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Effect of crop and livestock based integrated farming system on livelihood improvement of marginal farmers

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Abstract

The present field study was taken under all India coordinated research project on farming system, College of Agriculture, JNKVV, Rewa Madhya Pradesh during 2021-2022 to 2024-2025. On the basis of four year pooled data, it is clear that 0.4ha IFS model gave 133.76 quintal rice equivalent yield, gross return Rs 297056/-, net return Rs 116663/- & B:C ratio of 1.79. IFS dairy contributed 61.01% yield and 58.72% net profit while cropping system contributed net profit Rs 35731/- from 0.36 ha area. The present IFS model gave employment for 483 labours man-days in which farm family got 339 Man-days employment while hired labour get 154 man-days Month-wise employment generation varied from 35-47 man-days in different month. The flow of income was varied from Rs 8177/- per month to Rs 25604/- per month. The present IFS model gave sufficient green fodder, 33.97% dry fodder, 8.94% concentrate, 62.41% nitrogen, 68.33% phosphorous & 125% potash of total requirement. IFS model was found climate smart as greenhouse gas emission was (-3078.3) kg CO₂ equivalent. The yield sustainability was 95.8% & diversity index was 2.9 times over rice-wheat system. Soil carbon status was increased by 17.02%. Existing IFS model of 0.4 ha gave sufficient feed, cattle feed, year round income & employment for family size of 5 person & 2 cows.

Keywords: Diversity index, greenhouse gas emission, income enhancement & employment generation, rice equivalent yield, sustainable yield index

Introduction

Integrated Farming System is a holistic approach to manage a particular farm in such a way, which is very efficient and practical for tackling and addressing the challenges faced by small and marginal farmers (<2.0 ha land holders). In Rewa region of Madhya Pradesh about 13.46% farmers are marginal who have average land holding 0.43ha. IFS approach focuses to maintain various farm enterprises such as crops, horticulture (fruits and vegetables) and animals which are the main farm enterprises in IFS model that generate a year round employment and income better than other farming system like monocropping, (Rahangdale *et al.* 2025) ^[1]. This approach also helps to mitigate the risk of food security, nutritional sufficiency and stable income because of diversified cropping system and availability of livestock. The most important and cost-effective means are to be adopted in Integrated Farming System (IFS). Integrated Farming System with livestock enables a way to increase economic yield per unit area of time for farmers under small and marginal categories (Shanmugan *et al.* 2024). The waste produced gets recycled back in this system as a useful resource in the form of vermicompost and FYM (Singh *et al.* 2006) ^[9]. Several worker have reported that IFS approach helps to promote close loop nutrient recycling, which minimizes the external input use and enhances waste

recycling thereby reducing pollution load in the ecosystem with improved food production (Bahera and Mahapatra 1999 and Fatima *et al.* 2023) ^[4]. IFS may overall a better approach than other farming system as it is highly efficient to provide a better income and employment all over the year in a sustainable and ecological way. Meena *et al.* (2022) ^[5] found that a 1.5 ha IFS model comprising crops, dairy, horticulture, fishery & vermicomposting enterprises generated a gross return of Rs 6.12 lakh annually with a benefit cost ratio of 2.53, while acting as a negative greenhouse gas emitter. Yadav *et al.* (2019) ^[6] has reported that IFS model is a viable strategy of improving food security, income, employment & resilience in rural economics. Integrated farming system offer unique opportunities for maintaining and extending biodiversity. The emphasis in such systems is on optimizing resource utilization rather than maximization of individual element in the system (Soni *et al.* 2014) ^[7]. Optimum combination of different component in 0.4 ha area have not been studied at Kymore- Satpura agro climatic region of Madhya Pradesh. Keeping above facts in view present study was started in the year 2021-22 and still continue.

