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Deriving factors of adopting tea farming among the smallholders in the northern region of Bangladesh

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Abstract

Tea is the second-largest export-oriented cash crop of Bangladesh. It is widely cultivated in the northeastern hilly areas of Bangladesh, but in recent times, tea has also been cultivated in the northern region of Bangladesh, which remains flat land. Interestingly, smallholders are engaging in tea cultivation in these areas. Data were collected from two different upazilas (Thakurgaon Sadar and Baliadangi) of Thakurgaon District from December 2023 to January 2024. A total of 102 respondents (54 adopters and 48 non-adopters) were interviewed using the snowball sampling technique because of the scattered location of tea gardens and a mixed-method approach for the unexplored nature of the study area. Being a dichotomous dependent variable (adoption), a binary logistic regression model was used in this study. The result shows a statistically significant relationship with the three broad factors: personal attributes (such as education), economic conditions (including land size and household income), and institutional factors (attending training and availability of incentives). Tea cultivation can be a promising potential for the flatland in the northern region, especially among the smallholders. Policies should focus on enhancing education, expanding training opportunities, offering incentives to accelerate the adoption of tea farming, and promoting inclusive agricultural growth in Northern Bangladesh.

Keywords: *Adoption, Tea farming, Smallholders, Logistic Regression*
Jel Classification: Q12, Q16, O13, Q18

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Introduction

The *Camellia sinensis* plant is the source of the popular beverage known as tea, which originated in ancient China about 2737 BC. Tea has become crucial in developing Bangladesh's complex agricultural structure, although its primary cultural value is well recognized. The Bangladesh Tea Association maintains historical oversight of this heritage by identifying the mid-19th century as when Malnichhara in Sylhet became the first place where tea was sold commercially. Following independence, Bangladesh experienced significant growth in tea operations, particularly after overcoming its initial eastern limitations. According to BTA, this industry in Bangladesh produces 2% of worldwide tea production. The broad narrative of the agricultural sector in Bangladesh gains form as one of the historical events in the northern part of the country. Panchagarah District, leading Thakurgaon and other districts such as Dinajpur, Lalmonirhat, and Nilphamari Districts, followed suit, and this fundamental change occurred among the smallholders in the first half of the 21st century. The change in geographic boundaries successfully demonstrates tea cultivation flexibility while introducing sophisticated economic and environmental conditions that oppose past limits of tea-producing territories in the southeast. The tea industry plays a significant economic role in Bangladesh because it adds 0.11% to the national GDP (Mamun, 2019). This industry generates direct employment for more than 100 thousand people and has an extensive indirect labor effect for over 500 thousand people who work in various industries related to tea production. Tea cultivation in the country has progressed as a result of economic enhancement, the need for agricultural diversification, and environmental shifts (Rahman, 2022). This study examines the factors that drive individuals to engage in tea cultivation as it extends into northern areas. Examining in this study, the quantitative and qualitative dimensions linking land use patterns to resource availability and market fluctuations, as well as their social and cultural implications, to enhance understanding of these interrelations. This report will have a substantial impact on discussions regarding agricultural reforms and sustainable practices in the global tea industry. This study serves as a valuable resource for government officials, extension workers, and community members aiming to enhance tea plantation regions in Bangladesh. The remaining paper is organized into different sections. Section 2 presents the objectives of this study, whereas Section 3 outlines the rationale of the study. Section 4 describes the relevant literature. Section 5 reviews the methodology employed in this study. Data and variables used in the analysis are presented in Section 6. Section 7 reports the empirical results, followed by a discussion in Section 8. While Section 9 highlights the policy implications of the findings, Section 10 concludes the study.

Rationale of the Study

The agricultural sector of northern Bangladesh undergoes significant changes, while researchers lack information about elements that affect decisions regarding tea farming by smallholders. The implementation decisions in agriculture undergo a strong initial impact from a combination of land usage patterns and available resources, together with market variables and cultural elements. This study aims to answer this research question through an organized appraisal of major elements

driving smallholders into tea cultivation. Results from this study will assist local organizations, agricultural extension agents, and officials in developing intentional plans to promote long-term agricultural growth in addition to improved small-scale farmers' economic expansion.

Objectives

The purpose of this study is to look at the characteristics that affect smallholders' decisions to adopt tea farming. It also aims to give an extensive understanding of the factors influencing these farmers' decision to cultivate tea by looking at resource availability, financial conditions, and human characteristics.

