



Geospatial Distribution of Tea Estates in Bangladesh: A Cartographic Gestalt

Md. Abubakar Siddik^{1*}, Abdullah Al-Mamun², Md. Habibullah Siddiki³, Bondhon Chakraborty⁴ and Kanij Fatema Tuz Zohora⁵

¹Department of Crop Botany, Habiganj Agricultural University, Habiganj-3300, Bangladesh, Email: drmasiddik@hau.ac.bd

²Department of Computer Science, Habiganj Agricultural University, Habiganj-3300, Bangladesh, Email: mamun@hau.ac.bd

³Department of Soil Science, Habiganj Agricultural University, Habiganj-3300, Bangladesh, Email: habib@hau.ac.bd

⁴Department of Crop Botany, Habiganj Agricultural University, Habiganj-3300, Bangladesh, Email: bondhoncbt@hau.ac.bd

⁵Senior Scientific Officer, Soil Science Division, Bangladesh Tea Research Institute, Srimangal-3210, Moulvibazar, Bangladesh, Email: kanij@btri.gov.bd

*Correspondence: drmasiddik@hau.ac.bd, Tel: +8801619299400

Received: 14/07/2025

Accepted: 25/09/2025

Available online: 28/09/2025



Copyright: ©2025 by the author(s).

This work is licensed under a Creative Commons Attribution 4.0 License.

<https://creativecommons.org/licenses/by/4.0/>

Abstract: Tea is one of the important agricultural crops in Bangladesh and contributes to national GDP and exports. However, there is no adequate study on the approximate locations of tea estates in different districts and upazilas of Bangladesh. Therefore, a study was planned to locate tea estates in particular districts and upazilas in Bangladesh using Google Earth Pro and ArcGIS Pro. Tea estates were spotted on Google Earth and marked the location to assess the locations and coordinates. This study pointed to approximately one hundred and fifty-two tea estates scattered in twenty-two upazilas in four northern and northwestern districts of Bangladesh on the map. There were spotted twenty-three tea estates in Habiganj, eighty tea estates in Moulvibazar, eighteen tea estates in Sylhet, twenty-three tea estates in Chittagong, five tea estates in Panchagarh, one tea estates in Rangamati and one in Thakurgaon districts. Four upazilas in Habiganj, seven upazilas in Moulvibazar, five upazilas in Sylhet, three upazilas in Chittagong, and two upazilas in Panchagarh were found to contain with tea estates. This study provides a clear idea in the map about the tea cultivated districts, upazilas as well as approximate locations of tea estates in Bangladesh. Moreover, tea cultivation in Bangladesh demonstrated variable growth through different districts from 2021 to 2023, with prominent expansions in Habiganj, Sylhet, and Chittagong, while sharp declines in Moulvibazar in 2023. These created maps will contribute to increase tea cultivation in favorable locations, tea research and ultimately accommodate sustainable tea cultivation in more areas of Bangladesh.

Keywords: Tea Estates, District and Upazila, Google Earth Pro and ArcGIS Pro, Mapping.

INTRODUCTION

Mankind has been drinking tea for five thousand years and still is widely consumed all over the world. Tea is an evergreen shrub and aromatic beverage originating from the borderland of southwestern China in East Asia. However, tea was first made and tasted in 1843 home-grown in Chittagong near the Karnaphuli River, while commercial cultivation started in 1857 in Sylhet at the Mulnicherra Tea Estate (Chen, 2020) in Bangladesh. The northern and eastern districts with their temperate, climate, highlands, humidity and heavy rainfall are favorable for high-quality

tea production in the country. Bangladesh produces 3% of the world's tea and places as the 12th largest tea-producing country including four million employees in 166 commercial tea gardens (Mansur, 2006; Ahammed, 2015). Bangladesh Tea Research Institute has developed BTS (1-4) and BT (1-18) varieties from 1985 to 2010 (Ref. 4), while other varieties are also cultivated An1, Teen Ali, Tv23, Bt2, Bt19, Biclona etc.

In Bangladesh, tea is one of the major crops contributing to the national economy. Tea is a monoculture perennial crop usually cultivated between latitudes 41°N

and 16°S with large or small-scale plantations (Ahmed and Mamun, 2012). However, tea estates are predominantly located in some green spots between 21°30' and 25°10' north latitude and between 91°10' and 92°41' east longitude geographical locations. There are 163 tea estates in Bangladesh which are distributed in three ecological zones, like Halda Valley in Chittagong, Karatoa Valley in Panchagarh and Surma Valley in Sylhet division (Mamun, 2011).

There are different types of tea in the world which vary depending on their industrial manufacturing techniques like, green tea, black tea, oolong tea, etc. Commonly the soft tender leaves of the tea plant (*Camellia sinensis* L.) are used to prepare tea beverages while consumption patterns may vary according to location and environment. Green and oolong tea are popular in East Asia whereas Black tea is more widespread in South Asia, Europe and North America (Bhattacharjee, 2015). Tea consumption is also quite a common phenomenon in Bangladesh where per capita yearly consumption of tea is 550 g, while the national consumption per year is approximately 92.15 million kg, paralleling per day to 142.8 million cups (Boonerjee et al., 2025). Boonerjee et. al. has also mentioned the total tea production (93.829 million kg in 2022) and the domestic tea consumption (98.21%) with a surplus of only 1.95 million kg. The projection analysis advocates the positive growth trends in national tea production, consumption and exports in Bangladesh. However, there is a comprehensive importance of tea in the field of agriculture, national GDP and social life in Bangladesh. Thus, it is important to improve the tea research with a proper location mapping study of the tea estates for policymakers, stakeholders, industrialists, and researchers to upscale the sustainable development of tea in Bangladesh

MATERIALS AND METHODS

Bangladesh is an agrarian country with diversified crops, while tea is one of the important cash crops. Tea estates are distributed mostly in three broad locations, like the Sylhet division, Chittagong, and some northern districts of the country. To spot the locations of the tea estates in Bangladesh and show them on the map, a study was done by the Habiganj Agricultural University in 2025. Here is the detailed methodology described below:

Data Collection

a) Field Data Collection: Some locations were collected through visiting the tea estates near Habiganj district like Moulvibazar, Habiganj, Sylhet, etc., while the other data, like the name of the tea estates, size, and their addresses, were collected from government websites, field surveys, or secondary data from government and nongovernment sources like Bangladesh tea research institute (BTRI), BTRI website etc.

b) Satellite Imagery: Get high-resolution satellite imagery for Bangladesh from sources like Google Earth Pro. Google Earth Pro provides free access to historical and current

imagery for specific analysis. ArcGIS Pro was used to access Landsat for mapping.

c) Topographic Data: We use topographic and administrative boundary data of Bangladesh from sources such as government agencies (Humanitarian Data Exchange, <https://data.humdata.org> › Dataset).

Preprocessing of Data

The tea estates were marked district-wise and named as the Estate name. After marking all the estates, we imported the data in the KML format; this facilitated to creation of data visualization with the actual map location of tea estates. KML files were exported from Google Earth Pro for further exploration in ArcGIS.

Mapping the Tea Gardens

Google Earth Pro was applied to explore the tea estates' location to uphold the proper location and used the satellite view of the Earth for mapping the tea estates. At first, we found all of the tea Estates using Google Earth Pro for a satellite view of the Estate area according to the estate name and location. After finding the estate's locations, we marked them all using a polygon and added names to the estates. The marking area in the Google Earth was ~4000 inches on its actual land.

Geospatial Analysis in ArcGIS

a) Create and Define Layers: District and Upazila-wise tea estates were separated. The district layer was created to show all the particular locations of tea estates according to upazila in a district boundary map, and upazilas were the same to identify the tea estate locations. ArcGIS tools were used in the creation of layers and specify the locations in the created map.

b) Vectorization: We used a vector file to specify the location of the tea estate. Identifying the area and covering the area using a polygon. It helped to maintain the proper location of the tea estate.

c) Accuracy Assessment: Accuracy assessment was done in Haniganj District by comparing the locations on the created map of tea estates with preceding field data and/or Google Earth imagery to validate spots.

Mapping and Visualization

a) Map Creation: All of the locations of tea estates were marked in Google Earth Pro and imported as a KML file for making a usable form in ArcGIS Pro. Importing the Bangladesh land area shape file, we inserted all of the imported data, which was extracted from Google Earth Pro. We converted the KML file using geospatial tools to a Layer file to use in the ArcGIS Pro software. After inserting the Bangladesh Shapefile, we separate them as boundaries like District and Upazila, to mark the actual location of the estate in different views. All of the areas we took, where the tea estates are located. We were marked as a tea estate upazila of that district, the same color, and the

rest of the upazila was marked in another color for easy identification. Then, a separate upazila map was taken for the identification of the exact tea estate upazila from that district, taken in the map, and we made a green mark of the tea estate where it is located inside the upazila. We use the legend to find the tea estate easily, as well as coordinate for the actual location of the tea estates, and a meter scale was used for calculating the distance. Likewise, we make all the tea estates map district-wise and upazila-wise, which of those districts by marking the tea estate well. After completing the district and upazila we used the whole of the Bangladesh map where we inserted all of the tea estates according to the locations of the tea estates.

b) Overlay Layers: Administrative boundaries were used as a relevant layer of the tea estate as an upazila and district boundary, where tea estates were identified.

