

Sustainable Agricultural Supply Chain Management: A Strategic Roadmap for Development in Bangladesh's Diverse Terrain

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Abstract

The overall geographical location of entire Bangladesh has displayed significant agricultural potential with a diversified crop portfolio. However, challenges hinder the growth of the region's agricultural supply chain. This study introduces a comprehensive and sustainable long-term framework for expanding the agricultural sector throughout Bangladesh. The research begins by examining the historical constraints that have characterized Bangladesh's agricultural economy, including subsistence farming and the dominance of intermediaries. Recent infrastructural improvements, such as new transportation networks, have opened up new opportunities for cultivating profitable crops like fruits and spices. Nevertheless, transportation remains a major barrier, impacting effective supply chain management and market access. To fully harness the agricultural potential of Bangladesh, we propose the implementation of a sustainable supply chain management structure founded on principles of sustainability, efficiency, and traceability. The study identifies sectors such as manufacturing, storage, transportation, packaging, marketing, and information sharing as areas requiring enhancement. Combining both quantitative and qualitative data gathered from 100 farmers through questionnaires and interviews, the study highlights issues like low agricultural yields, post-harvest losses, inadequate storage facilities, costly transportation, crop damage during transit and storage, limited market opportunities, and poor information exchange. The suggested roadmap addresses these challenges by promoting improved farming practices, enhanced storage facilities, efficient transportation networks, appropriate packaging, expanded marketing avenues, and improved information flow. The adoption of this approach would lead to a more efficient, profitable, and environmentally sustainable agricultural supply chain throughout Bangladesh, benefiting farmers, consumers, and the nation as a whole. Collaboration among the local community, government, and commercial sector will be crucial for the effective implementation and overall growth of the region's agricultural sector.

Keywords:

Supply chain management, Framework, Sustainability, Efficiency, Traceability.

1. Introduction

Unlocking the full agricultural potential of Bangladesh demands a strategic reevaluation of its supply chain dynamics, particularly in the context of a circular model and efficient transportation systems. This study embarks on a journey through the historical constraints that have shaped the agricultural landscape of Bangladesh, emphasizing the persistent challenges posed by subsistence farming practices and the presence of intermediaries in the supply chain. While recent infrastructural developments have created new opportunities for cultivating high-value crops, the inadequacies in transportation infrastructure continue to impede effective supply chain management and hinder market access. In response to these challenges, this research advocates for the establishment of a sustainable supply chain management framework, underpinned by principles of sustainability, efficiency, and traceability. By addressing key sectors such as manufacturing, storage, transportation, packaging, marketing, and information sharing, the proposed framework aims to enhance the overall efficiency and resilience of the agricultural supply chain. The entire geographic area of Bangladesh, as well as its southern portion, has substantial agricultural potential and is home to a wide variety of crops. However, several obstacles stand in the way of the expansion and effectiveness of the agricultural supply chain in the area. Thus, with a focus on the circular supply chain and transportation model, this study presents a comprehensive and sustainable long-term framework intended to extend the agricultural sector over the entirety of

Bangladesh. The research commences by delving into the historical constraints that have characterized Bangladesh's agricultural landscape. These challenges include subsistence farming practices and the prevalence of intermediaries in the supply chain. Recent infrastructural improvements, such as the development of new transportation networks, have opened up new possibilities for cultivating profitable crops, including fruits and spices. However, transportation infrastructure remains a pivotal barrier, significantly affecting effective supply chain management and market access. To fully harness the agricultural potential of Bangladesh, we propose the implementation of a sustainable supply chain management structure anchored in principles of sustainability, efficiency, and traceability. Our study pinpoints various sectors in need of enhancement, including manufacturing, storage, transportation, packaging, marketing, and information sharing.

Objectives

The objectives of this research are:

To review the impact of past constraints, focusing on subsistence farming and intermediary roles in Bangladesh's agricultural supply chain.

To assess how recent infrastructural developments, especially in transportation, have influenced the agricultural landscape, creating opportunities for high-value crops and addressing supply chain challenges.

To evaluate and develop a comprehensive and sustainable supply chain management framework, anchored in sustainability, efficiency, and traceability principles.

