7.4.2 Cluster-II

It was observed from the Table 5.23 that, area allocated to paddy and *nagli* remain unchanged because, no other crops can be taken in Kharif season. The area under paddy was constant; however, the *nagli* area was slightly (1%) changed.

Table 5.23 depicts that, the requirement of cereals was 1012 qt and production under alternate plan was found to be 2284 qt. The surplus production of cereals (1272 qt) fulfils the cereal requirement of population under cluster-II. It was observed that the additional production of cereals provides additional net returns to the farmers. The net returns were found to be Rs 789600, Rs 69676 and Rs 16000 from paddy, summer paddy and *Vari* respectively. Regarding Pulses, it was observed that, the requirement was 25 quintals and surplus production of 195 qt after fulfilment of pulse requirement. The protein requirement might be fulfilled by consumption of fish and fish products, because the staple food of the study area is focused on rice and fish. Similar observations were recorded in Behera (2014)

It was observed from the Table 5.23 that, the production of vegetables in existing plan was 1300 qt and requirement was 450 qt. In alternate plan, the production of vegetables was observed to be 3600 qt. The additional production of vegetables concludes competitive crop and high profitability of vegetable crops in cluster-II. It was found that, under alternate plan Brinjal crop was the most profitable vegetable crop with the net returns of Rs 1043106 in cluster II. The higher profitability of Brinjal crop gives higher profit and net returns to the farmers. The higher yield of vegetable crops in alternate plan were might be due to conditions incorporated on various package of practices which were recommended by the University.

From Table 5.23 it was indicate that, the net returns were maximized in all the crops which were followed under major farming systems in the study area. It was observed that, the inclusion of vegetable crops in farming systems gives high profit to the farmer. It was found that, the area allocated to fodder maize encourages for inclusion of dairy enterprise in the farming systems in the study area. In case of

Table 5.23 : Net Returns under Optimum Plans for Farming Systems in cluster-II

Cluster-II											
Particulars	**Existing plan**				**Alternate plan**				**Recommended FYM Requirement (tonn)**	**Requirement (qt)**	**Surplus/deficit**
	Area (ha)	**Yield (qt)**	**Production (qt)**	**Net returns (Rs)**	**Area (ha)**	**Yield (qt)**	**Production (qt)**	**Net returns (Rs)**			
Paddy	35	22	770	22560	35	60	2100	789600	8	1012	+1272
Summer Paddy	4	20	80	17419	4	40	160	69676	8		
Nagali	3	7	21	8000	2	12	24	16000	5		
Wal	10	7	70	25300	5	10	50	126500	5	25	+195
Pawata	11	6	66	20919	7	10	70	146433	5		
Cowpea	10	6	60	22950	5	10	50	114750	5		
Bhendi	6	76	456	123928	5	100	500	619640	15	450	+3250
Brinjal	6	60	360	82436	8	250	2000	1043146	15		
Green Chilli	4	50	200	130427	5	120	600	412180	15		
Snake gourd	4	70	280	110400	4	150	600	552000	15		
Summer Groundnut	4	12	48	15000	4	20	80	60000	10	45	+35
Fodder maize	-	-	-	-	15	120	1800	300000	5	210	+1590

groundnut, the surplus production of 35 qt focus on processing of oil seed after fulfilment of requirement. Thus, it was concluded that, the crops included in the model can maximize the net returns by adopting the package of practices recommended by the university.

The findings of the present study are in conformity with the findings of, Ganesh, K., 2000, Dhole, V. V.*et.al* (2011), Behera, U. K. *et al*. (2014)

The results of the present investigation accept the hypothesis that, there is scope for optimum use of existing resources

5.8 Problems and Constraints

Various problems and constraints faced by farmers following different farming systems in both the regions are presented in Table 5.24. These problems and constraints are expressed as percentages of opinion of the total number of respondents.

5.8.1 Cluster-I

It was observed from Table 5.24 that, the 71.00 per cent farmers opined that the wage rates were high whereas 76.24 per cent farmers were facing the problem of shortage a labour. The other major constraints faced by the farmers were lack of knowledge of integrated farming (58.10%) and less knowledge of pest control (41.25%).

It was observed that, the major marketing constraints of the farmers were low prices for produce (80.57%), high marketing cost (65.00%) and price fluctuation (78.50%). Regarding financial constraints, it was observed that, 43.33 per cent farmers opined that they do not have easy access for credit. The 48.89 per cent farmers were of the opinion that the process of sanctioning of the loan in the banks was very lengthy. The other financial problems were too much documentation (40.00%) and scarcity of own fund (20.00%).

It was observed from the Table 5.24 that, farmers expressed constraints regarding high wage rates and shortage of labour. It might be due to farm practices were conducted more intensively in this region. As the farmers were engaged in managing the other activities of farm they had to depend heavily on hired labour. The farmers had faced the problem of shortage of labour which has resulted in to increasing

of wage rate. The other constraints the farmers had opined were less knowledge of integrated farming system. In this region farmers had tendency to

Table 5.24: Constraints Faced by Farmers in Study Area

Sl. No	Particulars	Cluster-I (*N*=100)	Cluster-II (*N*= 100)
I	**Production constraints**		
1.	High wage rates	71.00	67.58
2.	Non-availability of inputs in village itself	62.54	53.55
3.	Shortage of labour	76.24	81.71
4.	Non-availability of inputs in time	44.44	71.11
5.	High cost of fertilizers	51.34	48.65
6	Shortage of water in summer	20.00	41.35
7.	Electricity failure	30.00	44.50
8.	Fragmentation and sub division of land	16.58	28.24
10.	Less knowledge of integrated farming systems	58.10	64.58
11.	Less know how about pest control	41.25	70.65
13.	High incidence of pests	28.11	24.58
II	**Marketing constraints**		
1.	Price fluctuations	78.50	58.24
2.	High marketing cost	65.00	60.00
3.	Low price for produce	80.57	68.00
4.	Inadequate demand for output in local market	60.88	33.58
III	**Financial constraints**		
1.	Scarcity of own fund	20.00	53.33
2.	Lengthy process of loan sanction in banks	48.89	28.89
3.	Too much documentation	40.00	38.89
4.	No easy access for credit	43.33	47.78

increase the income from highly commercial crops such as vegetables, dairy etc due to market demand. The focus of farmers from other enterprises and internal linkage between the enterprises have moved some farmers to adopt specialized farming which

resulted in to less observations on the farm enterprise linkages and ultimately the integrated farming systems. The farmers also faced production constraints such as less knowledge about pest control, non-availability of inputs in time, high incidence of pests etc.

In case of marketing constraints the farmers had expressed their views regarding the low prices for produce and high cost of marketing. It was observed that farmers were getting less price whereas, in market the price paid by consumer was very high. So they opined that they should get more than what they are getting today. The observations in most of the crops were also similar. The other important constraint faced by the farmers was price fluctuation.

In case of financial constraints, the major constraints were lengthy process of loan sanction, no easy access for credit etc. These were due to the procedure adopted by the credit institutions and the illiteracy and less knowledge about the documentation on part of the farmers.

5.8.2 Cluster-II

It was observed that, the major production constraints faced by the farmers in this region were non-availability of inputs in time (71.11%), less knowledge about the pest control (70.65%), less knowledge of integrated farming system (64.58%), non-availability of inputs in villages, (53.55%), and high cost of fertilizers (48.65%).

Regarding the marketing problems it was observed that 58.24 per cent farmers were of the opinion that they were facing the problems of price fluctuation and 60.00 per cent farmers had faced the problem of high marketing cost. About 33.58 per cent of the farmers were in the opinion that they were inadequate demand for output in local market

As indicated in the Table 5.24, the farmers in this region have faced the constraints such as non-availability of inputs in village itself, non-availability of inputs in time and high cost of fertilizers. Other constraints faced by the farmers were less knowledge about the integrated farming system and pest control, which might be due to higher illiteracy rate.

As regards marketing constraints, it was observed that, very few farmers had expressed the marketing constraints such as high marketing cost and price fluctuations. It might be due to less marketable surplus with the farmers.

It was observed that the farmers in this area were facing greater financial constraints, majority of the farmers had expressed scarcity of own fund. The other constraints expressed were no easy access for credit, too much documentation and lengthy process in sanction of loans which may be due to less credit worthiness, illiteracy etc. on part of the farmers.