Key Tools and Software:

a) Google Earth Pro: For initial exploration, viewing, and exporting locations as KML/KMZ files.

b) ArcGIS Pro: For spatial analysis, classification, vectorization, and map creation.

RESULTS AND DISCUSSION

Tea Cultivated Locations in Bangladesh

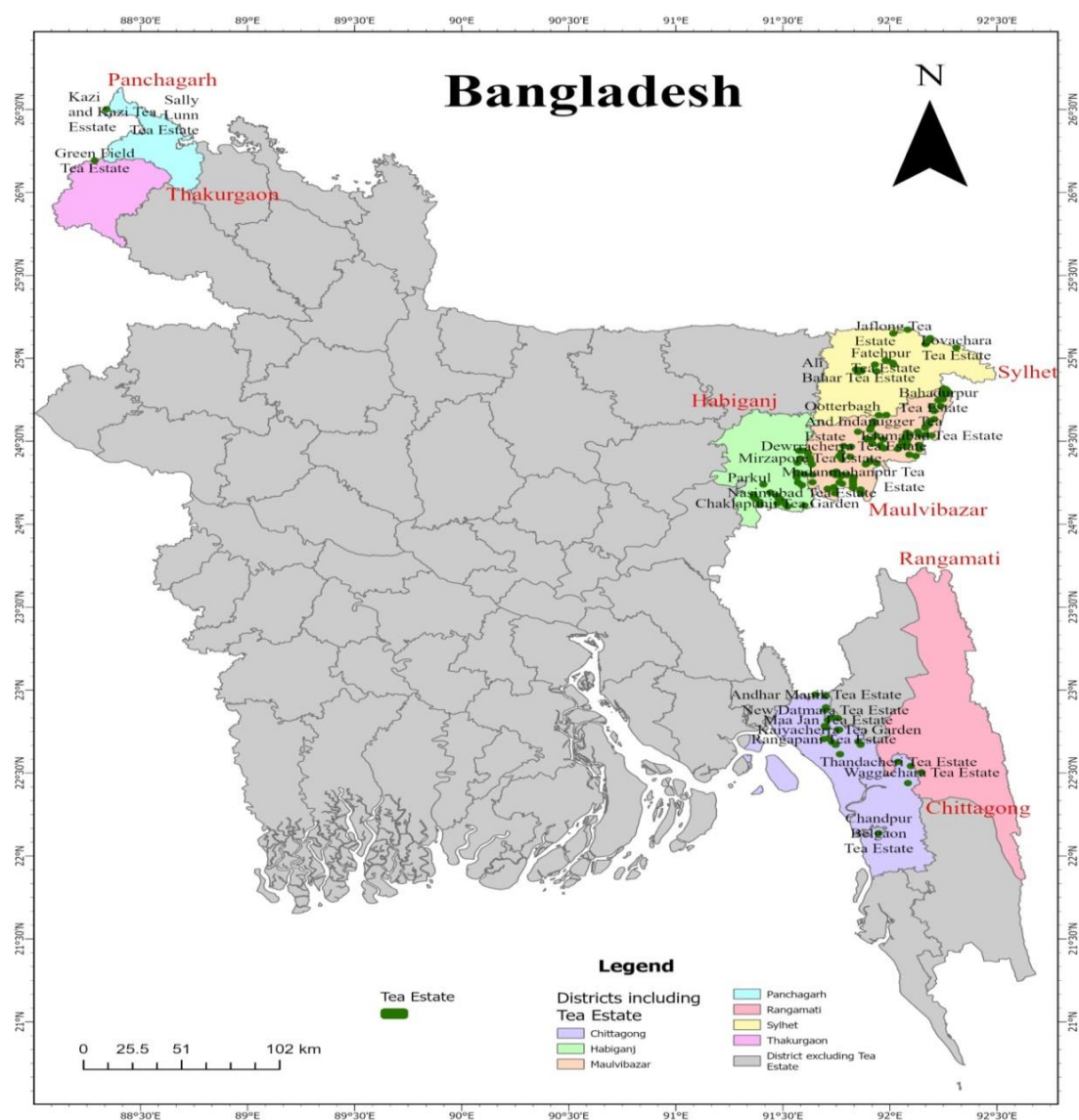


Fig. 1.: Map of Bangladesh encompassing Tea Estate Districts and Tea Estates. Map was accessed through Google Earth and ArcGIS.

Bangladesh is located in South Asia with an area of 148,460 square kilometers while largely rich in flat fertile acreage. The country is divided into 64 districts among those only seven districts have tea estates, while districts are subdivided into upazilas and only 23 upazilas contain

tea estates. Bangladesh is an important tea-producing country with 167 tea estates or gardens. The tea industry accounts for 3% of global tea production and it has 166 commercial tea estates with >4 million employees. The total areas were 141355 acres and 145182 acres while

productions were 93208 M Ton and 100660 M Ton in 2022-23 and 2023-24, consequently (BBS, 2024). Most tea is produced in the eastern and northern districts, like Sylhet, Habiganj, Moulvibazar, Lalmonirhat, Panchagarh, Dinajpur, Thakurgaon, and Bandarban. The temperate climate, humidity, heavy rainfall and highlands within these districts create a favorable condition for high-quality tea production. In this study, one hundred and fifty-two tea estates were pointed in the map using Google Earth Pro and ArcGIS (Fig. 1). Fig. 1 showed that tea estates were found to be scattered in twenty-two upazilas in four northern and northwestern districts of Bangladesh.

In Bangladesh, tea estates are under various management types and geographically distributed across valleys in several districts. A total of 156 tea estates are currently in operation, managed by existent companies, proprietary owners, private limited companies and Bangladeshi government-owned organizations. The largest operator with 16 tea estates is the Duncan Brothers (BD) Ltd. spread across Habiganj and Moulvibazar, particularly in the valleys of Luskerpur, Balishera, Lungla, Juri, and Manu-Doloi (Tea Estates Management Report, 2025). Noyapara Tea Co. Ltd. operates three estates exclusively in Habiganj while Deundi Tea Co. Ltd. Also manages three estates in Habiganj and Moulvibazar. The New Sylhet Tea Estate Ltd. has one estate located in Moulvibazar. Altogether, Sterling companies account for 23 tea estates. Bangladesh Tea Board manages five estates in the Juri and Lungla valleys

of Moulvibazar under Bangladeshi government ownership. Twelve 12 estates are operated across Habiganj, Moulvibazar, and Sylhet, with a presence in valleys such as Luskerpur, Balishera, Juri, Manu-Doloi, and North Sylhet by the National Tea Company Ltd.. However, Finlays operates seven tea estates, all located in the Balishera Valley, with two in Habiganj and five in Moulvibazar (Tea Estates Management Report, 2025).

Private limited companies represent the largest group with a total of 68 estates which are spread across Habiganj (14), Moulvibazar (32), Chattogram (16), Sylhet (3), and Panchagarh (3), and are located in valleys such as Luskerpur, Balishera, Lungla, Chittagong, Manu-Doloi, Juri, and North Bengal. Fifty-three estates are operated by Proprietary owners, including individuals and families across Habiganj (7), Moulvibazar (29), Sylhet (7), Panchagarh (7) and Chattogram (3), with a meditation in the same valleys (Tea Estates Management Report, 2025).

Moulvibazar is the central hub of tea cultivation in the country which has the most number of tea estates (81). However, Balishera, Luskerpur, Manu-Doloi, Juri, and Chittagong valleys play a key role in the total tea production. This distribution reflects a diverse and regionally concentrated industry, with both corporate and individual stakeholders playing important roles in the development and sustainability of Bangladesh's tea sector (Tea Estates Management Report, 2025).

