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Studies on Sustainable Resource Management for Climate Smart IFS Model

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Studies on sustainable resource management for climate smart 0.4 ha IFS model was taken under all India coordinated research project on integrated farming system, College of Agriculture Rewa during 2021 to 2022 and 2022 to 2023. The study reveals that 0.4 hectares size of IFS model gave 131 .24 q rice equivalent yield, gross return Rs.271531, Net profit Rs.130090 And B:C ratio 1.91. The net profit from 0.36 hectares cropping systems was Rs.36727 and REY 41.80 q. The dairy component with two cows gave net profit Rs.86933 and B:C ratio 1.92. Among different cropping systems okra – garlic gave B:C ratio 2.23 and net profit of Rs.8066 from 0.02 ha area. The employment generation was 36 labour man days in June to 51 labour man days in October. Total employment generation was 513 labour man days per year. Flow of year-round income was varied from Rs.2501/ month in June to Rs.29913 in April. Self-reliance status from IFS model was 89%, green fodder ,27.39% dry fodder and 41.87% concentrates for cattle. Vermicompost and compost unit gave 36.1% of total nitrogen ,46.26 %of total phosphorous and 95 % need of total Potassium.

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1. INTRODUCTION

Integrated farming system is a multi-Disciplinary whole farm approach and very effective in solving the problem of a small and marginal farmer. The approaches aimed at managing income and employment from a small holding by integrating various farm enterprises and recycling crop residues and by product within the farm itself. The farmers need to be assured of regular income for living at least above poverty line. The progress is in production or a steady growth in output is necessary to face the challenges posed by present economic, political and technological environment. In this context farming system approach is one of the important solutions to face peculiar situation as in this approaches the different enterprises can be carefully undertaken and location specific system are developed based on available resources which will result into sustainable development [1,2].

The emergence of integrated farming system (IFS) has enabled us to develop a framework for an alternative development model to improve the feasibility of a small size farming in relation to larger ones. Integrated farming system or integrated agriculture is commonly and broadly used word to explain a more integrated approach to farming as compared to monoculture approaches. It refers to agricultural systems that integrates livestock and crop production or integrate fish and livestock's and may sometime be known as integrated biosystem. In this system and interrelated set of enterprises used so that the "waste" From one component become an input for another part of the system, which reduces cost and improved production and income. Integrated farming system marks as a system of systems. Integrated farming system ensures that wastes from one form of Agriculture become a resource for another form. Since it utilised waste as resources will not only eliminate waste but we also ensure overall increase in productivity for the whole agricultural system [3]. Reddy et al. [4] reported that to avoid uncertain income and high degree of risk through single crop production enterprise, there is a need to develop Integrated farming system which can eliminate the economical constraints and also provide other household need, beside increasing the productivity of farm through effective utilization of space and time.

Singh et al. [5] Reported that rice – pea – okra was the most remunerative cropping sequence with highest rice equivalent yield of 17.88 ton/ha and net return than the conventional rice – wheat sequence. The rice based integrated farming system comprising of crop component dairy – poultry and fisheries was the most suitable and efficient farming system model which gave highest system productivity and ensured the multiple usage of water. This model generated significantly higher level of employment than rice wheat system.

Behera and Mahapatra [6], Reported that Integrated farming system increases the income and employment from a small holding by integrating various farm enterprises and recycling crop residue and by product within the farm itself. So thus, farming system approaches is one of the effective approaches to improves farmer income and livelihood by integrating different farm enterprises which must taken carefully location specific based on resources which will result into sustainable development of Rewa region. Keeping above fact in view present study has been taken. Anonymous [7] reported that one acre IFS model gave sufficient employment for a farm family for 365 days while, income flow was year round varied from 2400 / month to 28000 /month and net profit was more than 1 lakh per annum.

