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Sustainable farming systems: Case studies documented under irrigated and rainfed farming systems

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Abstract

The present investigation was carried out in Eastern and Southern dry zones of Karnataka state. Four case studies were documented on sustainable farming systems under irrigated and rainfed farming systems having two highest level of sustainability and two lowest level of sustainability. Mr. Chikkaboregowda having higher sustainable scores than average sustainable scores of the respondents of the research study, he is having indicator wise higher sustainable scores in water management, input output relationship, land use pattern, profitability, farm level risk management, information self reliance and quality of life. He is earning net profit of Rs. 4,49,273 annually from his land and in view of well-balanced optimum combination of enterprises the annual income generation from seasonal, annual, perennial crops, livestock and poultry enterprises is very encouraging and motivating to many farmers. Mr. Krishnareddy, M. B. is having indicator wise higher sustainable scores in water management, land use pattern, cropping pattern, profitability, farm level risk management, information self sufficiency and employment generation than average sustainable scores of respondents in rainfed situation and in view of well-balanced optimum combination of enterprises Rs. 8,24,520 of annual income he earns. Mr. P. Jaishankar is having less sustainable score than the average sustainable scores of respondents in irrigated situation. The sustainable indicators such as integrated nutrient management, integrated pest management, water management, profitability, input output relationship, farm level risk management, input self sufficiency and information self reliance are having less sustainable scores. Mr. Narayanaswamy is having less sustainable scores in water management, land use pattern, cropping pattern, farm level risk management, information self reliance, family food security and quality of life than the average sustainable scores of respondents. Mr. P. Jaishankar and Mr. Narayanaswamy is not practicing different components on the farm, not preparing compost, instead they using more chemical fertilizers than on farm inputs. Cost of production is not reduced by using by-products of one component as input of another linked component. Thus, the total income of the Mr. P. Jaishankar and Mr. Narayanaswamy farm is reduced. Farming systems aim for increased productivity, profitability, food and nutritional security, sustainability, recycling of unutilized resource, generation of income round the year, adoption of new technology, solving energy fuel and fodder crisis and increased employment generation.

Keywords: Sustainability, farming systems, case studies, irrigated farming systems, rainfed farming systems, annual income

Introduction

Agriculture is a major source of livelihood to Indian farmers who have been successful in achieving the food security of the nation. The food requirement is estimated to increase about 290 and 350 million tonnes in 2030 and 2050, respectively to meet the demand of increasing population. The Indian farmers would play a pivotal role in achieving the goal, however Indian agriculture is frequently affected by the monsoon vagaries. The fragmentation of operational farm holding is a great concern and is estimated to reduce further in the year 2050. The decreasing trend of per capita land poses a serious challenge to meet the population needs. Therefore, it will become very difficult to maintain profitability and sustainability in farming with limited land and resources. The scope for expansion of area under cultivation is limited and the only option for sustainable production is to increase the productivity per unit area by increasing the cropping intensity. There is a little scope for horizontal expansion of land but, vertical expansion is possible by integrating appropriate farming components that require lesser space and time. This will pave the way to ensure reasonable periodic income to farm families (Gill *et al.*, 2009) [2]. This vertical expansion involves multi-disciplinary approach with a new technology generation without deteriorating the resources. The Integrated Farming System (IFS) is one of the answer and an alternative innovation. It is a method of getting high productivity with substantial nutrient economy with replenishment of organic matter through recycling of organic residues/wastes etc., obtained through the integration of various land-based enterprises (Vision, 2050). IFS generate employment, maintain ecological balance and optimize utilization of

