



# Economic Potential and Production Constraints of Large Cardamom (*Amomum subulatum* Roxb.) Cultivation in Lower Subansiri District, Arunachal Pradesh

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## Abstract

**Background:** Large cardamom (*Amomum subulatum* Roxb.) has become an increasingly profitable alternative to traditional paddy cultivation in the Lower Subansiri district of Arunachal Pradesh, significantly influencing rural livelihoods. Farmers are shifting from low-yield subsistence farming toward high-value spice cultivation, driven by better market prospects and income potential. **Methods:** This study examined the economic viability, profitability, and challenges of large cardamom farming through a field survey of 100 purposively selected farmers across Yazali, Yachuli, and Param Putu circles. Data were analyzed using descriptive statistics, Analysis of Variance (ANOVA), and multiple linear regression modeling to identify key factors affecting profitability. **Results:** Over 80% of respondents reported replacing paddy cultivation with cardamom, resulting in notable improvements in household income, living standards, and employment generation. Among the three circles, Param Putu exhibited the highest productivity and profitability levels, while Yazali and Yachuli performed moderately. Regression analysis revealed that yield per bigha, market

access, price received, and credit availability significantly enhanced profitability, whereas higher input and labour costs had adverse effects. **Conclusion:** Large cardamom cultivation has proven to be economically rewarding and socially transformative in Lower Subansiri. However, recurring challenges such as pest infestations, post-harvest losses, limited technical knowledge, financial constraints, and poor infrastructure impede sustained growth. The study emphasizes the need for region-specific policy support, capacity-building programs, and improved market linkages to strengthen the long-term sustainability of cardamom farming and ensure inclusive rural economic development in Arunachal Pradesh.

**Keywords:** Large Cardamom Cultivation, Production, Living Standards, Lower Subansiri, Arunachal Pradesh

## 1. Introduction

Large cardamom (*Amomum subulatum* Roxb.), indigenous to the eastern Himalayan region, is a high-value spice crop cultivated primarily in Nepal, India, and Bhutan. Among the cardamom species grown in this region, large cardamom is distinctive for its size and dark brown to black coloration. The term “cardamom” derives from the Latin word *Cardamomum*, and the plant has a documented history of use dating back to ancient civilizations. Historical texts suggest its application in Ayurvedic medicine as early as the 6th century BC (Sharma, Sharma, & Sharma, 2009), with Greek and Roman references to *Amomum subulatum* also recorded by Theophrastus in the 4th century BC (Radhakrishna & Mohanan, 2005; Pradhan et al., 2014). In India, cardamom has long been

**Significance** | This study highlights large cardamom farming as a profitable, livelihood-transforming alternative to paddy, driving rural income growth in Arunachal Pradesh.

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Editor Abu Hena Mustafa Kamal, Ph.D., And accepted by the Editorial Board 13 October 2025 (received for review 19 August 2025)

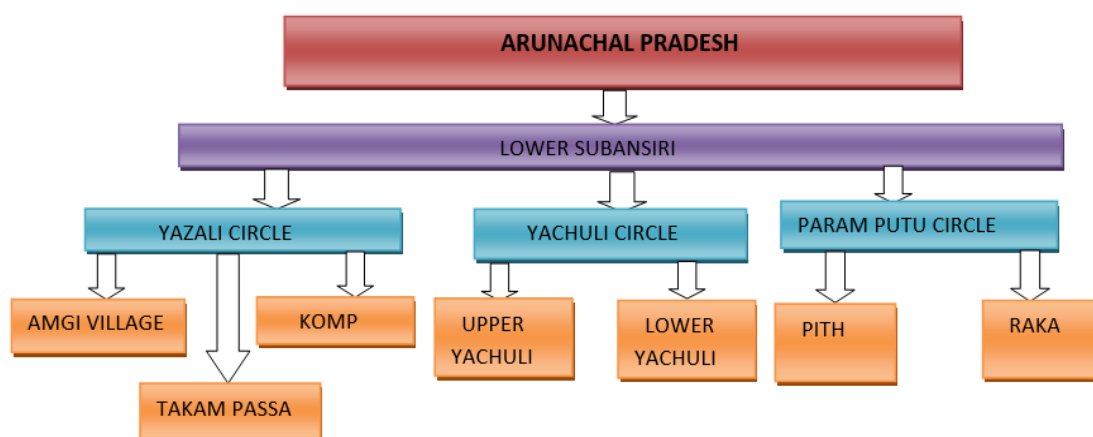
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## Please cite this article.

Upadhyay, V., Devi, &, Yazar, &. (2025). "Economic Potential and Production Constraints of Large Cardamom (*Amomum subulatum* Roxb.) Cultivation in Lower Subansiri District, Arunachal Pradesh", *Applied Agriculture Sciences*, 3(1), 1-15, 10363

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**Figure 1.** Sampling Framework

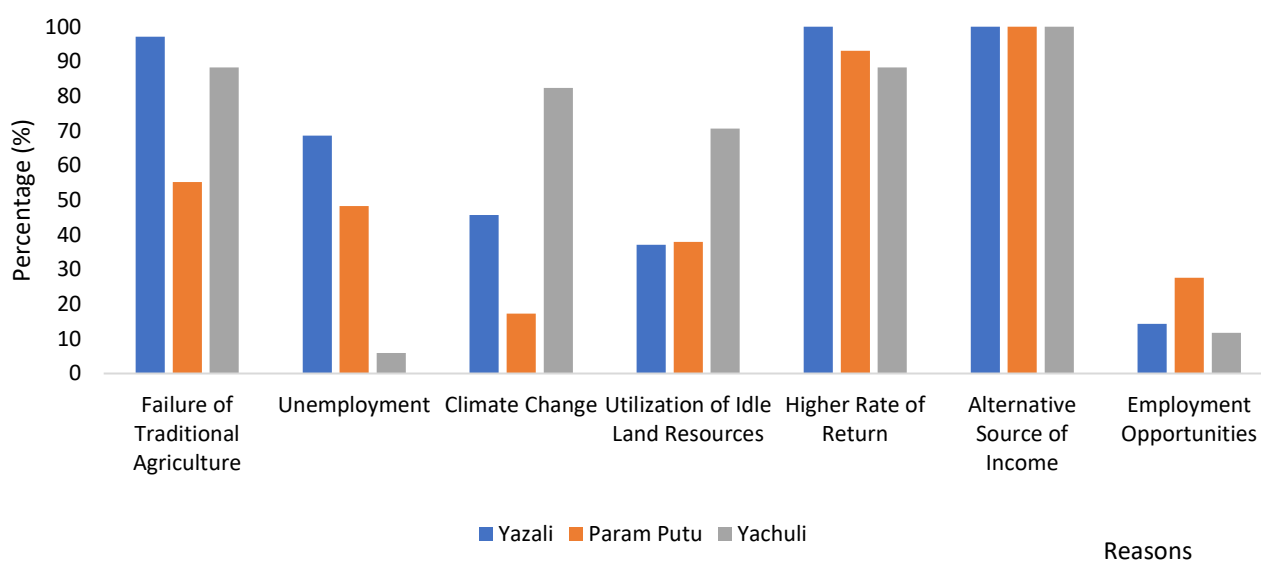
valued for its flavour enhancing properties, essential oils, and medicinal applications. Known by various local names, Ela in Sanskrit, Barlang in Bhutan, Bada Elaichi in Hindi, Alachi in Nepali, and Telw Pebw in the Nyishi language—it holds both cultural and economic significance. Belonging to the Zingiberaceae (ginger) family, cardamom is cultivated primarily for its aromatic seed capsules. Historically, the Lepcha community of Sikkim harvested cardamom from forest ecosystems for both medicinal and culinary use (Ajmera et al., 2018), and this knowledge spread gradually to regions such as West Bengal, Bhutan, and eastern Nepal.

