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Production and Marketing Barriers Faced by Smallholder Tea Farmers in Tetulia, Panchagarh, Bangladesh

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Abstract

Smallholder tea farmers in northern Bangladesh face multiple production and marketing difficulties, yet evidence on the relative severity of these perceived barriers and their socioeconomic correlates remains limited. This study identified the major perceived production and marketing barriers among smallholder tea farmers in Tetulia, Panchagarh, and examined socioeconomic and farm-related characteristics associated with farmers' overall barrier scores. A quantitative cross-sectional survey was conducted with 100 tea-farming household heads using a pre-tested structured interview schedule. Overall, 64% of respondents reported medium-level barriers, 33% high-level barriers, and 3% low-level barriers, with a mean respondent-level overall problem score of 69.38 (SD = 28.21; possible range: 0–104). At the individual-barrier level, the Problem Faced Index (possible range: 0–400) identified the survey item concerning perceived cheating by middlemen as the highest-ranked marketing barrier and drought and climate change as the highest-ranked production barrier. Low prices, low yield, labor shortages, lack of finance, high input costs, pest infestation, and irrigation constraints were also among the major reported barriers. Bivariate analysis showed significant associations of the overall problem score with education, total farm size, area under tea cultivation, and extension media contact. The regression model explained 19% of the variation; therefore, the multivariable relationships are interpreted as exploratory associations rather than causal effects. The findings indicate priorities for strengthening agricultural extension, climate- and water-management support, market information and price transparency, and fairer market linkages for smallholder tea farmers.

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Introduction

Tea (*Camellia sinensis*) is one of the world's most widely consumed beverages and an important agricultural commodity in many Asian and African economies. Its production depends on specific climatic, soil, labor, and market conditions, making tea farming highly sensitive to environmental stress and value-chain instability (Arefin & Hossain, 2022). In Bangladesh, tea has historically been concentrated in the Sylhet and Chittagong regions, but cultivation has expanded into northern districts such as Panchagarh through smallholding-based production systems. This expansion has created new livelihood opportunities for smallholder farmers, but it has also exposed them to climate variability, input-cost pressure, weak market access, and unequal bargaining relations with intermediaries.

Bangladesh has a more than 150-year history of producing tea, which was primarily centered in the greater Sylhet and Chittagong districts. The Bangladesh Tea Board and the Government of Bangladesh have decided to expand the tea plantation in various new suitable places of Bangladesh by implementing the smallholding tea cultivation system in light of the aforementioned facts. More recent evidence indicates that smallholder production is shaped by constraints related to finance, inputs, technical and extension support, climatic variability, market access, and price formation (Quddus & Kropp, 2020; Arefin & Hossain, 2022; Prodhan et al., 2022; Chen et al., 2026). Although previous studies have frequently examined tea estates and tea-garden workers (Hossain et al., 2017), smallholder tea farmers face distinct challenges related to production costs, climatic stress, limited technical support, and weak market power. Therefore, this study focuses specifically on smallholder tea-farming

households rather than tea-estate laborers. However, tea farmers in this region report numerous production and marketing difficulties that may affect farm performance and economic outcomes. To address these challenges, it is crucial to identify and analyze the barriers faced by tea farmers in northern Bangladesh. This research paper aims to identify the key barriers tea farmers face in this region in production and marketing.

Previous studies have examined tea production and farming challenges in Bangladesh (Ahmad & Hossain, 2013; Rahman et al., 2020; Islam et al., 2021), but evidence specifically integrating production and marketing barriers from the perspective of smallholder tea farmers in northern Bangladesh remains limited. Accordingly, this study uses a quantitative cross-sectional survey to identify and rank the perceived production and marketing barriers faced by smallholder tea farmers in Tetulia, Panchagarh, and to examine socioeconomic and farm-related characteristics associated with farmers' overall barrier scores.