2. Literature Review

Bangladesh constitutes a significant portion of horticultural produce. The crops of vegetables and fruits help farmers in generating employment and increasing their income. This sector also provides nutritional security to the people in the remote as well as urban areas (Gardas et al. 2017). Furthermore, factors like globalization, urbanization, changing lifestyles, and organized retail are driving its growth. However, the perishable nature of these items and their short shelf life pose significant supply chain challenges. Efficient Supply Chain Management (SCM) is crucial to cut costs and maintain the quality of perishable produce. (Negi & Anand 2015a). Bangladesh faces challenges in terms of inadequate infrastructure, particularly in transportation and storage, hindering agricultural sector growth. The cold chain infrastructure, essential for preserving freshness, remains a weak link, leading to substantial losses in the supply chain. This review seeks to analyze the current status of Bangladesh's agricultural supply chain, highlighting bottlenecks in the cold chain. Urgent attention is needed from stakeholders to develop a robust cold chain infrastructure to address these impediments in Bangladesh's agricultural supply chain.

In the last decade, building sustainable supply chains has gathered tremendous attention from environmentalists, NGOs, and businesses. This society-wide sustainability initiative has influenced many firms' supply chain strategies (Lu & Swaminathan 2015). Supply chain management orchestrates the flow of goods or services from raw material suppliers to end users. It involves planning, sourcing, production, logistics, and risk management to optimize efficiency, reduce costs, and meet customer demands. Coordinating suppliers, production, and distribution ensures timely delivery while minimizing inventory. Utilizing technology and strategic planning, it aims to streamline processes and adapt to market changes for competitive advantage. The pursuit of sustainability in supply chains encompasses sustainable packaging, warehousing, transportation, and reverse logistics (Panayiotou & Aravossis 2011). It involves packaging that minimizes environmental impact, warehousing focusing on proper handling and community engagement, transportation balancing mobility with environmental health, and reverse logistics to recapture value or dispose responsibly. Embracing environmental, social, and economic aspects is vital for sustainable practices across these supply chain components.

