International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 11, Issue: 05 "September-October 2025"

COST-BENEFIT ANALYSIS OF LITCHI PRODUCTION IN DINAJPUR DISTRICT, BANGLADESH

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DOI: https://doi.org/10.51193/IJAER.2025.11515

Received: 09 Sep. 2025 / Accepted: 19 Oct. 2025 / Published: 23 Oct. 2025

ABSTRACT

Litchi (*Litchi chinensis Sonn*.) is one of the widely cultivated and commercially important fruit crops of Bangladesh, and Dinajpur district is considered the main production hub of Litchi in Bangladesh due to having the most suitable soil and climate. Litchi farming, while being a very profitable enterprise, is constrained by several production and marketing challenges, and there is limited empirical evidence on its profitability dynamics at the local level. The returns to the region, input use, and constraints have often been disregarded in previous work on profitability; these studies are likely to have limited development policy/extension planning implications. This research was performed to determine the cost-benefit situation of litchi production at the Nawabganj Upazila of Dinajpur district in terms of its socio-economic aspects, profitability, and production constraints. Data were compiled from 83 respondents using Slovin's Formula and simple random sampling. Descriptive statistic was used to describe the variables across the Cobb-Douglas production function to estimate the input-output relationship. Results indicate that litchi cultivation is profitable; on average, it generates BDT 132,146 of gross return per acre, providing a net return of BDT 55,423 and a cost-benefit ratio (BCR) of 1.72. Fertilizer, pesticide, and irrigation inputs were the most important positive contributors to production, whereas over-labor usage and intercultural practices were negative determinants of output. Farmers identified serious limiting factors, including a high incidence of pests, expensive inputs, bad weather, poor training facilities, storage facilities, and an unfavorable market structure dominated by middlemen. The

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results indicate the economic profitability of litchi cultivation in Dinajpur and some crucial institutional and infrastructural lacunae. Significant gains in profitability and sustainability can be made by improving the training of farmers, the quality of input supply, the storage and transport infrastructure, and giving access to a fair market. These findings can be used as region-based evidence for policymakers, extension services, and development organizations for formulating a strategy to develop litchi growers and encourage the rural economy of Bangladesh.

Keywords: Litchi production; Cost-benefit analysis; Profitability; Cobb–Douglas production function; Production constraints.

1. INTRODUCTION

Litchi is one of the most favored and economically important fruit crops of the South Asia region owing to its typical taste, high consumer demand, and its staple contribution to the rural economy (Mondal *et al*., 2021; Sathe, 2011). It was first known in China more than 3000 years ago and subsequently became epidemic in Bangladesh, Myanmar, and the sub-tropical region (Hossain et al., 2014). Currently, litchi is grown in all major subtropical litchi-producing areas, which include China, Taiwan, Thailand, India, and Bangladesh (Singh *et al*., 2012, BBS, 2013). The Dinajpur district stands at the top of litchi fruit production because of its congenial soil and climatic factors (Alam, 2004; Hossain *et al.*, 2012). It has a double function of being a source of household income and a cash crop for smallholder and medium-sized farmers, in addition to having a strong domestic market demand (FAO, 2002; BBS, 2018).

However, Litchi production is not without challenges because, among other reasons, it is affected by high cost of production, pest infestation, perishability of fruits, and market imperfections (Momen *et al*., 1993; Molla *et al*., 2010; Aklimuzzaman *et al*., 2011). It is a very perishable fruit that registers rapid postharvest physiological changes, resulting in important losses during storage, transportation, and commercialization. Bombai, China-3, Bedana, and Madrazi are some of the common varieties in Dinajpur district; however, BARI Lichu-1, 2, and 3—in particular BARI Lichu-3-are promising varieties over the recently released high-yielding varieties, which performed well in yield and fruit quality (BARI *et al.*, 2017). Litchi has economic and nutritional importance as it is abundant in vitamin C, antioxidants, and minerals, and is commercially processed into canned, litchi squash, jelly, dried litchi, and litchi-based beverages (Bose & Mitra, 1990; Scanlan, 1995; Kumar *et al.*, 2018; Shimpy *et al.*, 2022).