resources resulting in maximization of productivity and profitability. In rainfed and irrigated areas, IFS can be taken up instead of mono-cropping. Integration of various enterprises in a farm ensures recycling of farm residues with optimum utilization of available resources. A combination of agricultural enterprises like dairy, poultry, piggery, fishery, sericulture etc. would bring prosperity to the farmers. No single farm enterprise is likely to support the small and marginal farmers for generation of adequate income and gainful employment year round (Dash *et al*., 2015) [1]. Hence, the farmers have linked two or more enterprises to enhance or improve their income and to remain employed in farms. The Integrated Farming System has become a sustainable agriculture system now in the country. It is being promoted and gaining acceptance all over the world as part of the latest efforts to encourage agriculture systems that are socially, ecologically and economically sustainable. Nutrient recycling within the system not only advocates self-sustainability of the system but also reduces dependency on the external inputs *viz*., seed/ fertilizers etc. Farming systems aim for increased productivity, profitability, food and nutritional security, sustainability, recycling of unutilized resource, generation of income round the year, adoption of new technology, solving energy fuel and fodder crisis and increased employment generation. The objectives of farming system in general are converging on to the development of suitable location specific farm technology to raise and sustain the total farm productivity in terms of food, feed, fodder and fuel and to meet the felt needs of the farmers. Keeping the above points, efforts were made to document some of case studies to know the possible reasons for higher sustainability and lower sustainability of farming systems.

Methodology

The present investigation was carried out in Eastern and Southern dry zones of Karnataka state. From each of the selected zone, one taluk representing highest irrigated and one taluk representing highest rainfed area were identified. Gubbi taluk and Srinivasapura taluk in Eastern dry zone and Mandya taluk and Gundlupet taluk in Southern dry zone. Two hoblies representing highest irrigated and two hoblies representing highest rainfed area in each selected taluk were identified again. Kasaba and Kadaba in Gubbi taluk, Kasaba and Kottathi in Mandya taluk having highest irrigation & Ronuru and Nelavanki in Srinivasapura taluk & Terkanambi and Hangla in Gundlupet taluk having highest rainfed were thus, selected. Three villages were randomly selected for the study from each of the selected hoblies based on the highest irrigated and rainfed area. From each of the selected 24 villages, 5 farmers were selected using random sampling method. Ex-post-facto research design was employed for conducting study. Data was collected by using a detailed interview schedule employing personal interview method. The responses were scored, quantified, categorized and tabulated using appropriate statistical tools. Based on sustainability level of farming system four case studies were documented, two farmers having highest sustainability level and two farmers having lowest level of sustainability under irrigated and rainfed farming systems.

Results and Discussion

Case 1: High sustainable farming systems practicing under irrigated situation

Background of the farmer: Mr. Chikkaboregowda aged about 58 years is staying in Sathnur village, Sathnur hobli of Mandya Taluk in Mandya district of Karnataka state. He studied up to 10th standard and having farming experience of 35 years. He is having land of 3 acres and 20 guntas and one bore well for permanent irrigation source. The family consists of wife and one son who are always residing on the farm.

Table 1 depicts that Mr. Chikkaboregowda having higher sustainable scores than average sustainable scores of the respondents of the research study. He is having indicator wise higher sustainable scores in water management, input output relationship, land use pattern, profitability, farm level risk management, information self reliance and quality of life.

Table 2 shows that he is cultivating sugarcane in an area of 2.5 acres, varieties are M-1, CO-62175, the special feature of this farmer is he use one eye bud for planting, wider spacing for mulching and practicing intercropping with crops like soya bean, bean, tomato and green leaf manure crops. He is cultivating paddy and ragi in an area of 0.5 acre each in kharif. Accordingly, he planted many perennial plantation trees like coconut and arecanut around the border. He also planted some tree fodders like Agase, subabul and timber species like Teak, Silver Oak. Along with this dairy as another subsidiary agricultural enterprise, he is maintaining 2 HF cows, one buffalo and 2 local cows. Small portion of the farm land is converted as poultry farm in an area of 80 x14 ft (Giriraja, Swarnadhara -1000 birds/batch), rearing goats (15 No., local breed), water storage tank is being profitably used for fish rearing (Catla – 250 No.). He constructed 2 composting tanks with 15 x 6 ft dimension, he using *Nadep* method of composting; it yields 4 tonnes of compost in 4 months. Fertigation tank has been installed for judicious usage of fertilizers and also to save labour. For judicious use of available water entire farm is drip irrigated thereby he saves labour and also weeds are under control. Integration of different agriculturally related enterprises with crops provided ways to recycle products. Cost of production is reduced by using by-products of one component as input of another linked component. Thus, the total income of the farm is raised. Multiple land use through integration of crops, livestock, poultry, fishery and goat rearing has given the best and optimum production from unit land area. He is earning net profit of Rs. 4,49,273 annually from his land and in view of well-balanced optimum combination of enterprises the annual income generation from seasonal, annual, perennial crops, livestock and poultry enterprises is very encouraging and motivating to many farmers. His advice for others is to adopt combination of planned cropping pattern, organic soil mulching besides he has adopted drip-irrigation for effective water use efficiency, labour management and to minimize expenditure.

