

Economic Analysis of Integrated Farming Systems for Livelihood Security among Smallholder Farmers in Dharwad District of Karnataka

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ABSTRACT

Integrated farming systems (IFS) are slowly gaining acceptance as strategies to promote the livelihood security of smallholder farmers through enterprise diversification, resource recycling and increased farm productivity that are resilient to climate change. The present study was conducted to evaluate the contribution of integrated farming towards enhancing the livelihood security to small farmers in Dharwad, Karnataka. The study was carried out in 2024-25 in Dharwad and Kalaghatagi taluks with multistage sampling technique and primary data were obtained from 120 smallholder farmers practicing integrated farming system by personal interview with a pre-prepared structured schedule. The results indicated that the majority of the farming system combinations in the study area were Agriculture + Horticulture + Dairy and Agriculture + Horticulture + Dairy + Vermicompost. Farm enterprises that reported the highest percentages of annual household income were field crops (41.8%), dairy (28.1%), horticulture (18.4%), vermicompost (5.8%) and forestry (5.9%). The average annual income for integrated farming systems was between ₹ 28,250 and ₹ 51,456 per farm, with the income varying according to the enterprise diversification. Economic analysis revealed that the diversified integrated farming systems performed well compared to less diversified farming systems, yielding gross returns of between ₹ 102,071 and ₹ 248,769 ha/year, net returns of between ₹ 74,592 and ₹ 189,069 ha/year, and a benefit-cost ratio of between 2.71 and 4.91. Some of the main barriers cited by farmers were lack of availability of inputs, prohibitive labour prices, low market prices and institutional credit and subsidy delays. In spite of these difficulties, it was clear that integrated farming systems had a positive impact on income diversification, year-round employment opportunities, nutritional security and resource-use efficiency. The study results suggest that IFS are a viable approach for sustaining agricultural development and improving livelihood security, climate resilience among the smallholder farmers in Dharwad district. Improving access to extension, markets and institutional services will further enhance adoption and sustainability of IFS in the region.

Keywords: Climate resilience, enterprise diversification, farm profitability, income generation, resource recycling, sustainable agriculture

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Achieving climate-resilient agriculture while advancing the Sustainable Development Goals (SDGs) – particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) – has become a major priority for agricultural development in India and globally (Krishna *et al.* 2024; Rishitha *et al.* 2025). Increasing climate variability, shrinking land holdings, soil degradation, soaring farming inputs and unpredictable farm incomes put smallholder farming under increasing pressure for sustainability particularly in semi-arid areas (Keshyagol *et al.* 2026; Maitra *et al.* 2026). This is being reflected in research and policy agendas as the demand for efficient use of resources, diversification of sources and resilience to climatic and economic shocks is growing. Integrated farming systems (IFS) are emerging as one of the best opportunities for climate-smart and nature-based solutions that can lead to sustainable agriculture production and enhance the livelihoods of small and marginal farmers (Manasa *et al.* 2021; Mukesh *et al.* 2024).

Integrated farming system is a system that utilizes the resources in the most efficient way but at the same time is also ecologically integrated, where the farming of crops is integrated with various other enterprises such as livestock, horticulture, agroforestry, vermicomposting etc which are mutually supportive. The production of one business becomes another business's input which helps to optimize nutrient recycling, minimize dependence on external inputs and maximize whole-farm production. This integration optimises the use of land, labour, water, biomass and family resources and creates multiple source of income throughout the year. IFS is considered as a sustainable intensification and livelihood improvement and risk mitigation option by smallholders in India as a means of achieving both economic and environmental sustainability (Singh *et al.* 2020; Behera, 2019; Sairam *et al.* 2025).