Literature Review

Historical Prevalence

The history of the tea industry in Bangladesh began with the establishment of Kunder's Garden in Chittagong in 1840 and Malnichhara in Sylhet in 1857 (Bangladesh Tea Association). Before independence, tea was initially cultivated in the Surma and Halda Valleys, and after that, the tea sector expanded significantly. Bangladesh now ranks ninth worldwide in terms of tea production, with almost 2% of total output. In numbers, there are 166 tea estates spanning almost 280,000 acres. This industry indirectly supports 500,000 people and directly employs about 100,000 people, indicating its importance to the national economy. Expanding and diversifying into green, oolong, and organic teas, and continuing the tea auction heritage are recent advances in the business that improve employment, export revenue, and poverty alleviation (Mamun, 2019). The only tea research institute in Bangladesh, BTRI, has been crucial in this growth by providing superior clones and hybrid seeds. Since tea has been 0.11% of the GDP, policies on maintaining land scarcity and increasing production plan is divided into intensive cultivation, virgin lands, establishing, and small tea plantations.

Economic Importance

The tea industry is economically crucial to Bangladesh because it promotes food security and contributes significantly to the national economy. It generates foreign cash, employs thousands of people, and helps protect biodiversity (Rahman, 2022). The tea business is a big export that helps poor people in the countryside and keeps the country's foreign exchange reserves safe. (Al-Amin, 2017). The tea business has grown because there are more places to grow tea and clones that make a lot of tea. This has caused an annual production of about 67.38 million kg, which is 0.11% of GDP (Arefin & Hossain, 2022; Mamun, 2019). But we need to find new ways to make more money because of changes in the way it rains and a drop in exports (Saha & Rahman, 2020; Islam et al., 2021). Although there are some issues, tea cultivation offers chances for independent work that can change the socioeconomic condition of rural communities, highlighting its crucial role in the economy of Bangladesh.

Factors Influencing Agricultural Adoption

Multiple variables are influencing the adoption of different practices and technologies related to agriculture all over the world. Li (2023) reveals how Chinese cotton farmers embrace smart agricultural technology because of policy satisfaction, together with normative views and control beliefs, while superior influencing factors exceed peer effects. Tey & Brindal (2022) identified some factors, such as access to credit, subsidies to the farmers, and extension services, as the key drivers for climate-smart agriculture. Sapbamrer & Thammachai (2021) highlighted the significance of education, off-farm income, gender, and supportive elements like government organizations and farm groups in the context of organic farming. Adoption is also linked in European research to information sources, education, and views about the economy and environment. Dessart (2019) divided effects into three different components: dispositional, social, and cognitive components, whereas Prokopy (2019) found that self-identification, environmental awareness, and program consciousness were linked to adoption in the United States. With assistance from cooperatives and extension services, Soviadan (2022) emphasized that family size, farm size, and knowledge all affect the adoption of chicken farming in Togo. Quan & Doluschitz (2021) found that the adoption of equipment in China had multiple effects, with land area and subsidies being positive variables and field diversity and regional differences being negative ones. Mohammed (2019) found similar influences for advanced maize methods in Ghana. The growth of tea regions and novel clones in Bangladesh has influenced the economic variability of tea production; nonetheless, falling exports and unfavorable weather patterns have raised expenses and losses (Arefin & Hossain, 2022; Md. M. Rahman, 2022; Saha & Rahman, 2020). The local difficulties, such as hailstorms and floods, are known to cause agricultural problems; hence, the necessity to have easier access to resources such as land, money, and information (Sarker et al., 2021; Rasul, 2009). Even though social and cultural factors influence behaviors and the availability of resources, training is crucial for acquiring knowledge and skills (Monira, 2022; Pervez et al., 2015). The government needs to create policies to be better executed and gender perceptive (Mamun, 2019; Shahabuddin & Rahman, 2017), and improving market facilities and infrastructure is crucial for fair pricing and regional integration (Haque, 2022; Khandker & Samad, 2018). Tea production is made more difficult by climate change; therefore, resilience requires organic cultivation and adaptable techniques (Ahmed & Fatema, 2023; Rahman, 2022).

