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Exploring The Supply Chain Of Assam's Tea Gardens: Analyzing The Dynamics Of Assam's Tea Supply Chain

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Abstract: This study offers a comprehensive overview of the tea supply chain that exists in Assam. In addition, it also deals with the adoption of green practices within the tea industries of Assam, showcasing the region's unwavering commitment to sustainability and environmental stewardship. Emphasizing the significance of green practices, particularly in light of the prevailing climate circumstances, the research delves into the current state of adoption in selected tea estates scattered across Assam, with a focus on operational and logistical functionality.

The findings reveal that while some tea estates have embraced green practices, ample opportunities for advancement and broader adoption still exist. Notably, the study highlights the growing utilization of renewable sources of energies, such as solar power, to operate tea factories and reduce dependence on fossil fuels.

This paper also tries to highlight the tea supply chain in context of Assam. The tea supply chain is constructed based on inputs from various managers, tea board members, and other important stakeholders. To the best of our knowledge, no such specific work has been done in documenting the supply chain of the tea industry in the context of Assam and this is the novelty of this paper. It divides the supply chain of tea industries in three categories.

In conclusion, the abstract emphasizes the challenges and future prospects for the adoption of green practices in the tea industry of Northeast India. It recognizes the necessity for ongoing collaboration among stakeholders, including government agencies, tea estates, and local communities, to overcome barriers and expand sustainable initiatives. Moreover, the abstract underscores the potential for sharing best practices and knowledge with other tea-producing regions worldwide.

Overall, this abstract provides a comprehensive portrayal of the adoption of green practices within the tea industry, showcasing the region's steadfast dedication to sustainability while highlighting the environmental, economic, and social benefits associated with these practices. It accentuates the significance of continuous efforts to promote a green revolution within the tea sector, ensuring a brighter and greener future for South Assam's tea industry.

Keywords: Tea Supply Chain, Green Practices, Tea Industry, Logistics, Operations, Sustainability.

1. Introduction: The study aims to address several key questions such as who are the stakeholders of the supply chain of tea Industry, also this paper includes the awareness and incorporation of green practices in daily operations by tea gardens, their willingness to adopt green practices despite potential burdens, and the major challenges and barriers to implementing green practices in the tea industry. The age of the Indian tea industry is roughly 172 years. States such as Assam, West Bengal, Tamil Nadu, Kerala, Karnataka, Tripura, Himachal Pradesh, Uttar Pradesh, and Bihar that grows tea, out of which the first five states produce tea in large quantities. The study done by (Samantaray and Ashutosh 2012) states that about 81% of the grand total tea produced in India is consumed by about 85% of all households. In the context of today's present environmental scenario, the adoption of sustainability and green practices has become a necessity.

The tea industry in Assam, Northeast India, is at a pivotal point in terms of implementing green practices for sustainability and environmental responsibility. While some t

ea gardens have already adopted green practices, there is still significant scope for improvement and wider adoption across the region. This study focuses on developing a tea supply chain in the context of Assam along with assessing the current adoption of green practices in a sample of Assam tea estates, with a specific emphasis on operational and logistical issues, as well as the utilization of alternative sources of energies like solar power to reduce reliance on fossil fuels in tea factories.

In addition to exploring green practices, the study recognizes the crucial role of supply chain management in driving sustainability and resilience in the tea industry. Although some argue that traditional supply chain management is becoming obsolete, it is evident that effective supply chain management remains a vital source of competitive advantage. Businesses need to possess the necessary skills to anticipate, detect, diagnose, activate, protect, and track known and unknown threats to confirm supply chain resilience. The ADDAPT framework for supply chain resilience offers a comprehensive approach to address disruptions and maintain the smooth flow of goods.

Sustainable supply chain management, which encompasses economic, environmental, and social dimensions, has emerged as the preferred approach to enhance supply chain efficiency. Factors such as uncertainty and risk, regulatory compliance, innovation and knowledge, integration, strategy, relationships and collaboration, infrastructure and services, fair trade, social responsibilities, and investment and accounting play critical roles in sustainable supply chain management.