Table 1: Indicator wise sustainability scores of Mr. Chikkaboregowda and average sustainability scores of respondents in irrigated farming system

Sl. No.	Indicators	Sustainability Score of respondent	Average sustainability scores
1	Integrated nutrient management	88.69	75.82
2	Integrated pest management	72.92	70.76
3	Water management	100.00	75.24
4	Land use pattern	113.89	94.70
5	Cropping pattern	100.00	90.37
6	Land productivity	92.33	46.68
7	Profitability	104.78	71.20
8	Input output relationship	141.10	97.58
9	Farm level risk management	85.71	60.48
10	Marketing	85.71	77.30
11	Input self sufficiency	53.15	47.87
12	Information self reliance	91.67	69.07
13	Employment generation	15.90	10.37
14	Family food security	51.67	42.83
15	Quality of life	91.40	71.90

Table 2: Net income generated from farming systems by Mr. Chikkaboregowda

Enterprise	Area	Cost of Production (Rs.)	Gross Income(Rs.)	Net Income (Rs.)
Sugarcane	2.5 acres	1,02,664	3,52,000	2,49,336
Paddy	0.5 acres	9,047	18,362	9,315
Ragi	0.5 acres	6,078	10,500	4,422
Coconut	72 Nos.	10,000	55,000	45,000
Arecanut	20 Nos.	2,000	9,000	7,000
Cows, Goat	2 HF, 1 Buffalo &15 No.	52,000	1,15,200	63,200
Poultry	1000 birds/batch- 4 batches/year	55,000	1,26,000	71,000
Total		2,36,789	6,86,062	4,49,273

Social Impact on Family

He renovated his house due to increased income he got from farming, Daughter has got married to an educated person, started investing on farm improvements, because of having more knowledge and experience many farmers are approaching him for practical knowledge, he is local leader and role model for the contemporary farmers, has a contact with local Agricultural, Horticultural, Forest department officials, Krishi Vigyana Kendra Scientist's, Non Governmental Organisations, Marketing and financial institutions and he is president of Vyavasaya Seva Sangha.

Recognitions and awards

He got 'Raita Theerpu' from Deccan Development Society, Hydrabad during 2009, he received Appreciation from Indian Council of Agricultural Research on November 2010, is an encouragement for reshaping the farmer oriented farm technologies across the country during national farm innovators meet 2010 held at JSS Krishi Vigyan Kendra, Suttur, Mysore. Awarded for natural farming in 2007 from Mandya district rural development organization, Sathnur hobli, Mandya taluk and received "Innovative Farmer" award in 2011 from Directorate of Rice Research, Rajendranagar, Hyderabad as well as "S. D. Jayaram Samudaya Seva Prashasti" in 2011from S. D. Jayaram Samagra grameena abhivruddi samste.

The integrated farming system approach has helped Mr. Chikkaboregowda to get stable returns from the entire farm. Hence, it is high time for the scientists, administrators and planners to provide adequate facilities and encouragement to the farmers to adopt integrated farming system all over the country. Since the integrated farming system is by itself self-employment oriented, these improved technologies would definitely provide lots of employment opportunities to the farmer. It also helps in maintaining livelihood security of the farmers in turn it reduces hunger and poverty of the society. Thus, the integrated farming system would improve the capabilities, assets and activities required for living means of the farmers.

