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RESEARCH ARTICLE

Economic evaluation of Integrated Farming Systems (IFS) in Jagtial district of Telangana

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Abstract

The study was initiated during 2019-20 to evaluate the economic viability, input utilization patterns and constraints of major Integrated Farming Systems (IFS) in the Jagtial district of Telangana. Using a cluster sampling technique, two mandals and four villages were purposively selected and a random sampling technique was employed to choose 120 farmers for the study. Data was analyzed using tabular analysis, financial analytical tools and Garrett ranking techniques. The findings revealed that the Crop + Dairy + Small Ruminants system was the most profitable and financially feasible, with a net returns of Rs 120004 and return per rupee of investment of 1.77. The integration of two buffaloes, three sheep and one goat with crops emerged as the optimal module for maximizing farm returns. It was followed by the crop + dairy system with net returns of of Rs 100427.86 and the return per rupee spent rose to 1.69. It was also found that small ruminant's enterprise was highly profitable as indicated by Net present value of 3.21 and Internal Rate of Return (IRR) of 220.02. The garrette ranking technique identified non-availability of labour in peak time for crop production as a significant challenge for most farmers The results emphasize the importance of promoting integrated farming systems among farmers through strengthened extension efforts. Recommendations include adopting the crop + dairy + small ruminants module to enhance income generation and sustainability. This study contributes to understanding IFS role in increasing farmers' incomes and achieving agricultural sustainability in the study area.

Keywords : crop; dairy; garrett ranking; profitability; small ruminants

Introduction

Agriculture in India continues to be a major livelihood source, engaging over 50 % of the population and contributing approximately 17-18 % to the national gross value added (1). Nearly 86 % of Indian farmers are small and marginal, cultivating less than 2 hectares of land (2). However, the widespread practice of monoculture, especially cereal-based systems, has led to issues like declining productivity, overuse of inputs, soil degradation and increased vulnerability to climate and market risks (3).

IFS are increasingly recognized as a sustainable alternative that addresses these challenges. IFS involve the purposeful integration of multiple enterprises such as crops, livestock, poultry, fisheries and horticulture within a farm unit to optimize resource use and diversify income (4). By creating complementarities among components, IFS improves productivity, promotes internal recycling and minimizes external input dependency, ultimately strengthening farm resilience (5).

Several studies have reported that smallholders adopting IFS have experienced increased income, employment generation and nutritional security (6). For example, in Telangana, farmers practicing IFS showed a 30-40 % increase in net returns compared to those engaged in mono-cropping. In addition, IFS has shown positive environmental outcomes, including improved soil health and water-use efficiency.

Despite these benefits, IFS adoption remains low due to barriers such as lack of technical guidance, access to finance and limited awareness of enterprise integration. Region-specific studies are needed to demonstrate economic feasibility and guide policy interventions.

The present investigation aims to evaluate the economic performance of different IFS modules adopted by farmers in the Jagtial district of Telangana and to identify major constraints affecting their adoption.

Hypothesis of the study

H_0: IFS do not significantly improve farm income and livelihood security among smallholder farmers in Jagtial district.

H_1: IFS significantly improve farm income and livelihood security among smallholder farmers in Jagtial district.

Materials and Methods

Study area

Jagtial district (18°49′ N, 78°50′ E), in northern Telangana on the Deccan Plateau, exhibits a tropical monsoon climate, with hot summers (37-38 °C), mild winters (22 °C) and mainly southwest monsoon rainfall (900-1500 mm annually). The soils ranging from red sandy loams and black soils to lateritic and salt affected types sit on granite-gneiss bedrock and show moderate fertility with varied texture and nutrient profiles. Water resources combine surface tanks and canal systems (enhanced by Mission Kakatiya) with groundwater that is moderately suitable for irrigation, supporting around 60 % irrigated agriculture alongside rainfed cropping. Land use is dominated by agriculture primarily paddy, pulses, maize and oilseeds with remnant dry-deciduous and thorn scrub vegetation characteristic of the Central Deccan ecoregion. It is bounded by Nirmal and Mancherial districts on the north and northeast, to the south and southwest by Karimnagar and Peddapalli districts respectively and on the west by Nizamabad district as shown in Fig. 1. Cluster sampling technique was used for selection of 2 mandals and 4 villages due to cost effectiveness, manageable logistics and representativeness. Random sampling technique was employed for selection of 30 farmers in each village. Hence, the entire sample becomes 120 as presented in Table 1.

Data was collected for the period 2020. Tabular analysis, cost concepts, discounted cash flow analysis and Garrett's ranking method for data analysis was employed to arrive at the conclusions. Financial performance indicators, including NPV, BCR and IRR, were employed to evaluate the profitability and long term sustainability of IFS farming. Additionally, Garrett's ranking method was applied to identify the constraints faced by the farmers.

Net Present Value (NPV)

NPV is the present value of net benefits, computed by deducting the total discounted costs from the total discounted returns. A positive NPV indicates the viability and worthiness of investing in IFS. Essentially, it reflects the net present worth of the cash flow over time.

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1=r)^t} \quad \text{(Eqn. 1)}$$

Where, Bt: benefits realized in rupees in t^{th} year, Ct: costs incurred in rupees in t^{th} year, n: number of years and r: discount rate 12 %.

