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COST BENEFIT ANALYSIS UNDER MIXED CROPPING SPECIAL CONTEXT WITH COCONUT, ARECA NUT, PEPPER, BANANA AND PINEAPPLE -CASE STUDY DAKSHINA KANNADA DISTRICT

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ABSTRACT
One of the essential elements of sustainable agriculture in Dakshina Kannada involves Mixed cropping System. This cropping system includes various crops such as coconut, areca nut, banana, pineapple and pepper. This paper analyses the cost-benefit mechanisms of these structures, concentrating on their environmental, social, and economic consequences. Coconut-centred multi cropping utilises the corresponding expansion structures of intercrops, enhancing land usage and asset efficiency. Financial analysis examines the improved earning capacity of multi cropping due to diversified income avenues along with decrease in reliance on a mono plantation. Ecological advantages include enhanced soil health, dec5rease in soil erosion, and enhanced water maintenance, providing to enduring environmental balance. These structures offer enhanced job prospects and nourishment safety, encouraging flexibility in agrarian societies Moreover, disputes such as labour severity, increase in foundational costs, and wider market reach for multicrops pose challenges to implementation. Moreover, disputes such as pest and disease management, employee scarcities, and market price volatility pose restrictions to wider implementation. The results highlight the necessities for farmer training, targeted policy interventions, and infrastructure growth to unlock the full potential of integrated harvesting in the areas like Dakshina Kannada.
KEYWORDS: *Mixed Cropping System, Cost Benefit Analysis, Environmental Impact, Integrated Harvesting*

BACKGROUND

Dakshina Kannada district in Karnataka is known for its agricultural variety, with crops like coconut, areca nut, banana, peeper, and pineapple playing a important aspects in the local economy. Multi cropping, where integrated harvests are planted together, is a traditional procedure that utilises land usage, decreases risk, and improves income sustainability. This structure also provides to soil fertility and biodiversity, making them environmentally sustainable. while disputes such as flexible market prices, pest outbreaks, and labour shortages persist. examining the cost-benefit dynamics of multi cropping in these areas offers insights into its economic viability and potential for sustainable growth. (Kumbar et al., 2015).

Tropical regions like Dakshina Kannada, where coconut based inter, cropping systems are well suited. The structure includes high-value multi crops like pepper, arecanut, pineapple, and banana, utilising land efficiency and decreasing financial related risks. In Dakshina Kannada, the supplementary expansion patterns of these plantations allow for maximum optimisation of horizontal and vertical area in agricultural plantation grounds, however the land areas fertile soils and tropical climate improves the feasibility of multi cropping procedure (Maheswarappa et al., 2001). Studies highlight that multi plantation structure can substantially enhance farm growth. For example, combined plantation in coconut gardens emerged in a cost benefit ratio of 1.36 and a recovery time of just five years, highlighting financial viability (Maheswarappa et al., 2001). Likewise, multi plantation with pepper, cardamom, and areca nut in Karnataka illustrated net returns that were 1.56 times more than single cropping system (Korikanthimath et al., 1997).

Enhancement in soil productivity in integrated plantation structure because of diverse root systems and organic resources enhances nutrient cycling and water maintenance. Trails with multi layered plantations, inclusive of long pepper and banana, highlighted enhanced soil properties and higher productivity enabling them appropriate for well drained soils (Anilkumar, 2016). Increase in foundational cost inclusive of workers along with resources like watering system, along with the challenges of managing various plantation, are substantial disputes. However,

focused government policies, inclusive of subsidies and extension assistance, could alleviate these problems (Jaganathan & Nagaraja, 2015).

1. INTRODUCTION

Integrated cropping is a sustainable agricultural procedure that is inclusive of planting two or more harvests simultaneously on the same piece of Terrain. The strategy is widely implemented in tropical areas like Dakshina Kannada, Karnataka, in which coconut acts as the foundational harvest and interactively produced with increased-value harvests such as areca nut, pepper, pineapple, and banana. This integration utilises the land usage and offers environmental and financial advantages, arranging them as important approach for dealing with the disputes of modern farming.

Coconut-driven multi cropping utilises the natural compatibility of plantations. Coconut plantation trees offer a tall cover, permitting shade-tolerant harvests like pepper to expand at transitional levels and tiny harvests like pineapple and pineapple at the lower side (Ghosh & Bandopadhyay, 2011).