Tea Cultivated Locations in Habiganj District

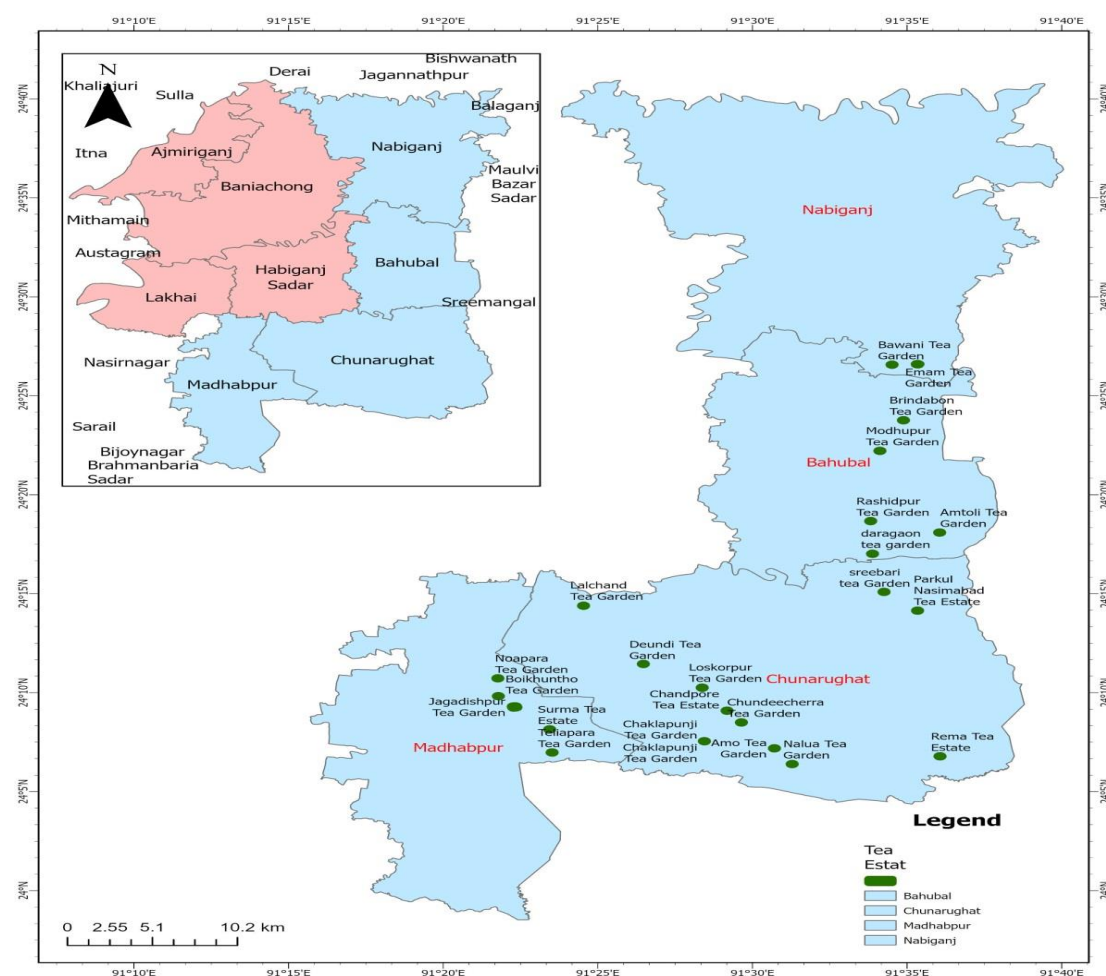


Fig. 2.: Map of Habiganj encompassing Tea Estate Upazilas and Tea Estates. Map was accessed through Google Earth and ArcGIS

Habiganj district is located at 24.3750°N 91.4167°E in Sylhet Division in the north-eastern part of Bangladesh. Habiganj is considered as alluvial plains which are vulnerable to both flood and drought. The land is rich in agriculture due to its fertile alluvial soils, where 1,54,953 hectares (60.22% of the total agricultural land) is under cultivatable agricultural land, 95 11,644 hectares (4.53% of the total land) is forestland. Moreover, Habiganj contains land with single-crop (51.6%), double-crop (38.7%), triple-crop (9.7%), and fallow land (521 hectares). Habiganj district has nine upazilas (Ajmiriganj, Baniachang, Bahubal, Chunarughat, Habiganj Sadar, Lakhsai, Madhabpur, Nabiganj and newly added Shaistaganj) where four upazilas contain tea estates or gardens such as Nabiganj, Madhabpur, Bahubal and Chunarughat (Fig 2). Twenty-three tea estates were spotted on Google Earth and marked the location to assess the locations, consequently. Habiganj district is the second-largest tea-producing district in Bangladesh and contributes to around 22% of the country's total tea production

(Rahman, 2007; Business Inspection, 2023). In the year 2022, 10.17 million kilograms of tea leaves were produced by 23 tea estates in Habiganj District (Table 1), which is located in the Laskarpur Valley of Chunarughat Upazila (Risingbd, 2023). Habiganj district contributed 1,135 kg per hectare on average which slightly exceeds the national average of 1,019 kg/ha (Rahman, 2007).

Tea Cultivated Locations in Moulvibazar District

Moulvibazar district is situated in the north-eastern part of Bangladesh and located at approximately 24.4833°N 91.7667°E in the Sylhet Division. This district contains undulating hills and fertile alluvial plains (loamy soils) with a subtropical monsoon climate which is the prerequisite for tea cultivation. However, tea is the most prominent agricultural product and approximately 2,42,000 hectares are under cultivation. It has a subtropical monsoon climate and fertile loamy soils, which support a wide range of crops (BBS, 2021).

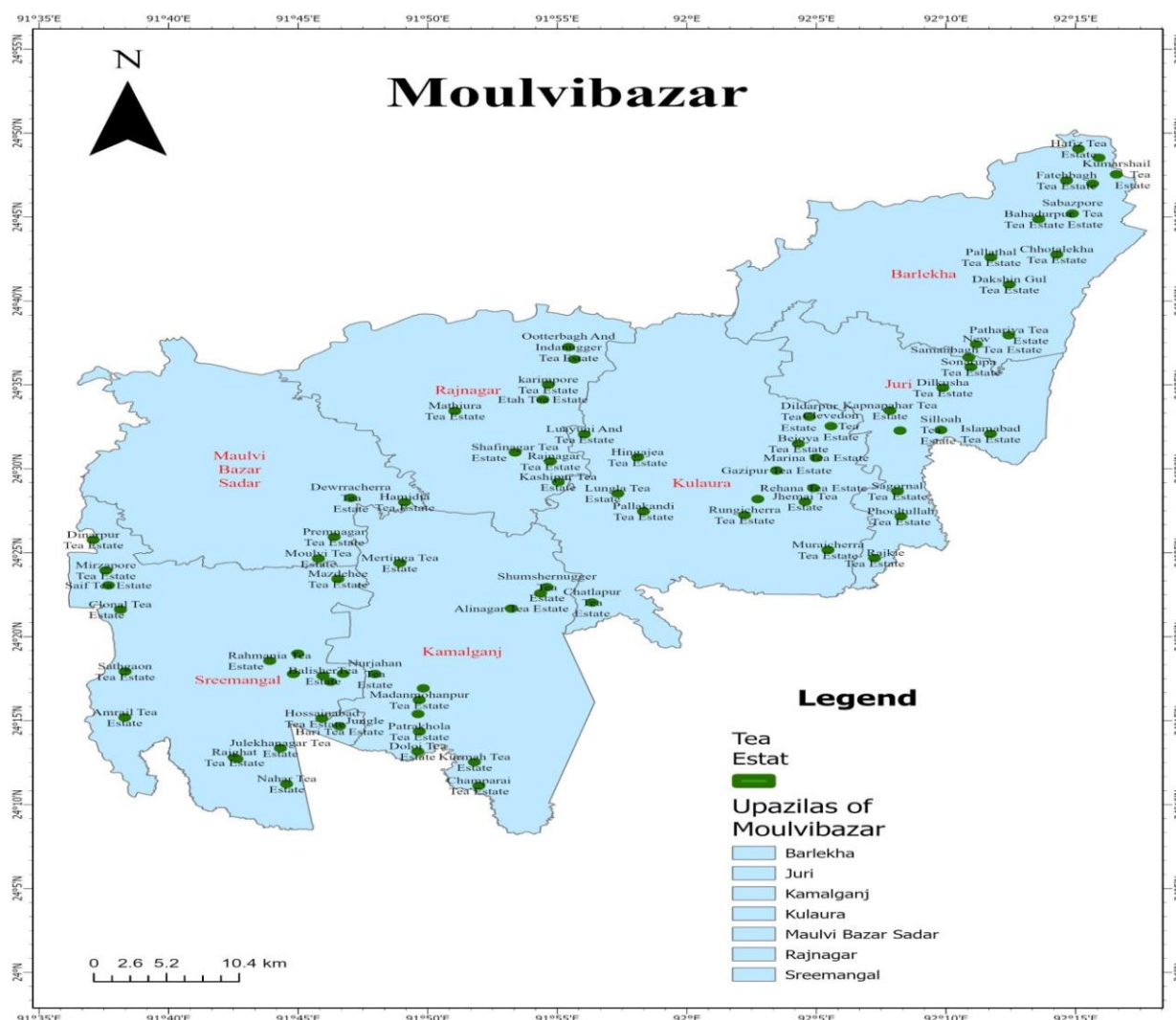


Fig. 3.: Map of Moulvibazar encompassing Tea Estate Upazilas and Tea Estates. Map was accessed through Google Earth and ArcGIS.