Strengths for achieving high sustainability in farming systems

Main strength is he and his family members resides always on the farm, enabling timely activities and saving time in transportation, he is having consolidated land holdings, interlinking of different components on the farm, recycling of farm and animal waste for manure, they are less dependency on external inputs & labour, effective utilization of available water through drip irrigation and he is having good contacts with experts/Scientists from University, Developmental department, Research Institutions and marketing agencies. He is generating sufficient organic matter on farm which is helpful in maintaining soil fertility and reduction in use of chemical fertilizers and his innovativeness and interest in updating knowledge and technology helped him in achieving higher sustainability of farming systems.

Case 2: High sustainable farming systems practicing under rainfed situation

Mr. Krishnareddy, M. B. aged about 52 years is staying in Paccharamakalahalli village, Nelavanki hobli of Srinivaspura Taluk in Kolar district of Karnataka state. He studied up to 10th standard and having farming experience of 30 years. He is having land of 10 acres and having sufficient water for irrigation; he has 4 bore wells and having

fragmented land.. The family consists of 12 members.

Table 3 indicates that Mr. Krishnareddy, M. B. is having indicator wise higher sustainable scores in water management, land use pattern, cropping pattern, profitability, farm level risk management, information self sufficiency and employment generation than average sustainable scores of respondents in rainfed situation.

From Table 4 we can see that he is cultivating mango in an area of 4.5 acres and intercropping of cotton, ragi, field bean, red gram and coriander. Cultivating tomato in an area of 2 acres, mulberry in 2 acres of land and eucalyptus in an area of 2 acres. Accordingly, he planted many perennial trees like tamarind around the border. He also planted some tree fodders like subabul and timber species.

Along with this dairy as another subsidiary agricultural enterprise, he is maintaining 2 HFcows and 4 buffalo. Rearing sheep and goat (50 sheep and 30 goats), water storage tank has been constructed for storage and judicious use of water. He constructed 3 composting tanks with 18 x 8 ft dimension; it yields 5 tonnes of compost in 3 months. Fertigation tank has been installed in field for judicious and approximate usage of fertilizers and also to save labour. For judicious use of available water entire farm is drip irrigated thereby he saves labour and also weeds are under control. Integration of different agriculturally related enterprises with crops provided ways to recycle products. Cost of production is reduced by using by-products of one component as input of another linked component. Thus, the total income of the farm is raised. Multiple land use through integration of crops, livestock, sheep & goat rearing has given the best and optimum production from unit land area.

Table 3: Indicator wise sustainability scores of Mr. Krishnareddy and average sustainability scores of respondents in rainfed farming system

Sl. No.	Indicators	Sustainability Score of respondent	Overall average sustainability scores
1	Integrated nutrient management	78.33	74.03
2	Integrated pest management	72.92	63.37
3	Water management	70.00	50.17
4	Land use pattern	166.70	94.35
5	Cropping pattern	166.70	89.74
6	Land productivity	13.33	11.46
7	Profitability	55.87	21.00
8	Input output relationship	36.75	23.83
9	Farm level risk management	71.43	53.33
10	Marketing	77.78	71.90
11	Input self sufficiency	52.25	48.56
12	Information self reliance	97.22	68.33
13	Employment generation	9.91	6.80
14	Family food security	26.82	30.34
15	Quality of life	77.14	63.81

