International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(6): 179-183
www.biochemjournal.com
Received: 25-02-2024
Accepted: 25-04-2024

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Integrated farming systems model for resource management and rural employment in Vidarbha region under rainfed condition

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DOI: https://doi.org/10.33545/26174693.2024.v8.i6Sc.1280

Abstract
A research experiment entitled “Integrated farming systems model for resource management and rural employment in Vidarbha region under rainfed condition” was conducted at All India Co-ordinated Research Project on Integrated Farming System Research, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif-rabi* season of 2022-23. The model was designed for one-hectare area with crop, horticulture, Goatery, poultry, compost, kitchen garden and boundary plantation. Employment generation in integrated farming system model was 222.5 Man day’s year^{-1}. The total quantity of recyclable products and byproducts produced within the system was 7045 kg.

Keywords: Employment generation, residue recycling, nutrient budgeting and soil fertility status

Introduction
Ensuring higher crop productivity, profitability, and better livelihoods for small and marginal farmers is crucial for rural prosperity. Conventional agriculture often focuses solely on crop production, leading to income uncertainty and employment instability. Integrating various agricultural enterprises tailored to the specific agro-climatic and socio-economic conditions of farmers is essential for increasing farm income and family labor employment (Mubarak and Sheikh, 2014) [5].
Crop-based agriculture is highly season-specific, with labor peaks at certain times of the year, leaving farmers with inadequate employment during other times. Integrated farming systems (IFS) have the potential to generate additional employment and ensure a more equitable distribution of employment throughout the year, providing a steady source of income for local labour forces. IFS is labour-intensive, with on-farm employment being largely contributed by the farmer and their family members (Dasgupta *et al.*, 2015) [1].
The IFS approach promotes ecological intensification and aims to reduce reliance on anthropogenic inputs by enhancing ecosystem functions like nutrient recycling, soil fertility enhancement, and environmental performance. Well-managed IFS are expected to be less risky, benefiting from enterprise synergies, product diversity, and ecological reliability. Residue recycling and improved land-use efficiency are key features of IFS, with component selection varying by region based on agro-climatic conditions, land type, water availability, farmer socioeconomics, and market demand. Establishing effective linkages and complementarities between components is crucial for developing holistic and effective farming systems (Paramesh *et al.*, 2021) [6].

Materials and Methods
During the 2022-23 period, a field experiment titled "Integrated farming systems model for resource management and rural employment in Vidarbha region under rainfed conditions" was conducted at the research farm of the AICRP-On Station Research Centre on Integrated Farming Systems, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The integrated farming system model encompassed a total area of 1.00 hectare, featuring components such as crop cultivation, horticulture, kitchen garden, goat farming, poultry, composting, and boundary plantation.

The aim of the study was to achieve year-round income, resource optimization and employment generation through the integrated farming system model. Labour requirements for various crop production activities were specified in man-days per hectare per year. Recyclable residues from each component were quantified in kilograms, and the value of each recycled product and byproduct within the system was determined based on market prices with animal byproducts utilized as nutrient sources in crops. The experimental plot's soil was classified as vertisol, characterized by uniform and level topography. To assess the soil's chemical composition, samples were collected from randomly selected spots across the experimental area at depths of 0-30 cm before sowing, composite soil samples were analyzed to determine the initial fertility status, revealing a soil pH of 7.90, electrical conductivity (EC) of 0.28 $dSm^{-1,}$ organic carbon content of 0.46%, and available nutrient levels including 163.07 kg ha^{-1} of nitrogen, 11.31 kg ha^{-1} of phosphorus, and 289.72 kg ha^{-1} of potassium.

