# Cost And Benefit Analysis (CBA) Of Litchi (*Litchi Chinensis*) Production in Dinajpur District of Bangladesh

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**Abstract:** This research examines the cost benefit analysis and determinant factors of Litchi and litchi in Dinajpur District in Bangladesh. Applying cost analysis and linear regression analysis on data collected from 164 farmers, the study compares the economic viability of the two top profitable crops. The combined production cost of Litchi and litchi was 246,433 BDT ha-1. The litchi has given substantial higher returns with gross income of 555,750 BDT and BCR 2.25 as compared with Litchi. Although Litchi is profitable to produce, the high fixed costs of production including land rent, which comprises 64.4% of the overall cost-still represents a significant challenge to the landless and smallholder farmers. According to regression analysis, education and cultivable land were positively and significantly associated with litchi production result. By contrast, number of HH members and other main sources of household income were negatively related to productivity, suggesting economic strain and resources dilution. The positive effect of income from litchi was found to be marginally significant. Notably, proximity to the local market and age did not significantly influence either. These results indicate a possibility of litchi production being economically more viable than Litchi and demonstrate a policy implication for supporting land access, increasing education, and infrastructure that includes post-harvest measures such as a cold storage and a transport system. Personalized interventions could lead to better profitability and resilience, especially among smallholder farmers. In general, this study adds to the wider literature of sustainable agriculture and rural development in Bangladesh by identifying possible on-farm determinants of farming success in high-value crops.

**Keywords:** Cos-Benefit analysis (CBA), Litchi farming, Profitability, Small farmers, Sustainable agriculture.

## 1. Introduction

Agriculture is a major contributor to every country's economy, significantly impacting food security, biodiversity, Gross Domestic Production (GDP), and nutrition (FAO, 2022). Litchi with its delightful taste aromatic fragrance, and considerable nutritional value, stands out among other fruits (Zhao et al., 2020). Originally from southern China, litchi is now widely grow in Bangladesh, particularly in Dinajpur, due to its favorable climatic conditions, soil quality, and other factors (Mudahar et al., 2010). These favorable conditions have allowed litchi to transition from a food crop to a major cash crop. Litchi farming has become a profitable business in areas best suited for its cultivation (Mudahar et al., 2010). The increasing demand for healthy fruits created new opportunities for farmers, especially smallholders, as litchi commands high market

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price. This has made it a profitable crop, contributing significantly to the economy (Rajwanshi et al., 2017).

However, despite its great potential, the litchi industry faces several challenges, including inadequate post-harvest management, poor quality control, and difficulties in regulation market price. This challenges expose farmers to exploitation by middlemen (Both et al., 2021). Litchi is also rich in essential vitamins such as vitamins C and B groups, along with minerals like magnesium, potassium, and copper. The antioxidants in litchi, including flavonoids, are associated with reducing the risk of chronic diseases like diabetes, cancer, and cardiovascular diseases (Zhao et al., 2020; Razzaque et al., 2025). Therefore, litchi has the potential not only to improve nutrition but also to address malnutrition and micronutrient deficiencies in both the local and export market (Yadav et al., 2020; WHO, 2021).

Additionally, litchi farming benefits the environment. Litchi gardens enrich the soil, conserve water, and sequester carbon, all of which are crucial for combating climate change. This makes litchi farming an attractive and sustainable avenue for farmers (Pham et al., 2003). Agricultural diversification, such as litchi farming, has also been shown to contribute to long term food security and ecosystem stability (FAO, 2022). Dinajpur is the largest producer of litchi in Bangladesh, where its cultivation significantly contributes to the agricultural economy (Mudahar et al., 2010). However, the sector faces issues related to production costs, reinvest in their farms (Rajwanshi et al., 2017) Therefor, conducting a comprehensive Cost and Benefit Analysis (CBA) is essential to understanding the economics of litchi farming, which can help farmers manage production systems and ensure sustainability. This analysis will also be valuable for policymakers and investors seeking to enhance litchi farming and agricultural development in Bangladesh (Both et al., 2021)

## 2. Literature Review

Litchi cultivation plays a crays role in Dinajpur, Bangladesh, contributing significantly to the local economy. The profitability of litchi farming is influenced by production costs, environmental conditions, technological advancements, and socio-economic factors. Several studies have explored these aspects, providing valuable insights into how each of these elements affects the cost-benefit structure of litchi farming**.** Litchi farming involves considerable costs, with labor and transportation accounting for the largest share. (Kumar et al., 2018) emphasized that labor, pest management, and soil fertility are major contributors to high production costs.

Investments in pest control and post-harvest infrastructure, such as cold storage, help reduce losses and improve profitability. (Wang et al., 2016) found that investments in cold storage could mitigate post-harvest losses and boost net revenue. Moreover, technological advancements like drip irrigated and mechanized topping have been shown to reduce labor costs by 20% and increase yields by 18% (Rahman and Hossain 2019). (Singh and Yadav 2020) highlighted that water-saving technologies could reduce water usage by 40% while improving yields by 15%.

