Original Research Article

Sustainable Agriculture and Livestock integrated farming systems for small and marginal farmers

Abstract:

Indian economy heavily depends on agriculture and livestock. Integration of livestock with crop provides scope for effective utilization of byproducts which assures the profitability of the farming system. An integrated farming system approach is required to enhance the living standards of ~~the~~ small and marginal farmers. ~~From~~ The study ~~conducted on~~ ' Sustainable livelihoods for small and marginal farmers through agriculture and livestock activities – A study of farming systems in Kurnool district' revealed the profitable farming systems in major farming situations. The farming systems with one or more components were found profitable. The economic sustainability of the faming systems was evolved through Sustainability Value Index (SVI). Most of the farming systems in the rain-fed black soils were found sustainable. But only one farming system in rain-fed red soils was found sustainable and none of the farming systems in irrigated black soils were found sustainable. The study results ~~of the~~ could be useful for small and marginal farmers to adopt the suitable farming system. (Abstract should be structured-consist of aims, study design,methodology, results and conclusion- refer author guidelines)

Add keywords:4-6

Introduction:

Indian economy is heavily dependent on ~~the~~ agriculture and livestock. Eighty five percent of the total farming ~~is~~ relies on small and marginal farmers, having 44% of operational land. The operational farm holding in India is declining and over 85 million out of 115 million arebelow the size of 1 ha. The decrease in per capita availability of land in our country is due to the increasing population (~~*Manjunatha et al., 2014*~~) [1].

Integration of crops and livestock is very much required for small and marginal farmers to increase ~~the~~ productivity, profitability, employment generation, food and nutritional security and ~~ultimately~~ agricultural sustainability (~~*Panda M et al., 2022*~~). Integrated

Farming system is the tool for sustainable agriculture in which the byproducts of one system become input for other. Livestock plays a key role not only as food and also as useful for crops as manure and draught power (*Witjaksono J et al., 2018*). The living standards of the small and marginal farmers can be enhanced by efficient utilization of different enterprises like dairy,fish, poultry and others (*Mir M S et al.,* 2022)

Kurnool district of Andhra Pradesh is located in a scarce rainfall zone with 630mm annual rainfall. The total cultivable land is 10.2 lakh ha, mostly are black soils (7.66 lakh ha) and red soils (2.05 lakh ha). Marginal holdings constitute 40% and small farmers have 28% of the total land holdings in the district. Kurnool district is having livestock population consisting 4.09 lakh cattle (8.9%), 4.1 lakh buffaloes (6.4%), 15.04 lakh sheep (11.11%), 5.05 lakh goats (11.13%) and 12.01lakh poultry (1.47%).

Several studies have ~~conducted and~~ suggested sustainable farming systems for different agro-climatic zones of Andhra Pradesh (*Rao S H et al., 2019 and Reddy S B et al., 2021*). Since data on sustainable crop–livestock farming systems is not available for the Kurnool district, the present study was conducted on "Sustainable livelihoods for small and marginal farmers through agriculture and livestock activities – A study on farming systems in Kurnool district" with the following objectives

- To identify major agriculture and livestock farming systems in major farming situations of Kurnool district.
- To analyze the economics of the farming systems for profitability
- To assess the economic sustainability of the farming systems under major farming situations in the Kurnool district

Materials and methods:

Selection of Villages and respondents

Three major farming situations viz. rain-fed black soils, rain-fed red soils and irrigated black soils have been selected among the 12 farming systems for the study. Three villages have been selected randomly from each farming situation, covering nine villages to identify viable farming systems. Thirty farmers from each village with two or more agriculture and livestock activities were selected randomly for this study. Data was collected from a total of 270 respondents representing three major situations.

Tools of data collection:

A semi-structured schedule was designed to collect the required information from the

samples regarding their socio-economic profile, factors involved in adopting integrated farming systems, different components and their management, economic indicators of crops and livestock, sustainability indicators and problems involved in farming systems.

Research Design and Statistical analysis:

'Ex-post facto' design was used for this study. Each farming system's benefit-cost ratio (BCR) was calculated to assess profitability.