Furthermore, due to environmental degradation, regulatory requirements, and growing customer awareness, green supply chain management has gained increasing attention among operations and supply chain management professionals. Green practices are driven not only by cost considerations but also by business values and the recognition of the need to protect the environment.

In conclusion, achieving a green revolution in the tea industry of Assam requires concerted efforts to overcome barriers and promote sustainable and environmentally responsible practices. By embracing green practices, the tea industry can enhance its sustainability, reduce its environmental impact, and reap the economic and social benefits of adopting a responsible approach to tea production. This transformation necessitates collaboration, knowledge sharing, and support from governmental organizations, tea estates, and local communities to pave the way for a greener and more sustainable tea industry in Assam and beyond.

2. Statement of Problem: When it comes to context of tea gardens in Assam, there is no specific supply chain that has been documented in research papers. In addition, when it comes to implementing green practices and encouraging sustainability and responsibility for the environment, the tea industry in Assam confronts both opportunities and obstacles. Green practices have been adopted by certain tea gardens, but there is still room for improvement and wider adoption throughout the region. This study focuses on operational and logistical issues in an effort to evaluate the present adoption of green practices by a sample of South Assam tea estates. In order to lessen reliance on fossil fuels in tea factories, it also looks at the growing use of alternative energy sources like solar power. However, there are obstacles to be addressed before green practices are widely used in Northeast India's tea sector. These difficulties include low levels of knowledge and comprehension of the positive effects of green practices, a lack of technical know-how, financial limitations, and inadequate stakeholder participation. Collaboration between governmental organizations, tea estates, and local people is crucial to addressing these issues and maximising the potential for a green revolution in the tea industry.

Through this collaboration, barriers should be removed, best practices should be shared, and information should be spread throughout the world's tea-producing regions. By doing this, the South Assam tea sector may increase sustainability while also reaping the financial and social advantages of environmentally friendly practices.

3. Review of literature, Concepts, and Framework

3.1 Supply chain Management: For a long time, one of the management sciences' most productive research areas has been supply chain management (SCM) (Laengle et al. 2017). The core of a company's operations, supply chain management, was recently declared to be dead in a Harvard Business Review article (Lyall et al. 2018). However, if one carefully examines their assertion, a different interpretation is possible: supply chains are being handled in different ways now, especially in terms of how to gather and analyze data and come to the best judgments. The management of the supply chain is still seen as a key source of competitive advantage.

In one of the studies, (Stolze et al. 2016) made the case that the question of "what is the right supply chain for companies" is not what the market needs to know. Rather, it needs to know "what is the right supply chain for customers." Businesses must have the skills necessary to anticipate, detect, evaluate, mobilize resources, mitigate, and track known and unknown but knowable threats. Rungtusanatham et al. (2022) in their study discusses the ADDAPT Framework for Supply Chain Resilience. This framework mainly makes a business immune to supply disruptions. The ADDAPT framework is as follows:

Anticipate: Think about why and how they can disrupt supply chains and systematically recall known triggers, anticipate unknown but knowable triggers, and plan ahead for them.

Detect: Recognize when a supply disruption trigger disrupts the physical flow of commodities and be alerted.

Diagnose: Recognize a supply disruption holistically, taking into account (1) the risks that could stop flows of goods, (2) the nature of the interruption, and (3) the choices available to quickly restore the flow of goods to the expected level.

Activate: Gather the necessary resources in an efficient and effective manner to apply solutions to a supply disruption.

Protect: Avoid supply interruptions brought on by known and unknown but known dangers.

Track: Continue to track and update the main supply disruption indicators.

3.2 Sustainable supply chain: The term "sustainable" has its ancestral roots dating back to the 18th century (Geissdoerfer et al. 2017). Development is considered sustainable if it satisfies the needs of the present generation without hampering the ability to meet the demands of the future generations (Brundtland 1985). The three main pillars of sustainability have been defined as the triple bottom line: the environment, the economy, and social equity (Vachon, S., & Mao, Z. 2008). In the context of today's scenario, the word sustainable is of utmost importance, especially considering the present-day climatic conditions and other factors. In the early conceptualizations of business sustainability, the terms "sustainability" and "environmental" were frequently used interchangeably (Carter & Liane 2011).