From Bangladesh and adjacent countries, there are few studies on the litchi profitability, marketing efficiency, and post-harvest issues (Akter *et al.*, 2015; Kumar and Kumar, 2018; Chandel, 2013). Results consistently demonstrate that litchi agriculture exhibits high gross margins and favorable benefit-cost ratios (Roy, 2020; Sharma & Singh, 2018; Akter *et al.*, 2016). Yet, most of these studies are essentially of a general nature and not of a regional application, focusing on average

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values at the basin level. Specifically, there is limited empirical information on the cost-benefit relationship of litchi production in Dinajpur. In addition, studies that incorporate production costs, returns, and the effect of inputs using economic models are limited (Newar & Borah, 2023; Kayastha *et al*., 2020). The absence of these local evidences restricts policy makers, including the extension agents, to have options and decisions that have the prospects of enhancing farmers' profitability.

To fill in this gap, in the present study, the cost-benefit analysis of litchi production was carried out in Nawabganj Upazila under Dinajpur district. Drawing upon primary data from the orchard growers and using descriptive statistics and the Cobb-Douglas production function, production cost returns, profitability indicators, and key constraints are evaluated. The significance of the set of factors at the regional level and the most influential inputs affecting litchi production is the leading leverage of the study. The study is expected to contribute to developing location-specific evidence for policy guidance, extension advisory, and for undertaking informed decisions to enhance marketing, sustainable litchi production in Bangladesh.

1.1 Objectives of the Study

i. To know the socio-economic condition of the litchi farmers.
ii. To evaluate the cost-benefit status of litchi in Dinajpur district.
iii. To identify the major challenges faced by litchi farmers in terms of the production of litchi in Dinajpur district.

2. LITERATURE REVIEW

It is indispensable to know the state-of-the-art of literature on litchi production, profitability, marketing, and postharvest management. Earlier reports have also focused that litchi is a profitable crop and is gaining importance because of consumer preferences and diversification avenues. For example, Belal (2023) demonstrated that Bangladeshi farmers perceive litchi plant growth to be attractive, even with limited resources, such as land. Litchi was reported as a very lucrative crop with the high gross margins per acre by Roy (2020), and Sharma and Singh (2018) also found that litchi gives more net returns if the farmer sale was done directly in the market instead of selling through preharvest contractors. Consistent findings were also reported by Akter and co-workers (2016), who found positive Benefit-Cost Ratios (BCR), Net Present Value (NPV), and Internal Rate of Return (IRR) for the Dinajpur litchi farming.

In addition, various researchers have focused on marketing efficiency and postharvest problems. Newar and Borah (2023) and Kayastha *et al.* (2020) determined that direct marketing is more remunerative than marketing through preharvest contractors, and Kumar and Kumar (2018) highlighted the variations in marketing efficiency among channels in Muzaffarpur. Chandel (2013)

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emphasized the small scale of India's presence in the international litchi trade because of poor postharvest conditions, and Molla *et al.* (2010) and Aklimuzzaman *et al.* (2011) reported high losses after harvest, and a short shelf-life interval and susceptibility to fungal diseases are the main challenges, respectively. More recently, Deshi *et al.* (2022) and Siddiqui *et al.* (2021) showed that postharvest treatments, including methyl jasmonate and hydrogen sulfide fumigation, might help in increasing shelf life, which showed that technological interventions could mitigate the losses. Socioeconomic research (Ibnat *et al.*, 2020; Alam, 2016) also highlighted the farmer characteristics, levels of adoption, and infrastructural constraints that affect productivity and profits.

There are still gaps in location-specific cost-benefit analyses despite the numerous existing studies at the global level. Though the profitability, marketing channels, and postharvest problems have been well documented (Akter *et al.*, 2015; Kumar & Kumar, 2020), only a few studies have been conducted to explicitly analyze the economics of production of litchi in Dinajpur. This study intends to fill that void by comprehensively analyzing the cost and return of litchi cultivation in the area. Such an analysis will enable policymakers and stakeholders to take evidence-based decisions and improve the production efficiency, marketing planning, and farmers' profitability in Bangladesh.

