



Integrated Farming Systems and Livelihood Sustainability: The Mediating Roles of Market Access and Market Diversification among Smallholder Farmers

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ABSTRACT

Integrated Farming Systems (IFS) offer smallholder farmers a pathway toward livelihood sustainability by combining complementary agricultural enterprises, improving resource-use efficiency, and diversifying income sources. However, the extent to which these benefits translate into sustainable livelihoods depends increasingly on farmers' ability to connect diversified production with viable markets. Drawing on the Sustainable Livelihoods Framework, this study examines the relationships among Integrated Farming Systems, Market Access, Market Diversification, and Livelihood Sustainability, with particular emphasis on the mediating role of Market Diversification. Using a quantitative, cross-sectional research design, the study applies Partial Least Squares Structural Equation Modelling (PLS-SEM) to test the proposed relationships. The findings demonstrate that IFS has a strong positive effect on Market Diversification ($\beta = 0.909$, $p < 0.001$), while Market Diversification ($\beta = 0.319$, $p < 0.001$) and Market Access ($\beta = 0.557$, $p < 0.001$) significantly enhance Livelihood Sustainability. Furthermore, Market Diversification significantly mediates the relationship between IFS and Livelihood Sustainability ($\beta = 0.290$, $p < 0.001$). The study extends IFS and sustainable-livelihood research by demonstrating that market-oriented mechanisms are critical in converting production diversification into sustainable livelihood outcomes.

Keywords: Integrated Farming Systems; Livelihood Sustainability; Market Access; Market Diversification; Sustainable Livelihoods Framework

1. INTRODUCTION

Smallholder agriculture remains central to rural livelihoods in developing economies, yet its (Dong, 2021). Under such circumstances, increasing farm productivity alone may not be sufficient to generate sustainable livelihood outcomes (Ahmadzai et al., 2021). Rather, farmers require production systems capable of combining enterprises, recycling resources, spreading production risks and connecting farm outputs with remunerative markets (Akter et al., 2026). Integrated Farming Systems (IFS) have emerged as an important systems-based response to these challenges (Cakmakci et al., 2025). Unlike specialised or monocropping systems, IFS combine complementary enterprises such as crops, livestock, horticulture, fisheries, poultry and other allied activities within a coordinated production system (Singh et al., 2020). The underlying principle is resource complementarity: outputs or wastes from one enterprise can become inputs for another, thereby improving resource-use efficiency, reducing production



costs and creating multiple income streams (Atapattu et al., 2025). Previous research has consequently associated IFS with higher productivity, profitability, employment generation, food and nutritional security, and reduced livelihood risk. However, the economic contribution of IFS should not be conceptualised exclusively through production-side outcomes (Ertör-Akyazi et al., 2025). A farm may generate diversified outputs without necessarily producing sustainable livelihoods if farmers cannot access appropriate markets, obtain adequate prices, or distribute their products across alternative market channels (Ma et al., 2024). Market institutions therefore constitute an important bridge between farm-level diversification and livelihood outcomes. Evidence from smallholder research demonstrates that geographical remoteness, poor infrastructure, information asymmetry, transaction costs, limited bargaining power, and inadequate business capabilities can constrain farmers' effective participation in markets (Marion et al., 2024).

Market access concerns farmers' ability to reach, participate in, and transact within agricultural markets, while market diversification reflects the ability to sell agricultural products through multiple channels or market outlets (Ma et al., 2024). (Golmohammadi & Hassini, 2020). The sustainable-livelihood perspective provides a useful theoretical foundation for integrating these relationships. Scoones' Sustainable Livelihoods Framework conceptualises livelihood sustainability as a process through which households combine different livelihood resources and strategies to pursue sustainable livelihood outcomes (Maketho, 2024). Livelihood diversification is one of the principal strategies through which rural households respond to vulnerability and pursue improved well-being. Similarly, Ellis (1998) conceptualises rural livelihood diversification as the process through which households construct diversified portfolios of activities and social support mechanisms to improve livelihood security and living standards (Sikhunyana et al., 2020). Despite the substantial literature on IFS, important conceptual and empirical gaps remain. Existing studies have predominantly examined IFS in relation to productivity, profitability, income, food security, resource efficiency, or ecological sustainability (Bhagat et al., 2024). Comparatively less attention has been given to how IFS produces sustainable livelihood outcomes through market-based mechanisms. In particular, the simultaneous role of market access and market diversification remains insufficiently integrated into an empirical IFS–livelihood framework (Ahmad et al., 2025).