Nowadays, sustainable supply chain management is typically regarded as the "best way" to increase supply chain efficiency (Miller 2008). As a result, supply chain managers who previously focused more on inventory reduction, ECR, and CRM techniques are now more likely to consider the direct advantages of supply chain management's economic, environmental, and social dimensions (McCue 2010).

(Jayaratne et al. 2011) identifies a variety of factors that could directly affect sustainable supply chain management. The factors are discussed below:

- "Uncertainty and risk"
- "Law & regulations"

• "Innovation and knowledge"
• "Integration"
• "Strategy"
• "Relationship and collaboration"
• "Infrastructure & services"
• "Fair trade"
• "Social responsibilities"
• "Investment and accounting."

3.3 Green Supply chain: Srivastava, S. K. (2007) in their study highlights that the scholars and practitioners of operations and supply chain management are becoming more and more interested in the green supply-chain management (GrSCM) mainly because of the following reasons

(i) Environmental degradation (Reduction in availability of raw materials, increase in pollution level, increase in wastage, etc.)
(ii) Regulatory compliances and
(iii) Pressure from customers who are now more aware of the environment.

In fact, a study done by Wilkerson, T. (2005) mentions that the adoption of Green practices is done because of business values and it is not cost oriented.

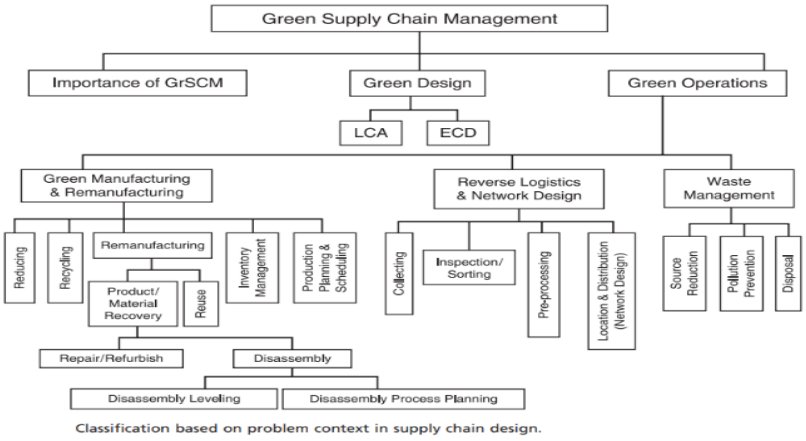

Fig1: Adopted from Srivastava, S. K. (2007).

Kopicki, et al.(1993) and Van Hoek (1999) in their study suggested three approaches that can be adopted in Green Supply Chain Management practices

(i) Reactive: In the reactive strategy, businesses invest a small percentage of resources to environmental management, begin identifying recyclable products, and use "end of pipeline" measures to mitigate production's impact on the environment.
(ii) Proactive: The company makes resource commitment to start product recycling and producing green products, businesses begin to anticipate the emergence of new environmental rules in the proactive approach.
(iii) Value-seeking: In the value-seeking approach, the businesses adapts environmental actions into their business strategies as strategic initiatives, such as green purchasing and ISO adoption.

4. Research Gap: To the best of our knowledge, after going through numerous literature reviews and interacting with the tea gardens, it was observed that although work related to sustainability has been done in context of India (ul Haq et.al 2021) however no specific study has been conducted to specifically consider the concept of sustainability and the adoption of green practices by tea gardens, particularly considering the climatic conditions and in context of Assam. The significance of the study increases because if green practices are not adopted soon, the impact on climatic conditions will become even more adverse. The study aims to assess the inclination of tea gardens towards the adoption of green practices in their operations and logistical functions.