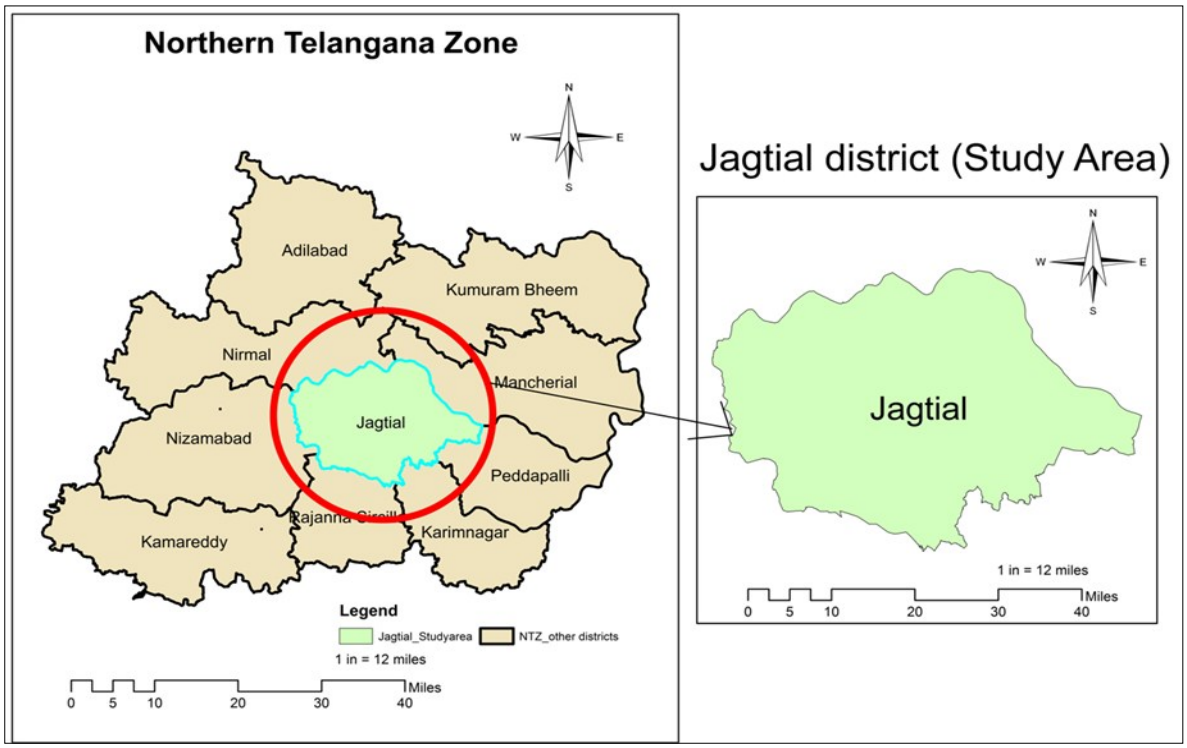

Fig. 1. Map showing area of Jagtial district of Northern Telangana zone.

Table 1. List of selected district, mandals, villages and sample farmers with key ecological factors relevant to each mandal/village cluster

District	Mandals	Villages	No. of farmers interviewed	Ecological factors
Jagtial	Jagtial Rural	Chelgal	30	Tropical monsoon climate; red sandy loam soils (pH 6.8-8.3) with moderate fertility; surface tanks/canals + moderately suitable groundwater; dominant
		Laxmipur	30	Tropical monsoon climate; red sandy loam soils (pH 6.8-8.3) with moderate fertility; surface tanks/canals + moderately suitable groundwater; dominant wet–dry cropping (rice, pulses)
	Korutla	Joganpally	30	Tropical monsoon climate: mixed soils (sandy–clay loam to lateritic/salt-affected); irrigation via tanks/canals; agriculture (rice, maize, oilseeds) in
		Venkatapur	30	Tropical monsoon climate: mixed soils (sandy–clay loam to lateritic/salt-affected); irrigation via tanks/canals; agriculture (rice, maize, oilseeds) in

Benefit Cost Ratio (BCR)

The BCR is another indicator used to evaluate the feasibility of an investment. It is the ratio of the sum of discounted net benefits to the sum of discounted capital costs. It is expressed as follows:

$$BCR = \frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{t=n} \frac{C_r}{(1+r)^t}} \quad \text{(Eqn. 2)}$$

Where, B_t: discounted benefits realized in rupees per ha per annum. C_t: discounted costs incurred in rupees per ha per annum, n: number of years of investment and r: discount rate 12 %.

Internal Rate of Return (IRR)

IRR is the discount rate that equates the net present worth of cash flow equal to zero. An investment is considered viable if the calculated IRR exceeds the bank interest rate, which represents the opportunity cost of capital.

$$IRR = r_a + \frac{NPV_a}{NPV_a - NPV_b}(r_b - r_a) \quad \text{(Eqn. 3)}$$

Where, r_a: lower discount rate, r_b: higher discount rate, N_a: NPV at r_a and N_b: NPV at r_b. Acceptable criterion: The IRR estimated is compared with the rate of return known as the cut-off or hurdle rate. The investment made is considered worthy if the IRR exceeds the bank rate.

Garrett's ranking technique

The technique is used to convert ranks assigned by respondents into scores, allowing for the prioritization of factors or constraints. In this study, Garrett's ranking technique was employed to rank the constraints faced by the farmers.

$$\text{Percentage position} = 100 * (R_{ij} - 0.5) / Nj \quad \text{(Eqn. 4)}$$

Where, R_{ij}= rank given for i^{th} factor by j^{th} individual, N_j= number of factors ranked by j^{th} individual.

Procedure

The ranks assigned by respondents were converted into percentage positions using the formula. The corresponding scores for the percentage positions were obtained from Garrett's table. For each factor, the scores from all respondents were summed and the mean value was calculated. The factors were arranged in descending order of their mean scores. The factor with the highest mean score was assigned the highest rank, indicating its importance. This method enables the systematic identification and prioritization of key issues based on respondent feedback (7).