5.8.3 Measures to Overcome the Constraints

The measures suggested by the farmers to overcome the constraints faced are presented in Table 5.25.

5.8.3.1 Cluster-I

It was observed from the Table 5.25 that, the farmers in this region stated their views regarding measures to overcome the constraints faced by them. The maximum number of farmers (60.58%) stated that there was need for demonstration on the control of Eryophite mite, a pest on the coconut palms, followed by regulation of wage rates and technical knowledge regarding control of pest on vegetables (60%), demonstration of farming system models (50.00%) and training on processing and preservation of products (41.00%). The other measures suggested were training on integrated farming system (45.00%), distribution of inputs in time (34.25%), use of organic fertilizer and replacement of seed (41.25%), and subsidy for fertilizers to farms (24.58%).

In case of marketing measures it was observed that maximum farmers (65.38%) opined that there was need to warehouse facilities, whereas 50.00 per cent farmers were of the opinion that there was need for reduction in the taxes charged by the commission agents trading agents. Other measures suggested by the farmers were regulation of the fruit prices (40.58%), collective purchase and sale of input and output (50.25%) and providing the transport facilities (45.35%).

It was revealed from results Table 5.25, the measures suggested by the farmers to overcome the constraints were demonstrations on Eryophite mite control, regulation of wage rates, demonstrations regarding farming system models and technical knowhow regarding pest in flowers etc.

In this region (coastal area) the coconut was one of the important crops along with paddy. The production of coconut was considerably affected by the Eryophite mite attack and farmers were not getting satisfactory results. So, they felt the need to

Table 5.25: Measures Suggested to Overcome the Constraints Faced by the Farmers in Study Area

Sl. No	Particulars	Cluster-I (*N*=100)	Cluster-II (*N*=100)
I	**Production**		
1.	Training in integrated farming system	45.00	20.00
2.	Distribution of inputs in time	34.25	51.11
3.	Regulation of wage rates	55.05	21.21
4.	Replacement of seed	41.25	37.78
6.	Demonstration of farming system models	50.00	32.22
7.	Subsidy for fertilizers to farmers	24.58	46.67
8.	Demonstration on Eryophite mite control	60.58	14.44
9.	Training on processing and preservation of products	41.00	24.44
10.	Technical knowledge to control pests in vegetables.	60.00	47.78
II	**Marketing**		
1.	Collective purchase of input and of sell output	50.25	47.28
2.	Regulation on price of fruit crops	40.58	54.00
3.	Warehouse facility	65.38	31.25
4.	Improvement of Transport facilities	45.35	24.65
5.	Reduction in (tax) commission by traders agent	50.00	20.00

have demonstrations for control of this pest. About more than 50 per cent farmers opined that there is need for pest control. The farmers were following various farming systems but they did not focus these systems in totality or as a farming system approach. Enterprise mix, interlinking, and their relations the complimentary relations between various enterprises within the farming system are required to be focused. It was observed that there is large variation in wage rate in various operations in different crops. Sometimes farmers had to pay very high wage rates. In this regard farmers stated that there is need for regulations of wage rates.

As regards the measures for improving the marketing operations the farmers emphasized the need of transport facilities. The farmers also stated to have regulation

on prices of fruits. They should get some assured price for fruits in the market so that they can manage the other operations in the farm efficiently. The farmers also opined that they have to pay a high amount of commission (about 15%) to agents which should be reduced. It can be done either by negotiation with traders by farmer's society or by some Govt. efforts.

5.8.3.2 Cluster-II

The measures suggested by the farmers in this region were distribution of inputs in time (31.11%), training on processing and preservation of products (24.44%) and training on integrated farming system (20%).

As regards marketing measures it was observed from Table 5.25 that, maximum number of farmers (46.67%) stated that collective purchase and sale of input whereas 54.00 per cent of the farmers expressed their views regarding Regulation on price of fruit crop. One of the important measures regarding production constraints suggested by the farmers in this region was the distribution of the inputs in time. More number of retail outlets may be opened to meet the farmers need in remote areas. In addition to this the facilities such as good road, transport vehicles are also required as was felt by 24.65 per cent farmers.

Regarding financial facility, the farmers were facing problems due to procedural requirement of loan. The most of the farmers were illiterate, so the official formalities, documents required etc. were difficult from the view point of farmers.

CHAPTER VI
SUMMARY AND CONCLUSIONS

In farming system approach, the farm is viewed in holistic manner. The farmers are confronted with many socio-economic, biological, institutional, administrative and technological constraints. The farming system conceptually is a set of elements or components, which are interrelated and interact among themselves. At the centre of interaction is the farmer himself, exercising control and choice regarding the type and results of interaction.

Recently research on farming system has been gaining momentum and the scientists and research scholars are developing tools and techniques to discover the more practicable methods to improve the farming. This study is an attempt in this direction covering different aspects of farming system with respect to agricultural development in South Konkan region of Maharashtra State.

Farming is a complex human activity consisting of farm enterprises which are interrelated and interact for the available resources and environment. It also involves application of highly sophisticated technology on one side and the physical, social and economic factor on other. Hence, successful attainment of total agricultural development depends on the farming system approach to a large extent. Many experts have also opined that there is need to understand and analyze the existing farming systems in order to quicken the pace of agricultural development. Failure to understand the existing farming systems and the proposed improved technology might often lead to failure of the new technology. It was therefore, felt necessary that study on farming systems be taken up. Present study was undertaken to examine the farming systems in South Konkan region with the following specific objectives

11) To identify the existing farming systems in the study area.
12) To work out the cost, returns and profitability of major farming systems.
13) To study the resource use efficiencies and productivities of major farming systems.
14) To assess the possibilities of optimization of profit in major farming systems.

15) To identify the constraints faced by the farmers in the existing farming systems and suggest remedial measures.

Hypotheses

1) In existing farming systems there is higher proportion of dryland horticulture.
2) In existing farming systems various resource allocation and resource levels are not properly organised.
3) There is scope for optimum use of existing resources

The multistage sampling procedure was followed in the present study. The South Konkan region has varied agro climatic conditions. Hence, it was felt necessary to delineate the region in to sub regions. The secondary data on various aspects were collected from the district statistical abstracts and Joint Director of Agriculture, Thane for both districts *viz.*, Ratnagiri and Sindhudurg.

Primary data on various aspects of farming were collected from head of each household with the help of a set of pre-tested comprehensive questionnaire designed for the study. Primary data so collected pertained to 100 samples from each region. In all, 200 farmers were selected to elicit information for study.

The present study made use of different statistical techniques such as percentages, ratios, correlations, different cost concepts and higher analytical techniques, such as cluster analysis, production function analysis and linear programming etc. The cluster analysis was carried out by using hierarchical agglomerative method. Cobb-Douglas type of production functions were formed separately for crop and other enterprises to study the resource use efficiency. The deterministic linear programming model was used for studying the optimum farming systems. The two types of optimum solutions simulated were: a) optimum farming system at existing resource level (optimum plan M-I) and b) optimum farming system at enhanced resource level (optimum plan M-II).

The important outcomes with reference to objectives referred for the study are presented in following paragraphs

6.1 Delineation of Study Area

The cluster analysis delineated the study area in to two distinct clusters. The first cluster included 9 tahsils namely Mandangad, Dapoli, Khed, Chiplun, Sangameshwar, Lanja, Rajapur, Ratnagiri, Guhagar. The second cluster consisted of 8 tahsils namely Devgad, Vaibhavwadi, Kankavli, Sawantwadi, Vengurle, Dodamarg, Kudal, Malvan..

6.2 General Characteristics of Sample Respondents

The average age of the farmers was 49.84 years with 86.00 per cent literacy. The average family size was 6.34. As regards to occupation at overall level, the majority of the farmers (74.00 %) have their main occupation as agriculture.

6.3 Existing Farming Systems

In study area 8 existing major farming systems were identified. In cluster I, 4 major farming systems were identified namely 1) Paddy + Rainfed plantations (FS-I), 2) Paddy + Irrigated plantations+ Dairy (FS-II), 3) Paddy + Other cereals pulses (FS-III), 4) Rainfed plantations+ Vegetables (FS-IV).

