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Transforming smallholder livelihoods: A case study on integrated farm planning in Subalaya village in Sundargarh district of Odisha, India

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Abstract

Integrated farm planning offers a sustainable pathway to improve smallholder farmers' livelihoods by optimizing resource utilization, increasing productivity, and diversifying income sources. This study employs a case study approach, focusing on the case of Mr. Daitari Patel from Subalaya village of Subdega block in Sundargarh district of Odisha. It evaluates the potential socio-economic impact of transitioning from a conventional farming system to an integrated farm plan. The existing farm plan, centered on rice cultivation (Surendra variety), yielded 23-25 quintals per acre with a Benefit-Cost Ratio (BCR) of 1.31 and net returns of ₹14,510 per acre. In contrast, the suggested alternative farm plan incorporated diversified cropping (Jamuna rice, sweet corn), organic inputs, and mushroom cultivation, leading to an estimated BCR of 1.75 and net returns of ₹21,503 per acre. Mushroom cultivation alone contributed towards a potential net profit of ₹5,420 with a BCR of 3.31, demonstrating the profitability of enterprise diversification. The findings highlight the significant economic and environmental benefits of integrated farm planning, including increased income, resource efficiency, and sustainability. The study advocates for its wider adoption to enhance the sustainability and profitability of smallholder farming systems.

Keywords: Integrated farm planning, smallholder farmers, diversified cropping, benefit-cost ratio, sustainability, case study

Introduction

Integrated farming systems (IFS) offer a holistic approach to agriculture by combining crop cultivation with livestock management, thereby enhancing resource utilization and promoting sustainability. This integration allows for the recycling of nutrients through manure, reducing the need for chemical fertilizers and improving soil health (Devendra *et al*., 2004) [1]. Additionally, it provides diversified income streams, mitigating risks associated with market fluctuations and climate variability, leading to more stable and increased income for farmers. Studies have shown that adopting IFS can positively affect farmers' income and welfare, with research indicating that farmers practicing horticulture-based IFS experienced increased income levels and improved welfare compared to those following conventional farming methods. Furthermore, integrating livestock with crop production can lead to higher productivity and profitability, allowing for efficient use of resources and diversification of income sources (Parajuli *et al*., 2018) [2].

Integrated Farming Systems (IFS) have been recognized for their potential to enhance agricultural productivity, economic returns, and sustainability. Integrating various land-based enterprises within a farm has been shown to generate net returns substantially higher than conventional rice-wheat systems (John, 2014) [3]. In Tamil Nadu, the combination of crops with fish and poultry resulted in a 25% increase in economic returns. Similarly, integrating crops with fish and livestock, such as pigs or ducks, has led to increased employment opportunities and improved livelihoods for farmers. The adoption of IFS has also been associated with enhanced water productivity, job creation, and energy output, making it a promising alternative to existing cropping systems. Moreover, IFS practices contribute to better resource management by reducing dependence on external inputs and improving soil health (Wazel *et al.*, 2014) [4]. The integration of livestock and fisheries with crops enhances nutrient use efficiency, promotes nutrient recycling, and boosts soil microbial activity. In regions like Kerala, integrating livestock into homestead farming systems has provided families with a year-round supply of vegetables, milk, and eggs on small landholdings. For small and marginal farmers, IFS plays a crucial role in meeting protein requirements through the production of animal-based food products (Elahi *et al.*, 2018) [5]. By optimizing resource utilization and incorporating diverse components such as legumes, vegetables, oilseeds, and agroforestry, IFS can contribute to food and nutritional security. Factors influencing the adoption of IFS include education, farming experience, family size, landholding size, and access to weather information. Effective utilization of agricultural loans and advisory services is also essential for small and marginal farmers to adopt IFS practices.

Given the challenges posed by climate change and the increasing demand for food and nutrition, regional implementation of IFS in India is vital. Research efforts have been directed toward promoting IFS with technical interventions to enhance food and nutritional security, economic viability, and employment generation among farmers.

By adopting IFS, farmers can achieve a balanced and resilient farming system that benefits the environment and their economic well-being. Agriculture in India predominantly relies on smallholder farmers who face numerous challenges, including limited access to resources, low crop yields, and vulnerability to market fluctuations. Integrated farm planning offers a comprehensive solution to these challenges by combining scientific knowledge with localized strategies. It emphasizes optimizing resource use, diversifying enterprises, and improving income stability for farmers (Gill *et al.*, 2009) [6].