3. METHODOLOGY

3.1 Study Design and Sample Distribution

The study used a quantitative research approach to examine the production practices of litchi farmers in Nawabganj Upazila, Dinajpur District. Due to time and resource constraints, it was not feasible to interview every litchi grower in the sample locations. Because of this, sample sizes for litchi growers that are at least adequate to meet the study's aims were selected using Slovin's Formula.

Table 3.1: Study area and population size

Union	Population size
Mahmudpur	211
Binadnagar	183
Daudpur	104
Total	498

Slovin's Formula $n = \frac{N}{1+Ne^2}$

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Where,

n is the sample size

N is the population size

e is the margin of error

Here,

N= 498

e = 10%= 0.1

$$n = \frac{498}{1+\{498\times(0.1)^{2}\}}$$
$$= \frac{498}{1+(498\times 0.01)}$$
$$= \frac{498}{5.98}$$
$$= 83.28 \approx 83$$

Respondent Sample Size $= \frac{\text{RPS}}{\text{N}} \times \text{n}$

Where,

RPS = Respondent Population Size

$$\text{Mahmudpur} = \frac{211}{498} \times 83 = 35.17 \approx 35$$

$$\text{Binadnagar} = \frac{183}{498} \times 83 = 30.5 \approx 31$$

$$\text{Daudpur} = \frac{104}{498} \times 83 = 17.33 \approx 17$$

Table 3.2: Sample distribution of litchi growers

District	Upazila	Union	Number of selected litchi growers
Dinajpur	Nawabganj	Mahmudpur	35
		Binadnagar	31
		Daudpur	17
Total litchi growers			**83**

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3.2 Selection of the Varieties

In the designated study area, various cultivars of litchi are cultivated, including Bombai, Bedana, Madrazi, China-2, China-3, and Mozaffarpuri, among others. Nonetheless, Bombai is the most esteemed among these cultivars due to its superior yield and palatable flavor. Nevertheless, the litchi varieties of Bombai, Bedana, Chaina-3, and Madrazi were chosen for this study.

3.3 Data Collection and Methods

In order to meet the study's objectives, the researcher personally interviewed a sample of litchi producers in order to get the essential data. Data was collected from May to June of 2024. The researcher went to the study region and introduced herself to the growers of litchi in order to gather trustworthy data.

For this study, data were gathered from both primary and secondary sources. Primary data is the main source of data used in this study. Primary data were gathered by the researcher personally visiting the chosen growers of litchi and conducting direct interviews with them. Throughout the primary data collection process, a questionnaire was utilized to gather information about the socio-economic status of the growers, their production practices, and the challenges they encounter.

The researcher obtained secondary data from several sources. A variety of sources, including research studies, journal articles, the Nawabganj upazila agricultural office, and websites, provided the information.

3.4 Model Specification

For litchi, the Cobb-Douglas forms of production function were approximated in order to ascertain the impact of the variable inputs. An explanation for litchi production was proposed based on seven variables. We employed regression analysis to ascertain the impact of these inputs. The overall model was thoroughly detailed to sufficiently describe the litchi's manufacturing process.

For litchi, the Cobb-Douglas production function was stated as follows:

$$\ln Y = a\, X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} Ui$$

In linear form, it is written as follows:

$$\ln Y = a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + U_i$$

Where,

Y= Production;

a=Intercept;

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X_1=Cost of rent;

X_2=Cost of human labor;

X_3=Fertilizer and manure cost;

X_4=Irrigation cost;

X_5=Hormone cost;

X_6=Pesticide cost;

X_7=Intercultural operation cost;

Ui = Error term;

b_1, b_2, b_3, b_4, b_5, b_6 represent the coefficients of the corresponding variables to be estimated.

