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Studies on climate smart IFS model for marginal farmers

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Abstract
Study on Climate smart 0.4 hectare Integrated Farming System Model was taken under All India Co-Ordinated Research Project on Farming system, College of Agriculture Rewa during 2022-23. The study reveals that 0.4 ha IFS Model with different components gave Rice Equivalent Yield 130.95 q, Gross Return Rs. 279242 and Net Profit Rs. 139352 with B:C ratio 1.99. Income flow in IFS Model was year round and varied from Rs. 3000 per month in July to Rs. 27944 per month in April. Employment generation was 526 man days which varied from 36 labours per month to 51 labour per month which is sufficient for average small family size. Greenhouse gas emission was -2436.5 kg CO_2 equivalent by which IFS Model was climate smart.

Keywords: IFS, climate, GHG emission, net return

Introduction
As the global population continues to increase the agriculture sector faces the intricate challenge of ensuring food, nutritional and livelihood security while minimizing it's ecological or carbon footprint. Agriculture contributes to greenhouse effect primarily through the emission and consumption of greenhouse gases such as CH_4, N_2O and CO_2. Various Agricultural practices act as a source as well as sink of greenhouse gases. The Agriculture sector in India contributes 28 percent of the total greenhouse gas emissions. According to IPCC, the average global emissions from agriculture was only 12 percent. Emissions from agriculture are primarily due to methane emission from lowland rice (23%). Fermentation in ruminant animals and nitrous oxide from the application of manures and fertilizers. Agriculture activities such as land clearing, cultivation of crops, irrigation, animal husbandry, fisheries, aquaculture have a significant impact on emission of greenhouse gases and consequent climate change (IPCC 2014) [2].
For the mitigation of the problem of Greenhouse gases IFS have emerged as a holistic approach comprising various agricultural practices to enhanced sustainability and productivity.
IFS embody a suitable blend of various farming enterprises (cropping, horticulture, livestock, poultry, fishery, forestry etc.) and the resources at the farmers disposal to cultivate them profitably. They engage effectively with the environment aiming to avoid disrupting ecological and socio- economic balances while striving to achieve national goals (Jayanthi *et al*., 2002) [3]. However, the emission of greenhouse gases with IFS requires meticulous scrutiny. Singh *et al*., (2006) [4] reported that Rice-pea-okra was the most remunerative cropping sequence with highest rice equivalent yield of 17.88ton/ha and net return than the conventional rice wheat sequence. The rice based integrated farming system compromising 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.
Behra & Mahapatra (1999) [1] reported that Integrated Farming System increase the income and employment from a small holding by integrating various farm enterprises and recycing 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.

Materials and Methods

The present field study was conducted under All India Co-ordinated Research Project on Integrated Farming System during the year (2022-23). The experimental field was silty clay loam in texture and neutral in reaction (soil PH 7.1). Organic carbon status was medium and experimental soil was low in available N (239.5 kg / ha), medium in available P_2O_5 and high in available K (284.5 kg /ha).

The size of IFS Model was 0.4 ha in which crop +agri-horticulture+ dairy + vermicompost+ boundary plantation was adopted. The major components in IFS Model were Rice- Wheat -Green Manure (0.2ha), Rice-Mustard-Bottle gourd (0.02 ha), Okra-Garlic (0.02 ha), Papaya +Cowpea -Vegetable pea – Onion (0.06 ha), Bajra -Barley -Maize + Cowpea fodder (0.06), Dairy 2 Cow (0.005 ha), Vermicompost + Compost (0.005 ha) and border plantation of karonda / citrus /guava. The total area under different activity was 0.37 ha while 0.03 ha area was kept for supporting activity. The study was started in the year 2020 and in the same year vermicompost structure was also prepared. Assured irrigation facilities was available for IFS Model. Greenhouse gases emission in terms of kg CO_2 equivalent was calculated by adopting apps of IIFSR, Modipuram (Meerut).

Results and Discussion

Yield: Data pertaining to yield under different components of 0.4 ha size of IFS Model has been given in Table -1. It is evident from the data that Rice - Wheat in 0.2 ha area gave 375 kg Rice and 502 kg Wheat, Rice - Mustard – Bottle gourd system in 0.02 ha gave 40 kg Rice, 27 kg Mustard and 272 kg Bottle gourd. Okra – Garlic in 0.02 ha area gave 181 kg Okra pod and 220 kg Garlic bulb. Papaya + Cowpea – Pea – Onion under Agri – horticulture system in 0.6 ha area gave 130 kg papaya, 127.5 kg Cowpea, 706 kg pea pod and 364 kg onion bulb. Bajra—Barley – Maize + Cowpea for fodder in 0.06 ha area gave total 6504 kg fodder yield. Dairy component with two cross breed Cow gave 2677 litre milk, two heifers and 9025 kg dung. Under vermicompost and Compost component in 0.005 ha area gave 2390 kg vermicompost and 5200 kg Compost. Boundary plantation of guava gave 30 kg guava fruits. (Nayak PK, 2019) [5].