Climate change presents a significant threat to litchi production. (Islam et al., 2021) observed that a 20% increase in temperature could reduce litchi yields by 20%. (Akratana et al., 2022) suggested that agroforestry and enhanced irrigation systems could mitigate the adverse effects of climate change. (Singh and Yadav 2020) emphasized water saving technologies, which reduce water usage and improve yield, addressing drought stress in Dinajpur. Climate-Smart Agriculture (CSA) practices, as discussed by (Dasgupta et al., 2020), further enhance resilience to climate variability. Market access and socio-economic factors are vital to profitability. (Chowdhury et al., 2018) noted that better market access stabilizes prices and reduces income volatility. However, seasonal labor migration creates labor shortages, disrupting productivity in Dinajpur (Chowdhury et al., 2019). Socio-economic barriers like land tenure issues and limited access to credit hinder the adopting of new technologies. (Das and Roy 2019) stressed that overcoming these barriers is crucial for increasing productivity and profitability. While challenges persist, adopting modern farming practices, improving irrigation systems, and investing in post-harvest technologies could substantially increase both productivity and profitability. Addressing socio-economic barriers is equally important. (Sarker et al., 2017) pointed out that limited access to credit and land tenure insecurity prevent farmers from investing in modern technologies. Overcoming these barriers will enable farmers to improve yields and increase income.

## 3. Methodology

### 3.1 Study Areas and Sample Size

The research was conducted in Dinajpur district and Sadar Upazila in Bangladesh. These are high litchi producing areas. Dinajpur is located in the northern part of Bangladesh. The region is characterized by favorable weather conditions and fertile soils, making it a key litchi producing area. Dinajpur's agricultural dominance and strong production of litchi made the district and the region suitable for studying the economics of litchi orchard. Sadar Upazila was selected due to its long litchi cultivation suburb. The area is a key producer of litchi in Bangladesh and provides a platform for litchi cultivation to small and large scale farmers. This makes the region an excellent area for studying the sustainable economics of litchi cultivation. Litchi cultivation in Sadar Upazila is an important livelihood activity for the residents and plays a vital role in the agricultural economy.

The region's accessibility, frequent visits by agricultural extension officers, and strong government support facilitated data collection and communication with the farmers. The research choice meets the country's agricultural sector focus that aims to enhance fruit production for both domestic use and international exports. The research's sample size of 164 farmers was large enough to make a valid conclusion about the cost-benefit finding. The sample's heterogeneity was diverse enough to stamp validity on the cost and margins findings of litchi cultivation. Consequently, the chosen study region and sample sufficiently support the research objective to give useful information about the economic practicality of litchi cultivation and its contribution to the nation-building via agriculture.

### 3.2 Data collection

The research was based on fieldwork for the objective of the study and on relevant secondary data for background and context debate. Data were collection through a semi-structured questionnaire administered in personal interviews with the famers. The survey was conducted between April 25, 2025 to April 28, 2025 in the Charhelgazi Union, Amtali, Bania Para, Kasba, and Mohonpur area of Dinajpur Sadar Upazila. A group of six people were assigned to collect data and collected 164 responses in 3 days.

The collection of the data required direct contact with the farmers, allowing the exactness of information through a standard and well-designed questionnaire. The main purpose of the per-test phase was to find common troubles that could cause confusion to the respondents. This allowed the exclusion of unclear or biased items in the questionnaire design and improved the questionnaire format for clearer understanding. After addressing the issues raised by the pilot survey, the questionnaire was finalized and considered suitable for both study sites. The 3-day period included capturing data collection from 9 a.m. to 5 p.m. daily.

The through data collection strategy ensured the credibility and dependability of the data to be used in further analysis to achieve the purposes of the study properly.

**Figure 1.** Pictures of data collection by the enumerators

**3.3 Data Analysis**

The "Cost and Benefit Analysis (CBA) of Litchi (Litchi chinensis) Production" was based on primary data collected from a field survey during April 2025. The data were closely reviewed to ensure that there were no errors or inconsistencies. The data was later organized in Microsoft Excel and analyzed by STATA 18.0 statistical software, which is designed for comprehensive statistical analysis.

The survey instrument consisted of three principal modules: a first module concentrated on socio-demographic aspects (age, gender, education, household size) a second module collected information on costs associated with litchi production; the third module examined income diversification and expenditure patterns of the household. The resulting data were coded, organized, summarized, and analyzed through descriptive and econometric models.

Descriptive types of analysis were used to present summary statistics in terms of numbers and percentages that were presented in several tables and produced with Excel and tabular methods. This approach properly represented the data and enabled the discovery of patterns and connections in the studied area.

Quantitative data were analyzed through Linear Regression Analysis and the Multinomial Logit Model to explore the relations between production costs, income, and benefits associated with the production of litchi. To verify the results, the validity and robustness of the study were tested through multicollinearity.

The analytical tools provided reliable information on the economic aspects of litchi production, contributing toward the overall comprehension of costs, returns, and income diversification, supporting the achievement of the objectives of the study.

**3.4 Production Function**

Litchi production is estimated based on the Cobb-Douglas production function, which is a valuable tool in agricultural economics to estimate the relationship between input and output (Tang et al. 2023; Ahmad et al., 2024). This production function measures the productivity effects of different inputs like labor, capital, and resources on litchi production (Schreinemachers et al. 2010; Rabbani and Ahmad, 2021).

