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INTEGRATED EFFECT OF CROP AND LIVESTOCK-BASED FARMING SYSTEM ON INCOME AND EMPLOYMENT GENERATION OF MARGINAL FARMERS

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ABSTRACT

The present field study was conducted under All India Coordinated Research Project on farming system, College of Agriculture, Rewa during 2022-2023 and 2023-2024. The study reveals that 0.4 ha IFS model gave 134.6 q rice equivalent yield, gross return Rs. 296286 and net profit Rs. 110333. The major sharing in IFS was of dairy unit which contributed 59.4% of total net profit. Among different cropping system Okra-garlic in 0.02 ha gave 8.34% of total net profit and 6.55% of total rice equivalent yield. The present IFS model generated the employment for 513 labour man days in which 71.17% labour man days was from farm families and 28.84% labours were hired. Flow of month wise income varied from Rs. 3000 to Rs. 28966 per month in different month. The maximum income Rs. 28966 per month was generated in April followed by Rs. 18756 in January. The sharing of cropping system in total revenue was 16.84% while dairy contributed 34.84% total revenue. Self- reliance status was 133.8% vermicompost, 53,76 % nitrogen, 67.9% phosphorus and 117% of potash of total requirement. Net GHG emission was -3562 kg CO_2 equivalent from 0.4-hectare size of IFS model therefore, present IFS model was climate smart.

***Keywords*:** Integrated Farming System, Rice equivalent yield, Employment generation, Income enhancement, Greenhouse gas emission.

Introduction

The Integrated Farming System (IFS) is a holistic and sustainable method of farming that prioritizes making the best use of resources at hand in order to maximize output while preserving ecological equilibrium. Integrated Farming System integrates with natural resources and regulation mechanism into farming activities to achieve maximum replacement of farm inputs secures sustainable production of high-quality foods and other products through ecological preferred technologies sustain farm income and sustains the multiple function of agriculture. Effective resource cycling, waste reduction and biodiversity enhancement are the cornerstones of IFS. For example, aquaculture water may be used to irrigate fields, animal dung can be utilized as organic fertilizer and crop wastes can be used as animal feed. This cyclical method reduces the environmental impact of farming operations while simultaneously increasing output. In tackling, contemporary agricultural issues including resource scarcity, climate change and land degradation, IFS is very important. Additionally, it increases the economic resilience of farmers, especially small and marginal farmers by diversifying sources of income and decreasing reliance on output inputs like chemical fertilizers and pesticides. IFS also enhances soil health, supports long term sustainability and increases food security making it crucial tactic for striking a balance between environmental stewardship, productivity and profitability. In contrast to traditional farming, which frequently concentrates on monocropping, IFS combines a variety of agriculture techniques, including crop production, livestock raising, aquaculture, agroforestry and horticulture into a cohesive and interdependent system. In order to maintain food production and revenue, the agricultural system of the future need shift from a single commodity system to a food diversification strategy. Therefore, IFS assumes increased importance for prudent farm resource management to promote farm activity, which will lessen the environment degradation, improves the lives of resource poor farmers and preserve agriculture's sustainability.

Integration is done such that the output of one component should be used as input for the other component with a high degree of complementary effects (Panke *et al.,* 2010) Some worker stated that crop residues can be fed to animals, however using livestock dung to increase agricultural output should be done by increasing nutrients that improve soil fertility and lowering the usage of artificial fertilizers. Integrating various components of IFS viz. field crops, horticultural crops, livestock, poultry, timber and fishery help to increase space and time utilization (Gupta *et al.,* 2012 and Paramesh *et al.,* 2023)

Materials and Methods

The present study on IFS was conducted in 2022-2023 and 2023- 2024 on silty clay loam soil at the college of agriculture, Rewa under all AICRP on integrated farming system. Major components were Crop + Agri horticulture + Dairy + Vermicompost + Boundary plantation. Present Integrated Farming System Model was 0.4 hectare size in which different cropping system were included as crop components like rice -wheat – green manure (0.2 ha), okra- garlic (0.02ha), rice – mustard- bottle gourd (0.02 ha), maize+ cowpea- vegetable pea- onion (0.06ha). Additional component were two cross breed cows under dairy, 1 compost, 1 vermicompost and border plantation of citrus, guava and karonda. The experimental soil was neutral in reaction p^H of 7.1, low inorganic carbon (0.47 %) and 239.5 kg/ha of available nitrogen. The available phosphorus and potash was moderate. The experiment was non replicated but various components were allotted in 0.4 hectare of land. Greenhouse gas emission was calculated by the Apps developed by IIFSR, Modi Puram, Meerut.