2. MATERIALS AND METHODS

The present study on integrated farming system has been taken on silty Clay loam soil of College of Agriculture, Rewa Under all India coordinated research project on farming system during 2021 - 2022 and 2022 - 2023. The major component were crop + Agri horticulture + Dairy + Vermicompost + Boundary plantation. The size of IFS model was 0.4 hectare in which different cropping system like rice - wheat – green manure (0.2 ha), Rice - mustard - bottle guard (0.02 ha), Okra – garlic (0.02 ha), Papaya +cowpea – vegetable pea – onion (0.06 ha) and bajra – barley – maize + cowpea fodder (0.06 ha) were taken under crop component. Other components were two cross breeds of cows under dairy, 1 vermicompost + 1 compost and boundary plantation of Guava/ karonda/ Citrus. Guava is giving fruits but citrus and karonda are not fruiting. Soil of the experimental field was silty clay loam in texture, neutral in soil reaction (pH-7.1) low inorganic carbon (0.47%) and available

nitrogen 239.5 kg /ha. Available phosphorus and potash were medium. IFS model was under assured Irrigation condition which was started 2020 to 2021.

3. RESULTS AND DISCUSSION

3.1 Yield

Pooled data pertaining to economical yield under different component in 0.4 ha size of IFS model is given in Table 1. After perusal of data, it is evident that rice – wheat system in 0.2 ha area gave 391 kg rice and 669 kg of wheat grain. Rice – mustard – bottle guard system in 0.02 ha area gave 46 kg rice ,39.5 kg mustard and 191.5 kg bottle gourd. Rice –garlic cropping system was taken in 0.02 hectare which yielded 197.5 kg okra and 198 Kg garlic bulb. Agriculture and horticulture system in 0.06 ha area gave 147.5 kg cowpea vegetable, 588Kg green pea and 357 kg onion. Fodder yield was 2222 kg In Kharif from Bajra, 2277 kg In Rabi from barley + berseem and 1588KG from maize + cowpea in summer from 0.06 ha area. Two cross breeds of cow gave 2825 litre milk and 2 heifers. Vermicompost and compost unit gave 3395 kg vermicompost and 8200 kg compost. Boundary plantation of guava gave 30 kg guava fruit.

3.2 Rice Equivalent Yield

All the component of IFS in 0.4 ha area were converted in to rice equivalent yield which has been given in Table 2. It is evident from the data that cropping system in 0.36 ha area gave 41.8 quintal rice equivalent yield. Maximum rice equivalent yield 6.91 quintal was noted from okra – garlic cropping system followed by 12.5 quintal from 0.06 ha in papaya + cowpea – pea – onion system. Cropping system in 0.36 ha area gave 31.74 % of total rice equivalent yield. Higher yield in okra – garlic was due to higher productivity and higher market price. Similarly, papaya + cowpea – pea – onion also gave higher rice equivalent yield than other system. These findings are inconformity with the finding of Singh et al. [5]. They reported that rice – pea – okra was most remunerative cropping system with highest equivalent yield 17.88 ton /ha and net return than the rice – wheat conventional cropping system. They also reported that IFS comprising of crop component + dairy + poultry and fisheries was most suitable and efficient farming system which gave higher system productivity [8,2].

Dairy of 2 cross breed of cows in 0.4 ha IFS model gave 83.79 q rice equivalent yield (with 2 heifers + milk). Vermi compost and boundary plantation gave 5.71q and 0.44 q rice equivalent yield respectively. Total rice equivalent yield was 131.74q from 0.4 ha area which is too much higher than rice – wheat alone. It is because of fact that integration of different crop and dairy component increase the rice equivalent yield. Similar finding was also reported by Singh et al. [5] from Uttar Pradesh.

Table 1. Economic yield obtained in 1 Acre IFS model during (2 year pooled)

Component	Area In ha	Yield kg/plot Kharif	Yield kg/plot Rabi	Yield kg/plot Summer
CS1 Rice- Wheat- GM	0.2	391	669	1400
CS2 Rice — mustard - Bottle	0.2	46	39.5	191.5
CS3 Okra — Garlic	0.2	197.5	198	-
CS4 Papaya + Cow pea — Pea(veg) — Onion (Agri. Honi.)	0.06	147.5	588.5	357
CS5 Bajra — Barley- Maize + Cowpea (fodder)	0.06	1654	2130	1880
T-6 Dairy 2 cows	0.005	-	-	2825 Lit + 2 Heifer
T-7 Vermicompost	0.005	-	1005 VERMI 3000 COMP	2390 VERMI 5200 COMP
T-8 Boundary plantation	-	-	Guava - 30 kg	-
T-9 Area for supporting activity	0.03	-	-	-
Total -	**0.4**	**-**	**-**	**0**