While the benefits of IFS are well-documented, there is need for more comprehensive studies that evaluate the long-term sustainability and resilience of these systems under varying agro-climatic conditions. Specifically, research should focus on understanding the socio-economic barriers to adoption, the role of policy support, and the impact of IFS on biodiversity and ecosystem services (Behera *et al.*, 2015) [7]. Additionally, there is limited information on the scalability of successful IFS models and their adaptability to different regions and farming contexts. Addressing these gaps will provide a more holistic understanding of IFS and inform strategies for wider implementation. With the above context, the current case study on Integrated Farm Planning was undertaken.

Materials and Methods

The current study was conducted using case study research design. The study was focused on evaluating the existing farming practices of the farmer under study, designing an improved alternative farm plan, and assessing its potential socio-economic impact on the farmer and his livelihood. The locale of the study was Subalaya village from Subdega block in Sundargarh district of Odisha, which was purposively selected for the study. The study was centred around the case of Mr. Daitari Patel, a smallholder farmer owning 3.5 acres of land in Subalaya village. His current farming practice, predominantly rice cultivation, faces issues of low profitability and underutilization of land. The alternative farm plan that was suggested integrates diversified cropping, organic practices, and mushroom cultivation to improve productivity and sustainability. Through a detailed cost-benefit analysis, the study demonstrates how strategic farm planning can significantly enhance livelihoods and productivity for smallholder farmers.

To provide a clear understanding of the methodological approach used in this study, a conceptual framework was developed. The conceptual framework depicted in Figure 1 outlines the key components of the research process, including data collection, analysis, and the comparison of farm plans. The framework integrates primary field data, cost-benefit analysis, and insights from prior studies on integrated farming systems.

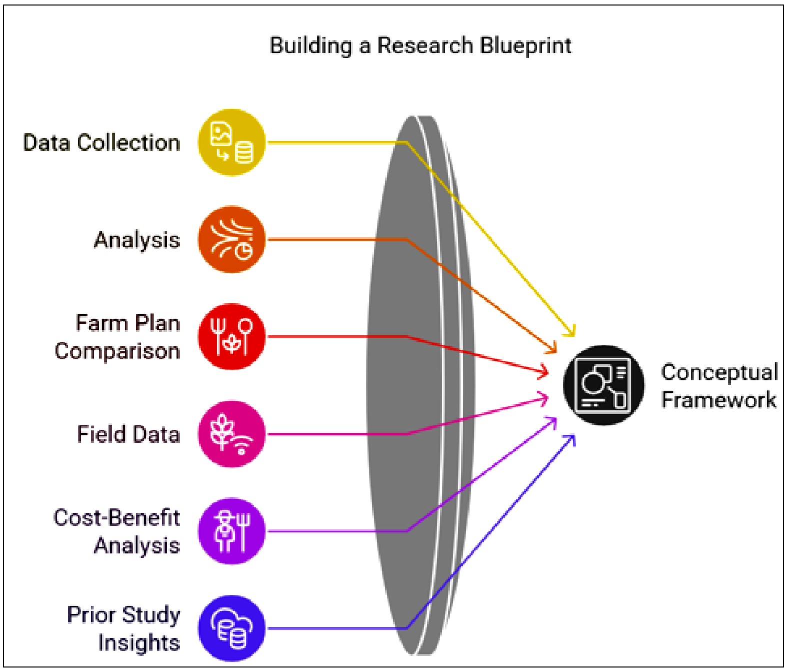

Fig 1: Conceptual framework of research

The data collection process involved a combination of primary field surveys, interview with the farmer, and cost-benefit calculations. The existing farm plan was analysed to determine inputs, outputs, and economic performance. Subsequently, an alternative farm plan was developed, incorporating diversified crops and improved practices based on the farmer's resource availability and market conditions. The photos from data collection are depicted in Figure 2.

