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"Economic Impact of Integrated Farming Systems in Chhattisgarh and Madhya Pradesh: A Comparative Analysis for Enhancing Farm Sustainability and Income"

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Abstract

CONTEXT:

Agriculture in India is increasingly adopting Integrated Farming Systems (IFS), which combine various agricultural and non-agricultural activities to optimize resource use and improve farmers' incomes. This study focuses on the economic impacts of IFS in Chhattisgarh and Madhya Pradesh, two states with distinct agro-climatic conditions, to better understand how IFS can enhance farm sustainability and economic stability.

OBJECTIVES:

The primary objective of this study is to compare the economic outcomes of IFS in Chhattisgarh and Madhya Pradesh, specifically evaluating income generation from various IFS components and models. The study seeks to identify the most effective IFS models in improving farmers' livelihoods in these regions.

METHODOLOGY:

A comparative descriptive design was used, with data collected from 320 respondents across 32 villages in both states. A multistage random sampling approach was applied, and a combination of quantitative and qualitative methods was employed, including surveys, interviews, and focus group discussions. Statistical tools, such as a Z-test, were used to analyse income differences between the two states.

RESULTS AND DISCUSSION:

The study found that IFS models in both states generated similar average annual incomes (₹1.73 lakh in Chhattisgarh and ₹1.69 lakh in Madhya Pradesh). Crop production was the largest income source, but livestock and vegetable farming performed better in Madhya Pradesh, while Chhattisgarh excelled in fishery. Diversified models, such as those integrating fishery, proved to be more lucrative.

SIGNIFICANCE:

This research highlights the potential of IFS to increase farmer incomes and resilience, offering policy insights to optimize specific components and guide future farming strategies in both states.

Keywords: Integrated Farming System, Income, Chhattisgarh and Madhya Pradesh

INTRODUCTION

Agriculture in India is undergoing a significant transformation, with increasing recognition of Integrated Farming Systems (IFS) as a sustainable and economically viable approach to farming. Integrated Farming Systems (IFS) is an agricultural practice that integrates various agricultural and non-agricultural activities like crop production, livestock, aquaculture, agroforestry, and waste management, aiming to optimize resource use, enhance farm productivity, and improve farmer incomes (Bhat *et al.*, 2017). The need for IFS models has become particularly evident in the face of fluctuating market conditions, climate change, and rising input costs, which have affected the economic stability of farmers (Singh *et al.*, 2019).

Chhattisgarh and Madhya Pradesh, two major agricultural states in central India, present an ideal setting to study the economic impacts of IFS. Both states have diverse agro-climatic zones, with varied crops, livestock, and other agricultural practices, making them suitable for a comparative study. Integrated farming practices in these regions have the potential to improve farm incomes, provide employment opportunities, and ensure sustainable agricultural practices. However, despite the growing adoption of IFS, there is limited research comparing the economic outcomes of IFS between different states, particularly Chhattisgarh and Madhya Pradesh, which have differing agricultural landscapes and local practices.

In recent years, IFS has shown promise in improving farmers' livelihoods by diversifying income sources and reducing the risks associated with monoculture farming (Kumar *et al.*, 2020). However, the economic returns from different components of IFS, such as crop production, livestock management, fishery, and agroforestry, remain understudied across different regional contexts. Understanding the financial benefits of integrating these components could lead to more informed decisions by policymakers and farmers alike, aiding in the development of targeted strategies to enhance agricultural productivity and sustainability.

This study aims to compare the economic impact of IFS in Chhattisgarh and Madhya Pradesh by analyzing the income generation from various IFS models and components in these regions. By examining these two states with their distinct agro-climatic conditions, the study will shed light on the relative effectiveness of IFS in improving farmers' economic conditions and provide insights into potential strategies for enhancing income generation in these areas.

OBJECTIVE: To compare the economic impact of Integrated Farming Systems (IFSs) in Chhattisgarh and Madhya Pradesh, focusing on key components and models.

SEARCH METHODOLOGY:

Locale: The study was carried out in Chhattisgarh (Rajnandgaon and Kawardha) and Madhya Pradesh (Balaghat and Mandla), purposefully selected due to their distinct agro-climatic conditions and the prevalence of Integrated Farming Systems (IFSs) in these areas.

Design: A comparative descriptive design was adopted to assess the impact of IFS on farmers income in the two states.