Table 2. Annual gross and Net return and B:C ratio of 1 acre IFS model (2 year pooled)

Component	Area sq.m	Rice equivalents Yield q/plot	GMR Rs./plot	Cost of cultivation Rs./plot	Net Profit Rs./plot	B:C Ratio
CS1 Rice- Wheat- GM	0.2	13.6	27789	19207	8587	1.45
CS2 Rice — mustard - Bottle	0.2	2.45	5032	3006	2026	1.67
CS3 Okra — Garlic	0.2	6.91	14160	6344	8066	2.23
CS4 Papaya + Cow pea — Pea(veg) — Onion (Agri. Honi.)	0.06	12.51	25699	13404	12295	1.91
CS5 Bajra — Barley- Maize + Cowpea (fodder)	0.06	6.33	13014	7006	6008	1.85
Sub Total	**0.36**	**41.8**	**85694**	**48967**	**36982**	**1.75**
T-6 Dairy 2 cows	0.005	83.795	171795.5	84862.5	86933	2.03
T-7 Vermicompost	0.005	5.71	11837.5	6127.5	5700	1.95
T-8 Boundary plantation	-	0.44	2205	1475	730	1.49
T-9 Area for supporting activity	0.03	-	-	-	-	-
Total -	**0.4**	**131.74**	**271531**	**141431**	**130090**	**1.91**

3.3 Gross and Net Profit

Gross and net profit of 0.4 ha IFS model on pooled bases are given in Table 2. It is clear from the data that cropping system in 0.36 ha area gave gross return Rs.85694 and net return Rs.36727 with B:C ratio 1.75. Integration of two crossbreed cows + vermicompost + boundary plantation in same area gave gross return Rs.271531 and net profit Rs.130090 with B:C ratio 1.91. It may be due to integration of 2 cow in 0.005 ha area and vermicompost in 0.005 ha area increase the rice equivalent yield 89.94 q which was more than two times than cropping system. Therefore, gross return and net profit were increased. Singh et al. [5] from Uttar Pradesh also reported the more income and net profit from integrated farming system than rice – wheat cropping system.

3.4 Benefit: Cost Ratio

Benefit: cost ratio of 0.4 ha IFS model under different component has been given in Table 2 reveals that rice – garlic cropping system gave higher B:C ratio 2.23 followed by2.03 in dairy with two cows in 0.4 ha IFS model. All other cropping system gave B:C ratio less than two. The whole IFS model of 0.4 ha gave B:C ratio 1.91 which was comparatively higher than B:C ratio of different crop component (1.71). Higher benefit: cost ratio due to integration of crop and dairy + horticulture component was also reported by Singh et al. [5].

3.5 Flow of Year Round Income in IFS Model

Flow of income from 0.4 ha IFS model (Crop + Agri horticulture + Dairy + Vermicompost + Boundary Plantation) is given in Table 3. It is clear from table that year-round income was given by 0.4 ha size of IFS model. The income was varied from Rs.2501/month in June to Rs.29913/month in April. The income was also higher in October and January month. Apart from monthly income 2 female heifers and recyclable produce were also given. Singh et al. [5] also reported the year-round income from integration of cows with rice-based cropping system.

3.6 Employment Generation

Date on employment generation from 0.4 ha size of IFS model is given in Table 4 reveals that total employment generation was 491 man-days in 2021 – 22 and 526 man -days in 2022-23. The monthly employment generation was 36 man-days in June to 51 man – days in October. The labour requirement in other month was 38 to 48 man - days per month. It may be due to integration of different component gave labour requirement at different period while dairy gave continuous employment. Behera and Mahapatra [6] also reported that IFS model increases the year round income and employment from small size holding by integrating various farm enterprises and recycling crop residue and by product within the system (farm).