In India, small and marginal farmers make up over 85% of the total number of farmers, and they suffer from multiple constraints including a lack of bargaining power in markets, low returns on crop production, dependence on precipitation, and fragmented land holdings. When this happens, single cropping combinations can be unpredictable and make farmers more vulnerable to climatic stress

(Santosh *et al.* 2024; Maitra *et al.* 2025). Diversification, in the form of crop–livestock–horticulture based integrated farming systems, can take the form of a single enterprise being reduced in its importance and risk being diversified across a number of enterprises. Previous studies have shown that integrated farming systems improve system productivity, profitability, nutrient recycling, employment generation, and food and nutritional security while reducing vulnerability to droughts, price shocks, and crop failures (Layek *et al.* 2023; Rathore *et al.* 2019; Kumar *et al.* 2025).

Mixed farming systems (field crops, dairy, horticulture and tree-based farming) have been and continue to be very important in sustaining rural livelihoods, especially in the northern (transition) zone of Karnataka. The district of Dharwad is one of the most significant agricultural areas of the region where smallholder farming involves diversified enterprises and intimate crop–livestock integration. The climate of the district is semi-arid, with highly erratic rainfall, and there is mixed farming system, which makes it highly suitable for study of integrated farming system as a livelihood system. Combinations like agriculture + horticulture + dairy and agriculture + horticulture + dairy + vermicompost have been documented earlier on the farm level in Dharwad and are a key aspect of enterprise diversification for income generation and resource recycling. Likewise, it has been observed in North Karnataka that net farm income and employment generation is significantly enhanced with crop–livestock–allied farming systems under smallholder farming conditions.

Although there is increasing awareness about the advantages of IFS in India, location specific empirical evidence of enterprise-wise diversification to livelihood security among small farmers in Dharwad district in India is still limited (Maitra *et al.* 2021). Moreover, there is limited documentation on the individual contribution of the various enterprises of the integrated enterprise to household income, resilience and sustainable development in the semi-arid situation of northern Karnataka, especially for climate resilience and sustainable development outcomes. These gaps suggest the need for district-level evidence on the relationships between enterprise composition and livelihood performance for farmers who are smallholders.

The present study was conducted to explore the role of integrated farming system for enhancing the livelihood security of the small farmers in Dharwad district of Karnataka. Study aims include understanding the dominant farming system combinations cultivated by the farmers, estimating impact of various enterprises within the farming system on farm income and livelihood security, assessing the economic performance of integrated farming systems, and determining the key constraints affecting farmers' adoption and management of the integrated farming systems. The results would be helpful in the context of the increasing body of evidence on climate-resilient and sustainable farming systems and would inform research, extension and policy actions on the path to resilient agricultural development and Food and Agriculture Sustainable Development Goals (SDGs) in Indian semi-arid regions.

MATERIALS AND METHODS

The present study was conducted in Dharwad district of Karnataka, India with the aim of evaluating the role of integrated farming systems (IFS) in improving livelihood security of small farmers. The climate of Dharwad district of Northern Transition Zone of Karnataka is semi-arid tropical climate with annual rainfall between 700 and 850 mm with the major portion of the rainfall received during South-West monsoon. Black and Red soils dominate the area and agricultural activities are broad ranging including field crops, horticulture, dairy and allied industries.

A multistaging sampling design was used for the selection of the study area and the respondents. The purpose of the selection of Dharwad district was to capture the characteristics of smallholder farmers' farming practices of mixed farming and diversification of enterprises. The taluks of the district were selected based on the level of adoption of integrated farming practices with crop production and horticulture, dairy and vermicomposting amongst the taluks of the district and were selected as Dharwad and Kalaghatagi taluk. Village wise IFS farmers were identified in consultation with the agricultural extension personnel and village records of the villages with relatively higher concentration of IFS farmers. Farmers in integrated farming systems were listed from the selected villages, and farmers

who continuously involved in at least two or more enterprises, and in possession of landholdings up to 2.0 ha were selected for the study. These were sampled proportionately and 120 respondents were interviewed during the agricultural year 2024–25.