Cardamom cultivation in the Indian context is generally classified into two categories: (a) Small cardamom (*Elettaria cardamomum*), commonly known as “green” or “true” cardamom, and (b) Large cardamom (*Amomum subulatum*), often called “Indian,” “Nepal,” or “false” cardamom. Large cardamom, a shade-loving crop, thrives in the cool, moist climates of the Himalayan foothills and is widely grown across Sikkim, Nagaland, and the eastern districts of Arunachal Pradesh. Large cardamom cultivation in Arunachal Pradesh is highly sensitive to climatic fluctuations, soil moisture imbalance, and pest infestations that threaten productivity and long-term sustainability, reflecting broader challenges of drought stress and adaptive agronomic management in perennial crops (Abdullah & Parvin, 2024), Shoukat & Tufail, 2025).

India is a major producer of cardamom, with large-scale cultivation in states such as Karnataka, Kerala, Tamil Nadu, and increasingly in Northeastern states. Among these, Sikkim is the largest producer of large cardamom in India, contributing approximately 80 per cent of the country’s production and over 50 per cent of the global output. Inspired by Sikkim’s success, many farmers in Arunachal Pradesh have transitioned from traditional subsistence crops, such as jhum rice, pulses, and tubers to commercial cardamom cultivation. As a result, Arunachal Pradesh is emerging as a major cardamom-producing region, particularly in districts such as Lower Subansiri, Tirap, Changlang, Lohit, and Anjaw.

The expansion of cardamom cultivation in Lower Subansiri is economically significant, marking a transition away from low-productivity paddy and shifting cultivation (jhum). The decline in traditional farming practices can be attributed to soil degradation, insufficient infrastructure, labour intensity, and volatile yields. In contrast, large cardamom has emerged as a more profitable alternative, offering higher returns, less labour input, and integration with market channels. Over 80 per cent of sampled farmers in the region have shifted from paddy farming to cardamom cultivation, reporting enhanced income and improved household living standards. Despite these gains, critical challenges remain: pest and disease outbreaks, price fluctuations, limited irrigation support, and lack of access to quality planting material. These issues not only threaten the sustainability of cardamom cultivation but also expose farmers to income risks and long-term livelihood vulnerability.

Various reports have revealed that Arunachal Pradesh is on its way to becoming the largest cardamom producer in the country, with Anjaw, Lower Subansiri, Tirap, Changlang, and Lohit as the leading districts in cardamom production across the state (Arunachal Times, 2019). In Lower Subansiri district, agriculture is the main source of livelihood, including activities like logging, kiwi and cardamom cultivation, fish farming, and vegetable gardening. Shifting paddy farming, characterised by low productivity, labour intensity, and income instability, is declining due to poor soil fertility, traditional methods of cultivation, and inadequate infrastructure. Traditionally reliant on shifting and terrace paddy farming, farmers have increasingly shifted to large-scale cardamom production in recent decades due to its higher profit potential compared to less profitable jhum cultivation. This transition has improved farmers’ income and living standards, with many now dependent on cardamom cultivation for their livelihoods (Ali & Shivalingaiah, 2022). However, farmers face challenges in accessing quality planting material, managing irrigation during dry spells and



Source: Field Survey, 2024

Figure 2. Reasons for Shift from Jhum Cultivation to Cardamom Cultivation (in %)

heavy rainfall, transplanting seedlings, and other management techniques. Given this context, this study aims to explore the economics of large cardamom cultivation in the Lower Subansiri district of Arunachal Pradesh. The focus is on understanding the growing popularity of large cardamom production and its socio-economic impact, pattern of cost and return of large cardamom and factors and challenges associated with large cardamom production in the Lower Subansiri district of Arunachal Pradesh. Through this analysis, the study seeks to provide insights and recommendations for enhancing the profitability and sustainability of large cardamom farming in the region.

## 2. Materials and Methods

### 2.1 Study Area

The study has been carried out in the Lower Subansiri district of Arunachal Pradesh as it is one of the leading districts of the state in the production of large cardamom. Three circles namely Yazali, Yachuli and Param putu circle were chosen for the study because they represent the primary cardamom-growing area within the district, where farmers have actively expanded the land dedicated to large cardamom cultivation. From each circles some major villages have been chosen for the study, where the production of large cardamom is more prominent (see figure.1).

### 2.2 Sample and Sampling Technique

The study is empirical one, which follows descriptive technique. The analysis is based on both qualitative and quantitative analysis. Both primary and secondary sources have been used for collecting data. Primary data is the main source of this research. Multistage sampling is followed to collect primary data. Secondary source data are collected from both published and unpublished work as well as secondary information from official records. Field survey has been

carried out in three circles viz., Yazali and Yachuli, Param Putu where the production of cardamom is more popular. The survey has been conducted by using structured schedule, interviews and by participant observation.

A total of 100 large cardamom producers were selected using purposive sampling, guided by the researcher's expertise and familiarity with the local context (see Figure 1 and Table 2). This non-probability sampling approach was chosen to specifically target knowledgeable producers actively engaged in large cardamom farming, ensuring the collection of relevant and detailed information. We acknowledge that purposive sampling does not yield statistically representative samples, limiting the generalizability of results to the entire district population. The absence of stratification or probabilistic sampling is a recognized limitation, which constrains the ability to extrapolate findings broadly across the district. To mitigate concerns regarding data validity and reliability, multiple data collection methods were triangulated: quantitative data from structured schedules were supplemented with qualitative insights obtained through interviews and participant observations.

### 2.3 Data Analysis

The data gathered from the field survey was coded and organized using the Statistical Package for Social Science (SPSS) and Microsoft Excel. Analysis was conducted using both SPSS and Excel. Descriptive statistics, including frequencies and percentages, were computed. Productivity per unit of land, Labour Capital, Land as well as total cost, Average Cost, total revenue and profit has been calculated using following formula.

$$\text{Productivity per unit of land (in KG)} = \frac{\text{Total Production (in KG)}}{\text{Area of Land (in Bigha)}}$$

Productivity of Labour (in KG) =  $\frac{\text{Total Output (in KG)}}{\text{Number of Labours}}$

Productivity per 100 Rupees of Capital (in KG) =  $\frac{\text{Total Output (in KG)}}{\text{Total Capital Input (in Rs.)}} \times 100$

Total Cost (TC) = Total Fixed Cost (TFC) + Total Variable Cost (TVC)

Average Cost (AC) =  $\frac{TC}{Q}$  (Where, TC is the Total Cost, Q is the quantity of output produced)

Total Revenue (TR) = P × Q (Where, P is the price per unit of the good or service, Q is the quantity of the good or service sold.