Table 1: Details of the components in IFS model

Sr. No.	Components	Area (ha)
A	**Cropping systems**	-
1	Soybean	0.70
2	Chickpea	
B	**Horticulture 90 plants each 5 m × 5 m distance**	-
3	Custard apple + Drumstick	0.20
C	**Livestock**	
4	Goat (10 doe + 1 buck) *Berari*	0.03
5	Poultry (200 birds)	
	Giriraj birds 50 birds per batch two batches per season	
6	Compost 1 pit	
D.	**Other**	-
7	Kitchen garden	0.02
8	Boundary plantation	0.05
	Total	1.00

Results and Discussion

Employment generation

Employment opportunities stemming from various components within the integrated farming system included 101 man-days per year from the goat unit, 70 from crop cultivation, 18 from poultry unit, 14 from horticulture, 11 from boundary plantation, 4.5 from the kitchen garden, and 4 from the compost unit. A higher level of employment, totaling 222.5 man-days per year, was observed in crop cultivation along with horticulture, goat farming, poultry, composting, kitchen gardening, and boundary plantation, followed by 175 man-days per year, comprising crop cultivation alongside goat farming and composting, other treatments generated employment ranging from 88 to 70 man-days per year, respectively.

Combining crops with livestock and other suitable enterprises not only yielded income but also provided year-round employment opportunities. These findings align with previous research by Kumar *et al.* (2018) [3] and Kharche *et al.* (2022) [2].

Table 2: Employment generation of different components in integrated farming system model

Components	Employment generation (Man days $year^{-1}$)
Crop	70
Horticulture	14
Goat	101
Poultry	18
Compost	4
Kitchen garden	4.5
Boundary plantation	11

Table 3: Employment generation in different integrated farming system model

IFS Components	Employment generation (Man days $year^{-1}$)
T_1: C	70
T_2: C+H	84
T_3: C+G+CO	175
T_4: C+P	88
T_5: C+KG	74.5
T_6: C+ BP	81
T_7: C+H+G+P+CO+KG+BP	222.5

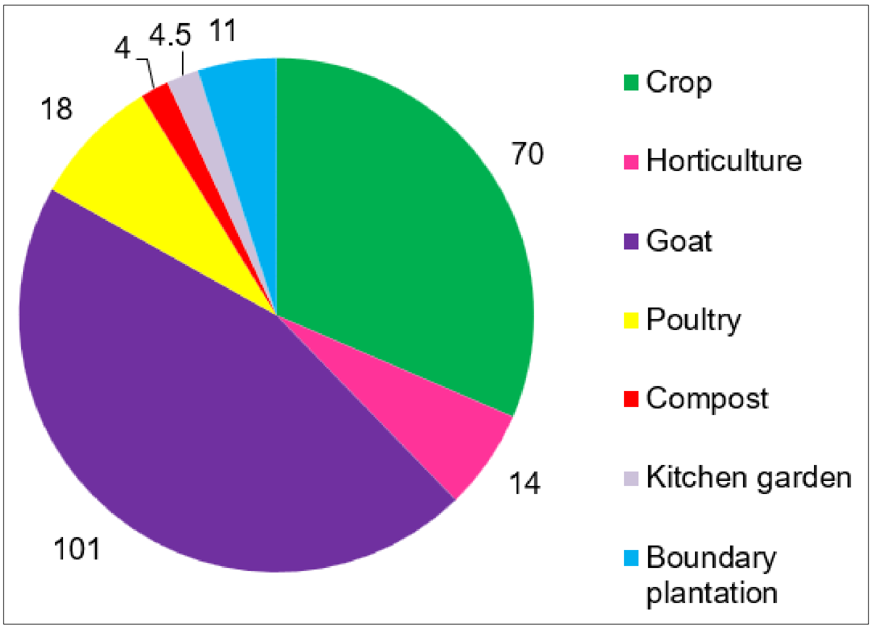

Fig 1: Employment generation (Man days year^{-1}) of different components in integrated farming system model

