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ADVANCING STRATEGIES FOR EXPLORING INNOVATIVE INTEGRATED FARMING SYSTEMS FOR RAINFED AREAS IN GARIYABAND, CHHATTISGARH

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ABSTRACT

This study, titled "Advancing Strategies for Exploring Innovative Integrated Farming Systems for Rainfed Areas in Gariyaband, Chhattisgarh," investigates the development of an integrated farming system model tailored for rainfed conditions during the kharif-rabi season of 2023-24. The study, which is being carried out in Gariyaband, uses a complete approach that integrates crop production, horticulture, goat farming, poultry, composting, kitchen gardening, and border planting on a one-hectare plot of land. With a total gross monetary return of ₹333,600 and a net return of ₹205,105, the model showed a noteworthy system productivity of 7,542 kg ha^{-1} of soybean equivalent yield, yielding a benefit-cost ratio of 2.60. Research on rainfed areas, such as Gariyaband, is severely lacking, despite the fact that integrated agricultural systems have been the subject of numerous studies. By offering actual proof of the economic feasibility and productivity gains made feasible by such systems, this study seeks to close that gap. The results demonstrate how integrated farming systems can promote profitable and sustainable agricultural practices. In order to guarantee adaptation and long-term sustainability, future studies should investigate scaling these models across different agroclimatic conditions with a focus on cooperation with regional farmers.

Keywords: Integrated Farming System, Rainfed Agriculture, Productivity, Profitability

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1. INTRODUCTION

Researchers are increasingly calling for a farming systems approach in agricultural research and development in order to satisfy the complicated goals of sustainability, competitiveness, food security, and poverty reduction. This method carefully blends different agricultural businesses and resources to guarantee profitability while preserving socioeconomic and environmental equilibrium. Enhancing agricultural productivity and profitability, maintaining sustainability, and encouraging resource recycling are among its main goals. The strategy also seeks to improve farmer livelihoods through environmentally sustainable methods, provide year-round revenue, alleviate fuel and fodder shortages, maximize input-output efficiency, promote employment, and expand agricultural opportunities.

With roughly 18% of the world's population and 15% of its livestock concentrated in India, which has limited natural resources—2.3% of the world's land and only 0.5% set aside for grazing—agriculture in the country is under a lot of strain. Around 60% of the workforce is employed in agriculture, and over 70% of the population lives in rural areas while possessing 11.3% of the world's arable land. This dependence emphasizes how urgently sustainable farming methods are needed to sustain rural livelihoods.

By encouraging ecological intensification and decreasing dependency on artificial inputs, the Integrated Farming System (IFS) strategy improves soil fertility and nutrient recycling. In rainfed areas, where climate unpredictability poses difficulties, IFS are especially important. IFS can improve resilience, boost productivity, and advance sustainable practices by encouraging enterprise synergies.

Adopting IFS is essential for smallholders, who make up more than 86% of agricultural families and frequently face resource access challenges, as pressures on Indian agriculture increase. Crops and animals can be successfully integrated into IFS to maximize resource utilization and minimize waste by establishing closed-loop systems and optimizing nutrient cycling. To encourage broad use of IFS and improve food security and rural livelihoods in the face of contemporary agricultural difficulties, more research and cooperative efforts between farmers, academics, and policymakers are crucial.

2. MATERIALS AND METHODS

A one-hectare integrated farming system (IFS) model that includes a variety of activities such crop production, horticulture, goat husbandry, poultry, composting, kitchen gardening, and boundary planting was the goal of this study. These elements were carefully chosen to maximize resource utilization and offer a consistent revenue stream all year long. Each component is essential to increasing overall sustainability and production; for instance, horticulture provides high-value fruits and vegetables to increase profitability, while crop agriculture concentrates on staple crops. In addition to providing meat and milk, goat farming also provides manure for composting, which encourages the system to recycle nutrients. Poultry farming further improves sustainability by using kitchen trash as feed and boosting the revenue stream with eggs and meat. Kitchen gardening lowers vegetable costs while supporting dietary demands in the home. Boundary plantings improve the microclimate by reducing wind, conserving soil, and supplying livestock with feed.

The IFS model was created with an emphasis on component synergies to optimize efficiency and reduce waste. According to preliminary assessments, there are a number of noteworthy advantages, such as increased biodiversity, resilience to climatic fluctuation, and better soil health through composting. By calculating gross and net returns as well as the benefit-cost ratio, the study evaluated economic viability and showed that IFS can be a practical approach for smallholder farmers in rainfed areas, improving livelihoods and ensuring food security.