Fig 2: Glimpses from the field visit and data collection

The analysis included detailed calculations of the cost of cultivation, gross revenue, net returns, and benefit-cost (B: C) ratios. The B: C ratio, defined as the ratio of net returns to the cost of cultivation, served as a critical indicator for assessing the economic viability of both the existing and alternative plans. Additionally, this study incorporated insights from research on integrated farming systems, which emphasize the importance of diversification and resource efficiency in achieving sustainable agricultural outcomes. A cost-benefit analysis framework was applied to evaluate economic viability. Financial indicators such as Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (BCR) were used to assess profitability, investment efficiency, and economic viability respectively. Additionally, environmental sustainability and resource efficiency were considered supplementary evaluation metrics. The indicators are as follows.

1. **Net Present Value (NPV):** The Net Present Value (NPV) of an investment is a key metric used to determine whether an investment is worthwhile. It represents the amount of cash an investor would need today to match the value of making the investment. If the NPV is positive, the investment is beneficial, as it is akin to receiving a cash payment equal to the NPV. Conversely, a negative NPV suggests the investment would result in a loss of cash today, making it unwise to proceed. When the NPV is zero, the projected return matches the discount rate, leaving the investor indifferent about the investment. NPV is calculated by discounting all future benefits and costs at the appropriate rate and subtracting the present value of costs from the present value of benefits.

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}$$

Where:

- CF_t = Cash flow at time t (can be positive for inflows or negative for outflows)
- r = Discount rate (the required rate of return or cost of capital)
- t = Time period (e.g., year $0,1,2,\ldots,n$)
- n = Total number of periods

2. **Benefit-Cost Ratio (BCR)**: The benefit-cost ratio takes the times series data on benefits and costs used to construct NPV and organizes them in a ratio form rather than as an absolute value. Alternatively, the BCR can be defined as the ratio of the discounted benefits to the discounted costs of an investment concerning the same point in time.

$$BCR = \frac{\sum B_t(1+r)^t}{\sum C_t(1+r)^t}$$

where,
B_t = Benefits in year t
C_t = Costs in year t
r = Discount rate (expressed as a decimal)
t = Period (year)

3. **Internal Rate of Return (IRR)**: The IRR reveals the rate of growth of capital invested in the business. For purposes of analyzing the economic impacts of R&D, IRR is called as private rate of return (PRR) when the return to a single company's (the innovator's) R&D investment is being studied, or the social rate of return (SRR) when industry-wide or economy-wide rates of return are estimated.

$$IRR = r_1 + \frac{NPV_1}{NPV_1 - NPV_2}(r_2 - r_1)$$

where,
r_1 = lower discount rate chosen
NPV_1= NPV at r_1
r_2 = higher discount rate chosen
NPV_2= NPV at r_2

The proposed alternative farm plan included diversification of cropping systems by introducing high-value crops such as sweet corn during the Rabi season, adoption of organic practices and inputs such as farmyard manure (FYM), and incorporation of mushroom cultivation as a supplementary enterprise. These elements were designed based on resource availability, local market demand, and best practices in integrated farming systems. The factors contributing to the development of alternative farm plan design are depicted in Figure 3. The comparative analysis of the existing and the alternative farm plan along with the comparison of their economic performance and their potential socio-economic impact have been discussed in detail in the section that follows.

