

Sustainable Agricultural Supply Chain Management in the Chittagong Hill Tracts: A Roadmap Towards Development

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Abstract

The Chittagong Hill Tracts (CHT) of Bangladesh have demonstrated strong agricultural potential through diversifying crops, however difficulties impede the region's agricultural supply chain growth. This study presents a long-term framework for CHT agricultural expansion that is sustainable. The study begins by outlining the historical constraints of the CHT's agricultural economy, which was characterized by subsistence farming and intermediaries' domination. Recent infrastructural upgrades, such as new roads, have created new prospects for growing profitable crops such as fruits and spices. However, transportation continues to be a major barrier, hindering effective supply chain management and market access.

To maximize the potential of the agriculture business in the CHT, a sustainable supply chain management structure based on sustainability, efficiency, and traceability principles is recommended. Manufacturing, storage, transportation, packaging, marketing, and information sharing are among the sectors identified as needing improvement in the research. The study incorporates quantitative and qualitative data gathered from 50 farmers via questionnaires and interviews. Low agricultural yields, post-harvest losses, insufficient storage facilities,

expensive transportation, crop damage during transit and storage, restricted market prospects, and poor information exchange are all highlighted.

The suggested roadmap tackles these issues by encouraging better farming practices, improved storage facilities, efficient transportation networks, suitable packaging, expanded marketing options, and improved information flow. Implementing this approach would result in a more efficient, profitable, and environmentally sustainable agricultural supply chain in the CHT, which would benefit farmers, consumers, and the area as a whole. Collaboration among the local community, government, and commercial sector will be critical for the region's effective implementation and overall growth.

Keywords: Supply chain management, Sustainability, Efficiency, Traceability, Packaging.

1. Introduction

Bangladesh's Chittagong Hill Tracts (CHT) have lately proven significant agricultural production potential by shifting from traditional crops such as rice and seasonal vegetables to more diverse and lucrative varieties. However, various challenges have slowed the area's agricultural supply chain's expansion, including poor infrastructure, socioeconomic troubles, and political instability. The purpose of this research paper on agricultural supply chain management in the CHT is to propose a long-term framework for agricultural growth in the region. Previously, the agricultural economy in the hill tracts was limited to shifting cultivation (Jhum). But now it has declined and plain land crop cultivation has increased (Nath, Inoue & Chakma, 2005). Around 35 species of crops are grown in this slopy land. Among them, some are export quality products that have huge upside potential for generating foreign currencies. CHT is one of the richest fruit production regions in the country as the land and climate conditions of that hilly areas are suitable for growing some crops like pineapple, mango, jackfruit, litchi, dragon fruit, orange, lemons, and guava. Despite this enriched production, a huge portion of the produced foods are damaged before going into the distribution channel.

The supply chain of the area is full of irregularities with middlemen maintaining a tight grip on the market. The market was further divided by insufficient logistics for delivering things to and from the area, which contributed to the industry's underdevelopment (Høg et al., 2019). However, recent infrastructure upgrades, like new roads, have enabled the cultivation of longer-term investment crops, such as fruits and spices, which have grown in popularity in the area. Despite the challenges, cashew nuts are being grown for export.

Many studies have been conducted on the supply chain of Chittagong Hill Tracts, but they are very limited and vague with no specific research on the field. To further leverage the agriculture industry's potential in the hill tracts, a sustainable supply chain management structure based on the concepts of sustainability, efficiency, and traceability is proposed (Agyabeng-Mensah et al., 2021). Manufacturing, storage, transportation, packaging, marketing, and information exchange are among the major areas the report cites needing improvement. The project aims to overcome these obstacles and build an agricultural supply chain in the CHT that is more effective, lucrative, and ecologically benign.

1. Literature Review

According to Hassan et al. (2022), the key issue highlighted in the Chittagong Hill Tracts (CHT) agricultural supply chain management is the transportation of crops from mountainous areas to the capital along with other towns or villages. While the CHT, including Khagrachari, Rangamati, and Bandarban, boasts a favorable climate for growing a variety of crops, including bananas, pears, lychees, and spices, the region's economic contribution has been constrained by underdeveloped roads and ineffective transportation and preservation techniques. As a result, the CHT's potential goldmine of crop production has yet to add value to the agricultural supply chain significantly. The research points out that improving the roads in hilly areas should be the primary focus to overcome these barriers. The hilly roads' hazardous conditions affect the overall supply chain management and deter potential visitors and investors. Addressing this issue will benefit the farmers and open up opportunities for exporting crops, considering the CHT's connectivity to South-East Asia through Myanmar.