Moulvibazar district contains seven upazilas such as Sreemangal, Juri, Moulvibazar Kamalganj, Sadar, Barlekha, Kulaura, and Rajnagar. Among these, the highest concentration of tea estates is in Sreemangal, Kamalganj, Kulaura, and Barlekha. Mapping was done (Fig. 3) using Google Earth and identified 80 tea estates across the district, most of which are concentrated in Sreemangal Upazila, often referred to as the “Tea Capital of Bangladesh” (Business Inspection, 2023). Tea estates locations and coordination are shown in Table 2. Moulvibazar is the leading tea-producing district in the country, contributing approximately 70–75% of the national tea production (Bangladesh Tea Board [BTB], 2022). In 2022, the 80 tea estates in Moulvibazar produced an estimated 36.85 million kg of tea leaves. The highest

yields were observed in the Sreemangal-Kamalganj corridor within the Sylhet Surma Valley, where the climate and soil conditions are optimal for tea (*Camellia sinensis*) cultivation (Risingbd, 2023; BTB, 2022).

The average yield in Moulvibazar was recorded at 1,185 kg per hectare, exceeding the national average of 1,019 kg/ha (Rahman, 2007). This higher productivity can be recognized by favorable topography, well-drained soils, moderate elevations, and expertise in tea agronomic practices. Additionally, improved estate management practices, skilled labor, and well-established infrastructure have further enhanced tea productivity in the district (Rahman, 2007; BTB, 2022).

Tea Cultivated Locations in Sylhet District

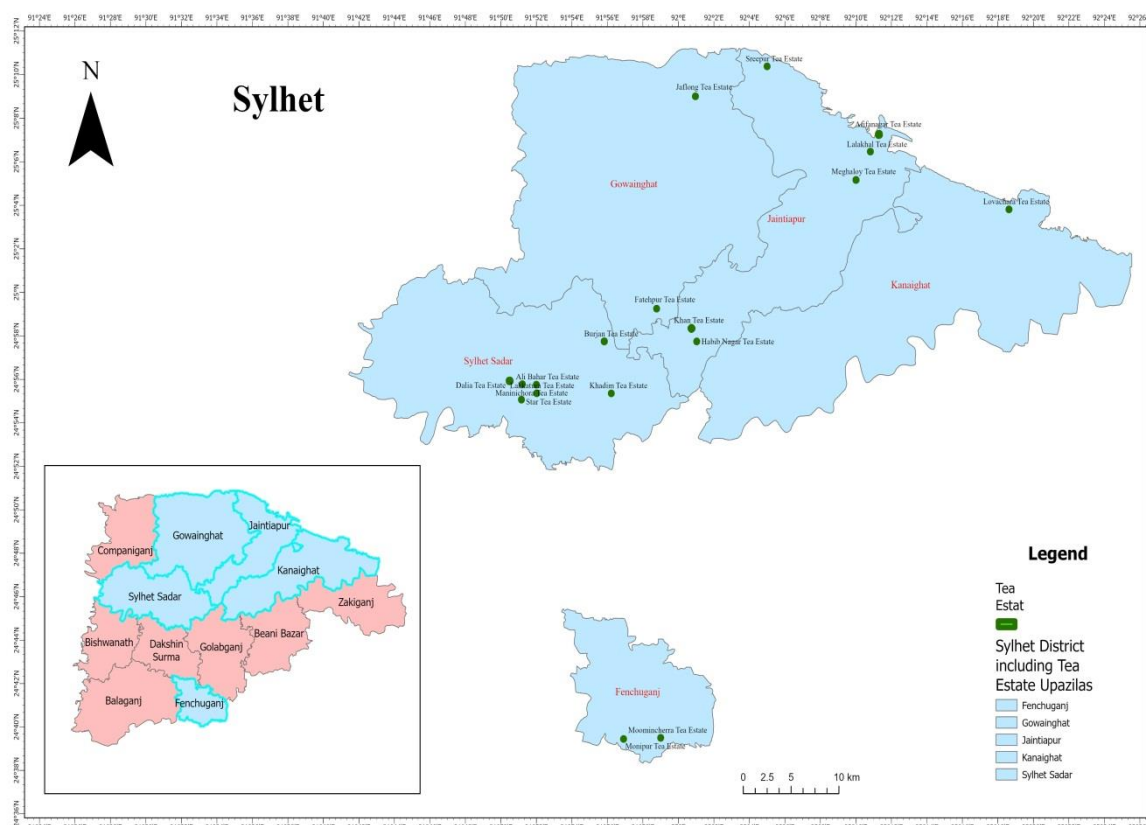


Fig. 4.: Map of Sylhet encompassing Tea Estate Upazilas and Tea Estates. Map was accessed through Google Earth and ArcGIS.

Sylhet is the birthplace of the tea industry in Bangladesh and Malnicherra Tea Estate is one of the oldest tea gardens in the subcontinent, established in 1854 (Rahman, 2007). Sylhet district is one of the most prominent districts for tea cultivation located at approximately 24.8917°N and 91.8833°E in the northeastern part of Bangladesh. It has a subtropical climate, rolling hills and undulating valleys with loamy to clay soil which is highly favorable to tea cultivation. There were 18 tea estates marked in the created map, predominantly located in upazilas like Gowainghat, Kanaighat, Sylhet Sadar, Jaintiapur, and Companiganj (Fig 3). These tea estates have been identified and geolocated through satellite imagery and ground verification using Google Earth. Tea estate locations and coordination are shown in Table 3.

Sylhet contributed approximately 18% of the nation's total tea production in 2022 only after the Moulvibazar and

Habiganj tea production (Bangladesh Tea Board, 2023). The total production was around 8.5 million kg of tea leaves in 2022 in Sylhet district. Sylhet district has single, double-cropped and rarely triple-cropped tea gardens with an area exceeding 10,000 hectares with diverse topography and climate variability. The average tea yield (1,090 kg/ha) remains slightly above the national average of 1,019 kg/ha (Business Inspection, 2023).

Here, Fig. 3 showed that tea estates were mainly clustered in the northeastern upazilas like Jaintiapur and Kanaighat, which aligns with previous studies demonstrating that well-drained hilly terrains, high-altitude, and acidic soils (Ahmed et al., 2013; Rahman et al., 2019). However, some estates are visible in southern upazilas like Balaganj and Fenchuganj which indicates expansion into new zones.

