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Production and marketing performance of guava: evidence from Pabna district of Bangladesh

Mahbub Alom[1], Mst Tania Parvin[1]*, Khandakar Ramisha Anjum Misha[1], Debasish Chandra Acharjee[1], Md Monjurul Islam[2], Armina Sarkar[1]

[1] Department of Agribusiness, Gazipur Agricultural University, Gazipur 1706, Bangladesh
[2] Department of Rural Development, Gazipur Agricultural University, Gazipur 1706, Bangladesh

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ABSTRACT

Guava (*Psidium guajava L.*) production has become significant in the horticultural economy of Bangladesh, driven by its strong market demand and high nutritional value. The objectives of the study were to determine the production performance, net return, and marketing efficiency of guava in the Pabna district of Bangladesh. Employing a multi-stage sampling technique, data were collected from guava farmers (80) and market intermediaries (20). A structured questionnaire was used to conduct face-to-face interviews from October to December 2024 to collect data from respondents. For empirical estimation, descriptive statistics, cost-return analysis, the Cobb-Douglas production function, and the marketing-efficiency index were employed. Benefit-Cost Ratio (BCR) of 3.97 suggests that guava cultivation was highly profitable among the surveyed farmers in the study area, indicating that for each BDT investment, BDT 3.97 was generated as gross return. A positive agro-ecological environment, which is characterized by loamy soil and efficient use of inputs, helped to achieve the higher profitability. Estimated values of the Cobb-Douglas model suggest that urea and crop protection costs positively affected the yield, while excessive irrigation had an adverse effect. Among the identified marketing channels, Channel 1 was identified as the most efficient channel (producer–retailer–consumer), with the highest marketing efficiency (2.14). On the other hand, Channel IV (producer–Aratdar–wholesaler–retailer–consumer) had the lowest efficiency (ME = 0.72). Though poor market information systems and fluctuations in prices were the core problems in marketing guava, other constraints associated with guava production were high wage rates, labor shortage, and costly planting materials. This study recommends farmer-based marketing groups, digital price information, direct producer-retailer links, and storage and transport facilities to improve farmers' prices and reduce marketing costs.

***Corresponding Author:** *Department of Agribusiness, Gazipur Agricultural University, Gazipur 1706, Bangladesh, E-mail: tania@gau.edu.bd

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Introduction

In countries of South and Southeast Asia, guava (*Psidium guajava L.)* is a popular tropical fruit. Guava is usually grown in diverse agro-ecological settings and contains high nutritional value. It is a good source of nutrition security and rural livelihoods and is rich in vitamin C, antioxidants, and dietary fiber (Hossain and Badiuzzaman, 2021). Internationally, there were some studies that pointed out that the margins and losses of the intermediaries after harvest significantly reduce the net returns of the guava producers (Bahloul, 2022; El-Dnasury, 2021). Cooperative marketing and training resulted in higher efficiencies in fruit crops in India (Meena *et al.*, 2020), and lower transaction costs and price information were linked to better marketing efficiency indices in Rajasthan (Chand *et al.*, 2020). Kanyua *et al.* (2015) and Khan (2019) found that education, farm size, and diversification had significant effects on the profitability of guava farming in a few other studies conducted in Kenya and Pakistan, respectively.

In developing countries like Bangladesh, India, and Egypt, studies revealed that the lack of a consolidated value chain, the high cost of transportation, and the powerful position of the intermediaries affected the income of the producers from guava farming (Al-Amin, 2024; Hasan *et al.*, 2017; Kamal *et al*., 2015). In parallel, developed countries implemented modern logistics, digital technologies, and a cooperative approach to boost transparency and harmony and improve the overall efficiency of the supply chains (Kauser and Alam, 2016; El-Dnasury, 2021; Bahloul, 2022). Despite the shift in the economic landscape towards other sectors, agriculture continues to be the primary source of food, revenue, and livelihood for the rural population of Bangladesh. In 2023-2024, the agricultural sector contributed to10.94% of GDP, and employed 44.67% of the total labor force (BBS, 2025; MoF, 2025). The horticultural subsector is one of the most promising subsectors that provides higher value addition, nutritional diversity, and export opportunities (DAE, 2023; FAO, 2023).