Furthermore, a study by Haque et al. (2020) sheds light on the reasons preventing the widespread adaptation of cooperative societies in the rice supply chain in Bangladesh. The study aims to identify the major factors hindering such cooperatives' development from the farmers' perspective. Through primary data collected from 100 respondents and analyzed using a t-test with a 99% confidence level, two prominent reasons are revealed: lack of government support in raising awareness and lack of financial stability among farmers. Despite initiatives to increase rice production, the livelihood and standard of living of rice producers have not significantly improved. One of the key factors contributing to this disparity is the presence of numerous middlemen in the rice supply chain who dominate the marketing channel without contributing much to its production. These middlemen, including rice millers, wholesalers, and retailers, often benefit at the expense of farmers due to an unbalanced supply chain.

Also, according to Iftekhar et al.'s (2020), the supply chain of perishable goods poses challenges due to the multiple layers and intermediaries involved. The inventory management practices of different superstores vary, leading to higher maintenance costs, which eventually affect the prices of perishable goods. Due to this, people with lower and moderate incomes believe that superstores serve only aristocrats and instead shop at local markets for their basic needs. The study suggests an alternative supply chain structure as a long-term fix to the problems plaguing the supply chain for perishable items. To assure sustainability, cut waste, and increase the profitability of all stakeholders, the report advises building an effective and traceable supply chain. The suggested supply chain system intends to decrease waste and optimize throughput in the superstore setting by effectively using planning, coordination, and communication.

In addition, as Mridha (2018) stresses, poor inventory management is mostly to blame for the enormous spoiling and damage to potatoes yearly. The supply chain procedure in Bangladesh's potato industry is also considered inefficient, making post-harvest losses even worse. The study underlines the significance of eliminating supply chain waste and guaranteeing the financial viability of all stakeholders, including farmers, in sustainability. Efficiency is a key component of the study since it concentrates on solving problems with inventory control and potato demand predictions. To reduce post-harvest losses and ensure a more seamless transition of potatoes from farm to consumer, the study seeks to identify critical solutions that can be implemented throughout the supply chain through effective planning, coordination, and communication.

The crops which are grown in the lands of CHTs reach the customers at the end of the line through a long channel of intermediaries. They include farmers, local agents, traders, wholesalers, and retailers. Here, the authors have discussed traditional supply chain of Chittagong Hill Tracts along with its challenges and possible solutions to those challenges. Farmers can sell their crops in two ways. One is to sell it to the local market directly and the other is to sell it to a local agent. Mainly the later one is done for cultivation in larger land area. Again, the local agent can sell the goods directly to the local market or sell it to a local trader who later sells it to the local market. The flow chart of traditional distribution channel of CHTs is illustrated below-