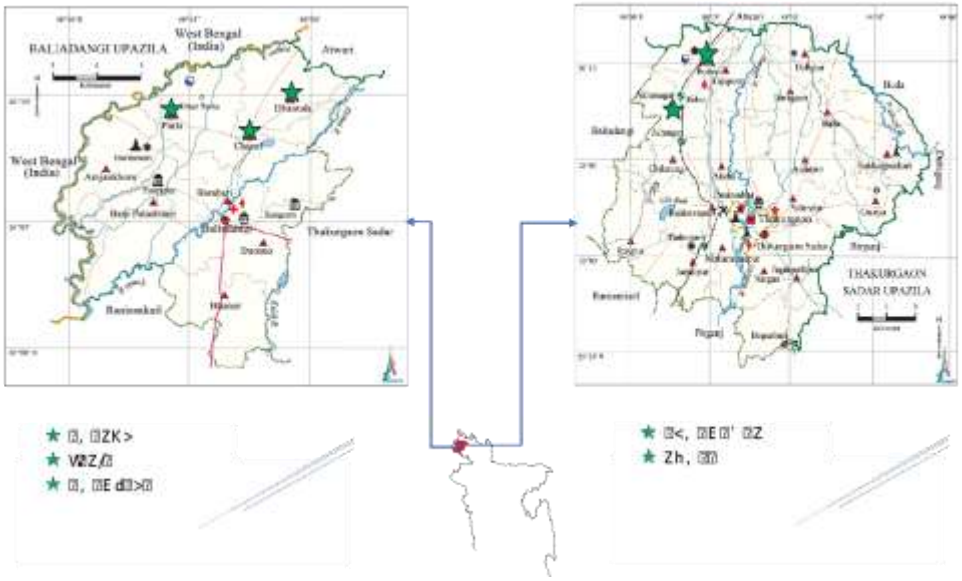
Methodology

Area of the Study

Thakurgaon District, covering 1781.74 sq. km and located between 25°40' and 26°12' north latitudes and 88°05' and 88°39' east longitudes, is bounded by Panchagarh District to the north, West Bengal, India, to the west, Dinajpur District to the south, and Nilphamari District to the east. Among the five upazilas of the Thakurgaon District, Thakurgaon Sadar and Baliadangi were selected for this study.

Most of the gardens are located in Baliadangi, where small-scale producers dominate; there is just one large tea farm, "Green Field Tea Estate" (locally known as ‘Madam'er Cha Bagan’), and a single tea processing company.

Map of the Study Area
(Source: Banglapedia)



While agriculture, including the cultivation of rice, wheat, corn, chili, vegetables, and other crops, is the primary livelihood, the adoption of tea farming is relatively new among the smallholders. The purpose of this study is to examine which factors lead smallholders to switch from growing conventional crops to growing tea.

Sample Size

Since this study required quantitative as well as qualitative information, a mixed-methods approach was required. As accurate information about the number of farmers in the study area was not available, we began with a preliminary qualitative study to gain a basic understanding of the local context.

Table 1: Sample Size

Upazila	Union	Number of KIIs		Quantitative Survey	
		Adapter	Non-Adaptor	Adapter	Non-Adaptor
Thakurgaon Sadar	Akhanagar	1	1	8	8
	Ruhia	0	0	4	4
	Charol	1	1	15	15
	Dhantala	0	0	15	15
Baliadangi	Paria	0	0	12	6
Total		2	2	54	48
		4		102	

Source: Author’s Calculation

Among the important stakeholders with whom we performed four interviews with key informants (KIIs) were the production manager and factory manager of Green Field Tea Estate (the only tea-producing factory in the area).

These interviews provided valuable insights into the tea farming situation in Thakurgaon and helped us provide a list of 300 farmers directly involved in tea cultivation. Tea gardens are mostly located near the 'Madam'er Cha Bagan' in Baliadangi Upazila, and a few are located near the only tea processing factory in Sadar Upazila. The production manager estimated that there might be a total of 400 farmers who were engaged in tea farming in that area.

We used this estimate to make a sample survey for the study's quantitative part. We followed a simple rule: we chose at least 10% of the total population. This meant picking 40 tea farmers and 40 non-tea farmers (general farmers), for a total planned sample size of 80.

To support the development of a well-structured questionnaire for this survey, we used the findings from the initial qualitative phase. In order to get comprehensive data from the participants, the final questionnaire had open-ended as well as closed-ended questions in addition to multiple-choice answers. In addition, two more KIIs with tea farmers were conducted to better understand the factors influencing the adoption of tea cultivation. Although we initially planned to survey 80 participants, at the end of the data collection period, we successfully surveyed 102 farmers, including 54 adopters and 48 non-adopters (Table-1).

Variables of the Study

In this study, adoption is the dependent variable, and various factors that impact the adoption of tea farming are considered as independent variables. These include key elements such as age, education, agricultural experience, access to credit, incentives, and more. Each of these independent variables represents a diverse aspect influencing the decision-making process connected with tea farming. Table 2 presents a description of the key variables of this study.