Materials and Methods

The present experiment was conducted under All India

coordinated Research Project on Integrated Farming System during 2021-2022 to 2024-2025. The experimental field was silty loam clay in texture & neutral in soil reaction (pH 7.1). Organic carbon status at initial stage was medium (0.47%) and experimental soil was low in available nitrogen (240 kg/ha), medium in available phosphorous (17.5 kg/ha) and high in available potash (284.5 kg/ha). The size of IFS model was 0.4 ha consisted of crop + Agri.horticulture + dairy + vermicompost + Boundary plantation. The major component in IFS model was Rice-wheat- Green manure in 0.2 ha (50% area), Ragi-Mustard-Bottle gourd in 0.02 ha (5% area), Okra- Garlic in 0.02 ha (5% area), Maize + Cowpea – Pea – Onion in 0.06 ha (15% area), Bajra- Barley –Maize + Cowpea fodder in 0.06 ha (15% area), Dairy with two crossbreed cows in 0.005 ha (1.25% area), Vermicompost & Compost unit in 0.005 ha (1.25% area) and Border plantation of Karonda, Citrus & Guava. The study was started in the year 2020-21 in the same year vermicompost and compost structure were also prepared. Assured irrigation facility was available for IFS model & all recommended packages of practices for different crops were adopted for irrigated condition, Greenhouse gas emission in terms of Kg CO₂ equivalent was calculated by adopting the Apps developed by IIFSR, Modipuram, Meerut. The sustainable yield index was calculated by following equation on the basis of last 4 year data.

$$SYI = \frac{\text{Mean Yield} - \text{Standard deviation}}{\text{Maximum yield}}$$

While, Diversity Index was calculated by adopting Strout (1975) and Wang & Yu (1975) for measure of multiplicity of farm product which are planted in a single year by computing the reciprocal of sum of square of the share of gross revenue or yield received from each individual farm enterprises in a single year.

$$DI = \frac{1}{\sum(Y_i / \sum Y_i)^2}$$

Where n is the total number of enterprise (crops or farm product) and Y_i is the gross revenue of ith enterprise product within one year.

Results and Discussion

1. Economical Yield

Economical yield obtained from different component of 0.4 ha IFS model existed at Rewa is given in Table 1. It is evident from the data that Rice – Wheat in 0.2 ha area gave 347 kg rice, 586 kg wheat and green manure which were equivalent to 12.7 quintal rice equivalent yield. Ragi – Mustard – Bottlegourd in 0.02 ha area gave 11.5 kg ragi, 37 kg mustard and 268.5 kg bottlegourd, which were equivalent to 2.92 quintal rice equivalent yield. Okra – Garlic cropping system in 0.02 ha area gave 172 kg okra & 206 kg garlic bulb which was equivalent to 8.62 quintal of rice equivalent yield. Maize + Cowpea – Pea – Onion in 0.06 ha gave 73.66 kg Green cow pea, 1185 number of cobs, 22 kg maize seed in *Kharif* and 442 kg green pea pod 9.5 kg pea seed in winter along with 346 kg onion bulb in *summer* which was equivalent to 11.28 quintal rice equivalent yield.

Bajra – Barley – Maize + Cowpea for fodder purposes has been taken in 0.06 ha area which gave 2318 kg green fodder in *Kharif*, 2260 kg in *Rabi* & 1575 kg in *summer* which was equivalent to 6.47 quintal rice equivalent yield. Dairy unit with two cows in 0.005 ha gave 2840.5 litre milk, 8955 kg dung and 2 heifer. Vermicompost and compost structure have been made in 0.005 ha which gave 3450 kg vermicompost and 6510 kg compost equivalent to 9.77 quintal rice equivalent yield. Boundary plantation of karonda and guava gave 8.2 kg karonda, 73.5 kg guava and 62 kg papaya which was equivalent to 0.39 quintal rice equivalent yield. Different component in 0.4 ha size of IFS model at Rewa gave 133.76 quintal rice equivalent yield.