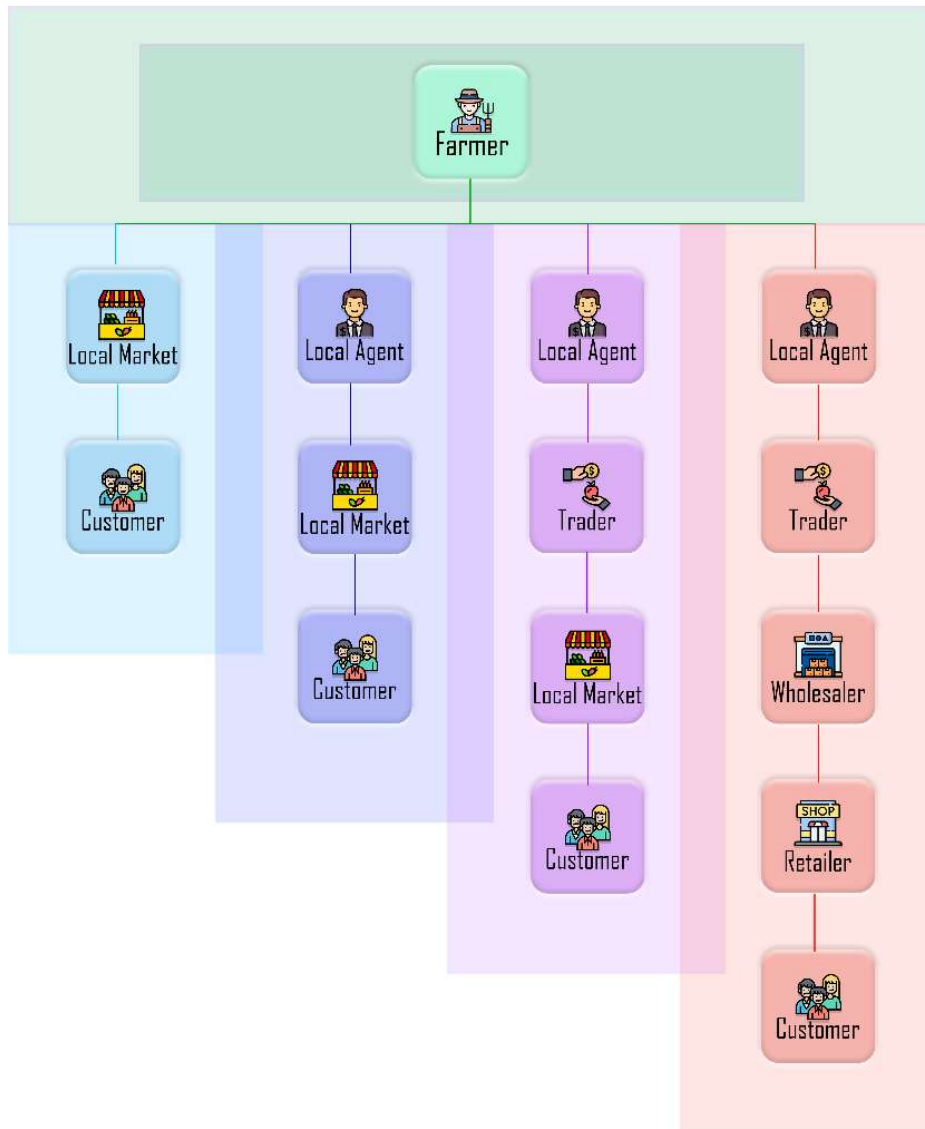


Figure 1- Traditional Supply Chain of CHTs.

In case of distributing the crops to major cities of Bangladesh, the local agents buy it from the farmers directly and sells it to a trader who then transports the goods to a trader in the city where it is transported. From there a wholesaler buys them and sells to a retailer. End customers purchases these products from cart vendors or traditional retailers.

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2. Methodology

3.1 Research Question

What are the main issues with the Chittagong Hill Tracts (CHT) agricultural supply chain, and how can a sustainable supply chain management framework be created to address these issues and advance effective, profitable, and environmentally friendly practices in the area?

3.2 Hypothesis

The agricultural supply chain in the Chittagong Hill Tracts is thought to be improved by identifying and addressing its problems and putting into practice a sustainable supply chain management framework based on sustainability, efficiency, and traceability. This would increase stakeholder profitability, lessen the region's negative environmental effects, and promote overall development.

3.3 Research Design

This study uses a mixed-methods research design to gather and analyze both quantitative and qualitative data. While the qualitative component will entail theme analysis of open-ended replies, the quantitative component will employ standardized questionnaires.

3.4 Data Collection Method

Fifty farmers in the Chittagong Hill Tracts were given questionnaires to complete to gather the primary data for this study. Both closed-ended questions, which produce quantitative data, and open-ended questions, which produce qualitative insights, are included in the questionnaires.

3.5 Sampling Technique

The 50 farmers participating in the study are chosen using a purposive sample approach. To create a broad and representative sample, the sampling process considers elements including geographic representation, the variety of crops farmed, and participation in various supply chain stages.

3.6 Data Collection Procedure

The surveys were sent to the Chittagong Hill Tracts' chosen farmers. Data was collected by trained enumerators who described the objective of the survey and assured respondent anonymity. Farmers were given enough time to complete the surveys, and any clarifications needed were addressed right away.

3.7 Questionnaire Design

The questionnaire was developed to collect pertinent information on the highlighted topics. Questions centered on farming techniques, the utilization of agricultural technologies, and the obstacles faced in boosting crop yields

and improving product quality for the production subject. Storage-related questions focused on present storage facilities, procedures, and the level of post-harvest losses. Questions on transportation addressed the difficulties in delivering crops from rural places to markets, the expenses involved, and recommendations for upgrading transportation infrastructure. Packaging-related inquiries delved into existing packaging procedures, damage difficulties during shipping and storage, and recommendations for better packaging options. Marketing inquiries seek to ascertain current market potential, demand, and impediments to entry into new markets. Finally, questions on information flow along the supply chain, communication routes, and possible areas for improvement in sharing essential data were asked.