The general form of the multiple regression equation for the Cobb-Douglas production function is as follows:

$$X = \alpha Y_1^{\beta 1} Y_1^{\beta 2} \ldots\ldots\ldots\ldots Y_n^{\beta 1} e^{ui}$$

Where,

X = Dependent Variable,

$Y_1 \ldots\ldots\ldots\ldots Y_n$= Independent Variable,

α = Independent Variable,

$\beta_1$, $\beta_2$…... $\beta_n$= Coefficient of Relevant Variable,

$u_i$ = Error Term,

e = Natural Logarithm. The Cobb-Douglas Production Function (CDPF), when transformed into linear form, is used in this study to assess the production of litchi. This transformation makes the estimation of model parameters addible through multiple regression (Chen & Yao 2024). The log form explains the associations between the dependent variable (output) and the explanatory variables (inputs), and it can be understood how these factors affect the production of litchi farming quite well (Huang et al. 2019; Tusher et al., 2025).

### 3.5 Production Function Application to Litchi Production

This research employs the Cobb-Douglas production function to describe the relationship between the input in litchi plantings, such as labor, capital, and land, and the output of litchi. This model allows us to determine the marginal product of each input as well as the effect of different levels of labor, capital, and other inputs on the total litchi yield achieved (Grovermann et al. 2013).

The regression enables the estimation of the coefficients $\beta_1$, $\beta_2$, and $\beta_3$ that provide very crucial information about resource allocation efficiency and efficacy in litchi production. If $\beta_1$ (labor coefficient) is large, this means that increasing labor input will significantly expand litchi production, other things being equal. If $\beta_3$ (the estimate for the use of fertilizer or pesticide) is small, it suggests that increasing the use of these inputs might not have much influence on yield.

The results yielded by the Cobb-Douglas production function will be important for understanding the cost-benefit trade-off in litchi production (. Thus, farmers and policymakers will see the most efficient and profitable input combinations for maximizing litchi output.

The standard logarithmic form of the Cobb-Douglas production function is given by:

$$\text{In}X_i = \text{In}\beta_0 + \beta_1\text{In}Y_{1i} + \beta_2\text{In}Y_{2i} + \beta_3\text{In}Y_{3i} + \beta_4\text{In}Y_{4i} + \beta_5\text{In}Y_{5i} + \beta_6\text{In}Y_{6i} + \text{In}Y_{7i} + \beta_8\text{In}Y_{8i} + \beta_9\text{In}Y_{9i} + u_i$$

Where,
In =Natural logarithm,
$X_i$ = Yield of Litchi for the i-th farm (Tk/kg),
$Y_{1i}$=Human labor (Man-Days),
$Y_{2i}$=Animal power cost (Taka),
$Y_{3i}$= Fertilizer (Cow dung, Urea, TSP, DAP, MoP, Magnesium, Vitamin) (Kg),
$Y_{4i}$=Pesticides (Kg),
$Y_{5i}$=Others (Zinc, Sulphate, Gypsum, etc.) (Kg),
$Y_{6i}$=Irrigation changes (Taka)
$Y_{7i}$=Depreciation of farm implements (Taka),
$Y_{8i}$= Land rental value (Taka),
$Y_{9i}$= Interest on operating cost (Taka), $\beta$s are unknown parameters to be estimated , $u_i$ = Stochastic error term derived from a composite error model $\varepsilon_i$ and $v_i$which are presumed to be completely and identically distributed random error and are independent of $u_i$

#### 3.5.1 Explanation and Relevance of model to Litchi Production

The above linearized version of the Cobb-Douglas production function provides a mathematical framework to analyze the impact of various inputs on the production of litchi. By estimating the coefficients ($\beta_1$, $\beta_2$, $\beta_3$, …, $\beta_9$), we can quantify how much each input factor contributes to the total output of litchi. For instance:

a) Labor Input (L): As the coefficient $\beta_1$ shows the degree of responsiveness of litchi production to the changes in labor. If $\beta_1$ is a big number, this means labor is important for litchi yield. Animal Power (A): The value of the coefficient $\beta_2$ will indicate the significance of animal power as an input in the production process. The positive and highly significant $\beta_2$

reveals the efficient utilization of animal power in the production of litchi.

b) Fertilizers (F) and Pesticides (P): The effects of the inputs -fertilizers and pesticides ($\beta 3$, $\beta 4$) on litchi yield will be analyzed. If the $\beta_3$ or $\beta_4$ would be larger, it would mean that these inputs have a greater role in enhancing productivity.
c) Irrigation (I) and Depreciation of Farm Implements (D): These conditions affect the general cost on the farm and hence affect the product. The cost effect coefficients $\beta_6$ and $\beta_7$ are useful to understand the role of such costs in production inefficiency.

**d) Land Rental Value (R) and Interest on Operating Costs (C)**

They represent land and capital costs, and coefficients $\beta_8$ and $\beta_9$ are used to estimate the impact of these factors on production. Using this functional form, this study can analyze the efficiency of resource allocation, and it can identify the most important inputs (human labor, capital, fertilizers, etc.) in the production of litchi. This study would be useful in determining economically viable options for increasing litchi yield by physical input application.