2. Area, Yield and Net profit sharing by different component

Data pertaining to area, yield and net profit sharing of 0.4 ha IFS model have been given in Table 2 and depicted in Fig.1 to Fig 3, After perusal of the result it is clear that Rice – Wheat – Green manure cropping system was taken in 0.2 ha area which was equivalent to 50% area of IFS, gave 9.94% of total yield & 5.81% of total net profit of 0.4 ha IFS model. Ragi- Mustard - Bottle gourd was taken in 5% area IFS model gave 2.18% of total rice equivalent yield & 3.31% of total net return. Okra – Garlic cropping system was taken in

0.02 ha area which is 5% area of total IFS model, gave 6.4% of total produce & 7.5% of total net profit. Maize + Cowpea – Pea - Onion cropping system was taken in 0.06 ha area which was 15% of 0.4 ha of IFS model gave 8.4% of total yield & 7.12% of total income, For production of fodder, Bajra - Barley – Maize + Cowpea was taken in 0.06 ha area which was equivalent to 15% of total IFS model area gave 4.8% of total rice equivalent yield & 6.61% of net profit. Under dairy component 2 crossbreed cows were taken in 0.005 ha area which was equivalent to 1.25% of total area of 0.4 ha gave 61% of total produce & 58.72% of total income. Vermicompost unit was established in 1.25% area which gave 7.3% of total income and 10.51% of total net income. Boundary plantation of guava, citrus and karonda gave 0.29% of total yield and 0.11% of total income. Different component were taken in 0.37 ha and 0.03 ha area was kept for supporting activities out of 0.4 ha IFS model. Total rice equivalent yield was

133.76 quintal and net profit was Rs 116663 from 0.4 ha area. It is too much higher than Rice- Wheat cropping system taken in 0.2 ha area. It may be due to integration of different crop component, dairy, vermicompost and boundary plantation which increase the yield and net profit. These findings also supported by Singh *et al.* (2006) ^[9] and Rahangdale *et al.* (2025) ^[11].

3. Gross return and Net profit

Data pertaining to gross profit, net return and benefit cost ratio of 0.4 ha IFS model have been given in Table 3. After perusal of the data, it is evident that okra – garlic cropping system gave higher gross return from 0.02 ha area is Rs 19317 and net profit of Rs 8817 while Rice – Wheat – Green manure was taken in 0.2 ha area gave gross return Rs 27910 and net profit Rs 6853 with benefit cost ratio of 1.3. Different crop component was taken in 0.37 ha area of 0.4 ha size of IFS model which gave gross return Rs 93472 net

profit Rs 35131 and benefit cost ratio of 1.61. Dairy and Vermicompost component with two crossbreed cows & composting structure taken in 0.01 ha area gave net profit Rs 80798 and benefit cost ratio of 1.6 & 2.2 respectively. The cost of cultivation on the basis of 4 year pooled data was Rs 180393 in 0.4 ha size of IFS model which gave Rs 297056 as gross profit and Rs 116663 as net profit with benefit cost ratio of

1.79. Higher gross return & net profit under 0.4 ha size of IFS model was due to better integration of different component & resource recycling which increased the net profit. Singh *et al.* (2006) ^[9] & Maurya *et al.* (2024) ^[2] have also reported similar findings in which dairy component gave more net profit than crop component among different crop component. Okra – Garlic was found best.

4. Flow of Income

Revenue generated from sale of milk, vegetables & other produce from 0.4 ha IFS model has been given in Table 4. After perusal of the data, it is clear that revenue received from milk was Rs 117355 which varied from Rs 6913 to Rs 13471 per month. Revenue from selling of vegetables & other was Rs 46886. The total revenue was Rs 164241 deposited in V.V. account while value of recycled produce such as seed, concentrate fodder, cow dung, heifers & others was Rs 132885. The gross return was Rs 297056 from 0.4 ha IFS model. The flow of income during different month was Rs 8177 to Rs 25604 per month. Maximum income was in April and January. It was due to sale of Pea & other vegetables in January & Garlic, Onion & other produce in April. Behera & Mahapatra (1999) ^[10], Singh *et al.* (2006) ^[9] & Maurya *et al.* (2024) ^[2] have also reported year round income from integration of crop, vegetables, fodder, cow, vermicompost, fishery & boundary plantation.