Results and Discussion

Table 2 depicts existing farming systems followed by sample households. More than two-thirds of the 120 farming households use mixed farming. The most common setup is growing crops with dairy animals i.e., 45 households, then crops, dairy and poultry together i.e., 35 households. Only 23 households grow crops alone and very few include goats or sheep in their farming. This shows farmers prefer starting with crops and dairy since it's easy and reliable and then adding poultry for extra income. Including small ruminants happens less often because they require more care. Overall, farmers are choosing simple, mixed systems to boost income, use resources wisely and make their farms more stable (8).

Table 3 presents the distribution of IFS farmers based on land holdings across four villages in the study area. Among the total 97 IFS farmers, Laxmipur had 7 marginal farmers, 11 small and 6 large farmers, making a total of 24 IFS farmers. In Chelgal, 13 marginal farmers, 7 small farmers and 4 large farmers were practicing IFS, bringing the total to 24. Joginpally had 10 marginal farmers, 8 small farmers and 6 large farmers, total of 24 IFS farmers. Venkatapur had 5 marginal farmers, 12 small farmers and 8 large farmers, with a total of 25 IFS farmers. This distribution reflects a diverse adoption of IFS across different landholding categories, with a relatively higher representation of small farmers in each village.

Table 4 presents the average farm size of sample respondents in hectares, comparing IFS farmers with control farmers across different landholding categories. Among

Table 2. Existing farming systems followed by sample households (in numbers)

Sl. No.	Farming system	Marginal farmers	Small farmers	Large farmers	Total
1	C	9	9	5	23
2	C+D	14	19	12	45
3	C+D+P	14	13	8	35
4	C+D+S	4	5	3	12
5	C+S+P	3	1	1	5
	Total	44	47	29	120

C-Crop, D-Dairy, P-Poultry, S-Small ruminants.

Table 3. List of IFS farmers according to land holdings in the study area

Name of village	Marginal farmers (No.)	Small farmers (No.)	Large farmers (No.)	Total (No.)
Laxmipuram	7	11	6	24
Chelgal	13	7	4	24
Joginpally	10	8	6	24
Venkatapur	5	12	8	25
Total	35	38	24	97

Table 4. Average farm size of sample respondents (in Ha).

S. No.	Particulars	Marginal		Small		Large		Grand total	
		IFS	Control	IFS	Control	IFS	Control	IFS	Control
1	No. of farmers	35	9	38	9	24	5	97	23
2	Avg. size of holding	0.58	0.64	1.52	1.30	3.43	2.92	1.84	1.62

marginal farmers, the average farm size for IFS practitioners was 0.58 hectares, slightly smaller than the 0.64 hectares for control farmers. For small farmers, IFS practitioners had an average farm size of 1.52 hectares, compared to 1.30 hectares for control farmers. Large farmers practicing IFS had an average farm size of 3.43 hectares, while control farmers in this category had a slightly smaller average of 2.92 hectares. Overall, the average farm size for IFS farmers across all categories was 1.84 hectares, compared to 1.62 hectares for control farmers. These findings highlight that IFS adoption does not necessarily require large land holdings and can be effectively implemented across various farm sizes, benefiting small and marginal farmers as well (9).

Table 5 outlines the cropping systems followed by sample farmers in the study area, categorized by season and village. In the *Kharif* season, all four villages - Laxmipur, Chelgal, Joginpally and Venkatapur predominantly cultivated paddy, with turmeric and maize also being common crops across all villages. Specifically, turmeric was cultivated in all four villages, while maize was also grown in all villages.

In the *Rabi* season, paddy was again the dominant crop in all four villages. Additionally, sesame was grown in all villages, while groundnut was cultivated in Laxmipur, maize in all villages. In Joginpally and Venkatapur, maize was also grown during the *Rabi* season, with no other significant crops reported in the respective villages. This cropping pattern indicates a strong focus on staple crops like paddy, with diversification through crops like sesame, maize and turmeric across the villages.

Table 6 presents the average number of livestock among sample farmers, categorized by landholding size. In terms of dairy livestock, marginal farmers had an average of 1.8 animals, small farmers had 2.5 and large farmers had 4.0, with the overall average across all farmers being 2.43. For sheep, marginal farmers had the highest average number at 4.3, followed by small farmers with 4.0 and large farmers with 2.0, resulting in an overall average of 3.43 sheep per farmer. The average number of goats was relatively similar across all categories, with marginal farmers having 1.6, small farmers 1.5 and large farmers 1.0, leading to a total average of 1.33 goats per farmer. Poultry numbers were notably higher, with marginal farmers owning an average of 20.11 birds, small farmers 19.1 and large farmers 11.3, yielding an average of 16.8 poultry across all farmers. This data reflects the greater emphasis on livestock, particularly dairy and poultry, among small and marginal farmers, which are key components of IFS (10).

Costs and returns of crops

Table 7 presents the costs and returns of major crops in IFS across different farm categories in the study area. The costs and returns are broken down for paddy, maize, turmeric, sesame and groundnut, with data provided for marginal, small and large farmers.