### 3.6 Profitability Analysis

Profitability examination is the possibility to assess the economic profitability of litchi cultivation. The input and output variables are measured per hectare in this study, such as production needs and total litchi production (Akter et al. 2015). The objective of the present study is to determine the profitability of lychee cultivation by working out a gross return, the net return, and other relevant economic parameters

#### 3.6.1 Gross Return

The gross return is the sum of the output value of litchi. This is calculated by multiplying the total quantity of litchi produced with the average market price of the litchi (Akter et al. 2015). This calculation finds the total earnings of litchi cultivation per acre.
The formula used to calculate the gross return is as follows:

$$GR_i = \sum_{i-1}^{n} Q_i P_i + \sum_{i-1}^{n} B_j$$

Where,
$GR_i$ = Gross return from ith production (Tk/ha),
$Q_i$ =Quantity of the main Product (Kg/ha),
$P_i$ = Average Price of the ith main Production (Tk/ha),
$B_j$ = Estimated value of ith by-product (Tk/ha)
where; i, j = 1, 2, 3, ……………, n.
In this case, the quantity of litchi is calculated per hectare, and the average price is derived from market data. The by-products of litchi farming, such as residues, compost, or secondary products, are also accounted for in the gross return, though they may be less significant compared to the main product.

#### 3.6.2 Net Return

The net return is the profit from litchi farming after all expenses (both variable and fixed) have been deducted from the gross return. It reflects the actual financial benefit a farmer gains from cultivating litchi (Schreinemachers et al. 2010).
The formula to calculate the net return is:

$$\prod = \sum P_m Q_m - \sum (P_{xi} X_i) - TFC$$

Where,
$\pi$ = Net return(Tk/ha),
$P_m$ = Per Unit Price (Tk/kg),
$Q_m$ = Quantity of the production per hectare (Kg),
$P_{xi}$ = Per unit price of i th inputs (Tk),
$X_i$ = Quantity of the inputs per hectare (Kg), TFC = Total Fixed Cost (TK),
i = 1, 2, 3, …… n. (number of inputs).
In this formula, the gross return (G) represents the total income from litchi production, while the term ($\sum (P_{xi} X_i$)represents the total variable costs associated with inputs such as labor, fertilizers, pesticides, irrigation, etc. TFC (Total Fixed Cost) is the sum of costs that is not attributable to any level of production directly like depreciation of farm machinery, Rental value of land or Interest on operating costs.

### 3.6.3 Breakdown of Costs

The study includes an itemized description of costs and receipts. These costs can further be divided into variable costs (i.e. costs that vary according to the volume of output, e.g. labour, fertilizers, pesticides) and fixed costs (i.e. costs which do not vary with output, e.g. depreciation of machinery, rental value of land). Gross return and net return are important indicators to measure input use efficiency and profitability of litchi farming.
Variable Costs: It comprises of costs of human labor (expressed in man-days), animal labor (in Taka), fertilizers (in kg.), pesticides (in kg.) and other inputs - zinc and gypsum, irrigation costs, etc.

### 3.6.4 Fixed Costs

These include depreciation of farm implements, land rental value, and interest on operating costs.

### 3.6.5 Benefit- Cost Ratio (BCR)

Benefit-cost ratio (BCR) is an important measure of profitability for litchi cultivation. It quantifies the returns to the input in relation to the costs (both fixed and variable) paid at the input market level (Afroz et al. 2025). A descendent of the BCR larger than 1 means the return is greater than the costs, and therefore, the considered investment is profitable.
The Benefit-Cost Ratio can be computed by the formula:

$$BCR = \frac{\text{Gross Benefit}}{\text{Gross Cost}}$$

Where
Gross Return = The total income generated from litchi farming (in Taka),

Total Costs = The sum of all variable and fixed costs incurred in the production process (in Taka).
A higher BCR indicates a more profitable litchi farm, and the investment in litchi production is a profitable investment compared to the cost incurred.

### 3.6.6 Factors affecting Profitability

Multivariate method was applied to investigate the determinants explain the profitability of litchi production (Li et al. 2019). This is considering the evaluation of Cost-Benefit Ratio (CBR) as the main economic return indicator. The CBR is the dependent variable and socio economic factors such as age, education, household size, land holding, distance to the market, income from litchi, other diverse income etc are independent variables in the analysis (Harvey et al. 2014).
The profit analysis model in a general form is:

$$\text{In}P_i = \text{In}\alpha_0 + \text{In}\beta_1 Y_{1i} + \text{In}\beta_2 Y_{2i} + \text{In}\beta_3 Y_{3i} + \text{In}\beta_4 Y_{4i} + \text{In}\beta_5 Y_{5i} + \text{In}\beta_6 Y_{6i} + \text{In}\beta_7 Y_{7i} + \varepsilon_i$$

Where**,**
In =Natural Logarithmic Function,
P = Profitability measured by Benefit-Cost Ratio (BCR),
$Y_1$ =Age of the Farmer measured in years,
$Y_2$ =Education level measured of schooling,
$Y_3$ = Household size measured in number,
$Y_4$ = Cultivable land measured in hectare,
$Y_5$ = Distance for local market measured in kilometer
$Y_6$ = Income from litchi measured in taka,
$Y_7$ = Diversified income source measured in number,
$\alpha_0$, $\beta_1$, $\beta_2$ $\beta_3$.....................$\beta_7$ = Represent the unknown parameters to be estimated in the model. These parameters account for the influence of various factors, and I denote the individual observations
where i = 1,2,3, ..., n by applying this model.