The major farming systems in cluster II region were 1) Paddy + Rainfed plantations+ Irrigated plantations (FS-I), 2) Paddy + Rainfed plantations+ Vegetables (FS-II), 3) Irrigated plantations+ Pulses + Dairy (FS-III), 4) Paddy + Other cereals +Oilseed (FS-IV).

6.4 Land Holding

The land holding pattern across all the farming systems adopted in cluster I regions indicated that per farm land holding was ranging from 1.75 hectares in FS-III to 3.17 hectares in FS-IV. In cluster II, the operational holding was ranging from 1.71 hectares in FS-IV to 3.35 hectares in FS-I.

6.5 Cropping Pattern

In the study area the crops grown and enterprises followed had a large variation not only between farming systems and also in different regions. The important crops grown in the study area were Paddy, Finger millet (Nagli), Mango, Cashewnut, Coconut, Arecanut. The pulses and vegetables crops included Lady’s finger, Brinjal, Cowpea, *Pawata*, *Wal*, Snake gourd, Chilli, Watermelon etc.

The gross cultivated per holding area in cluster I was ranging from 1 hectares in FS-III to 2.92 hectare in FS-IV. However, cropping intensity was less at 167 per cent in farming system III. In cluster II, the gross cropped area was ranging from 0.84 hectare in FS-IV to 2.91 hectares in FS-I. Cropping intensity I was found to highest in FS-III (167%) and cropping intensity II was ranging from 167 per cent to 242.73 per cent in cluster I. In cluster-II, on the area and crop duration basis cropping intensity II was ranging from 165.47 per cent to 255 per cent. The cropping intensity I was highest (165.47%) in FS-IV in cluster II

6.6 Per Unit Profitability

In South Konkan region it was observed that, in case of paddy the per hectare gross returns were maximum in FS-I (Rs.49000) followed by in FS- II (Rs 44000) in cluster I. The per hectare total cost of cultivation of paddy was maximum in FS-I Rs.52587.

In case of mango production per hectare net returns over total cost were Rs.45600 and Rs.45495 in in FS-I and FS-IV respectively (cluster- I). The per hectare gross returns worked out to Rs.100000 in both the farming systems. The per hectare net returns were ranging from Rs.50068 (FS-II) to Rs.58801 (FS-I) in cluster- II. Similar observation were also recorded by Swami (2004) and Bhuwad (2012) while studying farming systems in Ratnagiri district of Maharashtra.

The per hectare gross returns in Lady's finger, brinjal and snake gourd were Rs.245000, Rs.130000 and Rs.112200 respectively. The per animal total maintenance cost in dairy enterprise was Rs.43404, whereas the maximum gross returns were Rs.48700 in FS-III in cluster- II.

In case of watermelon the total cost and total gross returns were Rs. 84367 and Rs.142500 (cluster-I). Among the pulse crops per hectare gross returns (Rs. 78000) and net returns over total cost (Rs. 47466) were maximum in cowpea. The per hectare total cost and total returns in lady's fingure were Rs.131361 and Rs.290500 (cluster-I) which revealed that lady's fingure was most remunerative crop of the region.

In case of Cashewnut per hectare gross returns and total cost were Rs.114800 and Rs.58577 (FS-I). The returns on each rupee invested were ranging from Rs.1.87 in FS-II to Rs.1.96 in FS-I (Cluster-II). Swami (2004) in his study in Ratnagiri district also found that the input output ratio in coconut was 1.95

In case of coconut per hectare gross returns were maximum in FS-I (Rs.98000) followed by in FS-III (Rs.77500). The per hectare net returns at total cost were ranging from Rs.35844 in FS-III to Rs.43439 in FS-I. . The returns on per rupee invested by the farmers were ranging from Rs.1.80 in FS-I to Rs.1.86 in FS-III (Cluster-II)

6.7 Cost and Returns in Major Farming Systems

In case of Cluster-I region, among the farming systems followed in the region, maximum per farm labour used was in FS – IV (658 man days). The per farm net returns over total cost were maximum in FS-IV which amounted to Rs.195130 followed by FS - I (Rs.95056). The maximum returns on per rupee invested at total cost worked out to Rs.1.89 in FS – IV.

As regards Cluster-II region, among all farming systems followed, FS-IV required maximum labour (613 man days). The per farm gross returns were maximum in FS-II (Rs.336396) followed by FS-I (Rs.109472). The net returns over total cost were maximum in FS–II (Rs.134427). Similar results were found in Naik (2002) and Veerkar (2002)

The per farm total cost (Rs.220370) and gross returns (Rs.415500) were maximum in Rainfed plantations + Vegetables farming system in cluster-I region. However, in this system the returns on per rupee invested was maximum (Rs.1.89). In Paddy + Rainfed plantations + Vegetables farming system followed in Cluster-II region, the per farm total cost and gross returns were Rs.201969 and Rs.336396, respectively. The returns per rupee invested were Rs.1.67 in this system.

In South Konkan region the 8 farming systems were found to be major farming systems followed by the farmers. The per farm total human labour required was maximum (658 man days) in Rainfed plantations + Vegetables farming system. It can be concluded that the Paddy + Rainfed plantations + Vegetables was most remunerative system for income and employment generation in the study area.

The findings of the present study are in conformity with the findings of, Kandasamy (1998), Gumaste *et.al* (2000), Swami (2004), Bhuwad (2012). **The results of the present investigation lead to accept the hypothesis that, in existing farming systems there was higher proportion of income from dryland horticulture.**

6.8 Income and expenditure pattern of different farming systems

The total income of the farm families in cluster-I was Rs. 288413, Rs. 219686, Rs. 125102 & Rs. 485875 in faming system I, II, III & IV respectively. The income from other sources worked out to Rs. 58195 which contributed 20.18 percent of the total income. In farming system II, it was observed that out of the total income 38.23 percent income came from horticulture production, while 27.50 percent was from dairy enterprise. In case of Farming system IV, 86.60 percent income was from farm business income, while other than farm business activity (wages and business / service) contribution 14.40 percent of the total income.

In case of cluster-II the total income from farming system IV was very less as compared to other farming systems. While, in farming system I, more than 50 per cent income was derived from horticultural production. The income derived from dairy activity was equivalent to the crop production income in farming system III. Farmers have best alternative to go for livestock activity which also gave better profit.

In cluster-I, the expenditure on crop production was major expenditure in FS-IV, while expenditure on horticulture crop was major expenditure in FS-I. The total expenditure was found to be Rs. 28648, Rs.44880, Rs. 48058 and Rs.67910 in FS-I, FS-II, FS-III and FS-IV respectively.

In case of cluster-II, the family expenditure of sample farms were Rs. 34676, Rs.50230, Rs.59442 and Rs. 35805 in farming system I, II, III and IV respectively. In farming system II, also crop production activity shared 50.69 per cent. The expenditure on livestock activity in farming system III was found to be 23.85 per cent.

The sustainable farm income of farming systems I, II, III, IV were Rs.66409, Rs.1717, Rs. -38930 and Rs. 127220 respectively in cluster-I. The farming system I, II and IV have an economic surplus. It means farming system I, II and IV were having sustainable farm income. But farming system III could not meet their requirements on the basis of their farm business income. The income from other sources (wages, services and business etc.) was the only factor which helped them to sustain. In FS-I, II and IV, the sustainable income came to Rs. 124602, Rs. 45778 and RS. 197595 respectively.

In cluster-II, the sustainable farm income of farming system I and II were Rs. 74797 and Rs. 84201 respectively. These farming systems seemed to have more economic surplus. The sustainable income in farming system I, II, III and IV were,

141589, Rs. 150979. Rs. 58150 and Rs. 16474 respectively. It was observed that, farming system II have more sustainable income as compared to the other farming systems. Similar results were found in Dorge (2012)

In cluster-I and cluster-II, farming systems were ranked on the basis of sustainable farm income. In case of cluster-I, FS-IV was ranked I (First) in producing sustainable farm income while, in cluster II, FS-II was ranked I (First) which gives highest sustainable farm income as compared to other farming systems

6.9 Resource Use Efficiency in Major Farming Systems

6.9.1 Cluster-I

The results of resource use efficiency in paddy indicated that, seed, nitrogen and phosphorous were positive and influencing factors on production. The sum of regression coefficients indicated increasing returns to scale.