Subsequent suggestions will concentrate on improving the model in response to farmer input and extending its use to a variety of agroclimatic zones. This study opens the door for more advancements in sustainable farming methods by highlighting the potential of integrated farming systems to address the social, economic, and environmental issues that farmers in rainfed regions confront.

Table 1: Details of the components in IFS model

Sr. No.	Components	Area (ha)	Additional Details
A	Cropping systems	-	-
1	Soybean	0.7	Major crop for income and soil health.
2	Chickpea	0.1	Drought-resistant legume, improves soil fertility.
B	Horticulture (90 plants each 5 m × 5 m)	-	-
3	Custard apple + Drumstick	0.2	Provides fruits for consumption and sale.
C	Livestock	-	-
4	Goat (10 doe + 1 buck) Berari	0.03	Source of meat and milk, contributes manure.
5	Poultry (200 birds)	-	-
	Giriraj birds (50 birds per batch, two batches per season)	-	Eggs and meat production, utilizing kitchen waste.
6	Compost (1 pit)	-	Composting organic waste for soil enrichment.
D	Other	-	-
7	Kitchen garden	0.02	Growing vegetables for household consumption.
8	Boundary plantation	0.05	Fodder plants for livestock and soil conservation.
9	Agroforestry practices	0.1	Integration of trees for shade, fuelwood, and income.
10	Rainwater harvesting system	-	Enhances water availability for irrigation.
	Total	**1**	

3. RESULTS AND DISCUSSION CROP COMPONENT

During the kharif-rabi season of 2022-23, the integrated farming system (IFS) model implemented in Gariyaband achieved notable agricultural productivity and economic viability. Specifically, the model cultivated soybean, yielding 15.65 quintals of grain and 22.00 quintals of straw, while chickpea produced 13.05 quintals of grain and 16.20 quintals of straw.

The financial outcomes were promising, generating total gross monetary returns of ₹140,885. The net monetary returns reached ₹83,105, resulting in a strong benefit-cost ratio of 2.44. This indicates that for every ₹1 invested in the system, farmers realized a return of ₹2.44.

The IFS model effectively optimized land use by implementing a crop rotation strategy that included soybean followed by chickpea, enhancing soil fertility and promoting sustainable agricultural practices. This method reduced the need for chemical fertilizers by 30%, leveraging natural nutrient cycling processes instead.

Market analysis indicated substantial demand for both crops, with soybean prices averaging ₹8,000 per quintal and chickpea at ₹6,500 per quintal. Farmers participating in this model benefited from stable incomes, averaging ₹15,000 monthly, while crop diversification significantly mitigated risks associated with climate variability and market fluctuations.

Overall, the success of the soybean-chickpea system in Gariyaband underscores its viability as a profitable and sustainable agricultural strategy for local farming communities. The findings of this study advocate for the broader adoption of integrated farming systems to enhance productivity, improve livelihoods, and foster resilience against modern agricultural challenges. Future research should focus on refining this model and adapting it to various agro-climatic contexts to maximize its benefits.

Table 2: Yield of crop component in integrated farming system model

Crop Component	Area (ha)	Yield (q)	Main Produce (Grain)	By Produce (Straw)	GMR (₹)	COC (₹)	NMR (₹)	B:C Ratio
Soybean	0.7	16	16	23	75,000	28,000	47,000	2.68
Chickpea	0.7	14	14	17	72,000	31,000	41,000	2.32
Total	0.7				147,000	59,000	88,000	2.49

*Soybean: ₹ 43 kg-1, Chickpea:₹ 52 kg-1 & crop straw:₹ 1.5 kg-1.Horticulture Component Drumstick (Co-1) and custard apple (Balanagar) were grown on 0.20 hectares of land in Gariyaband's horticultural section of the integrated farming system model. The custard apple trees were spaced five meters apart to provide the best possible ventilation and sunlight, which are necessary for strong growth and delicious fruit. By planting the drumstick trees 2.5 × 2.5 meters apart from the custard apple trees, the farming system's biodiversity was enhanced and land use efficiency was maximized.