Table 4: Net income generated from farming systems by Mr. Krishnareddy

Enterprise	Area	Cost of Production (Rs.)	Gross Income (Rs.)	Net Income (Rs.)
Mango	4.5 acres	1,58,872	4,60,000	3,01,128
Cotton	2 acres	82,576	2,70,000	1,87,424
Ragi	2 acres	23,000	40,000	17,000
Red gram	1 acre	5,000	12,000	7,000
Avre	0.5 acre	2,000	5,200	3,200
Coriander	0.5 acre	5,600	10,000	4,400
Tomato	2 acres	1,48,782	3,22,450	1,73,668
Tamarind	20 No.	4,500	20,000	15,500
Cows	2 HF & 4 Buffalo	60,000	1,30,200	70,200
Sheep &Goat	Sheep 50 No. & Goat 30 No.	15,000	60,000	45,000
Total		5,05,330	13, 29,850	8,24,520

In view of well-balanced optimum combination of enterprises Rs. 8,24,520 of annual income generation from seasonal, annual, perennial, livestock, sheep and goat rearing enterprises is very encouraging and motivating to many farmers. His advice for others is to adopt combination of planned cropping pattern besides he has adopted drip-irrigation for effective water use efficiency, labour management and to minimize expenditure.

Social Impact on Family

He has renovated his house from the increased income from farming, started investing more on farm for improvements, many people are approaching him for his knowledge & experience in new technologies of agriculture and allied activities, he is local leader and role model for the contemporary farmers and has built up close rapport with local Agricultural, Horticultural, Forest department officials, Krishi Vigyana Kendra Scientist's, Non Governmental Organisations, Marketing and financial institutions.

Strengths for achieving high sustainability of farming systems in rainfed condition

The main strength is interlinking of different components on the farm, recycling of farm and animal waste for manure, less dependency on external inputs & labour, he is utilizing available water effectively through drip irrigation, he is having good contacts with experts/Scientists from University, Developmental department, Research

Institutions and marketing agencies. He is generating sufficient organic matter on farm which is helpful in maintaining soil fertility and reduction in use of chemical fertilizers and his innovativeness and interest in updating knowledge and technology leads him to achieve higher sustainable farming systems in rainfed condition.

Case 3: Low sustainable farming systems practicing under irrigated situation

Mr. P. Jaishankar aged about 42 years is staying in Umdahalli village, Sathnur hobli of Mandya Taluk in Mandya district of Karnataka state. He studied up to 10th standard and having farming experience of 28 years. He is having land of 4 acres and 10 guntas. The family consists of father, mother and wife who are residing on the farm, son is studying college.

Table 5 reveals that Mr. P. Jaishankar is having less sustainable score than the average sustainable scores of respondents in irrigated situation. The sustainable indicators such as integrated nutrient management, integrated pest management, water management, profitability, input output relationship, farm level risk management, input self sufficiency and information self reliance are having less sustainable scores.

He also having one bore well for irrigation and also use canal water for irrigation purpose. Table 6 depicts that he is cultivating sugarcane in an area of 3 acres and variety is CO-62175, he is not practicing mulching and intercropping. Paddy is cultivating in 1 acre during kharif and summer season. He planted only coconut around the border.

He is maintaining one HF cow, 2 local cows, one sheep and one goat. He is not practicing different components on the farm, he is not preparing compost, instead he using more chemical fertilizers than on farm inputs. Cost of production is not reduced by using by-products of one component as input of another linked component. Thus the total income of the farm is reduced.

Table 5: Indicator wise sustainability scores of Mr. Jaishankar and average sustainability scores of respondents in irrigated farming system

Sl. No.	Indicators	Sustainability Score of respondent	Average sustainability scores
1	Integrated nutrient management	61.31	75.82
2	Integrated pest management	62.50	70.76
3	Water management	60.00	75.24
4	Land use pattern	95.45	94.70
5	Cropping pattern	95.45	90.37
6	Land productivity	56.57	46.68
7	Profitability	21.89	71.20
8	Input output relationship	55.85	97.58
9	Farm level risk management	42.86	60.48
10	Marketing	71.43	77.30
11	Input self sufficiency	18.00	47.87
12	Information self reliance	33.33	69.07
13	Employment generation	6.89	10.37
14	Family food security	31.75	42.83
15	Quality of life	54.29	71.90