The diversity index was calculated by Strout (1975). I t measures the multiplicity of crops or farm products which are planted in a single year by computing the reciprocal of sum of square of the share of gross revenue reciprocated received from each individual farm enterprise in a single year.

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

Where n is the total number of enterprise (crops or farm product) and Y_i is the gross revenue of i^{th} enterprise product within one year.

Results and Discussion

Economical Yield

Average grain and economic yield data under different components of 0.4 hectare IFS model have been given in Table 1. It is clear from the table 1 that rice- wheat system gave 375 kg rice grain yield and 516 kg wheat yield from 0.2 hectare area. Ragi-mustard – bottle gourd in 0.02 hectare area gave 25 kg ragi, 23.5 kg mustard and 309 kg bottle gourd. Okra-garlic cropping system in 0.02ha area gave 179 kg Okra and 217 kg garlic, maize+ cowpea - pea - onion cropping system gave 448.5kg green pea pod and 6 kg grain with 300 kg onion in summer. Bajra – barley - maize + cow pea from 0.06 hectare area gave 2550 kg fodder in *kharif,* 2433 kg fodder in *rabi* and 1189 kg fodder in *summer*. Two crossbred cows gave 2576 litre milk and 10413 kg cow dung. Production of vermicompost and compost were 2400 kg and 6165 kg respectively.

All the above data has been converted into rice equivalent yield which is given in Table 2. After perusal of data given in Table 2, it is clear that rice-wheat system gave rice equivalent yield of 11.84 q, Ragi- mustard - bottle gourd system gave 2.68 q rice equivalent yield, okra -garlic system gave 8.82 q rice equivalent yield, maize + cowpea- pea- onion gave 10.3 q rice equivalent yield while barley- bajra – maize + cowpea fodder system gave 5.39 q rice equivalent yield. Dairy unit gave 83.42 q rice equivalent yield while vermicompost unit gave 10.84 q rice equivalent yield. The total production was 134.6 q from 0.4 hectare IFS model. The contribution from different component was 29.44% by crop component and 61.9% by dairy component and 6.58% by vermicompost and compost unit. Nayak (2019) and Maurya *et al.* (2024) also reported similar findings from small size of IFS model.

Gross and Net Profit

Gross and net profit from different component of IFS have been presented in Table 2 which reveals that gross profit was Rs. 296286 from 0.4 hectare IFS model in which 61.9% contribution was from dairy and remaining 38.1 % gross return was from other component. Net profit from 0.4 hectare IFS model was Rs. 110353 in which dairy unit gave 59.41 % net profit while crop component gave 30% part of total net profit. Higher income under IFS component is due to integration of different component in different ratio which increase the net profit. Singh *et al.* 2006 and Maurya *et al.* 2024 also reported the higher net return from small size IFS model as compared to traditional rice- wheat cropping system. Benefit cost ratio is given in Table 4 indicates that maximum benefit cost ratio 1.94 was obtained from okra- garlic under crop component followed by 1.7 from IFS dairy and 2.28 from vermicompost unit.