5. Employment generation

Data on employment generation from 0.4 ha IFS model has been given in Table 5. It is clear from the data that present IFS model gave the employment for 329 man-days to farm families & 154 man-days for hired labour. Total employment generation was 483 man-days at the rate of 35 labour man-days per month to 45 labour man-days per month in which 68.1% labour were male & 31.9% labour were female. Dairy component gave maximum labour employment for 329 man- days while different crop component gave employment for 154 labour man-days. The labour employment was generated throughout the year. It may be due to growing of vegetables, garlic, onion under crop component which require more labour for picking, transportation and selling, similarly dairy component also engaged approximately one labour per day with some additional work of IFS. The findings are supported by the findings of Bahera & Mahapatra (1999) & Maurya *et al.* (2024) ^[2].

6. Self-reliance status

Self reliance status was calculated by considering five members size of family and two cows. Their requirement has been taken & total production was considered which are given in Table 6, On the basis of 4 year pooled data, it is evident that green fodder production was 17.5% higher than the requirement. There was shortage of 66.0% of dry fodder

and 91.06% of concentrate requirement. NPK production from compost & vermicompost was calculated which is given in the Table 6 reveals that 62.41% of nitrogen requirement was met out from compost & vermicompost while 68.33% requirement of phosphorous was produced from different composting unit & Potassium production was sufficient to fulfill the need of 0.4 ha IFS model. Rahangdale *et al.* (2025) ^[1] also reported that small size IFS model with 2 cows fulfill the 53.76% need of total nitrogen, 67% need of phosphorous and 100% need of total K requirement.

7. Performance of IFS over different year

The IFS model was started in 2021-22 after completion of 4 years. Its performance was analysed in terms of net return, Employment generation

& greenhouse gas emission, which are given in Table 7, After perusal of the result, It is clear that gross return Rs 260344 was minimum during initial year and it is increased year by year and reached Rs 335288 in year 2024-25. Similarly, Rice equivalent yield was also increased by 6.6 quintals over initial stage by the end of 2024-25. Net profit varied from Rs 81355 to Rs 139352 with the average net profit Rs 116721 from 0.4 ha. IFS model gave employment generation for 432 man-days to 526 man- days with the average employment of 490 labours Man-days per year. Net greenhouse gas emission was -3078.3 kg CO₂ equivalent, therefore the model was climate smart. It may be due to use of FYM and vermicompost in different crop component and plantation of tree like guava, Karonda and citrus on border. Similar findings were also reported by Maurya *et al.* (2024) ^[2] and Behera and Mahapatra 1999 ^[10].

8. Performance of IFS over years

The major performance indicators of IFS model are given in Table 8 which reveals that soil organic carbon status was increased by 17.02% over initial status, Sustainable value Index was 0.825 while sustainable yield Index was 0.958 showing 96% sustainability of 0.4 ha IFS model. Employment generation was 483 man-days/year in which 329 labour man-days was as male labour and 154 as female hired labour, greenhouse gas emission was -3236.4 kg CO₂ equivalent, due to negative carbon dioxide balance the present IFS model was found climate smart. Rahangdale *et al.* (2025) ^[1] has also reported negative green house gases production from 1 acre IFS model.