The data used in the study were primary and secondary data. Structured and pre-tested interview schedule was used in personal interview for the purpose of primary data collection. Data on socio-economic attribute of the households, size of land holdings, cropping pattern, horticultural enterprises, livestock holdings, dairy production, vermicompost unit, enterprise-wise cost and returns, labour utilization, household income and constraints encountered in integrated farming were collected. Specific emphasis was placed on capturing enterprise combinations used by the respondents and role played by each enterprise in the household's livelihood. The secondary data of agro-climatic conditions, rainfall, land-use pattern and district agricultural profile was gathered from the University of Agricultural Sciences Dharwad, Department of Agriculture, Govt of Karnataka and agriculture related published sources in India.

The respondents' farms were categorized into farming systems based on the mix of enterprises they had on the farms, including field crops, horticulture, dairy, forestry, and vermicomposting. The relative prevalence of each farming system combination was estimated using frequency and percentage analysis. Key enterprise elements were also documented to gain an understanding of their function in production, nutrient recycling and income generation. This classification facilitated identification of the major IFS and their functionality in livelihood improvement among the smallholder farmers. The same method was used for previous research on enterprise diversification and interactions of the systems in integrated farming systems (Paramesh *et al.* 2022; Nayak *et al.* 2023).

The economic performance of the integrated farming systems was assessed by estimating the cost of cultivation, gross return, net return and benefit-cost ratio of enterprises and farming systems. Gross return was arrived at by multiplying the quantity of the produce from each enterprise by the market price at the time of sale:

$$\text{Gross Return (₹/farm/year)} = \text{Quantity of Produce} \times \text{Market Price}$$

Net return was estimated by deducting total cost of cultivation or enterprise maintenance from the gross return:

$$\text{Net Return (₹/farm/year)} = \text{Gross Return} - \text{Total Cost of Cultivation}$$

The benefit-cost ratio was computed to assess profitability of each farming system:

$$\text{Benefit-Cost Ratio} = \text{Gross Return} / \text{Total Cost of Cultivation}$$

Using these economic indicators, the viability of different IFS models were compared and the economic benefit of enterprise diversification were evaluated. The farm management and integrated farming system studies on profitability and sustainability are also conducted using similar analytical procedures.

Livelihood security of the farm households was evaluated in terms of enterprise-wise contribution to annual household income, food production, job creation and regularity of cash flow. Incomes from field crops, dairy, horticulture, vermicompost and forestry enterprises were estimated individually and the percentage proportion of each enterprise to total farm income was determined by the following equation:

$$\text{Enterprise Contribution (\%)} = (\text{Income from Individual Enterprise} / \text{Total annual household farm income}) \times 100$$

Total annual household farm income denotes the sum of all the incomes earned from enterprises combined in the farming system. This analysis facilitated quantification of relative importance of each enterprise in livelihood security. Diversified enterprise contributions under IFS provide more income stability, decrease economic risk, and increase household resilience towards climatic and market shocks.

Adoption and management constraints of integrated farming systems were assessed by noting farmers reactions to production, labour, financial, marketing and institutional constraints. Major constraints such as untimely availability of inputs, increasing labour costs, and limited access to machinery, low market prices, delayed credit availability, and inadequate

extension support were identified. Answers were consolidated into broad categories and reported as percentages of the number of respondents who mentioned each constraint. The recommendations offered by farmers on strengthening of the integrated farming systems including timely inputs supply, good market access, availability of credit, training and extension were also recorded. Institutional support and market infrastructure also have been cited as important for supporting diversified farming systems in integrated farming studies conducted in other parts of India, and are constraints that have been reported here (Jat *et al.* 2021). The data collected were coded, tabulated and analyzed through descriptive statistical tool which includes frequency and percentage, arithmetic mean and averages.