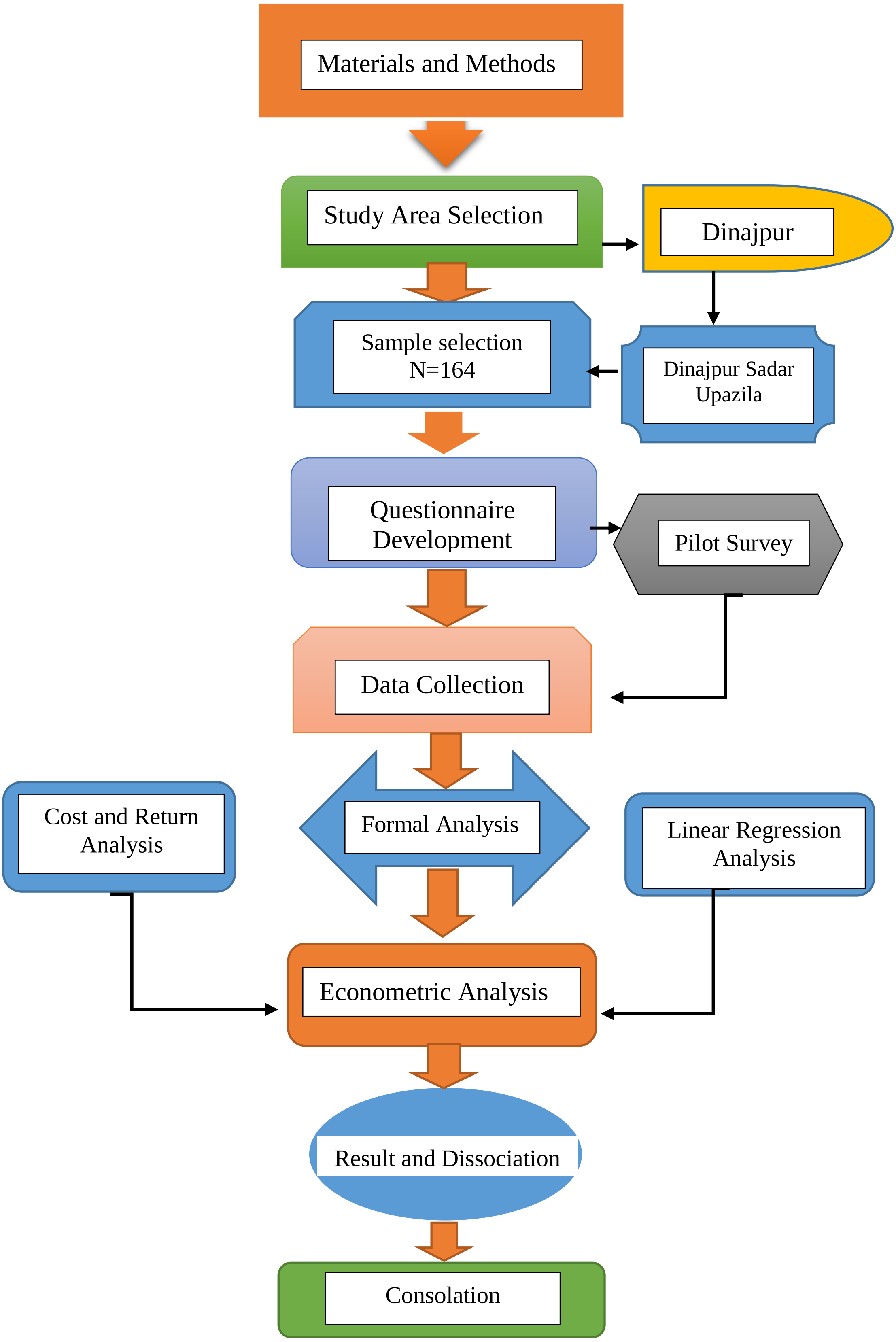




**Figure 2.** A schematic view of the methodology of this study

# 4. Result

## 4.1 Socioeconomic Characteristic of Farmers in Litchi Production

Farmers' socioeconomic status is an important factor in understanding their financial capacity and utilization of crop production resources, thereby enhancing production practices. From Table 1, we suggest the socioeconomic profile of the litchi farmers of Dinajpur in the next, which is based on the findings.

**Table 1.** Descriptive statistics of litchi farmers

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Age | 49.171 | 12.31 | 19 | 84 |
| Education level | 6.244 | 5.061 | 0 | 20 |
| No. of Dependent | 3.683 | 1.987 | 1 | 08 |
| Household size | 5.823 | 4.959 | 2 | 16 |
| Source of income | 2.024 | .821 | 1 | 4 |
| Homestead Land (hectare) | 0.056 | 4.129 | 0.021 | 0.43 |
| Asset (BDT.) | 3533652.4 | 3030653.6 | 30000 | 25000000 |
| Loan (BDT.) | 51165.644 | 141043.92 | 0 | 1000000 |
| Saving | 0.561 | .498 | 0 | 1 |
| Distance (Kilometer) | 5.285 | 4.614 | 0.10 | 17 |
| Cultivable land (ha.) | 0.894 | 80.708 | 0.097 | 4.48 |
| Litchi Cultivable land (ha.) | 0.556 | 9.129 | 0.061 | 2.43 |

**Source:** Authors own calculation from Field Survey, 2025

The above table 1 depicts the socio-economic features of litchi farmers. It issues different aspects that affect farming practices and the economic status of the farmer. The average age of farmers is 49.17; however, there is a wide range queue from 19 to 84, which includes a mix of young farmers and elderly farmers. This range may influence the availability of labour as young farmers might be more inclined to newer farming techniques than elderly farmers. Further, due to the high risk of physical activity and the inequalities of age, elderly farmers may be more exposed to physical strain. The overall education level is 6.24 years with substantial variations. In summary, the farmers are not the same; some farmers who have limited form of education are likely not to be well placed in managing their finance and be reluctant to foster other new farming techniques while business-oriented farmers will be very comfortable and manage to do well to earn more from plantation. The same applies to land, which is.056 hectares' homestead and 0.894 hectares cultivable with substantial variations. Tick farmers must have the advantage as they have plenty of lands to invest in and gain more produce. Furthermore, looking at the overall low-asset value, it shows there might be economies of financial capabilities.