Table 1: Economic yield in 1 acre IFS model during the year 2022-2023 and 2023-2024

Component	2 years pooled		
	Yield kg/plot		
	Kharif	***Rabi***	***summer***
C_{s1} Rice -Wheat -GM	375	516	1475
C_{s2} Ragi- Mustard- Bottle gourd	25	23.5	309.5
C_{s3} Okra-Garlic	179	217	-
C_{s4} Maize + cowpea- pea-onion	33.5kg 22kg 1146 cobs	448.5 - 6 kg	300.5
C_{s5} Bajra- Barley-Maize- Cowpea fodder	2550	2433	1189
T_{s6} Dairy 2 cows	-	-	2576.65 l 10413.5 kg
T_{s7} Vermicompost and compost	-	2400 VC 7130 C	-
T_{s8} Boundary plantation		73.50	

Table 2: Rice equivalent yield (q), Gross return (Rs./plot) and Net Profit (Rs./ plot) of IFS model during the year 2022-2023 and 2023-2024

Component	2 years pooled		
	Rice equivalent yield (q)	**Gross return (Rs./plot)**	**Net profit (Rs./plot)**
C_{s1} Rice -Wheat -GM	11.84 (8.79%)	26096.5 (8.80%)	5900 (5.34%)
C_{s2} Ragi- Mustard- Bottle gourd	2.68 (1.99%)	5933 (2%)	3320 (3%)
C_{s3} Okra-Garlic	8.82 (6.55%)	19672.5 (6.63%)	9168 (8.34%)
C_{s4} Maize + cowpea- pea-onion	10.39 (7.71%)	22590 (7.62%)	8535 (7.73%)
C_s Bajra- Barley-Maize- Cowpea fodder	5.93 (4.40%)	12987 (4.38%)	6254.5 (5.66%)
T_{s6} Dairy 2 cows	83.41 (61.9%)	183482 (61.9%)	65632 (59.4%)
T_{s7} Vermicompost and compost	10.84 (6.58%)	24140 (8.14%)	13815 (12.5%)
T_{s8} Boundary plantation	0.61 (0.45%)	1383.5 (0.46%)	1108.5 (1.004%)
	134.6	296286	110353

Figures in parentheses are % over total

Table 3: Area, Cost of cultivation, B: C ratio and Net income sharing in 0.4 ha IFS model

Component	2 years pooled					
	Area	**Area sharing (%)**	**Net profit (Rs./plot)**	**Net profit sharing (%)**	**Cost of cultivation (Rs./plot)**	**B:C ratio**
C_{s1} Rice -Wheat -GM	0.2	50%	5900	5.34%	20195	1.28
C_{s2} Ragi- Mustard- Bottle gourd	0.02	5%	3320	3.0%	2613	2.31
C_{s3} Okra-Garlic	0.02	5%	9168	8.34%	10504	1.94
C_{s4} Maize + cowpea- pea-onion	0.06	15%	8535.5	7.73%	17437	1.39
C_s Bajra- Barley-Maize- Cowpea fodder	0.06	15%	6254.5	5.66%	6733	1.92
T_{s6} Dairy 2 cows	0.005	1.25%	65632	59.4%	117850	1.7
T_{s7} Vermicompost and compost	0.005	1.25%	13815	12.5%	10325	2.28
T_{s8} Boundary plantation	-	-	1108	1.00%	275	4.94
Other	0.03	7.5%				-
Total	0.4	100%	110353	100%	185932	1.67

Diversity index

Data pertaining to key performance indicator of 0.4 hectare IFS model has been given in Table 4 indicates that soil organic carbon was increased by 10.63% while diversity index in 0.4 hectare IFS model was 2.5 times as compared to existing rice-wheat system. Greater biodiversity in small size IFS model was also reported (Anonymous, 2024).

Table 4: Key performance indicator of 0.4-hectare IFS model

Key performance indicators		**Value**	
Initial soil organic carbon (%)		0.47	
Soil organic carbon (%)		0.52	
Improvement in Soil organic carbon (%)		10.63	
Employment generation (man days)			
Male	366	Hired	135
Female	0	Family	135
Diversity index		2.5	
Insecticide used (a.i.)(kg or litre)		0.5	
Herbicide used (a.i.) (Kg or litre)		0.01	
Fungicide used (a.i.) (kg or litre)		0.2	
GHG emission (kg CO_2 equivalent)			
Source		5396	
Sink		8958	
Net (Source-sink)		**-3562**	