The fruit industry in Bangladesh has been rapidly expanding. Government programs have encouraged the concept of crop diversification, better orchard management, and value-chain formation, which increases employment opportunities in rural settings through engaging farmers in fruit cultivation (MoA, 2022; DAE, 2023). The annual guava production in Bangladesh increased 266,405 metric tons from 44,520 acres of land, compared with 257,984.6 metric tons in FY 2023-2024 (DAE, 2023). Compared with other commercial fruits, guava production has several benefits. It can also be adapted to the peri-urban and semi-arid ecosystems, which offer livelihood and nutrition security, because of its capability to withstand the marginal soils and other climatic conditions (Rahman, 2006).

Despite this, the guava producers have to face different organizational issues in Bangladesh. Farmers reduce their profits further due to poor skills in orchard management, control of the pests and diseases of the crops, and post-

harvest handling with price fluctuation at the farm gate (MoA, 2022; Hossain *et al.,* 2021). Guava producers' bargaining power remains low, and the marketing channel has no link with a chain of marketers. Inadequate storage, grading, and transport facilities reduce farmers' share of the consumer price. Although the digital price-information systems established by the Department of Agricultural Marketing (DAM) have increased transparency, producers still bring home a minor share of the final consumer price, which shows poor value chain coordination (Haque and Nasrin, 2019; Kabir and Rahman, 2020).

Previous studies on guava cultivation indicate net return and limitations in the value chains of fruit crops. Recent studies reported that guava and other fruit crops are profitable in Bangladesh, but farmers are limited by high input costs, weak market coordination, price fluctuation, and the dominance of intermediaries (Hossain *et al.,* 2021; Rahman *et al.*, 2021; Begum *et al.,* 2024). Guava production experiences poor organization of the market, though it is profitable in Pabna (Al-Amin, 2024). High levels of commission hinder the efficiency of marketing the fruits, and an enormous percentage of the retail price goes to intermediaries (Rahman *et al.,* 2006; Kauser and Alam, 2016). Additionally, the availability of irrigation, education, and inputs at the right time has a significant impact on the profitability of the fruit-based businesses (Hasan *et al.,* 2017; Uddin and Dhar, 2017).

A gap still exists in bringing together production and marketing aspects of guava production, although the mentioned research highlights that guava cultivation has become familiar in Bangladesh and worldwide, as producing guava can improve household income and nutrition. Most of the existing studies have focused on either production or marketing aspects, though an integrated approach can result in better outcomes than before. Pabna is a growing guava-producing district, but there is a limited number of region-specific studies in this area. Through financial viability and market performance assessment of guava producers in the Pabna region, this study attempted to fill the research gap and to provide effective recommendations for better productivity and profitability.

Methodology

Study area selection

Ishwardi Upazila of Pabna District of Bangladesh was chosen purposively to conduct the study. Another reason to choose Pabna district is that this district possesses favorable climatic conditions, well-drained loamy soil, and better irrigation facilities, which are favorable for guava cultivation. Additionally, the selected area appears as a rising commercial area for guava cultivation, as wholesale markets are available in Pabna Sadar and Rajshahi. The selection was finalized after field observation and consultation with personnel from Department of Agricultural Extension (DAE).