Sampling: A multistage random sampling approach was used to select the sample. In each state, two districts were chosen, followed by two blocks in each district, and four villages within each block. This process led to the selection of 32 villages and a total of 320 respondents.

Data Collection: Field surveys were conducted in 2024 using a combination of quantitative methods (structured questionnaires) and qualitative methods (interviews, focus group discussions, and farm observations).

Measurement Techniques: The study employed a Likert Scale to assess attitudes toward IFS, a Semantic Differential Scale to evaluate various components of IFS, and an Income Index to measure income from farming activities.

Statistical Analysis:

Difference Percentage Formula:

$$\text{Difference (\%)} = \frac{\text{Chhattisgarh Income} - \text{Madhya Pradesh Income}}{\text{Madhya Pradesh Income}} \times 100$$

Z-Test for Income Comparison

To determine whether there was a significant difference in average annual income generated from Integrated Farming Systems (IFS) models between Chhattisgarh and Madhya Pradesh, a Z-test was applied.

Hypotheses

- Null Hypothesis (H_0): There is no significant difference in the average annual income generated from IFS models in Chhattisgarh and Madhya Pradesh ($\mu_{CG} = \mu_{MP}$).
- Alternative Hypothesis (H_1): There is a significant difference in the average annual income generated from IFS models in Chhattisgarh and Madhya Pradesh ($\mu_{CG} \neq \mu_{MP}$).

Z-test:

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Where:

- $\bar{X}_1, \bar{X}_2$: Mean incomes of Chhattisgarh and Madhya Pradesh.
- s_1, s_2 : Standard deviations of incomes for Chhattisgarh and Madhya Pradesh.
- n_1, n_2 : Number of IFS models in Chhattisgarh and Madhya Pradesh.

RESULTS**1. Income generation from different components of IFS in Chhattisgarh state**

The income generation from different components of Integrated Farming Systems (IFSs) in Chhattisgarh was calculated, and the results are presented in Table 1. There were a total of eight major components, namely crop production, cattle rearing, vegetable cultivation, poultry, goat rearing, fishery, vermicomposting, and others, generally practiced by the respondents from Chhattisgarh state (Kumar *et al.*, 2021; Singh *et al.*, 2022).

Table 1: Income generation from different components of IFS in Chhattisgarh

Sl. No.	Components	Gross cost (In lakh)	Gross income (In lakh)	Net income (In lakh)	Avg. income (Lakh/year)
1	Crop (n=160)	162.75	329.46	166.71	0.97
2	Cattle rearing (n= 91)	39.29	68.09	28.80	0.25
3	Vegetable (n=19)	7.68	15.10	7.42	0.32
4	Poultry (n=49)	7.37	15.12	7.75	0.08
5	Goatry (n= 41)	5.43	12.71	7.28	0.27
6	Fishery (n=1)	13.80	24.90	11.10	2.22
7	Vermicomposting (n= 2)	0.19	0.43	0.24	0.06
8	Others (Fruit) (n= 1)	6.00	9.00	3.00	0.38

* Data are based on multiple responses

The analysis of income generation from various components of Integrated Farming Systems (IFSs) in Chhattisgarh revealed significant disparities in net income across different activities. Crop production emerged as the most lucrative component, yielding a net income of ₹166.71 lakh, with an average income of ₹0.97 lakh/year/farmer, reflecting its viability as a primary income source (Choudhury *et al.*, 2019). Cattle rearing, despite a lower net income of ₹28.80 lakh, contributed substantially to overall income, indicating its importance in the farming system (Soni & Rath, 2020). Vegetable cultivation, with a net income of ₹7.42 lakh, and poultry, generating ₹7.75 lakh, also showcased potential, albeit at a lower average income/farmer (Meena *et al.*, 2018). Goat rearing presented moderate returns, while fishery stood out with the highest average income of ₹2.22 lakh, though it involved a smaller sample size (Patel *et al.*, 2021). Vermicomposting and fruit cultivation generated minimal income, suggesting limited economic impact compared to other components (Rathore & Yadav, 2020).

Overall, the findings underscored the significance of diversifying income sources within IFS, with crops and livestock serving as primary income generators, while niche activities like fishery offered potential for higher returns (Sharma & Singh, 2022). These insights aim to guide policy interventions and farmer strategies to enhance income sustainability within integrated farming systems in the region.