RESULTS AND DISCUSSION

There were significant variations in enterprise combinations of the distribution of integrated farming systems on smallholder farms in Dharwad district, which is the result of farmers' efforts to optimize farm resources, such as land, labour and farm resources, within the local agro-climatic conditions (Table 1). Agriculture + horticulture + dairy and agriculture + horticulture + dairy + vermicompost were the most dominant systems among the surveyed households and few farmers tried more diversified combinations with forestry components. This pattern suggests that crop-livestock farming continued to form the foundation of smallholder farming in the northern region of Karnataka, and that recent times have seen an increasing number of crops-livestock-horticultural-and-organic recycling enterprises being introduced to increase productivity and income stability. Diversification in IFS decreases reliance on a single enterprise and protects farmers from climatic risks, price fluctuations and seasonal changes in farm income. The same findings were found by Das *et al.* (2019) who reported that diversification of farming systems showed significant positive benefits on the overall system productivity and profitability by accounting for enterprise complementarity and efficient resource utilization. Singh *et al.* (2017) also observed that crop-livestock-horticulture integration provides better livelihood resilience for smallholders as they get incomes throughout the year without production risk. Moreover, integrated

Table 1: Predominant integrated farming systems adopted by small farmers in Dharwad district

Sl. No.	Farming system combination	Dharwad taluk (%)	Kalaghatagi taluk (%)	Average annual income (₹/farm/year)
1	Agriculture + Horticulture + Dairy	36.66	15.00	28,250
2	Agriculture + Horticulture + Dairy + Forestry	28.33	16.66	37,330
3	Agriculture + Horticulture + Dairy + Vermicompost	21.66	30.00	41,773
4	Agriculture + Horticulture + Dairy + Forestry + Vermicompost	13.33	38.33	48,311–51,456

Table 2: Major crops and enterprise components contributing to livelihood security under IFS in Dharwad district

Component	Major enterprises/crops	Contribution to farm livelihood
Field crops	Jowar, maize, soybean, paddy, cotton, groundnut	Staple food, fodder, income generation
Horticulture	Mango, sapota, guava, banana	Fruit income and nutritional security
Vegetables	Brinjal, tomato, bhendi, cucumber	Cash income and household nutrition
Dairy	Cow and buffalo	Daily income through milk, manure
Forestry	Teak, nilgiri	Long-term income and biomass generation
Vermicompost	1–4 pits/farm	Nutrient recycling and input cost reduction

farming systems are considered as climate-resilient farming systems as they enhance farm adaptability with ecological balance and economic viability (Alemu *et al.*, 2009; Mishra and Kumar, 2018; Ray *et al.* 2025).