Data collection methods

To collect data, a multistage sampling technique was applied. Pabna District and

Ishwardi Upazila were purposively selected because of the concentration of commercial guava farming. Secondly, three villages (Solimpur, Laxmikundo, and Dashuria) were selected as guava-producing villages based on the intensity of guava cultivation. Third, a list of guava farmers was made with the assistance of Upazila Agriculture Office, Sub-Assistant Agricultural Officers (SAAOs), and farmer representatives. From the list, 80 guava farmers were randomly selected using the lottery method. The sample included 30 guava producers from Solimpur, 30 from Laxmikundo, and 20 from Dashuria. In addition, interviews with 20 market intermediaries, including Aratdar, wholesalers, Bepari, and retailers, were held to understand the supply chain and market aspects of guava. Additionally, a pilot test of a structured questionnaire was developed and tested on 10 farmers in nearby non-sampled villages (Sahapur and Muladuli). Expert consultation was conducted with one Upazila Agriculture officer, one Sub-Assistant Agricultural Officer, one agricultural economics researcher, and one local market actor. To make the questionnaire clear and consistent, all necessary modifications were made prior to final data collection. Data on socioeconomic profiles, farming practices, marketing channels, and limitations were collected through in-person interviews from October to December 2024. DAE reports, Bangladesh Bureau of Statistics (BBS, 2023), and other studies of interest were used to get secondary data. Information was checked daily after completing data collection. To avoid inconsistent and unreliable information regarding guava production and marketing, follow-up contacts were maintained to eliminate inconsistencies or any gaps in the responses.

Analytical techniques

Both descriptive and functional analytical methods were employed to meet the objectives of the study. To analyze the socioeconomic traits of the farmers, cost structure, and variables, descriptive statistics were applied in the form of mean, percentage, frequency distribution, and standard deviation. Economic and econometric methods, such as cost–return analysis, Cobb-Douglas production function, and marketing-efficiency model, were used for quantitative evaluation. The analytical methods have been adopted from Begum *et al.* (2011), Kauser and Alam (2016), and Acharya and Agarwal (2004), who are popular in the studies of agricultural economics in Bangladesh.

Cost and return analysis

To determine the profitability of guava production, the traditional cost-return model was used. The summation of variable costs and fixed costs is known as total cost. Employed and family labor (valued at market wage rate), seedlings, fertilizers, manure, irrigation, pesticides, and transportation were recorded as variable costs. Whereas, land rent, depreciation of equipment, and interest on operating capital were the fixed costs. Following Begum *et al.* (2011), the following equations were utilized for estimating the total cost:

$$TC = TVC + TFC$$

$$GR = \sum P_a Q_a$$

$$GM = TR - TVC$$

Where, TVC denotes total variable cost, TFC denotes total fixed cost, GR denotes gross return estimated from guava production, P_a denotes unit price of guava, Q_a denotes quantity of guava, GM denotes gross margin, and TR denotes total return from guava.

Net return is the subtraction of total return and total cost. Using the following equation (Kausar and Alam, 2016), the net return was estimated as:

$$NR = TR - TC$$

Where NR denotes net return, TR denotes total return, and TC = total cost.

The BCR is the cost of the necessary resources divided by the value of the goods and services produced by a farm.

$$BCR = \frac{TR}{TC}$$

Production function analysis

The Cobb-Douglas function was employed to determine the variables influencing guava production in the study region. It is an appropriate model for this study as it establishes the relationship between inputs and outputs to determine the input elasticities and returns to scale (Heady and Dillon, 1961; Kauser and Alam, 2016). This study only included major input variables (identified from the literature review of past studies) for production function analysis. Also, it is a log-linear model that can be easily estimated using OLS, and commonly employed to analyze agricultural profitability (Gujarati and Porter, 2009; Hasan *et al.,* 2017):

$$lny = lna + b_1 lnX_1 + b_2 lnX_2 + b_3 lnX_3 + b_4 lnX_4 + b_5 lnX_5 + b_6 lnX_6 + U_i$$

Where, Y = total output (kilogram/hectare); X_1 = human labor (person-days/hectare); X_2= land area (hectare); X_3 = seedling cost (BDT/hectare); X_4 = fertilizer and manure cost (BDT/hectare); X_5= irrigation cost (BDT/hectare); X_6= plant-protection material cost (BDT/hectare); = constant term; = output elasticity of input iii; and = random error term.

STATA was used to estimate the model using Ordinary Least Squares (OLS). At the probability levels of 10%, 5%, and 1%, the level of significance was determined, and R^2 was the coefficient of determination, which is also known as goodness of fit.