Tea Cultivated Locations in Chittagong District

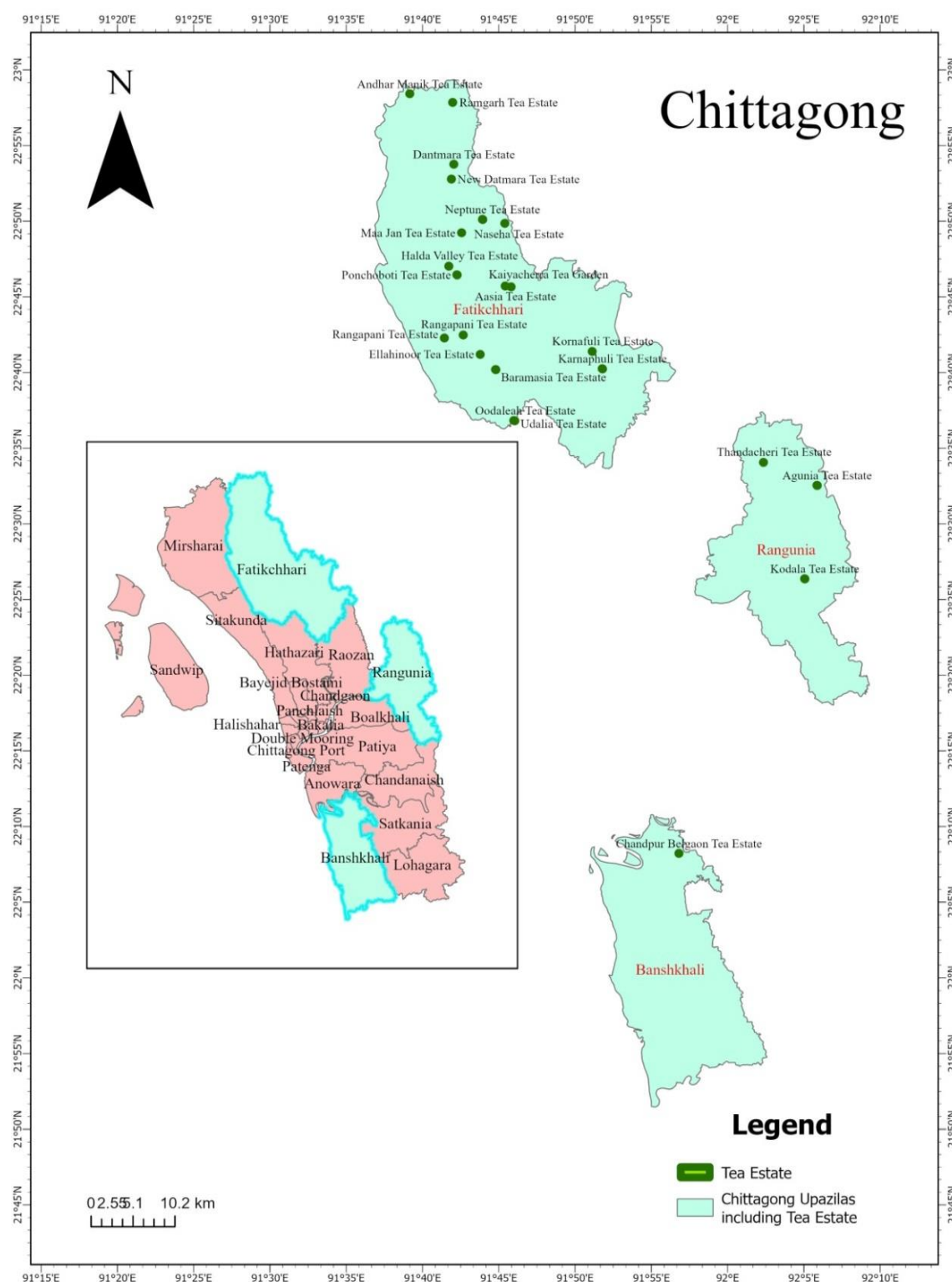


Fig. 5.: Map of Chittagong encompassing Tea Estate Upazilas and Tea Estates. Map was accessed through Google Earth and ArcGIS.

Chittagong is a southeastern district of Bangladesh with a diverse landscape comprising hills, plains, and valleys, situated at 22.3569°N, 91.7832°E under the Chittagong Division. Chittagong has hilly areas, well-drained loamy

soils and a subtropical monsoon climate ideal for tea cultivation. Chittagong district contains 15 upazilas, the most tea-cultivable lands were mostly in Fatikchhari, Rangunia and Banshkhali, upazilas (Fig. 3). A total of 23

tea estates were identified and mapped via Google Earth and ArcGIS, which were mostly located in hilly valleys with elevation, shade, and climatic conditions (Table 4). In Chittagong, three upazilas were found with tea estates where most of the tea estates were located in Fatikchhari upazila of the Chittagong district (Fig. 5).

In the year 2022, Chittagong produced around 1.11 million kilograms of tea which was just below the Moulvibazar and Habiganj district. Usually, the average tea yield of the

Chittagong district (1,147.64 kg per hectare) was slightly below the national average (1,239 kg/ha) in 2016 (Hoque et. al., 2021). Even though the district was previously documented as lower yielding it produced high-quality special teas and contributed to export-focused processing and value chains.

Tea Cultivated Locations in Panchagarh, Thakurgaon and Rangamati District

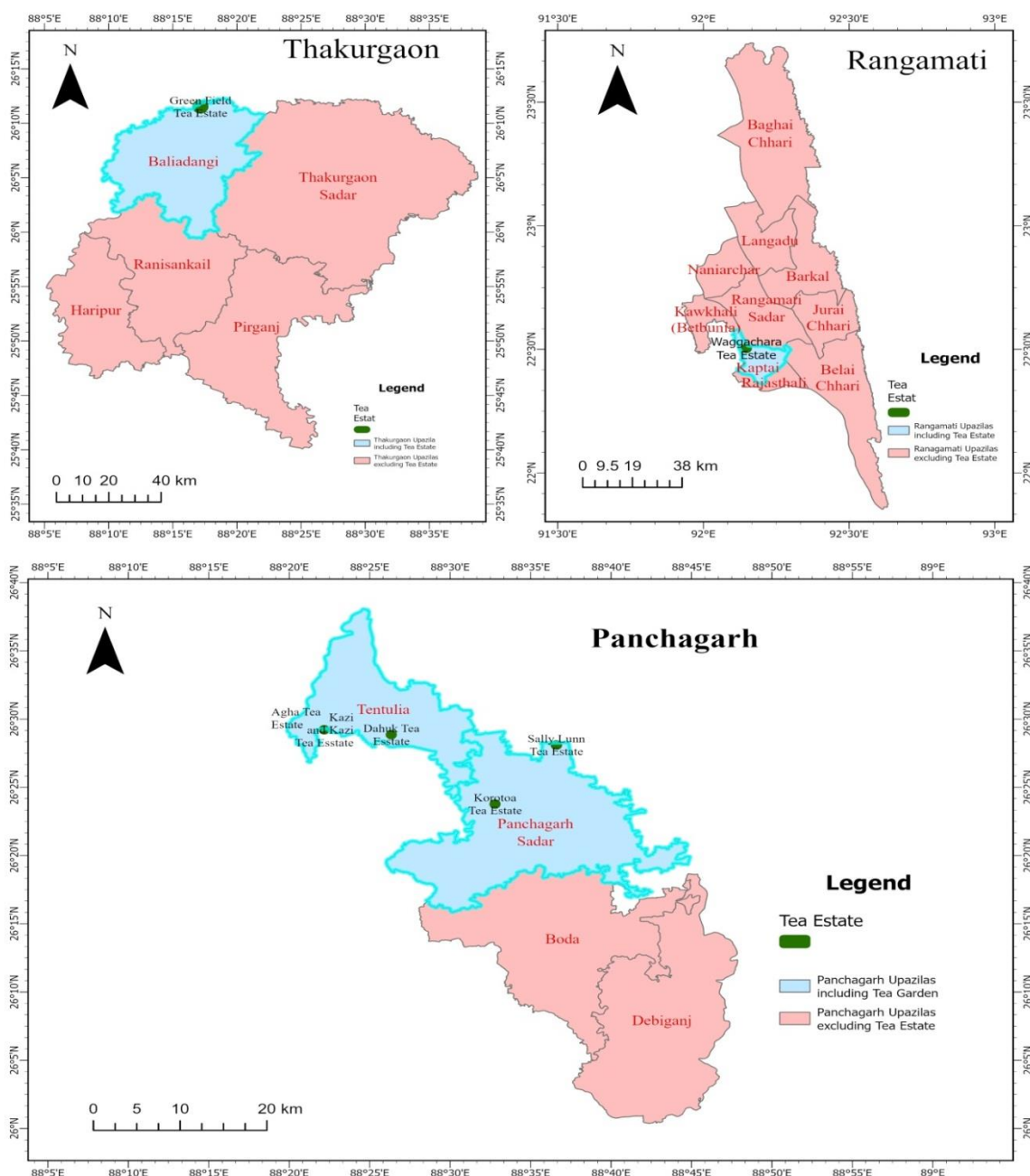


Fig. 6.: Map of Thakurgaon, Panchagarh and Rangamati encompassing Tea Estate Upazilas and Tea Estates. Map was accessed through Google Earth and ArcGIS.

Panchagarh is the northwestern district of Bangladesh in the Rangpur Division located at 26.3411°N, 88.5542°E. It has flat alluvial plain land with fertile sandy-loam soils that are well-suited for tea cultivation by the Karatoya and Dahuk rivers. Panchagarh offers a unique area without traditional

hilly tea zones and promotes tea cultivation in plain land. This district has approximately 108,000 hectares of agricultural land including single-crop (48%), double-crop (42%), and triple-crop land (10%). The district is in proximity to Darjeeling (India) and offers a potential long

growing season in a cool climate to enhance tea growing with time. Map (Fig. 6) showed three tea estates while there are more allocated tea gardens in the region. The locations and coordination of tea estates were shown in Table 5 which was assessed using Google Earth Pro and ArcGIS Pro. The created map showed tea estates in two upazilas, Panchagarh and Tetulia upazila.

Due to favorable soil and climatic conditions, Panchagarh district has emerged as a rapidly growing tea-producing region in the northern part of Bangladesh. This district included five notable tea estates: Sally Lunn Tea Estate, Dahuk Tea Estate, Kazi and Kazi Tea Estate, Korotoa Tea Estate, and Agha Tea Estate (Fig. 6). Among these tea estates, Kazi and Kazi Tea Estate produce organic tea and exports in international markets. In recent years, Panchagarh has perceived significant extension in tea cultivation areas in previously fallow lands. In 2022, Panchagarh produced around 2.1 million kilograms of tea leaves and an average yield of around 1,000 kg per hectare which was near to the national average production and established as one of the fastest-growing tea-producing regions in Bangladesh (Business Inspection, 2023; Bangladesh Tea Board, 2023; BTea Board Annual Report, 2023).

