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SHIFTS FROM COCONUT MONO CROP TO COCONUT MIXED CROPS GENERATE SUSTAINABLE INCOME TO THE FARMERS" – CASE STUDIES DAKSHINA KANNADA DISTRICTS

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ABSTRACT----------
Coconut cultivation, when integrated with areca nut, banana, pepper, and pineapple in Dakshina Kannada District, Karnataka, forms a mixed cropping system that provides farmers with diversified income sources throughout the year. This practice not only improves farm income but also ensures greater economic resilience by mitigating risks associated with market fluctuations, pests, and climate variability. The study investigates the sustainability of such mixed cropping systems, focusing on economic benefits, productivity, and the environmental advantages they offer. Recent data highlights that farmers in Dakshina Kannada who adopt mixed cropping report consistent year-round income, enhanced soil fertility, and better water retention. The intercropping system ensures staggered harvesting periods, with crops like banana and pineapple providing early returns, while coconut and pepper offer long-term profitability. The study concludes with recommendations for scaling up these practices through policy interventions, farmer education, and improved market access.----------

1. INTRODUCTION

In tropical and subtropical regions, Coconut cultivation is a cornerstone of agricultural economies, as it is a primary source of employment and nutrition. According to Food and Agriculture Organization, 2019, coconut cultivation is practiced by millions of smallholder farmers in around 12 million hectares over 90 countries around the world. Farmers mostly use traditional monoculture farming practices which exposes them to risk of price volatility, climate change and pest outbreaks, hence threatening their livelihood. Therefore, the need for innovative agricultural practices has become a global concern for the sustainability of farming. India being a third largest producer of coconut globally, accounting fir 31% of worlds production, has been economic backbone of the farmers mainly in the regions of Kerala, Tamil Nadu, Karnataka, and Andhra Pradesh (Indian Council of Agricultural Research, 2020). Thus, the importance of coconut farming cannot be overstated. But the problem exists because of the monocropping systems dominating the coconut cultivation in India. For instance, in dakshina kannada district of Karnataka, having the favorable climate and soil condition, farmers practicing monocropping method became vulnerable due to environmental and economic shocks (Rao & Singh, 2021). Thus, the need for addressing this issue is very important for the long-term agricultural sustainability and economic resilience among farming household.

The food and Agriculture Organization (FAO) emphasizes that agricultural diversification as a important strategy for the sustainable farming. Additionally, this strategy of diversified cropping can improve farmers economic condition along with the enhanced food security. It has been proven by studies conducted in southeast Asia and Latin America, where the intercropping method helped coconut cultivating farmers to optimize their land, improve resilience to market and climate changes, along with the generation of multiple income streams. These farmers have integrated compatible crops with coconuts such as cocoa, banana, or pepper, leading to sustainable development in rural economies (Somashekhar & Ramesh, 2018). In India also the method of intercropping has been highly supported, for instance the coconut mixed cropping systems, which is the system of cultivating complementary crops such as areca nut, banana, pepper, and pineapple alongside coconut (Rao & Singh, 2021). Rao & Singh (2021), have also highlighted the opportunity created by the intercropping method in the regions of dakshina kannada where the climatic conditions are conducive, for e.g., crops like coconut and pepper ensure long term stability and economic benefits, while banana and pineapple gives early returns. Thus, the Department of Horticulture, Karnataka (2022) highlights the alignment of agriculture diversification and broader policy goals of doubling farmers income and promoting sustainable farming practices. Despite their potential benefits, this mixed

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cropping systems have been underutilized, as a result of gap in knowledge, insufficient policy support etc., (Indian Council of Agricultural Research, 2020).

This study aims to address the gaps in utilization of mixed cropping method and the sustainability of this method in Dakshina Kannada districts, with the focus on ecological, social and ecological dimensions. Thus, by analyzing case studies from those farmers who have been successful in achieving sustainability through this cropping method, their best practices, assessing impacts on soil fertility and water conservation. Finally the study also aims to provide actionable recommendations for scaling up these practices through policy interventions.