Marketing margin (MM) analysis

The equations for total marketing cost, marketing margin, and price spread were adopted and modified from Kauser and Alam (2016) and Begum *et al.* (2024). The following formula was used to calculate total marketing costs:

$$K = K_f + K_{m1} + K_{m2} + ... + K_{mi}$$

Where K indicates total marketing cost, Kf indicates cost paid by the producer, Kmi indicates cost incurred by the intermediaries, and i indicates 1, 2… n.

Using the following formula, the total margin was calculated as:

$$\mathbf{TMM} = \sum(\mathbf{S_j} - \mathbf{P_j})/\mathbf{Q_j}$$

Where TMM denotes total marketing margin, Sj denotes the selling price of a guava paid by the jth firm, Pj denotes the purchase price of a guava paid by the jth firm, and Qi denotes the quantity of guavas handled by the j^{th} firm. Subtraction of price received by the farmer from the consumer's price is termed as total marketing costs.

$$P_a = C_p - P_f$$

Where Cp denotes the consumer's price, and P_f denotes the farmers' price received

Marketing efficiency (ME) analysis

Following Acharya's marketing efficiency index (2004), the marketing channels' efficiency for guava was evaluated. It involves the evaluation of farmers' prices, the intermediary's margin, and the total marketing cost.

$$ME = RB/ (MC + MM)$$

Where ME denotes marketing efficiency, RP denotes retail price, MC denotes marketing cost, and MM denotes marketing margin.

When ME is greater, the channel is considered more efficient. A value of above 2.0 is usually considered efficient (Kauser and Alam, 2016), whereas a value below 2.0 indicates inefficiencies in cost or structure of margin. Harvesting, packaging, handling, transportation, spoilage losses, and commission were the marketing expenses.

Result and Discussion

This section is divided into several sub-sections, which are discussed as follows:

Socioeconomic profile of the guava farmers

Table 1 presents that the farmers who were involved in guava cultivation in Ishwardi Upazila were mostly male (77.5%) and they had an average household size of 4.75; these findings are similar to the study by Hasan *et al.* (2017) and Rahman *et al.* (2021). There was a lack of exposure in the study area because only 3.75% of the participants had higher secondary education, and this kind of low literacy is also reported by Kauser and Alam (2016). The majority of the respondents in Ishwardi upazila were engaged in farming (71.24%), whereas 28.78% respondents had involvement in business or service. The study area had a cropping intensity of 180% suggests that a mixed commercialized cropping system existed in the study area. 0.73 hectares of average landholdings were found in the study area, and this is supported by the report of BBS (2023). The result shows 36% of the farmers were formally trained, while 41% had access to institutional credit, which is similar to these findings by Mandal *et al.* (2011) and Gajanana *et al.* (2015).

Economic performance of guava cultivation

The result shows the annual expenses for guava orchard establishment and the cost structure of guava cultivation. Total cost for orchard establishment was BDT 206,672 per hectare. Initially, guava cultivation is less

Table 1. Socioeconomic profile of sampled guava farmers in the study area

Particulars	Classification	No. of respondents	Share (%)
Household head	Male	62.00	77.50
	Female	18.00	22.50
Farming members (persons)	-	-	1.77
Family size (persons)	-	-	4.75
Literacy	Illiterate (no formal education)	43.00	53.76
	Primary (up to 5 years)	24.00	30.00
	Secondary (up to 10 years)	10.00	12.45
	Higher secondary and above	3.00	3.78
Occupation	Farming	57.00	71.24
	Business	13.00	16.27
	Service	10.00	12.51
Cultivated land area (%)	-	-	75.65
Cropping intensity (%)	-	-	180.04
Farm size (hectare)	-	-	0.73
Annual household income (BDT)	Below or equal to 150,000	18	22.50
	150,001 to 250,000	36	45.01
	Above 250,000	26	32.52
Experience in guava farming (years)	less than 5 years	21	26.28
	5 to 10 years	37	46.27
	above 10 years	22	27.53
Access to training	Yes	29	36.24
	No	51	63.77
Credit access	Bank/NGO	33	41.23
	Informal/self-finance	47	58.78
Membership status in a farmer organization	Yes	19	23.75
	No	61	76.25

(Source: Field survey, 2024)

capital-intensive. Fencing cost (19.98 %), which was also found to be high in the studies by Kauser and Alam (2016), as it is required to protect the livestock and prevent unauthorised access. Pit preparation (15.56%) and seedling cost (11.06%) demonstrate that the orchard is a labour-intensive crop, with the same trend recorded by Rahman *et al.* (2021) in guava production at Jashore.

