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Dairy based integrated farming system model for income enhancement of small farmers

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Abstract
Dairy production is an instrument of socio-economic change to improve income and quality of life with equity. There is tremendous scope of increasing productivity of dairy animals by improving nutrient availability from locally available feed and fodder resources under integrated farming system. The aim of present study was to develop dairy based integrated farming system model for enhancing income of small farm. The project is laid on an area of 1.00 ha with different sub-components *viz*., crop production (0.4 ha), fodder production (0.4 ha), dairy production (cattle-3; buffalo-3, goats-10), poultry farming (20 birds), fish pond and vermin-compost pits (0.2ha). The results revealed that the total milk production was 7580 liters from buffaloes, 6308 liters from cattle and 6012 liters from goats. An average increase of 26.95 per cent in milk yield was recorded due to supplementation of UMMB with C: B of 1:8.23. Similarly, the supplementation of polyherbal mixture in cattle increased milk yield by 21.53% with C: B of 1: 10.21. The contribution of dairy component was 59.89%, crop sector (wheat, rice and oat) was 32.75% and subsidiary enterprises (poultry, fishery and vermin-compost, etc.) contributed 7.36% in total net farm income in dairy based integrated production system with C: B ratio of 1: 1.60. Hence, promotion of dairy based IFS module for different situations to fit into socio-economic realm of resource poor famers is able to provide income throughout the year on sustainable basis.

Keywords: dairy, integrated farming system, milk yield

Introduction
India holds around 17% of the world's livestock population in 2% of world's geographical area, resulting in great pressure on land. Presently India's livestock population is 535.78 million head, which is expected to grow at the rate of 0.55% in the coming years and to reach 780.7 million by 2050. The majority of farmers (86%) in India are small and marginal, having less than two hectares of land. The average size of the landholding has declined to 1.08 hectare during 2015-16, from 1.16 ha and 2.28 hectare during 2010-11 and 1970-71, respectively (Agricultural Census of India, 2015) [1]. In general, these small and marginal farmers practice subsistence farming where they want to produce a continuous, reliable and balanced supply of food along with cash for basic needs and recurrent farm expenditure (Rani, 2015) [13]. It is difficult to achieve livelihood security and sustainability for these farmers with a single farm enterprise without turning to Integrated Farming Systems (Mahapatra, 1994, Misra *et al.*, 2010) [8, 10]. Due to explosion of population and rapid fragmentation of land holdings and shrinkage in fertile cultivated land, there is no further scope for horizontal expansion of land for agriculture. Integration of enterprises not only helps in ensuring food, nutrition and livelihood security but also ensures social, economic and environmental sustainability (Kumar *et al.*, 2017) [7]. Integration of crop and livestock is mutually beneficial to each other, since animal manure can be utilized as natural fertilizer to enhance crop production and to maintain soil fertility, whereas crop residues can be used as animal feed, and weeds and other waste materials can be converted into vermin-compost. Available evidences suggest that integrated crop livestock farming system is the most important farming system for maintaining the sustainable agricultural growth and environmental balance, and has potential to increase resource use efficiency, the sustainable use of ecological services and overall resilience of dairy production systems. Hence, emphasis needs to be growth and development of dairy based integrated farming system (IFS) module for different situations to fit into socio-economic realm of small and medium famers and at the same time able to provide income throughout the year on sustainable basis. Keeping these facts in view, ICAR-NDRI initiated the research work on "Developing dairy based integrated farming system model for income enhancement of small farmers".

Materials and Method

The present study was conducted at ICAR-National Dairy Research Institute, Karnal in the IFS unit from September, 2019 to February, 2021. The IFS unit is located at 290 43' N latitude and 760 58' E longitudes at an altitude of 245 meters above mean sea level (MSL) in the Trans Indo-Gangetic plain of India. The project is laid on an area of 1.00 ha with different sub-components *viz*., crop production (0.4 ha), fodder production (0.4 ha), dairy production (cattle-3; buffalo-3, goats-10), poultry farming (20 birds), fish pond and vermin-compost pits (0.2 ha) (Table-1). The wheat-rice based cropping systems were integrated with dairy, goatry, fishery, poultry and duckery with border planting of papaya and forage crops. Vermicompost was also prepared. Three Sahiwal cattle and three Murrah buffalo with ten crossbred goats (Alpine x Beetal) were maintained by the fodder obtained from the system under cut and carry system. A small fish pond with duckery and backyard poultry unit were also maintained (Fig.1).