Table 5. Cropping systems of sample farmers in the study area

	Cropping system of farmers			
Season/ Village	Laxmipur	Chelgal	Joginpally	Venkatapur
Kharif	Paddy	Paddy	Paddy	Paddy
	Turmeric	Turmeric	Turmeric	Turmeric
	Maize	Maize	Maize	Maize
Rabi	Paddy	Paddy	Paddy	Paddy
	Sesame	Sesame	Sesame	Sesame
	Groundnut	Maize	Maize	Maize
	Maize	-	-	-

Table 6. Status of livestock among sample famers (in average numbers)

Livestock	Marginal farmers	Small farmers	Large farmers	Average of all farmers
Dairy	1.8	2.5	4.0	2.43
Sheep	4.3	4.0	2.0	3.43
Goat	1.6	1.5	1.0	1.33
Poultry	20.11	19.1	11.3	16.8

Table 7. Costs and returns in major integrated farming systems in the study area

Crop	Paddy			
	Marginal famers	Small farmers	Large farmers	Average
Total cost of cultivation (Rs/ha)	38034.28	36887.57	34262.91	36394.92
Gross returns (Rs/ha)	52510.44	53151.14	55890.28	53850.62
Net returns (Rs/ha)	14476.2	16263.6	21627.4	17455.7
Returns per rupee spent	1.38	1.44	1.63	1.48
Crop	**Maize**			
	Marginal famers	**Small farmers**	**Large farmers**	**Average**
Total cost of cultivation (Rs/ha)	45091.57	44929.48	41861.02	43960.69
Gross returns (Rs/ha)	58992.98	59791.49	57890.28	58891.58
Net returns (Rs/ha)	13901.4	14862	16029.3	14930.9
Returns per rupee spent	1.31	1.33	1.38	1.34
Crop	**Turmeric**			
	Marginal famers	**Small farmers**	**Large farmers**	**Average**
Total cost of cultivation (Rs/ha)	76342.51	79018.58	79969.59	78443.56
Gross returns (Rs/ha)	97218.56	120087.82	121059.45	112788.61
Net returns (Rs/ha)	20876.1	41069.2	41089.9	34345.1
Returns per rupee spent	1.27	1.52	1.51	1.44
Crop	**Sesame**			
	Marginal famers	**Small farmers**	**Large farmers**	**Average**
Total cost of cultivation (Rs/ha)	24986.45	27882.29	31964.58	28277.77
Gross returns (Rs/ha)	41279.75	43557.27	46819.38	43885.47
Net returns (Rs/ha)	16293.3	15675	14854.8	15607.7
Returns per rupee spent	1.65	1.56	1.46	1.55
Crop	**Groundnut**			
	Marginal famers	**Small farmers**	**Large farmers**	**Average**
Total cost of cultivation (Rs/ha)	45305.04	44704.13	41874.28	43961.15
Gross returns (Rs/ha)	58873.28	57880.25	59891.82	58881.78
Net returns (Rs/ha)	13568.2	13176.1	18017.5	14920.6
Returns per rupee spent	13568.24	13176.12	18017.54	14920.63

For paddy, the total cost of cultivation ranged from Rs 34262.91 per ha for large farmers to Rs 38034.28 per ha for marginal farmers, with average gross returns of Rs 53850.62 per ha. The net returns ranged from Rs 14476.20 per ha for marginal farmers to Rs 21627.40 per ha for large farmers and the returns per rupee spent were the highest for large farmers (1.63), with an overall average of 1.48.

For maize, the per ha total cost of cultivation varied slightly between farm categories, with the highest cost for marginal farmers (Rs 45091.57) and the lowest for large farmers (Rs 41861.02). Gross returns averaged Rs 58891.58 per ha, with net returns of Rs 14930.90 per ha across all farmers. The returns per rupee spent were again highest for large farmers (1.38), with an overall average of 1.34.

For turmeric, the cost of cultivation ranged from Rs 76342.51 for marginal farmers to Rs 79969.59 for large farmers. Gross returns for turmeric averaged Rs 112788.61, with net returns of Rs 34345.10. Returns per rupee spent were highest for small and large farmers (1.52 and 1.51, respectively) and the overall average was 1.44.

For sesame, marginal farmers incurred the lowest cost of cultivation (Rs 24986.45) compared to large farmers (Rs 31964.58), with average gross returns of Rs 43885.47. Net returns were highest for marginal farmers (Rs 16293.30) and the overall return per rupee spent was 1.55, with marginal farmers earning 1.65.

For groundnut, the cost of cultivation ranged from Rs 41874.28 per ha for large farmers to Rs 45305.04 per ha for marginal farmers, with an average gross return of Rs 58881.78 per ha. Net returns were slightly higher for large farmers (Rs 18017.50 per ha) compared to marginal farmers (Rs 13568.20 per ha). The return per rupee spent was 1.65 for large farmers and averaged 1.55 across all farmers.

These results suggest that while the returns per rupee spent are higher for large farmers in certain crops, marginal and small farmers also experience positive returns, especially in crops like paddy, maize and groundnut, which highlights the viability of IFS across different farm categories.

Costs and returns of marginal farmers of IFS

Table 8 and Fig. 2 presents a comparative analysis of the economics of different IFS modules versus conventional crop production for marginal farmers in the study area. The costs and returns of various components- crop, dairy, small ruminants and poultry are calculated for different IFS modules.

For the conventional crop production system (C), the per unit total cost of production was Rs 111618.45, with gross returns of Rs 149540.74, resulting in net returns of Rs 37922.29 and returns per rupee spent of 1.34 shown in Fig. 2. When dairy (C+D) was integrated, the total cost increased to Rs 149654.28, but gross returns also increased significantly to Rs 234638.16, leading to net returns of Rs 84983.88 and returns per rupee spent of 1.57 shown in Fig. 2.