Flow of Income

Data pertaining to revenue generation in different month from 0.4-hectare IFS model has been given in Table 5. After perusal of data, it is clear that 0.4 hectare IFS model with 2 desi cows gave Rs. 103235 from cow milk and 49910 from sale of vegetable and other produce. The value of recyclable produce was Rs. 143141 in terms of fodder, heifer, cows, wheat grain, rice grain and vermicompost. The total gross income was Rs. 296286 in which 48.31% produce of grain, straw, vermicompost and 3 cows (2 heifer, 1 cow) were recycled in the IFS model on death of old cow. The monthly income has been presented in Table 5 which reveals that monthly income per month varied from Rs. 3000 to 28966 per month in the year. The minimum income was in July and maximum income was in January, April and May. Present IFS model 0f 0.4 hectare size gave year round income to farm families. Singh *et al.* 2006, Behra and Mahapatra 1999 and Maurya *et al.* 2024 also reported that year round higher income due to integration of cows, agri horticulture + boundary plantation in IFS model.

Table 5: Revenue generation in different month

Month	**2 years pooled**		
	Receipt deposited in V.V. account (Rs.)		
	Milk	**Vegetable + other**	**Gross total**
July	3000	-	3000
Aug	7050	1455	8505
Sept	7940	5148	13088
Oct	10490	2232.5	12722.5
Nov	9280	2626.5	11906.5
Dec	8840	2320	11160
Jan	11660	7095	18755
Feb	11920	740	12660
March	12700	-	12700
April	9760	19206	28966
May	8880	7783	16663
June	6740	1004	7744
Total	**103235**	**49910**	**153145**