Accordingly, this study develops and empirically examines a model in which IFS influences livelihood sustainability through market-related mechanisms. Specifically, the study examines whether IFS enhances market diversification, whether market diversification contributes to livelihood sustainability, whether market access contributes to livelihood sustainability, and whether market diversification mediates the relationship between IFS and livelihood sustainability (Pattanaik et al., 2026). The study contributes to the literature in three ways. First, it moves beyond a production-centred understanding of IFS by incorporating market mechanisms into the livelihood sustainability relationship (Kansanga & Luginaah, 2019). Second, it connects farming-system theory with the Sustainable Livelihoods Framework by positioning market-related capabilities as mechanisms translating production diversification

into livelihood outcomes (Merino-Gaibor et al., 2026). Third, it provides empirical evidence using PLS-SEM on the relationships among IFS, market diversification, market access, and livelihood sustainability (Luna et al., 2026).

2.1 LITERATURE REVIEW AND THEORETICAL BACKGROUND

2.1 Integrated Farming Systems

Integrated Farming Systems represent a coordinated approach to agricultural production in which multiple enterprises are combined within a farm system to exploit complementarities between enterprises (Atapattu et al., 2025). The system may integrate crops with livestock, horticulture, poultry, fisheries, agroforestry and other enterprises. The principal advantage of IFS is that the farm is treated as an interconnected system rather than as a collection of independent production activities (Singh & Dubey, 2023). Crop residues may support livestock, livestock manure may improve soil fertility, livestock enterprises can provide regular income while crop enterprises provide seasonal returns, and different enterprises can collectively reduce dependence on a single source of income. Behera's review of IFS in India argues that smallholder farmers face fundamental problems associated with declining land availability, climate change, resource degradation, and insufficient profitability, making integrated approaches particularly relevant to small farms (Bayu, 2020). Research on IFS adoption in Kerala and Tamil Nadu found that IFS generated additional gross and net income and improved household dietary diversity relative to non-adopting households (Rao et al., 2024). A recent IFS model developed in the North-Western Himalayan region further demonstrates the potential of integrated systems for profitability, employment, resource recycling and soil-health improvement (Thakur et al., 2025). These findings indicate that IFS can create a more resilient production structure by combining economic, social and environmental functions. Nevertheless, much of this literature conceptualises IFS benefits as direct outcomes of production integration (Shyam et al., 2023). The market pathway remains less explicitly theorised. This study therefore proposes that the benefits of IFS may partly depend on farmers' capacity to convert diversified production into diversified market opportunities (Meena et al., 2024).

2.2 Livelihood Sustainability

Livelihood sustainability extends beyond household income. It incorporates the capacity of households to maintain and improve their livelihood conditions while coping with shocks and preserving the resource base required for future livelihood generation (Knutsson & Ostwald, 2023). Scoones' Sustainable Livelihoods Framework identifies livelihood resources—including natural, economic, human and social capital—and explains how these resources are combined through livelihood strategies such as agricultural intensification, extensification, diversification and migration (Balgah et al., 2025). From this perspective, sustainable livelihoods require more than higher agricultural output. Farmers must possess sufficient resources, capabilities and institutional opportunities to respond to uncertainty (Li et al., 2020). Sustainable livelihood outcomes therefore include improvements in well-being, poverty reduction, livelihood resilience and the long-term sustainability of the natural-resource base.

For smallholder farmers, IFS can contribute to these outcomes through several pathways (Arif et al., 2025).