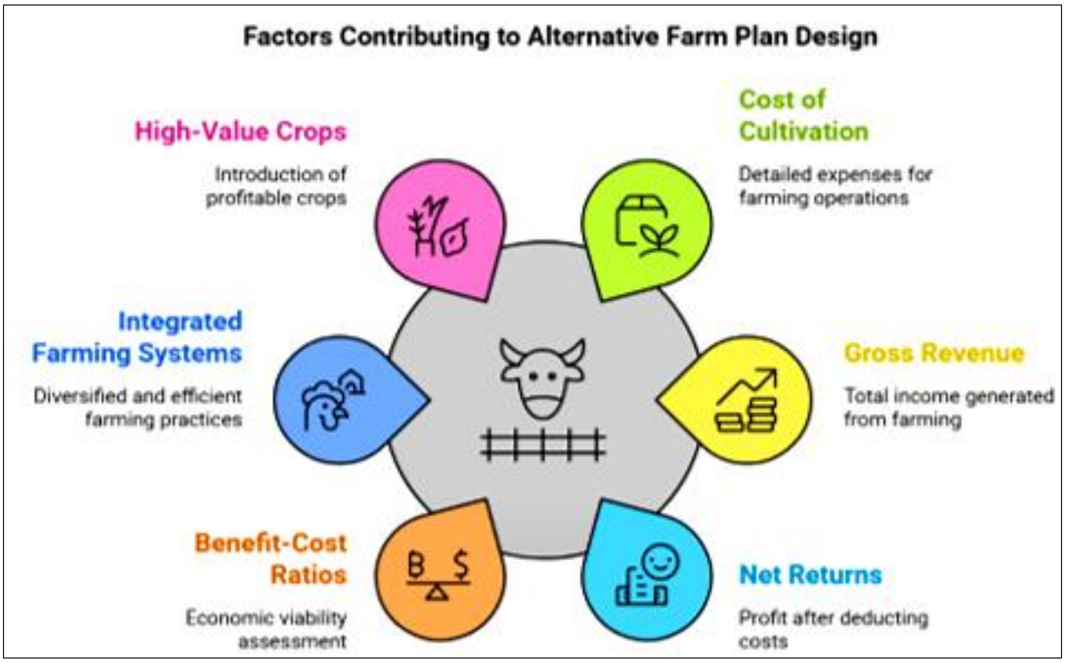

Fig 3: Factors contributing to alternative farm plan design

Results and Discussion

Existing Farm Plan

The current farming practices of Mr. Patel predominantly involve rice cultivation, utilizing the Surendra variety, across three acres of land. The average yield from rice cultivation is approximately 23 to 25 quintals per acre. The details of the existing farm plan are depicted in Table 1.

Table 1: Details of the existing farm plan

Parameter	Value
Crop	Rice (Variety: Surendra)
Yield (Quintals/acre)	23–25
Cost of Cultivation (₹)	32,990
Gross Income (₹)	48,500
Net Returns (₹)	14,510
Benefit-Cost Ratio	1.31

The existing plan, though functional, is limited by its reliance on a single crop and heavy usage of chemical fertilizers. Labor costs constitute a significant portion of expenses, with hired labor being employed for various operations, including land preparation and harvesting. The use of machinery, such as tractors and threshers, also adds to the cost. The gross returns, while sufficient to cover costs, leave minimal scope for significant profit or investment in farm improvements. The details of the inputs and expenditure for existing farm are shown in Table 2.

Table 2: Inputs and expenditure for Rice cultivation (Surendra variety) in existing farm plan

Inputs and Expenditures for Rice (Per Acre)	Details
Fertilizers (Chemical)	₹8850
Organic Fertilizers (FYM)	₹4500
Human Labor	₹8820
Machine Labor (Tractor, Thresher)	₹7250
Plant Protection Chemicals	₹1130
Seed Cost	₹1440
Total Cost	₹32,990

Proposed Alternative Farm Plan

To address the limitations of the existing plan, an alternative farm plan was designed. This plan includes the adoption of Jamuna rice, a higher-yielding variety, alongside sweet corn cultivation on one acre during the Rabi season. Additionally, mushroom cultivation was introduced as a supplementary enterprise to enhance income diversity.

The proposed plan prioritizes the use of organic fertilizers such as farmyard manure (FYM) and incorporates improved plant protection measures. The addition of sweet corn as a high-value crop further diversifies the income streams, while mushroom cultivation provides quick returns on investment. The details of crop and inputs for alternate farm plan are depicted in Table 3.

Table 3: Details of crop and inputs for alternate farm plan

Crop and Inputs for Alternate Plan	Rice (Jamuna)	Sweet Corn
Area (Acres)	3.0	1.0
Yield (Quintals/Acre)	25–30	45–55
Fertilizer Costs (₹)	₹6100	₹1080
Organic Fertilizer (FYM, ₹)	₹6000	₹1500
Labor Costs (₹)	₹8820	₹1800
Seed Cost (₹)	₹1500	₹7800
Gross Income (₹)	₹50,440	₹72,000
Net Returns (₹)	₹12,530	₹53,113
Benefit-Cost Ratio	1.4	2.8

Mushroom Cultivation

Mushroom cultivation was included in the alternative plan to supplement income. With an investment of ₹1,640, the yield of 45 kilograms was achieved, sold at ₹160 per kilogram. This resulted in a net profit of ₹5,420 and a benefit-cost ratio of 3.31. The simplicity and quick returns make mushroom cultivation a viable enterprise for smallholder farmers. The details of the mushroom cultivation are depicted in Table 4.