The Cobb-Douglas production function was used for this investigation because it strikes a compromise between mathematical simplicity, empirical robustness, and economic interpretability. Its capacity to predict elasticities, returns to scale, and input contributions makes it an excellent model for studying litchi production. As a result, the Cobb-Douglas model remains the most practical and theoretically viable option for this study.

4. RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of the Respondents

Table 4.1: Socio-economic Characteristics of the Respondents

Variable	Categories	Frequency	Percent	Mean	Std. Deviation
Location (Union)	Mahmudpur	35	42.17	1.7831	0.76586
	Binadnagar	31	37.33		
	Daudpur	17	20.50		
	Total	**83**	**100**		
Occupation	Farmer	57	68.70	1.6145	1.02209
	Doctor	5	6.03		
	Teacher	9	10.80		
	Businessman	12	14.47		
	Total	**83**	**100**		
Age Group	25–40 (Young Aged)	13	15.66	2.9157	1.03835
	41–55 (Middle Aged)	47	56.63		
	56+ (Old Aged)	23	27.71		

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Variable	Categories	Frequency	Percent	Mean	Std. Deviation
	Total	**83**	**100**		
Education	Illiterate	9	10.84	2.5060	1.07492
	Primary (1–5)	17	20.48		
	Secondary (6–10)	29	34.94		
	HSC (11–12)	13	15.66		
	Graduate or Postgraduate	15	18.07		
	Total	**83**	**100**		
Family Size	Small	43	51.80	1.5060	0.54936
	Medium	38	45.80		
	Large	2	2.40		
	Total	**83**	**100**		
Farm Size	Landless	7	8.43	2.6386	1.08850
	Marginal	19	22.89		
	Small	34	40.96		
	Medium	23	27.71		
	Total	**83**	**100**		

The participants in this research were chosen from three unions, such as Mahmudpur, Binadnagar, and Daudpur of Nawabganj upzila in Dianjpur district, which are famous for high-level production of litchi fruit. Mahmudpur was home to the maximum number of litchi orchards, 42.17% of the sample, while litchi orchards in Binadnagar constituted 37.33% and in Daudpur, it was 20.5%. The information reveals that most of the functional extension contact persons of litchi growers belonged to the Mahmudpur union and were dominant in litchi farming in that geographical area.

Agriculture, especially rice cultivation, vegetables, and litchi farming, was the main source of income for most of the litchi growers, noted the study. Only small proportions of them worked in enterprises, in teaching, and in medical fields, etc. Farmers were the majority (68.7%) of the respondents, followed by business (14.47%), teaching (10.8%), and healthcare (6.03%). This suggests that the practice of farming litchi is primarily for agriculture in the region, and farmers might have abundant experience in crop cultivation, which leads to high yields and good fruit quality.

In terms of demographics, the majority of the litchi growers were middle-aged (56.63%), followed by old-aged (27.71%) and young (15.66%). For the educational level, a large percentage of the respondents (34.94%) had at least a secondary school education, and 18.07% had graduated from college or university. A few of them were unable to read and write (10.84%). More than half

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(51.8%) of the respondents had small families, whereas 40.96% had landless to small, 27.71% medium, and 22.89% marginal-sized farms. These results indicate that an overwhelming majority of litchi growers in the study region are smallholders with little formal education but rich field experience.

4.2 Economic and Institutional Characteristics of the Respondents

Table 4.2: Economic and Institutional Characteristics of the Respondents

Variable	Categories	Frequency	Percent	Mean	Std. Deviation
Annual Income (BDT)	1,00,000–10,00,000	57	68.70	927590.36	597585.77
	11,00,000–20,00,000	22	26.40		
	20,00,000+	4	4.80		
	Total	**83**	**100**		
Farming Experience	Low (≤10 yrs.)	2	2.40	2.0843	0.35630
	Medium (11–30 yrs.)	72	86.70		
	High (31+ yrs.)	9	10.80		
	Total	**83**	**100**		
Training Received	Yes	14	16.90	1.8313	0.37674
	No	69	83.10		
	Total	**83**	**100**		
Credit Facilities	Yes	8	9.60	1.9036	0.29691
	No	75	90.40		
	Total	**83**	**100**		
Sources of Credit	None	75	90.40	0.2169	0.71650
	Bank	2	2.40		
	SKS	2	2.40		
	BRAC	4	4.80		
	Total	**83**	**100**		