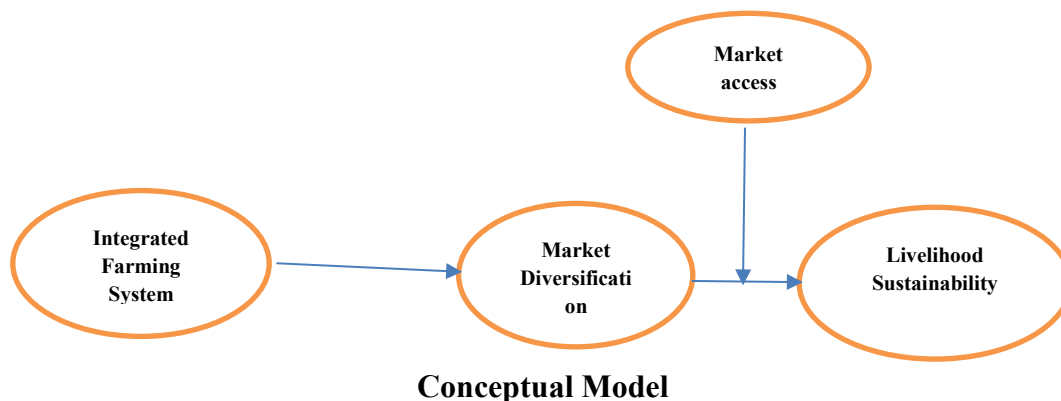
2.3. Market Access as a Livelihood Mechanism

Market access is not merely physical proximity to markets. It encompasses farmers' ability to participate effectively in markets, obtain information, reach buyers, transact at acceptable costs, and secure remunerative returns (Kumar et al., 2025). It highlights the importance of market participation in determining whether smallholders can benefit from agricultural commercialisation. Market participation is affected by transaction costs, production capacity, asset ownership, and institutional conditions (Sher et al., 2020). The relationship is especially important under IFS because diversified production can increase the volume, type, and timing of products available for sale. Without effective market access, however, production diversification may not translate into livelihood improvement (Thakur et al., 2025).

2.4. Market Diversification

Market diversification refers to farmers' use of multiple market outlets, buyers, channels or destinations rather than depending on a single marketing pathway (Dias et al., 2022). Market diversification is theoretically important because dependence on a single market exposes farmers to buyer power, price fluctuations, and demand shocks. Diversified market participation can provide farmers with greater flexibility in deciding where and when to sell (Deng et al., 2025). The concept is consistent with the broader livelihood-diversification literature. Argues that diversification enables rural households to construct portfolios of activities and resources that can enhance livelihood security (Ellis, 1998). The importance of market diversification becomes especially apparent under IFS. Because IFS generate multiple agricultural products, farmers potentially require multiple marketing channels suited to different products (Pattanaik et al., 2026). The structural model proposes that IFS enhances farmers' ability to participate in diversified markets. In turn, diversified market participation is expected to improve livelihood sustainability. Market access is additionally hypothesised to have a direct positive effect on livelihood sustainability. The model therefore captures both direct and indirect mechanisms linking farm-system diversification with livelihood outcomes. The hypotheses tested are:

- H1:** Integrated Farming System has a significant positive effect on Market Diversification.
- H2:** Market Diversification has a significant positive effect on Livelihood Sustainability.
- H3:** Market Access has a significant positive effect on Livelihood Sustainability.
- H4:** Market Diversification significantly mediates the relationship between Integrated Farming System and Livelihood Sustainability.



3. RESEARCH METHODOLOGY

3.1 Research Design

This study adopts a quantitative, cross-sectional research design to empirically examine the relationships among Integrated Farming Systems (IFS), Market Access (MA), Market Diversification (MD), and Livelihood Sustainability (LS). The research is grounded in the Sustainable Livelihoods Framework, which conceptualises livelihood sustainability as an outcome of the effective mobilisation and combination of livelihood resources and strategies. In this framework, IFS represents a farm-level diversification strategy, while market access and market diversification represent market-oriented mechanisms through which diversified agricultural production may be translated into sustainable livelihood outcomes. A cross-sectional design is appropriate because the study seeks to assess farmers' perceptions and experiences at a specific point in time and to test theoretically derived relationships among multiple latent constructs. Consistent with the study's predictive orientation, Partial Least Squares Structural Equation Modelling (PLS-SEM) is employed. PLS-SEM is particularly appropriate for models involving multiple latent constructs and mediation relationships and where the objective includes prediction and theory development.