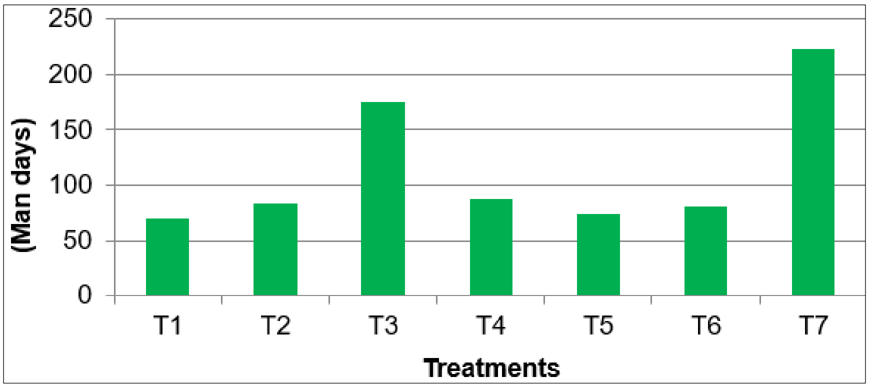

Fig 2: Employment generation in different integrated farming system model

Residue recycling

The integrated farming system operates on the principle of utilizing byproducts and products from one component as inputs for another, ensuring efficient resource utilization. These products and byproducts are recycled and reused within the system, with their quantities quantified and converted into marketable values. Within the cropping sequence, a total of 3880 kilograms of byproducts were recycled these included low-grade grains used as poultry feed, crop straw utilized as dry fodder for livestock and materials for composting. The total market value of recycled products from the crop component amounted to ₹6810, in the horticulture component, 85 kilograms of byproducts, including pruning leftovers and degraded fruits were recycled for composting with a total market value of ₹85 whereas in the livestock component and compost unit, a total of 2930 kilograms of byproducts, such as goat manure, poultry manure, and compost applied to various crops within the system, were recycled. The total market value of recycled products from these components was ₹10690. Furthermore, the kitchen garden and boundary plantation component contributed 150 kilograms of recycled byproducts, including vegetable waste, karonda residues, degraded fruits, and glyricidia leaves for composting, with a total market value of ₹150.

The system generated a total of 7045 kilograms of recyclable products and byproducts, valued at ₹17735 in the market. The gross expenditure encompassed on-farm, off-farm, and daily wages. Savings from on-farm inputs obtained from other components amounted to ₹17735, representing 13.80% of the total recycled within the system. Off-farm costs, reflecting the price of inputs purchased externally, totaled ₹62460, contributing 48.60% to the overall expenditure. The total investment in daily wages reached ₹48300, specifically, human labor engaged in crop components amounted to ₹21000. Daily wages for labor involved in horticulture, goat farming, poultry, composting, kitchen gardening, and boundary plantation were ₹4200, ₹15150, ₹2700, ₹600, ₹1350, and ₹3300, respectively. The collective contribution of daily wages within the system accounted for 37.59%

Table 4: Recycled products in integrated farming system model its total quantity and market value

Sr. No.	Farm enterprises and related byproduct used for recycling within the system	Quantity produced (kg)	Intermittent use of recycled farm produces and by- products (kg)							Market value of total product recycled (₹)
			Crop unit	Horti. unit	Goat unit	Poultry unit	Compost unit	Kitchen garden unit	Boundary plantation unit	
A	Low grade grains (used as feed)	60	-	-	-	60	-	-	-	1080
	Crop straw	3820	-	-	995	-	2825	-	-	5730
	Total (A) Crop component	3880	-	-	995	60	2825	-	-	6810
B	Horti. residue and waste	85	-	-	-	-	85	-	-	85
	Total (B) Crop component	85	-	-	-	-	85	-	-	85
C	Goat manure	720	435	215	-	-	-	15	55	1440
	Total (C) Goat	720	435	215	-	-	-	15	55	1440
D	Poultry manure	410	173	217	-	-	-	20	-	2050
	Total (D) Poultry	410	173	217	-	-	-	20	-	2050
E	Compost	1800	990	450	-	-	-	40	320	7200
	Total (E) Compost	1800	990	450	-	-	-	40	320	7200
F	Kitchen garden residue	25	-	-	-	-	25	-	-	25
	Boundary plantation residue	125	-	-	-	-	125	-	-	125
	Total (F) Kitchen garden + Boundary plantation	150	-	-	-	-	150	-	-	150
	Grand Total (A+B+C+D+E+F)	7045	1598	882	995	60	3060	75	375	17735

