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Identifying Socio-Economic and Agronomic Constraints in Cardamom Cultivation: Evidence from Small scale Farmers in Idukki District

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Abstract
This study examines the socio-economic and agronomic constraints faced by smallholder cardamom farmers in Idukki district, Kerala, which accounts for over 40,000 hectares of cardamom cultivation. Primary data were collected from 120 respondents through structured surveys and field interviews across major cardamom-growing taluks including Udumbanchola, Peermedu, and Devikulam. The research employs a mixed-methods approach combining quantitative analysis of production economics with qualitative assessment of farmer perceptions. Key findings reveal that extreme price volatility (ranging from ₹1,549 to ₹3,116 per kg in 2024), climate-induced crop failures affecting 16,211 hectares during the 2024 summer drought, high input costs (₹2.5 lakh per acre annually), labor shortages with dependency on migrant workers, and water scarcity despite high rainfall (3,600 mm annually) constitute the primary constraints. Fungal disease outbreaks, inadequate extension services, and declining soil fertility further compound these challenges. The study finds that 70% of farmers operate on holdings under 3 acres with annual profits of ₹75,000-150,000, making them highly vulnerable to production shocks. Recommendations include establishing price stabilization mechanisms, developing climate-resilient varieties, improving irrigation infrastructure, strengthening farmer cooperatives, and enhancing extension service delivery to ensure sustainable cardamom cultivation in the region.

Keywords: cardamom cultivation, Idukki district, smallholder farmers, price volatility, climate constraints, water scarcity, production economics, Kerala spices

1. Introduction

Idukki district, known as the "Spice Hub of India," accounts for the largest share of cardamom cultivation in Kerala, with over 40,000 hectares under production. Cardamom, often referred to as the "Queen of Spices," has been cultivated in the Cardamom Hill Reserves and surrounding areas since the 11th century, transforming from a wild forest product to a major cash crop. The Puttady Cardamom Auction Center handles 70,000-100,000 kg daily, making it a crucial commercial hub. Major cultivation areas include Kumily, Vandanmedu, Nedumkandam, Udumbanchola, and Kattappana taluks.

Despite its economic importance, cardamom farmers in Idukki face mounting challenges. The devastating 2024 summer drought destroyed crops across 16,211 hectares, with estimated losses exceeding ₹175 crore. Climate change manifests through temperature extremes reaching 36°C, erratic rainfall patterns, and prolonged dry spells. Concurrently, price volatility creates financial instability, with cardamom prices fluctuating dramatically—from record highs of ₹3,116 per kg to lows of ₹1,549 per kg within the same season. Water scarcity has emerged as a critical issue, with police reporting monthly cases of water theft in traditionally rain-abundant areas.

This study investigates the multidimensional constraints affecting smallholder cardamom farmers in Idukki district through systematic primary data collection and analysis. The research objectives are to: (1) identify and analyze agronomic constraints including disease, pest, and climate factors; (2) examine socio-economic challenges related to markets, inputs, labor, and infrastructure; (3) assess the economic viability of cardamom cultivation; and (4) provide evidence-based recommendations for sustainable production systems.

2. Research Methodology

2.1 Study Area

The study was conducted in Idukki district, Kerala, focusing on three major cardamom-producing taluks: Udumbanchola, Peermedu, and Devikulam.

These areas represent the core of Kerala's cardamom production zone, characterized by elevations of 600-1,500 meters, annual rainfall of 2,500-3,600 mm, and temperatures ranging from 10°C to 32°C. The region's unique agroecological conditions support both traditional and improved cardamom varieties under shade-grown agroforestry systems.

2.2 Sampling Design

A multistage sampling procedure was employed for respondent selection. In the first stage, three taluks were purposively selected based on cardamom cultivation intensity. In the second stage, five villages from each taluk were randomly selected. In the third stage, systematic random sampling was used to select 120 cardamom farmers (90 from conventional farming and 30 from organic farming systems) proportionate to the farmer population in each village.

2.3 Data Collection

Primary Data: Structured questionnaires were administered through personal interviews during August-October 2024. The questionnaire covered socio-demographic characteristics, land holding patterns, cultivation practices, input usage, yield data, cost of production, marketing channels, constraints faced, and farmer perceptions. Field visits to 25 cardamom plantations were conducted for direct observation of cultivation practices and constraint validation.
Secondary Data: Supporting information was obtained from Spices Board of India statistics, Department of Agriculture records, Cardamom Auction Center data, research publications, and meteorological department climate records.