4. FINDINGS AND RESULTS

4.1 Measurement Model Assessment

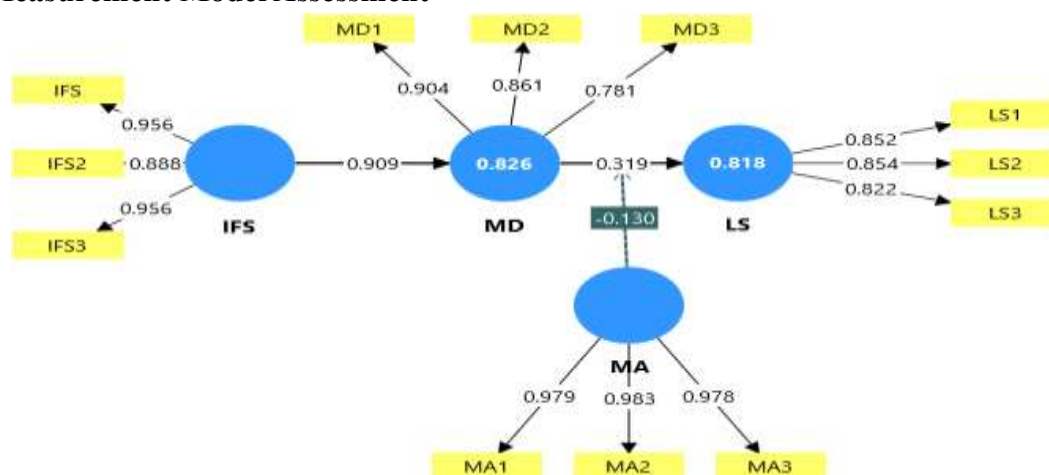


Table 1: Outer loadings of Measurement Model

Constructs	IFS	LS	MD	MA
IFS	0.956			
IFS2	0.888			
IFS3	0.956			
LS1		0.852		
LS2		0.854		
LS3		0.822		
MA1				0.979
MA2				0.983
MA3				0.978
MD1			0.904	
MD2			0.861	
MD3			0.781	

The uploaded results demonstrate strong internal consistency. Cronbach's alpha values range from 0.801 to 0.979, while composite reliability values range from 0.880 to 0.986. AVE values range from 0.710 to 0.961. All reported AVE values exceed the conventional 0.50 threshold, indicating satisfactory convergent validity. The individual outer loadings are also strong. IFS indicators range from 0.888 to 0.956; LS indicators from 0.822 to 0.854; MA indicators from 0.978 to 0.983; and MD indicators from 0.781 to 0.904.

Table 2: Reliability and convergent validity

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
IFS	0.926	0.931	0.953	0.872
LS	0.801	0.819	0.880	0.710
M	0.806	0.817	0.886	0.723
MA	0.979	0.980	0.986	0.961

4.2 Discriminant Validity

The Fornell–Larcker criterion provides evidence regarding discriminant validity. The square roots of AVE reported on the diagonal are sufficiently high relative to corresponding inter-construct correlations in most comparisons. However, the uploaded HTMT matrix contains values of 1.040 and 0.970 for some construct pairs. This point should be addressed before submitting the manuscript to a Q1 journal. If the study follows the stricter HTMT < 0.85 or <0.90 criterion, these values may indicate insufficient discriminant validity. The authors should therefore re-examine the indicators and construct conceptualisation, especially the constructs producing HTMT values above the recommended threshold.