Table 5: Contribution of different farm enterprises in resource recycling and overall saving in production cost

Components	On farm	Off farm	Daily wages	Total
	(₹)			
Crop	5695	31085	21000	57780
Horticulture	3315	2345	4200	9860
Goat	1493	507	15150	17150
Poultry	1080	23920	2700	27700
Compost	4472	-	600	5072
Kitchen garden	290	210	1350	1850
Boundary plantation	1390	4393	3300	9083
Total	17735	62460	48300	128495
Per cent of gross expenditure	13.80	48.60	37.59	100

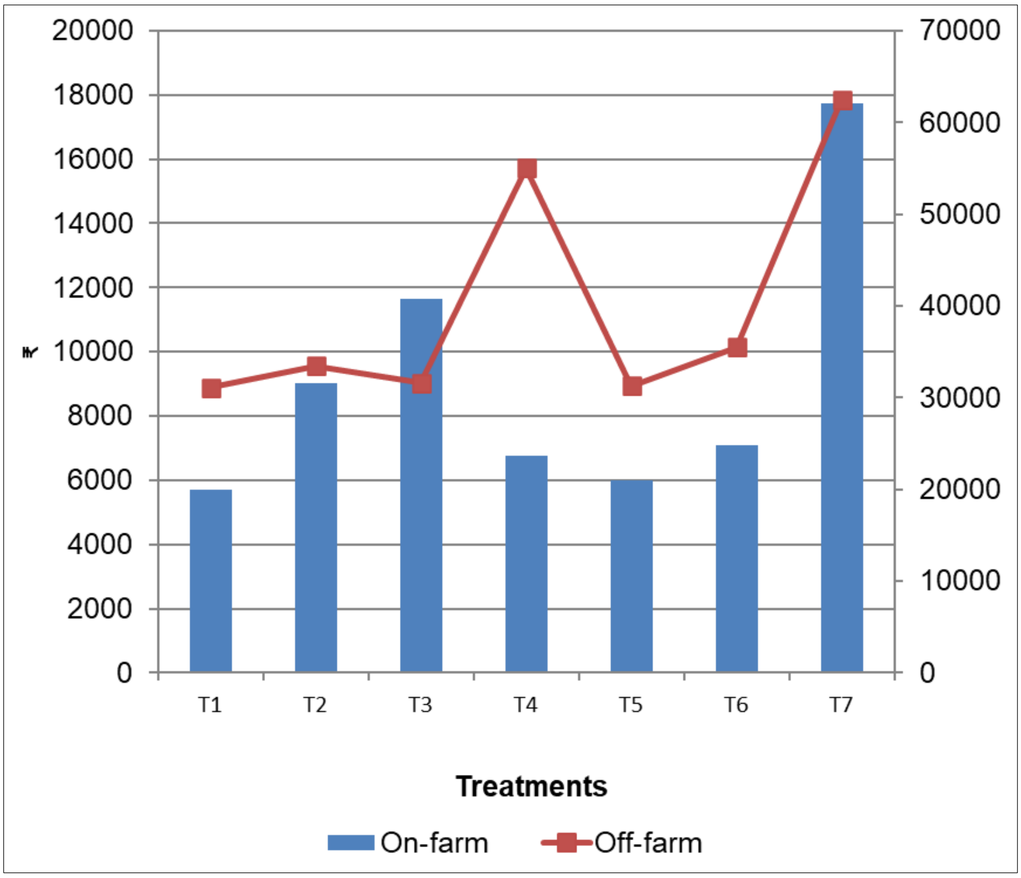

Fig 3: Contribution of different integrated farming system model in residue recycling

Nutrient budgeting

The total quantity of product from livestock components amounted to 1130 kg. The nutrient content recycled in goat manure and poultry manure was 16.64 kg of nitrogen (N), 13.82 kg of phosphorus (P) and 9.21 kg of potassium (K). Additionally, the compost unit produced a total of 1800 kg of product, with nutrient recycling of 28.26 kg of N, 17.10 kg of P, and 14.94 kg of K. Altogether, through goat manure, poultry manure, and compost, the system recycled

44.90 kg of N, 30.92 kg of P, and 24.15 kg of K from 2930 kilograms of organic manure.