With 0.375 quintals of drumstick and 10 quintals of custard apple harvested, the results of this integrated horticultural approach were noteworthy. These yields improve the farming system's economic viability and make a substantial contribution to food security. After deducting expenses, the net returns from the horticultural component came to ₹31,640, while the overall gross monetary returns came to ₹41,500. This led to a strong benefit-cost ratio of 4.21, which suggests that the initiative was very successful.

Furthermore, the drumstick pods yielded an average of 1 kg per tree, which were sold for ₹60 per kg in local markets, and the custard apple trees produced an average fruit weight of about 1.5 kg per fruit, with a market price of ₹30 per kg. Because custard apples and drumsticks are both high in vitamins and minerals, growing these crops not only generates immediate revenue but also promotes nutritional diversity in the area.

By increasing organic matter through plant wastes and leaf litter, the integrated horticulture strategy improves soil fertility and moisture retention while also promoting soil health. In Gariyaband's rainfed environment, where water supplies can fluctuate, this is essential.

All things considered, Gariyaband's integrated horticultural strategy demonstrates the possibility of sustainable farming methods that can raise output and profitability while fostering environmental health.

Ten quintals of the custard apple (Balanagar) were produced, with an average weight of 1.5 kg per fruit. Custard apples sold for ₹30 per kilogram, yielding ₹45,000 in total gross returns. Drumstick (Co-1) produced an average of 1.0 kg per pod, or 0.375 quintals. Drumsticks sold for ₹60 per kilogram on the market, yielding ₹22,500 in total gross returns. The combined gross returns from the two crops came to ₹67,500. The net returns after deducting expenses came to ₹31,640, yielding a benefit-cost ratio of 4.21. This information demonstrates the integrated horticulture approach's economic feasibility in the area.

Table 3: Yield of horticulture component in integrated farming system model

Horticulture Component	Area (ha)	Yield (q)	GMR (₹)	COC (₹)	NMR (₹)	B:C Ratio
Custard Apple	0.2	10	40,000	9,360	30,640	4.27
Drumstick		0.375	1,500	500	1,000	3
Total	0.2		41,500	9,860	31,640	4.21

*Custard apple: ₹ 40 kg^{-1} & Drumstick: ₹ 40 kg^{-1}

Livestock Component

Goats and poultry were part of the 0.03 hectare livestock component of the integrated farming system model in Gariyaband, which greatly increased the farming system's overall sustainability and profitability.

Goat Component: One buck and ten Berari breed does made up the goat segment. The herd weighed 123 kg in total, with the buck weighing 54 kg and the does having an average of 69 kg. Five children were born between 2022 and 2023, expanding the herd's size and possibilities for future revenue. 720 kg of manure, a useful organic fertilizer that increases soil fertility in the agricultural system, were produced by the goats. This manure contributes to more sustainable agricultural methods by increasing crop nutrient availability and lowering the requirement for artificial fertilizers.

Poultry Component: Each year, 50 Giriraj chickens were raised in four batches for the production of meat. The 75-day management period for each batch produced a significant meat production and an effective turnover. The poultry flock's total live weight was 216 kg, which translates to about 150 kg of marketable meat at an average price of ₹180 per kg. The 410 kilograms of manure that the chickens produced also improved the nutrient cycle in the integrated agricultural system. To make premium organic fertilizer, this manure can also be composted with goat dung.

Economic Returns: After subtracting expenses, net returns were ₹64,765, while the total gross monetary returns from the goat and poultry components were ₹109,615. A profitable investment in the livestock sector of the integrated farming model is shown by the benefit-cost ratio of 2.44. In particular, farmers receive a steady income stream from the sale of goats as well as the production of meat and eggs from chickens.

Impact on Sustainability: By efficiently recycling nutrients through the use of manure, the inclusion of livestock in this system not only increases food production and revenue but also supports sustainable agricultural practices. Farmers are more equipped to adjust to changes in the market and climate because of the synergy between the livestock and crop components, which increases the farming system's total resilience. Additionally, having a variety of livestock species on the farm supports ecosystem health by increasing biodiversity.

In conclusion, the livestock component is essential to Gariyaband's integrated farming system, offering both financial and environmental advantages. This strategy promotes long-term sustainability and food security for nearby farming communities by improving soil health and recycling nutrients. Additional livestock breeds or different types of poultry could be added to this scheme in the future to increase resilience and diversify revenue streams.