Thakurgaon district is in the Rangpur Division located at 26.0333°N, 88.4667°E while it shares almost similar agro-ecological characteristics to Panchagarh. It has plain fertile and flat land with sandy-loam to clay-loam soils that support diversified crop cultivation. Tea cultivation in this district has started in recent times and several initiatives have been activated using plain lands for the extension of tea cultivation area. The district has approximately 139,000 hectares of agricultural land with single-crop (52%), double-crop (38%), and triple-crop (10%). The map Fig. 6 showed a single tea estate located in the Thakurgaon and the location was assessed by using Google Earth Pro and ArcGIS Pro (Table 5) in Baliadangi upazila. Green Field

Tea Estate was the main producer and was found in the Thakurgaon district. Tea cultivation is still relatively new while ideal alluvial soil and climatic traits may result quickly a popular industry. The production estimates averaging roughly 900–1,000 kg per hectare according to existing agricultural surveys, although its contribution is small might increase with proper initiatives (Ahmed and Hossain, 2021; Ministry of Agriculture, 2023).

Rangamati District is located in the southeastern hilly tracts under the Chattogram Division at 22.7324°N, 92.2985°E including rugged hills, dense forest cover and valleys. Unlike the flat fertile sandy-loam plains of Thakurgaon and Panchagarh, this district has sloping land and upland for high-potential tea cultivation. The district is mostly rich in forest coverage (over 60% of total land) and agricultural lands are largely limited to valley basins. Rainfed cropping systems or agricultural activities are practiced on terraced fields. The cultivation of tea is still evolving here, with a small number of tea estates at high altitudes. In this study, Fig. 6 showed a tea estate in Rangamati upazila while its location and coordination were assessed by using Google Earth Pro and ArcGIS Pro (Table 5). Rangamati tea cultivation areas are parts of the Chittagong Hill Tracts, its rocky terrain and forest cover constrain the tea production. This area has the potential to supply special types like organic and mocha teas. Rangamati district produces less than 1% (700 to 850 kg per hectare) of the country's total tea production while still contributing to local livelihood and agro tourism. (Hill Tracts Development Board, 2022).

Area

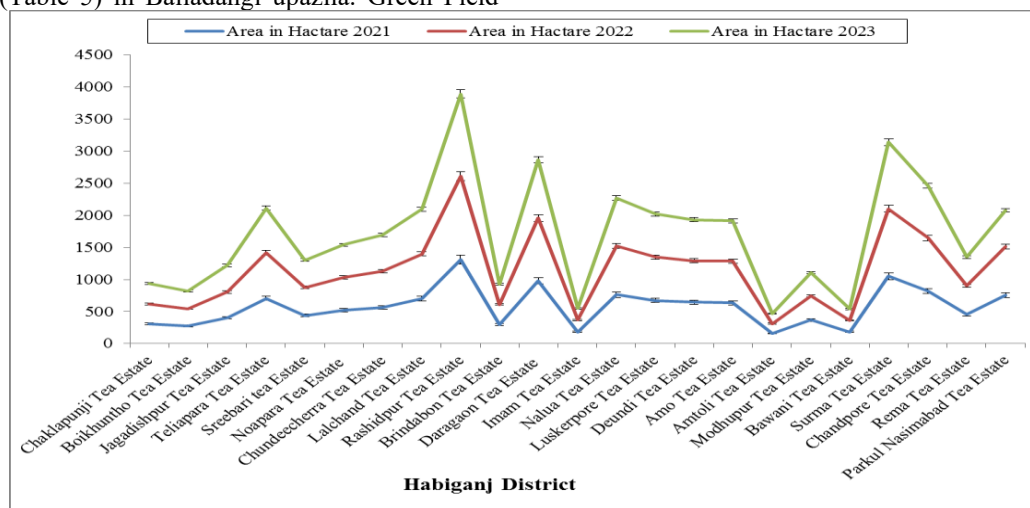


Fig. 7: The tea cultivation area covered by tea estates in Habiganj district

In Habiganj District, the tea cultivation area showed a clear expansion from 2021 to 2023. Here, tea estate coverage was small (<1000 hectares) with only a few crossings of 1,000 hectares in 2021, 2022 and 2023, whereas many tea estates

showed a slight noticeable expansion compared to the previous year. However, the most significant progress was observed in 2023, when Rashidpur tea estates and Surma tea estates reached between 1,000 and 1,300 hectares. Rashidpur and Surma tea estates were the largest

contributors to this enlargement, with peaking close to 1,300 hectares in 2023. On the other hand, Tealiapara, Daragaon, Nalua, Luskerpore, Deundi, Amo tea estates consistently remained less than 1,000 hectares, whereas Chaklapunji, Baikunthapore, Jagadishpore, Imam, Brindabon, Amtoli, Bawani, and Rema tea estates also

remained less than 500 hectares; imitating slower growth regardless of the overall progressive trend. Finally, the results highlight a slightly significant increase in tea cultivated area over the three years, indicating a constant development in the tea industry in Habiganj.

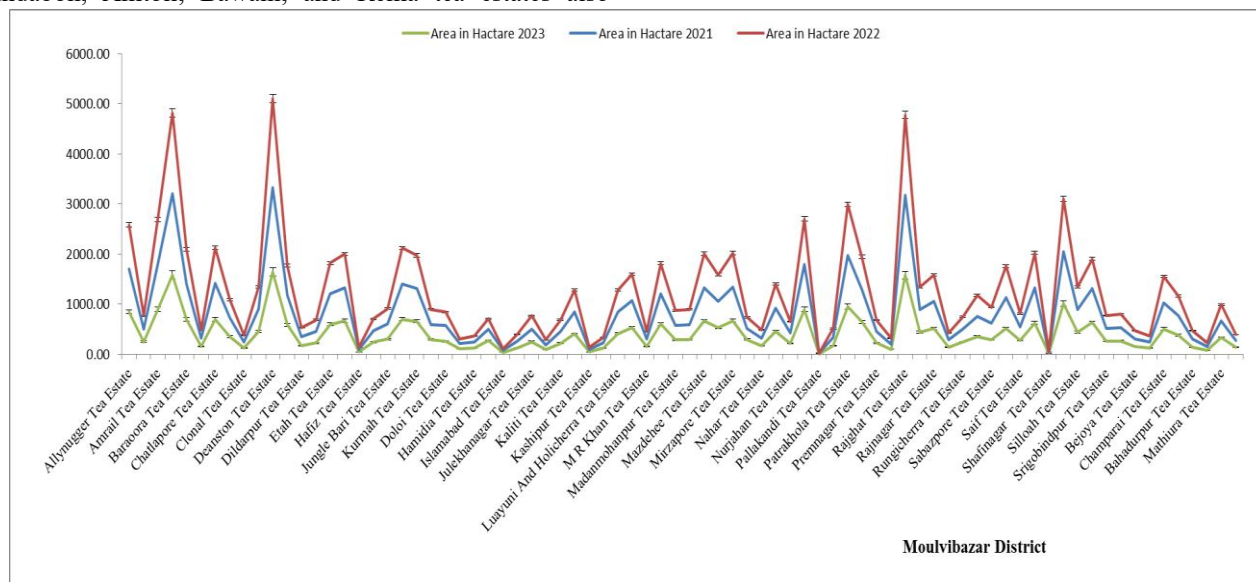


Fig. 8 : The tea cultivation area covered by tea estates in Moulvibazar district

In the above figure, most tea estates had small coverage, with many ranging between 10 ha to less than 500 hectares in 2021 to 2023. However, the highest expansion occurred during 2022, most of the tea estates' area coverage is 120 ha to 390 ha, where Chotolekha, Deuracherra, Kapnapahar, Luyani and Holicherra, New Samanbagh, Rajki, Siloah had area coverage ranges 380 ha to 470 ha with a steady improvement. Pallakandi and Shafinagar tea estates had very poor area coverage by tea plants, 9.1 ha and 15.29 ha, respectively. The tea estates decreased their cultivation areas for tea may be due to a lack of adoption infilling program with high vacancy.

In Moulvibazar, the tea cultivation area showed significant fluctuation in three years. Most tea estates had moderate

coverage, with many ranging between 900 to 1700 hectares in 2021 to 2023. However, the highest expansion occurred during 2022, when several tea estates such as Balishera, Deanston, Patrakhola, Rajghat and Shumshernugger extended their cultivation area by 1,017.07 to 1,776.41 hectares. In 2023, there was a sharp decline in tea cultivation areas, in many cases dropping about 1582.24 ha for Balishera tea estates, 1638.51 ha for Deanston tea estates, 954 ha for Patrokhola tea estates, etc., where all tea estates decreased their cultivation areas for tea may be due to a lack of adoption of infilling and new extension programs. Finally, the results highlighted that a significant increase in tea cultivation in Moulvibazar in 2022, while a notable decline in 2023, indicated possible challenges affecting tea production.