Annually, BDT 83,700 per hectare was required for guava cultivation, which included 37.50% labor, 110.3% plant-protection, and 18.60% fertilizer. The dominance of labor is a manifestation of high dependency on family and paid workforce during pruning, irrigation, and harvesting of the fruits, which is also found by Hasan *et al.* (2017). Expenditure was high during the first year, and gradually expenses reduced and became constant for guava production. This finding aligns with the studies by Begum *et al.* (2024) and Al-Amin (2024). Cost-effectiveness and long-term profitability of guava cultivation can be improved with efficient utilization of inputs and nutrients.

Cost-benefit analysis of guava

Profitability analysis of guava includes estimation of gross return, gross margin, net return, and benefit-cost ratio (BCR). Variable costs and fixed costs were considered for computing the total cost of guava production.

Pabna district shows high profitability in the case of guava cultivation. BDT 229,927 per hectare was recorded as total variable cost (TVC), and the fixed cost (TFC) was BDT 95,104 per hectare, resulting in a total cost of BDT 325,031 per hectare. With a gross margin of BDT 1,060,448, the total

Table 2. Cost structure of guava orchard establishment and annual costs in the study area (BDT/hectare)

Expenses	Orchard establishment cost (BDT)	Proportion (%)	Annual production cost (BDT)	Proportion (%)
Preparation of land	14,692	7.11	8,450	10.79
Pit excavation and preparation	32,160	15.56	-	-
Sapling and transplanting	22,872	11.06	1,200	1.57
Organic and chemical fertilizer	10,553	5.11	14,300	18.64
Pest and disease management	-	-	7,900	10.3
Hired and family labor	-	-	28,800	37.54
Irrigation	12,309	5.96	5,200	6.78
Farm tools and equipment	21,790	10.54	-	-
Intercultural management operation	15,196	7.36	-	-
Interest on operating capital	2,900	1.4	3,300	4.3
Infrastructure and fencing	41,291	19.98	-	-
Land rent and depreciation	10,800	5.23	12,000	15.65
Miscellaneous	17,464	8.45	2,550	3.32
Total cost	206,672	100	83,700	100

(Source: Field survey, 2024)

production of guava was 33,300 kg per hectare in the study area. Guava cultivation had a Benefit-Cost Ratio (BCR) of 3.97 in the study area, suggesting that every BDT 1 invested in guava production generated a gross return of BDT 3.97. This finding is in line with Al-Amin (2024) and Pokharkar *et al.* (2016), who have found that fruit crops, including guava and mango, are more profitable when subjected to better nutrient and irrigation practices. Similarly, BCR for guava production at Alexandria, Egypt, was found to be 3.2 to 4.0 by El-Dnasury (2021). This high return is attributed to the high-yield variety adoption, favorable agro-ecological factors, and the proximity to the urban wholesalers.

Table 3. Cost and profitability indicators of guava cultivation in the study area (BDT/ hectare)

Indicators	Unit	Amount
Total Variable Cost (TVC)	BDT/ha	229,927
Total Fixed Cost (TFC)	BDT/ha	95,104
Total Cost (variable + fixed cost)	BDT/ha	325,031
Selling price (per kg)	BDT/kg	38.75
Total yield	Kg/ha	33,300
Gross Return (Ty × selling price per quintal)	BDT/ha	1,290,375
Gross Margin (GR - TVC)	BDT/ha	1,060,448
Net Margin (GR - TC)	BDT/ha	965,344
BCR		3.97

Cobb–Douglas production function

The estimated Cobb–Douglas production function model is specified as:

$$log\ Y = 6.421+0.164log\ X_1+0.097logX_2+ 0.082lnX_3-0.137lnX_4+0.172lnX_5+0.142lnX_6$$

