



DETERMINANTS OF LOW PROFITABILITY IN GREENHOUSE VEGETABLE FARMING IN KERALA: AN ANALYTICAL STUDY OF ANNUAL PERFORMANCE

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ABSTRACT

Greenhouse vegetable cultivation was introduced in Kerala as a technological intervention to enhance productivity, stabilise supply, and improve farm income. However, despite the expansion of protected farming since 2009–10, profitability remains uncertain. This study aims to investigate the real factors contributing to low profitability by analysing the annual performance of 165 greenhouse farms out of 837 units established between 2009–10 and 2019–20. Using farm-level data, the study evaluates the structure of cost and revenue, examines cost–output elasticity, and compares required and realised prices for major greenhouse crops.

Findings reveal that although 85% of greenhouse farmers have regular buyers for their produce, only 10% receive attractive prices, while 54% sell at prices considered insufficient. The analysis of cost–output elasticity suggests that while production efficiency has improved, profitability continues to decline due to poor price realisation. Large disparities are observed between the average prices required and those received, particularly for crops such as tomato, capsicum, cauliflower, and cabbage, indicating that market prices often fall below cost-recovery levels. The results imply that the key constraint is not production inefficiency but weak marketing and pricing mechanisms.

The study concludes that the sustainability of greenhouse vegetable farming in Kerala depends largely on improving market structures, ensuring remunerative pricing, and developing collective marketing and price stabilisation strategies. Addressing these issues is essential to convert the technological and productivity gains of protected cultivation into viable and enduring farm incomes.

KEYWORDS: Greenhouse Farming; Profitability; Cost–Output Elasticity; Price Realisation; Protected Cultivation; Marketing Constraints

1. INTRODUCTION

Kerala has increasingly turned toward protected cultivation, particularly greenhouse (polyhouse) vegetable farming, to address the persistent gap between local demand and production. This strategy stems largely from constraints on open-field expansion due to fragmented land holdings and rapid urbanisation, which necessitate technology-driven intensification (Department of Economics & Statistics, Government of Kerala, 2016; Kerala State Planning Board, 2023).

It is expected that protected cultivation promises higher and more stable yields, improved quality, and better input-use efficiency. Studies across India indicate that greenhouse systems can generate higher gross and net returns when scale, management, and design are optimised (Nimbrayan et al., 2018). However, in Kerala, outcomes are mixed: an explorative analysis found that many greenhouse units struggle to cover costs due to high establishment expenses and insufficient revenue realisation (Panancheri, 2024), while other case studies highlight pests, diseases, and limited climate control as major drags on productivity (Swathy Lakshmi et al., 2018).

Several factors cause this low profitability. First, scale is severely constrained: Kerala's average size of greenhouse among the Indian states is the smallest, limiting economies of scale. Second, labour costs are among the highest nationally, and farmers frequently report shortages during peak operations, reducing margins (Government of Kerala, 2023a). Third, while electricity for agriculture is subsidised, recurrent energy expenses for irrigation, foggers, and ventilation remain a burden, and tariff adjustments create uncertainty in costs (Government of Kerala, 2023b; Kerala State Electricity Board, 2022).

Production risks are also significant. Most polyhouses in Kerala are naturally ventilated, which permits the spread of pests and viral diseases. Poor-quality cladding materials and inadequate maintenance further weaken microclimate regulation. Empirical work from Kerala documents soil-borne problems and pest infestations that directly reduce revenue per square metre (Swathy Lakshmi et al., 2018). Moreover, many farmers perceive greenhouse cultivation as infeasible without timely information on finance, pest management, and technology support, pointing to persistent extension gaps (Poornima & Husain, 2023).



Marketing challenges escalate the problem. Case studies show that specialty produce such as parthenocarpic cucumbers and coloured capsicums often face limited local demand, price volatility, and weak aggregation, forcing farmers into distress sales (Kerala State Planning Board, 2023). Even with subsidies offered by the State Horticulture Mission and the National Horticulture Board, profitability hinges on sound design, integrated pest management, crop planning, and reliable market linkages (National Horticulture Board, 2022; State Horticulture Mission–Kerala, 2023).