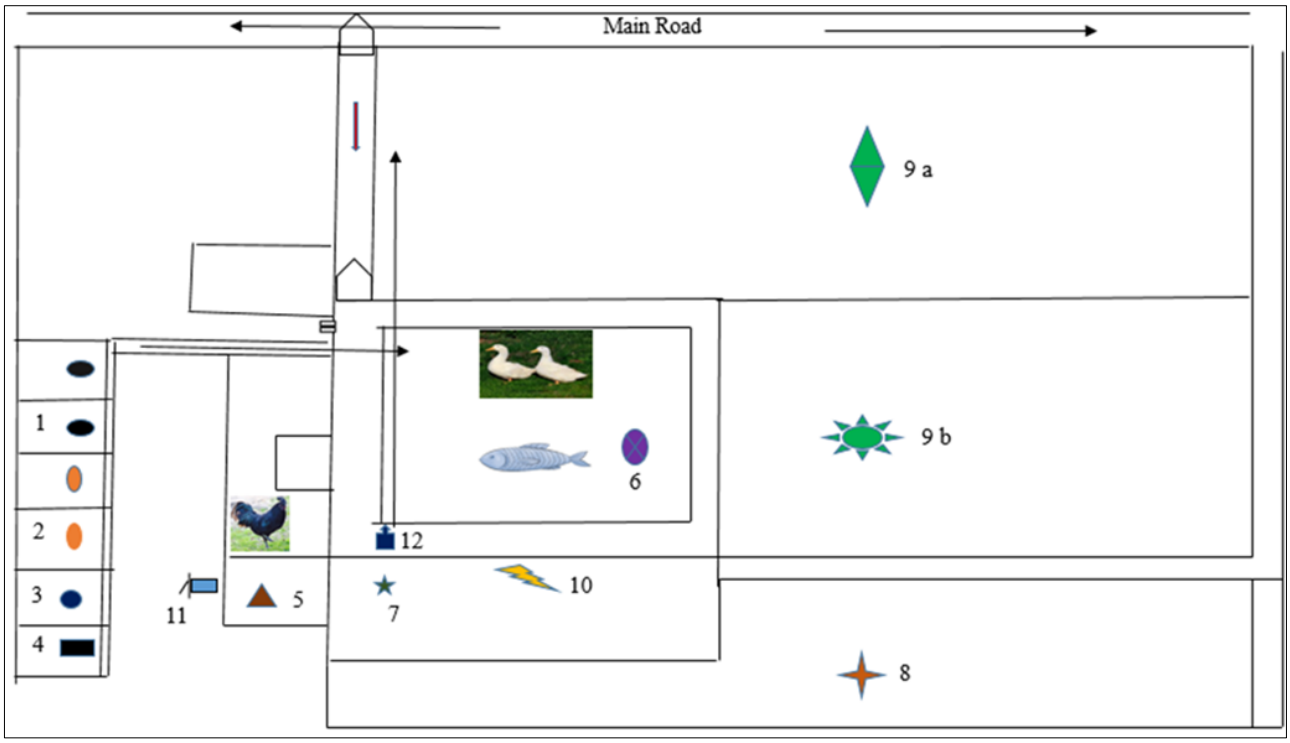

Fig 1: Design of dairy based IFS model under 1 ha. area. (1. Buffalo shed, 2. Cattle shed, 3. Goat shed, 4. Poultry and Duck shed, 5. Vermicompost unit, 6. Fish Pond, 7. Nursery, 8. Crop component, 9. Forage production (a-perennial forage with intercrops and b-annual forage), 10. Fruit plants, 11. Chaff cutter machine and 12. Electric motor for water)

Dairy Component

A dairy unit shed having adequate facilities with sufficient open and covered area and concrete floor covered with rubber mats were used for housing of animals. Crop residues, straw, fodder cowpea, Hybrid Napier and berseem were used as per availability of fodder. Cattle and buffaloes fed on an average 25 kg green fodder was provided to animals after chopping to reduce the wastage round the year. The supplementation of polyherbal mixture and UMMB were provided during lactating stage of dairy animal. It was ranged from 100 to 315 g/animal/day. Concentrate feed was also provided @ 1kg per 2.5 kg of milk to meet the nutrient requirement as per ICAR, 2013 standard. The dung and shed waste were recycled into the system through vermicomposting and composting; and washing of the shed are recycle to fish pond (Fig. 2). Milk yield during morning and evening were recorded daily.