2.4 Variables Measured

Dependent Variables: Yield (kg per acre), production cost (₹ per acre), gross income (₹ per acre), net profit (₹ per acre)
Independent Variables: Farm size, plant density, variety cultivated, fertilizer application, irrigation status, pest/disease incidence, labor availability, market distance, years of experience
Constraint Variables: Agronomic constraints (disease, pest, climate, water, soil), socio-economic constraints (price, labor, inputs, credit, extension, infrastructure)

2.5 Analytical Methods

Descriptive Statistics: Frequency distributions, percentages, means, and standard deviations were calculated for socio-economic characteristics and constraint identification.
Correlation Analysis: Pearson correlation coefficients were computed to examine relationships between cost, yield, and profit variables.
Constraint Analysis: Garrett's ranking technique was used to prioritize constraints based on farmer perceptions, with ranks converted to percent scores for comparative analysis.
Economic Analysis: Production costs and returns were analyzed using cost concepts (fixed costs, variable costs, gross income, net income, benefit-cost ratio).

2.6 Limitations

The study limitations include:
(1) Cross-sectional design limiting causal inferences
(2) Recall bias in farmer-reported data, particularly regarding costs and yields
(3) Seasonal variation not captured due to single-period data collection
(4) Potential response bias given the 2024 drought context and
(5) Geographic limitation to three taluks, limiting generalizability across all Idukki cardamom areas.

3. Results and Discussion

3.1 Socio-Economic Profile of Respondents

The majority of respondents (62%) belonged to the below-40 age group, indicating relatively younger farmer demographics compared to aging agricultural populations elsewhere. Education levels showed that 58% had secondary education, 23% primary education, and 19% higher secondary or above. All respondents (100%) identified agriculture as their primary income source, highlighting complete dependence on farming livelihoods. Land holding patterns revealed that 68% cultivated cardamom on less than 3 acres, 24% on 3-5 acres, and only 8% on holdings exceeding 5 acres, confirming the dominance of smallholder production systems. All farmers held patta land titles, providing tenure security.
Plant density varied considerably: 45% maintained 250-500 plants, 32% had 500-750 plants, and 23% cultivated over 750 plants per holding. Annual dried

cardamom yield ranged from 3,000-6,000 kg for 54% of farmers, 1,500-3,000 kg for 28%, and over 6,000 kg for 18%. Production costs concentrated in the ₹2-4 lakh range annually for 61% of farmers, while annual net profits ranged from ₹75,000-150,000 for 52% of respondents, ₹150,000-300,000 for 23%, and below ₹75,000 for 25%, indicating significant income variability.

3.2 Agronomic Constraints

3.2.1 Climate Change and Weather Extremes

The 2024 summer drought emerged as the most devastating climate event in recent history. Kattappana experienced 140 consecutive rainless days from January to May, with temperatures exceeding 36°C—far above the optimal 22-25°C range. Survey data revealed that 87% of farmers experienced severe crop damage, with 16,211 hectares completely destroyed and an additional 13,349 hectares suffering extensive damage. Individual farmers reported losses exceeding 2,000 plants across 4-acre holdings, representing 2-3 years of investment completely lost.

Water scarcity has become acute despite annual rainfall averaging 3,600 mm. Intensive groundwater extraction for irrigation, combined with altered precipitation patterns concentrating rainfall into shorter periods, has created unprecedented water stress. Police records documented monthly water theft cases in Nedumkandam during 2024, reflecting desperation among farmers. Survey findings showed 73% of farmers now require irrigation during traditionally rain-fed periods, but only 14% have access to adequate irrigation infrastructure. The shift from traditional low-input systems to water-intensive cultivation of high-yielding varieties like Njallani has exacerbated demand beyond natural recharge capacity.

3.2.2 Disease and Pest Pressure

Fungal disease outbreaks, particularly during monsoon periods following the drought, affected 68% of surveyed farms. Heavy rains and strong winds in June-August 2024 created conditions conducive to fungal proliferation, causing extensive plant damage. Farmers reported difficulties in disease identification (71% could not correctly diagnose diseases) and management (79% lacked access to appropriate control measures). The intensive monoculture of Njallani variety, which has displaced traditional varieties like Mysore Vazhukka, Kanipparamban, and Elam Rani, has reduced genetic diversity and increased disease vulnerability.

Pest management challenges were cited by 64% of respondents, with thrips, shoot borers, and root grubs causing significant damage. The labor-intensive nature of pest monitoring and the concealed nature of many pests make effective control difficult. Chemical control costs average ₹8,000-12,000 per acre annually, representing substantial expense for smallholders already operating on tight margins.

3.2.3 Soil Health Degradation

Continuous cardamom cultivation under chemical-intensive management has led to declining soil fertility. Field observations and farmer testimonials revealed that 76% of respondents noted reduced plant vigor compared to earlier years, attributing this to soil exhaustion. Only 18% conducted soil testing, while the majority applied fertilizers based on tradition rather than soil requirements. Excessive chemical usage in pursuit of higher yields from Njallani variety has created cycles of dependency, with farmers requiring increasing inputs to maintain yields. Organic matter depletion, nutrient imbalances, and soil compaction were commonly observed issues.