Even with government backing and technical promise, greenhouse vegetable farming in Kerala is still essentially unfeasible from an economic standpoint, especially for extremely modest and small-scale operations. Subsidies by themselves, however, cannot address the fundamental cost disadvantages that smaller businesses confront. The findings make it abundantly evident that multifaceted support systems beyond subsidies are required, including farmer training, cooperative production models, effective marketing avenues, the production of high-value vegetables, and the rationalisation of input costs. To make greenhouse farming a viable and expandable source of income in Kerala, future initiatives must also concentrate on increasing management capability and expanding access to high-value markets (Panancheri, 2025).

In sum, the low profitability of greenhouse vegetable farming in Kerala reflects a confluence of factors: very small size of farms, high labour costs, production risks in partially controlled structures, information gaps, and weak marketing systems. Moving from survival to sustainability will require a shift from hardware-focused subsidies toward integrated support systems encompassing technology services, market organisation, and extension.

In conclusion, while greenhouse vegetable farming in Kerala was promoted as a promising strategy to enhance local production and farmer incomes, existing evidence indicates that profitability has often fallen short of expectations. Preliminary assessments suggest that both production-side factors—such as labour intensity, pest and disease incidence, and high establishment costs—and market-side constraints, particularly unstable and low price realisation, may be responsible for this outcome. However, the relative weight of these factors in shaping farmers' returns remains insufficiently explored. To address this gap, the present study undertakes a detailed enquiry into 165 greenhouse vegetable farms, selected from among 837 units established across Kerala during 2009–10 to 2019–20, with the objective of systematically identifying the critical determinants of low profitability.

2. RESEARCH PROBLEM

Although greenhouse vegetable farming in Kerala was introduced to enhance productivity and ensure higher farm incomes,

evidence so far suggests that its profitability remains uncertain and often lower than anticipated (Panancheri, 2024; Swathy Lakshmi et al., 2018). While subsidies and technological support have facilitated the establishment of 837 greenhouse units in the state between 2009–10 and 2019–20 (State Horticulture Mission–Kerala, 2022), many farmers continue to report difficulties in recovering investment costs and sustaining operations (Kerala State Planning Board, 2023). The reasons are not clearly understood, as both production-related factors—such as rising labour costs, pest and disease management, and structure maintenance (Poornima & Husain, 2023)—and market-related issues—such as low and volatile crop prices and weak marketing channels (Government of Kerala, 2023)—appear to play a role. However, the relative contribution of these factors has not been systematically examined in Kerala's context. The identified gap in knowledge forms the basis of the research problem—understanding why greenhouse vegetable farming continues to show low profitability despite significant technological potential. To address this, the study undertakes an in-depth analysis of 165 representative greenhouse farms selected from the 837 units established between 2009–10 and 2019–20.

3. OBJECTIVES OF THE STUDY

1. To assess the influence of cost–output efficiency on the profitability of greenhouse vegetable farms, using evidence from 165 representative units established between 2009–10 and 2019–20.
2. To evaluate the role of price realisation in determining the profitability of greenhouse vegetable farms, based on empirical data from the same sample of units.

4. RESULTS AND DISCUSSION

4.1 Cost-Output Elasticity of Greenhouses

Understanding cost–output elasticity is crucial for evaluating the profitability of greenhouse vegetable farming. This concept measures the responsiveness of costs to changes in output, thereby indicating whether increases in production are achieved efficiently or at disproportionately higher expenses. When cost–output elasticity is less than one, output grows faster than costs, suggesting improving profitability; but when it approaches or exceeds one, costs rise at the same rate or faster than output, undermining financial viability. In Kerala's context, where greenhouse farming involves high establishment and operating costs, analysing cost–output elasticity provides vital insights into whether additional production is achieved economically or whether escalating costs offset yield gains, thereby constraining profitability (Panancheri, 2024; Swathy Lakshmi et al., 2018).

Table 1 presents the regression results used to estimate the cost–output elasticity of greenhouse vegetable cultivation based on primary data. The regression model is log-linear, where the dependent variable is the natural logarithm of total cost (measured as C3 cost per annum) and the independent variable is the natural logarithm of output (measured in kilograms).



Table 1: Cost-Output Elasticity and Returns to Scale in Greenhouse Vegetable Cultivation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	7.015	0.261	26.85	0.000
Log of Output (in Kg.)	0.625	0.33	19.03	0.000
Adjusted R Square	0.689			
Prob (F-statistic)	0.000			
a. Dependent Variable: Log of Cost C3(in Rs),				
b. Predictors: (Constant), Log of Output (in Kg.)				