Benefit-Cost Ratio (BCR):

To know the profitability of the farming systems, Benefit-Cost Ratio was calculated for each farming system with the following formula.

BCR= Gross Income/Cost of production

Sustainability value index (SVI):

The sustainability Value Index was calculated to know the economic sustainability of the prevailing farming systems with the following formula (Kiresur et al., 2010)

$$SVI = \frac{ANI - (1.96 \times SD)}{MNI}$$

Where

SVI = Sustainability Value Index
ANI = Average Net Income
MNI = Maximum Net Income
SD = Standard Deviation
CV = Coefficient of variation

Results and discussion:

Identification of farming systems

Existing farming systems with crop and livestock (dairy, sheep and poultry) combinations were identified in the study area of major farming situations of Kurnool district and selected major farming systems in which 10 or more farmers were practicing (table1)

Major farming systems in rain-fed black soils:

The major farming systems identified in the rain-fed black soils of the Kurnool district were Crops + Dairy + Sheep & Goat + Poultry (FS-IV: 24 No), followed by crops alone (FS-I: 19 No), Crops + Dairy (FS-II: 16 No), Crops + Dairy + Sheep & Goat (FS-IV:12 No) and Crops + Dairy + Poultry (FS-III: 10 No).

Major farming systems in rain-fed red soils:

The major farming systems identified in the rain-fed black soils of Kurnool districtwere Crops + Dairy (FS-II: 26 No) followed by Crops alone (FS-I: 20 No), Crops + Dairy +

Poultry (FS-III: 17 No), Crops + Dairy + Sheep & Goat + Poultry (FS-IV: 12 No) and Crops + Dairy + Sheep & Goat (FS-IV: 10 No).

Major farming systems in rain-fed black soils:

The major farming systems identified in the rain-fed black soils of Kurnool district were Crops + Dairy (FS-II: 32 No) followed by Crops alone (FS-I: 23 No), Crops + Dairy + Poultry (FS-III: 14 No) and Crops + Dairy + Sheep & Goat + Poultry (FS-IV: 13 No).

Comparative economic analysis of major farming systems:

The profitability of the farming systems in rain-fed black soils was observed in FS-V (1.91) followed by FS-IV (1.90), FS-III (1.71), FS-II (1.70) and FS-I (1.50). The lowest profitability was observed in the farming system involving the crops only, whereas the inclusion of the livestock components greatly influenced the profitability of the farming system.

Similarly, among the major farming systems in rain-fed red soils, the highest profitability was observed in FS-II (1.82) followed by FS-III (1.71), FS-V (1.56), FS-IV (1.55) and FS-I (1.25). Unlike in the rain-fed black soils, the increase in the livestock components did not influence the profitability of the farming system due to increased production costs as the crop residues of pulses were not available in sufficient quantities to feed the livestock. At the same time, the highest profitability in the farming system involved the dairy as the only componentis due to effective resource use efficiency through grazing.

Among the four major farming systems in irrigated black soils, The highest profitability was observed in FS-V (1.84) involved the livestock components, viz. dairy, sheep and poultry along with crops, followed by FS-II (1.71), FS-III (1.26) and FS-I (1.21). The abundance of crop residues to feed the livestock in the irrigated black soils had greatly influenced the profitability.

The results are in accordance with *Reddy S B et al., 2021* identified crop + dairy and crop + dairy + horticulture are ~~the~~ sustainable integrated farming systems for the Anantapuram district. Similarly, *Rao S H et al., 2019* have also identified profitable farming systems for Vijayanagaram, Vishakhapatnam and Srikakulam districts. Higher profitability index and rate of returns were high in horticulture – livestock – fish farming in Banda district of Uttar Pradesh (*Mir MS et al., 2022*). The highest income was observed in Cattle + Crop farming systems in Odisha (*Kumari and Chouhan, 2021*).

Economic sustainability of major farming systems:

To measure the sustainability of the major farming systems in the Kurnool district, the sustainability Value Index (SVI) was calculated and presented in table 3.