The expansion of plain-land tea cultivation has increased the importance of tea to agricultural livelihoods and the rural economy of northern Bangladesh, particularly in Panchagarh (Arefin & Hossain, 2022; Prodhan et al., 2022). However, significant obstacles in both production and marketing limit the potential of tea producers in this area and prevent them from promoting sustainable development. To help tea producers and improve the whole tea business in northern Bangladesh, it is crucial to comprehend these obstacles and devise effective solutions to overcome them. The body of available literature shows a limited awareness of the particular production and marketing difficulties encountered by tea growers in northern Bangladesh. There is a paucity of research that focuses explicitly on the significant obstacles faced by tea farmers in this area, despite several studies looking at the country's tea production in its larger context.

Recent evidence suggests that smallholder tea production constraints are multidimensional rather than purely agronomic. Studies of smallholder and agricultural production systems identify access to finance, extension, inputs, market information, and institutional support as important determinants of farmers' production and marketing conditions (Quddus & Kropp, 2020; Prodhan et al., 2022). Tea-specific research further shows that climatic variability and adaptation capacity increasingly shape production decisions (Chen et al., 2026), while value-chain structure, certification, market access, and price formation influence the opportunities available to small producers (Langford, 2021; Wang & Tsai, 2026). These findings indicate the importance of examining production, climatic, financial, informational, and marketing barriers jointly. However, evidence integrating these dimensions from the perspective of smallholder tea farmers in the emerging tea-growing areas of northern Bangladesh remains limited.

This study addresses these empirical and analytical gaps by jointly examining the perceived production and marketing barriers faced by smallholder tea farmers and assessing their associations with selected socioeconomic and farm-related characteristics. Rather than treating production and marketing difficulties as separate issues, the study considers climatic, technical, financial, informational, and market-related constraints within a common analytical framework. This approach provides evidence on both the relative severity of specific barriers and the characteristics associated with farmers' overall problem scores, thereby extending existing largely descriptive accounts of Bangladesh's tea sector and providing a more focused basis for agricultural extension and market-support interventions. Previous research suggests that differences in education, farm resources, farming experience, training, and extension access may shape farmers' access to knowledge, productive resources, technical support, and market information, and may therefore help explain variation in how production and marketing barriers are perceived (Quddus & Kropp, 2020; Prodhan et al., 2022). Understanding these constraints is therefore important for designing context-specific agricultural extension and market-support interventions. Therefore, this study addresses the following two research questions: (a) What production and marketing barriers are perceived by smallholder tea farmers in Tetulia, Panchagarh? and (b) Which socioeconomic and farm-related characteristics are associated with farmers' overall perceived barrier scores?

The overall objective of the study is to identify and rank the perceived production and marketing barriers faced by smallholder tea farmers and to examine socioeconomic and farm-related characteristics associated with their overall barrier scores. Specifically, the study aims to: (a) identify and rank the major perceived production and marketing barriers; (b) examine associations between selected socioeconomic and farm-related characteristics and farmers' overall barrier scores; and (c) derive empirically grounded implications for agricultural extension and market support.

This study contributes to the literature in three ways. First, it extends smallholder resilience research to the emerging tea-growing region of northern Bangladesh, where farmers operate under overlapping production, climate, financial, and market pressures. Second, by combining farmers' perceived problem scores with the Problem Faced Index, the study identifies the relative severity of both production and marketing constraints, showing which barriers are perceived by farmers as most severe. Third, the study links these barriers with farmers' socioeconomic characteristics, including education, farm size, training exposure, extension media contact, and experience in exportable tea production. In doing so, the study moves beyond a purely descriptive account of tea-sector problems and provides evidence relevant to more targeted agricultural extension and market-support interventions in northern Bangladesh.

Materials and Methods

Locale of the Study

Tetulia Upazila is located in Panchagarh District in northwestern Bangladesh, bordering West Bengal, India, and covers approximately 189.12 km². Tetulia was selected purposively because it is one of the earliest and most established centers of plain-land tea cultivation in northern Bangladesh and contains a substantial

concentration of smallholder tea producers. At the time of the survey, the sampling frame obtained from the local agricultural office contained 998 tea-farming households in the study area. The wider northern plain-land tea economy had also expanded substantially by 2022. Across the five northern tea-growing districts, 8,355 smallholders cultivated approximately 12,079 acres of tea and produced about 90.27 million kg of green tea leaves, which yielded approximately 17.76 million kg of processed tea. The processed output was valued at approximately BDT 2.84 billion. These contemporary statistics demonstrate the growing economic importance of smallholder tea production in the region and provide a more appropriate context for the 2022 field survey.