Source: Author’s calculation from primary data

$$\text{Log (CostC3)} = 7.015 + 0.625 \log (\text{Output}) + \varepsilon$$

This regression framework follows the cost-output elasticity model, which is grounded in neoclassical production theory and used to measure the responsiveness of total cost to changes in output. The estimated coefficient of 0.625 on the log of output implies that a 1% increase in output leads to only a 0.625% increase in total cost. Since the elasticity is less than 1, this indicates the presence of increasing returns to scale (IRS) in greenhouse vegetable production.

According to economies of scale theory, increasing returns occur when total cost increases less than proportionately with output, thereby reducing average cost per unit (Varian, 2014). This is particularly relevant in capital-intensive systems such as protected cultivation, where fixed costs (greenhouse structures, drip irrigation systems, and climate control units) constitute a major component of total cost. As output increases, these fixed costs are distributed over a larger production volume, resulting in lower per-unit costs—a concept aligned with the long-run average cost curve in production economics (Samuelson & Nordhaus, 2010).

The regression output shows that the relationship between cost and output is highly statistically significant:

- The t-statistic (19.03) and p-value (<0.001) for the coefficient on log(output) confirm the reliability of the estimate.
- The adjusted R² of 0.689 indicates that nearly 69% of the variation in total cost (C3) is explained by variations in output, reflecting a robust model fit.
- The F-statistic is also highly significant (p < 0.001), validating the overall regression model.

These findings are consistent with empirical studies on protected cultivation. Evidence from Himachal Pradesh shows that per-unit production costs in polyhouse cultivation—such as for capsicum—decrease significantly with increasing polyhouse size, reflecting notable economies of scale (Chahal, 2016). In Maharashtra, studies of bell pepper under protected cultivation indicate that larger polyhouse structures yield higher returns per area and lower break-even thresholds, further supporting cost-

efficiency gains from scale (Economic feasibility of polyhouse...., 2023 study).

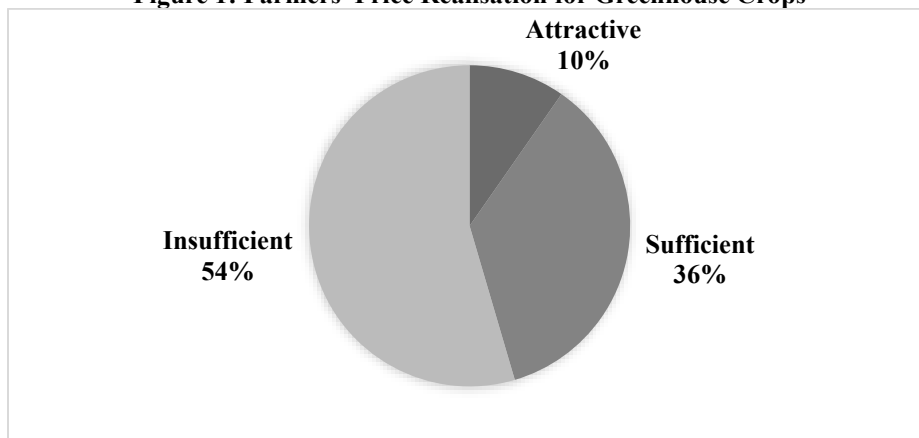
4.2 Marketing and Pricing of Greenhouse Vegetable Crops

Effective marketing and fair price realisation are central to the profitability of greenhouse vegetable farming. Even when farms achieve higher yields and quality produce through protected cultivation, inadequate marketing channels and unstable prices often erode potential gains. In Kerala, where small-scale greenhouse farmers face high production costs, the absence of organised marketing systems, weak bargaining power, and seasonal price fluctuations frequently result in distress sales (Kerala State Planning Board, 2023). Recent studies also emphasise that without proper aggregation and assured marketing outlets, greenhouse cultivation becomes financially unviable despite its technical advantages (Poornima & Husain, 2023; Swathy Lakshmi et al., 2018). Ensuring reliable market linkages, collective marketing, and mechanisms for remunerative pricing is therefore essential to convert the technical potential of greenhouse farming into sustainable farm incomes.

Regular buyers are essential for the success of any production activity, as they provide stability and reduce marketing uncertainties. In Kerala, greenhouse vegetable production enjoys a relatively steady market, with nearly 85% of the units reporting regular buyers for their produce, while only about 15% of farmers lack such consistent market linkages (Panancheri, 2024). However, despite the presence of regular buyers, greenhouse vegetable cultivation as a whole has not emerged as a financial success, primarily due to the persistently low prices received for the produce (Swathy Lakshmi et al., 2018; Kerala State Planning Board, 2023).