Rice Equivalent Yield: Rice Equivalent Yield of different component of IFS is presented in Table – 2. After perusal of the result it is evident that Rice Equivalent Yield was varied from 0.44 q to 83.85 q under different component. Area alloted to Rice – Wheat cropping system under IFS model was 0.2 ha which was equal to 50 percent of the total IFS Model gave 11.46 q REY. The contribution of Rice – Wheat system in total production of IFS model was 8.61 percent. Okra – Garlic and Papaya + Cowpea – Pea – Onion under Agri – horticulture system which was taken in 0.08 ha area (20%) Contributed 19.8 q REY which was equal to 14.88% of the total production. Bajra – Barley – Maize + Cowpea fodder in 0.06 ha gave 6.8 q REY. So, thus total crop component in 0.36 ha area gave 30.4 percent of total REY while Dairy component in 1.25 percent area with two cross breed cow gave 83.85 q REY which was equal to 63.06 percent of the total produce. Vermicompost + Compost and boundary plantation gave 8.16 and 0.44 q REY respectively. Total Rice Equivalent Yield was 132.95 q from 0.4 ha IFS Model. It is too much higher than Rice – Wheat system alone. It may be due to integration of different crop component, Dairy component, Vermicompost and boundary plantation increase the yield by which REY was increased. Similar, finding was also reported by Singh *et al*., (2006) [4] from Uttar Pradesh.

Net Return: The data on gross and net profit along with cost of cultivation have been given in Table.2 reveals that total net profit Rs. 139352 was obtained from 0.4 ha lFS model in which dairy components contributes Rs. 95880, Vermicompost and Compost Rs.8125, Boundary plantation of guava Rs.730 while crop and agri-horticulture system in 0.36ha area gave net profit Rs. 37617. Higher income under IFS system is due to integration of different component in different ratio increase the net profit. Singh *et al*., (2006) [4] also reported higher net profit from IFS than Rice - Wheat cropping system. Benefit cost ratio of IFS model was 1.99 in which dairy component gave B:C ratio 2.19 and Okra-Garlic 2.14. Remaining component of IFS gave B:C ratio below 2.

Employment Generation: Employment generation under different crop component has been presented in Table.1 reveals that Rice - Wheat system gave employment for labour man days. Other components gave labour employment from 6 to 44 labour man days under different cropping components. Dairy component gave maximum employment for 334 days and other vermicompost component gave 7 days employment.

Labour employment was generated throughout the year which varied from 36 labour man days in June to 51 labour man days in October. Total employment was generated for 526 labour man days from 0.4 ha IFS model. Farm families get 365 days work while additional labour requirement was 161 days. Behera and Mahapatra (1999) [1] also reported that IFS increases the income and employment from small holding by integrated various.

Flow of Income: Data pertaining to flow of Income in different month of the year has been given in Table: 03 reveals that income was varied from Rs. 3000 per month in July to Rs. 27944 per month in April and total two heifers and recycled produce, costing Rs. 118321.So, thus total Rs. 279242 was produce as gross return from 0.4 ha IFS model. Singh *et al*., (2006) [4] also reported year round income from integration of cow & fisheries with Rice based cropping system. Behera and Maha (1999) [1] reported higher employment and profit.

Greenhouse Gas Emission: Greenhouse gas emission in IFS model was calculated from the apps developed by IIFSR, Modipuram which is given in Table.4 reveals that total sources of different component produces 7164kg CO_2 equivalent while total sink was 9600.6 kg. So, thus greenhouse gases emission was -2436.5kg CO_2 equivalent by which IFS model was climate smart. (Kumar S, 2012) [6].

Table 1: Economic yield obtained in one acre IFS model during the year 2022-2023.