5. Research Question:

Are tea gardens aware of the concept of green practices and sustainability in their daily operation?

Are tea gardens willing to incorporate green practices even if it becomes an extra burden for them?

What are the major challenges or barriers to implementing Green Practices in the Tea Industry?

6. Objectives of the study

(i) To develop a supply chain for the tea industry specific to its operations in the context of Assam.
(ii)To access the awareness level in the tea industry about the concept of sustainability and green practices.
(iii)To identify the major barriers or challenges in implementing green practices in the tea industry.

7. Research scope and limitations: The study considers a total of twenty tea gardens from Assam, which were selected using a non-probability sampling method. The research utilizes a convenient sampling technique. The study includes Jalinga tea estate, the largest organic tea estate in South Assam. It also examines Roskandy tea estate, which is a popular and favored brand among the people in South Assam. Additionally, Duwarbond tea estate, and others are included in the study.

The limitations of the study are as follows:

- Thematic limitation: The study is focused solely on the chosen theme.
- Geographic, Cost, and Time limitations: Due to constraints in cost and time, the study only considers twenty tea gardens located across various districts in Assam.

8. Research Methodology

Research type: The research is empirical (Huda, et.al 2012) and exploratory (De Jesus, F. S. 2020) in nature.

Data source: The data collected is primary data.

Sampling type: A non-probability sampling method was used, specifically a convenient sampling technique was adopted.

Research Instrument: A well-structured mixed questionnaire was used to conduct the study

Analysis of Data: The data was analyzed in a sequential and logical way. Data Tab.Net and Excel were used for data analysis.

Contact Method: One-to-one interview through a well-structured mixed questionnaire.

Unit of research study: A total of twenty tea gardens were taken as a sample, comprising both organic and inorganic tea gardens. The size of the tea gardens was also taken into consideration. The study also considered the well-known tea garden of Barak Valley, Roskandy, which is one of the most famous tea brands.

9. Data Analysis and Interpretation

Hypothesis Testing

Null hypothesis	Alternative hypothesis
There is no association between Limited availability of green technologies and Green logistics approach is more suitable for the Tea Industry	There is an association between Limited availability of green technologies and Green logistics approach is more suitable for the Tea Industry

Spearman correlation test was performed to determine if there is a correlation between variables Limited availability of green technologies and Green logistics approach is more suitable for the Tea Industry. There is a very high, positive correlation between variables Limited availability of green technologies and Green logistics approach is more suitable for the Tea Industry with r= 0.73. Thus, there is a very high, positive association.

Spearman correlation's results showed that there was a significant correlation between Limited availability of green technologies and Green logistics approach is more suitable for the Tea Industry, $r(7) = 0.73$, $p = .026$.

However, the outputs of the descriptive statistics show that the Limited availability of green technologies group had equally high values for the dependent variable (*Mdn* = 4) than the Green logistics approach is more suitable for the Tea Industry group (*Mdn* = 4).

For the given data in the study a Mann-Whitney U-Test showed that the difference between Limited availability of green and Green logistics approach is more suitable for the Tea Industry with respect to dependent variable was not statistically significant, U=32, p=.489, r= 0.19. Thus, the null hypothesis is not rejected.

Statistics for Mann-Whitney U-Test

	Values
Mann-Whitney U	32
Z	-0.8
Asymptotic Significance (2-tailed)	.426
Exact Significance (2-tailed)	.489

10. Findings and Discussions: Out of the twenty tea gardens, we observed the following information

(i) Tea gardens in Assam can be broadly classified into the following categories:

1. **Estate Garden**: These gardens not only grow tea but also have their own processing factories. Which can be further classified as:
    - **Private Estate Garden**: Owned and operated by private individuals or entities.
    - **Government-Funded Estate Garden**: Operated with government support.
    - **Estate Garden Under a Group of Companies**: Managed by large conglomerates with multiple tea gardens.
2. **Tea Grower**: These growers only have land for cultivating tea leaves, without their own processing facilities. Which can be further divided into:
    - **Small Tea Growers**: Small-scale operations.
    - **Large Tea Growers**: Larger operations with more extensive land holdings.
3. **Factories**: Tea processing facilities can be categorized into:
    - **Estate Tea Factories**: Owned by estate gardens for processing their own tea leaves.
    - **Bought Leaf Factories**: Purchase leaves from various growers for processing.