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The participants' annual income reported in this research was also seen to have a wide range, i.e., BDT 100,000-BDT 3,000,000. The mean annual income was BDT 927,590.36, and the standard deviation was BDT 597,585.77. Litchi growers' earnings. Most of the litchi growers (68.7%) had low earnings, a quarter of them (26.4%) had medium earnings, and only 4.8 per cent of the respondents had high earnings in a year (Table 4.7). It is therefore suggested that the majority of the study's respondents earned relatively low to moderate incomes, indicating the financial difficulties experienced by small-scale litchi growers in the area.

The respondents were diversified regarding farming experience, ranging from 5 to 50 years in litchi cultivation. The average number of years of farming was 2.08 years, SD 0.36. Most of the interns (86.7%) had moderate experience, while others 10.8% had high, and 2.4% had low experience. This indicates the litchi growers were highly experienced, and such a high level of awareness may lead to high productivity and profitability in litchi cultivation.

The level of training of the respondents was evidently low, as only 16.9% of litchi producers had received some litchi production-related formal training. The majority of respondents (83.1%) had not undergone such u investment, implying a potential deficit in agricultural knowledge. This lack of education could lead to poor farm practices, IPM, and postharvest handling, all of which can affect yield as well as income. Furthermore, in credit services, only 9.6% farmers had used credit facilities, of which 90.4% of the farmers were dependent on self-help. Borrowers who had loans primarily borrowed from entities such as BRAC, SKS, or local banks, indicating constrained access to formal credit.

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4.3 Costs and returns of Litchi Production

Table 4.3.1: Descriptive Statistics of Cost Components and Return from Litchi Cultivation per Acre

Cost/Return Items	Mean	Median	Mode	Std. Deviation	Range	Minimum	Maximum	Sum	Acres of Land	Cost/Return per Acre (BDT.)
Rent	2,234.94	2,500	3,000	1,085.77	3,500	500	4,000	185,500	185.5	1,000
Labor	88,507.83	75,750	54,000	38,166	118,200	44,600	162,800	7,346,150	185.5	39,601
Fertilizer	17,174.51	13,090	10,800	9,248.06	26,710	8,790	35,500	1,425,485	185.5	7,684
Irrigation	3,283.13	1,500	1,500	3,314.71	19,300	700	20,000	272,500	185.5	1,469
Hormone	386.75	300	200	353.38	2,800	200	3,000	32,100	185.5	173
Pesticides	53,743.37	46,000	39,150	17,814.4	81,000	33,000	,000	4,460,700	185.5	24,046
Intercultural Operation	6,146.99	6,500	1,500	3,718.06	12,500	1,000	13,500	510,200	185.5	2,750
Return (Litchi)	295,338.55	215,0000	422,000	190,722	726,500	87,400	815,750	24,513,100	185.5	132,146

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The findings shown in the Table indicate the proportion of the major cost items involved in litchi cultivation in Dinajpur district. Results reveal labor to be the costliest farm activity with an average value of BDT 88,507.83 per acre, reflecting its indispensability from the moment a crop is sown to its harvesting (fertilization, watering, weed control, and finding from harvesting on average). Significant amounts were spent on pesticides (BDT 53,743.37) and fertilizers (BDT 17,174.51), indicating the high percentage of the budget of the growers for keeping health and productive plants. On the other hand, the cost of rent, the cost of irrigation, the cost of hormones, and the cost of intercultural operations were relatively less but remained significant for orchard sustainability and the side of plant output.

The variation in costs among farmers is also of interest. Costs of labor and pesticide were between BDT 44,600 and BDT 162,800 and BDT 33,000 and BDT 81,000, respectively, which suggests differences among farms in size, management practices, and input use intensity. Likewise, the fertilizer cost between BDT 8,790 and BDT 35,500 implies the difference in the amount of application and preference for organic and inorganic fertilizers by the farmers. These differences were more evident when compared to the highest standard deviations, in the case of labor and pesticide costs, indicating a non-homogeneous distribution of production expenses in the study area. One explanation is due to differences in financial resources, resource access, and personal resource control.