Profit = Total Revenue (TR) - Total Cost (TC).

Also, Analysis of Variance (ANOVA) was employed to assess significant differences across circles in various aspects of cardamom production, including profit per household, and productivity of land, labour, and capital.

Further, this study employs a multiple linear regression model to analyze the key farm-level determinants affecting per unit profit in cardamom cultivation (PUP) of the  $i^{\text{th}}$  household. The model aims to quantify the relationship between per unit profit and various explanatory variables such as yield, input costs, labour expenses, post-harvest losses, market access, price received, and extension support. Formally, the regression model is specified as follows:

$$PUP_i = \alpha + \beta_1 LY_i + \beta_2 COI_i + \beta_3 COL_i + \beta_4 PHL_i + \beta_5 MA_i + \beta_6 PRC_i + \beta_7 CA_i + \beta_8 ES_i + \epsilon_i$$

The selection of explanatory variables in the regression model is guided by economic theory, previous empirical studies, and the specific context of cardamom cultivation. Each variable included in the model is hypothesized to influence per unit profit either directly or indirectly through its impact on productivity, cost structure, or market efficiency. The justification for the inclusion of each explanatory variable, along with its expected relationship with per unit profit is as follows:

Yield per Bigha of Land (LY) is a determinant of per unit profit in cardamom cultivation. As the amount of cardamom produced per acre increases, farmers can generate higher revenue, which tends to improve profitability. Yield reflects the efficiency of farm management practices, soil quality, and climatic conditions. Therefore, it is expected that higher yields positively influence per unit profit, assuming input costs and other factors remain constant (Binswanger, 1978; Ali & Flinn, 1989).

Input cost (COI) encompasses expenses on fertilizers, pesticides, seeds, and other materials necessary for cardamom cultivation. While investment in inputs is essential to enhance productivity, excessive or inefficient use can escalate costs disproportionately, thereby reducing net profit. Hence, it is hypothesized that higher input costs negatively affect per unit profit unless they lead to significant yield improvements (Rahman, 2003; Shetty, 2004).

Labour cost (COL) represents the monetary value of labor engaged in planting, maintenance, harvesting, and post-harvest activities. Since cardamom cultivation is labor-intensive, labor expenses constitute a substantial part of total costs. If labor costs rise without corresponding increases in output or quality, they tend to reduce profitability, indicating a negative relationship with per unit profit. (Thomas & Satheesha, 2021; Bhattarai & Narayanamoorthy, 2003) Post-harvest loss (PHL) refers to the percentage of produce lost due to improper harvesting, handling, drying, storage, or transportation. Such losses reduce the quantity of marketable cardamom, directly impacting the revenue and profit per unit. Minimizing post-harvest losses is thus vital for improving profitability, and this variable is expected to have a significant negative effect on per unit profit. (Kader, 2005; Kitinoja & Alhassan, 2012) Market access (MA) is captured through a dummy variable indicating whether farmers sell their produce directly to buyers or rely on intermediaries. Direct market (represent with 1) access often enables farmers to obtain better prices by avoiding middlemen (represent 0), who typically reduce margins. Consequently, farmers with direct market access are expected to experience higher per unit profits compared to those who depend on middlemen. (Barrett, 2008; Magesa et al., 2014).

Price per kilogram (PRC) is the selling price received by farmers for their cardamom produce. As a direct determinant of revenue, higher prices contribute positively to per unit profit. Price fluctuations can depend on factors such as quality, market demand, and seasonal variation. Including this variable helps isolate the effect of market conditions on farm profitability. (von Braun & Kennedy, 1994; Timmer, 1987).

Credit availability (CA) is included as a key explanatory variable to capture the role of financial access in influencing farm-level profitability. This variable is typically coded as a binary indicator, where 1 denotes that the farmer had access to institutional or non-institutional credit during the cropping season, and 0 indicates otherwise. Access to credit enables farmers to invest in timely and quality inputs such as fertilizers, planting material, and hired labor, which can improve productivity and reduce yield gaps (Zeller et al., 1997; Feder et al., 1990). Moreover, it provides liquidity to manage risks and meet short-term operational needs without distress sales. Extension support (ES) is a binary variable representing whether farmers have received technical guidance, training, or other assistance from agricultural extension services (represented with 1). Extension support aims to improve farm practices, pest and disease management, and post-harvest handling, which can enhance yields and reduce losses. Therefore, farmers who receive extension services are hypothesized to have higher per unit profits than those without such support. (Anderson & Feder, 2007)

**Table 1.** Production of Large Cardamom in Indian States ('000 Tonnes)

Sl. No.	State	2011–12 Production	Share (%)	2021–22*	Share (%)
1	Kerala	7.80	49.32	15.54	58.64
2	Sikkim	3.51	22.19	5.24	19.77
3	Nagaland	1.50	9.48	2.23	8.42
4	Arunachal Pradesh (Lower Subansiri, Tirap, Changlang, Lohit, and Anjaw)	0.00	0.00	1.36	5.13
5	Karnataka	1.90	12.01	0.92	3.47
6	West Bengal	0.70	4.43	0.82	3.09
7	Tamil Nadu	0.40	2.53	0.35	1.32
8	Uttarakhand	0.00	0.00	0.05	0.19
9	<b>Total</b>	<b>15.81</b>	–	<b>26.51</b>	–

Source: National Horticulture Board (NHB), 2021–22 (1st Advance Estimate).

**Table 2.** Distribution of Sample Farmers Across Circles and Villages

Circle / Villages	Number of Farmers	Percentage (%)
<b>Yachuli</b>	20	20.0
Lower Yachuli	11	11.0
Upper Yachuli	9	9.0
<b>Yazali</b>	45	45.0
Komp	11	11.0
Takam Pasa	14	14.0
Amgi	20	20.0
<b>Param Putu</b>	35	35.0
Pith	19	19.0
Raka	16	16.0
<b>Total</b>	<b>100</b>	<b>100.0</b>

Source: Field Study, 2024.

**Table 3.** Extent of Shift from Jhum Cultivation to Cardamom Cultivation

Circles	Households Shifted (No.)	Households Shifted (%)	Total Households (No.)	Total (%)
Yachuli	17	85.0	20	100.0
Yazali	35	77.78	45	100.0
Param Putu	29	82.86	35	100.0
<b>Total</b>	<b>81</b>	<b>81.0</b>	<b>100</b>	<b>100.0</b>

Source: Field Survey, 2024.

Note: Figures in parentheses represent percentages.

### 3 Results and Discussion

#### 3.1 Growing Popularity of Large Cardamom Production in Lower Subansiri District

In Arunachal Pradesh, the area under large cardamom cultivation has expanded significantly, increasing from 6,308 hectares in 2018-19 to 11,684 hectares in 2021-22 (Spices Board Statistics, 2022). Correspondingly, production rose from 1,545 tons to 1,695 tons during the same period, indicating growing farmer interest in this cash crop. Such expansion aligns with broader trends observed in Northeastern India, where cash crop cultivation is increasingly replacing traditional subsistence farming, driven by both economic and environmental factors (Govindasamy et al., 2023).