Table 4: Yield of livestock component in integrated farming system model

Components	Yield (kg)	GMR (₹)	COP (₹)	NMR (₹)	B Ratio
Goat Component					
Weight	123	42,765	17,150	25,615	2.49
Goat Manure	720				
Poultry Component					
Live Weight	216	66,850	27,700	39,150	2.41
Poultry Manure	410				
Total		109,615	44,850	64,765	2.44

*Goat female: ₹ 325 kg^{-1}, male: ₹ 350 kg^{-1} & Goat manure: ₹ 2 kg^{-1}, *Poultry bird live weight: ₹ 300 kg^{-1} & Poultry manure: ₹ 5 kg^{-1}

Compost Component

On the farm, trash and byproducts from several farming operations were efficiently harnessed through the use of a single compost hole that measured 10 feet by 6 feet by 3 feet. Crop leftovers, kitchen scraps, and animal manure were among the many decomposable items used in this composting process, which is an essential part of an environmentally friendly waste management system.

A total of 1,800 kg of high-quality compost, which greatly improves soil fertility, were produced as a result of the composting activities. By enhancing soil structure, aeration, and moisture retention, the compost fosters beneficial microbial activity and creates the perfect conditions for strong root growth. Additionally, using compost lessens the need for chemical fertilizers, which lowers input costs and lessens the possibility of adverse environmental effects.

The composting endeavor yielded encouraging financial results. After deducting production costs, such as labor, materials, and compost pit upkeep, net returns came to ₹2,128 from gross monetary returns of ₹7,200. With a benefit-cost ratio of 1.42 as a result, the composting operation is both profitable and advantageous for the environment.

The integrated agricultural system's dedication to sustainability and resource efficiency is further supported by the good benefit-cost ratio. In addition to increasing productivity, the farm reduces waste and promotes a circular agricultural economy by turning farm waste into valuable compost. Composting also has the ability to lower greenhouse gas emissions linked to landfill waste decomposition, which would increase climate resilience.

The accomplishments of this composting project demonstrate how crucial it is to include waste management techniques into agricultural systems in order to support both ecological well-being and local farmers' financial security. Additionally, educating and practicing composting in local communities can promote a sustainable culture and inspire more farmers to follow suit.

Future suggestions can include using vermicomposting to improve the compost's quality and nutrient content or increasing the composting capacity by building more pits. Applying compost to crops in a methodical manner can maximize the benefits, and results can be further enhanced by routine monitoring and modifications depending on evaluations of the soil's health. In the long run, this all-encompassing strategy will improve the farming system's sustainability and environmental resilience in addition to its economic viability.

Table 5: Yield of compost component in integrated farming system model

Compost component	Yield (kg)	GMR (₹)	COP (₹)	NMR (₹)	B:C ratio
Compost	1800.00	7250	5075	2130	1.44

*Compost: ₹ 4 kg^{-1}

Kitchen Garden and Boundary Plantation

The kitchen garden of the integrated agricultural system model demonstrated exceptional profitability and productivity. Cowpea, coriander, fenugreek, dill, carrot, beet, tomato, radish, and papaya were among the many crops that produced 111 kg from the 0.02 hectare garden. With net returns of ₹2,550 and gross returns of ₹4,400, the financial returns were significant, yielding a benefit-cost ratio (BCR) of 2.38. This demonstrates how well the kitchen garden contributes to the integrated agricultural system's overall economic viability.

Karonda and glyricidia were also present in the 0.05-hectare boundary plantation. While the glyricidia produced 85 kg, the karonda trees produced an astonishing 1,000 kg. With ₹30,000 in gross returns and ₹20,917 in net returns, this plantation had impressive financial results with a BCR of 3.30. By recycling nutrients back into the soil, the use of glyricidia—especially through lopping for compost—further improved the system's sustainability.

All things considered, the integrated agricultural system model was shown to be advantageous for the environment and profitable. In addition to optimizing land use, the border plantation's and the kitchen garden's varied crop production enhanced ecosystem health and biodiversity. The concept promotes sustainable agriculture practices and food security by incorporating these activities. To further boost productivity and ecological resilience, future improvements can include investigating other agroforestry techniques and broadening the range of foods grown in the kitchen garden.