These classifications provide a framework for understanding the different operational models within the tea industry.

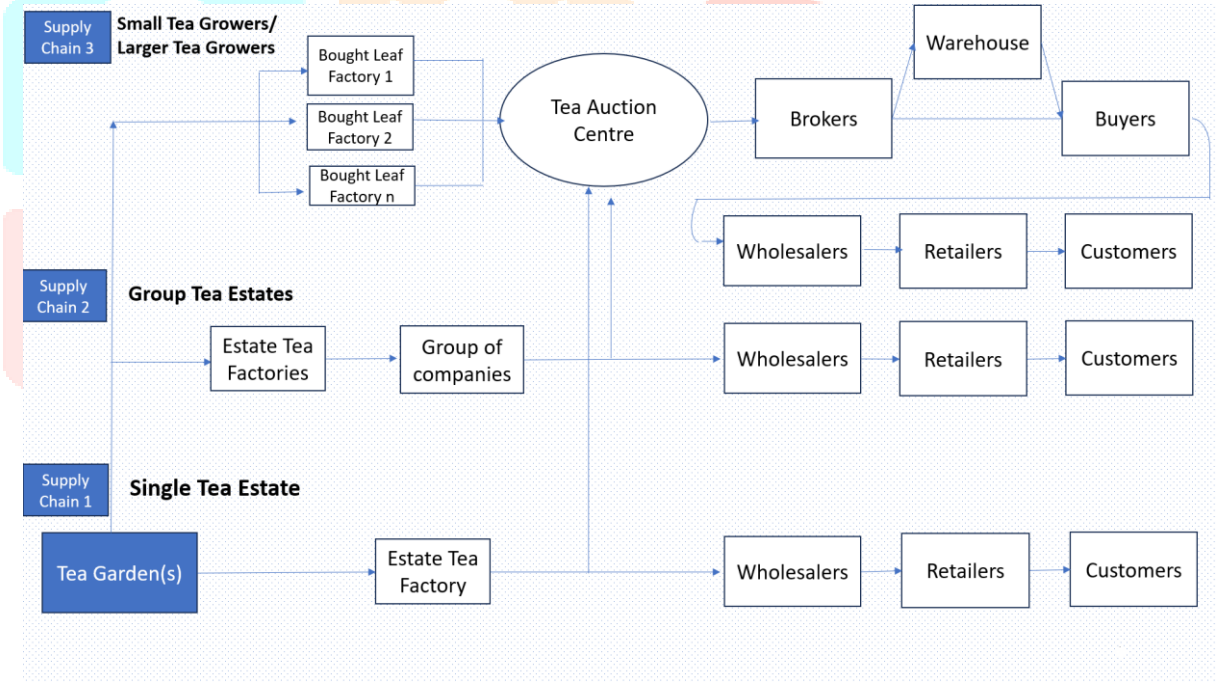

Fig 2: Authors Compilation (Developed based on the interaction with managers from various tea garden & Tea Board Association)

In Assam, the tea supply chain can be divided into three main categories:

A. **Supply Chain 1: Single Tea Estate**
   - In this supply chain, tea growers either work alone or team up with other gardens to share a common factory.
   - Most of these growers either sell their tea at auction centers or have their own marketing channels.

B. **Supply Chain 2: Group Tea Estate**
   - This supply chain involves tea growers who operate under larger companies.
   - Each garden typically has its own factory, although sometimes a few gardens may share one.
   - These gardens are usually larger and don't rely on auction centers. Instead, they have their own supply chain channels.

C. **Supply Chain 3: Small Tea Growers/ Large Tea Growers**
   - Here, small-scale tea growers don't have their own factories and depend on nearby factories to process their tea. In some cases they sell their green leaves to other gardens.
   - After processing, they often take their tea to auction centers for sale and distribution. Sometimes, they might have their own distribution networks.