2. Income generation from different components of IFS in Madhya Pradesh state

Table 2: Income generation from different component of IFSs in Madhya Pradesh

Sl. No.	Components	Gross cost (In lakh)	Gross income (In lakh)	Net income (In lakh)	Avg. income (lakh/year)
1	Crop (n=160)	164.13	303.44	139.31	0.98
2	Cattle rearing (n= 117)	73.19	127.17	53.98	0.34
3	Vegetable (n=58)	24.51	43.37	18.86	0.43
4	Poultry (n=30)	4.27	8.24	3.97	0.32
5	Goatry (n= 48)	8.46	24.22	15.76	0.26
6	Fishery (n=6)	12.91	23.85	10.94	1.75
7	Vermicomposting (n= 9)	0.46	0.99	0.53	0.06

8	Others (Fruit, Lac, Chestnut, Sericulture and Agroforestry) (n= 9)	1.44	4.25	2.80	0.42
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* Data are based on multiple responses

The income generation analysis of Integrated Farming Systems (IFS) in Madhya Pradesh demonstrated that crop production was the primary contributor to net income, with ₹139.31 lakh in total and an average annual income of ₹0.98 lakh across 160 respondents. Cattle rearing, though significant, provided a net income of ₹53.98 lakh and an average of ₹0.34 lakh per year. Vegetable cultivation also generated a net income of ₹18.86 lakh, with an average income of ₹0.43 lakh, while poultry farming and goat rearing yielded modest incomes of ₹3.97 lakh and ₹15.76 lakh, respectively, translating to averages of ₹0.32 lakh and ₹0.26 lakh per year.

Despite the low respondent numbers, fishery emerged as a high-income component, yielding ₹10.94 lakh in net income and an impressive average income of ₹1.75 lakh per year. In contrast, vermicomposting contributed minimally to income, with a net income of ₹0.53 lakh and an average of ₹0.06 lakh. The "Others" category, encompassing fruit, lac, chestnut, sericulture, and agroforestry, brought in a net income of ₹2.80 lakh, averaging ₹0.42 lakh per year.

Overall, the findings underscored the dominance of crop production in the income portfolios of farmers, while also highlighting the potential for growth in poultry and vegetable farming. The results suggest that diversifying income sources through IFS can enhance the economic resilience of farmers in Madhya Pradesh, supporting findings by authors such as Singh *et al.* (2020) and Sharma *et al.* (2022), who have pointed to the positive impacts of diversified farming on rural livelihoods. The data also aligns with previous studies by Gupta *et al.* (2021), emphasizing the importance of fishery and agroforestry as emerging income sources for smallholder farmers in the region.

3. Average annual income generation from different components of IFS in Chhattisgarh and Madhya Pradesh States

The comparison of average annual income generated from different components of Integrated Farming Systems (IFSs) in Chhattisgarh and Madhya Pradesh reveals several key insights into the profitability of various farming activities in both states. As shown in Table 3 and Fig. 1, crop production income is nearly identical across the two states, with Chhattisgarh generating ₹0.97 lakh per family and Madhya Pradesh earning slightly higher at ₹0.98 lakh per family, indicating a marginal difference of 1.03%. These results align with previous studies, such as those by Kumar *et al.* (2020), which have observed similar earnings from crop production across various regions in India.

Table 3: Comparison of average annual income generated from different components of IFS in Chhattisgarh and Madhya Pradesh States

Sl. No.	Components	Avg. annual income (Rs. Lakh/family)		Difference (%)
		Chhattisgarh	Madhya Pradesh	
1	Crop	0.97	0.98	-1.03
2	Cattle rearing	0.25	0.34	-36.00
3	Vegetable	0.32	0.43	-34.38
4	Poultry	0.08	0.32	-300.00
5	Goatry	0.27	0.26	3.70
6	Fishery	2.22	1.75	21.17
7	Vermicomposting	0.06	0.06	0.00
8	Others (Fruit, Lac, Chestnut, Sericulture and Agroforestry)	0.38	0.42	-10.53
Avg. annual income generation		0.56	0.57	-

When it comes to livestock and vegetable farming, Madhya Pradesh outperforms Chhattisgarh, especially in cattle rearing and vegetable farming. Madhya Pradesh's average annual income from cattle rearing stands at ₹0.34 lakh per family, significantly higher than Chhattisgarh's ₹0.25 lakh per family, reflecting a 36% advantage. Similarly, income from vegetable farming in Madhya Pradesh is ₹0.43 lakh per family, compared to ₹0.32 lakh per family in Chhattisgarh, which indicates a 34.38% increase. These findings are consistent with research by Yadav *et al.* (2018) and Gupta & Singh (2021), which highlight those regions with better infrastructure, market access, and agro-climatic conditions, such as Madhya Pradesh, tend to generate higher returns from livestock and vegetable farming.