As regards mango cultivation, nitrogen, potash and plant protection chemicals were positive and significant inputs. In cashewnut production, the increasing returns to scale was observed whereas, nitrogrn, phosphorus and potash were significantly contributing to the production and their use was more than the desired level. Similar observation were also recorded by Nikam (2006) and Pawar (2006)

In case of arecanut, nitrogen, male labour and female labour were contributing to the production positively and significantly. The nitrogen, male labour female labour and were excessively used than the desired level.

As regards dairy enterprise, green fodder and concentrates, male labour and female labour were positive and significant, while the green fodder and concentrate, male labour and female labour were utilized at less extent than the required quantity. It was concluded that there is need to have proper mix of these inputs in milk production

6.9.2 Cluster-II

As regards paddy production, F.Y.M, nitrogen and potash were most influencing variables along with seed in FS-I, whereas phosphorus had shown negative influence in FS-V.

In mango production, F.Y.M., phosphorous, potash and male labour were contributing positively and significantly. F.Y.M and phosphorous were less utilized than desired level whereas, use of potash and male labour was more than the desired level. The increasing returns to scale was observed in mango production. Similar results were found in Wagale (2007)

As regards cashewnut, the inputs such as F.Y.M., phosphorous and plant protection chemicals were contributing positively. The extent of use of phosphorus was less than the desired level where as F.Y.M. and plant protection chemicals were utilized more than the desired level. The decreasing returns to scale was observed in Cashewnut production. In brinjal cultivation, seed was most influencing input positively on the production along with nitrogen and plant protection chemicals. Seed was utilized more than the optimum level whereas, plant protection chemicals were utilized less than the desired level. The decreasing returns to scale was observed in brinjal production.

Dairy enterprise was found to be influenced positively and significantly by male labour, female labour and veterinary expenses, out of which male labour was utilized more than optimum level and female labour and veterinary expenses were utilized less than the desired level. Similar observations were found in Borude (2002)

The findings of the present study are in conformity with the findings of Kalara, *et al.* (2007), Mudasir Iqbal *et.al* (2010), Makadia, *et.al* (2014)

The results of the present investigation lead to accept the hypothesis that, in existing farming systems various resource allocation and resource levels are not properly organized.

6.10 Optimum Farming Systems

6.10.1 Cluster-I

The alternative plan suggested increase in area under nagli whereas paddy area was decreased. In alternative plan, area under paddy was decreased and the number of dairy animals was increased. It was observed that, the area under *vari* was slightly reduced while area under vegetables crops was increased. In alternative plan, the area under pawata was unchanged and additional resources were utilized for dairy enterprise. In case of fodder maize, 4.12 ha area was diverted in alternative plan. The number of dairy animals was also increased in the alternative plan.

In existing plan, the cereal requirement was 1090 qt and production was 990 qt. The alternate plan gave surplus production of 1466 qt from cereal crops which fulfiled the cereal requirement. The net returns observed in alternate plan for paddy, *nagli* and *vari* were Rs 797920, Rs 70000 and Rs 24000 respectively over existing plan. The net returns for bhendi, ghewada and snake gourd were observed to be Rs. 550000, Rs 108546 and Rs 618840 respectively over existing plan. In alternate plan it was observed that, the production of vegetable was 1330 qt and requirement was 400 qt. The surplus production (1788 qt) of vegetables can gives more net returns and benefit to the farmers by selling the surplus production. Similar results were found in Srinivasa (2005)

6.10.2 Cluster-II

In alternative plan, the area under paddy was unchanged. However, the area under brinjal was increased from 6.00 per cent to 8.00 per cent. The number of dairy animals were also found to be increased in alternative plans. As regards, the area under pulses (*wal, pawata* and cowpea) was decreased and diverted to the fodder maize cultivation. The number of dairy animals were also increased due to area allocated to the fodder maize for the fulfilling the green fodder requirement of the dairy animals.

In alternate plan, the production of vegetables was observed to be 3600 qt. The additional production of vegetables concludes competitive crop and high profitability of vegetable crops in cluster-II. The net returns were found to be Rs 789600, Rs 69676 and Rs 16000 from paddy, summer paddy and *vari* respectively. Regarding pulses, it was observed that, the requirement was 25 quintals and surplus production of 195 qt after fulfilment of pulse requirement. The protein requirement might be fulfilled by

consumption of fish and fish products, because rice and fish are the major items of the staple food of the study area. Similar observations were recorded in Behera (2014)

It was indicated that, the net were maximized in all the crops which were followed under major farming systems in the study area It was concluded that in both the regions, reallocation of existing resources and adoption of recommended technologies had shown a higher returns than those from the existing plans. Hence, it was imperative to reallocate, rearrange the existing resources in all the farming systems and in both the regions. Thus, it was revealed that the resource optimization has good potential to enhance the income through resource mobilization and allocation.

The findings of the present study are in conformity with the findings of, Ganesh, 2000, Dhole *et.al* (2011), Behera *et al*. (2014)

The results of the present investigation accept the hypothesis that, there is scope for optimum use of existing resources

6.11 Problems and Constraints

The study of production constraints in South Konkan region, revealed that, the constraints faced by the farmers were shortage of labour (76.24%), high wage rates (71.00%), non-availability of inputs in time (62.54%) and in village, less knowledge of integrated farming system (58.10%), inadequate know how about pest control (41.25%), high cost of fertilizers (51.34%), shortage of water in summer (20.00%), and fragmentation of holding (16.58%),

The problems faced by the farmers in South Konkan region indicate difference between sub regions. However, the above mentioned problems indicate in general the situation that farmers were facing. It can be concluded that the major problems of study area in production aspects were high cost of fertilizers, non-availability of inputs, and inadequate knowledge about pest control, integrated farming system, high wage rates, shortage of water in summer and fragmentation of holding etc.

As regards marketing problems the major problems observed in South Konkan region were price fluctuation and inadequate transport, storage and warehousing facilities. In case of financial problems too much documentation and no easy access to credit and high interest rates were found to be the major problems.

6.12 Measures to overcome the constraints

It was revealed from the results that, the suggestions from the farmers from both the were different. But in general in South Konkan region, the measures to facilitate the farmers in adoption of the farming systems were demonstrations on control of Eryophite mite (60.58%), demonstrations on farming system models (50.00%) and the training on processing of fruit products (41.00%). So that the farmers will replace seed regularly and productivity can be improved. These were found to be major measures in South Konkan region.

In case of marketing, warehousing facility (65.38%), improvement in transport (45.35%), regulation of prices in general of agricultural products (40.58%), particularly fruits were marketing measures suggested by the farmers in the study area.

In case of financial aspects the reduction in the interest rates and the easy procedure for loan were the two measures suggested by the farmers. Recently, Government of Maharashtra had taken a decision to give loans to women self-help groups at the rate of four per cent. This decision may help the farmers in study area to avail credit at cheaper rate and to invest in agriculture.

Conclusions

11) In study area eight major farming systems were followed by the farmers. The farming systems in cluster I were 1) Paddy + Rainfed plantations 2) Paddy + Irrigated plantations+ Dairy 3) Paddy + Other cereals + pulses 4) Rainfed plantations+ Vegetables. In cluster II, 1) Paddy + Rainfed plantations+ Irrigated plantations 2) Paddy + Rainfed plantations+ Vegetables 3) Irrigated plantations+ Pulses + Dairy 4) Paddy + Other cereals +Oilseed

12) In case of crop enterprises, crops were grouped as a system component or crop group enterprises such as rainfed plantation, irrigated plantation, other cereal, pulses, (excluding paddy). Paddy crop was considered as a separate enterprise because it is a main staple food crop of the region and cultivated on large scale. The non-crop farm enterprise undertaken by sample respondents was dairy.

13) Among both the clusters in South Konkan region, the farming systems namely 1) Paddy + Rainfed Plantation, 2) Rainfed Plantation + Vegetables, 3) Irrigated Plantation + Pulses + Dairy, 4) Paddy + Rainfed Plantation + Irrigated Plantation, 5) Paddy + Rainfed Plantation + Vegetables were found to be highly

profitable farming systems among the major farming systems (8) identified in the study area.