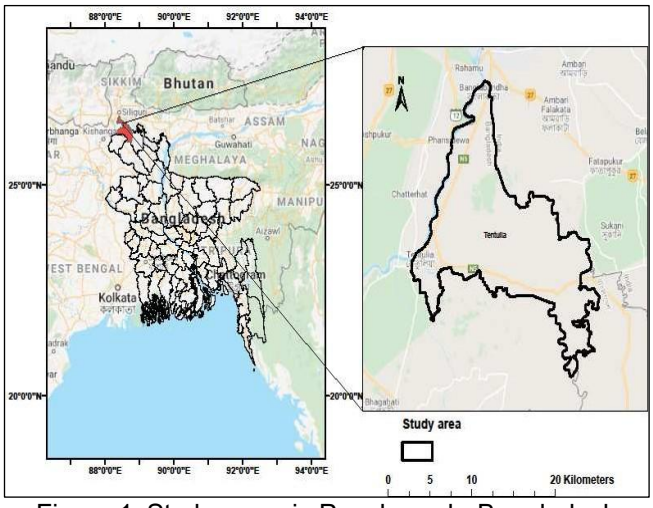


Figure 1. Study areas in Panchagarh, Bangladesh (Source: Prodhan et al., 2022)

Population and Sample

The target population consisted of 998 tea-farming households included in the sampling frame obtained from the local agricultural office. A total of 100 household heads were selected from this sampling frame using a random sampling procedure. The achieved sample represented approximately 10% of the listed population (100 of 998 households). The available study documentation does not record a formal a priori power- or precision-based sample-size calculation; therefore, the sample should be interpreted as the achieved field sample rather than as a statistically optimized sample size. This limitation is considered in interpreting the exploratory multivariable analysis. Because a reproducible stratum-level allocation is not documented in the available study records, the revised manuscript does not characterize the sampling procedure as a stratified or proportional design. Although a reserve list had been prepared before fieldwork, no replacement of the originally selected respondents was required.

Data collection

Data were collected through face-to-face interviews between 15 April and 15 May 2022. Local agricultural officials assisted only with initial access to the study area and were not involved in administering the interviews or recording respondents' responses. This period coincided with the active tea-production and harvesting season in Panchagarh: tea production in the northern region generally begins in March, while harvesting and marketing activity intensify from May onward. Consequently, respondents were reporting their experiences while production and green-leaf marketing activities were ongoing. The timing may therefore have increased the salience of seasonal concerns such as rainfall and drought conditions, labor availability, green-leaf prices, and access to buyers. The findings should accordingly be interpreted as farmers' perceptions during an active production and marketing period rather than as seasonally invariant assessments of conditions throughout the entire year. Before each interview, the purpose of the study and the voluntary nature of participation were explained to respondents, and informed consent was obtained. Respondent information was treated confidentially, and no personally identifying information is reported.

Measurement of tea farmers' characteristics

The study measured respondents' socioeconomic and farm-related characteristics using a structured interview schedule. Age, farming experience, tea cultivation experience, and experience in exportable tea production were recorded in completed years. Gender was recorded as male or female according to the categories used in the survey instrument. Because respondents were restricted to household heads, the study did not independently capture the perspectives of other household members who may also have participated in tea farming. Education was measured by years of schooling, with zero assigned to respondents who could not read or write or could only sign their names. Family size was measured by the total number of household members sharing a common residence and meal. The number of persons involved in tea farming was measured as the number of household members participating in tea-farming activities. Total farm size was measured in hectares using the formula: farm size = A + B + (C + D)/2 + E + F, where A = homestead area, B = own land under own cultivation, C = land given to others on borga, D = borga land received from others, E = leased or mortgaged land, and F = other land uses. Farm size under tea cultivation was measured as the total area specifically devoted to tea cultivation and expressed in hectares. Annual family income and income from tea were calculated from all relevant on-farm and off-farm sources and expressed in thousand Bangladeshi taka. Training exposure was measured by the number of training days received from government, non-government, or other organizations during the previous three years. Extension media contact was assessed using selected media sources and scored as regular, occasional, seldom, and never, with scores of 3, 2, 1, and 0, respectively; the total score represented each respondent's overall level of extension media contact. These socioeconomic and farm-related characteristics were examined as potential correlates of farmers' overall perceived barrier scores rather than as causal determinants.