The average return from litchi per acre was BDT 295,338.55, which ranged from BDT 87,400 to BDT 815,750. This extremely high profitability indicates that litchi farming is potentially profitable for some farmers with significant differences in the ability of farmers to access the income earner, yet it depends strongly on the size of the orchard, management instinct, and marketing situation. The net per acre return (BDT 132,146) is much higher than the sum of the average production costs, suggesting that the benefit-cost ratio is positive for the growers. In sum, findings of this analysis indicate that litchi farming in Dinajpur is a profitable business to be involved in; however, profitability is largely subject to better cost management and access to appropriate inputs.

The labor cost, pesticides, and fertilizers are the largest cost structure of litchi cultivation, while other costs represent a similar small share. As the range of expenses per acre varies, but the return stands far above the cost of production, the litchi farming of the Dinajpur region is profitable. Nevertheless, heterogeneity in input use and management results in great income heterogeneity among producers.

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Table 4.3.2: Per Acre Cost and Profitability of Litchi Production

Particulars	Amount (BDT)
Total Fixed Cost	1,000
Total Variable Cost	75,723
Total Cost	76,723
Gross Revenue	132,146
Gross Margin	56,423
Net Revenue	55,423
Benefit-Cost Ratio (BCR)	1.72

The profitability analysis of litchi cultivation (Table 4.3.2) reveals that it is quite remunerative in Dinajpur district. From the results, it is found that the total fixed cost per acre is low (BDT 1,000) because the rent value was the only fixed cost entered. On the other hand, the total variable cost was BDT 75,723, which comprised large production costs, i.e., labor cost, fertilizer cost, irrigation cost, pesticide applications, hormone applications, and intercultural operations. Considering all the costs combined, the total cost of cultivation amounted to BDT 76723 per ha. In contrast, the gross income of the litchi was BDT 132,146 per acre, indicating that farmers get a good return for their investment.

Profitability ratio also supports this positive result. The difference between the gross revenue and the variable cost, in other words, gross margin, was BDT 56,423 per acre, which indicates that even after covering all variable expenses, farmers were left with a healthy margin of surplus. It was the BDT 55,423 per acre, which was the real earning or profit per acre from litchi cultivation after deduction of fixed and variable costs. The BCR of the practice was determined to be 1.72, indicating that a farmer returns BDT 1.72 for every 1 BDT invested for production. Looking at return on cost (BCR), any value more than 1 is profitable, and therefore, a BCR higher than 1 is considered a bonus, which not only makes litchi cultivation sustainable but also highly rewarding. The findings of this research indicate that litchi cultivation in Dinajpur is economically feasible and can mean a lot by enhancing the farm income and rural quality of life.

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Table 4.3.3: Estimated Coefficients of Cobb–Douglas Production Function for Litchi Cultivation

Explanatory Variables	Estimated Coefficients	Standard Error	t value	P value
Constant	2.429148	2.027822	1.20	0.235
Cost of Rent	-.0401117	.0935216	-0.43	-0.43
Cost of labor (hired)	-.7484405	.2348366	-3.19	0.002
Cost of Fertilizers	1.538473	.2429777	6.33	0.000
Cost of Irrigation	.2933842	.1249539	2.35	0.022
Cost of Hormone	.0108481	.1227044	0.09	0.930
Use of Pesticides	.5643882	.1162911	4.85	0.000
Cost of Intercultural Operations	-.5372037	.1194717	-4.50	0.000
R^2	0.6952			
Adjusted R^2	0.667			
F value	24.44			
Return to Scale ($\sum b_i$)	1.0813376			