14) The horticulture plantations plays a very dominant role in profitability of the farming systems. Which underline its importance and need to concentrate on these enterprises for making farming systems more profitable. Thus the proper balance between livestock enterprises and crop enterprises need to be encouraged to bring remaining farming systems more profitable.

15) The total income of the farming system-IV in cluster-I was maximum as compared to other farming systems. Indicated that, other farming systems needs to depend more in other farm business activity as compared to farming system IV.

16) The farmers of all the farming systems of both the regions were having sustainable farm income except FS-III (cluster-I) and FS-IV (cluster-II)

17) The cobb-Douglas production function analysis in different farming systems has shown that more than 90 per cent variation in gross returns were contributed by seed , FYM and fertilizers,

18) The results of resource use efficiency in paddy indicated that, seed, nitrogen and phosphorous were positive and influencing factors on production. The sum of regression coefficients indicated increasing returns to scale

19) In mango production, F.Y.M., phosphorous, potash and male labour were contributing positively and significantly. F.Y.M and phosphorous were less utilized than desired level whereas, use of potash and male labour was more than the desired level

20) As regards cashewnut, the inputs such as F.Y.M., phosphorous and plant protection chemicals were contributing positively. The extent of use of phosphorus was less than the desired level where as F.Y.M. and plant protection chemicals were utilized more than the desired level

21) The crop enterprises such as paddy, coconut, mango, ,arecanut, cashewnut, vegetables and other enterprises such as dairy had shown their influence and competitiveness in the alternative plans

22) Optimization exercise suggested that, there is great scope for reallocation or rearrangement of the existing resources and also it is possible to increase the net income supported by proper allocation at increased resource level and adoption of package of practices with recommended technology.

23) The problems faced by the farmers in this study area are shortage of labour, less knowledge of integrated farming system, high incidence of pest, high cost of fertilizer, electricity failure or irregular supply, less knowledge about pest control, low prices for produce, high marketing cost, lengthy process in sanction of loan, no easy access for credit and high interest rates

Policy implications:

On the basis of study on farming systems the following suggestions and policy implications are made.

6) The region wise specific farming systems needs to be focused/promoted such as
    a) In cluster-I, 1) Paddy + Other Cereals + Pulses, 2) Paddy + Irrigated Plantation + Dairy are suggested for implementation on larger area.
    b) In cluster-II, 1) Paddy + Other Cereals + Oilseed suggested for implementation on extended area.
7) In study area it is found that the farming systems followed by the farmers are of varied nature and training on integrated farming systems will be helpful for making the farming systems more profitable.
8) Rice is the pre-dominant crop of the study area but existing yield level was very low as compared to the recommended technology. Effort need to be taken to motivate the farmers for adopting modern technologies.
9) The awareness among the farmers is needed to follow packages of practices for various crops. The human labour should be used judiciously so that it would be cost effective.
10) The allocation of resources and rearrangement of enterprises has greater scope in majority of the farming systems. The rearrangement in existing perennial crops is difficult but in case of establishment of new plantations it can be easily implemented

LITERATURE CITED

Aldender Mark S, and Blashfield Roger K., (1984), Cluster analysis, *Quantitative Application in the Soc. Sci.*, sage university. 44.

Alves, E. P.,Silva, M. L. da,Oliveira Neto, S. N. de.,Barrella, T. P.,Santos and R. H. S.(2015), Economic analysis of a coffee-banana system of a family-based agriculture at the Atlantic forest zone, Brazil. *Ciência e Agrotecnologia*. **39**(3): 232-239.

Amarnath, J. S. (2009), Diversification of agriculture for sustainability and its impact of farm income. *Agric. Econ. Res. Review*, **22**(1):508-5016.

Anonymous, (2015), *District Socio-economic Review of Ratnagiri District.* Directorate of Economics and Statistics, Government of Maharashtra.

Anonymous, (2015), *Agricultural Statistics Report of Joint Director*, Thane.

Anonymous, (2015), *District Socio-economic Review of Sindhudurg district*. Directorate of Economics and Statistics, Government of Maharashtra.

Baba, S. H., M. H. Wani, and Bilal A. Zargar (2011), Dynamic and sustainability of livestock sector in Jammu & Kashmir.*Agric. Econ. Res. Rev*., **24**(2):119-132.

Behera, U. K. and Rana, D. S. (2013), Fuzzy linear programming for integrated farming systems in multi-objective environment. *Indian Journal of Agronomy*. **58**(1): 119-124.

Behera, U. K. and Rana, D. S. (2014), Multi-objective optimization and design of integrated farming systems using goal programming. *Indian Journal of Agronomy*. **59**(3) 460-467.

Bhuwad, S.S (2012), Economics of farming system in Ratnagiri district. *M.Sc. Thesis* (Unpub.), Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

Biswajit Debnath., Ananthan, P. S.,Biradar, R. S. and Datta, S. K.(2009), Resource use efficiency and social profitability of an integrated aqua-farm, Tripura, India. *Aquaculture Economics & Management*2009. **13**(4): 344-354.

Biswas, B. C (2010), Farming system approach to improve IUE, employment and income in eastern India. *Ind. J. Agric.Econ.*, **41** (5): 6-12.

Budiasa, I. W., Ambarawati, I. G. A. A., Mega, I. M. and Budiasa, I. K. M. (2013), Integrated farming system modeling to support sustainable agriculture. *Bumi Lestari*. **13**(1): 135-148.

Chakraborty, A. J. and Bera, B. K. (2014), Analysis of economic viability of rice production by alternative systems of farming in West Bengal.*Environment and Ecology*. **32** (4): 1544-1548.

Chandel, B. S. and Ravinder Malhotra (2006), Livestock systems and their performance in poor endowment of India. *Indian Agric. Econ. Res. Rev.*, **19**(2): 311-326.

Chandrasherkar, S., (2001) Production constraints faced by potato growers.*Rural India*, **64**(2-3): 33-34.

Chipte, 1997, Economics of farming systems in Thane district. *M.Sc.(Agri.) Thesis*, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli

Chitnis, D. H. and Bhikgaonkar, M. G., (1987), Constraints causing technological gap in dry farming systems. *J. Maharashtra Agric. Univ*., **12**(1): 84-88.

Dorge, J.T., Joshi G.G. and Sanap, D.J. (2015), Employment and income pattern of different farming systems in Western Maharashtra. *Internt. Res. J. Agric. Eco. & Stat*., **6**(2): 356-363

Dhole, V. V., Mahesh Kothari and Purohit, R. C.(2011), Optimal irrigation planning for a command area of Som-Kagdar Irrigation Project, Rajasthan *Green Farming*. **2**(5): 586-590.

Dikshit, A. K. and P. S. Birthal (2010), India's livestock feed demand: Estimates and Projections. *Agric. Econ. Res. Rev.*, **23**(1):15-28.

Ganesh Kumar B. and R. B. Rai, (2006), Economic status of poultry farming enterprises in Andaman and Nicobar island. *Agric. Econ. Res. Rev*., **19**(2): 377-386.

Ganesh, K., (2000), Evaluation of alternative farming systems in Gazani lands of Karnataka – An economic analysis. *M.Sc.(Agri.) Thesis*, Univ. Agric. Sci., Dharwad.

Gautam, T. (1993), Application of linear programming for note on resource allocation in rice-based farming system in Nepal. *Journal of the Institute of Agriculture and Animal Science*. **14**: 87-91.

Gavisiddappa (2001), Problems in Gherkin production and trade in Haveri district of Karnataka. *Rural India*, **64**(9): 184-186.

Gireeshayya Udagatti (2005), An economic analysis of farming systems in tank commands of northern Karnataka. *M.Sc. (Agri.)* Thesis, Univ. Agric. Sci., Dharwad.

Goswami, S. N.,(1997), Economic appraisal of indigenous farming systems of West Garo Hills district of Meghalaya. *Indian J. Agric. Econ.* , **52**(2): 252-259.

Goswami, S.N. and Meenakshi Sundaram, V., (1992), Prospects of increasing farm income in traditional hill farms of west Garo hills district (Meghalaya). *Indian J. Agric. Econ.*, **47**(2): 247-254.

Gumaste, A. K. and S. G. Borude (2000), Profitability of dairy enterprise in Kokan region. *Maharashtra J. Agric. Econ*., **10**(1): 34.