Table 4: Details of mushroom cultivation

Mushroom Cultivation Details	Values
Total Cost (₹)	1,640
Yield (kg)	45
Sale Price (₹/kg)	160
Gross Income (₹)	7,200
Net Profit (₹)	5,420
Benefit-Cost Ratio	3.31

Economic Comparison

The comparison of economic parameters between the existing and alternative farm plans reveals significant improvements. The alternative plan demonstrates a higher net return and a substantially improved benefit-cost ratio, as shown below in Table 5.

Table 5: Economic comparison of existing and alternate farm plan

Economic Parameters	Existing Plan (₹)	Proposed Plan (₹)
Total Cost of Cultivation	32,990	50,497
Total Revenue	48,500	72,000
Net Returns	14,510	21,503
Benefit-Cost Ratio	1.31	1.75

The existing farming practices predominantly involved rice cultivation. Economic analysis revealed that rice (variety: Surendra) yielded approximately 23-25 quintals per acre, with a cost of cultivation of ₹32,990 per acre. The gross income was ₹48,500 per acre, resulting in net returns of ₹14,510 per acre and a Benefit-Cost Ratio (BCR) of 1.31. While the current plan ensured subsistence, it offered limited economic returns and sustainability due to its reliance on chemical inputs and monocropping. The alternative plan integrated diversified cropping and organic practices, emphasizing resource optimization and income diversification. It included the cultivation of rice (Jamuna variety), a higher-yielding variety for the Kharif season, alongside sweet corn cultivation during the Rabi season on one acre. Mushroom cultivation was also incorporated as a supplementary enterprise providing quick returns. Economic analysis of the proposed plan showed significant improvements, with net returns increasing to ₹21,503 per acre and the Benefit-Cost Ratio improving to 1.75. Mushroom cultivation yielded a net profit of ₹5,420 with a Benefit-Cost Ratio of 3.31.

The findings underscore the transformative potential of integrated farm planning for smallholder farmers. Diversified cropping systems reduced risks associated with monocropping and enhanced profitability. The introduction of organic inputs contributed to long-term soil health, aligning with sustainable agricultural practices. The alternative plan's higher Benefit-Cost Ratio and net returns demonstrated its economic superiority over the existing plan. Integration of high-value crops and mushroom cultivation maximized resource use and income diversification. Reduced dependence on chemical inputs supported environmental sustainability and aligned with global trends in sustainable agriculture. This study highlights the importance of training and support for farmers in adopting integrated farm plans. Extension services should focus on promoting awareness of high-value crops and supplementary enterprises, facilitating access to organic inputs and local markets, and providing financial and technical assistance for implementing diversified farming systems. These findings advocate for policy interventions to promote integrated farm planning as a viable solution for smallholder farmers in similar agro-climatic regions.

Practical Implications

The proposed farm plan showcases the potential of diversified cropping systems to enhance smallholder farmers' incomes. By integrating high-value crops such as sweet corn and supplemental enterprises like mushroom cultivation, the plan not only increases profitability but also reduces the risks associated with monocropping. Furthermore, the adoption of organic inputs contributes to long-term soil health, aligning with sustainable agricultural practices.

Conclusion

This study highlights the potential of integrated farm planning to transform smallholder agriculture by enhancing economic viability, resource efficiency, and sustainability. The proposed alternative plan characterized by diversified cropping, organic practices, and supplementary enterprises yielded substantial improvements in net returns and BCR compared to the conventional farming system. It addressed the challenges of monocropping, low profitability, and environmental degradation by reducing dependency on chemical inputs and optimizing land use. The findings underscore the importance of supporting smallholder farmers through training, access to organic inputs, and market linkages for high-value crops. Policy interventions are essential to facilitate the adoption of integrated farm planning across diverse agro-climatic regions. Future research should explore the long-term sustainability, scalability, and resilience of integrated farming systems to varying climatic and economic conditions. Emphasis should also be placed on understanding socio-economic barriers to adoption and their mitigation through targeted extension services and financial incentives.

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