Dependent Variable: Production

Table 4.3.3 Estimates of input use in litchi cultivation by the Cobb–Douglas production function. The estimations of the Cobb–Douglas production function for litchi cultivation are shown in Table 4.3.3, which exhibits the influence of various input costs on production. The coefficients are elasticities, which indicate that a one percent change in an input variable results in a percentage change in litchi production, keeping all other things constant. The model fits optimally well (R^2 = 0.695), suggesting that the estimated 69.5% variation in litchi production can be accounted for by the considered input variables. The adjusted R^2 (0.667) also reflects the strength of the model, and the F-statistic (24.44) indicates that the explanatory variables as a group are statistically significant in explaining production. Furthermore, the total elasticity ratios (1.081) indicate that there are

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increasing returns to scale (for a given proportionate change in the amounts of all inputs, output increases by more than the proportionate change).

The findings indicate that fertilizer, pesticides, and irrigation are the most decisive factors affecting litchi production. Fertilizer also exhibits the largest positive coefficient (1.538, $p<0.01$), which implies that a 1 percent rise in fertilizer use enhances production by approximately 1.54 percent. This is indicative of the relevance of soil fertility management for increased yield. Pesticide application (0.564, $p<0.01$) similarly significantly increases yield, highlighting the required role of managing pests in sustaining productive orchards. The irrigation also has a positive and significant (0.293, $p<0.05$) influence, indicating that proper water management leads to increased production. These findings show that proper input use, especially fertilizers and pesticides, is important in order to enhance litchi farming performance in the study field.

Conversely, other variables have negative or non-significant effects. Waged work (–0.748, $p<0.01$) has a significant negative impact on production, suggesting that excessive or inefficient use of wage labor raises costs without yielding better harvests. Negative coefficient and significance can also be found in intercultural operation (–0.537, $p<0.01$), indicating that frequent/excessive field operation may lead to low efficiency. The negative, but insignificant, coefficients for rent cost (–0.040) and hormone application (0.011) show that the contribution of rent cost and hormone application was not significant in explaining output in the prevailing production system. Collectively, the results illuminate the importance of rational input application - although fertilizers, irrigation, and pesticides exert significantly positive (with diminishing) influences on total factor productivity, labor and excess field operations generate the inverse effect of decreasing returns.

4.4 Problem Confrontation by the Farmers in Litchi Cultivation

Table 4.4.1: Challenges Affecting the Cost-Efficiency and Production of Litchi

Parameters		Frequency	Percent	Mean	Std. Deviation
Shortage of land	No	83	100.0	2.0000	.00000
Shortage of labor	No	83	100.0	2.0000	.00000
Poor soil fertility	Yes	8	9.6	1.9036	.29691
	No	75	90.4		
Lack of credit fertility	No	83	100.0	2.0000	.00000
Lack of good-quality litchi plants	Yes	13	15.7	1.8434	.36566
	No	70	84.3		
High occurrence of insects and pests	Yes	83	100.0	1.0000	.00000

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High Price of Pesticides and Fertilizers	Yes	83	100.0	1.0000	.00000
Lack of Farm Machinery	Yes	26	31.3	1.6867	.46664
	No	57	68.7		
Adverse Weather Condition	Yes	83	100.0	1.0000	.00000
Lack of Information about Climate Change	Yes	32	38.6	1.6145	.48968
	No	51	61.4		
Lack of Training Facilities on Litchi Farming	Yes	69	83.1	1.8313	.37674
	No	14	16.9		
Lack of Storage Facilities	Yes	74	89.2	1.1084	.31282
	No	9	10.8		
Poor Transportation and Communication	Yes	43	51.8	1.4819	.50271
	No	40	48.2		
Lack of Market Knowledge/Information	Yes	15	18.1	1.8193	.38713
	No	68	81.9		
Lack of Monetary Authority/Stakeholders	Yes	15	18.1	1.8193	.38713
	No	68	81.9		
Influence of the middleman/Dalal	Yes	15	18.1	1.8193	.38713
	No	68	81.9		
Low Price of Litchi in the Harvesting Period	Yes	83	100.0	1.0000	.00000

The results in Table 4.4.1 indicate some key constraints observed among litchi farmers in the study area that affect production and profitability substantially. Several key issues were reported, such as an infestation of insects or pests (100%), followed by the high cost of pesticides and fertilizers (100%). Farmers also unanimously expressed the negative effects of unfavorable weather conditions on flowers and pods, setting stages with great loss of yield. Together, these parameters contribute to higher production costs and decreased tunnel marketable yields, ultimately decreasing profitability. Notably, not a single farmer reported resource constraint (availability of land and labor) as a problem, implying that natural and market-induced constraints trump resource constraints.