Evaluation of the Focus Variable

The focus variable was assessed using a 26-item inventory of perceived production and marketing barriers. The 26 items were refined during questionnaire pre-testing and consultation with disciplinary experts to

improve their relevance and clarity for the local tea-production context. The available study records do not document the number of pre-test participants, composition of the expert group, or a formal item-retention procedure; these details were therefore not reconstructed retrospectively. Accordingly, the instrument is treated as a structured descriptive barrier inventory rather than as a formally validated unidimensional psychometric scale. Each barrier was rated on a five-point response scale ranging from 0 ("not at all") to 4 ("very high"). Scores across the 26 items were summed to obtain a respondent-level overall problem score ranging theoretically from 0 to 104, with higher values indicating a greater cumulative level of reported production and marketing difficulty. Separately, a Problem Faced Index was calculated for each individual barrier to compare its relative severity across all respondents.

$$PFI = \mathrm{Pvh} \times 4 + \mathrm{Ph} \times 3 + \mathrm{Pm} \times 2 + \mathrm{Pl} \times 1 + \mathrm{Pn} \times 0 \quad (1)$$

where PFI denotes the Problem Faced Index. Pvh = Number of respondents who describe the issues as "very high". Ph = Number of respondents that describe the difficulties as "high". Pm = Number of respondents who describe the issues as "medium." Pl = Number of respondents who describe the issues as "low". Pn = Number of respondents who indicated that they had no concerns at all.

The items represented heterogeneous production and marketing constraints rather than interchangeable indicators of a single latent construct. Accordingly, the Problem Faced Index (PFI) was used as a descriptive ranking measure to compare the relative severity of individual barriers across respondents. With 100 respondents, the theoretical PFI for each item ranged from 0 to 400. The respondent-level summed score and the item-level PFI therefore served different analytical purposes: the former represented cumulative reported barrier burden, whereas the latter ranked individual barriers by perceived severity. The measure should consequently be interpreted as a structured barrier inventory rather than as a fully validated unidimensional psychometric scale.

Data processing, categorization, and analysis

After the field survey, all responses were checked, coded, converted into standard units where necessary, and entered into a master sheet for tabulation and analysis. Qualitative responses were transformed into numerical scores using the predefined scoring procedures. For descriptive presentation, overall problem scores were grouped as low (≤30), medium (31–70), and high (>70). These cut-offs were used as descriptive groupings rather than externally validated thresholds; correlation and regression analyses used the continuous overall problem score. Data were analyzed using SPSS version 25.0. Descriptive statistics, including frequency, percentage, mean, standard deviation, and rank order, were used to summarize respondents' characteristics and the severity of barriers. Pearson's product-moment correlation was used to examine relationships between farmers' characteristics and perceived barriers, with significance tested at the 5% level. Multiple linear regression was then applied to identify factors associated with barriers to tea production and marketing. The model was specified as:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + b_{12}X_{12} + b_{13}X_{13} + e \quad (2)$$

where *Y* represents the perceived overall barriers; b_0 is the constant; b_1–b_{13} are regression coefficients; X_1–X_{13} represent age, education, family size, persons involved in tea farming, total farm size, farm size under tea cultivation, annual family income, income from tea, training exposure, overall farming experience, extension media contact, experience in tea cultivation, and experience in exportable tea production, respectively; and e is the error term.