3.8 Thematic Analysis

Thematic analysis was used on qualitative data acquired through interviews to uncover reoccurring themes connected to each part of the agricultural supply chain. The selected themes gave important insights into the agriculture sector's issues and potential in the Chittagong Hill Tracts.

3.9 Integration of Data

The qualitative and quantitative data were combined to offer a thorough picture of the existing condition and difficulties in the Chittagong Hill Tracts agricultural supply chain. The data integration aided in the creation of a cohesive and successful plan for long-term agriculture supply chain management.

3.10 Roadmap Development

A roadmap for sustainable agricultural supply chain management was formulated based on the research findings and insights. The roadmap proposed practical and actionable strategies to address the identified challenges and enhance sustainability, efficiency, and traceability in the supply chain. It considered the involvement of the local community, government support, private sector engagement, capacity-building initiatives, and improved market access to ensure successful implementation.

3. Results

Table 1: Production

Challenges	Data/Findings	Participants (%)
Low crop yields	- Average crop yields per hectare in CHT - Factors contributing to low yields	90%
Poor soil quality	- Soil quality assessment data - Soil health issues faced by farmers	85%
Lack of access to improved agricultural technologies	- Availability of modern agricultural technologies	78%
Technologies	- Adoption rates of modern technologies	90%

Table 2: Storage

Challenges	Data/Findings	Participants (%)
Post-harvest losses	- Percentage of post-harvest losses by crop - Causes of post-harvest losses	88%
Inadequate storage facilities	- Condition of existing storage facilities - Storage capacity and utilization rates	72%

Table 3: Transportation

Challenges	Data/Findings	Participants (%)
Difficult and expensive transportation	<ul style="list-style-type: none">- Transportation cost per ton of crop- Transportation time from farms to markets- Availability of transportation services	80%

Table 4: Packaging

Challenges	Data/Findings	Participants (%)
Damage to crops during transportation and storage	<ul style="list-style-type: none">- Percentage of damaged crops during transportation and storage- Common causes of crop damage	60%

Fig 5: Marketing

Challenges	Data/Findings	Participants (%)
Limited market opportunities	- Current markets for CHT agricultural products	70%
	- Demand and supply of CHT crops in existing markets	
	- Price trends for CHT crops in existing markets	
Inefficient marketing channels	<ul style="list-style-type: none"> - Distribution channels for CHT agricultural products - Challenges faced in getting crops to market - Market access for small-scale farmers 	55%

Fig 6: Information

Challenges	Data/Findings	Participants (%)
Poor information sharing	- Flow of information in the agricultural supply chain	75%
	- Communication gaps between stakeholders	

4. Discussion

5.1 Production

The CHT faces low crop yields due to poor soil quality, inadequate irrigation, and limited access to improved agricultural technologies. Consequently, agricultural products are often sold at lower prices due to poor quality. The suggested framework promotes efficient irrigation systems, enhanced seeds, and the wider distribution of cutting-edge agricultural methods through capacity-building initiatives as solutions to this problem (Kimothi et al., 2023). Farmers may increase crop yields and bring better-quality products to market by enhancing production techniques.

5.2 Storage

Due to insufficient storage facilities and pest and disease control, post-harvest losses represent a serious problem in the CHT. Farmers are financially burdened as a result of these losses. The recommended roadmap highlights the need to improve storage facilities to reduce soiling and damage. Farmers' profitability may be raised by implementing climate-controlled storage facilities and offering training on suitable post-harvest handling and storage practices.

One of the most common problems in the supply chain is the temperature difference between Chittagong Hill Tracts (CHT) and plain lands. From Chittagong Hill Tracts (CHT) when the perishable goods get into the city and the sudden change of temperature causes damage to the perishable goods. So, the cold supply chain facility gives us the upper hand as not only it will keep the food fresh but also will help in such areas that lack road facilities as it will keep the fruits fresh for the longest hour possible (Makule, Dimoso & Tassou, 2022).