Table 8. Comparative economics of different IFS modules against conventional crop production of marginal farmers

Component/ Module	Crop (Rs /unit)		Dairy (Rs /Unit)		Small ruminants (Rs /Unit)		Poultry (Rs /Unit)		Total costs (Rs /farm)			
	Costs	Returns	Costs	Returns	Costs	Returns	Costs	Returns	Costs	Returns	Net Returns	Returns per rupee spent
Crop	111618.45	149540.74	-	-	-	-	-	-	111618.45	149540.74	37922.29	1.34
C+D	111618.45	149540.74	35760.83	85097.42	-	-	-	-	149654.28	234638.16	84983.88	1.57
C+D+P	111618.45	149540.74	35760.83	85097.42	-	-	2275.00	10654.00	147379.28	245292.16	97912.88	1.66
C+D+S	111618.45	149540.74	35760.83	85097.42	10583.66	31590.00			157962.94	266228.16	108265.22	1.69
C+S+P	111618.45	149540.74			10583.66	31590.00	2275.00	10654.00	124477.11	191784.74	67307.63	1.54

Crop - unit - 1 ha, Dairy - unit - 2 animals, Small ruminants - unit - 3 sheep +1 goat, Poultry - unit - 20 birds.

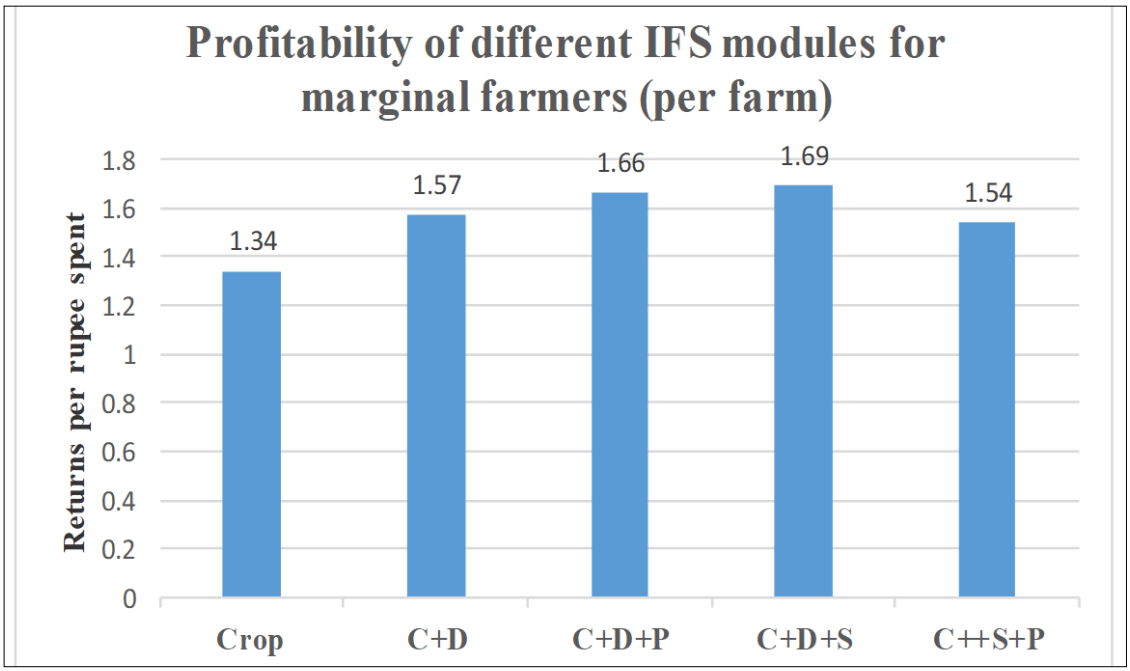

Fig. 2. Profitability of different IFS modules of marginal farmers (per farm).

The addition of poultry (C+D+P) further enhanced returns, with per unit total cost of Rs 147379.28 and gross returns of Rs 245292.16, yielding net returns of Rs 97912.88 and returns per rupee spent of 1.66 shown in Fig. 2. When small ruminants (C+D+S) were included, the total cost rose to Rs 157962.94, but gross returns increased to Rs 266228.16, leading to net returns of Rs 108265.22 and the highest returns per rupee spent at 1.69 shown in Fig. 2.

For the combination of small ruminants and poultry (C+S+P), the per unit total cost was Rs 124477.11, with gross returns of Rs 191784.74, resulting in net returns of Rs 67307.63 and returns per rupee spent of 1.54 shown in Fig. 2. These findings suggest that incorporating multiple components like dairy, small ruminants and poultry into the farming system increases profitability and resource-use efficiency for marginal farmers, with the C+D+S module offering the highest net returns and returns per rupee spent.

Table 9 and Fig. 3 shows comparative analysis of different IFS modules against conventional crop production for small farmers, the economic performance of each system was assessed based on costs, returns and net returns.

The conventional crop production system (C) generated a net return of Rs 45627.07 with a return per rupee spent of 1.40. In contrast, integrating dairy into crop production (C+D) significantly improved profitability, yielding net returns of Rs 106599.71 and a return per rupee spent of 1.74. The addition of poultry (C+D+P) further enhanced returns, with net returns reaching Rs 115111.42 and a return per rupee spent of 1.78. The combination of crop, dairy and small ruminants (C+D+S) showed the highest economic efficiency, providing net returns of Rs 127341.13 and a return per rupee spent of 1.81, making it the most profitable IFS module. The system integrating crop, small ruminants and poultry (C++S+P) also provided positive returns, but at a lower net return of Rs 74880.20 and a return per rupee spent of 1.59. These findings underscore the advantages of diversified farming systems over conventional monoculture crop production, highlighting the potential for increased profitability and resource efficiency in smallholder farming (11).