Given the sample size of 100 respondents relative to the number of explanatory variables included in the model, the multivariable analysis was treated as exploratory rather than confirmatory. Accordingly, individual coefficients were interpreted cautiously and were used to identify possible associations rather than to establish causal relationships. Before interpreting the regression coefficients, model assumptions were assessed using residual diagnostics and tests for multicollinearity. Multicollinearity was evaluated using tolerance and variance inflation factor (VIF) statistics, while the distribution and variance of residuals were examined to assess approximate normality and homoscedasticity. The final model statistics, including R^2, adjusted R^2, F-statistic, degrees of freedom, and model-level p-value, were verified against the original SPSS output.

Results and Discussion

Problems faced by the farmers in tea cultivation and marketing

Table 1 presents the distribution of respondents according to their overall production and marketing problem scores. Of the respondents, 33% reported high-level problems (scores >70), 64% reported medium-level problems (scores 31–70), and 3% reported low-level problems (scores ≤30). The mean overall problem score was 69.38 (SD = 28.21), indicating considerable variation in the level of perceived barriers across respondents.

Table 1. Problems faced by the farmers in tea cultivation and marketing

Categories (scores)	Respondent farmers		Mean	Standard deviation
	Number	Percent (%)		
Low problem (up to 30)	3	3		
Medium problem (31-70)	64	64	69.38	28.21
High problem (above 70)	33	33		
Total	100	100		

Table 2. Socioeconomic and farm characteristics of tea farmers

Characteristics	Scoring method	Categories	Number	Percent	Mean (SD)
Age	Years	Young (up to 35)	26	26	45.79 (12.22)
		Middle (>36-50)	38	38	
		Old (above 50)	36	36	
Education	Years of schooling	Low education (Up to 5)	56	56	6.41 (3.80)
		Medium education (6-10)	29	29	
		Higher education (above 10)	15	15	
Family size	No. of persons	Numbers	-	-	5.10 (0.94)
Persons involved in tea farming	No. of persons	-	-	-	2.15 (0.83)
Farm size	Hectare	Landless farm (< 0.2)	0	0	2.44 (0.90)
		Small farm (0.201-0.99)	6	6	
		Medium farm (1-3)	70	70	
		Large farm (above 3)	24	24	
Farm size (tea only)	Hectare	Landless farm (< 0.2)	0	0	1.67 (0.58)
		Small farm (0.201-0.99)	1	1	
		Medium farm (1-3)	10	10	
		Large farm (above 3)	89	89	
Annual income	BDT (000)	Low income (up to 120)	43	43	143.03 (44.49)
		Medium income (> 120-240)	57	57	
		High income (above 240)	0	0	
Income from tea	BDT (000)	Low income (up to 120)	76	76	107.81 (23.23)
		Medium income (> 120-240)	24	24	
		High income (above 240)	0	0	
Training Exposure	Days	No training (0)	1	1	17.81 (7.05)
		Low training (up to 10)	64	64	
		Medium training (10-20)	35	35	
		High training (above 20)	0	0	
Overall farming experience	Years	Low (less than 10)	17	17	23.13 (11.12)
		Medium (10-20)	23	23	
		High (above 20)	60	60	
Extension media contact	Scores	Low (up to 10)	29	29	13.32 (8.08)
		Medium (11-20)	53	53	
		High (above 20)	18	18	
Experience in tea cultivation	Years	Low (up to 5)	5	5	12.49 (4.00)
		Medium (6-15)	76	76	
		High (above 15)	19	19	
Experience in exportable tea production	Years	Low (up to 5)	6	6	11.44 (3.19)
		Medium (6-15)	86	86	
		High (above 15)	8	8	

Only 3% of tea farmers reported low overall barrier scores, indicating that production and marketing difficulties were widely perceived among the surveyed farmers. However, the problem score alone does not establish whether respondents with lower scores had better access to resources, knowledge, or markets (Saikia, 2019). Most farmers faced medium-level barriers (64%), while 33% experienced high-level barriers, indicating that production costs, low yields, weak market access, price instability, inadequate training, and limited extension support were among the major production and marketing difficulties reported by respondents. These findings suggest the need for targeted interventions, including improved access to inputs, technical training, financial support, collective marketing, and stronger market linkages to reduce farmers' production and marketing challenges (Ho et al., 2022).