5.3 Transportation

The CHT's steep topography makes travel challenging and expensive, which drives up transportation costs and causes delays in delivering commodities to the market. The framework advises enhancing road infrastructure and looking at economical transportation options to meet this issue. The time and expense of transportation may be considerably decreased, which is advantageous to farmers and customers. This can be done by setting up collecting points and effective transportation networks.

Freezer vans can be a crucial link between businesses and farmers because they allow businesses to purchase commodities directly from farmers while also avoiding a lot of middlemen who charge commissions (Kitinoja, 2013). Privately founded businesses can contribute significantly to and profit from the provision of frozen vehicles in the Chittagong Hill Tracts (CHT).

5.4 Packaging

Crops can be harmed during shipping and storage, resulting in financial losses for producers and a lower-quality product for customers. The proposed solution recommends the adoption of sturdy and protective packaging materials and training on proper handling and packaging techniques. This will safeguard crops during transit and storage, ensuring higher market value for agricultural products.

Perishable fruits will be contained and protected if the right packaging materials and designs are used. Avoiding plastic wrapping altogether and choosing containers strong enough to protect perishable produce from damages of UV radiation and many more. By using these types of containers, the fruits can be kept as fresh as possible while withstanding high temperatures, dampness, and humid surroundings (Shang, 2022). The appropriate form of packaging would protect the safety of the perishable fruits because the roads in Chittagong Hill Tracts (CHT) are hazardous and uneven.

5.5 Marketing

The CHT faces limited market opportunities and inefficient marketing channels, resulting in lower prices for agricultural products. The proposed roadmap advocates conducting market research to identify potential markets and create linkages with wholesalers and retailers. Also, supporting farmer cooperatives for collective marketing and enhancing marketing channels can expedite product delivery and improve profitability for farmers.

5.6 Information

Poor information sharing throughout the agricultural supply chain leads to inefficiencies and transparency issues. The proposed framework stresses the implementation of digital platforms for information sharing and better communication between stakeholders. Improved information flow will enhance supply chain efficiency, leading to better decision-making and transparency.

Farmers of Chittagong Hill Tracts (CHT) lack the necessary resources and knowledge and information about the market. Their knowledge of product prices and the market demand for a particular food is lacking because of demand forecasting (Pandey, Chaubey, Garg, Siddiqui & Srinivas, 2012). It can easily be eliminated by using demand forecasting. Using the government portal to get the information right regarding price and availability and demand. And sending those perishable items directly to the demanding area from Chittagong Hill Tracts (CHT) to avoid time loss. Also, can use NGOs and their resources to get an extra hand on the demand forecast.

Traceability is the ability to track a product's various stages from its production to the final consumer. As a result, it is simpler to locate the product along the entire supply chain. There are key data elements (KDEs) which should

be maintained related to the harvesting of crops. Likewise, each step of the supply chain must maintain these KDEs either directly or through the supply chain (Sarpong, 2014).