Table 3: Fornell-Larcker Criterion

Construct	IFS	LS	M D	MA
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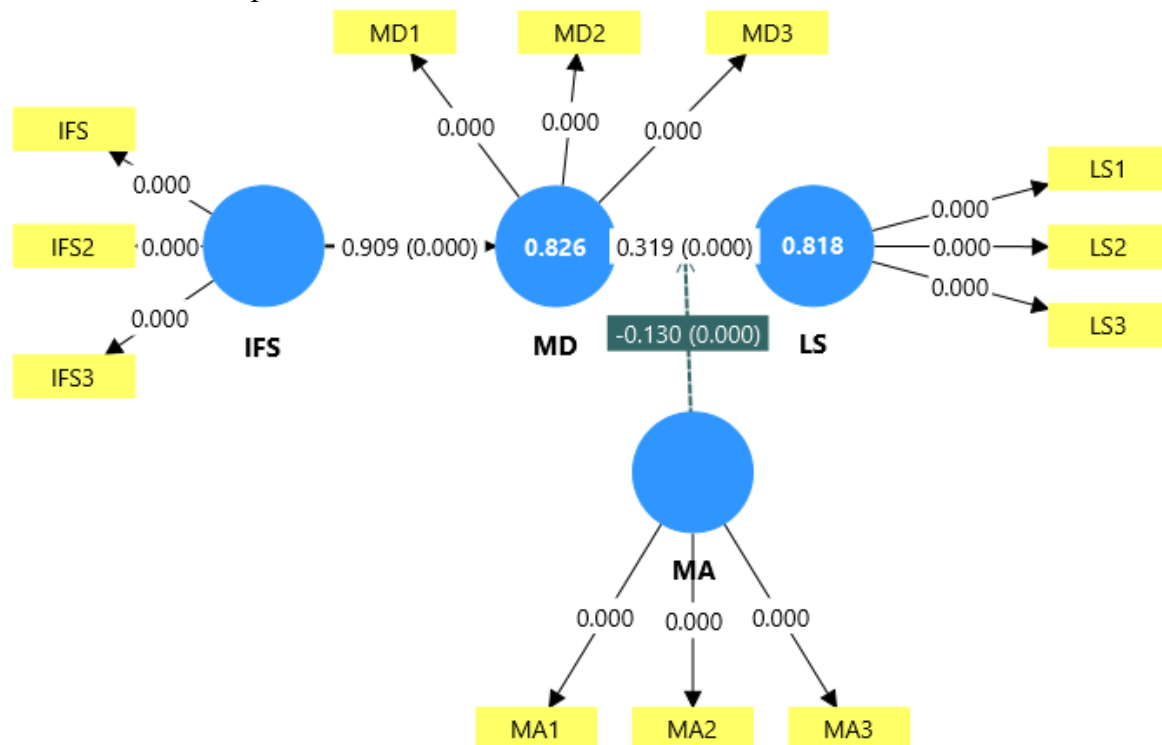
IFS	0.934			
LS	0.643	0.843		
M	0.909	0.769	0.850	
MA	0.536	0.825	0.587	0.980

Table :4 Heterotrait - Monotrait Ratio (HTMT)

Constructs	IFS	LS	M D	MA
IFS				
LS	0.745			
M	1.040	0.970		
MA	0.564	0.874	0.661	

4.4 Structural Model Assessment.

After establishing the adequacy of the measurement model, the structural model is evaluated using path coefficients (β), standard errors, t-values and p-values. The significance of the hypothesised relationships is assessed through bootstrapping. The results indicate that all four proposed hypotheses are statistically supported. IFS has a very strong positive relationship with Market Diversification ($\beta = 0.909$, $t = 128.818$, $p < 0.001$). Market Diversification has a positive effect on Livelihood Sustainability ($\beta = 0.319$, $t = 7.831$, $p < 0.001$), while Market Access demonstrates a comparatively stronger positive effect on Livelihood Sustainability ($\beta = 0.557$, $t = 21.684$, $p < 0.00$).



Structural Model Assessment

4.5 Effect of IFS on Market Diversification

The strongest structural relationship in the model is between IFS and Market Diversification. The coefficient of $\beta = 0.909$ indicates a very strong positive association. The relationship is statistically significant at $p < 0.001$, with an exceptionally high t-value of 128.818. This finding indicates that integrated farming substantially increases the capacity or tendency of farmers to engage in diversified markets.

4.6 Effect of Market Diversification on Livelihood Sustainability

Market Diversification has a positive and statistically significant effect on Livelihood Sustainability ($\beta = 0.319$, $t = 7.831$, $p < 0.001$). The finding suggests that diversified market engagement contributes to farmers' ability to maintain and improve their livelihood conditions.

4.7 Effect of Market Access on Livelihood Sustainability

Market Access exhibits a relatively stronger effect on Livelihood Sustainability than Market Diversification, with $\beta = 0.557$. The relationship is highly significant ($t = 21.684$, $p < 0.001$). This finding suggests that the ability to access markets may be a particularly important condition for transforming agricultural production into sustainable livelihood outcomes

Table 5: Structural Model Results and Hypothesis Testing

Hypothesis	β	SD	t-value	P values	Decision
H1: IFS $\rightarrow$ Market Diversification	0.909	0.007	128.818	0.000	Supported
H2: Market Diversification $\rightarrow$ LS	0.319	0.041	7.831	0.000	Supported
H3: Market Access $\rightarrow$ LS	0.557	0.026	21.684	0.000	Supported

4.8 Mediation analysis

The mediation analysis reveals a significant indirect relationship between IFS and Livelihood Sustainability through Market Diversification. The indirect effect is: $\beta = 0.290$, $SD = 0.038$, $t = 7.680$, $p < 0.001$. Therefore, H4 is supported. The finding provides empirical support for the proposition that IFS contributes to livelihood sustainability partly by enabling farmers to diversify their market participation. The mediating role of Market Diversification is examined using the indirect effect of IFS on Livelihood Sustainability through Market Diversification. The results indicate a significant indirect effect ($\beta = 0.290$, $SD = 0.038$, $t = 7.680$, $p < 0.001$), supporting H4.