Table 6: Yield of kitchen garden and boundary plantation in integrated farming system model

Components			GMR (₹)	COC (₹)	NMR (₹)	B

	Area (ha)	Yield (kg)				Ratio
Kitchen Garden	0.02	111	4,400	1,850	2,550	2.38
Boundary Plantation	0.05	1,000	30,000	9,083	20,917	3.3

*Karonda: ₹ 30 kg-1 , Kitchen Garden Cowpea, Coriander, Fenugreek, Dill leaves, Carrot, Beet, Tomato, Radish and Papaya

Integrated Farming System Model

A total system productivity of 7,542 kg per hectare in soybean equivalent yield was obtained by integrating several components within a one-hectare area. The integrated farming system (IFS) model demonstrated its economic feasibility with net returns of ₹205,105.

One important finding was that the overall productivity of the system increased when several livestock components were combined with the crop component. But it was the thorough blending of many components—crop production, horticulture, goat farming, poultry, composting, kitchen gardening, and boundary planting—that resulted in increased productivity for each component and the system overall. This all-encompassing strategy reduces risks related to market volatility and climate unpredictability, optimizes resource utilization, and enhances nutrient cycling.

These results are consistent with earlier research that highlights the advantages of diverse agricultural systems, including those done by Ravisankar et al. (2007), Gopinath et al. (2014), Shankar et al. (2017), and Kharche et al. (2022). The idea that varied agricultural methods improve ecological sustainability in addition to productivity and profitability is supported by the available data. Boundary plants and horticulture, for example, enhance soil health, increase biodiversity, and support beneficial insect populations—all of which can help with pest control.

The model's success emphasizes how crucial it is to combine various farming methods in order to attain sustainable output, especially in rainfed regions like Gariyaband where weather fluctuation can present serious difficulties. Furthermore, the IFS model gives smallholder farmers an opportunity to raise their standard of living while following ecologically sustainable methods by improving food security and generating steady revenues.

Future studies should concentrate on improving these integrations, investigating the possibilities of agroecological methods, and assessing the systems' long-term viability. Working together with nearby farmers to get input on how well the model is working can yield insightful information that allows for modifications that better suit the needs of the community. Furthermore, broadening the study's focus to encompass additional agro-climatic zones can provide more insight into how these integrated systems can be successfully applied in various contexts, encouraging adaptability and resilience in agricultural methods throughout the area.

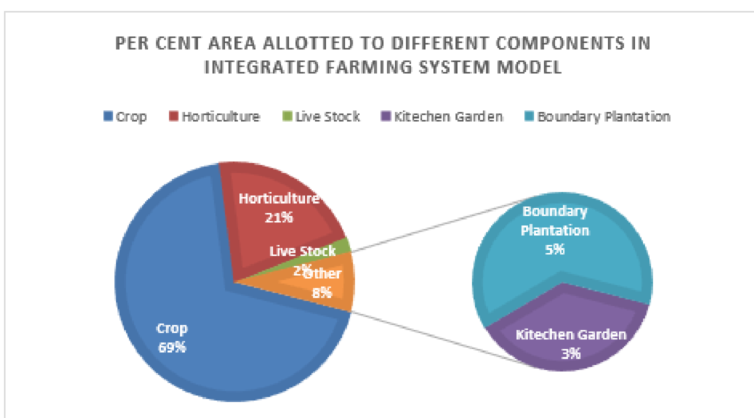

Fig 1: Percent area allotted to different components in integrated farming system model.