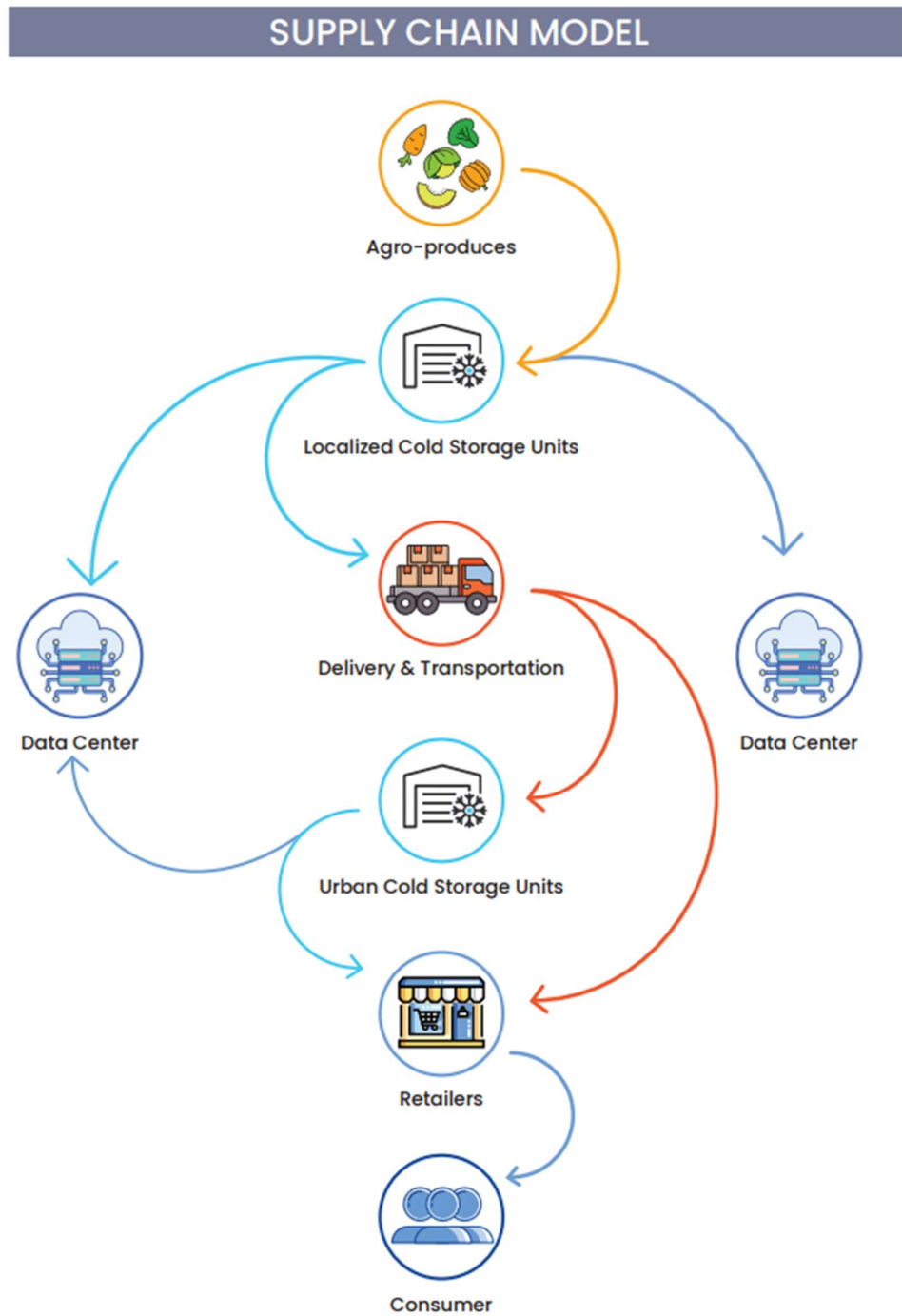


Figure 2- Proposed Supply Chain Model of CHTs.

5. Conclusion

In conclusion, the proposed sustainable agricultural supply chain management framework in the Chittagong Hill Tracts addresses critical challenges in production, storage, transportation, packaging, marketing, and information sharing. This roadmap aims to create a more resilient and profitable agricultural supply chain in the CHT by promoting sustainability, efficiency, and traceability. The solutions will require collaborative efforts from the local community, government, and private sector to ensure successful development and prosperity for all regional stakeholders. In the Chittagong Hill Tracts (CHT), there are two types of farming: plain land ploughing and non-plough slope farming. Both of these lack improved agricultural equipment, but due to the high agricultural output, a lot of food was wasted solely because it lacked the necessary supply chain resources. And in order to prevent that, we plan to build neighborhood-based cold storage facilities in each district and sub-divisions (upazilla), which will serve as a central hub for the supply chain and be delivered using frozen vans. By doing this, we will not only guarantee the quality of the perishable goods but also cut out the middlemen and deliver directly to customers or to the degraded location. As the CHT roads can be challenging during the monsoon, which can cause roads to become blocked, using the railway system can totally prevent this, which can lead to a major rise in the supply chain. In this case, packaging is also essential. For the transportation of perishable goods in the Chittagong Hill Tracts (CHT), we use a special kind of network that will get a minimal cost plan to move a good from a number of sources to a number of destinations. We cut out the expensive options and chose the most effective strategy. As our source and destination, Chittagong Hill Tracts (CHT) is planned so that each source can only supply a limited number of units of the product, and each destination only has a fixed demand for the product. Transportation can be applied to transport perishable goods we work on a special type of networks that will get a minimum cost plan transport a commodity from a number of sources to number of destinations in future research. The freshness of the perishable goods will be ensured by the use of the proper packaging and materials. Additionally, by using traceability to collect data at each stage, it will be possible to identify potential issue areas and take corrective action. When demand forecasting and traceability are combined, both farmers and consumers benefit from the best of both worlds. We can establish a reasonable supply chain to send out by using these methods.

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