Table 3 documents the shift in agricultural practices across three circles in Arunachal Pradesh. In Yachuli Circle, 85 per cent of farmers have transitioned from Jhum cultivation to cardamom production. Similarly, Yazali Circle shows a 76.78 per cent shift, and

Param Putu Circle reports 82.86% adoption of cardamom farming. This movement away from Jhum a slash-and-burn practice often criticized for environmental degradation and low productivity reflects a regional agricultural transformation characterized by diversification towards more sustainable and profitable crops (Arunachalam, 2021).

This pattern mirrors findings from other hill farming regions where farmers increasingly adopt cash crops like cardamom to improve livelihoods and mitigate the adverse effects of shifting cultivation (Singh, 2019). The shift can also be interpreted within the framework of agricultural modernization and market integration theories, which emphasize transitions from subsistence to commercial farming driven by changing market demands, policy incentives, and environmental imperatives (Pingali, 2015).

Table 1 below shows the production of large cardamom across Indian states, highlighting Arunachal Pradesh’s significant growth

**Table 4.** Socio-Economic Impact of Large Cardamom Production

Sl. No.	Statements	Rating and Number of Responses	Total Score	Rank
		1	2	3
1	Large cardamom cultivation has brought about improvement in our standard of living.	3	0	19
2	Large cardamom cultivation has increased our income.	0	3	15
3	Large cardamom cultivation has changed demographic features in the block.	0	3	39
4	Large cardamom cultivation has created employment in the block.	1	7	37
5	Large cardamom cultivation has helped us to acquire consumer durables.	1	7	58
6	Large cardamom cultivation has induced cultural changes in the block.	4	11	49
<b>Total</b>		<b>9</b>	<b>31</b>	<b>217</b>

**Note:** Rating 1 reflects complete disagreement, whereas Rating 5 reflects complete agreement with the statement.

**Source:** Calculated from data collected during Field Survey, 2024.

**Table 5.** Productivity of Labour and Capital in Cardamom Production

Circle	Productivity (per unit of land)	Productivity of Labour	Productivity of Capital (per ₹100 of capital use)
Yazali	38.63	18.00	137.06
Param Putu	54.15	21.97	156.56
Yachuli	53.04	9.48	61.45
<b>Total</b>	<b>47.70</b>	<b>18.02</b>	<b>371.02</b>
<b>ANOVA</b>	<b>6.19 (p &lt; 0.05)</b>	<b>8.55 (p &lt; 0.05)</b>	<b>9.24 (p &lt; 0.05)</b>

**Note:** Capital refers to the initial investment.

**Source:** Calculated from Field Survey, 2024.

**Table 6.** Cost of Cardamom Production in Lower Subansiri District

Circle	Production (kg)	Total Cost (₹)	Average Cost (₹/kg)
Yazali	13,249 (33.06)	435,000 (40.28)	32.83
Param Putu	22,366 (55.82)	500,000 (46.30)	22.36
Yachuli	4,455 (11.12)	145,000 (13.43)	32.55
<b>Total</b>	<b>40,070 (100.0)</b>	<b>1,080,000 (100.0)</b>	<b>26.95</b>
<b>ANOVA</b>	–	–	<b>6.10 (p &lt; 0.05)</b>

**Note:** Figures in parentheses represent the percentage of the column total.

**Source:** Calculation based on Field Survey, 2024.

trajectory, with Lower Subansiri becoming one of the most productive districts.

Figure 2 illustrates the reasons behind the shift from Jhum cultivation to cardamom cultivation, presented as percentages. In Yazali, the most significant reasons are higher rates of return and an alternative source of income (both at 100 per cent), followed by the failure of traditional agriculture (97.14 per cent). Param Patu also highlights the importance of higher returns and alternative income (both at 100 per cent), with notable percentages for the failure of traditional agriculture (55.17 per cent) and unemployment (48.27 per cent). Yachuli shows a strong influence of climate change (82.35 per cent) and the utilization of idle land resources (70.58 per cent), alongside high rates of return and alternative source of income (both at 88.23 per cent).

### 3.1.1 Socio-economic Impact of Large Cardamom

Cardamom cultivation has brought substantial socio-economic benefits to the study area, aligning with similar agricultural

transitions observed in other mountainous and agro-ecologically sensitive regions. To assess its impact, farmers were asked to rate six socio-economic statements on a five-point Likert scale (1 = complete disagreement; 5 = complete agreement). The results indicate that large cardamom cultivation significantly enhanced the standard of living, with 54 per cent of respondents rating this at 4 and 24 per cent at 5. These findings resonate with studies from Sikkim and Nepal, where the shift from subsistence-based to high-value cash crops has been shown to improve rural livelihoods and increase household income (Subedi et al., 2018). Income-related impacts were especially pronounced in the current study, with 66 per cent of respondents rating income growth at 4 and 16 per cent at 5. This supports the broader narrative within agricultural transformation literature that links market-oriented crop diversification to poverty reduction and livelihood resilience (Pingali, 2012).

The data also reveal demographic changes attributed to cardamom cultivation: 39 per cent of respondents rated this at 3 and 53 per cent at 4, suggesting moderate to high impact. This mirrors findings from the Eastern Himalayas, where migration patterns and youth retention have been influenced by the economic promise of cash crops (Ramalingam et al., 2024). Employment generation, another key outcome, was acknowledged by 37 per cent of respondents at level 4 and 7 per cent at level 5, an observation that aligns with regional experiences of labour absorption in crop-based economies (Joshi, Gulati, & BIRTHAL, 2007). Although the acquisition of consumer durables was rated lower (58 per cent at 3 and 29 per cent at 4), the trend still reflects growing purchasing power, a phenomenon observed in similar transitions from traditional to commercial farming systems (Barrett et al., 2001). (Table 4)

### **3.2 Productivity, Cost and Return of Large Cardamom in Lower Subansiri District**

Productivity is commonly defined as the efficiency with which resources (such as labour, capital, or land) are used to produce goods or services, essentially measuring output per unit input. Table 5 presents productivity metrics for labour, capital, and land in cardamom production across different circles within Lower Subansiri District. Productivity per unit of land varies, with Yazali recording 38.63 kg, Param Putu 54.16 kg, and Yachuli 53.04 kg of cardamom produced per unit land, averaging 47.70 kg across circles. Labour productivity shows Yazali at 18.00 kg per labour unit, Param Putu at 21.97 kg, and Yachuli at 9.48 kg, with an average of 18.02 kg. Capital productivity, measured as cardamom output per 100 Rs. of initial investment, stands at 137.06 kg for Yazali, 156.56 kg for Param Putu, and 61.45 kg for Yachuli, with an overall average of 118.36 kg (Table 5). ANOVA results confirm statistically significant differences ( $p < 0.05$ ) in productivity measures among circles, highlighting spatial heterogeneity in production efficiency. Comparing these results with studies from other hill agricultural systems reveals consistent patterns of productivity variation shaped by agroecological conditions, input use, and market integration. For instance, (Sharma & Partap, 2016) reported similar productivity ranges for cardamom in the Sikkim Himalayas, where differential access to improved planting materials and extension services accounted for regional disparities. Likewise, Joshi et al. (2004) emphasized that diversification towards high-value crops like cardamom can substantially enhance land and labour productivity compared to traditional subsistence farming. These findings align with broader agricultural transformation frameworks (Pingali, 2012) that emphasize the transition from low-input, low-output systems to market-oriented, specialized production as a driver of rural economic development and livelihood improvement.