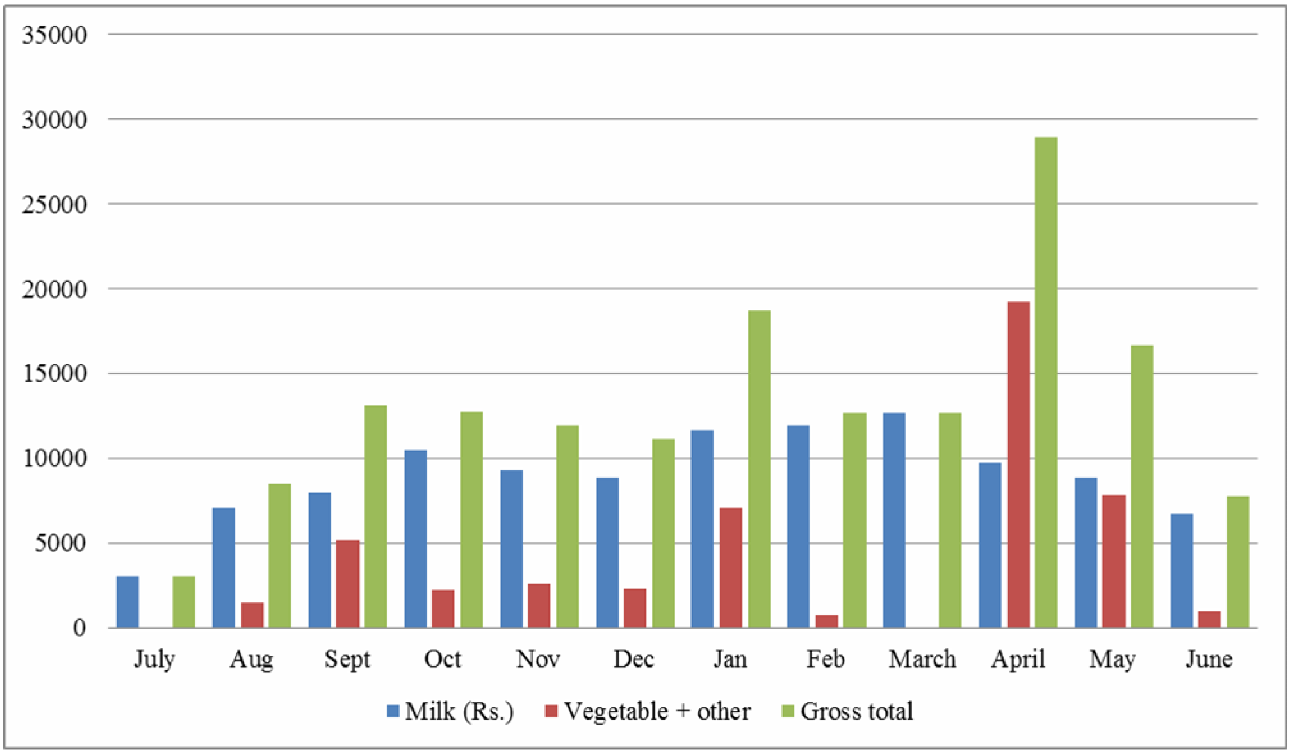

Fig.1 : Revenue generation in different Month

Employment generation

Employment generation from 0.4 hectare model of IFS is given in Table 6. It is clear from the data that 0.4-hectare IFS model gave employment for 513-man days in which 365-man days from farm families and 148-man days from hired labours. The sharing of farm families labour were 17.71 % while hired labour was 28.82%. The employment generation was 38 labour man days per month to 47 labour man day per month during the year. It may be due to inclusion of vegetables like okra, cowpea, onion, garlic, pea and bottle gourd which require for picking and weeding from time to time. Maurya *et al.* 2024, Bahera and Mahapatra 1999 and Singh *et al.* 2006 have also reported the similar findings from small IFS model.

Table 6: Month wise employment generation from 0.4 ha IFS model

Month	2 Years pooled		
	Farm families labor man days	**Additional labor in man days**	**Gross total**
July	31	9	40
Aug	31	10	41
Sept	30	14.5	44.5
Oct	31	16.5	47.5
Nov	30	17	47
Dec	31	10.5	41.5
Jan	31	8	39
Feb	28.5	18.5	47
March	31	10.5	41.5
April	30	14	44
May	31	11	42
June	30	8.5	38.5
Total	**365.5 (71.17%)**	**148 (28.84)**	**513.5**