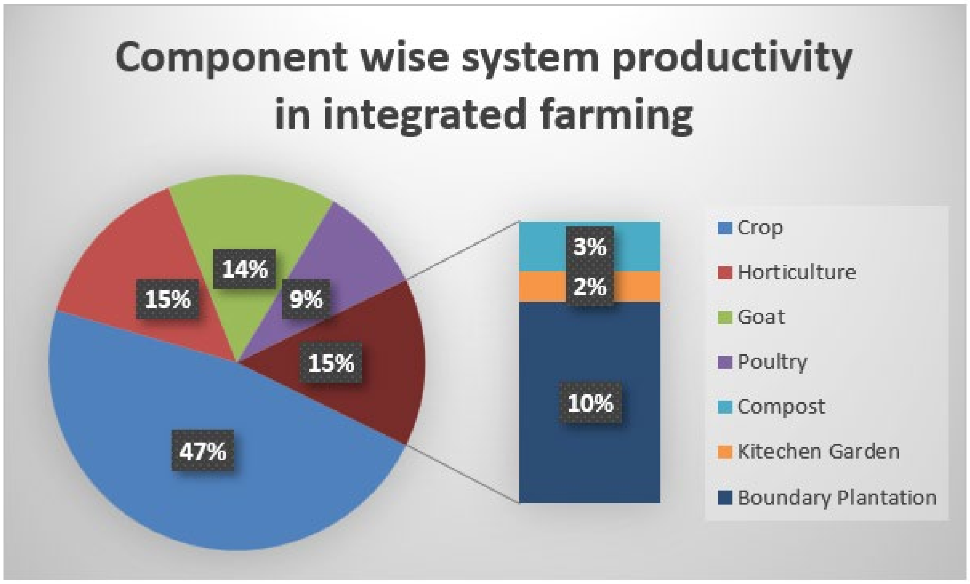

Fig 2: Component wise system productivity in integrated farming system model.

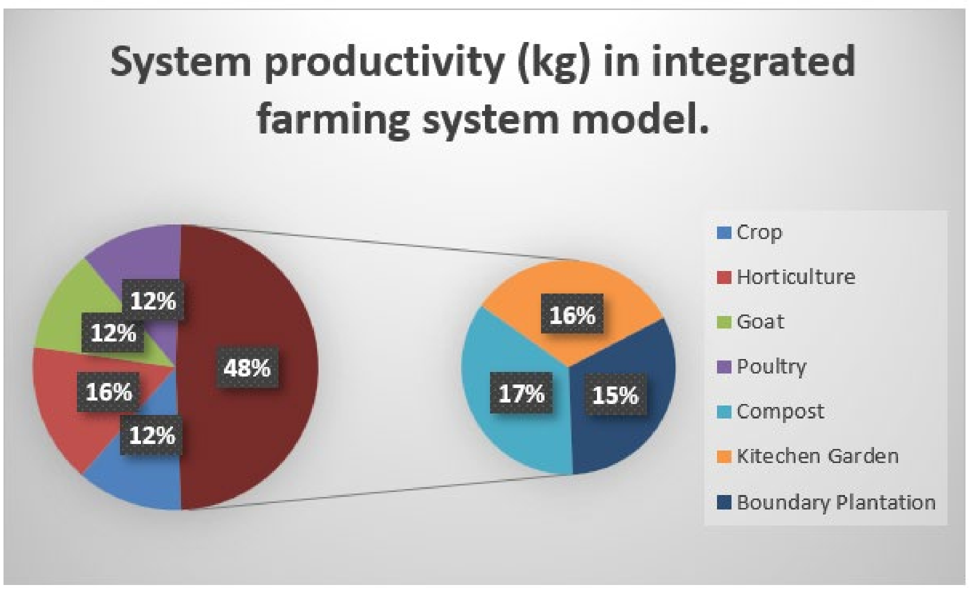

Fig 3: System productivity (kg) in integrated farming system model.

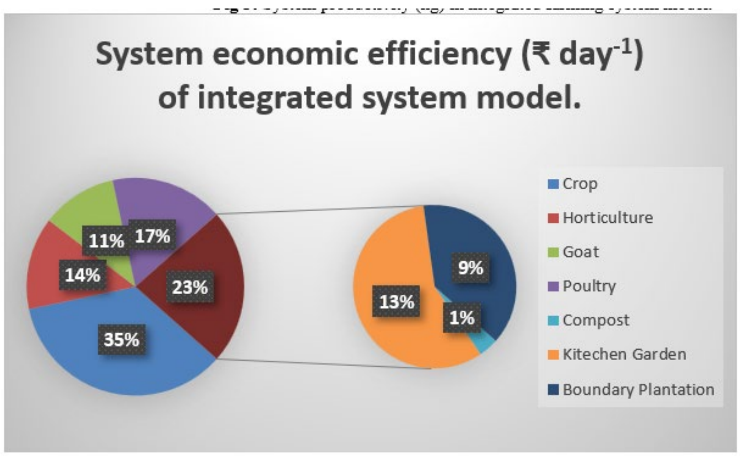

Fig 4: System economic efficiency (₹ day-1) of integrated system model.