The cost of cardamom production across different circles of the study area is presented in table 6. Within Lower Subansiri district, Param Putu emerges as the leading producer, yielding 22366 kg of cardamom, followed by Yazali with

13249 kg and Yachuli with 4455 kg. In terms of total expenditure, Param Putu invested the most, spending Rs. 500000, followed by Yazali with Rs. 435000. and Yachuli with Rs. 145000. Param Putu also exhibits the lowest average cost per kilogram at Rs. 22.35, while Yachuli and Yazali have slightly higher average costs at Rs. 32.56 and Rs. 32.83 per kilogram, respectively. The average cost per kilogram for all circles in the study area is Rs. 26.95 (Table 6). Param Putu remarkably contributes the highest percentage of production and cost, followed by Yazali and Yachuli. The ANOVA result ( $F = 6.13$ ) indicates a statistically significant difference in Average cost of production of large cardamom across the three circles at the 5% level.

### **3.3 Labour and Wage**

In the production of large cardamom, labour primarily consists of family labour and exchange labour provided by Self-Help Groups (SHGs) or other community organizations. These groups typically charge lower daily wages for their members compared to market rates, although wage rates vary across villages. For example, in Yachuli Circle, Lower Yachuli's Jhat Youth and Tnoon groups, each with 11 members, charge 300 INR per member per day within the group (totaling 3,300 INR) and 350 INR for outsiders (totaling 3,850 INR). Upper Yachuli's Thursday group, comprising 17 members, charges 2,000 INR within the group and between 5,000 INR (with food) and 8,000 INR (without food) for outsiders. Meanwhile, the Church group, with 30 to 70 members, charges a uniform rate of 150 INR per person per day for both members and outsiders (Table 7).

This pattern of labour organization and wage differentiation aligns with findings from other hill farming regions where community-based labour sharing systems play a crucial role in reducing labour costs and promoting social cohesion (Rawat & Subba, 2017). Similar studies from the Eastern Himalayas and North East India highlight how SHGs and informal labour exchange networks help buffer the high labour demand during peak agricultural seasons, particularly in cash crop cultivation such as cardamom and tea (Cheek & Corbett, 2023). These labour arrangements are situated within broader agricultural trends that emphasize the role of cooperative institutions and community participation in sustaining smallholder farming systems amid rising labour costs and market pressures (Pingali, 2015). Consequently, the wage differentials observed between members and outsiders reflect both economic incentives and social norms that shape labour mobilization in these agroecological settings.

In Yazali Circle, Amgi village's SHG charges 200 INR per member per day (total 2400 INR) and 500 INR for outsiders i.e. for people who are not members of their group (total 6000 INR). The Fellowship Youth group, with 40 members, charges 200 INR per member per day (total 8000 INR) and 300 INR for outsiders i.e. for people who are not members of their group (total 12000 INR) (Table 8). Takam Pasa village's SHG charges 2500 INR per day for

**Table 7.** Labour Strength and Wage Distribution in Yachuli Circle

Name of the Group	Member Strength	Within Member Fees (₹ per person/day)	Outsider Fees (₹ per person/day)
<b>Lower Yachuli</b>			
Jhat Youth	11	300 × 11 = 3,300	350 × 11 = 3,850
Twoon Group	12	300 × 11 = 3,300	350 × 11 = 3,850
<b>Upper Yachuli</b>			
Thursday Group	17	2,000	5,000 (with food) / 8,000 (without food)
Church Group	70 (max), 30 (min)	150 per person	150 per person

Source: Field Survey, 2024.

**Table 8.** Labour Strength and Wage Distribution in Yazali Circle

Name of the Group	Member Strength	Within Member Fee (₹ per person/day)	Outsider Fees (₹ per person/day)
<b>Amgi Village</b>			
SHG (Self-Help Group)	12	200 × 12 = 2,400	500 × 12 = 6,000
Fellowship Youth	40	200 × 40 = 8,000	300 × 40 = 12,000
<b>Takam Pasa Village</b>			
SHG	15	2,500	3,000
Church Den	10	2,000	2,500
Common Church	18	3,000	5,000
<b>Komp Village</b>			
Komp Den (Women)	17	2,000	3,000
Pert Den (Old Age Women)	20	2,500	3,500

Source: Field Survey, 2024.

**Table 9.** Labour Strength and Wage Distribution in Param Putu Circle

Name of the Group	Member Strength	Within Member Fee (₹ per day)	Outsider Fees (₹ per day)
<b>Raka Village</b>			
Raka Youth Association	15	1,500	1,500 / 1,000 (for poor person)
Raka Den Ajin	8	1,000	1,500
<b>Pith Village</b>			
Pith Den Ajin	10	1,500	2,000

Source: Field Survey, 2024.

**Table 10.** Revenue and Profit on Cardamom Production in Lower Subansiri District

Circle	Revenue (₹)	Profit (₹)	Profit per Household (₹)
Yazali	10,385,490	9,950,490	221,122
Param Putu	16,774,500	16,274,500	464,985.7
Yachuli	3,405,400	3,260,400	163,020
<b>Total</b>	<b>30,565,390</b>	<b>29,485,390</b>	<b>294,853.9</b>
<b>ANOVA</b>	—	—	<b>15.63 (p &lt; 0.01)</b>

Source: Calculation based on Field Survey, 2024.

members and 3000 INR for outsiders i.e. for people who are not members of their group. Church Den charges 2000 INR for members and 2500 INR for outsiders i.e. for members outside their group, while Common Church charges 3000 INR and 5000 INR, respectively. Komp village's KOMP Den (Women) group charges 2000 INR for members and 3000 INR for outsiders i.e. for people outside their group, and PERT Den (Old Age Women) charges 2500 INR and 3500 INR, respectively.

In Param Putu circle, Raka Village's Raka Youth Association charges 1500 INR per day for everyone i.e. both members and outsiders, with a reduced rate of 1000 INR for poor individuals. Raka Den Ajin charges 1000 INR per day for members and 1500 INR for outsiders. Pith Village's Pith Den Ajin charges 1500 INR per day for members and 2000 INR for outsiders. (Table 9)

<https://doi.org/10.25163/agriculture.3110363>

Groups use collected funds for community activities and loans, with varying interest rates for members of the group and outsiders i.e. for people who are not members of their group.

The revenue generated from cardamom cultivation is calculated by multiplying the quantity produced by its prevailing market price, while profit is determined by deducting the total production costs from the gross revenue. Table 10 provides a detailed overview of the revenue and profit dimensions in the cardamom sector of Lower Subansiri District. Among the three circles studied, Param Putu stands out as the principal contributor, generating revenue of Rs. 16,77,450 and securing a profit of Rs. 16,27,450, outpacing both Yazali and Yachuli. Collectively, the three circles contribute a total revenue of Rs. 3,05,65,390 and a cumulative profit of Rs. 2,94,85,390 (Table 10). Further, the average profit per household offers a micro-

level perspective on the economic returns of cardamom farming. Households in Param Putu record the highest average profit at Rs. 4,64,985.70, followed closely by those in Yazali and Yachuli. The ANOVA result ( $F = 15.63$ ) reveals a statistically significant difference in profit per household among the circles at the 1% level, reflecting considerable regional variation in financial outcomes.