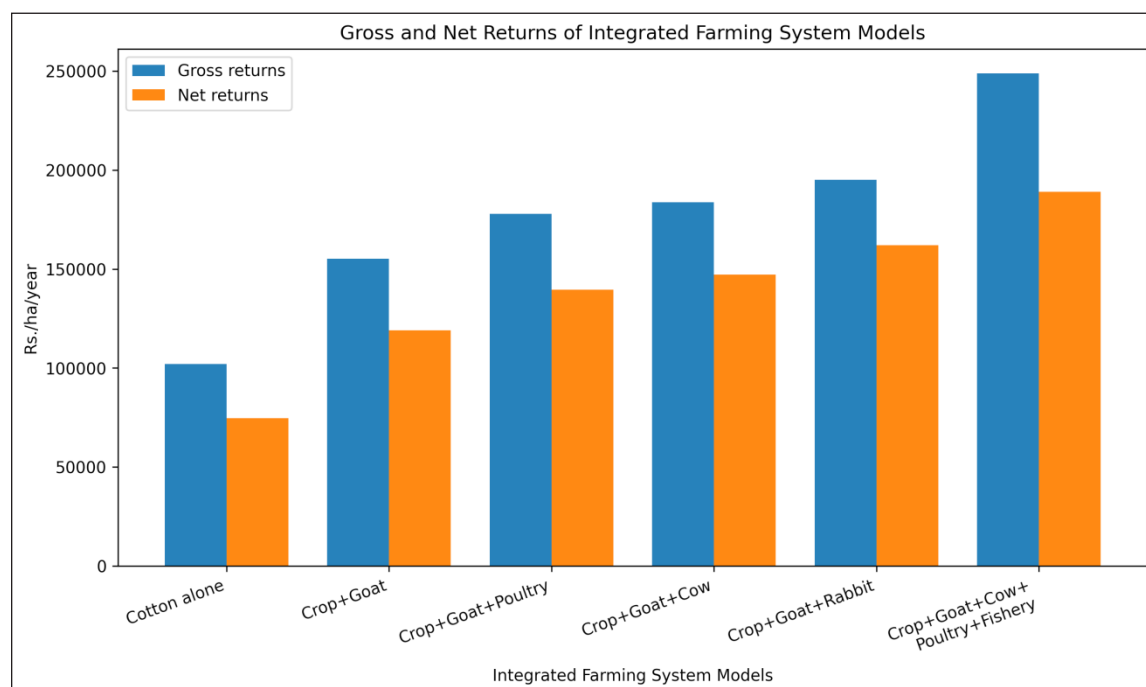
The major crops and enterprise contributing to livelihood security in the study area are shown in Table 2. Maize, sorghum, soybean, cotton and paddy were the major crops grown for subsistence and the market, represented in the field. Horticultural crops and vegetables were important elements in dietary diversification and cash income, and dairy offered a guaranteed income in the form of milk sales year round. The use of vermicompost units and tree-based businesses enhanced inner cycles of nutrients and biomass development, which boosted sustainability of the system. The findings show that IFS creation is not only based on one enterprise but on several interlinked enterprises that create food, fodder, income and organic inputs. Dairy is particularly important in connecting the crop and livestock elements – via manure recycling and feed use. The integration of crops, livestock and use of organic nutrient cycling significantly boosts farm sustainability and profitability in Indian production systems, as highlighted by Babu *et al.*

(2023). Furthermore, Fatima *et al.* (2023) noted that the varied structure of enterprises is associated with better nutritional security, less waste, and more efficient use of resources. Research studies in South Asia also show that IES enhances food security in the household and decreases their reliance on external sources of agricultural inputs (Ravisankar *et al.* 2025).

The economic assessment showed that diversified integrated farming systems performed economically better than single enterprise agriculture as shown in Table 3. Fig. 1 represents the comparative gross and net returns from various models of integrated farming system adopted by the small farmers at Dharwad district. The integrated models had greater gross returns, net returns and benefit–cost ratios than sole crop-based models. Farm enterprises which involved both crop production and allied activities like dairy, goat rearing, poultry etc. had significantly high annual income and employment per farm. This increased profitability is explained by the efficient recycling of the crop residues, livestock wastes and farm by-products into the system, which lowers production expenses and raises the production of several enterprises. Income diversification also helped farmers to ensure a steady income stream year-round, which was helpful in coping with the

Table 3. Economics of integrated farming system models relevant to livelihood security of small farmers in Karnataka

Farming system model	Total cost (₹/ha/year)	Gross income (₹/ha/year)	Benefit: Cost ratio	Employment generation (man-days/ha/year)
Cotton alone (F1)	27,479	102,071	2.71	79
Crop + Goat (F3)	36,066	155,177	3.30	120
Crop + Goat + Poultry (F4)	38,325	177,928	3.64	134
Crop + Goat + Cow (F5)	36,727	183,825	4.01	176
Crop + Goat + Rabbit (F6)	33,034	195,078	4.91	135
Crop + Goat + Cow + Poultry + Fishery (F7)	59,700	248,769	3.17	206