Table 10 and Fig. 4 showed the comparative analysis of different IFS modules against conventional crop production for large farmers which reveals significant differences in profitability and resource efficiency.

Conventional crop production (C) generated a net return of Rs 52045.01 with a return per rupee spent of 1.48. Integrating dairy (C+D) substantially improved economic returns, yielding net returns of Rs 107424.99 and a return per rupee spent of 1.76. The addition of poultry (C+D+P) further boosted profitability, with net returns of Rs 115728.60 and a return per rupee spent of 1.80. Similarly, the integration of small ruminants along with crop and dairy (C+D+S) produced net returns of Rs 124406.95 and a return per rupee spent of 1.81, making it the most economically efficient system among those analyzed. The system combining crop, small ruminants and poultry (C+S+P) also showed positive returns, but at a lower net return of Rs 77330.58 and a return per rupee spent of 1.63. These findings suggest that diversified farming systems are more profitable and efficient than conventional crop production for large farmers (12).

Table 11 and Fig. 5 shows the comparative analysis of different IFS modules against conventional crop production for IFS farmers. Conventional crop production (C) generated a net return of Rs 45198.13, with a return per rupee spent of 1.41. By integrating dairy into crop production (C+D), net returns

Table 9. Comparative economics of different IFS modules against conventional crop production of small farmers

Component/ Module	Crop (Rs /unit)		Dairy (Rs /Unit)		Small ruminants (Rs /Unit)		Poultry (Rs /Unit)		Total costs (Rs /farm)			
	Costs	Returns	Costs	Returns	Costs	Returns	Costs	Returns	Costs	Returns	Net returns	Returns per rupee spent
Crop	112808.78	158435.85							112808.78	158435.85	45627.07	1.40
C+D	112808.78	158435.85	31876.56	92849.20					144685.34	251285.05	106599.71	1.74
C+D+P	112808.78	158435.85	31876.56	92849.20			2269.29	10781.00	146954.63	262066.05	115111.42	1.78
C+D+S	112808.78	158435.85	31876.56	92849.20	11888.58	32630.00			156573.92	283915.05	127341.13	1.81
C++S+P	112808.78	158435.85			11888.58	32630.00	2269.29	10781.00	126966.65	201846.85	74880.20	1.59

Crop – unit – 1 ha, Dairy - unit – 2 animals, Small ruminants - unit – 3 sheep+1 goat, Poultry - unit – 20 birds.

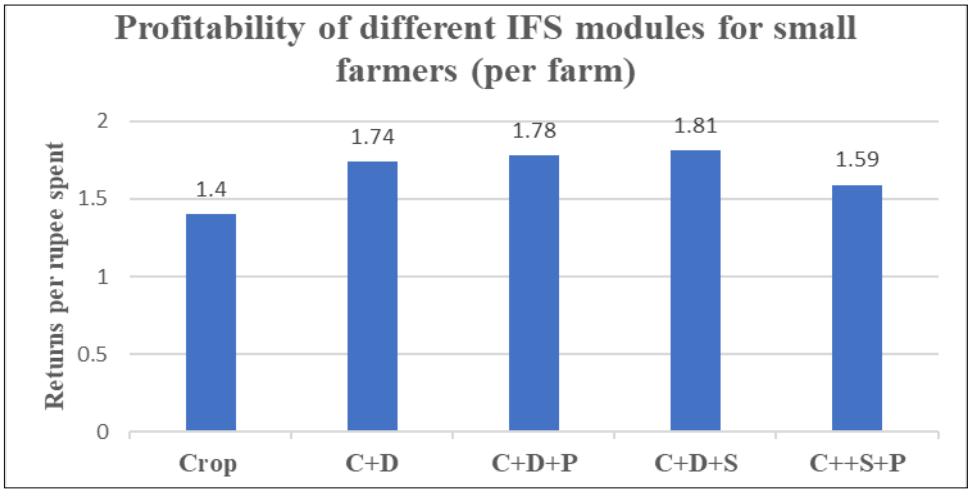

Fig. 3. Profitability of different IFS modules of small farmers (per farm).

Table 10. Comparative economics of different IFS modules against conventional crop production of large farmers

Component/ Module	Crop (Rs /unit)		Dairy (Rs /Unit)		Small ruminants (Rs /Unit)		Poultry (Rs /Unit)		Total costs (Rs /farm)			
	Costs	Returns	Costs	Returns	Costs	Returns	Costs	Returns	Costs	Returns	Net Returns	Returns per rupee spent
Crop	108458.71	160503.73							108458.71	160503.73	52045.01	1.48
C+D	108458.71	160503.73	33507.70	88887.68					141966.41	249391.41	107424.99	1.76
C+D+P	108458.71	160503.73	33507.70	88887.68			2243.39	10547.00	144209.80	259938.41	115728.60	1.80
C+D+S	108458.71	160503.73	33507.70	88887.68	11618.04	28600.00			153584.45	277991.41	124406.95	1.81
C++S+P	108458.71	160503.73			11618.04	28600.00	2243.39	10547.00	122320.14	199650.73	77330.58	1.63

Crop – unit – 1 ha, Dairy - unit – 2 animals, Small ruminants - unit – 3 sheep+1 goat, Poultry - unit - 20 birds.