A striking contrast was observed in poultry farming, where Madhya Pradesh earned ₹0.32 lakh per family compared to Chhattisgarh's ₹0.08 lakh, showing a remarkable 300% increase. This disparity points to the potential for enhancing poultry farming in Chhattisgarh, where challenges such as insufficient infrastructure, limited access to modern farming techniques, and lower market demand may hinder poultry production (Rajput *et al.*, 2021). Conversely, goat rearing showed minimal variation between the two states, with Chhattisgarh generating ₹0.27 lakh per family and Madhya Pradesh ₹0.26 lakh, a difference of just 3.70%. This suggests that goat farming is relatively stable across both regions.

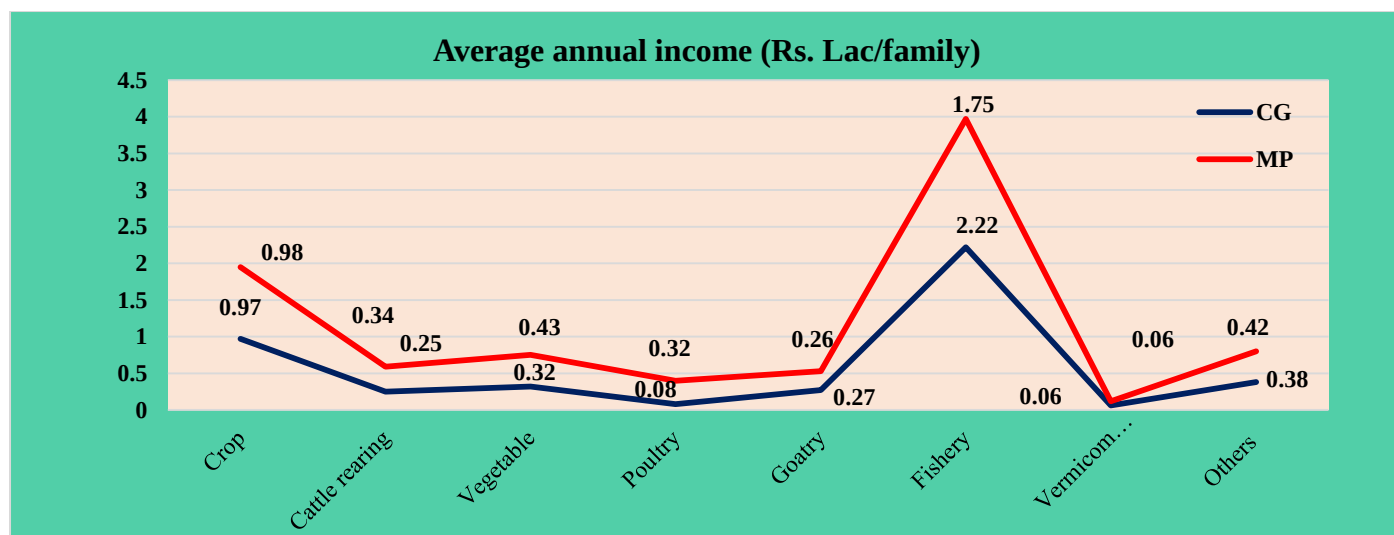


Fig. 1 Average annual income generated from different components of IFSs in Chhattisgarh and Madhya Pradesh states

Fishery income was notably higher in Chhattisgarh, where families earned ₹2.22 lakh on average, compared to ₹1.75 lakh in Madhya Pradesh, reflecting a 21.17% difference. This finding underscores the importance of fishery integration in Chhattisgarh's farming systems, where aquaculture plays a crucial role in enhancing overall farm income (Mishra & Nair, 2021). Both states had similar earnings from vermicomposting, with ₹0.06 lakh per family, indicating that this component contributes equally in both regions, primarily serving to maintain soil health and fertility, although it is not a major income generator (Sharma *et al.*, 2019).