3.3 Socio-Economic Constraints

3.3.1 Extreme Price Volatility

Price instability ranked as the foremost socio-economic constraint, affecting 92% of respondents critically. Puttady Auction Center data from August 2024 showed prices ranging from ₹1,549 to ₹3,116 per kg within a single day's trading, representing over 100% variation. While record high prices might appear beneficial, they failed to compensate farmers adequately given the 70% production loss from drought damage. Farmers emphasized that profitability requires stable prices averaging ₹1,500 per kg, but unpredictability makes financial planning impossible.

Historical price fluctuations create cycles of boom and bust. Farmers recalled periods when investments in plantation expansion were followed by price crashes, resulting in debt traps. The current high prices reflect supply shortages rather than improved market conditions, and farmers anticipate

price crashes once production recovers. Intermediaries and brokers extracting substantial margins (estimated 30-40% of final retail price) further reduce farmer returns. Survey data showed that 89% of farmers lack bargaining power, selling to local traders who dictate prices rather than accessing auction centers directly.

3.3.2 High Input Costs and Production Economics

Production costs have escalated sharply, with farmers reporting annual expenses of ₹2-4 lakh per acre. Labor costs constitute the largest component (45-55% of total costs), followed by fertilizers (20-25%), plant protection (10-15%), and other inputs. North Indian migrant workers form the backbone of the labor force, with approximately 20,000 workers from Tamil Nadu employed in Idukki's cardamom sector. Labor wages now exceed ₹600-800 per day, compared to ₹300-400 five years ago. Weekend and peak season premiums add 30-50% to wage bills.
Planting material costs have surged from ₹60-80 per plant to ₹120-175 following the drought, as nurseries charge premium prices for scarce healthy seedlings. Establishing new plantations now requires ₹2.5 lakh per acre, with no returns for 2-3 years until plants mature. Fertilizer prices have increased 35-40% over three years. Correlation analysis revealed a significant positive relationship between costs and yields ($r = 0.73$, $p < 0.01$), indicating that higher investment produces greater output. However, negative correlation between costs and profits ($r = -0.42$, $p < 0.01$) demonstrates diminishing returns and margin compression.

3.3.3 Labour Shortage

Labour availability emerged as a critical bottleneck, with 81% of respondents citing inadequate labour during peak periods. Cardamom cultivation is highly labor-intensive, requiring year-round attention for weeding, shade management, and multiple harvest rounds. The harvesting window spans 6-8 months, demanding continuous labor inputs. Local youth migration to urban areas for better opportunities has created dependency on migrant workers. However, competition from other crops and sectors has tightened labor markets. The 2024 survey found farmers offering 30-50% wage premiums to secure workers for urgent replanting operations, with some unable to find workers at any price.

3.3.4 Extension Service Deficiencies

Agricultural extension coverage remains grossly inadequate. Only 16% of respondents reported regular contact with extension personnel, with average extension interactions occurring 1-2 times annually versus recommended monthly visits. Extension staff ratios of 1:800-1,000 farmers prevent effective service delivery. The knowledge gap is substantial: 71% of farmers could not identify major diseases, 83% lacked information about integrated pest management, 69% were unaware of soil testing procedures, and 88% had never received training on climate adaptation strategies. The Spices Board research station at Myladampara provides technical backstopping, but outreach to dispersed smallholder farms remains limited.

3.3.5 Marketing and Infrastructure Constraints

Marketing challenges affect 78% of respondents. Geographic isolation increases transportation costs, while inadequate post-harvest infrastructure causes quality deterioration. Traditional sun-drying methods, used by 91% of farmers, remain vulnerable to unseasonal rains. Only 9% have access to mechanical dryers, despite their advantages for quality consistency. Storage facilities are rudimentary, with 86% storing cardamom in basic conditions leading to 8-12% post-harvest losses from moisture absorption, pest damage, and quality degradation.
Market information asymmetry disadvantages farmers. Most depend on local traders for price discovery, lacking access to real-time auction data or quality grading knowledge. Only 12% belong to farmer cooperatives that could facilitate collective marketing and bargaining power. The Cardamom Planters' Association and cooperative societies provide some support, but membership and benefits reach only a fraction of smallholders.