Rain-fed Black Soils:

The data given in table 3 indicate that among the major farming systems, the highest positive SVI was observed in FS-III (0.287) followed by FS-V (0.163) and FS-IV (0.171). In contrast, negative SVI was observed in FS-I (-0.118) and FS-II (0.016). The data clearly indicated that FS-III (Crops + Dairy + Poultry), FS-IV (Crops + Dairy + Sheep) and FS-V (Crops + Dairy + Sheep + Poultry) were found to be economically sustainable, whereas theFS-I (Crops only) and FS-II (Crops + Dairy) were observed as negative. An increase in the numberof components has contributed income for sustainability of the farming systems in the farming situation of rain-fed black soils.

Rain-fed red soils:

It is evident from the table 3 consisting the sustainability value indices of major farming systems under rain-fed red soils that the positive and highest SVI was observed onlyin FS-V (0.204) and negative SVI was observed in FS-I (-0.192), FS-II (-0.07), FS-III (-0.196) and FS-IV (-0.085). The data clearly indicated that the farming system consisting of crops + Dairy + Sheep + Poultry was found economically sustainable, whereas the other farming systems FS-I (Crops only), FS-II (Crops + Dairy), FS-III (Crops + Dairy + Poultry) and FS-IV (Crops + Dairy + Sheep) were found economically non sustainable. The data indicated that the vagaries in the rains, unavailability of feed and fodder to the livestock and low production in crops and livestock influenced the income stability.

Irrigated black soils:

The data presented in table 3 clearly indicated that negative SVI was observed in all farming systems, viz. FS-I (-0.181), FS-II (-0.278), FS-III (0.088) and FS-IV (-0.051). Among the major farming systems negative and lowest SVI was observed in FS-II (Crops + Dairy) followed by FS-I (crops only), FS-III (Crops + Dairy + Poultry), and FS-V (Crops + Dairy + Sheep + Poultry). The high cost of inputs in crop production and livestock production and fluctuations in the yield and the sale price were the major reasons for the negative sustainability of the farming systems in the irrigated black soils. Similar to the rain-fed red soils, an increase in the components has influence on the economic sustainability of the farming system.

Kiresure et al., 2010 reported the sustainability value index was higher for the farming system with the combination of horticultural crops in Karnataka. Chouhan et al., 2022 ~~have~~ reported that the farmers had medium (71.6%) of livelihood security, ~~in~~ which 55.7% of the economic security to the total livelihood security if the farmers in NEH regions. Boussaada et al., 2022 have reported the economic sustainability of sheep farming systems in the eastern steppe ecosystem of Algeria.

Conclusions:

The major farming systems consisting of one or more livestock components are found to be more profitable than the crops alone. The sustainability of the farming systems under rain-fed black were found to be positive, whereas only one farming system in the rain-fed red soils was found positive. But all the farming systems in the irrigated black soils were found to be negative. The study results are useful for small and marginal farmers to adopt a suitable farming system to get sustainable income.

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Tables:

Table 1. Farming systems practiced by the sample respondents in the study area

S.No	Farming systems	Irrigated Black soils N=90	Rain-fed Blacksoils N=90	Rain-fed RedSoils N=90
1	Crops	**23 (25.6)**	**19 (21.1)**	**20 (22.2)**
2	Crops + Dairy	**32 (35.6)**	**16 (17.8)**	**26 (28.9)**
3	Crop + Dairy + Poultry	**14 (15.6)**	**10 (11.1)**	**17 (18.9)**
4	Crop + Dairy + Sheep & Goat	3 (3.3)	**12 (13.3)**	**10 (11.1)**
5	Crop + Dairy + S&G + Poultry	**13 (14.4)**	**24 (26.7)**	**12 (13.3)**
6	Crop + Poultry	3 (3.3)	4 (4.4)	1 (1.1)
7	Crop + Sheep + Poultry	2(2.2)	5 (5.6)	2 (2.2)
8	Crop + S&G	0	0	2 (2.2)
	Total	90 (100)	90 (100)	90 (100)