Hagel, H., Hoffmann, C., and Doluschitz, R. (2014), Mathematical programming models to increase land and water use efficiency in semi-arid NE-Brazil. *International Journal on Food System Dynamics*. **5**(4): 173-181

Haque, T. (2006), Resource use efficiency in Indian agriculture. *Indian J. Agric. Econ* **61**(1): 65-76.

Hirla, J., and Verma, H. K., (2004), Constraints faced by the paddy growers in adoption of recommended plant protection practices. *Rural India*, **67**(6-7): 122.

Hota, S. K. and Aryashree Debapriya (2013), Resource productivity and technical efficiency of rice (paddy) farms. *Asian Economic Review*. **55**(3): 403-418.

Ibitoye, S. J., Shaibu, U. M. and Omole, B. (2015), Analysis of resource use efficiency in tomato (*Solanum lycopersicum*) production in Kogi State, Nigeria. *Asian Journal of Agricultural Extension, Economics and Sociology*. **6**(4): 220-229.

Jagtap, P. P.,Shingane, U. S. and Kulkarni, K. P. (2014), Resource use efficiency and economics of marketing of green chilli. *Journal of Spices and Aromatic Crops*. **23**(1): 32-37.

Jawanjal, B. G.,Naik, V. G.,Talathi, J. M.,Malave, D. B. and Wagale, S. A. (2015A), Cost, returns and profitability in sugarcane cultivation in Konkan region (MS). *International Journal of Commerce and Business Management*. **8**(1):17-22.

Jawanjal, B. G.,Naik, V. G.,Talathi, J. M.,Malave, D. B. and Wagale, S. A. (2015B), Resource use efficiency in sugarcane production in Konkan region (M.S) *Agriculture Update*. **9**(4): 566-570.

Jaya Tiwari and Sushant More (2012), Costs, returns and resource use efficiency of soybean cultivation in Indore district of Madhya Pradesh. *Agriculture Update* **7**(3/4): 214-217

Jyoti Kachroo.,Arti Sharma and Tarunvir Singh (2008), Technical efficiency of paddy crop in Jammu Distric of J & K State. *Agricultural Situation in India*. **65**(3): 151-155.

Kakade, A. D., Pawar, B. R. and Bankar, S. S.(2011), Resource productivity and resource use efficiency in grape wine production. *International Journal of Commerce and Business Management*. **4**(1): 18-20.

Kalara, B. S. and Singh, A. K.(2007), Resources utilization and optimal rice production in an irrigated area in Western Uttar Pradesh - a case study.*Agricultural Situation in India*. **64**(2): 45-50.

Kandasamy, G. S., (1998), An economic analysis of integrated farming system in Dharampuri district, Tamil Nadu. *Farming Systems*, **14**(1&2): 26-33.

Karthick, V., Alagumani, T. and Amarnath, J. S.(2013), Resource-use efficiency and technical efficiency of turmeric production in Tamil Nadu - a stochastic frontier approach. *Agricultural Economics Research Review*. **26**(1): 109-114.

Kiresur, V.R., Gaddi, G.M., Gummagolmath, K.C., Wader, P. R., and Kulkarni, V.S., (2004), Optimum plan for sustainable farming systems in northern eastern dry zone in Karnataka. *Bihar J. Agric. Market.*, **12**(1): 16-27.

Koppad, M.B. and Khan, H.S.S., (1996), Economic analysis of maize based farming systems on large farms in Malaprabha Command Area, Karnataka. *Farming System*, **12**(1-2): 1-4.

Korikanthimath, V. S. (2009), Integrated farming systems for sustainability in agricultural production. *Ind. J. Agronomy.*, **54**(2): 295-301.

Kumar Parveen and Slathia, P. S.(2014), Economic analysis of horticulture based farming system in Kandi area of Jammu region. *Trends in Biosciences.* **7**(9): 700-702.

Landge, V. V.,Pawar, B. R.,Deshmukh, D. S. and Yeware, P. P. (2010), Resource productivity and resource use efficiency in drip irrigated banana production.*Agriculture Update.* **5**(1/2): 203-205.

Mahendran R.M., Chandrasekaran, M. and Gurunathan, S., (2006), A study on evolving optimal cropping patterns in Groundwater over exploited region of Perambalur district of Tamil Nadu. *Agric. Econ. Res. Review,* **19**(1): 95-108.

Mahesh N., Swaminathan, N., Pouchepparadjou, A. and Nasurudeen, P., (2002), Measurement of technical efficiency in stochastic frontier production function model: Application Tea industry in dooars region of west Bengal. *The Bihar J. Agric. Market.*, **10**(3): 285- 291.

Makadia, J. J.,Patel, K. S. and Ahir, N. J. (2014), Economics and resource use efficiency of SRI and traditional method of paddy cultivation in Gujarat.*International Research Journal of Agricultural Economics and Statistics*. **5**(2): 211-215.

Mandeep, S., and A. S. Joshi (2008), Economic analysis of crop production and dairy farming on marginal and small farms in Panjab. *Agric. Econ. Res. Rev.,* **21** (2):251-257.

Mane, A. L.,Pawar, B. R.,Chivare, S. A. and Kauthekar, P. U. (2012), Resource productivity and resource use efficiency in cocoon production. *International Journal of Commerce and Business Management.* **5**(2): 203-206

Menasinahal, A. S.,Kunnal, L. B. and Gamanagatti, P. B.(2012), Resource use efficiency in paddy and cotton cultivation in Uttara Kannada district of Karnataka. *Agriculture Update*. **7**(1/2): 105-109

Mudasir Iqbal and Jyoti Kachroo (2010), Resource use efficiency and investment appraisal of mango in rainfed ecosystem of Jammu district of India. *Bangladesh Journal of Agricultural Economics*. **33**(1/2): 121-132.

Muralidharan, P.K., (1987), Resource use efficiency in kole lands in Trichur District, Kerala. *Indian J. Agric. Econ.* , **42**(4): 578-586.

Mythili G., and Shanmugam, K. R., (2000), Technical efficiency of vice growers in Tamil Nadu a study based on panel data. *Indian J. Agric. Econ.*, **55**(1): 16-25.

Nagaraj, T.,Khan, H. S. S. and Karnool, N. N.,(1996) Economic analysis of maize-sunflower farming system (Irrigated) in Tungabhadra command area (Karnataka). *Journal of Agriculture Sciences*. **12**(3/4): 28-36.

Nagendra Singh., Singh, P. K. and Aalok Singh (2009), Resource use-efficiency in agriculture Ghazipur district of Uttar Pradesh.*Advances in Plant Sciences.* **22**(1): 313-316.

Naik, A.D., Shankarurthy, H.G., Teggi, M.Y. and Koppad, M.B., (1988), Resource use efficiency in onion cultivation in Bijapur district, Karnataka. *Karnataka J. Agric. Sci*, **11**(1): 277.

Naik, V. G.; H. K. Patil and S.M. Mulik (2002), Economics of farming systems in South Konkan coastal region of Maharashtra state. Paper presented in 13th annual convention of Maharashtra Society of Agricultural Economics held at Amravati, Feb.2002.

Naik, V. G.; S. G. Borude and S. S. Wadkar (1991), Economics of farming systems in Sindhudurg district. *J. Maharashtra Agric. Univ.*, **10**(3): 407-409.

Nanja Reddy, C., (1980), Income and employment potential of small farmers in Chennapatna block, Bangalore district, Karnataka. *Ph.D. Thesis,* Univ. Agric. Sci., Bangalore.

Nedunchezhian, P. and M. Thirunavukkarasu (2009), Economics of livestock enterprises in different farming systems. *Indian J. of Veterinary and Anim. Sci.*, **5**(2): 1-228.

Nikam, M. B.,Veerkar, P. D. and Deorukhakar, A. C. (2006), Profitability and resource use efficiency in cropping systems in command area of Natuwadi Irrigation Project in Ratnagiri District of Maharashtra State.*Journal of Maharashtra Agricultural Universities*. **31**(3): 331-333.

Pandian, A. S. S.,Shree, J. S.,Raja, M. B. and Vetrivel, D. (2013), Efficiency of resources use in urban milk production in the state of Tamil Nadu, India. *International Journal of Veterinary Science*. **2**(4): 118-120.