Figures in parentheses are % over total

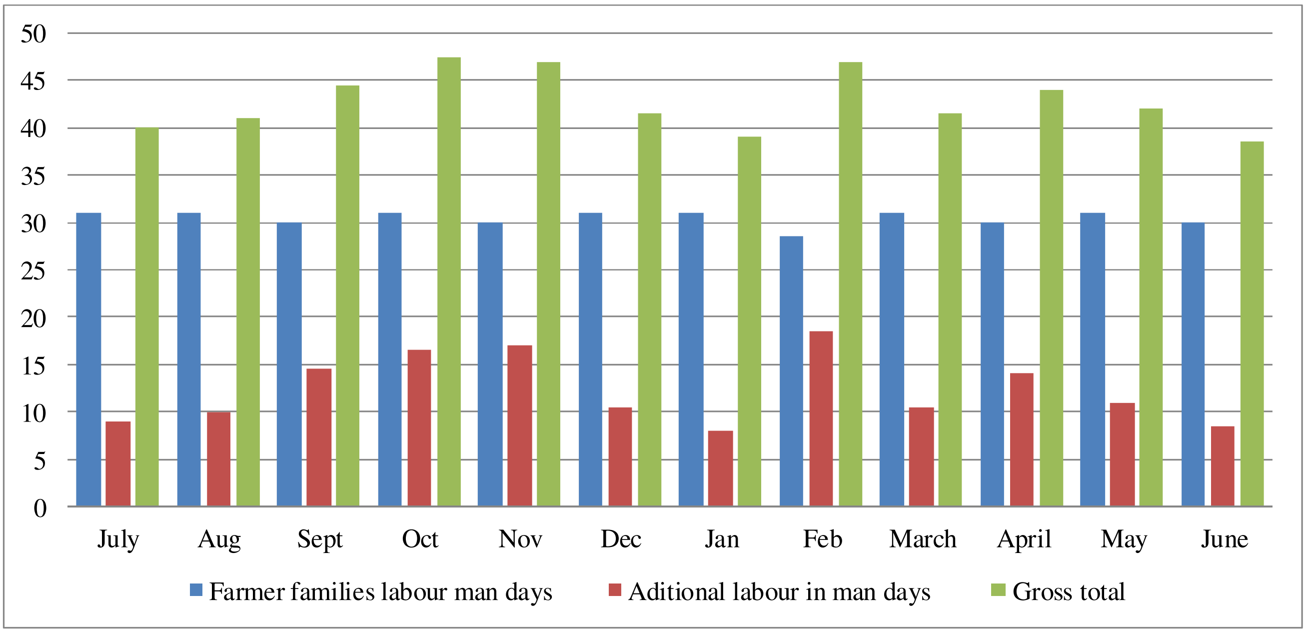

Fig. 2 : Month wise employment generation from 0.4 ha IFS model

Vermicompost Production and Self-reliance status of NPK

Data pertaining to vermicompost and compost production from 0.4-hectare IFS model and with dairy have been given in Table 8. It is clear that vermicompost production was 2400 kg while compost production was 6165 kg annually. The production of 8565kg of compost gave self-sufficiency because it fulfills 133.8% of the total need of 0.4-hectare IFS model. So there was surplus of compost by 33.8%. The whole vermicompost and compost was converted in terms of NPK.It gave 53.76% total need of nitrogen, 67.9% of total need of phosphorus and complete need of potash. The self-sufficiency in compost production was due to better utilization of weeds and crop residues from different resources. The annual report of IFS subcenter Rewa also indicated that 0.4-hectare IFS model fulfill the need of vermicompost and 40-50% need of NPK (Anonymous 2024).

Table 7: Receipt generation and value of recycled

	2 years pooled
	Total revenue
Cropping system	49910 (16.84%)
Dairy	103235 (34.84%)
Value of recycled	143141 (48.31%)
Gross Total	296286

Figures in parentheses are % over total

Table 8: Vermicompost and compost production in IFS and self-reliance status

Particulars	**Quantity (kg)**	**Nitrogen(kg)**	**Phosphorus(kg)**	**Potash(kg)**
Vermicompost	2400	36.47	19.75	27.3
Compost	6165	33.42	21.00	19.50
Total	8565	69.89	40.75	46.80
Requirement	6400	130	60	40
Self-reliance status %	133.8%	53.76%	67.9%	117.0%

Figures in parentheses are % over total

Greenhouse gas emission

Greenhouse gas emission was calculated in 0.4 hectare IFS model by the Apps developed by IIFSR, Modi Puram which is given in Table 9. It is clear from the table that different sources produce 5396 kg

CO_2 equivalent gas and maximum 4032 kg CO_2 equivalent was produced from livestock and dairy. Boundary plantation of guava, citrus, karonda and other plant under forestry and addition of compost and biomass absorb 8958kg CO_2 equivalent from 0.4 hectare IFS model by which net greenhouse gas emission was -3562 kg CO_2 equivalent. Thus due to -GHG emission the present IFS model was climate smart. Kumar 2012 and Maurya *et al*, 2024 reported the IFS model as climate smart due to negative balance of GHG emission.

Table 9 : Green- house gas emission in 0.4 ha IFS model (CO_2 e in kg)

Carbon source	**Enterprises**	**CO_2 e in kg**
1	Cropping system	
C_{S1}	Rice-wheat-GM	521.8
C_{S2}	Ragi- Mustard-Bottle gourd	82.9
C_{S3}	Okra- Garlic	91.3
C_{S4}	Maize + Cowpea-Pea-Onion	207.1
C_{S5}	Bajra-Berseem-Maize+ Cowpea	362.3
	Paddy special	96.8
	Livestock (cattle)	4032.8
	Border plantation and agroforestry	0.0
	Energy used for household	1.0
Carbon Sink	Agroforestry-sink	2240
	Total Biomass/ Compost added SINK	6717.6
	Total source	5396
	Total sink	8958
	Net GHG-IFS	**-3562**