Nutrient budgeting reveals that through recycling all available farm components, a total of 44.90 kg of N, 30.92 kg of P, and 24.15 kg of K were added to the soil. This represents a savings of 99.97 kilograms of NPK (45.44%) out of the 220 kilograms of NPK annually required for field and plantation crops. On average, the total NPK requirement for the system trialed in the IFS model was 95, 70, and 55 kilograms per hectare, respectively.

Nutrient budgeting strongly supports the self-sustainability of the system, reducing reliance on external inputs and saving money otherwise spent on expensive chemical fertilizers. This approach effectively addresses the challenges of organic farming and lays the groundwork for the eventual conversion of the entire system into organic farming through IFS activities. These findings are consistent with previous research by Vinodakumar *et al*. (2017) [7], and Meena *et al.* (2022) [4].

Table 6: Nutrient recycling through organic manures in integrated farming system model

Organic source	Quantity of manure (kg)	Nutrient content (%)			Nutrient supplied (kg)			Total (kg)
		N	P	K	N	P	K	
Goat manure	720	1.11	0.97	0.66	7.99	6.98	4.75	19.72
Poultry manure	410	2.11	1.67	1.09	8.65	6.84	4.46	19.95
Compost	1800	1.57	0.95	0.83	28.26	17.10	14.94	60.30
Total	2930	-	-	-	44.90	30.92	24.15	99.97
% of total requirements	-	-			47.26	44.17	43.91	45.44
Total nutrient requirement (kg ha^{-1})	-	-			95	70	55	220

Soil fertility status

The initial soil pH and electrical conductivity of the experimental field were 7.90 and 0.28 dSm^{-1}, respectively, by the end of the experiment these values were slightly reduced to 7.70 and 0.26 dSm^{-1}. Throughout the farming system, there was a notable increase in the organic carbon content of the soil, rising from 0.46% initially to 0.52% by the end of the period. Additionally, improvements were observed in the soil fertility status concerning available nitrogen, phosphorus, and potassium, the available nitrogen increased from 163.07 to 188.16 kg per hectare, phosphorus from 11.31 to 12.48 kg per hectare and potassium from 289.72 to 301.70 kg per hectare, respectively.

Table 7: Soil fertility status in integrated farming systems model

Soil properties	Initial	Final
Soil pH	7.90	7.70
EC (dSm^{-1})	0.28	0.26
Organic Carbon (%)	0.46	0.52
Available N (kg ha^{-1})	163.07	188.16
Available P (kg ha^{-1})	11.31	12.48
Available K (kg ha^{-1})	289.72	301.70

Conclusion

The findings of the current investigation indicate that the Goat component generated the highest level of employment, closely followed by the crop component. Integration of multiple components, including crop, horticulture, goat, poultry, compost, kitchen garden, and boundary plantation, resulted in maximum employment generation. The utilization of waste material or byproducts from one component as input for another facilitated efficient resource utilization within the system, with products and byproducts being recycled and reused. Nutrient budgeting underscores the self-sustainability of the system, reducing dependency on external inputs and saving costs on expensive chemical fertilizers. This approach effectively addresses the challenges of organic farming, paving the way for the gradual conversion of the entire system into organic farming through integrated farming system (IFS) activities. The production process of compost and manure played a crucial role in increasing income, soil fertility, while also maximizing the recycling of byproducts within the system. Composting requires relatively low investment, yet the resulting value-added product has a high demand in the organic manure market. Furthermore, auxiliary enterprises and associated activities, beyond crop cultivation alone played a significant role in bolstering economic conditions and enticing rural youth to engage in agriculture as a profitable enterprise.

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