Financially, multi harvesting structure has proven to improve earning potential. For example, research has shown that combined agriculture structure inclusive of coconut and increase in value harvests like pepper and areca nut generate up to 50% increased outcome return in comparison to to single crop agriculture (Korikanthimath et al., 1997). The varied nature of these structure decreases reliance on a mono crop, reducing economic risks connected with market flexibility and crop failures. alternatively, coconut-cantered multi cropping offers rural livelihoods by providing more job prospects through labour-related agricultural procedures. (Jaganathan & Nagaraja, 2015). Ecologically, multi cropping improves soil fertility and decreases erosion. Various root structures offer to enhanced nutrient cycling and water maintenance, which are crucial for areas prone to seasonal water deficiencies (AnilKumar, 2016). Current paper examines the cost-benefit dynamics of coconut-centred multi cropping structure in Dakshina Kannada, concentrating on their financial viability, ecological influence, and disputes. By examining these elements, the paper aims to offer actionable information for policymakers and farmers to enhance sustainable agricultural procedures.

2. REVIEW OF LITERATURE

2.1 Cost-Benefit Analysis in Mixed Cropping

Cost benefit analysis (CBA) is a critical technique for examining the financial feasibility of farming procedures, specifically in multi cropping structure. Integrated harvesting, by combining multiple harvests on the same terrain provides agriculturists a varied earning stream, thereby decreasing economic risks combined with market volatility and climatic flexibility. A paper illustrated that multiple harvesting in coconut-centred structure substantially improves earning potentiality. Over a period of eight years, their research identified that mixed cropping yielded net returns between INR 49,700 and INR 126,900 per hectare annually, with a benefit-cost ratio of 1.36. The payback period for investments was estimated at just five years, highlighting the economic viability of such structure (Maheswarappa et al., 2001).

Padma (2018) concentrated on aromatic and medicinal multi crop like citronella and patchouli, combined into coconut lands. These structures achieved substantially increased net incomes, with a benefit-cost ratio of up to 2.84, in comparison to single cropping coconut itself (Padma, 2018). Cost-benefit analyses consistently underscore that multi cropping structure are financially advantageous.

2.2 Economic Viability of Coconut-Based Mixed Cropping

coconut cantered multi cropping structure have been demonstrated to outperform single cropping in terms of financial outcome return. These structures utilise the complementary expansion feature of harvests like areca nut, banana, pineapple, and pepper. Padma, (2018) reported that agriculturists combining citronella and patchouli into coconut gardens land attained net returns of INR 1.43 lakh per hectare, throwing back the potential of high-value multi to boost agricultural returns.

2.3 Environmental and Social Benefits

With an ecological perspective, multi cropping structure offers to soil health by making available harvests with complementary root system. Study identified multistorey cropping with coconut found that these structures enhance nutrient cycling and water maintenance, decrease soil erosion in sandy soils. Organic farming procedures combined with multi harvesting improved soil properties, with substantial improvement in soil organic matter and nutrient availability (Anilkumar, 2016).

Multi cropping structure also offers to social cohesion by motivating cooperative agriculture procedures and knowledge-sharing within farmers. For instance, study observed that farmers combining medicinal plants with coconut benefitted from coordinated marketing and shared assets for pest control. These procedures helped decrease operational costs and enhances overall profitability Padma, (2018).

2.4 Challenges of Mixed Cropping

Financial constraints are one of the foundational barriers to implementation. Study examined that the high cost of resources such as irrigation system, fertilisers, and pest management techniques demotivate many agriculturists. Moreover, flexible market prices for high-value multi crops like pepper and areca nut exacerbate economical risks (Jaganathan & Nagaraja, 2015). Employment necessities also pose a dispute. Integrated cropping structure demand with essential skilled labour for crop-specific work such as harvesting, pruning, and pest management. agriculturists with less assets often struggle to attain these labour demands, decreasing their skills to manage varied crops efficiently (Maheswarappa et al., 2001). Other major constraint is the technical abilities needed to manage various cropping structures. agriculturists must analyse crop combination, nutrient requirements, and pest dynamics.

Market reach and infrastructure even limit the scalability of mixed harvesting. Padma (2018) emphasised the lack of organized trading markets for medicinal and aromatic harvests, which decreases the earning capacity of multi cropping structure. Poor storage and transport availability exacerbate post-harvest losses, specifically for perishable multi crops like pineapple and banana (Padma, 2018).

Understanding and addressing these disputes requires comprehensive policy interventions. Financial incentives, subsidies for inputs, and access to training programs can alleviate economic and technical barriers.