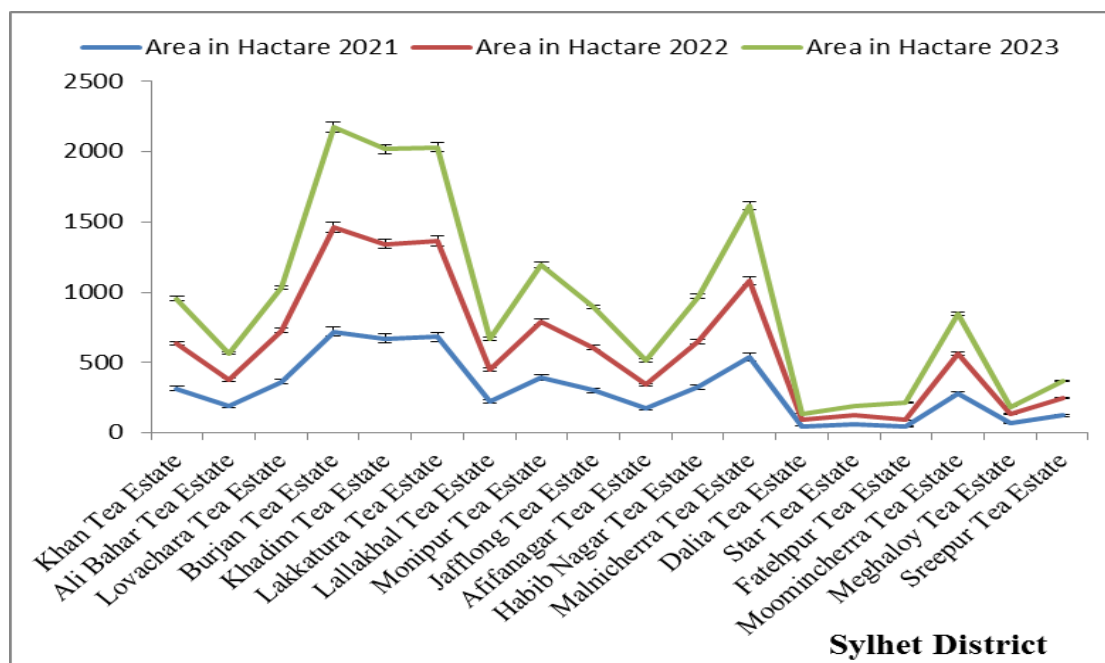


Fig.9: The tea cultivation area covered by tea estates in Sylhet district

The tea cultivation area in the Sylhet district showed a very slight increase from 2021 to 2022. In 2021, most estates occupied lesser areas, with only a few like Burjan, Khadim, Lakkatura, and Mulnicherra tea estates crossing 500 to 700 hectares. In 2022, a few tea estates increased their tea production areas, ranging from 1% to 3%. Most of the tea estates remained steady with their areas. The most prominent expansion was observed in 2023, when Khadim tea estates reached more than 600 hectares, making it the

leading estate in Sylhet with increased area coverage. However, Monipur also showed noticeable increases, with areas rising from 393.9 to 409.06 hectares. Moreover, smaller estates like Moonicherra, Fatehpur, Star, and Steeppur steadily remained below 500 hectares across the years, though they didn't show any enhancements in 2023. Finally, the results showed a steady and slightly positive growth in tea cultivation areas in Sylhet.

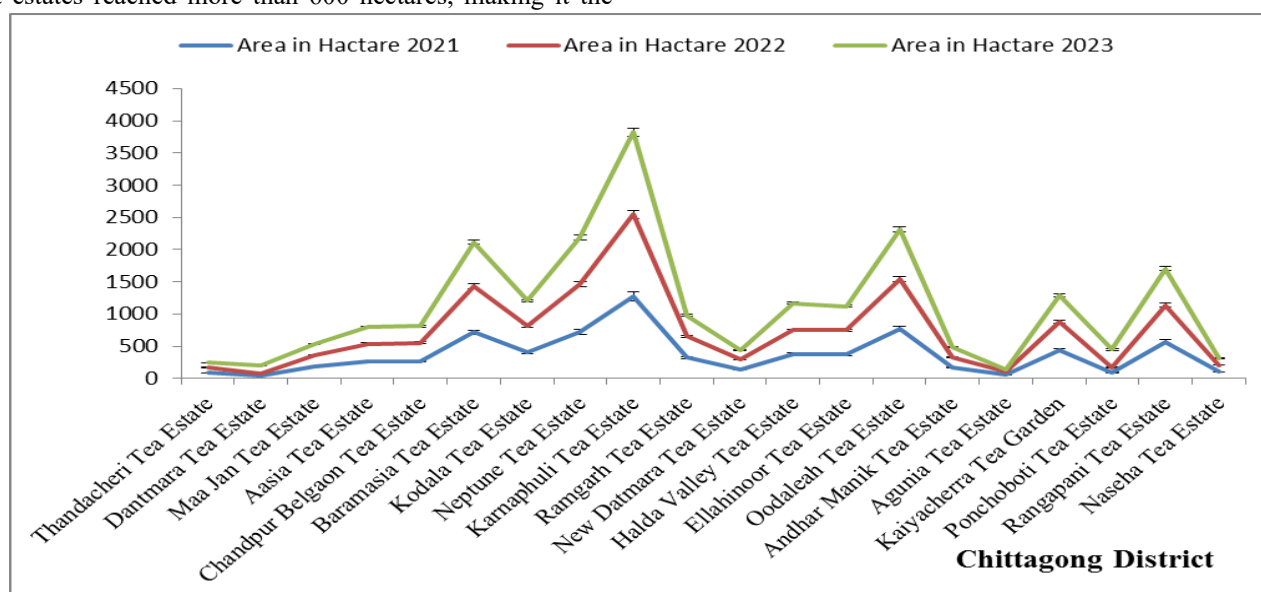


Fig.10 : The tea cultivation area covered by tea estates in Chittagong district

Chittagong district showed a consistent growth in tea cultivation areas throughout 2021, 2022, and 2023. The highest expansion in tea cultivation area was observed in 2022, while most tea estates had relatively small coverage (<1,000 hectares). In 2022, there was significant growth in many estates, with Karnaphuli tea estate reaching around 1273.92 ha area under tea, and Baramasia, Neptune, Oodaleah, and Rangapani tea estates showed steady growth

below 1,000 hectares. The peak of expansion occurred during 2023, with Karnaphuli tea estate (<1500 hectares), making it the largest contributor. However, smaller estates like Haldavelley, Dantmara, Maa Jan, Thandacherri, and Kayacherrra stayed below 500 hectares, though they too showed some growth. Finally, these results revealed that tea cultivated areas in the Chittagong district had expanded steadily over the years.

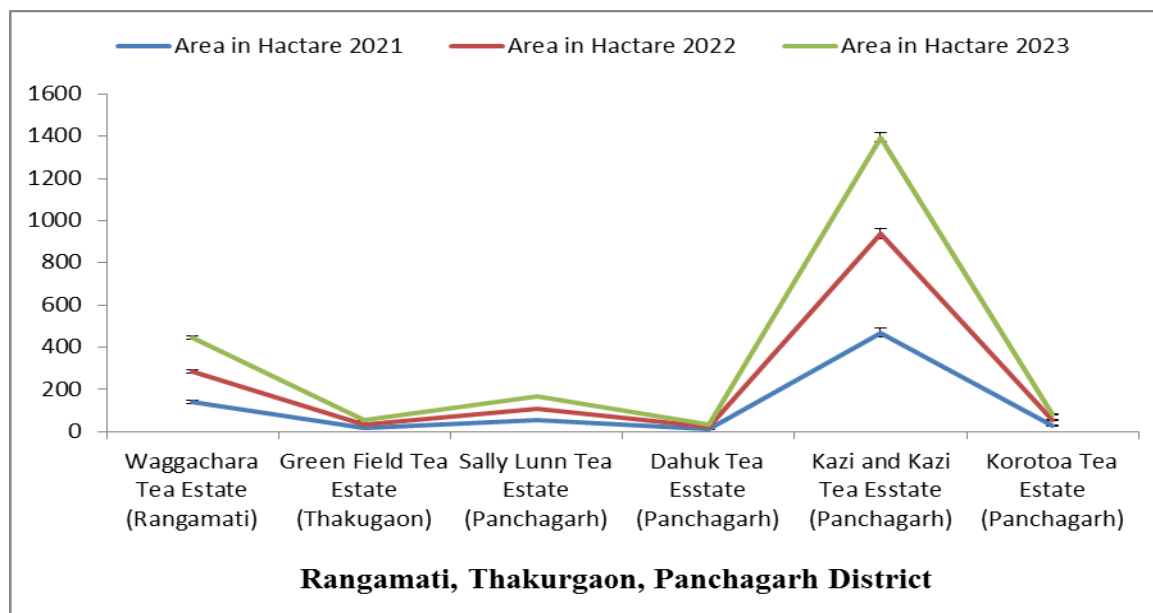


Fig.11: The tea cultivation area covered by tea estates in Rangamati, Thakurgaon, and Panchagarh districts

Rangamati, Thakurgaon, and Panchagarh districts showed a mixed but overall growing trend from 2021 to 2023 in tea cultivation areas. From 2021 to 2023, most of the tea estates showed a steady area coverage, where very low coverage was found 10.52 ha, 17.8ha and 55.26 ha for Dahuk tea estate, Green Field tea estate and Sally Lunn tea estate, respectively. Most tea estates had comparatively small coverage, with only exception of Kazi and Kazi Tea Estate, Panchagarh, with 469.26 hectares in 2022, but a sharp decline in 2023 with 456.28 ha. In 2023, there was a noticeable increase in areas across estates, with Waggachara tea estate in Rangamati reaching approximately 163.45 hectares. Meanwhile, Korotoa tea estate, Green Field, Sally Lunn and Dahuk consistently persisted in small (<100 hectares). Finally, the results highlighted that tea cultivation areas were dominated by Kazi and Kazi tea estate in Panchagarh and Thakurgaon districts, while smaller estates grew modestly.