Table 2: Description of Variables

Category	Variable Name	Label	Type	Description
Dependent Variable				
	Adoption	adoption	Binary	0 = No, 1 = Yes
Independent Variables				
Personal Factors	Age of HH head	r_age	Cont.	Number of Years
	Agri Experience of HH head	agri_exp	Cont.	Number of Years
	Education of the HH head's	schooling	Cont.	Number of Years
Economic Factors	Total amount of land	t_land	Cont.	In terms of Acre
	Total HH income	t_income	Cont.	In terms of BDT per thousand
	Off-Farming Occupation	off_occupat	Binary	0 = No, 1 = Yes
Institutional Factors	Attending Training/Seminar	training	Binary	0 = No, 1 = Yes
	Access to Credit	credit	Binary	0 = No, 1 = Yes
	Availability of Incentives	incentive	Binary	0 = No, 1 = Yes
	Distance of the Local Factory	proximity	Binary	0 = >5 km, 1 = <5 km

Source: Author's Calculation, 2024

Data Collection

Primary and secondary sources were used in the data-gathering process for this study to give an in-depth understanding of agricultural practices in the Thakurgaon district. To guarantee effective, paperless data collection, three trained enumerators assisted in conducting field surveys utilizing the SurveyCTO program, Key Informant Interviews (KIIs), and a well-crafted questionnaire. Because of the scattered locations of tea gardens, this study adopted a snowball sampling technique that effectively used local networks among tea growers and enabled the team to reach an extensive and diverse group of respondents. Books, journals, newspapers, and statistical reports were examples of secondary data that offered useful background information and a wider perspective. The main survey phase, which ran from mid-December 2023 to January 2024, was smooth and well-timed thanks to substantial changes made to the questionnaire based on a trial survey that was carried out in early December 2023. A reliable and comprehensive dataset that enables a relevant investigation of agricultural sustainability and production in the area was produced by this integrated and flexible method.

Data Analysis

Quantitative Data Analysis

Due to the dichotomous character of the dependent variable, which takes a value of 1 if a smallholder embraces tea cultivation and 0 otherwise, the empirical model in this study uses the logit model. As a subset of generalized linear models, binary logistic regression is a generalized linear model extension that makes it easier to describe probabilities between 0 and 1. It is preferred

over the linear probability model (LPM), which has drawbacks such as fitted probabilities exceeding 1 or going below 0 and ongoing partial effects of explanatory variables (Wooldridge et al., 2008). Smallholders are divided into "adopters" and "non-adopters" according to the dependent variable (Y), which is a binary consequence of the adoption choice. Thus, a firm is defined as an "adopter" where Yi = 1 or as a "non-adopter" where Yi = 0 (Kontogeorgos et al., 2008). Probit and logit analyses are well-established methods for this purpose, as they are quite similar and nearly identical. However, we chose the logit model due to its simplicity of interpretation (Gujarati & Porter, 2003). In a study in Peshawar, Pakistan, the same model was used to identify the factors of adoption of organic farming (Ullah et al., 2015). Similarly, the logit model was used to identify the factors of adopting organic tea farming in the northern region of Bangladesh (Pradhan et al., 2022).

The logistic regression model is a type of generalized linear model that extends the linear regression model by linking the range of real numbers to the range 0 – 1.

$$\pi_i = \frac{1}{1+e^{-z_i}} \quad (1)$$

The term π_i is the probability that the i^{th} case will adopt tea farming, and the value of the z^i is the value of the unobserved continuous variable for this i^{th} case. This model is also assuming that Z is linearly related to the predictors.

Thus, $$z_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots + \beta_n x_n + e_i \quad (2)$$

The term z_i is the i^{th} value of the dependent variable, and x_i is the i^{th} value of the independent variable. The term e_i is known as the "error" and contains the variability of the dependent variable not explained by the independent variable. Where the number of independent variables is indicated by n. The regression coefficients are estimated through an iterative maximum likelihood method.

The following model was used to assess the adoption of tea farming in the study area.

$$Logit(\pi) = \beta_0 + \beta_1 agri_{exp} + \beta_2 schooling + \beta_3 t_{land} + \beta_4 t_{income} + \beta_5 off_{occupant} + \beta_6 training + \beta_7 credit + \beta_8 incentives + \beta_9 proximity + e_i \quad (3)$$

Where, β_0= is the intercept term, β_i = slopes of the coefficient, x_i = independent variable, e_i = error term.