Table 6: Mediation analysis

Hypothesis	β	SD	t-value	P values	Decision
H4: IFS $\rightarrow$ Market Diversification $\rightarrow$ LS	0.290	0.038	7.680	0.000	Supported

5. DISCUSSION AND CONCLUSION

This study examined the mechanisms through which Integrated Farming Systems contribute to Livelihood Sustainability, with particular emphasis on the roles of Market Access and Market Diversification (Nepali et al., 2024). Drawing on the Sustainable Livelihoods Framework, the

study moves beyond a production-centred interpretation of integrated farming and demonstrates that the livelihood value of diversified farming systems depends substantially on farmers' capacity to connect diversified production with appropriate markets (Chipenda & Adesina, 2025). The empirical findings provide support for all four hypothesised relationships. First, the exceptionally strong positive association between IFS and Market Diversification ($\beta = 0.909$, $p < 0.001$) indicates that farmers operating integrated production systems are considerably more likely to engage with diversified market channels. This finding reinforces the argument that production diversification creates a broader and more varied portfolio of outputs, which in turn can encourage farmers to explore multiple buyers and marketing channels (Bahta & Musara, 2023). Second, Market Diversification significantly contributes to Livelihood Sustainability ($\beta = 0.319$, $p < 0.001$). This suggests that access to multiple markets can reduce farmers' dependence on a single buyer or marketing channel and provide greater flexibility in responding to price, demand and market-related shocks (Merino-Gaibor et al., 2026). Third, Market Access emerges as a particularly important determinant of Livelihood Sustainability, with a stronger coefficient ($\beta = 0.557$) than Market Diversification. This finding indicates that diversified production cannot automatically produce sustainable livelihood outcomes when farmers face barriers related to market participation, transaction costs, information, infrastructure or bargaining power (Fernando et al., 2026). Effective market access therefore constitutes a critical institutional and economic condition for converting agricultural production into sustainable livelihood gains (Marion et al., 2024). Most importantly, the significant indirect effect of IFS on Livelihood Sustainability through Market Diversification ($\beta = 0.290$, $p < 0.001$) confirms the mediating role of market diversification (Rafiu et al., 2026). This finding provides empirical support for a market-mediated livelihood pathway, whereby integrated farming enhances the diversity of agricultural outputs, encourages participation in multiple markets, and ultimately contributes to more sustainable livelihood outcomes (Wu et al., 2026).

5.1 Theoretical Contribution

The study makes an important theoretical contribution by integrating farming-system theory with the Sustainable Livelihoods Framework (Meshram et al., 2026). Rather than treating IFS as an intervention whose benefits arise solely from higher productivity or resource efficiency, the findings demonstrate that market mechanisms should be incorporated into explanations of livelihood sustainability (Manono, 2026). This extends the existing IFS literature, which has predominantly focused on productivity, profitability, food security, resource recycling and ecological sustainability (Bhagat et al., 2024).

5.2 Practical Implications

The findings suggest that policies promoting integrated farming should not focus exclusively on production technologies (Adenle & Azadi, 2026). Market infrastructure, market information, farmer–buyer linkages, transportation facilities, collective marketing, price information and access to alternative market outlets should form an integral component of IFS development programmes (Vincent & Saravanan, 2020). Strengthening farmers' market



capabilities may enable them to capture greater economic value from diversified production and reduce their vulnerability to market shocks (Mekonnen et al., 2024).

5.3 Conclusion

Overall, the findings demonstrate that integrated farming can contribute to sustainable livelihoods, but its effectiveness depends substantially on the market environment in which farmers operate (Bhagat et al., 2024). IFS creates the production base for diversification, while Market Diversification and Market Access provide important pathways through which this production potential is converted into livelihood sustainability (Raghavendra et al., 2024). The study therefore supports a shift from a narrowly production-oriented approach towards a production–market–livelihood perspective of agricultural development (Senou, 2025).

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