## 4.2 Per Hectare Cost Structure of Litchi Production

Table 2 shows an elaborate breakup of the cost per hectare for litchi. The costs are categorized into variable costs and fixed costs**.** This breakdown helps us understand how the costs for litchi farming are structured and which cost components are more significant.

The table 2 elaborates the production costs, denoted in BDT, such as the operating or working capital involved in litchi farming. As shown, the latter can be broken into two categories:

variable and fixed costs. Human labour costs 24,750 BDT for a total of 45 man-days, which corresponds to 10.04 per cent of all costs and one of the areas where litchi farming entails the most expenses. Animal power is not paid for as such, which can be an indication that it is not used for work such as plowing. Fertilizer costs of producing cow dung, urea, TSP, DAP, MoP, magnesium and vitamins are 31,566 BDT for 12.80 per cent, which is expensive yet crucial for soil fertility and crop growth. Pesticides are among the costliest at 13,832 per 5.61 percent for 4.61 kg and utilized for pest control and fruit quality sustainment. Other costs such as zinc sulphate and gypsum contribute 8,589 per 3.48 percent to soil improvement. Irrigation is costly but not exceedingly and amounts to 7,000 BDT 2.84 percent. The total variable cost equals to 85,727 BDT or 34.79 percent. The fixed cost comprises the depreciation of farm implements 970 BDT 0.39 percent. Land rental takes the largest share at 158,700 BDT, which is 64.40 percent of the overall fixed costs burden and suggests a significant financial cost of land use in this case of cultivation. Interest reflects the financing cost of operating the farm and amounts to 1,036 BDT 0.04 percent of the overall costs. Therefore, the total cost of litchi farming is 246,433 BDT with 34.79 percent being variable costs and 65.21 percent fixed. The latter is particularly notable given the importance of fixed costs such as land rental which significantly affects the overall financial feasibility of litchi farming in the area.

**Table 2**. Per Hectare Cost Structure of Litchi Production

| **SL. No.** | **Inputs of Production** | **Units** | **Average Quantity** | **Cost (Tk.)** |
|---|---|---|---|---|
| **A.** | **Variable cost** | | | |
| 1. | Human labor | Man-days | 45 | 24750 (10.04) |
| 2. | Animal power cost | Taka | 0 | 0 (0.00) |
| 3 | Fertilizer (Cow dung, Urea, TSP, DAP, MoP, Magnesium, Vitamin) | Kg | 352 | 31,566 (12.80) |
| 4 | Pesticides | Kg | 4.61 | 13832 (5.61) |
| 5 | Others (Zinc sulphate, Gypsum, etc.) | Kg | 409 | 8589 (3.48) |
| 6. | Irrigation charges | Tk. | 3 | 7000 (2.84) |
| **Total variable cost** | | **Taka** | **813.61** | **85,727** (34.79) |
| **B.** | **Fixed cost** | | | |
| 7 | Depreciation of farm implements | Taka | -------- | 970 (0.03) |
| 8 | Land rental value | Taka | -------- | 158700 (64.40) |
| 9 | Interest on operating cost | Taka | -------- | 1036 (0.04) |
| **Total fixed cost** | | **Taka** | **--------** | **160,706** **(**65.21) |
| **C.** | **Total Cost (A + B)** | **Taka** | **813.61** | **246433.00 (100)** |

**Source:** Authors own calculation from Field Survey, 2025
**Note:** Figures within parenthesis indicate percentage of total cost

### 4.3 Litchi Yield, Cost and Profitability for Small Farmers

The yield, cost, and returns data for small farmer company-led litchi cultivation can be seen in Table 3. It focuses on the economic issues of litchi cultivation with specifics of gross return, net return, gross margin, benefit-cost ratio (BCR). The table 3 demonstrates the economic analysis of litchi farming for small farmers. The analysis accounts for the yield, cost, and the final return that benefits the farmers. In this case, small farmers produce 185,250 units of litchi, from which they receive 555,750 BDT as a gross return. The total cost of production is 246,433 BDT, with variable cost of 85,727 BDT, which includes cost of labour, fertilizers, and pesticides, and fixed cost of 160,706 BDT, including land rental, depreciation, and interest on operating costs. The difference between variable cost and gross return is a gross margin of 470,025 BDT which indicates the returns from operations before fixed cost. The net return after considering both variable and fixed cost is 309,317 BDT, indicating the overall profitability of the farming operation. The Benefit-Cost Ratio of 2.25 reveals that for every 1 BDT spent on litchi farming, the farmers realize a return of 2.25 BDT. In conclusion, litchi farming is an economically viable venture for a small farmer due to the positive net return and vast return on invested income.