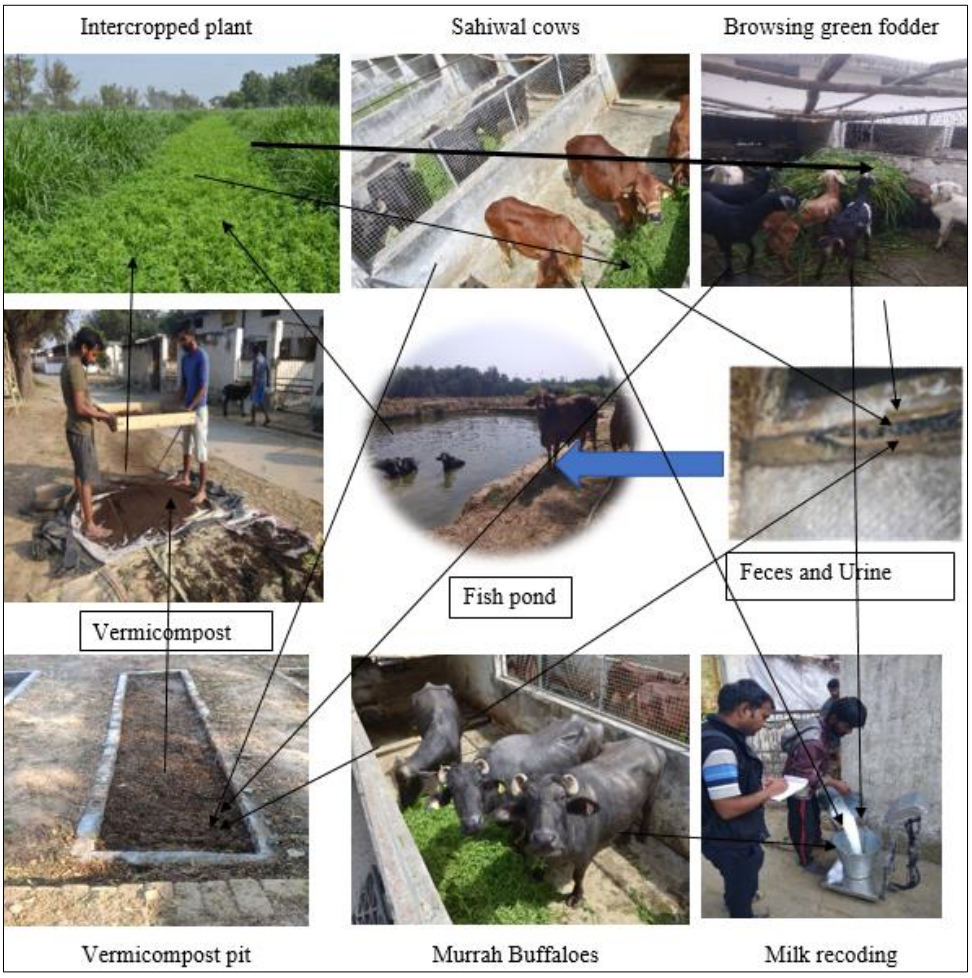

Fig 2: Nutrient recycling in dairy based integrated farming system model

Crop component

The various crop components i.e., wheat during winter and maize/sorghum-cowpea-corn during summer season and rice during kharif season were grown following recommended package of practices. Crop residues were recycled and used as fodder for dairy animals and waste was used for vermicompost. Season-wise fodder crops were grown in the system. During rabi season, berseem (BL-42) and Mustard (Chinese cabbage) and oat (Kent) were grown and Kharif and summer season cow pea and maize were grown; *Moringa oleifera* and Hybrid Napier- perennial fodder was grown in rows to maintain the supply of green and nutritious fodder throughout the year. Berseem and cowpea were grown as intercrop between rows.

The area of each enterprise is calculated based on the potential of the technologies realized by the farmers. Since the supply of green fodder throughout the year was a major challenge, hence emphasis was given on production of quality green fodder and developing feeding strategies for dairy animals.

Table 1: The area distribution of dairy based IFS of each enterprise at NDRI

Area	Components	Proposed interventions
Livestock 5ACU	Sahiwal cattle - 3 Buffaloes -3 Crossbred (AxB) goats - 10 Poultry -20	
	Annual and perennial forage crops	Berseem (BL-42) + Japanese Sarsoo HN+ Berseem + Japanese Sarsoo Moringa
0.4ha	Cereal crops	Wheat (HD 3086) Rice (Pusa Basmati 1121)
0.1 ha	Fruit tree on pond dyke	Papaya (Taiwan red lady-786)
0.1 ha	Misc.	Compost/Vermin-compost, Fishery (25 x 15 x 3)

Results and Discussion

Hybrid Napier (*Pennisetum glaucum* × *P. purpureum*) and Moringa (*Moringa oleifera*) based model of fodder production was developed in 0.4 ha for round the year quality fodder availability. The mean green fodder yield of 1052 q/ha with dry matter yield of 221.07 q/ha was recorded from four cuttings.