When compared with similar studies in other mountainous and hill regions, these findings reveal congruent patterns. For instance, Sharma and Partap (2016) in their study on the Sikkim Himalayas found that areas adopting improved management practices and enjoying better market connectivity reported significantly higher profits from large cardamom cultivation. Similarly, Joshi et al. (2007) emphasized that diversification into high-value cash crops like cardamom could substantially enhance rural incomes and reduce vulnerability, particularly in marginal farming systems. These patterns resonate with agricultural transformation frameworks, particularly those articulated by Pingali (2012), who underscores the role of commercialization, technological upgrading, and institutional support in boosting profitability and livelihood security in agrarian economies.

### 3.4 Factors affecting the profitability

Table 11 presents the regression results identifying the determinants of per unit profit in cardamom cultivation at the household level. The model demonstrates strong explanatory power, with an R-squared value of 0.82, indicating that 82 percent of the variation in per unit profit is accounted for by the included variables. The overall model is statistically significant, as reflected by an F-statistic of 62.87 ( $df = 8, 91$ ), significant at the 1 percent level. However, the significant Breusch–Pagan (BP) test statistic (12.45) suggests heteroskedasticity; therefore, robust standard errors have been employed to ensure the reliability of inference.

In line with theoretical and empirical literature on agricultural profitability in high-value cash crops (e.g. 2024; Rawat & Subba, 2017), yield per bigha (LY) shows a strong positive association with profitability, with a coefficient of 0.75. This supports the notion that enhancing productivity through improved agronomic practices can significantly boost net returns, a trend observed in similar studies across the Indian Himalayan and other marginal farming regions. Input cost (COI) and labour cost (COL) are negatively associated with profitability, with coefficients of -0.04 and -0.03 respectively, both statistically significant. These findings align with those of (Jena & Sodyongkri, 2020) and (Haokip, 2022) who report that escalating input and labour costs, particularly in labour-intensive hill crops, can reduce profitability unless offset by efficiency gains or higher output prices.

Although post-harvest loss (PHL) carries a negative sign (-2.10), it is statistically insignificant. This could either reflect underreporting or minimal post-harvest losses in the sample, contrasting with findings in other cash crop systems where post-harvest inefficiencies are critical (e.g., Ellis, 2000). Importantly, market

access (MA) significantly enhances profitability: farmers with direct market links earn ₹45.30 more per kg than those dependent on intermediaries. This result echoes broader agricultural transformation trends that stress market integration as a critical pathway to improving smallholder income (Pingali, 2015). Price per kg (PRC) also has a strong positive effect (coefficient = 1.02), reinforcing the role of favourable market conditions in driving profitability.

Credit availability (CA) shows a positive and significant effect on profitability (coefficient = 1.22), consistent with studies emphasizing the role of institutional credit in enabling better farm-level decisions and investment (Shivaswamy et al., 2020). While extension support (ES) has a positive but statistically insignificant coefficient, the result highlights potential issues with the reach or effectiveness of advisory services in remote regions a finding comparable to other hill region studies (Rawat & Subba, 2017).

### 3.5 Challenges Associated with Large Cardamom Production in the Lower Subansiri District

Cardamom production may be affected by several factors, which includes availability of agricultural inputs, technical improvements, environmental factors like soil quality, elevation, and climate and agricultural regulations etc (Sharma et al., 2016). Further, the prevalence of pests and illnesses, as well as cultural traditions and traditional knowledge, may also have an impact on the success the production of cardamom. Apart from this, Socioeconomic issues such as resource availability, land tenure systems, and market dynamics could all have an impact on large cardamom (Pradhan et al., 2023). In the study area, following sets of factors are more prominent.

#### 3.5.1 Lack of information & Skill on Cultivation

Cardamom production requires cautious attention from planting to harvesting, in addition to routine duties such as shade management, pesticide application, and off-season irrigation. Despite the Spices Board's introduction of innovative methods through materials such as brochures and booklets, many planters lack standardized farming expertise due to reasons such as limited access to information, poor communication, illiteracy, and apathy (Murugan et al., 2011).

In Yazali, 33.33 per cent of respondents stated they were 'not at all' affected by a lack of information and expertise, while 31.11 per cent said they were affected 'a lot'. In Param Putu, the majority (48.57 per cent) reported being affected 'Some', whereas in Yachuli, 35 per cent reported being affected 'Some extent' and another 35 per cent reported being affected 'A lot' (Table 12).

#### 3.5.2 Lack of Time

The paucity of time is a big barrier to cardamom production. Farmers frequently struggle to commit enough time to the agricultural process, which requires regular attention from planting to harvesting due to competing obligations and limits. This lack of time might result in poor management methods such as delayed

**Table 11. Determinants of Profitability of the Household**

Variable	Notation	Coefficient (Robust Std. Error)	VIF
Intercept (Constant)	—	-115.50 (85.40)	—
Yield per Bigha of Land (kg)	LY	0.75 (0.18) ***	2.15
Input Cost (₹/acre)	COI	-0.04 (0.01) ***	3.10
Labour Cost (₹/acre)	COL	-0.03 (0.012) **	2.85
Post-Harvest Loss (%)	PHL	-2.10 (1.20)	1.60
Market Access	MA	45.30 (10.22) ***	1.20
Price per kg (₹)	PRC	1.02 (0.20) ***	3.55
Availability of Credit	CA	1.22 (0.12) ***	1.31
Extension Support	ES	7.70 (9.50)	1.05

**Model Summary**

F Statistic (8, 91): 62.87\*\*\*

BP Test Statistic: 12.45\*\*\* (Robust SE used)

R<sup>2</sup>: 0.82

Observations: 100

Source: Authors' calculation.

Note: \*\*\*, \*\*, \* denote significance at 1%, 5%, and 10% levels, respectively.

**Table 12. Responses to Lack of Information & Skill on Cultivation (%)**

Circle	Not at all	A Little	Some	A Lot	Don't Know	Total
Yazali	33.33	26.67	8.89	31.11	0.00	100.0
Param Putu	22.86	22.86	48.57	5.71	0.00	100.0
Yachuli	10.00	20.00	35.00	35.00	0.00	100.0
<b>Total</b>	<b>25.00</b>	<b>24.00</b>	<b>28.00</b>	<b>23.00</b>	<b>0.00</b>	<b>100.0</b>

Source: Researchers' compilation from Field Survey, 2024.

**Table 13. Responses for Lack of Time (%)**

Circle	Not at all	A Little	Some	A Lot	Don't Know	Total
Yazali	20.00	37.78	33.33	8.89	0.00	100.0
Param Putu	2.86	17.14	68.57	11.43	0.00	100.0
Yachuli	20.00	20.00	45.00	15.00	0.00	100.0
<b>Total</b>	<b>14.00</b>	<b>27.00</b>	<b>48.00</b>	<b>11.00</b>	<b>0.00</b>	<b>100.0</b>

Source: Researchers' compilation from Field Survey, 2024.