These three supply chains show how tea moves from the gardens to the market in Assam, catering to different needs and approaches of growers and companies.

Following are the elements that constitute the block diagram

1) **Tea Garden(s)**: Assam, renowned for its rich and flavorful tea, hosts a vibrant tapestry of tea gardens spread across its picturesque landscapes. According to government sources, there are a whopping 803 tea gardens dotting the region's verdant expanse.[1] As per data from the Indian Tea Association, the combined efforts of these tea gardens yield a staggering 507 million kilograms of tea annually. These gardens collectively cover an extensive area of approximately 312,210 hectares..[2]

2) **Factory/ Factories**: Factories are place where the freshly plucked green leaves from the tea gardens undergo processing to become the delightful beverage we all love. In Assam, there's a variety in how factories operate. Some tea gardens have their own factories, where they process their own leaves. However, not every garden has its own factory. In such cases, they rely on other factories to process their leaves. Interestingly, some tea gardens collaborate and form a cartel, sharing a common factory. This helps them streamline operations and reduce costs. So, whether it's a garden with its own factory or a collaborative effort, factories play a vital role in transforming raw tea leaves into the final product enjoyed by tea enthusiasts worldwide. Broadly Tea Factories can be classified as two categories

   (i) **Estate Tea Factories:** Each factories have their own factories and their setups.

   (ii) **Bought Leaf Factories:** They don’t have their own gardens, they only process the brought leaves.

3) **Tea Auction Centre**. In Assam, there are two Tea Auction centers, with one in Guwahati and the other one in Jorhat. In addition, now users can use the e-auction centre to participate in the auction process .[3] It has Four elements Marks(garden), Brokers, Buyers, and Warehouses.

[1] https://ttwd.assam.gov.in/frontimpotentdata/list-of-tea-garden-at-assam
[2] https://www.indiatea.org/tea_growing_regions
[3] https://www.teaauction.gov.in/Home.aspx

a. ***Marks (garden)***: These are the registered gardens or growers who must register themselves to participate in the auction process. According to government data, 1296 gardens are registered.[4]
b. ***Brokers:*** These are the parties who actually purchase tea from the gardens through a bidding process. The bidding process occurs at regular intervals of 15 days. Once they make a purchase, they store the tea in warehouses. Government records indicate that 9 brokers are registered.[5]
c. ***Warehouses:*** These are the parties that store tea products. When the quantity of tea is high, brokers store it in warehouses. Simultaneously, buyers purchase tea from the brokers through the warehouse. Government records show that 127 warehouses are registered.[6]
d. ***Buyers:*** These are the parties who purchase tea after the bidding process concludes. Normally, the bidding process is business-to-business (B2B). These buyers are mainly businesses that handle necessary branding and then incorporate the product into their supply chain, which includes wholesalers and retailers, respectively. According to government data, 353 buyers are registered.[7]

4) **Group of Companies:** Group of Companies in the tea industry refers to entities that oversee several tea gardens operating under their umbrella. These companies typically manage multiple gardens, which often boast their own factories. In some cases, these gardens might share a common factory to streamline operations. These groups are known for their significant scale, producing tea in bulk quantities.
5) **Whole Sellers:** They play a crucial role in the tea supply chain by purchasing tea directly from tea gardens or groups of companies. They act as intermediaries, bridging the gap between producers and retailers. Wholesalers ensure a smooth flow of tea from the source to the market, facilitating distribution on a larger scale. They are private players and is not a part of auction process.
6) **Retailers**: They represent the final phase of the tea supply chain. They are the storefronts, online platforms, or establishments where consumers directly purchase tea products. Retailers curate a diverse range of teas from various sources, catering to the preferences of consumers. They play a pivotal role in making tea accessible to customers, offering a variety of options to suit different tastes and preferences..
7) **Customers**: Customers are the ultimate end-users of tea products. They are the individuals who purchase and consume tea for its taste, aroma, and various health benefits. Customers drive the demand for tea, shaping trends and preferences within the industry. Their choices and feedback influence the entire tea supply chain, from production to distribution.