Qualitative Data Analysis

The extensive qualitative data gathered from stakeholders was systematically organized into categories to enhance analysis after the completion of the Key Informant Interviews (KIIs). This qualitative study aimed to achieve two main objectives: to guide the design of a future quantitative questionnaire and to leverage insights from key informant interviews to formulate the survey questions. The qualitative analysis provided a strong foundation that improved the questionnaire and yielded a thorough overview of various research contexts and participant interactions.

Results

The results of this study are shown in Table 3. They include descriptive statistics that indicate how different factors affect households' decisions to start tea farming. The dependent variable, adoption, indicates that around 52.94% of households have commenced tea cultivation. One of the independent variables is the average age of the participants who took the survey, which is 47.89 years (SD = 11.57). The average number of years of school is 8.41 (SD = 4.76), and the average number of years of farming experience is 26.83 (SD = 12.51). Economic factors reveal that the average amount of land holdings (t_land) is 4.56 acres, and 4.09 is the standard deviation, while total income (total_income) averages at 427.25 (SD = 391.11). The percentage of off-farm occupation (off_occupant) is notably high at 64.71%. Among the institutional factors, 50% of households have attended training regarding agriculture, 52.94% have accessed credit, 24.51% have received incentives from the government or from any other sources, and 84.31% cite proximity to tea cultivation areas. These statistics describe an overview of the characteristics of the households and provide important information on the distribution and fluctuation of significant variables in the adoption of tea farming.

Table 3: Descriptive Statistics

Categories of Variables	Name of the variables	Mean for continuous Variable	Percentage for the binary variables
Dependent Variable			
	adoption		52.94
Independent Variables			
Personal Factors	r_age	47.89 (11.57)	
	agri_exp	26.83 (12.51)	
	schooling	8.41 (4.76)	
Economic Factors	t_land	4.56 (4.09)	
	t_income	427.25 (391.11)	
	off_occupant		64.71
Institutional Factors	training		50
	credit		52.94
	incentives		24.51
	proximity		84.31

Note: Standard deviations (SD) are in parentheses.

Source: Author's Calculation, 2024

Based on the logistic regression analysis from 102 observations, it demonstrates that the model is statistically significant and provides a strong fit to the data table-4. The Wald chi-square test (χ^2 (9) = 43.60, *p* < 0.0001) confirms that at least one predictor has a significant relationship with the response variable (Sreejesh, 2014; Hilbe, 2016). Additionally, the pseudo-R^2 of 0.6442

indicates that the model explains a substantial proportion of the variance in the dependent variable, though this metric should not be interpreted identically to linear regression's R^2 (Joseph M., 2009). Overall, these findings imply that the predictors make a significant contribution to explaining variability in the outcome, consequently confirming the model's validity and utility for inference or prediction.

Starting with the personal factors, education has a positive but statistically insignificant effect on adoption, suggesting that the more educated farmers are likely to adopt new farming practices, whereas the less educated persons are afraid of using new practices. The number of years spent in the field of agriculture (agri_exp) shows a negative relation with adoption, indicating the likelihood of adoption is higher among young-aged farmers.

Table 4: Results of the Binary Logistic Regression

Categories of Variables	**Variables**	
Personal Factors	**schooling**	0.0108
		(0.111)
	agr_exp	-0.0265
		(0.0412)
Economic Factors	**t_land**	0.634***
		(0.201)
	t_income	-0.00576***
		(0.00177)
	off_occupat	2.475***
		(0.914)
Institutional Factors	**training**	3.797***
		(1.281)
	credit	-0.102
		(0.882)
	gov_incentive	2.725**
		(1.188)
	proximity	-2.072*
		(1.229)
	Constant	-1.537
		(2.016)
	Observations	102
	Wald chi2(9)	**43.60**
	Prob > chi2	**0.0000**
	Pseudo R2	**0.6442**

Notes: Robust standard errors are in parentheses; Sig = *** p<0.01, ** p<0.05, * p<0.1
Dependent variable: adoption
Source: Author's Calculation using STATA, 2024

Turning to economic factors, total landholding (t_land) has a higher positive and statistically significant value at the 1% significance level. On the other hand, total HH income is negatively associated with adoption, which is statistically significant at the 1% level. As we mentioned earlier in our descriptive part, incurred losses from cultivating tea are one of the major reasons for having lower HH income. Off-farming occupation is positively and significantly related to adoption, also at the 1% significance level. Off-farming occupation also demonstrates a positive relationship with adoption, and this relationship is statistically significant at the 1% significance level. Moving on to other factors, specifically institutional factors, among them, attending training/seminars (training) exhibits a highly positive correlation with adoption, and this relationship is significant at the 1% significance level. Although access to credit shows a negative coefficient, it is not statistically significant. Availability of incentives (government or private) positively influences adoption and is significant at the 5% level. Finally, proximity to the local factory is negatively associated with adoption and significant at the 10% level.