Socioeconomic and farm characteristics of tea farmers

Table 2 shows that the respondent tea farmers were mostly middle-aged or older, with a mean age of 45.79 years, and had relatively low education, averaging 6.41 years of schooling. The average family size was 5.10, while 2.15 persons per household were involved in tea farming. Respondents had an average total farm size of 2.44 hectares and 1.67 hectares under tea cultivation. Annual family income averaged BDT 143.03 thousand, of which BDT 107.81 thousand came from tea. Mean training exposure was 17.81 days, the mean extension media contact score was 13.32, and mean overall farming experience was 23.13 years. These statistics provide a descriptive profile of respondents' training exposure, information contact, and farming experience.

Comparative severity among the problems faced by the tea farmers

The Problem Faced Index (PFI) and rank order of the numerous issues that tea growers face throughout production and selling are shown in Table 3. The table

Table 3. Problem Faced Index (PFI) with Rank Order

Problems	Number of farmers					PFI	Rank order
	Very high	High	Medium	Low	Not at all		
Production barriers							
Poor soil fertility	0	3	52	44	1	157	17
High costs of inputs	9	55	35	1	0	272	7
Lack of Irrigation Facility	2	35	51	11	1	226	11
Low yield	33	65	2	0	0	331	4
Pest Infestation	2	35	53	9	1	228	10
Old tea gardens	0	35	48	17	0	218	12
Low quality tea	1	21	53	15	10	188	14
Drought and climate change	62	38	0	0	0	362	3
Poor workers-employee relationship	0	0	5	24	71	34	26
Labor shortage	25	58	17	0	0	308	5
High costs of labor	3	39	51	7	0	238	9
Higher intercultural management cost	0	31	52	17	0	214	13
Poor access to information	0	2	20	59	19	105	24
Lack of training	0	0	10	78	12	98	25
Lack of Finance	24	54	22	0	0	302	6
Lack of fertilizer/pesticide	0	6	41	48	5	148	18
Marketing barriers							
Low market demand	0	13	57	29	1	182	15
Tea hawking	0	0	28	60	12	116	21
Lack of knowledge of value addition	0	0	28	56	16	112	22
Low local consumption	0	3	57	40	0	163	16
Lack of regulatory support	0	6	31	54	9	134	19
Low access to market	0	0	19	72	9	110	23
Low price	72	28	0	0	0	372	2
High cost of transportation	0	59	41	0	0	259	8
Cheating by middleman	82	16	1	0	1	378	1
Lack of information about pricing	0	0	29	63	8	121	20

sheds light on the relative seriousness of various issues, with higher PFI values suggesting more seriousness. The rank order column shows a problem's severity according to its PFI score, with lower rankings denoting more difficult barriers.

Table 3 shows that drought and climate change were the most severe production barrier, followed by low yield, labor shortage, lack of finance, high input costs, pest infestation, and irrigation constraints. These results indicate that respondents perceived overlapping climatic, technical, financial, and labor-related difficulties in tea production. The high ranking of drought and climate change, together with irrigation, input-cost, finance, and labor constraints, suggests that farmers experience climatic stress within a broader set of interrelated production challenges. Similar studies on smallholder tea systems show that climate stress, input costs, weak technical support, and limited farm investment reduce tea-sector resilience (Tran & Goto, 2019; Voora et al., 2019). More recent evidence similarly emphasizes the importance of climate-risk perception and adaptive capacity in shaping tea farmers' production decisions (Chen et al., 2026), reinforcing the relevance of climatic and resource-related constraints identified in the present study. These findings suggest that irrigation, climate-adaptation support, pest management, affordable input access, and extension services are relevant areas for addressing the production difficulties reported by farmers.