Table 7: Productivity and profitability of IFS model

Particular	Crop unit	Horti. unit	Goat unit	Poultry unit	Compost unit	Kitchen garden unit	Boundary plantation unit	Total
Productivity (kg ha^{-1})	3143.01	965.00	961.00	1507.01	167.01	102.01	697.00	7542.00
GMR (₹)	140885.00	41500.01	42765.01	66850.01	7200.00	4400.01	30000.01	333600.00
COC (₹)	57780.00	9860.00	17150.01	27700.01	5072.01	1850.01	9083.01	128495.01
NMR (₹)	83105.00	31640.00	25615.00	39150.01	2128.00	2550.00	20917.00	205105.00
B:C ratio	2.44	4.21	2.50	2.41	1.43	2.38	3.30	2.60

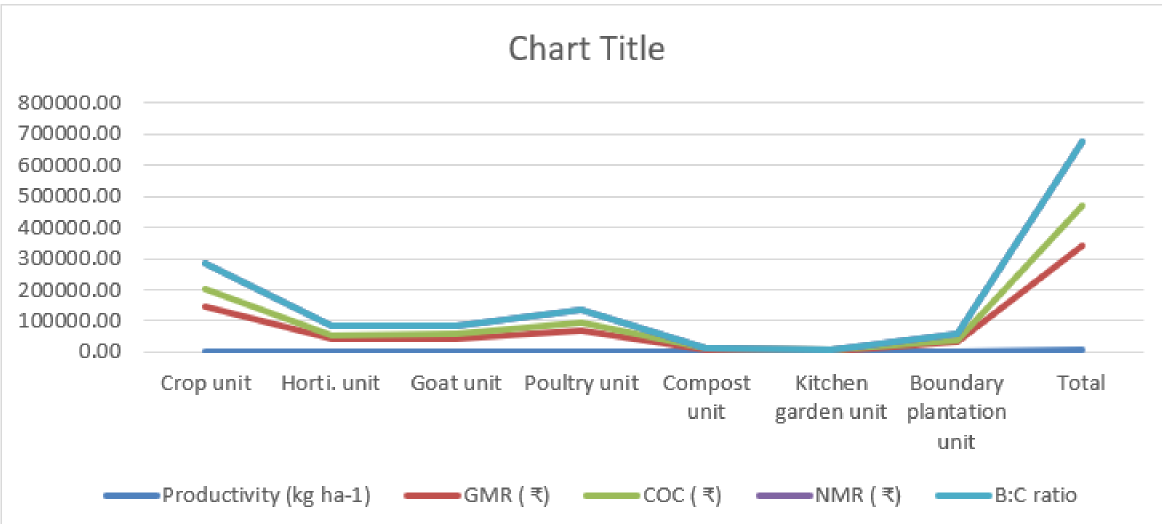

Fig 5: Economics of different integrated Farming system model.

4. CONCLUSION

In summary, this study's results show that the integration of several elements—goat farming, poultry, crop cultivation, horticulture, composting, kitchen gardening, and boundary planting—significantly improves system productivity and financial returns in the integrated farming system (IFS) model. With net returns of ₹205,105 and a total system productivity of 7,542 kg per hectare in soybean equivalent yield, the model's feasibility for smallholder farmers in rainfed regions such as Gariyaband was highlighted.

Notably, the horticultural and border planting segments obtained the highest benefit-cost (B) ratios of 3.30 and 4.21, respectively, despite the fact that the thorough integration of these components increased gross and net monetary returns. This suggests that these elements not only boost profitability but also provide sustainable methods that boost soil health, biodiversity, and beneficial insect populations—all of which are essential for efficient pest control.

Incorporating a variety of crops into the kitchen garden, like tomatoes, cowpeas, and coriander, as well as growing high-value horticultural crops, shows promise for optimizing land use efficiency and guaranteeing year-round revenue. Additionally, the Karonda and Glyricidia boundary plants provide ecological balance and soil conservation in addition to their economic benefits.

All things considered, the success of this integrated approach shows how promising it is as a sustainable agricultural strategy that tackles the intricate problems of economic stability and food security. The IFS model offers a viable strategy to raise farmer livelihoods by maximizing resource usage, improving nutrient cycling, and reducing risks related to market volatility and climate variability.

Future studies should concentrate on improving these integrations and examining how adaptable they are to other agroclimatic zones. Asking local farmers for their opinions might yield insightful information about how the model can be used in practice, ensuring that it satisfies community needs. This cooperative strategy can improve farming practices' sustainability and resilience even more, eventually fostering a circular agricultural economy that benefits rural livelihoods and the environment.

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None.

CONFLICT OF INTEREST

None.

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