**Fig. 1:** Comparison of gross returns and net returns of different integrated farming system models practiced by small farmers in Dharwad district of Karnataka

risk of crop failure or price fluctuations. The results are similar to Bahadur *et al.* (2024) that IFS is found to be very useful for enhancing the profitability and productivity of the resources in rain-fed agriculture in India. Panwar *et al.* (2018) also reported that diversified farming systems outperform conventional monocropping systems in terms of improved land, labour and biomass utilization resulting in higher net returns. Very recently, Bais and Bahadur *et al.* (2023) found that IFS significantly increases enterprise diversification, nutrient recycling and labour utilization, which are key inputs to farmers' income. Furthermore, it is known that integrated systems can enhance the ecological efficiency and, at the same

time, boost the economic returns, especially in the context of smallholders' livelihoods in semiarid areas (Maitra *et al.* 2001; Pandey *et al.* 2023).

The limitations faced by the farmers using integrated farming systems (IFS) in Dharwad district suggest that there are still some operational and institutional limitations that prevent IFS from achieving their full potential of productivity and profitability (Table 4). The availability of agricultural inputs at the right time, increasing labour wages, and the lack of access to agricultural machinery were some of the production constraints commonly noted by farmers. Low market prices, price fluctuation, poor

Table 4: Major constraints faced by IFS farmers in Dharwad district and suggested interventions

Category	Major constraints reported	% farmers reporting	Suggested intervention
Production	Non-availability of inputs in time	78–87	Timely supply through village-level agri input centers
Production	High wage rates	83–87	Farm mechanization and labour-saving technologies
Marketing	Low remunerative prices	80–92	Collective marketing / Farmer Producer Organizations
Marketing	Price fluctuations	83–85	Value addition and storage facilities
Financial	Delay in loan sanction	82–85	Simplified agricultural credit procedures
Financial	Non-availability of subsidies in time	78–82	Direct benefit transfer and timely release
Management	Lack of coordination among enterprises	65–77	Training on integrated farm planning
Management	High gestation period of perennial enterprises	60–72	Enterprise diversification and phased investment planning

Table 5: Enterprise-wise contribution of integrated farming system components to livelihood security of small farmers in Dharwad district

Sl. No.	Enterprise component	Average annual income (₹/farm/year)	Contribution to total household income (%)	Major livelihood benefit
1	Field crops	42,500	41.8	Food grain production and primary income
2	Horticulture	18,750	18.4	Nutritional security and seasonal cash income
3	Dairy	28,600	28.1	Daily cash flow through milk sale and manure
4	Vermicompost	5,950	5.8	Input cost reduction and sale of compost
5	Forestry / tree components	6,000	5.9	Biomass, fuelwood and long-term asset generation
Total		1,01,800	100.0	—

storage facilities and relying on middlemen were also factors affecting marketability, which further depressed profitability. Limited access to credit and subsidies due to financial constraints also limited the expansion of enterprises like dairy, horticulture and vermicomposting. The results indicate that, apart from enterprise integration on the farm, livelihood benefits of IFS are also linked to external support available to the farmers such as extension, institutional credit and market infrastructure. Likewise, Mariappan *et al.* (2023) reported that lack of institutional support and market access are also significant issues for the adoption of IFS among smallholders. In response, extension interventions like farmer producer organizations, local input supply systems, enterprise-specific training and value addition facilities have been recommended to

enhance the efficiency of the systems and farmer's income. Recent publications also have emphasized on improving institutional linkages and market linkages and also increasing access to credit for scaling up the integrated farming systems sustainably across India (Sarkar *et al.* 2001; Jat *et al.* 2021).

In Table 5 and Fig. 2, the contribution of individual enterprises to household livelihood security is presented, with the enterprises in the field of crops being the highest contributor of annual income for households followed by the enterprises in dairy, horticulture, vermicompost and forestry enterprises. While the main occupation was still farming, dairy was a year round occupation providing a more regular cash flow between crop seasons. Horticulture enhanced both income and nutrition security by supplying the household with fruits and

vegetables for market sales and own consumption. Vermicompost also had indirect benefits in the form of lower chemical fertiliser costs, and also produced extra income from selling the compost. The forestry elements offered long-term economic security, in terms of timber, fuelwood and biomass. The varied contribution of these enterprises demonstrate that integrated farming systems enhance livelihood security by diversifying their income sources and spreading risk among various enterprises.