Perceived cheating by middlemen was the most severe marketing barrier, followed by low prices, high transportation costs, low local consumption, limited market information, weak regulatory support, and poor value-addition capacity. Taken together, these reported barriers suggest perceived disadvantages related to bargaining position, price transparency, dependence on intermediaries, and access to alternative markets. Because these indicators were based on farmers' perceptions, however, the study does not independently establish exploitative behavior by intermediaries. Previous studies similarly show that smallholders receive lower returns when market linkages, price information, collective marketing, and value-addition opportunities are weak (Tran & Goto, 2019; Voora et al., 2019). These findings support greater attention to transparent price information, farmer–buyer linkages, collective marketing where feasible, and improved access to market information, particularly because intermediary practices, low prices, and transportation costs ranked prominently among respondents' concerns.

Correlation between farmers' characteristics and barriers

Table 4 shows that education, total farm size, farm size under tea cultivation, and extension media contact were significantly associated with farmers' overall problem scores. Total farm size showed the strongest negative relationship with the problem score ($r=-0.31$, $p<0.01$), followed by farm size under tea cultivation ($r=-0.29$, $p < 0.01$) and extension media contact ($r=-0.22$, $p<0.05$). Education was positively associated with the problem score ($r=0.21$, $p<0.05$). The negative associations of total farm size, tea-cultivated area, and

Table 4. Pearson's product-moment correlation coefficient showing the relationship between dependent and independent variables

Dependent variable	Independent variables	Correlation coefficient (r)
Problems faced by the farmers in tea production and marketing	Age	0.13
	Education	0.21*
	Family size	0.09
	Persons involved in tea farming	0.17
	Farm size	-0.31**
	Farm size under tea	-0.29**
	Annual family income	0.17
	Income from tea	-0.09
	Training exposure	-0.19
	Overall farming experience	-0.09
	Extension media contact	-0.22*
	Experience in tea cultivation	0.14
	Experience in exportable tea production	0.06

**Significant at 0.01 level of probability, *Significant at 0.05 level of probability

extension media contact with overall problem scores may indicate that greater resource availability and access to agricultural information are associated with lower perceived difficulties. In contrast, the positive association with education should not be interpreted as evidence that education increases production and marketing problems; more educated farmers may instead identify or report production standards, market requirements, and institutional limitations more critically, although this mechanism was not directly measured.

Annual family income and training exposure did not reach the 5% significance level. Other variables, including age, family size, persons involved in tea farming, income from tea, overall farming experience, tea cultivation experience, and experience in exportable tea production, were not significantly related to farmers' barriers. These findings are consistent with studies showing that smallholder constraints are shaped not only by farm resources but also by access to knowledge, extension, market information, and institutional support (Quddus & Kropp, 2020; Voora et al., 2019).

Factors associated with production and marketing barriers

Table 5 presents an exploratory multiple linear regression examining socioeconomic and farm-related characteristics associated with farmers' overall production and marketing problem scores. Some variables differed in statistical significance between the bivariate and multivariable analyses. This does not necessarily represent contradictory evidence because Pearson correlations describe unadjusted relationships, whereas regression coefficients represent associations after adjustment for the other predictors included in the model. Given the modest sample size relative to the number of predictors, the model is interpreted cautiously as an exploratory assessment of multivariable associations rather than as a causal or predictive model. The final model explained 19% of the variation in overall perceived barrier scores ($R^2 = 0.19$; adjusted $R^2 = 0.07$) and was not statistically significant, $F(13, 86) = 1.55$, $p = 0.116$. Family size, farm size, and extension media contact showed negative adjusted associations with perceived barrier scores. These relationships indicate that household composition, land resources, and information access may differentiate farmers' reported experiences, but the cross-sectional design does not establish that these characteristics reduce barriers. Education, training exposure, and experience in exportable tea production showed positive adjusted associations with perceived barriers. One possible explanation is that farmers with greater education, training, or exposure to export-oriented production may be more aware of quality standards, input requirements, and market constraints; however, this interpretation remains tentative because these mechanisms were not directly measured. Because the model had limited explanatory power and contained several related farm, income, and experience variables, the individual coefficients should be interpreted cautiously. The results indicate exploratory associations rather than causal effects. Future studies should include larger samples and additional institutional, climatic, and market variables to better explain the variation in farmers' barriers (Quddus & Kropp, 2020; Tran & Goto, 2019; Voora et al., 2019).