(ii) Three gardens have fully implemented solar power panels for factory operations. The cost of installing the solar panels will be recovered within a duration of 4.5 years for these tea gardens. However, the cost of recovery depends on the requirements and the number of solar panels to be installed. It has been observed that the solar panels will provide energy for the next 25 years, thus significantly reducing costs in the long run.

(iii) Remaining tea gardens are currently in the process of installing solar panels. They have not been installed yet but are awaiting official approvals. They estimate that the cost will be recovered within a duration of 3.5 to 4 years.

(iv) Three gardens have used electric scooters for logistical purposes in their factory operations and are planning to buy an electric car for logistics purposes as well. However, other gardens do not have any plans for implementing green logistics in their factory operations due to the high initial cost.

[4] https://assamteaxchange.com/
[5] https://assamteaxchange.com/
[6] https://assamteaxchange.com/
[7] https://assamteaxchange.com/

(v) Three gardens have implemented battery-operated tea leaf plucking machines as a measure to implement green practices in their gardens.

(vi) We interacted with the largest organic tea garden in the South Assam region, and they reported a significant decrease in the yield pattern of the tea plants due to climatic conditions and global warming. They are ready to implement any feasible green practices, but they emphasized that support from government organizations and all stakeholders plays a crucial role.

(vii) The majority of tea gardens agreed that implementing green practices will reduce carbon emissions, save costs, and improve the brand image as well. Some gardens also added that it improves the microclimate and thereby increases tea production.

(viii) High initial cost, limited availability of green technologies or solutions, and resistance to change within organizations are considered to be the major barriers in the implementation of green practices in tea gardens. However, they disagreed that a lack of knowledge is a barrier in implementation, as they believe that almost every tea garden manager has the required knowledge.

(ix) Tea is a perennial crop, but in the present era, the yield pattern is going down. There are four phases of tea output. The 1st phase starts from March to April. The 2nd phase starts from May to the mid of June. The 3rd phase ranges from July to September, and the 4th phase starts from November and ends in December. The months of January and February and the mid of March are generally the off-season, and it is during that phase that a tea garden undergoes an upgrade in technology or performs major maintenance repairs. The maximum yield is seen during July to October.

(x) Tea gardens such as Roskandy took climate change into consideration back in the year 1982. They have adopted the following measures:

- Growing shade trees in the plantation.
- Planting trees on the roadside to provide shelter to birds and a natural habitat, while also creating a microclimate for the tea plantation.
- Converting all low-lying areas unsuitable for tea plantation into water bodies to conserve rainwater.
- Harvesting roof water for humidification and machine washing purposes.

11. Conclusion: In conclusion, the study
sheds light on the adoption of green practices in the tea industries of Assam, emphasizing the region's dedication to sustainability and environmental stewardship. While some tea estates have made progress in implementing green practices, there remains ample opportunity for further advancements and wider adoption throughout the region. The study highlights the growing use of renewable energy sources like solar power to reduce reliance on fossil fuels in tea factories.

However, the study also identifies several obstacles that need to be addressed for the widespread adoption of green practices in Northeast India's tea sector. These include low awareness and understanding of the benefits of green practices, limited technical knowledge, financial constraints, and insufficient stakeholder participation.

To overcome these challenges and unlock the full potential of a green revolution in the tea industry, collaboration between government organizations, tea estates, and local communities is crucial. By working together, these stakeholders can eliminate barriers, share best practices, and disseminate information to other tea-producing regions worldwide.

In summary, this study provides a comprehensive overview of the current state of green practices adoption in the tea industry. It underscores the region's commitment to sustainability and highlights the environmental, economic, and social benefits associated with these practices. By addressing the identified challenges and fostering collaboration, the Assam tea sector can enhance its sustainability while reaping the rewards of environmentally friendly practices.

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