Only about 10% of farmers were able to secure an attractive price for their produce, as shown in Figure 1, while 36% received a price they considered just sufficient. Unfortunately, the majority—nearly 54% of farmers—had to sell their output at prices they regarded as insufficient, highlighting a major constraint in ensuring profitability.

Figure 1: Farmers' Price Realisation for Greenhouse Crops



Source: Primary Data

Figure 2: Comparison of Average Prices Required versus Prices Received for Various Greenhouse Crops



Source: Primary Data

Figure 2 presents a comparison between the average price required by farmers to cover costs and earn a reasonable profit and the average price actually received for various greenhouse vegetable crops in Kerala. For most crops, farmers are receiving prices significantly lower than the prices they consider necessary to cover costs and earn a reasonable return, highlighting the price-related constraints on profitability. Only Green Chilli and Spinach show relatively smaller gaps between required and received prices, suggesting that these crops are closer to being financially viable. The largest discrepancies occur in Capsicum, Cauliflower, and Tomato, indicating critical areas where marketing, price stabilisation, or cost reduction strategies may be necessary to improve profitability. Figure 2 underscores that while production under greenhouse conditions may be technically successful, low-price realisation for most crops remains a major factor limiting profitability.

5. MAJOR FINDINGS

The analysis of price realisation in greenhouse vegetable farming in Kerala reveals a significant mismatch between the average prices required by farmers to sustain profitability and the prices actually received in the market. The survey of 165 greenhouse farms shows that only a very small proportion of farmers could sell their produce at attractive prices, while the majority struggled to obtain remunerative returns.

- **Price Realisation Patterns:**

Figure 1 demonstrates that only 10% of farmers secured attractive prices, while 36% received sufficient prices, and a majority (54%) reported insufficient prices for their produce. This aligns with earlier observations that polyhouse and greenhouse farmers often fail to cover costs despite stable demand (Swathy Lakshmi et al., 2018).

- **Crop-Wise Discrepancies:**

A crop-wise analysis (Figure 2) highlights significant variations between the required and realised prices. For



crops such as tomatoes, Capsicum, Cabbage, Cauliflower, and Bitter Gourd, the gap was particularly wide, with realised prices falling well below the required benchmark. For example, farmers needed around ₹80/kg for Capsicum but received only ₹37.66/kg, and similarly, Cauliflower required ₹60.77/kg but fetched only ₹29.60/kg. In contrast, Green Chilli (₹81.50 required vs. ₹79.85 received) and Spinach (₹47.00 required vs. ₹43.87 received) exhibited relatively smaller gaps, suggesting better market performance. These results are consistent with the Kerala State Planning Board (2023), which emphasises that market price fluctuations, rather than a lack of production capacity, drive low returns in vegetable cultivation.

• **Dependence on Regular Buyers:**

The study found that nearly 85% of greenhouse units had regular buyers, indicating that market linkages exist to some extent. However, the persistence of low profitability despite stable buyers reveals that price inadequacy rather than market access per se is the central problem. Poornima and Husain (2023) also observed that while farmers are informed about production practices, information and support for efficient marketing remain insufficient.

• **Cost–Output Elasticity:**

An assessment of cost–output elasticity indicates that while efficiency in production exists to some degree, the profitability crisis is primarily triggered by farmers' inability to realise adequate prices in the market. Even when costs and output remain balanced, the diminished market value of produce prevents financial sustainability.

6. CONCLUSION

The findings clearly establish that low price realisation is the primary determinant of poor profitability in greenhouse vegetable farming in Kerala, outweighing even cost-related inefficiencies. Although the majority of farmers have regular buyers and achieve reasonable levels of productivity under protected cultivation, the gap between required and received prices continues to erode their financial gains. Crops such as Capsicum, Cauliflower, and Tomato emerge as particularly vulnerable to market underpricing, while only a few, like Green Chilli and Spinach, show near-viable returns.

This situation underlines the urgent need for policy interventions in price stabilisation, collective marketing, and assured procurement mechanisms to ensure that greenhouse farmers receive remunerative prices. Without such measures, the technical and yield-related advantages of greenhouse cultivation will remain underutilised, and the system as a whole will struggle to emerge as a sustainable model for agricultural income generation in Kerala.

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