For this model, R^2 was 0.702, implying that 70.2% of the output in guava cultivation could be explained by the independent variables of the model. The remaining variation may be explained by unobserved factors, such as farmers' different management practices, different weather conditions, and soil. Among the estimated variables, Urea (0.082) and the plant-protection expenses (0.172) showed positive and significant effects on guava yield. Balanced use of fertilizer and pest control measures played a positive role in increasing the productivity of guava cultivation. These findings are in line with the results of Hasan *et al.* (2017) and Rahman *et al.* (2020), who also reported positive responses to fruit crops in Bangladesh. On the contrary, irrigation (–0.137) had a significant negative coefficient, suggesting that excessive irrigation or inadequate drainage may adversely affect guava yield. This negative effect occurred due to stress for water or fruit loss caused by unsuitable moisture conditions. The sum of input elasticities was 0.92, indicating a decreasing return to scale, and suggesting that a rise in output would not be proportional if there were an equal increase in all inputs. Therefore, the findings suggest that the farmers might increase yield through better input management, particularly fertilizer management and irrigation methods.

Table 4. Estimated Cobb-Douglas production function for guava cultivation in the study area

Variables	Estimated coefficient	t-statistics	Standard error	p-value
Constant	5.270***		0.00	
Human labor	0.015	1.24	.0145	0.219
Urea	0.082*	-0.13	.0755	0.898
TSP/DAP	0.010	-0.75	.0605	0.455
MoP	0.032	-2.14	.0570	0.036
Irrigation cost	-0.137**	2.75	.0617	0.033
Plant protection cost	0.172**	1.56	.0798	0.210
R^2		0.70		
No. of observation		80		

****, **, and * indicates statistical significance at 1%, 5% and 10% levels, respectively.*

[Cobb-Douglas function included only major input variables (identified from literature review of past studies) that directly affect guava yield. Other fixed cost items were excluded from the production function but included in the cost-return analysis. Fertilizer variables were used based on actual fertilizers applied by farmers, namely Urea, TSP/DAP, and MoP.]

Production utilization and marketing pattern of guava

Per hectare, total yield was 33,300 kg (Table 5). 1.80% of the total output was retained by the farmers for household consumption, and 6.31% of total production was lost due to pest and disease infestation, suggesting a low level of field loss. 91.89% of the total yield was sold in the market, indicating that guava cultivation in Pabna is commercial in nature. Similar findings are also found in the study by Hossain and Badiuzzaman (2021).

Table 5. Production utilization and marketing pattern of guava in the study area (kg/hectare)

Category	Amount (kg)	%
Total output	33,300	100
Retained for home Consumption	600	1.80
Losses from pests and diseases	2,100	6.31
Quantity sold in the market	30,600	91.89

Marketing channels of guava

Marketing channels describe the route through which guava moves from the grower's point to end consumers, involving various intermediaries. In the study area, four marketing channels were identified:

Channel I. Producer → Retailer → Consumer

Channel II. Producer → Bepari → Retailer → Consumer

Channel III. Producer → Faria → Bepari → Aratdar → Retailer → Consumer

Channel IV. Producer → Aratdar → Wholesaler → Retailer → Consumer

Among these, Channel I and Channel II were mainly found in local markets, where guava was sold through shorter trading routes. In contrast, Channels III and IV involved more traders and were mainly associated with large-scale marketing. The number of intermediaries grew in a steady order, Channel I to IV, which naturally increased the handling and transaction costs and reduced the share of the producer, as is done with maize and vegetables in Bangladesh; similar channels were also identified by Kauser and Alam (2016) and Begum *et al.* (2024).

Marketing cost

Expenses involved in grading, packaging, transportation, weighing, and commission are known as marketing costs. Such expenditures directly affect producers' returns and the price paid by consumers.