Table 6: Net income generated from farming systems by Mr. Jaishankar

Enterprise	Area	Cost of Production (Rs.)	Gross Income (Rs.)	Net Income (Rs.)
Sugarcane	3 acres	1,51,000	3,30,000	1,79,000
Paddy	2 acres	30,595	55,400	24,805
Coconut	30 Nos.	4,500	22,000	17,500
Cows	1 HF	17,000	34,400	17,400
Total		2,03,095	4,41,800	2,38,705

Weakness's for low sustainability

- Not practicing different components on the farm
- Not recycling farm and animal waste for fuel and manure
- More dependency on external inputs
- Less mechanization
- Not have much expert contacts
- Less innovativeness

Case 4: Low sustainable farming systems practicing under rainfed situation

Mr. P. G. Narayanaswamy aged about 41 years is staying in Paccharamakalahalli village, Nelavanki hobli of Srinivaspur Taluk in Kolar district of Karnataka state. He is illitrate and having farming experience of 20 years. He is having land of 4 acres. The family consists of wife she is residing on the farm, daughter and son is going for school.

Indicator wise sustainability scores of Mr. Narayanaswamy and average sustainability scores of respondents in rainfed farming system was depicted in table 7 and he is having less sustainable scores in water management, land use pattern, cropping pattern, farm level risk management, information self reliance, family food security and quality of life than the average sustainable scores of respondents.

He doesn't have bore well and depends on rain for irrigation. Table 8 reveals that he is cultivating mango in an area of 2 acres, ragi + Red gram + Avre in an area of 1acre.He is not practicing intercropping and 2 acres of land is barren. He is maintaining only one sheep and two goats. He is not practicing different components on the farm, he is not preparing his own compost, instead he using more chemical fertilizers than on-farm inputs. Cost of production

is not reduced by using by-products of one component as input of another linked component. Thus the total income of the farm is reduced.

Table 7: Indicator wise sustainability scores of Mr. Narayanaswamy and average sustainability scores of respondents in rainfed farming system

Sl. No.	Indicators	Sustainability Score of respondent	Overall average sustainability scores
1	Integrated nutrient management	63.33	74.03
2	Integrated pest management	56.25	63.37
3	Water management	30.00	50.17
4	Land use pattern	73.33	94.35
5	Cropping pattern	60.00	89.74
6	Land productivity	10.67	11.46
7	Profitability	17.61	21.00
8	Input output relationship	24.87	23.83
9	Farm level risk management	28.57	53.33
10	Marketing	77.78	71.90
11	Input self sufficiency	81.16	48.56
12	Information self reliance	55.56	68.33
13	Employment generation	9.24	6.80
14	Family food security	16.93	30.34
15	Quality of life	57.14	63.81

Table 8: Net income generated from farming systems by Mr. Narayanaswamy

Enterprise	Area	Cost of Production (Rs.)	Gross Income (Rs.)	Net Income (Rs.)
Mango	2 acres	80,000	1,98,000	1,18,000
Ragi + Red gram + Avre	1 acre	11,500	28,500	17,000
Total		91,500	2,26,500	1,35,000

Weakness's for low sustainability

Weakness for low sustainability score he got is because of not practicing different components on the farm, he is not recycling farm and animal waste for fuel and manure, he is more dependent on external inputs, not have much expert contacts and he is having less innovativeness.

Conclusion

Sustainability is the objective of the farming system where production process is optimized through efficient utilization of inputs without infringing on the quality of environment with which it interacts on one hand and attempt to meet the national goals on the other. In farming system, the farm is viewed in a holistic manner. Farming enterprises include crops, dairying, poultry, fishery, sericulture, piggery, apiary and tree crops etc. a combination of one or more enterprises with cropping when carefully chosen planned and executed gives greater dividends than a single enterprise. Farming systems aim for increased productivity, profitability, food and nutritional security, sustainability, recycling of unutilized resource, generation of income round the year, adoption of new technology, solving energy fuel and fodder crisis and increased employment generation.

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