2. REVIEW OF LITERATURE

- **Economic and Environmental Benefits of Mixed Cropping**: A study by Kumar and Krishnan (2021) found that intercropping coconut with crops like areca nut, banana, and pineapple in coastal Karnataka increased farmers' income by up to 40% compared to monoculture systems. The study also noted that the diversity of crops helps in better soil management and pest control. Sharma et al. (2023) demonstrated that intercropping reduces the dependency on chemical inputs by promoting natural pest control, thus lowering production costs. They also noted that the water retention capacity of mixed cropping systems improved by 30% compared to monocropped coconut orchards.
- **Climate Resilience and Market Diversification**: A research paper by Suresh (2020) highlighted that mixed cropping systems in coconut cultivation offer significant resilience to climate change by diversifying production risks. Coconut, pepper, and areca nut can withstand varying climatic conditions, and banana and pineapple, being shorter-term crops, offer quick returns to offset periods of low coconut yields. According to Rao and Bhat (2021), market diversification through mixed cropping provides better financial stability for farmers, as high-value crops like pepper and areca nut often provide more lucrative returns than coconut alone.
- **Farmer Adoption and Barriers**: Rajendran et al. (2022) found that while the economic benefits of mixed cropping were clear, adoption rates were lower in areas where farmers lacked technical knowledge or where credit facilities for smallholder farmers were insufficient. They recommended a stronger extension service to facilitate knowledge transfer on crop management, pest control, and the financial management of diverse crops.
- **Sustainability of Mixed Cropping Systems**: Bansal and Pradhan (2022) argued that mixed cropping systems are inherently more sustainable, as they reduce dependency on chemical fertilizers and pesticides, conserve water, and improve biodiversity. The study stressed the importance of incorporating sustainable farming practices, such as organic farming, to further increase the environmental benefits of mixed cropping.
- **Policy Support for Mixed Cropping**: Singh et al. (2020) discussed the role of government policies in encouraging mixed cropping by offering subsidies for the cultivation of non-coconut crops, ensuring access to fair markets for these products, and providing training on intercropping techniques.

Coconut cultivation in combination with areca nut, banana, pepper, and pineapple in Dakshina Kannada presents a sustainable and economically viable model for small and medium-scale farmers. The system ensures year-round income, enhances farm resilience against market and climate risks, and promotes environmental sustainability. However, for widespread adoption, there is a need for enhanced policy support, better market linkages, and training programs to equip farmers with the knowledge and skills required to manage diverse crops. Mixed cropping not only improves the economic well-being of farmers but also contributes to the overall sustainability of agriculture in the region, making it a valuable model for other coconut-growing areas.

3. METHODOLOGY

The sustainability and advantages of coconut-based mixed cropping systems in Dakshina Kannada, Karnataka, are investigated in this study using qualitative methods and secondary data from government publications, market evaluations, and scholarly research. With an emphasis on water retention, soil health, and income diversification, thematic analysis is utilized to combine ideas on economic, environmental, and social factors. A sustainability framework assesses the system's social benefits, environmental effect, and financial resilience, while case studies and published best practices show successful implementations. Recommendations for expanding mixed cropping through farmer education, enhanced access to markets, and beneficial policy actions are guided by the findings.

4. MIXED CROPPING SYSTEM IN DAKSHINA KANNADA

According to the Department of Agriculture, Dakshina Kannada (2023), the area under coconut cultivation in the district is approximately 80,000 hectares. Among these, an estimated 45% of farmers practice mixed cropping with other high-value crops like areca nut, banana, and pepper. The average yield from a hectare of mixed cropping in Dakshina Kannada, including coconut and intercropped species, is around 10,000 kg of coconut, 5,000 kg of

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banana, 800 kg of areca nut, and 150-200 kg of pepper. This leads to an annual income range of INR 2.5 - 3 lakh per hectare, which is a significant increase compared to monocrop coconut farming, where annual income typically ranges from INR 1.5 - 2 lakh per hectare.