2.5 Recent Developments and Data

Current advancements in multi cropping procedures examines their expanding implementation and evolving effectiveness. In some areas, over 40% of coconut agriculturists now combine high-value multi crops like areca nut, pineapple, and pepper, reflecting the enhancement popularity of multi harvesting (Padma, 2018). Digital creations, specifically in nutrient along with irrigation management, have further enhances the earning capacity of multi cropping structure. study reported that the combination of organic resources like vermicompost and coir pith substantially improved soil fertility and harvest yield in multistorey structure. These procedures decrease dependency on chemical fertilizers, decreasing expenses and enhancing environmental consciousness (Anilkumar, 2016).

3. METHODOLOGY

This paper employs a secondary research technique to examine the cost-benefit dynamics, financial viability, disputes, and environmental advantageous of multi cropping structure in Dakshina Kannada. Information was sourced from peer-reviewed journals, government reports, and published case studies, concentrating on coconut-based multi cropping structure with areca nut, pineapple, pepper, and banana. Secondary data assures a comprehensive understanding of multi harvesting structure, drawing from validated papers to offer evidence-based information.

4. FINDINGS AND DISCUSSION

The practice of mixed cropping in Dakshina Kannada, particularly involving coconut as the primary crop with areca nut, pepper, banana, and pineapple as intercrops, presents a model for sustainable agriculture with clear economic and ecological benefits.

4.1 Economic and Productivity Insights

They allow a diversification of forms of income and a more efficient use of land, thus making a mixed cropping system an economically viable one. As an illustrative example, coconut-based cropping systems with high-density multi-species intercropping, including banana and pineapple crops, have led to significant net return and productivity improvements. The outcome of studies showed that coconut-based systems could have net returns up to INR 1.26 lakh per hectare per year and thus hinting that coconut-based systems could overtake the one-crop farming methods in terms of profitability (Maheswarappa et al., 2013).

4.2 Environmental Contributions

Mixed cropping systems have many ecological benefits. Systems based on coconut contribute to improving soil quality thanks to recycling nutrients and decreasing water erosion. Studies by Intercropping with shade-tolerant

species, specifically pepper, not only maximized land use but also improved resource recycling with an annual biomass production of 8.72 to 10.35 tons per hectare (Sujatha et al., 2016). Mixed cropping improves biodiversity, soil fertility, and water conservation. For instance, coconuts and pepper are grown together as intercropping systems that can enhance the soil nutrient profiles and also stability in yield (Farsanashamin, et al., 2016).

4.3 Cost-Benefit Analysis

Notable economic benefits have been reported from mixed cropping systems involving coconut along with areca nut, pepper, banana and pineapple. According to studies, the mixed cropping practice results in higher returns than monocropping because of the different income generation from an integrated crop rotation and residue conservation through mixed cropping leading to agro-ecosystem sustainability. Studies recorded net returns from pepper-banana and coconut-pepper-banana combinations much higher than from monocropping with BCR ranging from 1.36 to 2.22 depending on the combination (Maheswarappa et al., 2001). Further, planting high-value crops like pepper and banana in and around areca nut gardens increased the net gains by more than 50% (Korikanthimath et al., 1997).

4.4 Profitability

Multi cropping structure improves profitability by optimising land usage and decreasing economic risks concerned with crop failure. Coconut-pineapple-pepper structure have been noted for their high earning capacity, with net returns substantially exceeding those of multicopper coconut (Ghosh et al., 2011). Moreover, organic approach of mixed cropping has resulted financially viable, with lower reliance costs and higher earnings over time in comparison to inorganic approach (Kumbar et al., 2015).

4.5 Challenges and Constraints

Agriculturists face many barriers some of them are:

1. **Pests and Diseases**: Coconut and black pepper are exposed to illness such as Phytophthora and rhinoceros beetle infestations, which can badly influence harvests (Likesh et al., 2012).
2. **Employee Scarcities**: Multi harvesting is Work-intensive, along with the accessibility of capable employee traces a dispute (Angadi et al., 2023).
3. **Resource Costs**: increase in costs for organic fertilizers and upkeep in some harvesting integration decreases profitability during the starting period.

4.6 Market Risks

For high-value crops such as pepper and pineapple, the system is clearly dependent on the temperamental market forces. Variations in international pepper prices have led to a decline in farmers' profit (Lokesh et al., 2012). The absence of organized marketing systems and also the delayed price information worsen the financial risk for small farmers as well (Kumar et al., 2014).

Multi harvesting structure in Dakshina Kannada includes coconut, pepper, areca nut, pineapple, and banana presents a highly returnable and ecological sustainable agriculture approach. While concentrating trade risks, labour shortages, and pest management disputes is fundamental for optimising the advantages of these structures.