Table 2: Cost and returns of different components of dairy based IFS

Details (in Rs)	C + B: 6 (12 m)	Goats-10 (18 m)	Poultry (12m)	Ducks (3 m)	Fish (25x15x3m)	Vermi-compost (4 pits)	Papaya (2)
Fixed cost	3,62,000	72000			24000	5000	
Interest +Dep. on FC @18%	97740	12,960			4320	1350	
Variable cost	535740	511880	12650	4400	9600	4000	
Gross cost (FC+VC)	633480	164840	12650	4400	13920	5350	300
Gross return	871705	278580	27565	5320	30960	15,000	1000
Net return	238225	113740	14915	920	17040	9650	700
B:C ratio	1.38	1.69	2.18	1.21	2.22	2.80	3.33

The total milk production was 7580 liters from buffaloes, 6308 liters from cattle and 6012 liters from goats. 257 eggs and 350 kg fishes were sold from the system. One cycle of vermin compost was completed, and 1000 kg vermin-compost was produced. Effect of polyherbal mixture supplementation on milk production in cattle was evaluated. An average increase of 21.53% in milk yield was recorded due to polyherbal mixture supplementation with cost benefit ratio of 1:10.21 (Bipate and Misra, 2020) [2]. The present findings are in consonance with the finding of Patel *et al.* 2017 [11] and Japheth *et al.* (2019) [5] who reported that feeding of polyherbal mixture in crossbred cattle significantly improved milk yield. Thakur *et al.* (2006) [15] also reported that dietary supplementation of commercial herbal feed additive to lactating crossbred cows increased the milk yield. An average increase of 26.95% in milk yield was recorded due to supplementation of UMMB with C: B of 1: 8.23 the results are in accordance with Bipate and Misra, (2020) [3] that supplementation of UMMB enhances the milk yield of buffaloes significantly. Improvement in milk production due to UMMB supplementation has been well established and may vary widely depending on nature of basal feed and feeding system (Singh and Singh 2003) [14]. The production data (Table 4) shows the soundness of various components of IFS. The overall returns from Dairy, Crops and Subsidiary enterprises were calculated and observed to be 59.89%, 32.75% and 7.36% respectively. Similar results recorded in a comparative study conducted in Karnataka by Channabasavanna, *et al.*, (2009) [4] that Integrated farming system approach recorded 26.3 and 32.3 per cent higher productivity and profitability, respectively over conventional rice-rice system. However, another study conducted in IIFSR, Modipuram by Kaur *et al.* 2021 [6] on different type of interventions consisting of improved crop cultivation practices, diversified crops, improved livestock rearing practices, waste recycling, inclusion of poultry reported increase in income ranging from 84.8 to 103.2 percent. The adoption of integrated farming approach could generate per hectare additional income, depending on inclusion of kind and number of additional farm enterprises and their effective combination as reported by Ponnusamy and Gupta (2009) [12]. It takes two to three years to achieve the targeted goals because the project involved perennial components and enterprises that start giving returns from second/third year of establishment of the project.

Table 3: Cost and returns of crop and fodder components of dairy based IFS

Details (in Rs.)	Wheat 2 seasons	Rice	Berseem+Mustard	HN	Mazie + Cowpea
Gross cost	23400	19500	25200	59000	15850
Gross return	57200	30400	72000	126300	49500
Net return	33800	10900	46800	67300	33650
B:C ratio	2.44	1.55	2.86	2.24	2.12

Table 4: Cost and returns (Rs.) of different enterprise as a whole system of dairy based IFS

Details	Gross cost	Gross return	Net return	B:C ratio
Dairy	6,33,480	8,71,705	2,38,225	1.38
Goat	1,64,840	2,78,580	1,13,740	1.69
Poultry	12,650	27,565	14,915	2.18
Ducks	4,400	5,320	920	1.21
Fish	13,920	30,960	17,040	2.22
Papaya	300	1,000	700	3.33
Vermi-compost	5,350	15,000	9,650	2.80
Wheat	23,400	57,200	33,800	2.44
Rice	19,500	30,400	10,900	1.55
Berseem + Mustard	25,200	72,000	46,800	2.86
HN	59,000	1,26,300	67,300	2.24
Maize + cowpea (2:1)	15850	49500	33650	2.12
IFS as a whole	9,77,890	1,56,5530	5,87,640	1.60
Return/year			3,91,760	

Return from - Dairy: 59.89%, Crops: 32.75%, Subsidiary enterprises: 7.36%

Conclusions and way forward

Results suggest that dairy based integrated farming system model not only increased the production and profitability but also ensured the food and nutritional security through regular supply of milk and eggs round the year and has potential to increase resource use efficiency and overall resilience of the production system. Hence, emphasis needs to be given on development of dairy based IFS module for different situations to fit into socio-economic realm of small and medium famers and at the same time can able to provide income throughout the year on sustainable basis. Availability of key inputs and support services needs to be strengthened and improved to enable the small and marginal farmers for dairy based IFS development. A favourable policy environment in terms of access to micro-credit and assured market will have to be provided for up scaling the developed models.

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