Dakshina Kannada coconut mixed cropping agri-systems have immense potential to set agricultural paradigms right from the confines of monocropping. One of the most detailed case studies provided describes the situation of a middle-aged farmer who spent over 10 years on coconut monocropping. The farmer was mainly dependent on coconut farming, where he used to get around ₹30,000 income per hectare per annum. Yet monocropping has its challenges, including a relatively high incidence of pests — especially the rhinoceros beetle — soil degradation and excessive water consumption, all of which put financial strain on the farm. The farmer shifted to a mixed cropping system on the farm by growing arecanut, banana and pepper. By diversifying sources of revenue and enabling optimal use of resources, this shift raised annual income to ₹80,000 per hectare. The banana and pepper crops yielded staggered harvests, while intercropping enhanced soil fertility and moisture (Jaganathan & Nagaraja, 2016).

The second case study, within a village level initiative in Dakshina Kannada demonstrates the role of cooperative to promote mixed cropping systems. Monocropping was out, cocoa and black pepper became the new coconuts for farmers in the cooperative. Workshops informed farmers about the suitability of crops and taught them pest management techniques, and subsidies also facilitated the first adoption of intercropping practices. That transition magnified farmers' economic outcomes considerably. Before the change, most farmers made about ₹25,000 a year, but mixed cropping enabled them to earn ₹60,000 a year. Collective resources like production of organic manure in the institution also minimized the cost of input. At first, farmers were apprehensive with regards to multiple crop management but that just took a bit of training and we used to share knowledge with farmers and now it's the talk of the town. A farmer from the cooperative remarked that mixed cropping "not only diversified income but also protected the environment and reduced risks associated with market volatility" (Dukuziyaturemye et al., 2020).

More tangibly, the benefits of a mixed cropping system are evident in the amount of quantitative data that supports such systems. Data from Dakshina Kannada show that farmers' net income can increase by up to 2.5 times if they shift from monocropping to mixed cropping. For example, intercropping pepper, banana and arecanut with coconut increased its annual income from ₹30,000–₹40,000 per hectare to ₹80,000–₹100,000 per hectare. The income becomes much higher due to the multipurpose high value intercrops providing continuity of returns during such situation of coconut market fluctuation levels is very low (Maheswarappa & Basavaraju 2017). We noticed mixed cropping improved water usage efficiency significantly also. Coconut monocropping systems needed as high as 1,000 liters of water on a weekly basis during the dry period, but mixed cropping systems were reported to reduce water requirements by as high as 30% because of higher moisture retention as a result of crops like banana and the use of legumes that enrich the soil (Kumar & Aggarwal, 2013).

Results on pest management were just as encouraging. Mixed cropping on smaller farms reduced pest infestations by up to 40 per cent — beetles, weevils and the like — due to the greater biodiversity of mixed farming that disrupts pest cycles; Pest outbreaks that had previously cost farmers dearly were noted to be less frequent, and a case study showed far healthier crops and increased yields once farmers adopted mixed cropping systems (Samarakoon et al., 2023). Soil fertility also improved, especially with the addition of legumes, which fix nitrogen in the soil naturally. Studies cite nitrogen levels in the soils increased 20%, and that was directly correlated to more productive crops. There was a 15% increase in average coconut yields along with good supplementary income from intercrops like pepper and banana (Jaganathan & Nagaraja, 2016).

Overall, these qualitative and quantitative case studies demonstrate the economic, environmental, and social benefits of mixed cropping systems in Dakshina Kannada. Given the veracity and widespread and unique benefits of mixed cropping, mixed cropping is a sustainable way to increase agricultural livelihoods while simultaneously addressing the limitations of monocropping, namely income instability and resource inefficiency. Farmers tell stories, complemented by rigorous statistical analyses, illustrating the transformative nature of these systems that can provide income year-round and greater resilience to climatic and marketplace change.