**Table 3.** Litchi Yield, Cost and Profitability for Small Farmers

| Sl. No. | Particulars | Units | Small farmers |
|---|---|---|---|
| 1. | Yield | Quantity Number | 185250 |
| 2. | Gross return (Unit Price × Yield) | Taka | 555750 |
| 3. | **Total cost (a + b)** | Taka | **246433** |
| a. | Total variable cost | Taka | 85,727 |
| b. | **Total fixed cost** | Taka | **160,706** |
| 4. | Gross margin (2 – 3.a) | Taka | 470025 |
| 5. | Net return (2 - 3) | Taka | 309317 |
| 10. | BCR (Undiscounted) (2 ÷ 3) | Taka | 2.25 |

**Source:** Authors' calculation from field survey, 2025

### 4.4 Determinants of Profitability of Litchi Cultivation

The regression model results (Table 4) reveal the relationship between various socio-economic factors and the likelihood of a specific outcome predicted in litchi farming. Here, the probability of the dependent variable is the choice of yielding more output; all else remaining constant. Table 4 below summarises the regression model results on the eight independent variables considered, where the coefficients represent their relationships to the dependent variable. Thus, the regression model shows that: age with a coefficient of -0.035 on age has a statistically insignificant p-value of 0.683; that is, age has no significance on the likelihood of the dependent variable. Educational status having p value of 0.039 on an insignificant coefficient of 0.025 at the 5% level implies that farmers with advanced education are more likely to obtain the outcome, which means education-related quality improvement in farming or decision-making. Coefficient on the household size is -0.023, with a p-value of 0.062 that is marginally significant at the 10% level; the negative coefficient suggests a reduction in the likelihood of the outcome; this increases consumption demands or reduces available labour. The coefficient on cultivable land is 0.682, with a p-value of 0.004 statistically significant at the 1% level; this indicates a highly positive term implying that greater cultivable land increases the likelihood of the outcome. The coefficient from the local market is 0.054, and the p-value is 0.688, is statistically insignificant. A coefficient of 0.236 on litchi income, with a p-value of 0.056, is not statistically significant.7. The coefficient on diversified income sources is -0.005, with a p-value of 0.001. The coefficient is negative and highly statistically significant at the 1% level; thus, diversified income sources reduce the likelihood of the outcome. The constant term is 3.653 with a p-value of 0.000 indicates that the univariate symmetrical likelihood is highly significant. The model explains 15.8% of the variance in the dependent variable, signifying a relatively poor fit. The F-test result is significant at the 1% level, and the AIC and BIC values provide evidence for the model's goodness of fit. Overall, the quality in the model results shows that education, land size, and income diversification significantly impact the outcome variable, with land size being the most significant.

**Table 4.** Linear Regression Analysis

| **Variables** | **Coef.** | **St.Err.** | **t-value** | **p-value** | **Sig** |
|---|---|---|---|---|---|
| Age | -0.035 | 0.086 | -0.41 | 0.683 | |
| Educational status | 0.025 | 0.012 | 2.08 | 0.039 | ** |
| Household size | -0.023 | 0.012 | -1.88 | 0.062 | * |
| Cultivable lands | 0.682 | 0.234 | 2.92 | 0.004 | *** |
| Distance from local market | 0.054 | 0.133 | 0.40 | 0.688 | |
| Income from litchi | 0.236 | 0.123 | 1.93 | 0.056 | * |
| Diversified Income source | -0.005 | 0.002 | -3.27 | 0.001 | *** |
| Constant | 3.652 | 0.258 | 14.14 | 00.00 | *** |
| Extra Statistics | | | | | |
| Mean dependent var | 2.961 | SD dependent var | 0.795 | | |
| R-squared | 0.158 | Number of obs | 164 | | |
| F-test | 4.197 | Prob > F | 0.000 | | |
| Akaike crit. (AIC) | 377.026 | Bayesian crit. (BIC) | 401.825 | | |

*Asterisks indicate *** p<.01, ** p<.05, * p<.1*

**Source:** Authors own calculation from Field Survey, 2025

### 4.5 Result of Multicollinearity Test

Testing for multicollinearity is vital for the reliability of regression estimates. Multicollinearity happens when independent variables show high correlation, resulting in high standard errors and unstable estimates. To ascertain this, the VIF values for each variable was tested. The VIF scores ranged from 1.040 to 1.240, mean of 1.110, well below the point where it becomes problematic at 10 indicating no multicollinearity concerns (Table 5). This then affirms that independent variables avail independent information and thus the developed regression model is robust and statistically valid for evaluating litchi profitability in the study area.

**Table 5.** Multicollinearity Test

| **Variable Name** | **VIF** | **1/VIF** |
|---|---|---|
| Age | 1.240 | 0.806 |
| Educational status | 1.170 | 0.856 |
| Household size | 1.130 | 0.884 |
| Cultivable lands | 1.090 | 0.918 |
| Distance from local market | 1.050 | 0.952 |
| Income from litchi | 1.050 | 0.954 |
| Diversified Income source | 1.040 | 0.959 |
| **Mean vif** | **1.110** | |

**Source:** Authors own calculation from Field Survey, 2025

## 5. Discussion

This study provides a detailed cost and benefit analysis of litchi farming in Dinajpur, Bangladesh, revealing that litchi farming is profitable but requires careful management of key challenges such as land rental costs, labor demands, and input expenses to ensure sustainability. The benefit-cost ratio (BCR) of 2.25 and the net return of 309,317 BDT per hectare indicate that litchi farming provides more than double the return on investment. These results are in line with (Kumar et al., 2021), who found similar profitability in India's Eastern region, where climatic conditions are comparable to Dinajpur.