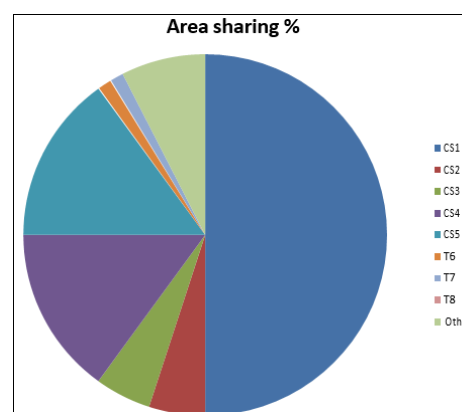


Fig 1: Pie chart of Area sharing of 0.4 ha IFS model

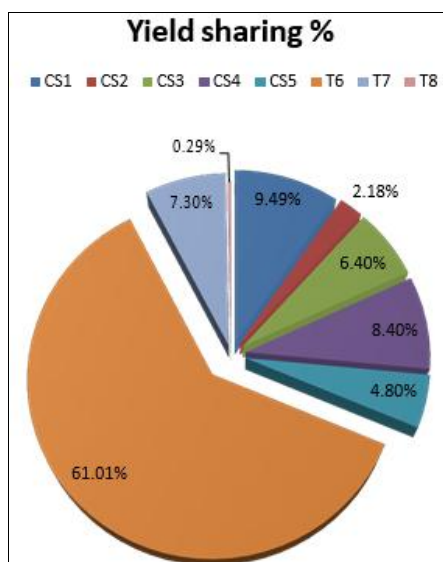


Fig 2: Pie chart of yield sharing of 0.4 ha model

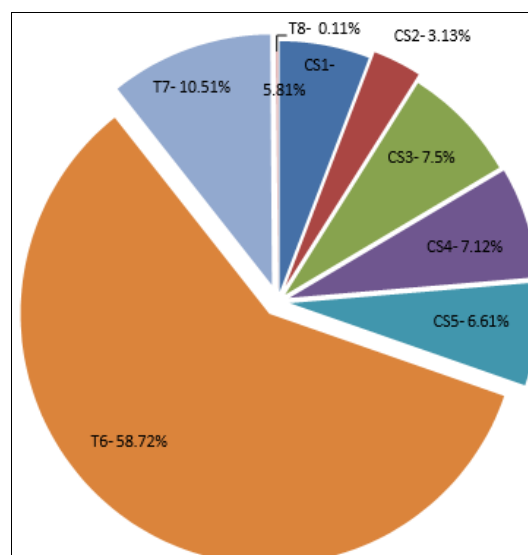


Fig 3: Pie chart of net profit sharing of 0.4ha IFS model

Table 1: Grain yield of different component of 0.4 ha IFS model

Component	4 Years pooled		
	Kg/Plot		
	Kharif	Rabi	Summer
CS-1 Rice - Wheat – GM	387	586	1340
CS – 2 Ragi – Mustard – Bottlegourd	11.5	36	268.75
CS – 3 Okra – Garlic	172	206	-
CS – 4 Maize + Cowpea – Pea – Onion	73.66 Kg (cowpea) 22 Kg (maize seed) 1185 cobs	442 Kg (pod) 9.5 (seed)	346
CS – 5 Bajra – Barley – Maize – Cowpea (Fodder)	2318	2260	1575
T ₆ – Dairy 2 cows	-	-	2840.5 Litter 8955 Kg (Dung)
T ₇ – Vermicompost and compost	-	3450 6510	-
T ₈ – Boundary plantation	8.2 Kg	73.5 Kg	62 Kg

Table 2: Area, Yield, Net profit sharing by different component in 0.4 ha IFS model

Component	4 years pooled					
	Area (ha)	Area sharing (%)	Net profit (Rs/plot)	Net profit sharing (%)	Rice equivalent yield (q)	Yield sharing (%)
CS1 Rice-Wheat- Green manure	0.2	50%	6853	5.81%	12.70	9.49
CS2 Ragi-Mustard- Bottle gourd	0.02	5%	3950	3.31%	2.92	2.18
CS3 Okra- Garlic	0.02	5%	8817	7.50%	8.62	6.40
CS4 Maize+ Cowpea- Pea- Onion	0.06	15%	8324	7.12%	11.28	8.40
CS5 Bajra-Barley- Maize+cowpea	0.06	15%	7787	6.61%	6.47	4.80
T ₆ Dairy 2 cows	0.005	1.25%	68531	58.72%	81.61	61.01
T ₇ Vermicompost& Compost	0.005	1.25%	12267	10.51%	9.77	7.30
T ₈ Boundary Plantation	-	-	134	0.11%	0.39	0.29
Other	0.03	7.5%	-	-	-	-
TOTAL	0.4 ha	100%	116663	100%	133.76	100

Table 3: Cost of cultivation, Gross return, Net return and B:C ratio of 0.4 ha IFS model