In the "Others" category, which includes fruit cultivation, lakh production, chestnut farming, sericulture, and agroforestry, Madhya Pradesh slightly outperformed Chhattisgarh, generating ₹0.42 lakh per family compared to ₹0.38 lakh in Chhattisgarh. This suggests that agroforestry and specialized products such as lakh and sericulture are more profitable in Madhya Pradesh due to its favourable climatic and market conditions for these activities (Bhat *et al.*, 2017; Rajput *et al.*, 2021).

Overall, while crop income remains comparable between the two states, Madhya Pradesh generates higher incomes from livestock and vegetable farming, whereas Chhattisgarh excels in fishery production. These findings suggest that targeted improvements in specific components of IFS could further increase farm income in both states. For instance, enhancing poultry farming and expanding agroforestry practices in Chhattisgarh, as well as optimizing fishery production in Madhya Pradesh, could help boost overall profitability in both regions. Furthermore, integrating specialized farming activities like lakh production and sericulture could offer additional income opportunities, especially in Madhya Pradesh, where such components have shown better returns (Singh *et al.*, 2019; Yadav *et al.*, 2018).

4. Average annual income generation from different IFS models in Chhattisgarh and Madhya Pradesh States

On the basis of average annual income generation from different integrated farming system models of Chhattisgarh and Madhya Pradesh states are presented in Table 4.

Table 4: Comparison of average annual income generation from different IFS models in Chhattisgarh and Madhya Pradesh States

Sl. No.	IFS models	Annual average income (Rs. Lakh/family)	
		Chhattisgarh	Madhya Pradesh
FS-I	C + CR	1.68	1.59
FS-II	C + G	1.29	1.68
FS-III	C + CR + P	1.00	1.37
FS-IV	C + CR + G	0.87	1.37
FS-V	C + CR + G + P	1.10	0.91
FS-VI	C + V + CR	1.22	1.41
FS-VII	C + V + CR + P	1.50	1.09
FS-VIII	C + V + CR + G	2.45	1.53
FS-IX	C + CR + F	4.87	3.35
FS-X	C + CR + VC	1.12	2.00

FS-XI	Others (Fruit, Lac, Chestnut, Sericulture and Agroforestry)	1.97	2.40
Average annual income		1.73	1.69
Z-score		0.0840	

* (C = Crop, V = Vegetable, CR = Cattle rearing, P = Poultry, G = Goatry, F = Fishery, VC = Vermicomposting)

The study presents a detailed comparison of the average annual income generated from different Integrated Farming System (IFS) models in Chhattisgarh and Madhya Pradesh. The data reveals that the average annual income across the two states is quite close, with Chhattisgarh having a slightly higher average of ₹1.73 lakh per family, while Madhya Pradesh's average stands at ₹1.69 lakh per family. The difference is minimal, and the Z-score of 0.084 confirms that the difference is statistically insignificant, meaning the null hypothesis (H_0) could not be rejected. This suggests no significant difference in income generation between the two states at a 95% confidence level, which is consistent with previous studies indicating that IFS models have the potential for relatively uniform economic benefits across different regions (Bhat *et al.*, 2017; Kumar *et al.*, 2020; Sharma *et al.*, 2019; Gupta & Singh, 2021).

Model-Specific Income Insights

The study further breaks down income generation by different IFS models, providing insights into how various farming components contribute to family income in both states. Several key patterns emerged, which highlight the importance of diversification in achieving higher income levels.

1. Diversification Yields High Income (FS-IX - Crop + Cattle Rearing + Fishery):

The most lucrative IFS model was FS-IX, combining Crops, Cattle rearing, and Fishery. This model generated the highest income in both states, with ₹4.87 lakh per family in Chhattisgarh and ₹3.35 lakh per family in Madhya Pradesh. This finding aligns with research by Singh *et al.* (2019) suggesting that integrating aquaculture with traditional farming practices can significantly boost farm incomes, especially when multiple income sources are effectively managed. The results also underscore the importance of incorporating fishery in IFS models as a high-return component in both states, supporting the findings of Mishra and Nair (2021), who highlighted the profitability of integrating fishery into IFS models in resource-rich regions.