4.1 Environmental Impact Assessment

In Dakshina Kannada, coconut-based mixed cropping systems exhibited marked environmental benefits over monocropping. Mixed cropping-based farms showed an impact on soil fertility due to the contributions of nitrogen-fixing legumes to the soilwere and soil nutrients, and nutrient value resulted in reduced dependency on chemical fertilizers. In a study about intercropping systems, it was reported that nitrogen level of the soil was increased by 20% while organic matter content improved considerably using practices like mulching and

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composting (Jaganathan & Nagaraja, 2016). In addition, mixed cropping requires insufficient production at inducing outbreaks that keeps beneficial insects and permits less harmful levels of pest low, which enhances biodiversity and helps to keep it more complex. The water retention capacity was also significantly improved in the banana and ground-cover crops intercropping systems since the combination minimized soil erosion and moisture retention (Kumar & Aggarwal, 2013). Diversified cropping led to a skilled natural pest control (Dissanayaka et al., 2023), which alongside the associated reductions in chemical pesticide application enabled healthier ecosystems and lower levels of groundwater contamination, thus meeting sustainability objectives.

4.2 Cultural and Social Impacts

Mixed cropping systems have not only provided financial rewards but also had an immensely positive impact on rural livelihoods in Dakshina Kannada. With a steady supply of vegetables, fruit and spices for their own consumption and for sale, these systems have improved food security by diversifying the sources of income. As a result, it has lessened seasonal hunger and improved household nutrition (Dukuziyaturemye et al., 2020). Also, the income drawn from mixed cropping has reduced rural-to-urban migration by rendering farming a worthy way of life. Moreover, gender roles have also improved positively with more and more women involved in managing the intercrops (vegetables and spices). The in-depth quantitative analysis suggested that women in mixed cropping households participated in decision making and were important contributors to income (Rukmani et al., 2018). Desirable agricultural knowledge that may include a combination of organic mulches and pepper vine plantation on coconut trees has also supported the pervasiveness of mixed cropping (Jaganathan & Nagaraja, 2016).

4.3 Barriers to Adoption and Solutions

They detail how some of the benefits of mixed cropping are undermined by challenges such as financial constraints, lack of technical knowledge, and insufficient market access. Many farmers are unable to afford initial investments in intercrop saplings or irrigation infrastructure, and others may also lack the skill to maintain diverse cropping systems (Samarakoon et al., 2023). Additionally, poor market linkages continue to add to the problem as farmers are often unable to sell intercrops at profitable prices. Such solutions consist of government schemes that target intercropping inputs with financial subsidies, and training programs for farmers to build capacity. NGOs and cooperatives could play a critical role by facilitating knowledge-sharing, marketing support, and access to credit (Dissanayaka et al., 2023).

4.4 Long-Term Sustainability and Climate Resilience

A crop rotation system is more sustainable than a monocropping system. Enthusiasts argue that such diversity makes local economies less reliant on single crops and more adaptable to price fluctuations. From an ecological perspective, mixed cropping enhances soil health, water-use efficiency and greenhouse gas emissions in drops by reducing chemical inputs. Additionally, systems with diverse crops provide some buffering against climate variability, asmultiple extreme weather events are in less risk of affecting one common cash crop (Dissanayaka et al., 2023)

4.5 Technological Interventions

Dakshina Kannada Mixed Cropping: Innovative Technology To Make A Difference Precision farming tools — from soil sensors to mobile apps — can provide the data farmers need to optimize how much they irrigate and apply fertilizer. New pest management options — such as pheromone traps and biological control agents — can further decrease reliance on chemical pesticides. So have crop-monitoring drones and digital platforms for market linkage that can likewise increase productivity and profitability (Kumar et al., 2013).