**Table 14. Responses for Lack of Capital (%)**

Circle	Not at all	A Little	Some	A Lot	Don't Know	Total
Yazali	2.22	6.67	28.89	57.78	4.44	100.0
Param Putu	0.00	2.86	42.86	54.29	0.00	100.0
Yachuli	0.00	5.00	30.00	65.00	0.00	100.0
<b>Total</b>	<b>1.00</b>	<b>5.00</b>	<b>34.00</b>	<b>58.00</b>	<b>2.00</b>	<b>100.0</b>

Source: Researchers' compilation from Field Survey, 2024.

planting, ineffective pest control techniques, and insufficient attention during important growth stages (Choi et al., 2011). As a result, a shortage of time reduces the total efficiency and productivity of cardamom production, limiting farmers' capacity to maximize yields and quality.

In Yazali, 37.78 per cent of respondents reported being affected 'A Little' by a lack of time, while 33.33 per cent indicated they were affected to 'Some' extent. In Param Putu, the majority (68.57 per cent) reported being affected 'some', while only 2.86 per cent reported being affected 'not at all' (Table 13). Similarly, 45 per cent of Yachuli residents reported being affected to 'Some' extent.

**3.5.3 Lack of Capital**

Cardamom cultivation has become an expensive business, with growing material costs and escalating labour pay. Planters must continually tend to field operations, even during the off-season, which requires a significant financial expenditure. However, acquiring finances becomes difficult as financial institutions sometimes prove unavailable, and government subsidies and schemes remain elusive due to bureaucratic barriers. As a result, insufficient funding impedes field operations, resulting in financial losses for planters and ultimately affecting total production and productivity of cardamom plantations (Pribadi, 2022).

In Yazali, significant portions (57.78 per cent) of respondents reported being affected 'A Lot' by the lack of capital, while 28.89 per cent indicated being affected to 'Some' extent. In Param Putu, the majority (54.29 per cent) stated being affected 'A Lot', with 42.86 per cent reporting being affected 'Some'. Similarly, in Yachuli, 65 per cent reported being affected 'A Lot', with 30 per cent indicating being affected 'Some extent'. (Table 14)

### 3.5.4 Lack of Security

The lack of security poses a significant impediment to cardamom production. Planters encounter a variety of threats, including theft, vandalism, and natural calamities that endanger both crops and infrastructure (Dyer, 2023). Inadequate security measures expose plantations to various dangers, potentially resulting in yield and investment losses. Further, concern about security jeopardizes farmers' well-being and confidence, limiting their ability to operate their activities in a sustainable manner.

In Yazali, a substantial majority (57.14 per cent) of respondents reported being greatly affected by the lack of security, while 40 per cent indicated experiencing a moderate impact. In Param Putu, a significant portion (57.78 per cent) stated being greatly affected, with 17.78 per cent reporting a moderate impact. (Table 15). Similarly, in Yachuli, 70 per cent expressed a considerable impact, while 15 per cent mentioned a moderate effect.

### 3.5.5 Lack of Labour and Machines

Cardamom requires highly trained labour for both cultivation and processing because low skill levels can negatively affect output and productivity (Korikanthimath, 2016). However, there is a dearth of professionals in the study region who possess adequate expertise of cardamom processing and cultivation. Government extension agents and developmental organizations continue to make insufficient attempts to solve this problem. In addition, since cardamom is grown in so many different places make it more difficult to find qualified workers for every plantation.

In Yazali, a significant proportion (44.44 per cent) of respondents reported being greatly affected by the lack of labour and machines, while 24.44 per cent indicated experiencing a moderate impact. In Param Putu, a majority (54.29 per cent) stated being greatly affected, with 22.86 per cent reporting a moderate impact (Table 16). Similarly, in Yachuli, 45 per cent expressed a considerable impact, while 30 per cent mentioned a moderate effect.

### 3.5.6 Pests

Thrips, borers, fungal infections, mosaic virus, and other pests and diseases can seriously harm cardamom plants' general health and productivity. It is imperative to act quickly to save plantations from suffering significant harm. Planters must so arm themselves with a thorough understanding of pest and disease management strategies. Planters can protect their cardamom plants, lessen the effects of pests and diseases, and increase yields by using integrated systems and using the right pesticides at the right times (Thomas & Bhai, 2016).

In Yazali, no respondents reported no impact from pests, while 40 per cent indicated a significant impact. In Param Putu, none reported no impact, with 45.71 per cent indicating some level of impact. Yachuli had 5 per cent reporting no impact, with 35 per cent indicating a significant impact. (Table 17)

### 3.5.7 Post Harvesting/Storing

Cardamom needs to be stored carefully after curing in order to maintain its quality. The main feature of the capsules is their green colour, which fades if the cardamom is stored improperly or exposed to different types of weather (Sulochanamma et al., 2008). Additionally, the seeds in the capsule's oleoresin will gradually degrade and cause significant loss. To preserve the colour and quality of the capsules, it is crucial to keep the product in an appropriate manner. However, not all planters have these kinds of amenities.

It is seen that in Yazali and Yachuli circle most of the farmers (33.33 per cent and 50 per cent respectively) stated that post harvesting or storing facility has a lot of effects on production of cardamom. While in Param Putu, the effect of post harvesting was responded as 'some' extent by majority of the farmers (48.57 per cent). (Table 18).

### 3.5.8 Others

In addition to previously discussed issues, several other critical factors adversely influence large cardamom production in the Lower Subansiri district. These include transportation bottlenecks, price volatility, high input costs, marketing challenges, weak governance structures, and the intermediary role of middlemen. Field data presented in Table 19 shows how farmers in different circles perceive the impact of these factors.

In Yazali, 48.89 per cent of respondents indicated that these issues have a significant impact on production, while 20 per cent reported no impact. In Param Putu, 48.57 per cent of respondents also reported a high impact, though only 2.86 per cent saw no effect. The situation is more severe in Yachuli, where 70 per cent of farmers acknowledged a strong influence from these issues, and no respondents reported "no impact." This variation indicates that while all regions are affected, the degree of vulnerability varies by location, potentially due to differences in infrastructural access and institutional support.

To better understand the nature of these challenges, Table 20 ranks the specific factors based on cumulative scores derived from the field survey. The most pressing issue across all sites was the *lack of information and skill on cultivation*, followed by *time constraints* and *post-harvest/storage problems*. Other issues such as *labour shortages*, *pest infestations*, and *lack of capital* also featured prominently.

These findings align with existing literature on spice and high-value crop cultivation in remote hilly regions. For instance, studies in Sikkim and parts of Nepal where large cardamom is also grown have similarly highlighted constraints related to technical know-

**Table 15. Responses for Lack of Security (%)**

Circle	Not at all	A Little	Some	A Lot	Don't Know	Total
Yazali	0.00	2.86	40.00	57.14	0.00	100.0
Param Putu	15.56	8.89	17.78	57.78	0.00	100.0
Yachuli	5.00	10.00	15.00	70.00	0.00	100.0
<b>Total</b>	<b>8.00</b>	<b>7.00</b>	<b>25.00</b>	<b>60.00</b>	<b>0.00</b>	<b>100.0</b>

Source: Researchers' compilation from Field Survey, 2024.