Component	Area in sq. metre	Yield kg/plot			Employment Generation man days
		Kharif	Rabi	Summer	
C_{S1} Rice- Wheat - GM	2000	374	502	1200	64
C_{S2} Rice- Mustard - Bottle gourd	200	40	27	272	13
C_{S3} Okra - Garlic	200	181	220	_	32
C_{S4} Papaya + Cowpea-Pea- Onion (Agri.Horti)	600	130 Papaya 127.5 ©	706	364	32
C_{S5} Bajra –Barley-Maize –Cowpea Fodder	600	2790	2424	1290	44
T_{S6} Dairy 2 cows	50	_	_	2677 Lit+2 Heifers+9025 kg dung	334
TS7 Vermicompost and Compost	50	–	2390 kg 5200 kg	–	6
T_{S8} Boundary plantation	_	_	30 kg	_	1
T_{S9} Area for supporting activity	300	_	_	_	_
Total -	4000	_	_	_	526

C = Cowpea pod
Diversity index =2.39
Water Productivity =69.83 Rs/m ^{3}

Table 2: Rice Equivalent Yield (q.) Gross return and Net profit Rs/ plot.

Component	Area in sq. metre	Rice equivalents yield q.	Gross return Rs./plot	Net profit Rs./plot	Cost of cultivation Rs./plot	B:C ratio
C_{S1} Rice-Wheat - GM	2000 (50)	11.46 (8.61%)	24083	4376	19707	1.22
C_{S2} Rice- Mustard- Bottle gourd	200 (50)	2.41 (1.81%)	5061	2055	3006	1.68
C_{S3} Okra Garlic	200 (5)	6.43 (4.83%)	13520	7203	6317	2.14
C_{S4} Papaya + Cowpea-Pea-Onion (Agri.Horti)	600 (15)	6.80	14300	7294	7006	2.04
Sub- Total cropping system	3600 (90)	40.50 (30.4%)	85057	34617	50440	1.68
T_6 Dairy 2Cows	50 (1.25)	83.85 (63.06%)	176105	95880	80225	2.19
T_7 Vermicompost and Compost	50 (1.25)	8.16 (6.13%)	17150	8125	9025	1.90
T_8 Boundary plantation	_	0.44 (0.33%)	930	730	200	4.65
T_9 Area for supporting activity	300 (7.5%)	_	_	_	_	_
Grand Total	4000	132.95	279242	139352	139890	1.99

Figures in Parentheses are percent over total.

Table 3: Month wise employment generation.

Month	Farm families man days	Additional labour in man days	Total man days	Income Flow Rs.
July-22	31	8	39	3000
Aug.-22	31	10	41	8270
Sept.-22	30	16	46	16366
Oct.-22	31	20	51	17035
Nov.-22	30	20	50	14732
Dec.-22	31	9	40	13275
Jan.-23	31	8	39	22820
Feb.-23	28	22	50	10250
March-23	31	12	43	10520
April-23	30	18	48	27944
May-23	31	12	43	13741
June-23	30	6	36	2968
Total-	365	161	526	160921
Value of recycle produce +2 Heifers				118321
Total-				279242

Table 4: Emission of greenhouse gas from different components in IFS Model.

Carbon Sources	Enterprises	CO_2-e(kg)
1	Cropping system	
C_{S1}	Rice -Wheat-Green Manure	504.9
C_{S2}	Rice-Mustard-Bottle gourd	84.1
C_{S3}	Okra-Garlic	60.0
C_{S4}	Papaya-Cowpea-Pea-Onion	113.4
CS5	Bajra-Barley-Maize+Cowpea	245.1
	Fodder crops	2442.9
	Horticultural-Vegetable crops	125.0
	Paddy-special	96.8
	Livestock (Cattle and Buffalo)	3491.0
	Energy used for household	1.0
Carbon Sink	Agro-forestry-sink	1268.6
	Total Biomass/Compost added-SINK	8332.0
	Total Source	7164.1
	Total Sink	9600.6
	GHG-IFS	-2436.5

Conclusion

On the basis of above studies it has been concluded that one acre climate smart IFS model for marginal farmers gave rice equivalent yield 130.95q, gross return Rs. 279242 and net profit Rs. 139352 with B:C ratio 1.99. One acre IFS model for marginal farmers in Rewa region can help in the doubling farmers income. The present IFS model is climate smart as sink is higher than source and it is -2436.5kg CO_2 equivalent. This model also gave employment throughout the year varied from 36 man days per month to 51 labours man days. Total employment generation was 526 man days. The flow of income was year round which varied from Rs. 3000/month to Rs. 27944 with gross return and Rs. 279242. Dairy component gave higher net return Rs.95880 while cropping system in 90% area only gave 24.8% net return.

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