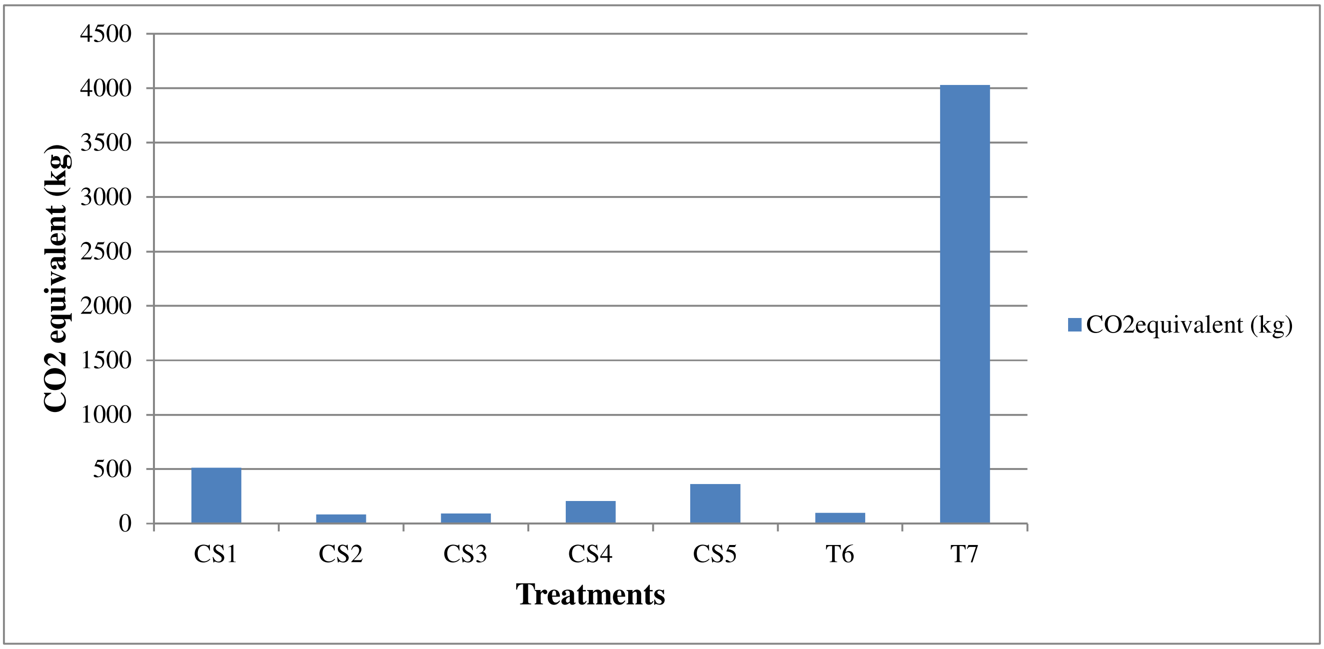

Fig. 3 : GHG Emission CO_2 equivalent (kg)

Conclusion

On the basis of above studies, it was concluded that 0.4 ha IFS model gave 134.6 q rice equivalent yield from 0.4 ha in which major contribution was from dairy which contributed 61.9% of total produce while crop component gave 29.44%. The above IFS model gave net profit Rs. 110333 in which dairy component gave Rs. 65632 which was equal to 59.4% of total net return. Among different cropping system okra- garlic with 5% area gave 8.34% of total net profit with benefit cost ratio 1.94. Revenue generation varied from Rs. 3000 per month to Rs. 28966 per month. Maximum income per month was noted from dairy unit which was Rs. 103235 followed by cropping system Rs. 49910. Value of recycled produce was 143141. The employment generation varied from 38 labours per month to 47.5 labour man days per month. This model gave employment for 513.5 labour man days. Self – reliance status was 133.8% of total requirement of compost, 53.76% of nitrogen, 67.9 % of phosphorus and 117% of total requirement of potash. IFS model was climate smart because greenhouse gas emission was -3562 kg CO_2 equivalent per year from different component.

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Conflict of Interest All authors certify that they have no conflict of interest

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