Policy recommendations

The findings suggest that smallholder tea farmers in the study area may benefit from coordinated extension, production, climate-adaptation, and market-support interventions. First, agricultural extension services should be strengthened to provide practical training on soil fertility management, integrated pest management, irrigation, pruning, input use, and farm management (Nur et al., 2024; Quddus & Kropp, 2020). Second, climate adaptation should be prioritized through improved water management, shade systems, drought-tolerant tea varieties, and climate-smart advisory services (Bermudez et al., 2024; Chen et al., 2026). Third, because labor shortage and high labor costs ranked among the reported production barriers, locally appropriate labor-saving practices and feasible mechanization options warrant further consideration. Fourth, market linkages should be improved by forming farmer groups or cooperatives, promoting collective marketing, reducing transport barriers, and connecting farmers directly with processors and buyers (Bermudez et al., 2024; Langford, 2021). Fifth, transparent price-information systems and appropriate market oversight should be strengthened to address farmers' reported concerns regarding intermediary practices, low prices,

Table 5. Factors associated with the barriers of the tea farmers in tea production and marketing

Independent variables	Standardized coefficients (Beta value)	Significance
Age	-0.12	0.70
Education	0.13	0.05
Family size	-0.72	0.04
Persons involved in tea farming	0.06	0.92
Farm size	-0.32	0.01
Farm size (only tea)	-0.02	0.81
Annual family income	-0.12	0.78
Income from tea	0.03	0.46
Training exposure	0.26	0.01
Overall farming experience	0.04	0.59
Extension media contact	-0.21	0.00
Experience in tea cultivation	0.06	0.72
Experience in exportable tea production	0.27	0.04
$R^2 = 0.19$		
Adjusted $R^2 = 0.07$		
$F(13, 86) = 1.55$, $p = 0.116$		
n = 100		

and limited bargaining opportunities. Finally, capacity building for value addition, including processing, grading, packaging, branding, and certification support, may improve farmers' opportunities to participate in higher-value markets (Langford, 2021; Larsen, 2016; Mohan, 2016; Quddus & Kropp, 2020). These recommendations are directly linked to the principal production and marketing barriers reported by respondents and are consistent with wider evidence emphasizing extension access, climate adaptation, market transparency, and producer organization in smallholder tea systems.

Conclusion

This study identified the major perceived production and marketing barriers faced by smallholder tea farmers in Tetulia, Panchagarh, and examined socioeconomic and farm-related characteristics associated with their overall barrier scores. Most respondents reported medium-to-high levels of production and marketing difficulty. At the individual-barrier level, drought and climate change was the highest-ranked production barrier, followed by low yield, labor shortages, lack of finance, high input costs, pest infestation, and irrigation constraints. Among marketing barriers, the survey item concerning perceived cheating by middlemen ranked highest, followed by low prices, high transportation costs, limited market information, weak regulatory support, and limited value-addition capacity.

The bivariate analysis showed that education, total farm size, area under tea cultivation, and extension media contact were significantly associated with farmers' overall problem scores. The regression model explained 19% of the variation in perceived barriers ($R^2 = 0.19$); consequently, the multivariable findings should be interpreted as exploratory associations rather than causal relationships.

The findings suggest several priorities directly linked to the barriers reported by respondents. Agricultural extension should provide more accessible technical and market information, while climate- and water-management support should address drought and irrigation-related difficulties. Improved price information, stronger farmer–buyer linkages, and greater transparency in intermediary transactions may help address the principal marketing concerns identified by respondents. Because the study is based on a cross-sectional survey of 100 household heads in one upazila and measures perceived rather than independently verified barriers, its findings should not be generalized beyond comparable smallholder tea-growing settings without caution. Future studies should employ larger samples, longitudinal or mixed-method designs, and direct measures of production, market performance, climatic exposure, and institutional conditions.

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