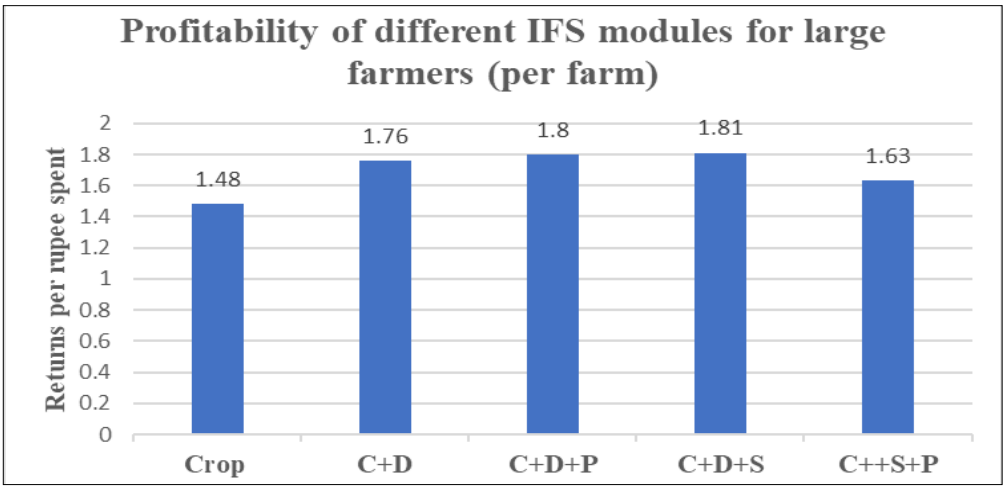

Fig. 4. Profitability of different IFS modules of large farmers (per farm).

Table 11. Comparative economics of different IFS modules against conventional crop production of IFS farmers

Component/ Module	Crop (Rs /unit)		Dairy (Rs /Unit)		Small ruminants (Rs /Unit)		Poultry (Rs /Unit)		Total costs (Rs /farm)			
	Costs	Returns	Costs	Returns	Costs	Returns	Costs	Returns	Costs	Returns	Net returns	Returns per rupee spent
Crop	110961.98	156160.11							110961.98	156160.11	45198.13	1.41
C+D	110961.98	156160.11	33715.03	88944.77					144677.01	245104.87	100427.86	1.69
C+D+P	110961.98	156160.11	33715.03	88944.77			2262.56	10660.67	146939.57	255765.54	108825.97	1.74
C+D+S	110961.98	156160.11	33715.03	88944.77	11363.43	30940.00			156040.44	276044.87	120004.43	1.77
C++S+P	110961.98	156160.11			11363.43	30940.00	2262.56	10660.67	124587.97	197760.77	73172.81	1.59

Crop – unit – 1 ha, Dairy - unit – 2 animals, Small ruminants - unit – 3 sheep+1 goat, Poultry - unit – 20 birds

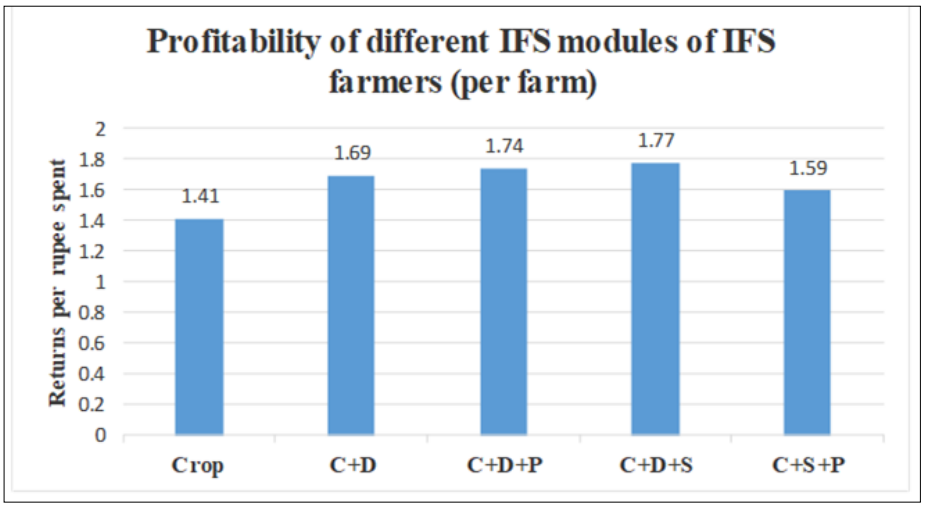

Fig. 5. Profitability of different IFS modules against conventional farmers (per farm).

increased to Rs 100427.86 and the return per rupee spent rose to 1.69. Adding poultry to the system (C+D+P) further boosted profitability, with net returns reaching Rs 108825.97 and a return per rupee spent of 1.74. The integration of small ruminants along with crop and dairy (C+D+S) resulted in net returns of Rs 120004.43 and a return per rupee spent of 1.77, making it the most efficient system in terms of economic returns. The combination of crop, small ruminants and poultry (C+S+P) also provided positive returns, but with a lower net return of Rs 73172.81 and a return per rupee spent of 1.59. These results highlight the economic advantages of diversified farming systems over conventional crop production for IFS farmers (13).

Table 12 showed the discounted cost and returns of dairy enterprise carried out by IFS farmers. Almost all the IFS sample farmers had dairy component in the study area. The cost and returns realised for 2 buffaloes were worked out. The discounted cost of dairy enterprise was found to be Rs 109737.42. Similarly, the discounted returns per unit of dairy enterprise was Rs 362162.39 with a net return of Rs 252424.97. It is to be noted that dairy enterprise was highly profitable as indicated by BCR 3.30. Further IRR was 120.63 % and is higher than prevailing bank rate 12 %. Hence, almost all the farmers have included dairy component in the IFS farming system because of profitable enterprise with regular returns (14).