Table 2. Comparative economics of the major farming systems in the study area

S.No	Farming system	Total variable costs	Total fixed cost	Total cost	Gross income	Net Returns	Net returns over	BCR
Rain-fed Black Soils								
1	FS-I	₹ 69,048.00	₹ 24,521.00	₹ 93,569.00	₹ 1,40,419.00	₹ 46,850.00	₹ 71,371.00	1.5
2	FS-II	₹ 1,58,114.00	₹ 36,750.00	₹ 1,94,864.00	₹ 3,29,537.00	₹ 1,34,673.00	₹ 1,71,423.00	1.7
3	FS-III	₹ 1,25,945.00	₹ 28,140.00	₹ 1,54,085.00	₹ 2,64,000.00	₹ 1,09,915.00	₹ 1,38,055.00	1.71
4	FS-IV	₹ 2,14,896.00	₹ 22,250.00	₹ 2,37,146.00	₹ 4,50,495.00	₹ 2,13,349.00	₹ 2,35,599.00	1.9
5	FS-V	₹ 1,80,058.00	₹ 29,750.00	₹ 2,09,808.00	₹ 4,01,518.00	₹ 1,91,710.00	₹ 2,21,460.00	1.91
Rain-fed Red Soils								
1	FS-I	₹ 70,251.00	₹ 30,300.00	₹ 1,00,551.00	₹ 1,26,053.00	₹ 25,502.00	₹ 55,802.00	1.25
2	FS-II	₹ 1,03,855.00	₹ 30,023.00	₹ 1,33,878.00	₹ 2,43,942.00	₹ 1,10,064.00	₹ 1,40,087.00	1.82
3	FS-III	₹ 1,09,445.00	₹ 29,294.00	₹ 1,38,739.00	₹ 2,37,904.00	₹ 99,165.00	₹ 1,28,459.00	1.71
4	FS-IV	₹ 1,96,030.00	₹ 32,160.00	₹ 2,28,190.00	₹ 3,54,820.00	₹ 1,26,630.00	₹ 1,58,790.00	1.55
5	FS-V	₹ 2,18,029.00	₹ 37,750.00	₹ 2,55,779.00	₹ 3,99,830.00	₹ 1,44,051.00	₹ 1,81,801.00	1.56
Irrigated Black Soils								
1	FS-I	₹ 2,05,873.00	₹ 60,521.00	₹ 2,66,394.00	₹ 3,22,550.00	₹ 56,156.00	₹ 1,16,677.00	1.21
2	FS-II	₹ 2,38,962.00	₹ 66,993.80	₹ 2,84,862.00	₹ 4,88,348.00	₹ 2,03,486.00	₹ 2,49,386.00	1.71
3	FS-III	₹ 3,65,706.00	₹ 1,54,130.00	₹ 5,19,836.00	₹ 6,54,220.00	₹ 1,34,384.00	₹ 2,88,514.00	1.26
4	FS-V	₹ 2,31,628.00	₹ 56,511.80	₹ 2,88,140.00	₹ 5,31,335.00	₹ 2,43,195.00	₹ 2,99,707.00	1.84

Table 3. Economic sustainability indices of major farming systems in the Kurnool district

Farming system	Maximum Net Income	Average Net Income	SD	CV (%)	Sustainability Value Index
Rain-fed Black Soils					
FS-1	169000	71372	46576	65	-0.118
FS-II	398000	201764	106095	53	-0.016
FS-III	200600	142901	43495	30	0.287
FS-IV	368800	225703	82986	37	0.171
FS-V	384150	218159	79391	36	0.163
Rain-fed Red Soils					
FS-I	203000	55409	48107	87	-0.192
FS-II	387500	151800	91237	60	-0.070
FS-III	298400	188467	65117	79	-0.196
FS-IV	399700	168390	103189	61	-0.085
FS-V	365700	132547	104125	35	0.204
Irrigated Black Soils					
FS-I	543200	117007	109856	94	-0.181
FS-II	639700	258836	153916	59	-0.278
FS-III	560250	290193	173308	60	-0.088
FS-V	847490	304337	177403	58	-0.051