Patr, M. K., Sonuwara Begum and Deka, B. C. (2014), Problems and prospects of traditional pig farming for tribal livelihood in Nagaland. *Indian Research Journal of Extension Education* 2014. **14**(4): 6-11

Pawar, B. R. andPawar, D. B.(2006), Resource productivity, resource use efficiency and optimum resource use in rainfed pearl millet production.*International Journal of Agricultural Sciences*. **2**(1): 112-114.

Pawar, B. R. and Vijaykumar, N. (2012), Resource productivity and resource use efficiency in soybean production.*International Journal of Commerce and Business Management.* **5**(2): 262-264

Pawar, B. R.,Mane, P. S. and Dahiwade, P. M. (2014), Resource elasticity, marginal productivity, resource use efficiency and optimum resource use in groundnut production. *International Research Journal of Agricultural Economics and Statistics*. **5**(1): 76-79.

Pawar, B. R. and Haral, Y. R. (2013), Resource productivity and resource use efficiency in custard apple production. *Agriculture Update.* **8**(1/2): 240-243

Pawar, D. B. and Pawar, B. R. (2005), Resource productivity and resource use efficiency in soyabean. *Journal of Cotton Research and Development.* **19**(2): 287-290.

Pawar, D. B. and Pawar, B. R. (2007), Resource productivity, resource use efficiency and optimum resource use in rainfed JKCH-666 cotton production. *International Journal of Agricultural Sciences.* **3**(1): 43-45.

Ponnusamy, K., Shukla, A. K. and Kundan Kishore (2015), Studies on sustainable livelihood of farmers in horticulture-based farming systems.*Indian Journal of Horticulture*, **72**(2): 285-288.

Prasanth, V. (2012), Livestock based sustainable farming systems in Pariyaram panchayat. *Journal of Indian Veterinary Association, Kerala* (JIVA). **10**(2): 45-51.

Rai, R. B., Dhama, K., Chakraborty, S., Ram, R. A., Balvir Singh., Tiwari, R., Saminathan, M. and Damodaran, T. (2013), Comparative evaluation of crop productivity and profitability under traditional farming and integrated farming system in Northern plains of India..*South Asian Journal of Experimental Biology*, **3**(5): 220-225.

Rajashekharappa, M.T., K.B. Umesh and N. Sivaramane, (2004), Assessment of Technical efficiency in Arecanut Production: An application of non-parametric linear programming. *Agric. Econ. Res. Review*, **17**(1): 121-129.

Rajkumar B. Biradar (2007), Economics of redgram based cropping systems in Bidar district. *M.Sc. (Agri.)* Thesis, Univ. Agric. Sci., Dharwad.

Ram Suresh and Singh, H. L., (2008), Cost and return structure of sugarcane- livestock based farming system in Gonda district of Uttar Pradesh.*International Journal of Agricultural Sciences.* **4**(2): 477-479.

Ramesh Kumar, S.C., (1993), Risk efficient farming system for the eastern dry zone of Karnataka - A comparative study of watershed and non-watershed area. *Ph.D. Thesis,* Univ. Agric. Sci., Bangalore.

Rangasamy A., Annudurai, K., Subbian, P., and Chinnasamy, J., (2002), Farming system in the tropics. Kalyani Publishers., pp.3-33.

Rangaswamy, R., (1986), Rapporteur's report on science and technology for dry land farming. *Indian J. Agric. Econ*., **41**(3): 413-417.

Rao, I.V, Y.Rama (2011), Estimation of efficiency, sustainability and constraints in SRI (system of rice intensification) vis-à-vis traditional methods of paddy cultivation in North Coastal zone of Andhra Pradesh. *Agric. Econ. Res. Rev.*, **19**(2): 377-386.

Ravikumar, K. T.,Hosamani, S. B. and Desai, N. R. M. (2015), Resource use efficiency and marketing channels for pomegranate in Chitradurga district of Karnataka, India: an economic analysis. III International Symposium on Pomegranate and Minor Mediterranean Fruits, Tai'an, China.*Book Acta Horticulturae* .pp. 229-235.

Reddy, A. A and G. P. Reddy (2010), Supply side constraints in production of pulses in India: A case study of lentil. A*gric. Econ. Res. Review*., **23**(1):129-136.

Reddy, S. V. and Mundinamani, S. M.(2014) Resource use efficiency in organic farming systems in Karnataka: an economic approach to optimal use of resources in organic agriculture. *International Journal of Agricultural and Statistical Sciences*2014. **10**(2): 457-463.

Reddy, S. V. and Mundinamani, S. M. (2014), an economic analysis of organic farming systems in Karnataka State of India - a key for diversification of farm enterprise.*International Journal of Agricultural Sciences.* **10**(2): 533-539.

Regeena.S. (2009), Integrated farming for resource-use efficiency and profit maximization. *Agric. Econ. Res. Rev*., **22**(2): 495-499.

Rohile, V. V.,Naik, V. G. and Talathi, J. M.(2006), Resource use efficiency in banana production in Sindhudurg District. *International Journal of Agricultural Sciences.* **2**(1): 198-200.

Sachinkumar, T.N, Basavaraja, L.B, G.N.Kulkarni and S.B. Mahajanshetty (2012), Economics of farming systems in northern transitional zone of Karnataka. *Karnataka J. Agrc. Sci.,* **25** (3): (350-358)

Saharia, J Gogoi, P. K.,Minakshi, Mili, and Sarmah, B. K. (2014) Economics of integrated farming in Assam. *Indian Journal of Animal Production and Management.***30** (1/2): unpaginated.

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.

Sain, I., (1991), A comparative study of wheat paddy versus wheat-cotton farming systems in the south-western Punjab. *Indian.J. Agric. Econ*., **46**(3):461-462.

Salam, M. A., Sreekumar, D., Mohanakumaran, N.and Babu, K. S.(1991), Coconut-based homestead farming: a model. *Indian Coconut Journal (Cochin)*. **22**(4): 4-12.

Sankhayan, P. L. and Cheema, H. S., (1991), Using linear programming models for generating optimum farm plans – An expository analysis. *Indian J. Agric. Econ.* , **46**(4): 601-612.

Sankhayan, P. L., Dhillon and Balkar Singh (1977), Application of linear programming models in Indian agriculture - some fallacies. *Indian Journal of Agricultural Economics.* **32**(2): 51-58.

Sastry, N.T.V., (1993), Optimum enterprise system for farmers in Chittoor district, Andhra Pradesh. *Ph.D. Thesis*, Univ. Agric. Sci., Bangalore.

Satpute, T. G., More, S. S. and Sanap, D. J.(2009), Costs, returns and resource use efficiency of organic and inorganic soybean farming in Parbhani, India. *Agriculture Update.* **4** (1/2): 189-193.

Senthivel, T.; K. R. Lath and N. Gopalswamy (2002).The farming system approach for sustainable yield and income under rainfed vertisole in Tamil-Nadu. *Madras J. Agric*., **85**(1) : 65-67.

Shalander Kumar, D.K. Jain, and Rajvir Singh, (2006), Increasing income and employment through sustainable farming systems in water scarce region of Uttar Pradesh. *Agric. Econ. Res. Review,* **19** (1): 145-157.

Shanmugam K. R., and Atheendar Venkataramani, (2006), Technical efficiency in agricultural production and its determinants an exploratory study at district level. *Indian J. Agric. Econ*. , **61**(2): 169-184.

Sharma, V.P. and Singh, R.V., (1993), Resource productivity and allocation efficiency in milk production in Himachal Pradesh. *Indian J. Agric. Econ.*, **48**(2): 201-215.

Shetye, A. S.,Talathi, J. M.,Naik, V. G.,Torane, S. R. and Wagale, S. A.(2012), Resource use efficiency in organic and inorganic cashew production. *International Research Journal of Agricultural Economics and Statistics.***3**(2): 266-270

Shivanaikar, M., Guledagudda, S. S. and Prakash Mokashi (2014), Economics of sugarcane cultivation under organic and inorganic farming in Bagalkot district of Karnataka. *International Journal of Commerce and Business Management*. **7**(1): 84-87.

Singh, M.P., (2004), Economics cropping systems in Madhya Pradesh. *Rural India,* **67**(1): 29-33.