The lowest marketing cost (1.60 BDT/kg) was incurred in Channel I. It indicates a short marketing route and fewer intermediaries, as the produce directly moves from farmers to retailers. Channel II involved the intervention of Bepari, which increased the expense of transportation between farm and urban marketplaces. Marketing costs were comparatively higher for Channel III and Channel IV, estimated at 3.41 BDT/kilogram and 4.04 BDT/kilogram, respectively, because these channels involved multiple transportation and repeated handling at different stages, and higher commission charges. Similar results are reported by Hossain and Badiuzzaman (2021) and Rahman *et al.* (2021) due to the prevalence of transportation and packaging expenses (more than 50%) across all channels in the guava supply chain. When transaction frequency, distance, and reliance on intermediaries increase, marketing costs rise steadily throughout the channels.

Price spread across different guava marketing channels

Price spread refers to the difference between the price paid by the consumer and the price received by the producer (Omar and Hoq, 2014). Table 7 indicates that Channel I produced the lowest price spread (BDT 15.76) as the produce was sold to retailers by farmers without any intermediary profits. In this channel, farmers received about 67% of the price paid by the consumer, which is the highest share of the producers among all channels. However, in Channel II, price

Table 6. Marketing cost incurred by guava farmers across different channels in the study area (BDT/kg)

Cost items	Channel I (P–R–C)	Channel II (P–B–R–C)	Channel III (P–F–B–A–R–C)	Channel IV (P–A–W–R–C)
Sorting and grading costs	0.29	0.35	0.42	0.47
Packaging costs	0.35	0.4	0.53	0.61
Transport cost	0.83	1.32	1.89	2.27
Weighing costs	0.06	0.08	0.11	0.13
Commission fees	0	0.18	0.26	0.31
Othes (meal, tips, etc.)	0.07	0.13	0.2	0.25
Total	1.6	2.27	3.41	4.04

[Producer, Aratdar, Bepari, Consumer, Faria, Retailer, and wholesaler are denoted by P, A, B, C, F, R, and W, respectively]

Table 7. Channel-wise price spread and producer's share in guava marketing (BDT/ kg)

Particulars	Channel I	Channel II	Channel III	Channel IV
Price received by producer	38.75	43.00	37.40	34.80
Marketing cost	1.60	2.27	3.41	4.04
Net price realized by the farmer	37.16	40.73	33.99	30.76
Consumer's price	54.51	75.99	76.70	83.00
Price spread	15.76	32.99	42.71	48.20

spread rose to BDT 32.99 because of Beparis' margins and increased transportation costs. A further increase is observed in channel III (BDT 42.71) as Faria, Bepari, and Aratdar share a portion of their revenue in commissions and markups of profits. The most significant price difference (BDT 48.20) was found in Channel IV, as the farmers lost their share to 41% through distance marketing and multi-tier transactions. These findings are similar to those of Kauser and Alam (2016) and Al-Amin (2024), as they reported that the producer's share reduces as the number of intermediaries increases.

Marketing efficiency of guava across different channels

Findings of Table 8 show that Channel I had maximum efficiency (2.14). In this channel, guava was sold to the retailers directly by producers, which reduced costs and ensured a shorter marketing route, faster payment, and higher profit for farmers. The channel II had an efficiency of 1.30, which was moderate due to the fact. Involvement of Bepari expanded market access for farmers; however, it raised total marketing costs through extra expenses for handling and commission charges. The efficiency of channel III (0.95) was low

Table 8. Marketing efficiency of guava across different marketing channels in the study area (BDT/kilogram)

Channel	Consumer price	Producer's price	Price spread (MC+MM)	Efficiency (ME)
I (P–R–C)	54.51	38.75	17.36	2.14
II (P–B–R–C)	75.99	43.00	32.99	1.30
III (P–F–B–A–R–C)	76.70	37.40	39.30	0.95
IV (P–A–W–R–C)	83.00	34.80	48.20	0.72

because several intermediaries (Faria, Bepari, Aratdar) had a series of costs added, which reduced the margins of farmers even when prices to consumers were higher. At Iswardi Upazila, Channel IV had the longest supply chain, where farmers were burdened with high transport charges and their prices were reduced by different intermediaries. Due to this, this channel had the lowest efficiency of 0.72. The findings are aligned with those of Hasan *et al.* (2017), who found deteriorating efficiency in marketing guava as the number of intermediaries rose, and Rahman *et al.* (2020), who found that direct or short-way marketing channels had a significant positive impact on the net incomes of fruit farmers in Bangladesh. Channel IV recorded the lowest marketing efficiency, reflecting the impact of a longer marketing channel, higher intermediary margins, increased handling and transport costs. Hence, improving local markets, encouraging farmer-based cooperatives, and creating direct linkages may enhance the performance of the guava marketing in Pabna.