4.6 Comparative Analysis with Other Regions

An examination of Kerala and Tamil Nadu compared to Dakshina Kannada in terms of mixed cropping shows variances in success and methods. Farmers in states like Kerala with more mature agroforestry systems and stronger government support, such as for spices like pepper and nutmeg, have higher adoption rates. In Tamil Nadu, water shortage has led to intercropping of drought-effective crops in coconut plantation which improved income stability. Although Dakshina Kannada has done well, considerably more investment in training and market infrastructure needs to be undertaken to replicate Kerala's success (Samarakoon et al., 2023).

4.7 Economic Viability

Non-coconut crops are also essential for improving the farm income in the mixed cropping systems. The access to high value intercrops such as banana, pepper, and cocoa which can be very profitable and provide faster returns than coconuts. To provide alternative sources of income and more efficient use of resources, some farmers have also ventured into economic activities such as aquaculture, poultry farming and other allied activities. Research studies show integrated crop livestock farming systems give best net returns and employment opportunities (Nagaraju & Rao, 2015).

4.8 Policy Recommendations

India's agricultural policies currently fall short in promoting mixed cropping systems, homing in on monoculture cash crops. Policies should encourage intercropping through subsidies for input adapted to mixed cropping, like sprinkling irrigation system, and pest resistant plant varieties. Cooperative banks or microfinance institutions can strengthen farmers' access to credit facilities. Specialized market platforms for intercrops and IT-based price discovery tools can improve the access and profitability of smallholders (Kumar & Aggarwal, 2013).

5. DISCUSSION AND CONCLUSION

Coconut is a primary crop in Dakshina Kannada, and farmers integrate areca nut, banana, pepper, and pineapple as intercrops to diversify their income. Mixed cropping provides a balanced approach to resource use, leveraging different growth cycles and market demands for year-round returns. The integration of high-value crops like areca nut, pepper, and banana with coconut provides multiple revenue streams, reducing reliance on a single crop and stabilizing farm income. Recent data from the Department of Agriculture (2023) shows that farmers in Dakshina Kannada can earn INR 2.5 to 3 lakh per hectare annually from mixed cropping systems, a 30-40% increase over monocrop coconut cultivation. Bananas and pineapples provide quick returns, often harvested within 9-12 months, while coconut and pepper offer long-term financial stability. This staggered harvesting pattern ensures consistent cash flow for farmers. The combination of these crops offers income diversification, as different crops peak at different times, allowing farmers to smooth out seasonal income fluctuations. Mixed cropping systems improve soil health by enhancing organic matter, reducing soil erosion, and improving water retention. This is crucial in coastal areas like Dakshina Kannada, where soil salinity and erosion are common issues. Studies (Sharma et al., 2023) have shown that diverse root systems of intercrops enhance soil structure and prevent nutrient depletion, making the land more resilient to climatic shocks. Diversified crops protect farmers from price volatility in the coconut market. For example, the price of coconut may fluctuate, but stable markets for areca nut, pepper, and bananas provide a buffer against income loss. Climate change impacts, such as erratic rainfall and rising temperatures, are mitigated by the biodiversity of crops, which ensures some crops thrive even when conditions are unfavorable for others. Mixed cropping systems require more labor and management than monoculture, but the availability of diverse crops for harvest and sale creates more employment opportunities within rural communities. Integrated pest management (IPM) practices in mixed cropping reduce the dependency on chemical pesticides, lowering input costs and benefiting both the farmer and the environment. Government policies should focus on providing subsidies for crop diversification, technical assistance, and better access to markets for secondary crops like areca nut, pepper, and banana. The establishment of local farmer cooperatives and the promotion of organic certification could enhance market prices for the crops, improving farm profitability. Despite the benefits, challenges include high initial setup costs, labor management, and the complexity of crop-specific care. Some farmers may lack the knowledge or resources to adopt these integrated farming systems effectively. A lack of formal market linkages for non-coconut crops (like pineapple or pepper) can limit the economic potential of the system.

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