Singh, R., Singh, A. and Saini, S., (1988), Integration of improved technology of crops and milk production for increasing income and employment. *Agric. Situation in India*, **43**(9): 751-755.

Singh, S. K., Agarwal, S. B. and Chandel, B. S.(2012)Resource use efficiency in buffalo milk production in Varanasi district of Uttar Pradesh India. *Journal of Dairying, Foods and Home Sciences*.**31**(4): 259-263.

Singh, S. N., Singh, K. P., Gupta, L. R., Kadian, V. S. and Singh, N., (1991), Comparative studies on income and employment potentials of integrated farming systems on small holdings. *Indian J. Agric. Econ.*, **46**(3): 468-469.

Singh, S. P. (2008). Economics of sugarcane-based farming system in western Uttar Pradesh. *Agric. Econ. Res. Rev.*, **21**(2): 109-117.

Singh, S. P, B. Gangwar and M. P. Singh (2009), Economics of farming systems in Uttar Pradesh. *Agric. Econ. Res. Rev.*, **22**(1) :129-138.

Sirohi, A.S., Sharma, B.M., Singh, I. and Dayal, R., (1980), Role of dairy and poultry enterprises for increasing income and employment on farms in the union territory of Delhi. *Indian J. Agric. Econ.*, **35**(4): 119-129.

Srinivasa G, Chengappa, P.G. Lalith Achoth, Keshava Reddy and Nagaraja, G. N., (2005), Optimum cropping for sericulture-dominant farms in southern dry zone of Karnataka. *Agric. Econ. Res. Review*, **18** (1) 117-132.

Srivastava, S. K., Sivaramane N., and V. C. Mathur., (2010), Diagnosis of pulses performance of India. *Agric. Econ. Res. Rev.*, **23**(1) : 137-148.

Sudheer, P. S. K. (2013), Economics of organic versus chemical farming for three crops in Andhra Pradesh, India. *Journal of Organic Systems*. **8**(2): 36-49.

Sulaiman, M.,Abdulsalam, Z.,Damisa and M. A.,Siewe, F. (2015), Resource use efficiency in sugarcane production in Kaduna state, Nigeria: an application of stochastic frontier production function. *Asian Journal of Agricultural Extension, Economics and Sociology*. **7**(2): AJAEES.18630.

Sunanda N., and Narendra, I., (2003), Resource productivity of mesta farms In Srikakulam district of Andhra Pradesh. *The Andhra Agric. J.*, **50** (3&4): 327-331.

Sunny Kumar.,Sanjay Kumar.,Jasdev Singh. and Prabhjit Singh (2013), Economics and resource use efficiency of important vegetables in Punjab.*Agricultural Situation in India*.**69**(10): 3-9.

Surender, S., (2010). Efficiency of value chain: A study of dairy farming in Haryana. *Agric. Econ. Res. Rev.*, **23**(1): 561

Suresh E. (2010), Economic analysis of cropping systems under tank irrigation in northern Karnataka. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad.

Suresh Kumar, A. P.,Patel, K. S.,Asodiya, P. S. and Parmar, V. K. (2014), Input use, costs structure, return and resource use efficiency analysis of wheat crop in South Gujarat, India.*International Journal of Agricultural Extension*. **2**(1): 5-12.

Surwase, R. V.,Kshirsagar, P. J.,Talathi, J. M. and Gore, S. T. (2015), Costs, returns and profitability of sapota in Thane district. *International Research Journal of Agricultural Economics and Statistics*. **6**(1): 96-99.

Surwase, R. V.,Kshirsagar, P. J.,Talathi, J. M.,Malave, D. B. and Gore, S. T.(2015), Resource use efficiency of sapota in Thane district of Maharashtra. *International Research Journal of Agricultural Economics and Statistics*.**6**(1): 57-61.

Swami K. S. (2004), Economics of farming system in Ratnagiri district (M.S.). *M.Sc. (Agri.) Thesis*, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

Swami, K. S.,Talathi, J. M.,Deorukhkar, A. C. and Patil, H. K. (2007), Economics of farming system in Ratnagiri, India. *International Journal of Agricultural Sciences*. **3**(2): 43-44.

Takale, D. P. (2013)A study of resource-use efficiency in sugarcane cultivation. *Cooperative Sugar*. **44**(8): 49-55.

Tanveer Ahmed (2006), An Economic analysis of paddy based farming systems i n Southern Karnataka - A Case Study of Mandya District., *M.Sc. (Agri) Thesis*, Univ. Agric. Sci., Dharwad.

Thorve, P.V. and Galgalikar, V.D., (1985), Economics of diversification of farming with dairy enterprise. *Indian J. Agric. Econ.*, **40**(3): 317-323.

Tirlapur, L. N. and Mundinamani, S. M.(2015), Resource use efficiency in cultivation of major crops of Dharwad district. *Agriculture Update.* **10**(2): 93-99.

Torane S. R. (2009), An Econometric analysis of farming systems in north Konkan region of Maharashtra. *Ph.D.Thesis*, Univ. Agric. Sci., Dharwad.

Torane. S. R. (2011), Farming systems diversification in north Konkan region of Maharashtra-An economic analysis. *Agric. Econ. Res. Rev.*, **24**(1) : 91-98

Vagdevi, T. S. N.,Raju, V. T. and Shareef, S. M. (2004), Resource productivity and resource use efficiency on vegetable farms of Krishna District of Andhra Pradesh. *Economic Affairs* (Calcutta). **49**(1): 35-38.

Vasanthi, R. and Chandrasekaran, M.(2014), Evaluation of technical efficiency of rice farmers in canal and tank irrigated systems in Tamil Nadu.*International Journal of Commerce and Business Management.* **7**(2): 343-348.

Veerkar, P. D. and S. H. Kamble (2002), Economics of crop-dairy farming in Chiplun block of Ratnagiri district. Paper presented in 13th annual convention of Maharashtra Society of Agricultural Economics held at Amravati, Feb.2002.

Veerkar, P. D., (2004), An economic analysis of coconut based cropping system in Konkan region (M.S.). *Ph.D.Thesis*, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

Veerkar, P. D.; S. S. Bhosale and S. N. Patil (2002), Constraints analysis in goat farming in Ratnagiri district of Konkan region (M.S.). Paper presented in 13thannual convention of Maharashtra Society of Agricultural Economics held at Amravati, Feb.2002.

Verma, A.R., (2002), Economics of production, resource use efficiency and constraints: A case study of onion in Shajapur district of Madhya Pradesh. *The Bihar J. Agric. Market.*, **10**(4): 429-439.

Vichare, (2007), Economics analysis of rice based cropping systems in north Konkan region of Maharashtra. *Ph.D. Thesis*, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli.

Vijaykumar, N.,Patil, S. S. and Goudappa, S. B. (2014), Socio-economic characteristics of soybean growers with existing and alternative farm plans in Latur district

of Maharashtra. *International Journal of Agricultural Sciences*. **10**(1): 378-381.

Vishweshwar, S.P., (1994), Economics of hybrid cotton with special reference to pest management in Malaprabha command area. *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad.

Wadear, (2003), Animal Based Farming Systems for Long Term Sustainability in Northern Karnataka. – A Socio-Economic Assessment. *Ph.D Thesis*, Univ. Agric. Sci., Dharwad

Wadkar, S. S, S. R. Torane, D. B. Malve and S. B. Chipte (2002), Economics of farming systems in Thane district. Paper presented in 13th Annual convention of Maharashtra Society of Agricultural Economics held at Amravati, Feb.2002.

Wagale, S. A.,Talathi, J. M.,Naik, V. G. and Malave, D. B. (2007), Resource use efficiency in Alphonso mango production in Sindhudurg district (M.S.). *International Journal of Agricultural Sciences*. **3**(1): 28-34.

Wagh, M. P, B. R. Desai and S. B. Shinde (2002), Constraints in adoption of dairy technology by dairy entrepreneur. Paper presented in 13th annual convention of Maharashtra Society of Extension Education held at MAU, Parbhani.

Waghmode, R. R.,Deshmukh, K. V. and Kolambkar, R. A. (2015), Resource productivity and resource use efficiency in sugarcane production. *Journal of Ag riculture Research and Technology*. **40**(1): 176-179.