Challenges faced by guava farmers

Table 9 indicates that low availability of labour and high labour costs were the topmost production constraints, followed by shortage of technical knowledge, unaffordable planting material, and expensive chemicals. Price fluctuation and lack of efficient market information were stressed as the main obstacles in marketing, while the other two problems, transportation cost and lack of grading and packaging facilities, were given equal importance. The results indicate the importance of technical training, input cost support, market information, and post-harvest and transport facilities for the guava growers.

Conclusion and Policy Recommendations

The findings of the study indicate that guava cultivation in Pabna District offers strong economic returns and has good commercial potential. The estimated BCR of 3.97 suggests high profitability of growing guava in the study area. Cobb-Douglas production function results showed that Urea fertilizer and plant-protection expenses had significant

Table 9. Major challenges encountered by guava farmers in the study area

Constraints	Garrett score	Rank
Labor unavailability and high labor charges	5,979	1
Lack of technical knowledge	4,421	3
Costly planting material	3,375	4
High cost of chemicals	3,365	5
Price fluctuation in the market for guava	5,680	1
Lack of an efficient marketing information system	4,298	2
High transportation cost	3,833	3
Grading and packaging facilities are not available	2,348	5

positive effect on guava yield. This implies that proper input management and effective pest and disease control can considerably increase productivity. The negative coefficient for irrigation suggests that excessive or poor irrigation may reduce yield. The marketing analysis revealed Channel I (Producer-Retailer-Consumer) was the most effective channel that offered the highest share to the producers (greater than 65) and the least marketing cost. However, the least efficient channel was Channel IV (Producer-Aratdar-Wholesaler-Retailer-Consumer) because of higher handling costs, commissions, and transportation costs. This finding identifies that the shorter marketing chains are more helpful to the farmers because they allow farmers to receive a higher share of the consumer price.

Despite high profitability, guava farmers still face some production and marketing constraints. Labor scarcity, high labor wages, limited technical knowledge, and high input prices, poor market information system and limited access to post-harvest facilities remain major obstacles to sustainable guava production and marketing. Nevertheless, guava cultivation provides opportunities for income diversification, employment creation, and rural economic growth. With appropriate policy support, better farm management, and a more efficient marketing system, guava cultivation can emerge as an important horticultural sector in the economy of Bangladesh.

The following policy recommendations are proposed in light of the study findings to improve guava cultivation and market performance in Pabna District:

i. Farmers should be educated on balanced fertilizer application, plant protection, and better orchard management since fertilizer application and plant protection inputs had positive effects on guava yield. Additionally, farmers should be given practical information on irrigation schedules and drainage management as irrigation had a negative effect on yield.
ii. Direct producer–retailer linkages and farmer-based marketing groups should be encouraged as they have proved to be the most efficient and cost-effective marketing channel.
iii. Digital price information services, local grading, packaging, storage, and transport facilities should be strengthened to enhance the effectiveness of the

guava marketing system, as the cost of transportation and the absence of grading and packaging facilities were identified as major marketing constraints.

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Conflict of Interest

The authors declared that there was no known conflict of interest associated with this study.

Author Contributions

Mahbub Alam: Conceptualization, data collection, formal analysis, and original draft preparation. Mst. Tania Parvin: Supervision, methodology, manuscript preparation, manuscript review, and editing. Khandakar Ramisha Anjum Misha: Data collection, literature review, data interpretation and manuscript preparation. Debasish Chandra Acharjee: Supervision, methodology, and critical review. Md Monjurul Islam: Supervision, methodological support, data interpretation, and manuscript review. Armina Sarkar: Data collection, data organization, and editing.

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