Table 1: Cost benefit analysis of mixed cropping systems

Cropping Combination	Cost of Cultivation (₹/ha)	Net Returns (₹/ha)	Benefit-Cost Ratio (BCR)	Reference
Coconut + Pepper + Banana	~₹1,27,135 (organic methods)	₹4,93,460 (organic)	1.74 (organic)	Kumbar et al., (2015)
Areca nut + Cardamom	₹40,683 (mixed cropping)	₹1,61,837	1.48	Korikanthimath et al., (1997)
Coconut + Pepper + Pineapple	Not specified	₹45,600	Not specified	Ghosh & Bandopadhyay (2011).
Coconut + Vegetables	Not specified	₹4,03,551 (okra-tomato cycle) ₹3,60,365 (corn-gherkin)	Not specified	Maheswarappa et al., (2017)
Coconut + Aromatics (e.g., citronella)	Not specified	₹1,43,705	2.12	Padma, (2018)

Source: Compiled by authors

5. POLICY IMPLICATIONS FOR PROMOTING MIXED CROPPING SYSTEMS

To efficiently enhance integrated harvesting structure in areas like Dakshina Kannada, concentrated policy measures are important.

1. **Integrated supports systems:** Study highlighted that a lack of particular policies enhancing agroforestry and integrated harvesting in Kerala has led to the dominance of single crop system. motivations such as subsidies for resources, reach to irrigation, and crop insurance can reduce financial risks and draw small land farmers to implement integrated harvesting (Guillerme et al., 2011)
2. **Training and Capacity Building:** Agriculturists education is fundamental for managing varied crops effectively. Study examined that stakeholder awareness and ability building are crucial to implementing sustainable agricultural procedures, inclusive of crop diversification (Dhanda et al., 2022).
3. **Market Linkages and Infrastructure Expansion:** Policies need to tackle disputes related to market access for multi crops. Paper suggested that enhancing value chains and expanding markets for various agricultural products could improve the profitability of multi cropping structure. Enhanced storage and transportation infrastructure are also important for high-value harvests. Bisht et al. (2020)
4. **Research and Development:** Investments in R&D for mixed harvesting structure can offer agriculturists with high-yield, pest-resistant crop varieties compatible for intercropping. Study noted that conservation agriculture advantages from required solutions developed through research, which could also be implemented to enhance mixed harvesting structure (Somasundaram et al., 2020).

Policy frameworks that blend financial motivation, agrarian training, market connections, and R&D investments can change mixed harvesting structure into sustainable and scalable agricultural models.

6. CONCLUSION

Mixed harvesting structure, specifically those inclusive coconut as the foundational crop multi harvested with areca nut, banana, pineapple, and pepper, present a compelling model for long term and earning profitability through agriculture in Dakshina Kannada. The financial viability of multi harvesting is well-documented. structures combined with high-value multi crops, such as black pepper and banana, provide higher net earnings in comparison to single cropping. Paper analysed that coconut-cantered high-density multi-species structure enhanced net returns and ensured year-round income stability, with agricultures able to achieve benefit-cost ratios exceeding 2:1 under optimal management (Maheswarappa et al., 2013). Ghosh and Bandopadhyay (2011) similarly highlighted the financial advantages of models combining coconut, black pepper, and pineapple, demonstrating that well-structured mixed cropping systems outperform monocultures (Ghosh & Bandopadhyay., 2011)

Multi cropping structure offers substantially to environmental sustainability. Multi cropping enhances soil health, improves water maintenance, and decreases erosion. Additionally, the diversified nature of these systems reduces vulnerability to pests and diseases while enhancing biodiversity. Socially, Multi cropping proves more job prospects in rural areas due to the labour-centred management of integrated crops. It also assures food security by manufacturing a diverse of resource outputs that stabilize income over market volatility (Karna et al., 2022).

Disputes such as increase starting investment expenses, employ needs, and reduced market access for some intercrops need to be focused. Training programs for farmers on nutrient management, crop compatibility, and pest control are important to enhance the efficiency of mixed cropping. Policy interventions, including financial support and enhanced market infrastructure, are crucial to come out of these barriers (Sujatha et al., 2016).

Moreover, disputes such as pest management, labour shortages, and market volatility hinder diverse adoption (Jaganathan & Nagaraja (2015). Addressing these constraints through improved extension services, marketing strategies, and organic procedures can ensure long-term viability and socio-economic advantages for farmers (Kumbar et al., 2015

In summary, multi cropping structure in Dakshina Kannada provides a balanced approach to achieve economic profitability, environmental sustainability, and social well-being. By analysing the existing disputes through targeted policy measures and farmer education, mixed cropping has the importance to change traditional agriculture into a resilient and sustainable structure that will be advantages both farmers and the environment.

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