Discussion

The acceptance of tea planting in Thakurgaon has been significantly influenced by a number of institutional, economic, and human variables, as demonstrated by the logistic regression study. Mellon-Bedi (2020) and Beghin (2022) contend that education is beneficial; nevertheless, agricultural experience, contrary to prevailing views and research like Prokopy (2019) and Prager (2010), reveals a negative link, as evidenced by Pradhan (2022). Ahmed (2022) asserts that land size positively influences adoption; yet, research reveals substantial engagement among smallholders, hence contesting this assertion. He discovered that employment outside of agriculture promotes the adoption of new technologies; nevertheless, significant household income may impede this process, possibly due to financial losses linked to tea production. Zheng (2019) and Nicolas (2019) did not witness this phenomenon. This shows how hard it is to solve economic problems and how farmers come up with new ways to make money. Taking part in different training sessions and seminars makes adoption much more likely. This supports the findings of Islam et al. (2021) and Kexiao Xie (2022) and shows that extension services need to be improved. Oyeyemi and Balana (2020) claimed that financial accessibility and adoption should have a favorable relationship; they did not give any proof to back up this claim. This can mean that people are using credit in the wrong way. The incentives that the government and corporations gave were very effective. Li (2023) and Islam et al. (2021) found that the Green Leaf Tea Company started the procedure. Living close to manufacturers makes it more likely that people who live nearby will use technology. The results give us important information that will help us make decisions and stick to our goals. This change is good for the tea business in the area.

Conclusion

To investigate what drives tea farming adoption in Thakurgaon District, logistic regression was used for this study. The result shows that three categories of determinants, including personal factors, economic conditions, and institutional facilities, strongly affect farming decisions.

Education served as a facilitating factor in tea cultivation adoption, but amazingly, agricultural experience shows a negative relationship with tea adoption. Farmers who are younger tend to take the risk of adopting new farming practices. Among the economic conditions, land size proved to have a significant positive relation with adoption, which was previously assumed, but surprisingly, total household income was found to have a negative relationship with adoption because of incurred losses from tea cultivation. Institutional considerations have shown the importance of training programs in adoption. Farmers who adopted tea farming attended training and seminars based on agriculture. Credit availability and incentives are deeply interconnected with tea farming adoption. Most of the adopters got incentives in the form of tea plants or loans from the local tea factory. The favorable relation between local industry and adoption highlights farmers' logistical concerns.

The findings of the logistic regression offer important information for developing laws that will encourage the development of tea production. Giving education financing first priority might benefit the sector, particularly for experienced farmers. Necessary policies to take on creating non-farming jobs for the farmers will help to increase income divergence. It is recommended that policymakers promote participation in training programs due to their noteworthy, favorable influence on adoption. Credit availability must be considered, but more importantly, given their strong positive and statistically significant correlation with adoption, attention must be paid to public or private incentives. It's also advised to solve the logistical issues that farmers near nearby company’s face. A thorough plan that includes these specialized methods might greatly increase the uptake of tea cultivation and build a robust and long-lasting sector.

Limitations and Future Research Directions

This study has several limitations that should be acknowledged. First, a small sample size (n = 102) and potential sampling biases could be questionable for the reliability of the findings. Second, logistic regression provides only association among variables, not causality, which is a major drawback of this model. And there might be some unmeasured confounders or omitted variables that could affect the results of this study. Third, as this study was carried out only in Thakurgaon District, it limits the generalizability of the conclusions to broader contexts. In order to improve the ability to generalize and show causal patterns, future research should use linear designs combined with bigger and more varied populations. Researchers can explore the cost-benefit analysis as the farmers are facing losses from cultivating tea. In some cases, farmers are opting out of cultivating tea. Searching for the factors for abandoning tea farming can be an interesting topic. Comparative cross-regional analyses and evaluations of agricultural policies could reveal best practices and assess the efficacy of interventions. Developing adaptive solutions that improve the sustainability and resilience of tea-growing systems requires multidisciplinary research that integrates socioeconomic, environmental, and agricultural views in light of the stresses posed by climate change.

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