3.3.6 Credit Access and Financial Vulnerability

Financial constraints limit adaptive capacity. While 67% accessed formal credit from banks or cooperatives, loan amounts often prove insufficient for comprehensive farm improvements. Interest rates of 9-12% for agricultural loans, combined with uncertain returns, create debt risks. The remaining 33% rely on informal sources at 24-36% annual interest, perpetuating debt cycles. Crop insurance

penetration remains below 8%, leaving farmers fully exposed to production risks. The 2024 drought demonstrated this vulnerability, with uninsured farmers facing total losses without compensation until government relief provisions.

3.4 Constraint Ranking

Garrett's ranking technique applied to farmer perceptions yielded the following constraint hierarchy:
Rank 1: Price volatility and market instability (Garrett score: 76.4)
Rank 2: Climate extremes and weather variability (Garrett score: 68.2)
Rank 3: Labor shortage and high wage costs (Garrett score: 61.7)
Rank 4: Water scarcity and irrigation inadequacy (Garrett score: 58.3)
Rank 5: Disease and pest management challenges (Garrett score: 54.9)
Rank 6: High input costs (Garrett score: 49.1)
Rank 7: Inadequate extension services (Garrett score: 43.6)
Rank 8: Poor post-harvest infrastructure (Garrett score: 38.2)
Rank 9: Limited credit access (Garrett score: 32.8)
Rank 10: Soil fertility decline (Garrett score: 28.5)
This ranking reveals that market and climate factors overshadow technical production constraints in farmer perceptions, though all factors interact to constrain overall system performance.

4. Recommendations

Immediate Measures (0-1 year):

1. Establish minimum support price mechanisms linked to production costs to stabilize incomes
2. Provide emergency drought relief including replanting subsidies for affected farmers
3. Organize farmer field schools for hands-on training in disease identification and integrated pest management
4. Deploy SMS-based weather advisories and market price information systems
5. Facilitate formation of farmer producer organizations for collective marketing

Short-term Interventions (1-3 years):

1. Develop and disseminate climate-resilient cardamom varieties through research-extension-farmer linkages
2. Establish community-level processing and drying centers with subsidized access (one center per 200-300 farmers)
3. Implement micro-irrigation infrastructure in water-stressed areas with 75% subsidy
4. Create cardamom crop insurance schemes with premium subsidies to manage production risks
5. Strengthen extension services by recruiting additional staff and deploying ICT-based advisory platforms
6. Promote soil health through subsidized organic amendments and mandatory soil testing programs

Medium-term Strategies (3-5 years):

1. Build strategic cardamom buffer stocks for price stabilization during surplus periods
2. Develop value addition clusters for processing, packaging, and branding to increase farmer share of retail value
3. Establish rural business hubs connecting farmers directly to end-buyers and export markets
4. Create watershed management programs integrating water conservation with cardamom sustainability
5. Introduce mechanization for labor-intensive operations to address labor shortages
6. Strengthen cooperative infrastructure for collective procurement, processing, and marketing
7. Implement precision agriculture technologies (soil sensors, weather stations, mobile apps) for optimal resource management

5. Conclusion

This study provides comprehensive empirical evidence of the multifaceted constraints confronting smallholder cardamom farmers in Idukki district. The confluence of extreme price volatility, climate-induced production shocks, escalating input costs, labor scarcity, and institutional deficiencies creates a precarious situation threatening the sustainability

of cardamom cultivation systems. The 2024 summer drought, destroying 16,211 hectares and causing ₹175 crore losses, exemplifies the vulnerability of production systems to climate extremes. Meanwhile, price fluctuations exceeding 100% within single trading sessions create financial instability that undermines investment in sustainable practices.

Economic analysis reveals that while cardamom cultivation remains profitable for most farmers (net returns ₹75,000-150,000 annually), small land holdings (68% under 3 acres) and high production risks make livelihoods precarious. The positive correlation between costs and yields (r=0.73) indicates that productivity improvement requires investment, yet the negative correlation between costs and profits (r=-0.42) demonstrates that margin compression threatens viability. This paradox necessitates interventions that simultaneously enhance productivity while controlling costs through improved input efficiency and reduced losses.

The study identifies clear priorities for intervention: price stabilization mechanisms, climate adaptation support, irrigation infrastructure development, labor management strategies, extension service strengthening, and farmer institutional capacity building. However, the interconnected nature of constraints demands integrated approaches rather than siloed interventions. Success requires coordinated action by government agencies, research institutions, extension services, farmer organizations, and private sector actors.

Despite formidable challenges, cardamom cultivation retains significant potential for smallholder prosperity in Idukki district. Its high value, strong market demand, compatibility with agroforestry biodiversity conservation, and historical importance to regional economy make it worthy of sustained support. With appropriate policy interventions, technological innovations, institutional strengthening, and farmer empowerment, the cardamom sector can achieve resilient and profitable production systems supporting thousands of farming families in Kerala's high ranges.

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