Component	4 Years pooled			
	Cost of cultivation	Gross Return (Rs/plot)	Net profit (Rs/plot)	B:C ratio
CS1 Rice-Wheat- Green manure	21057	27910	6853	1.3
CS2 Ragi-Mustard- Bottle gourd	2613	6563	3950	2.50
CS3 Okra- Garlic	10500	19317	8817	1.80
CS4 Maize+ Cowpea- Pea- Onion	16937	25261	83224	1.4
CS5 Bajra-Barley- Maize+cowpea	6634	14421	7787	2.20
Total	57741	39472	35731	1.61
T ₆ Dairy 2 cows	111559	180090	68531	1.60
T ₇ Vermicompost & Compost	10093	22360	12267	2.2
T ₈ Boundary Plantation	1000	1134	134	1.10
Total	180393	297056	116663	1.79

Table 4: Revenue generation month-wise from 0.4 ha IFS model

Month	4 years pooled		
	Receipt deposited in V.V. account (Rs)		
	Milk	Vegetables + Others	Gross return
July	8011	166	8177
August	8112	1677	9789
September	8949	6321	15270
October	10338	1201	11539
November	9321	2964	12585
December	8759	2120	10879
January	9998	8647	18645
February	12400	682	13082
March	13471	764	14235
April	11399	14205	25604
May	9384	6331	15715
June	6912	1808	8721
Total	117355	46886	164241

Table 5: Month-wise employment generation from 0.4ha IFS model

Month	4 years pooled		
	Farm families labour man-days (Male)	Additional labour man-days (Female)	Gross total
July	28	15	43
August	28	9	37
September	27	13	40
October	28	19	47
November	27	15	42
December	28	8	36
January	28	7	35
February	25	17	42
March	28	14	42
April	27	16	43
May	28	11	39
June	27	10	37
Total	329 (68.1%)	154 (31.91%)	48300%

Figures are in parenthesis% over total

Table 6: Self reliance status of 0.4 ha IFS model at Rewa

Resource recycling	Green fodder (Kg)	Dry fodder (Kg)	Concentrat feed (Kg)	Mineral mixture (Kg)	Nitrogen (Kg)	Phosphorous (Kg)	Potash (Kg)
Requirement (A)	7300	4380	2190	73	130	60	40
Production in IFS model (B)	8545	1488	196	00	81.4	81.4	50
Self reliance%(B/A*100)	117.5	33.97	8.94	00	62.41	68.33	125

Table 7: Performance of IFS model over years

Year	Gross return (Rs)	REY (g)	Net return (Rs)	Employment generation days	Net GHG emission (Kg Co2 equivalent)
2021-22	260344	130.16	117350	501	-
2022-23	279342	132.95	139352	526	-2436.5
2023-24	313330	136.23	81355	501	-3562
2024-25	335288	136.86	128768	432	-3236.4
Mean	297056	133.76	116721	490	-3078.30

Table 8: Key performance indicators of 0.4 ha IFS model

Key Performance Indicators		Value
Initial Soil organic carbon%		0.47
Soil organic carbon (%)		0.55
Improvement in SOC (%)		17.02
Employment generation (Man-days)		483
Male	329	Hired 154
Female	154	Family 329
SVI		0.825
SYI		0.958
Diversity Index		2.90
GHG emission (kg Co2 equivalent)		
Source		6664.6
Sink		9901.1
Net (Source – Sink)		-3236.5

Conclusion

On the basis of above studies, it has been concluded that 0.4 ha IFS model gave 133.76 quintal rice equivalent yield, Net profit Rs 116663 and benefit cost ratio of 1.79 on the basis of 4 year pooled data. Revenue generation was Rs 8177 per month to Rs 25604 per month throughout the year. Employment generation was 483 man-days per year which varied from 35 labour man-days per month to 47 labour man-days per month. Self reliance status was 100% in green fodder, 33.97% in dry fodder, 8.94% in concentrated feed production, 62.41% of total requirement 68.33% of total P requirement and 100% need of Potash. Soil organic carbon status was increased by 17.02% over initial status, sustainable value Index was 0.82 & sustainable yield index

was 0.96. greenhouse gas emission was -3236.4 kg CO₂ equivalent by which present IFS model was found climate smart and sustainable.

Author Contributions

All authors equally contributed to the research and to preparing the manuscript. The authors have read and agreed to the submitted version of the manuscript.

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Declarations

Conflict of Interest

All authors certify that they have no conflict of interest

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