**Table 16. Responses for Lack of Labour and Machines (%)**

Circle	Not at all	A Little	Some	A Lot	Don't Know	Total
Yazali	2.22	26.67	24.44	44.44	2.22	100.0
Param Putu	0.00	22.86	54.29	22.86	0.00	100.0
Yachuli	0.00	25.00	45.00	30.00	0.00	100.0
<b>Total</b>	<b>1.00</b>	<b>25.00</b>	<b>39.00</b>	<b>34.00</b>	<b>1.00</b>	<b>100.0</b>

Source: Researchers' compilation from Field Survey, 2024.

**Table 17. Responses for Pest as a Factor (%)**

Circle	Not at all	A Little	Some	A Lot	Don't Know	Total
Yazali	0.00	37.78	22.22	40.00	0.00	100.0
Param Putu	0.00	22.86	45.71	31.43	0.00	100.0
Yachuli	5.00	30.00	25.00	35.00	5.00	100.0
<b>Total</b>	<b>1.00</b>	<b>31.00</b>	<b>31.00</b>	<b>36.00</b>	<b>1.00</b>	<b>100.0</b>

Source: Researchers' compilation from Field Survey, 2024.

**Table 18. Responses for Post-Harvesting / Storing as a Factor (%)**

Circle	Not at all	A Little	Some	A Lot	Don't Know	Total
Yazali	13.33	28.89	22.22	33.33	0.00	100.0
Param Putu	0.00	28.57	48.57	20.00	0.00	100.0
Yachuli	0.00	15.00	25.00	50.00	5.00	100.0
<b>Total</b>	<b>6.00</b>	<b>26.00</b>	<b>32.00</b>	<b>32.00</b>	<b>1.00</b>	<b>100.0</b>

Source: Researchers' compilation from Field Survey, 2024.

**Table 19. Responses for Other Factors (%)**

Circle	Not at all	A Little	Some	A Lot	Don't Know	Total
Yazali	20.00	13.33	15.56	48.89	2.22	100.0
Param Putu	2.86	20.00	28.57	48.57	0.00	100.0
Yachuli	0.00	0.00	20.00	70.00	10.00	100.0
<b>Total</b>	<b>10.00</b>	<b>13.00</b>	<b>21.00</b>	<b>53.00</b>	<b>3.00</b>	<b>100.0</b>

Source: Researchers' compilation from Field Survey, 2024.

how, post-harvest handling, and market access (Sharma, Sharma, & Sharma, 2009). The lack of coordinated support services and infrastructural investment further isolates these producers from markets, mirroring the challenges faced in Lower Subansiri.

From a broader agricultural transformation perspective, these findings suggest that cardamom growers in the region are largely in a subsistence-to-commercial transition phase. As with other high-value horticultural sectors in developing economies, success in this transition depends on institutional support, value chain integration, and targeted extension services. The strong presence of intermediaries and low financial literacy reported by respondents indicates a need for better regulatory oversight and producer cooperatives to enable more equitable market participation.

#### 4. Discussion

While the economic potential of cardamom cultivation and its growing popularity among farmers have been highlighted in prior literature and policy documents, this study builds on those insights by providing a district-level, micro-contextual understanding of cardamom's socio-economic role in Lower Subansiri. It identifies not just the income-generating potential of cardamom, but also the structural and institutional barriers that hinder equitable and sustainable outcomes. By drawing attention to specific localities such as Param Putu, where cardamom cultivation has substantially raised household incomes, the study offers place-based evidence to support regionally nuanced agricultural policy and investment planning.

**Table 20.** Factors Affecting Large Cardamom Production in Lower Subansiri District

Sl. No.	Factors	Rating and Number of Responses	Total Score	Rank
		1	2	3
1	Lack of information & skill on cultivation	25	24	28
2	Lack of time	14	27	48
3	Lack of capital	1	5	34
4	Lack of security	8	7	25
5	Lack of labour & machines	1	25	39
6	Pests	1	31	31
7	Post-harvesting / storing	6	26	32
8	Others	10	13	21
<b>Total</b>		<b>66</b>	<b>158</b>	<b>258</b>

**Source:** Computed from Field Survey data, 2024.

**Note:** Ratings 1 to 5 indicate the degree of influence, where 1 = **Not at all** and 5 = **Very high** impact.

A critical synthesis of the findings suggests that the shift from traditional Jhum cultivation to cardamom is not merely a response to market demand, but also a survival strategy shaped by ecological pressures, labour dynamics, and shifting state development priorities. However, despite its promise, cardamom cultivation remains constrained by entrenched vulnerabilities, including limited technical knowledge, inadequate financial support systems, exploitative market structures, and infrastructural deficiencies. These challenges are not isolated issues but are deeply interconnected with broader themes of rural economic development, agricultural commercialization, and governance.

Addressing these challenges requires more than generic recommendations; it calls for an integrated, evidence-based approach tailored to local realities. For example, training programs must be rooted in the specific agronomic needs of the region and implemented through community-based institutions such as Farmer Producer Organizations (FPOs) and Krishi Vigyan Kendras (KVKs). Financial inclusion cannot be advanced through broad appeals alone; targeted credit mechanisms, such as interest subvention schemes and mobile-enabled microfinance should be prioritized for cardamom farmers, particularly those in marginalized and remote communities.

Moreover, market interventions should not be limited to improving price realization. There is a need for institutional innovation, such as cooperative-led marketing, transparent price discovery platforms, and temporary Minimum Support Price (MSP) guarantees to counterbalance the disproportionate power of middlemen. These mechanisms must be supported by state-led regulatory oversight and farmer training in marketing literacy. Similarly, infrastructural development, including last-mile roads, cold storage, and rural electrification, must be integrated into district-level rural development plans and monitored through participatory governance structures to ensure alignment with agricultural priorities.

The role of research and extension services also warrants emphasis.

**Public agricultural universities and research institutions must**

<https://doi.org/10.25163/agriculture.3110363>

collaborate with local bodies to develop pest-resistant, climate-resilient cardamom varieties. These research outputs must be disseminated through proper extension systems, potentially leveraging digital platforms and vernacular content for broader outreach. Risk mitigation strategies, including weather-indexed crop insurance and community-based early warning systems, should also be mainstreamed through public-private partnerships. Lastly, inclusive development cannot be achieved without addressing intra-household and social inequalities. Empowering women and marginalized groups through secure land rights, leadership training, and dedicated financial products can enhance both productivity and social equity. Institutional arrangements must therefore be designed to facilitate their meaningful participation in decision-making processes be it through Self Help Groups (SHGs), cooperative boards, or village-level planning committees.

## 5. Conclusion

In conclusion, while cardamom cultivation presents a viable pathway for rural economic growth in Lower Subansiri, realizing its full potential requires a coordinated strategy rooted in evidence, linked to stakeholder roles, and attentive to issues of equity and sustainability. The paper thus contributes to the discourse not by reiterating well-known benefits, but by identifying the gaps in implementation and proposing actionable, context-specific solutions with clear institutional accountability.

## Author Contributions

The author solely conceived, designed, and conducted the study, collected and analysed the data, and prepared the manuscript in its entirety.

## Acknowledgment

Not applicable

## Competing financial interests

The author declares that there is no conflict of interest regarding the publication of this paper.

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