A primary factor impacting profitability is the high cost of land rental, which constitutes 64.40% of fixed costs. This is a major barrier, especially for farmers who do not own land. As (Das and Mukherjee 2017) pointed out, renting land restricts farmers from benefiting from long-term land appreciation and makes them vulnerable to fluctuating rental prices. Research by (Smith et al. 2019) has also shown that land tenure systems significantly influence farming profitability, further supporting the need for land reforms. Addressing this issue through land reform policies, such as reducing rental costs or offering land ownership programs, could significantly improve farmers' profitability. For example, in China, land reforms have successfully increased land productivity and farmer incomes (Chen et al., 2018).

Implementing similar policies in Dinajpur could help stabilize farmers' earnings. Labor costs, representing 10.04% of total production costs, also impact the profitability of litchi farming. Litchi cultivation is labor-intensive, requiring significant human effort during planting, pruning, pest control, and harvesting. As (Rahman & Hossain 2019) highlight, labor dependency in agriculture is high, and reducing this reliance through mechanization can lead to greater efficiency and cost savings. According to a study by (Patel et al. 2020**)**, countries like Thailand have successfully integrated mechanization in fruit farming, boosting productivity and reducing labor costs. Similarly, introducing mechanization in Dinajpur could help farmers reduce the labor burden and increase production efficiency.

Fertilizer and pesticide expenses make up 12.80% and 5.61% of the total production costs, respectively. These inputs are crucial for maintaining soil health and controlling pests. However, high input costs can be a financial strain on farmers. In countries like Vietnam, cooperative purchasing systems and government subsidies have been successful in reducing input costs for farmers. A similar approach by (Lin and Zhang 2021) in promoting bulk purchasing for fertilizers reduced costs significantly. Moreover, integrated pest management (IPM) practices, as used in Brazil and India, could reduce pesticide costs and minimize environmental impact while improving crop yields. Post-harvest losses due to inadequate cold storage and transportation infrastructure also affect profitability. (Sarker et al. 2020) highlighted that such losses could reach up to 25%, which directly impacts farmers' revenue. This issue is not unique to Dinajpur, as countries like the Philippines face similar challenges.

However, investing in cold storage and transportation systems, as seen in Israel, has significantly improved the shelf life of fruits and market access. A report by (Delgado et al., 2021) provides evidence that enhancing post-harvest infrastructure can increase profitability by reducing waste and extending market reach. Implementing such systems in Dinajpur would result in higher profits for farmers by reducing wastage and ensuring fresher produce reaches the market. Farm size and education level also play a significant role in determining profitability. Larger farms benefit from economies of scale, which allow them to spread fixed costs over greater production volumes, thus reducing per-unit costs (Pender & Gebremedhin, 2008). Additionally, educated farmers are more likely to adopt modern agricultural practices and improve farm management, leading to higher productivity. Studies in Kenya have shown that agricultural education programs lead to increased adoption of modern technologies, resulting in higher yields and income.

This suggests that promoting education and training programs for farmers in Dinajpur could improve both productivity and profitability (Sultana & Rahman, 2020). The study also reveals that income diversification negatively affects litchi profitability. Farmers who engage in non-agricultural activities tend to focus less on expanding litchi production. Specialization in litchi cultivation, as seen in Nepal, where farmers focusing on high-value crops like litchi achieved better economic returns, could lead to more profitable outcomes in Dinajpur as well.

## Conclusion

This study was a detailed account of the economic feasibility and profitability of Litchi honey cultivation in Dinajpur, Bangladesh. It demonstrates the high potential of Litchi cultivation for small burden farmers, but also highlights the constraints limiting its profitability. For farmers, the high cost of land rental, intensive labor and losses during the post-harvest period because of insufficient storage and transport, are serious constraints. Nevertheless, Litchi farming is still a profitable enterprise with BCR of 2.25 but provision of infrastructures, market accessibility and technological adoption are sine qua non for sustainability. The research also proves that the development of value-added product like products (Jam and Juice) is very important which can increase the shelf life of Litchi and generate additional income for the farmers. It also asks for greater linkage for farmers with the international markets, especially the ones in Southeast Asia and Middle East, policy support in the form of cheap credit, mechanization and responses to climate change to cushion the effects of environmental variance. The study recommends, not only financial transformation, but the provision of education, modern agricultural practices and farming technologies to farmers among others so that farming could be optimized for cost and efficiency. Although the research is informative to understand the constraints and possibilities of Litchi cultivation in Dinajpur, it has limitations such as retrospective concentration on small areas and absence of follow-up data. These vacuum existences provide with potential areas of further investigation, thus a focus on climate change, technology evolution, and export markets on Litchi production. In the end, this paper provides a base for future investigations on sustainable Litchi farming and provide important policy implications that could potentially enhance agricultural economy in Bangladesh and improvements in rural farmers' livelihoods.

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**Conflict of Interest**
Authors declare that they have no conflict of interest.

**Data Availability**
Data will be available on reasonable request.

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