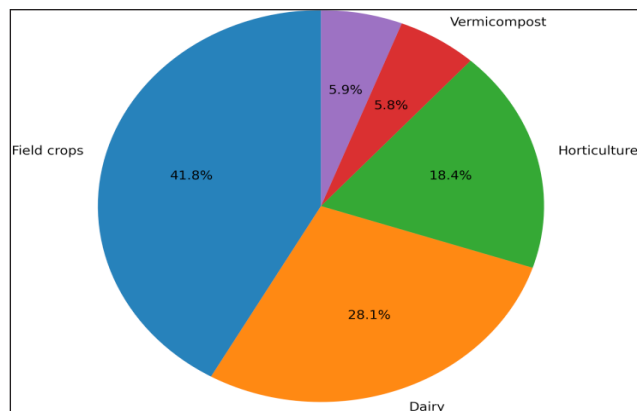


Fig. 2: Enterprise-wise contribution (%) of integrated farming system components to total household income of small farmers in Dharwad district of Karnataka

This diversification helps to reduce the impact of climatic variability, pest infestation and price fluctuations and guarantees a year-round income and employment and food availability. Roy *et al.* (2024) found that diversified IFS models had a positive impact on enhancing income stability, nutritional security and sustainability of smallholder households. Similarly, Nath *et al.* (2016), and Raghavendra *et al.* (2024) found that under IFS, enterprise diversification enhances resilience, farm profitability and sustainability of livelihoods by optimising the use of resources and not being very sensitive to external shocks.

CONCLUSION

The present study proves that integrated farming system is feasible and sustainable approach for improving the livelihood security of small farmers of Dharwad district of Karnataka. Diversified enterprise combinations with field crops, horticulture, dairy, vermicomposting, and tree-based enterprises point to the significance of enterprise integration in the

smallholder farming system. The results suggest that integrated farming would improve the efficient land, labour, biomass and household resource use and would produce a variety of outputs from a farming production unit. Diversification is likely to enhance farm productivity and resilience to climatic variability and uncertainties in production and market price. Integrated farming systems provide a viable tool for supporting sustainable intensification, income diversification and ecological sustainability for smallholder farmers in the context of climate resilient agriculture and the SDGs.

The economic analysis showed that diversified integrated farming systems achieved higher gross returns, net returns and benefit-cost ratios than less diversified farming systems, thus confirming the economic benefits of enterprise integration. Food crops accounted for the bulk of household income, while dairy, horticulture, vermicompost and forestry activities had an auxiliary role in providing a steady cash flow as well as nutritional security and recycling of resources in the farm. The mutual dependency of enterprises enhanced the nutrient cycling, less dependence on external inputs and enhanced farm profitability. The results further support previous studies indicating that crop-livestock-based integrated systems positively affect income stability, resource-use efficiency and farm sustainability, especially in the case of smallholder farming in semi-arid regions of India.

Yet, the study also came up with some constraints which hinder the potential of the integrated farming systems, which are: availability of inputs at untimely time, labour shortage, institutional credit constraints, marketing constraints, etc. To scale-up integrated farming systems in the region, addressing these barriers by timely supply of inputs, better extension services, improved credit facility, market infrastructure and farmer-oriented training will be crucial. The study, in general, finds that the integrated farming systems have great potential to contribute towards improving livelihood security, along with climate resilience and sustainable agricultural development in Dharwad district. The coordinated policy, research and extension interventions to promote location specific IFS models can be a key element in enhancing the resilience and prosperity of smallholder farming communities in Karnataka and similar agro-ecological regions.

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