CONCLUSION

The tea industry in Bangladesh is an important economic industry. In recent years, the expansion of tea cultivation has occurred in several districts and favorable tea cultivation environments and ecological locations. A precise distribution map of tea estates is required for tea plantation management and expansion. In this study, we evaluated the locations of tea estates in Bangladesh and

spotted them on Google Earth Pro and ArcGIS Pro. We found that one hundred and fifty-two tea estates scattered in four northwestern and two northern districts which occupy twenty-two upazilas. We also found that the Moulvibazar district has the most number of tea estates. In the northern districts, few tea estates were scattered while hilly regions like Chittagong also showed several tea estates. The cultivation area of tea in Bangladesh showed both growth and reduction between 2021 and 2023, fluctuating significantly across districts. This study will allow accessing the tea estates for future research and tea industry development. Finally, this method may also be used to create maps for different crop cultivation locations.

Author Contributions

All authors contributed in the same way during analyzing, writing, providing valuable suggestions, editing, and discussion to improve the manuscript.

Funding

This research was funded by UGC Funded Research Grants for 2024-2025, Habiganj Agricultural University Research System (HAURES).

Acknowledgments

Authors acknowledge the University Grant Commission, Bangladesh; Habiganj Agricultural University Research System and Bangladesh Tea Research Institute. The author also acknowledges Habiganj Agricultural University (HAU) for the opportunity of research in the Department of Crop Botany, Faculty of Agriculture, HAU, Habiganj-3300.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

REFERENCES

- Dr. Kazi Muzafar Ahammed. "Investment for Sustainable Development of Bangladesh Tea Industry – An Empirical Study". Bangladesh Economic Association. Retrieved 3 April 2015. <http://bea-bd.org/site/images/pdf/9.pdf>
- Digital Herbarium of Crop Plants. Varieties released by BTRI. Department of Crop Botany. Gazipur Agricultural University. <https://dhcrop.bsmrau.net/varieties-released/varieties-released-by-btri/>
- Mamun, M.S.A. 2011. Development of tea science and tea industry in Bangladesh and advances of plant extracts in tea pest management. *Int. J. Sustain. Agril. Tech.*, 7(5): 40-46. https://www.researchgate.net/publication/216456310_Development_of_tea_science_and_tea_industry_in_Bangladesh_and_advances_of_plant_extract_in_tea_pest_management
- Tea Estates Management Report. (2025). Distribution of Tea Estates by Type of Management, District, and Valley. Unpublished internal data chart.
- Bangladesh Bureau of Statistics (BBS). (2024). Summary Crop Statistics: Area, Yield Rate, and Production of Minor Crops 2022–23 and 2023–24. Dhaka: Ministry of Planning, Government of the People's Republic of Bangladesh. Retrieved from <https://www.scribd.com/document/778949891/BBS-2023>
- Business Inspection. (2023). Investment Surges in Tea Gardens as Demand Soars. <https://businessinspection.com.bd/investment-surges-in-tea-gardens-as-demand-soars>
- Rahman, M. (2007). Tea production, consumption and exports in global and Bangladeshi perspective. ResearchGate. <https://www.researchgate.net/publication/227576446>
- Bangladesh Bureau of Statistics (BBS). (2021). District Statistics 2021: Moulvibazar. Ministry of Planning, Government of Bangladesh. <http://nsds.bbs.gov.bd/en/summary-information>
- Bangladesh Tea Board (BTB). (2022). Annual Report 2022. Ministry of Commerce, Government of Bangladesh. https://teaboard.gov.bd/site/view/annual_reports/Annual-Report?utm_source=chatgpt.com
- Business Inspection. (2023). Tea Industry in Bangladesh – An Overview. Retrieved from <https://businessinspection.com/tea-industry-in-bangladesh/>
- Rahman, A. (2016). An enquiry into the living conditions of tea garden workers of Bangladesh: a case study of Khan Tea Estate (Doctoral dissertation, BRAC University).
- Risingbd. (2023). Moulvibazar Tea Estates Produce 36.85 Million Kg in 2022. Retrieved from <https://www.risingbd.com/english/>
- Business Inspection. (2023). The Tea Industry of Bangladesh: History, Growth and Future. Retrieved from: <https://businessinspection.com>
- Risingbd. (2023). Tea Production Statistics 2022. Retrieved from: <https://www.risingbd.com>
- Bangladesh Tea Board (2020) Statistical handbook on Bangladesh tea industry 2019. Project Development Unit, Bangladesh Tea Board, Srimangal-3210, Moulvibazar, Sylhet, Bangladesh, vol VIII, pp1–146.
- Ahmad I, Hossain MA (2013) Present status of Bangladesh tea sector in respect of world tea: an overview. *J Appl Sci Technol* 9(1).
- Rahman, M. A. (2019). History of tea in Bangladesh: A colonial legacy. *International Journal of Tea Science*, 5(1), 10-22.
- Bangladesh Tea Board. (2023). Annual Report on Tea Cultivation and Expansion Strategies. Bangladesh Tea Board, Government of the People's Republic of Bangladesh.
- Business Inspection. (2023). Tea Industry in Bangladesh: A Growing Sector. Retrieved from <https://businessinspection.com/tea-industry-in-bangladesh>
- Bangladesh Tea Board (BTea Board). (2022). Annual Tea Production Report 2022. Dhaka: Ministry of Commerce, Government of Bangladesh.
- Bangladesh Tea Board (BTea Board). (2023). Annual Report on Tea Sector 2023. Dhaka: Ministry of Commerce, Government of Bangladesh.
- Ahmad I, Hossain MA (2013) Present status of Bangladesh tea sector in respect of world tea: an overview. *J Appl Sci Technol* 9(1).
- Ministry of Agriculture, Bangladesh. (2023). Agricultural Statistics Yearbook 2023. Dhaka: Government of Bangladesh.
- Hill Tracts Development Board. (2022). Tea Production and Eco-tourism Development in Rangamati. Rangamati: HTDB Publications.
- Hoque, M. E., Chowdhury, K. J., Dutta, S., Chowdhury, P., Kumer, R. T., Sanjoy, D., & Jarin, A. (2021). Status and productivity of tea estates of the Chattogram tea-valley, Bangladesh. *Int. J. Biosci*, 18, 251-260. DOI:10.12692/ijb/18.3.251-260
- Mansur, Muhammed Alea (September 2006). "Bangladeshi Tea in the International Market" - Problems and Prospects (MBA). Southern University. Retrieved 24 March 2015 – via Scribd. <https://www.scribd.com/doc/16189200/Tea>

- Chen, Alice (17 September 2020). "The World's Top Tea-Producing Countries". World Atlas. Retrieved 19 March 2023. <https://www.worldatlas.com/articles/the-worlds-top-10-tea-producing-nations.html>
- Risingbd. (2023, March 4). Production falls in 24 tea gardens in Habiganj. <https://www.risingbd.com/english/country/news/93440>
- Boonerjee, S., Islam, M. A., Islam, S. M., Paul, S. K., Uddin, M. T., & Alamgir, M. S. (2025). Consumption and export potential of tea in Bangladesh: A field study. *Journal of Agriculture and Food Research*, 19, 101607. https://www.sciencedirect.com/science/article/pii/S2666154324006446?ssrnid=4724892&dgcid=SSRN_redirect_SD
- Bhattacharjee, Jayeeta. 2015. "A Study on the Benefits of Tea." *International Journal of Humanities & Social Science Studies* II(II): 109–21. <https://oaji.net/articles/2015/1115-1443860999.pdf>
- Ahmed, M. and, and M.S.A. Mamun. 2012. "DISTRIBUTIONAL PATTERN AND SEASONAL ABUNDANCE OF MAJOR PESTS OF TEA IN BANGLADESH M." *Tea Journal of Bangladesh* 41: 17–26. [https://btri.portal.gov.bd/sites/default/files/files/btri.portal.gov.bd/page/78377489_e4c4_4024_8697_19b7a1d370ab/Tea J. Bangladesh 2012.pdf](https://btri.portal.gov.bd/sites/default/files/files/btri.portal.gov.bd/page/78377489_e4c4_4024_8697_19b7a1d370ab/Tea%20J.%20Bangladesh%202012.pdf).