Table 3. Month wise receipt generated and deposited in account and value of produce left for disposal /recycled

Month	2021-2022	2022-2023	Mean
July	3000	18765	1O882
August	8270	17495	12882
Sept.	16366	19285	17825
Oct.	17035	23915	20475
Nov.	14732	14750	14741
Dec.	13275	14887	14081
Jan.	22820	19010	20915
Feb.	10250	9690	9970
March	10520	11600	11060
April	27944	31883	29913
May	13741	13597	13669
Jun	2968	2035	2501
Value of female calves	60000	30000	45000
Recycable produce	58321	28407	43364
Total	**279242**	**255319**	**267280**

Table 4. Month wise emloyment generation

Month	Total man /days 2021-22	Total man/ days 2022-23	Mean
July	49	39	44
August	43	41	42
Sept.	32	46	39
Oct.	45	51	48
Nov.	39	50	44
Dec.	36	40	38
Jan.	38	39	38
Feb.	41	50	45
March	45	43	44
April	50	48	49
May	37	43	40
Jun	36	36	36
Total	**491**	**526**	**513**

Table 5. Details of vermicompost and compost and nutrient supplied (2 year pooled)

Particulars	Quantity in kg	Quantity of NPK kg found in compost		
		N	P	K
Vermicompost	1697.5	25.66	17	20.3
NADEP	3600	21.6	10.75	18
Total	**5297.5**	**47.26**	**27.76**	**38.3**

Table 6. Self reliance status of 0.4 hectare IFS

Resource recycling	Green Fodder Kg	Dry Fodder Kg	Concentrate Feed Kg	Mineral Mixture	Nitrogen kg/ha	P Kg/ha	K Kg/ha
Requirement	7300	4380	2190	73	130	60	40
Production in IFS Model	6500	1200	917	-	47	27.76	38
Self reliance %	89.04%	27.39%	41.87%	0%	36.15%	46.26%	95%

3.7 Nutrient Recycling

Date pertaining to compost and vermicompost have given in Table 5 reveals that total 1697 kg vermicompost was prepared which gave 25.66 kg N, 17 kg P_2O_5 and 20.3 kg K_2O. Total compost production was 3600 kg/year equivalent to 21.6 kg N, 10.75 kg P_2O_5 and 18 kg K_2O/year. These

nutrients were recycled within the system for production of different crops. Ponnusamy et al. [9] also reported that integration of different farm enterprises and residues helps in maintaining the soil fertility and achieving the economy objective by limiting the use of external input.

3.8 Self Reliance Status

Self-reliance status of 0.4 ha IFS model existed at Rewa is given in Table 6. It is evident from the data that IFS model gave 89.04% fodder requirement, 23.39% dry fodder needs and 41.87% of concentrate needs of two cattle. Nutrient reliance status is given in Table 6 showed that 36.15% of total need of nitrogen, 46% total need of phosphorus and 95% total need of Potash can be obtained from vermicompost and compost unit. Ponnusamy et al. [9] and Kumar et al. [10] also reported that maximum needs of nutrient and fodder can be meet out from recycling of farm waste. The maximum need of nutrients for different crop component can be obtained from vermicompost and compost which reduce the use of costly external input such as fertiliser [9].

4. CONCLUSION

On the basis of above studies, it has been concluded that 0.4 ha IFS model gave net profit of Rs.130090 with B:C ratio 1.91. Rice equivalent yield was 131.74 q and gross return was Rs.271531. Integration of crop + Agri Horticulture + Dairy + Vermicompost + Boundary plantation in 0.4 hectare gave employment for 513 man days ranging from 36 labour/month to 48 labour / month. Year-round income was Rs.2501 /month to Rs.29913/month. This model also provides 89% need of green fodder 27.39% dry fodder and 41.87% need of concentrates for cattle. Vermicompost and compost unit gave 47 Kg nitrogen 27.76 kg P05 and 3 8.3 kg K2O which fulfil the need of total nitrogen 36 .15%, P205 46.26% and 95% K2O.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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