Another group of important limitations is due to the absence of technical and infrastructural assistance. Another challenge mentioned by the majority of farmers was no training on litchi farming (83.1%) and poor storage of fruit (89.2%). Lack of knowledge and skills is also a major constraint in that, without proper training, many farmers are unwilling or cannot use improved

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production technologies or integrated pest management techniques, and therefore, they become more susceptible to crop loss and wastage due to inefficiencies. So, they must sell them as soon as they are harvested, sometimes at rock bottom prices, and income shrinks even more. Secondly, inadequate transportation and communication services (51.8%), which more than half of the farmers identified, reveal that poor infrastructure hampers efficient supply chain management as well as access to faraway markets.

The market-related issues were also recognized as major constraints. Farmers also rated the low price of litchi during harvest (100%) and the involvement of the middlemen/Dalal (18.1%) as the major constraints to profitability. Insufficient market information/knowledge (18.1%) and the weak support from the monetary authorities or stakeholders (18.1%) make the issue even more complex. All these leads to the farmers being at a losing end as they are forced to rely heavily on middlemen who control the selling price. Lack of good-quality litchi plants (15.7%) and poor soil fertility (9.6%) also contribute to yield potential, but to a lesser extent than market-induced and climate-induced problems. On the whole, the findings imply that although natural risks and steep input prices are the main problems, there are market inefficiencies and insufficient institutional support, which are also critical to the profitability of the litchi growers. This problem can also be solved by providing the needful training, infrastructural development, and better market linkage, which would not only increase litchi production but also the welfare of the farmers in this region.

5. CONCLUSION

This research attempted to estimate the cost–benefit ratio of litchi production in Dinajpur district of Bangladesh, where litchi is an important fruit-producing crop as well as a major source of income for the rural people and the regional economy. While this itself is a highly relevant issue, according to which the reasons are identical in trend with those of the developed countries, there has been a paucity of systematic empirical information on profitability, cost structure, and constraints of Litchi production in this region. Using descriptive statistics, as well as the Cobb–Douglas production function, the study sought to offer specific observations on production practices, farmers' socio-economic attributes, the relationship of input and output, and the main constraints that influenced efficiency and gains.

The results revealed that litchi cultivation is a very profitable undertaking and a benefit–cost ratio of 1.72, revealing that the investment of every taka farmer gets too significant return. Fertilizers, pesticides, and irrigation were found as the most dominant contributing inputs, which positively align with output, while excessive use of labor and intercultural operations are found as counterproductive to efficiency. Farmers also suffer from serious limitations such as pests and diseases, high cost of inputs, adverse climate, lack of training, storage facilities, high middleman

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control in marketing, etc. These findings suggest the economic opportunity for litchi production in Dinajpur, as well as institutional barriers that prevent farmers from fully profiting.

The significance of the present study is that it offers region-specific information on cost–benefit performance and production drivers for litchi, which has important implications for policy makers, extension personnel, and development agencies. It is indicated that enhanced training, input availability, infrastructural facilities, and market linkages are the key to enhancing the profitability as well as the welfare of the farmers. The study, however, was conducted in a single upazila with a small sample size, which would limit the generalizability of the findings. The next step in research work could be studies involving a wider geographical area, as well as studies of the postharvest value chains and comparative studies involving other types of fruit crops. In general, this study highlights that, through appropriate institutional support and effective utilization of resources, litchi cultivation could still be an ever-sustainable and lucrative venture and play a vital role in generating incomes and rural development in countries like Bangladesh.

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