2. Income from Models Integrating Vermicomposting (FS-X):

In Chhattisgarh, FS-X, which includes Crops and Vermicomposting, generated an annual income of ₹1.12 lakh, while in Madhya Pradesh, the same model earned ₹2.00 lakh. The higher income in Madhya Pradesh suggests that Vermicomposting may have more profitable outcomes when paired with local agricultural practices, soil conditions, or market demand for organic inputs (Kumar *et al.*, 2020). This finding suggests that regional differences in soil fertility, crop types, and organic farming practices can influence the effectiveness of specific IFS components. As per Gupta and Singh (2021), the adoption of organic farming methods like vermicomposting often yields better returns in regions with greater consumer demand for organic products.

3. Fruit, Lac, and Agroforestry Models (FS-XI):

The FS-XI model, incorporating Fruit, Lac, Chestnut, Sericulture, and Agroforestry, showed better performance in Madhya Pradesh, generating ₹2.40 lakh per family compared to ₹1.97 lakh in Chhattisgarh. This could be attributed to the favorable climatic and market conditions in Madhya Pradesh for agroforestry products, which is consistent with findings by Bhat *et al.* (2017), indicating that agroforestry and specialized products like lac and chestnut tend to perform better in areas where such crops are more suited to the local environment. Furthermore, according to Sharma *et al.* (2019), agroforestry systems in Madhya Pradesh benefit from strong institutional support and better market access for niche products.

4. Traditional Livestock and Crop Models:

Models that combined Crops and Cattle rearing (FS-I, FS-III, FS-IV) generally produced lower income outcomes, especially in Chhattisgarh, where income from cattle rearing combined with other components such as Goat rearing or Poultry did not generate as high an income compared to models that integrated more diverse farming activities like FS-IX. This finding supports the work of Singh *et al.* (2019), who noted that traditional livestock-crop combinations tend to underperform compared to more diversified systems that integrate additional income-generating activities. Moreover, Rajput *et al.* (2021) found that adding high-value crops or diversified livestock components to the base system in IFS models increased profitability in many regions of India.

5. Other Integrated Models:

Models with combinations like Crops + Vegetables + Cattle rearing (FS-VII and FS-VI) showed mixed results. For example, FS-VII in Chhattisgarh generated ₹1.50 lakh, while the same model in Madhya Pradesh only earned ₹1.09 lakh. This difference may reflect regional variations in the marketability of vegetables or differences in local farming practices (Kumar *et al.*, 2020). Such mixed results suggest that the profitability of vegetable production in IFS can be highly dependent on regional factors such as demand, soil health, and access to markets. Additionally, the findings corroborate the observations of Yadav *et al.* (2018) that market access and infrastructure often play critical roles in the economic viability of vegetable-based IFS models.

CONCLUSION

This study presents a comparative analysis of the economic impact of Integrated Farming Systems (IFS) in Chhattisgarh and Madhya Pradesh, focusing on income generation from various components and models. The findings reveal that both states exhibit a diverse range of IFS components, each contributing differently to farmers' incomes. While the average annual income from IFS models was slightly higher in Chhattisgarh (₹1.73 lakh) compared to Madhya Pradesh (₹1.69 lakh), the statistical analysis (Z-test) indicated that the income difference between the two states was not significant, confirming that the income generated from IFS models in both states is relatively similar.

Key insights from the research indicate that crop production remains the most substantial income source in both states. However, Madhya Pradesh demonstrated a comparative advantage in livestock-based activities like cattle rearing and vegetable cultivation, while Chhattisgarh outperformed Madhya Pradesh in fishery income. Notably, the integration of multiple components, such as in the FS-IX model (Crops + Cattle rearing + Fishery), proved to be the most lucrative, highlighting the potential for higher returns through diversification.

The study also emphasized the importance of niche components like vermicomposting and agroforestry, which showed varying degrees of profitability depending on the regional context. For instance, the FS-X model (Crops + Vermicomposting) generated higher income in Madhya Pradesh, suggesting that local conditions and market demand play a crucial role in determining the economic success of certain activities.

Overall, the findings underscore the importance of adopting diversified IFS models to enhance income sustainability and resilience for farmers in both states. While both regions benefit from IFS, targeted interventions to optimize the potential of specific components, like poultry and vermicomposting in Chhattisgarh and livestock and vegetables in Madhya Pradesh, could lead to improved economic outcomes. These insights can inform policy decisions and farm management strategies aimed at boosting agricultural productivity and income generation in the context of integrated farming systems.

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