Table 13 revealed investment analysis of small ruminants under the IFS. The NPV was Rs 59953.56, indicating a substantial gain over the investment period. The BCR of 3.21 suggests that for every rupee invested, a return of Rs 3.21 is realized, highlighting high profitability. Further IRR was 220.02 % (15) and is higher than prevailing bank rate 12 %. Overall, small ruminant farming under IFS proves to be a profitable and sustainable enterprise for farmers (16).

The Table 14 clearly indicates that among the production constraints, non-availability of labour during peak period was the major constraint which was the major problem in adopting IFS in the study area (17). Among the marketing constraints, non-availability of premium prices for the produce was the major problem (18) and among the infrastructure facilities, lack of funds for purchasing improved input was the major constraint (19). If farmers are provided with adequate knowledge coupled with supply of area specific need based necessary critical inputs and other services, it would go a long way in improving livelihood security of small farm holders in the region.

Table 14. Major constraints in practicing integrated farming systems in the study area

Particulars	Garette	Rank
Production constraints		
Low yield of local seed	39.50	6
Scarcity of family labour	56.99	3
Insufficient power supply	29.99	8
Lack of adequate literature for adoption of IFS	34.50	7
Non-availability of labour in the peak period	65.50	1
Lack of knowledge on management of pest and diseases	58.01	2
High cost of the production	51.99	5
Lack of affordability among small and marginal	56.91	4
Marketing constraints		
Delay in obtaining the sales proceeds	36.50	8
High Transportation cost	43.10	6
Defective and faulty weighting	33.90	9
Lack of adequate storage facilities	45.10	5
Exploitation by commission agents	62.50	3
Non-availability of market information	59.50	4
Price fluctuation	65.99	2
Inability to meet export demand	38.99	7
Non-availability of premium prices for the produce	71.99	1
Infrastructure constraints		
Lack of funds for purchasing improved inputs	63.5	1
Lack of schemes to support initial 2-3 years on the conversion to IFS	51.01	4
Lack of extension training or field demonstrations	51.9	3
Lack of veterinary facilities	56.5	2
Lack of processing facilities	41.5	5

Conclusion

The study identified Crop + Dairy + Small ruminants as the most profitable, economically viable and financially feasible integrated farming system in the Jagtial district, yielding the highest return per rupee invested 1.77 followed by Crop + Dairy farming. These systems demonstrated their ability to enhance farmers' incomes by diversifying their income streams and ensuring year-round financial stability. The integration of two buffaloes, three sheep and one goat with crops proved to be the optimal module for maximizing returns. However, farmers

Table 12. Net present value of investment in dairy farming of IFS farmers: Rs/Unit

year	Fixed cost	Variable cost	Gross return	Net return	Discount factor	Net present value	Discounted cost	Discounted benefit	Discounted net returns
1	64708.62	27876.56	91999.98	-585.20	0.89	-522.50	24889.78	82142.84	57253.06
2		30664.21	101199.98	70535.77	0.80	56230.68	24445.32	80676.00	56230.68
3		33730.63	111319.98	77589.34	0.71	55226.56	24008.80	79235.36	55226.56
4		37103.70	122451.97	85348.28	0.64	54240.37	23580.07	77820.44	54240.37
5		40814.07	134697.17	93883.10	0.57	53271.79	23159.00	76430.79	53271.79
6		44895.47	148166.89	103271.41	0.51	52320.51	22745.44	75065.96	52320.51
7		49385.02	162983.58	113598.56	0.45	51386.22	22339.28	73725.49	51386.22
8		54323.52	179281.93	124958.41	0.40	50468.61	21940.36	72408.97	50468.61
9		59755.88	197210.13	137454.25	0.36	49567.38	21548.57	71115.95	49567.38
10		65731.46	216931.14	151199.68	0.32	48682.25	21163.77	69846.02	48682.25
					NPV	252424.97	109737.42	362162.39	252424.97
	Net Present Value					252424.97			
	Benefit Cost Ratio					3.30			
	Internal Rate of Return					120.63			

Table 13. Net present value of investment of small ruminants of IFS farmers

	Fixed cost	Variable cost	Gross return	Net return	Discount factor @	Net present value	Discounted cost	Discounted benefit	Discounted net benefit
1	17667.84	7963.43	25543.33	-87.93	0.89	-78.51	7110.20	22806.55	15696.35
2		8759.77	28097.67	19337.90	0.80	15416.05	6983.23	22399.29	15416.05
3		9635.75	30907.43	21271.69	0.71	15140.77	6858.53	21999.30	15140.77
4		10599.32	33998.18	23398.86	0.64	14870.40	6736.06	21606.46	14870.40
5		11659.25	37397.99	25738.74	0.57	14604.85	6615.77	21220.63	14604.85
					NPV	59953.56	34303.80	110032.22	75728.41
Net Present Value						59953.56			
Benefit Cost Ratio						3.21			
IRR						220.02			

highlighted challenges such as delays in the supply of critical inputs for crop production, emphasizing the need for timely input distribution by implementing agencies. The study underscores the importance of promoting IFS through strengthened extension efforts to popularize the most beneficial modules, thereby improving income and sustainability for farmers in the region.

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Authors' contributions

Writing the original draft and conceptualization was done by DARD. Supervision, visualization was performed by GS. Data curation and writing was done by PG. Mapping was prepared by BS. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: The Authors do not have any conflict of interest to declare.

Ethical issues : None

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