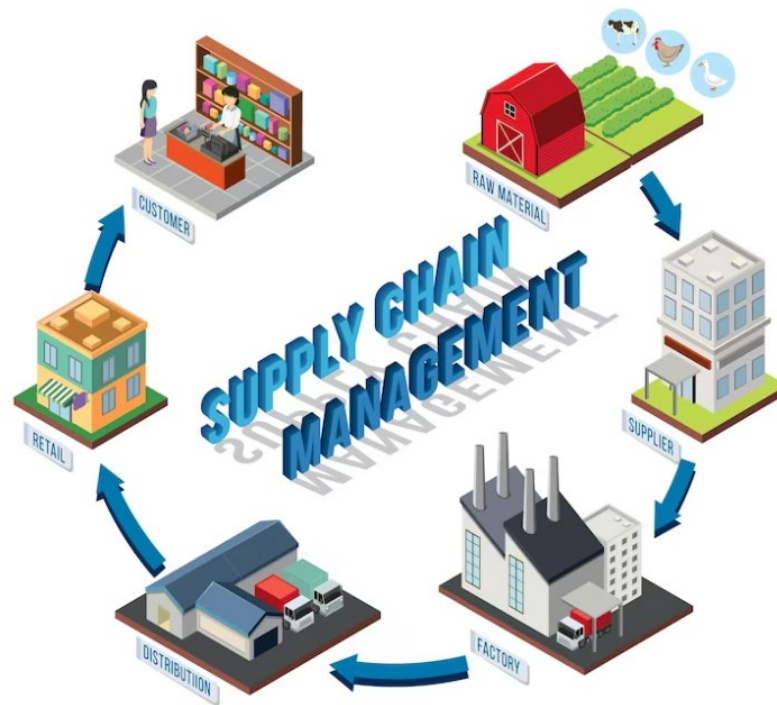


Figure 1. Supply Chain Management

2.1 Overview

The scope and definition of supply chain management has been ever changing. The meaning of the word supply chain management in industry parlance is not the same that it was 20 years ago. It is continuously evolving and broadening its scope. (Parkhi et al. 2015). The wide and diverse stream of research conducted into different aspects of SCM may be explained by the interdisciplinary nature of this subject area. Therefore, SCM is considered as a multidisciplinary field that has been explored from many different perspectives (Salleh 2017). The agricultural supply chain in Bangladesh faces significant challenges, including fragmentation, inadequate infrastructure, information asymmetry, middlemen dominance, and post-harvest losses. Fragmented connections between farmers and markets contribute to inefficiencies, while poor infrastructure leads to substantial post-harvest losses. Farmers lack access to crucial market information, resulting in unfair pricing and poor decision-making. Middlemen often exploit this gap, paying low prices to farmers while selling produce at higher rates. Financial constraints and inconsistent policies further hinder progress in the agricultural supply chain. To improve this system, Bangladesh needs comprehensive solutions. Proper preservation method, proper transport services and proper roads are possible solutions to the problems in supply chain management (Md. Sanadiule Shorif Ullash et al. 2023). Infrastructure development, including storage facilities and efficient transportation networks, can reduce post-harvest losses. Providing farmers with direct access to market information through technology-driven platforms can empower them to make informed decisions. Establishing direct market access for farmers and enhancing financial inclusion through accessible credit are essential. Additionally, policy reforms to streamline regulations and encourage fair trade are crucial for the sector's growth. Collaboration among government, private sectors, and communities is pivotal to create a more resilient and efficient agricultural supply chain in Bangladesh, ensuring fair returns for farmers and better access to quality produce for consumers.

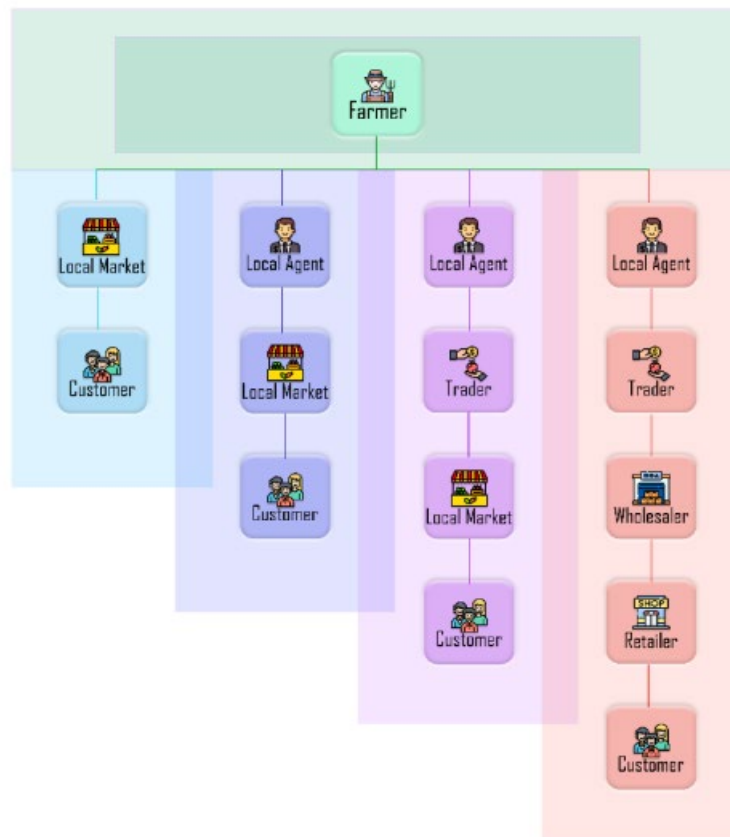


Figure 2. Traditional Agricultural Supply Chain (Md. Sanadiule Shorif Ullash et al 2023).

2.2 Qualitative Analysis

Agricultural inputs are important elements for production and productivity. (Honja 2014). In Bangladesh, particularly in hilly areas, a shift from traditional crops to diverse and lucrative varieties has shown agricultural potential. Despite this, challenges like poor infrastructure, socio-economic issues, and political instability hinder the agricultural supply chain's expansion. This research paper aims to propose a long-term framework for agricultural growth in Bangladesh. However, inefficiencies in the supply chain, dominated by middlemen, result in significant food wastage. Recent infrastructure upgrades, including new roads, enable the cultivation of investment crops like fruits and spices. Three types of supply chain models followed in fruits and vegetables sector i.e. traditional supply chain model, hub and spoke model, and value chain model (Negi & Anand 2015b). To fully exploit the agricultural industry's potential, a sustainable supply chain management structure is proposed, emphasizing sustainability, efficiency, and traceability. Key areas for improvement include manufacturing, storage, transportation, packaging, marketing, and information exchange. The project seeks to build a more effective, lucrative, and environmentally friendly agricultural supply chain across Bangladesh. The solutions will require collaborative efforts from the local community, government, and private sector to ensure successful development and prosperity for all regional stakeholders (Md. Sanadiule Shorif Ullash et al. 2023). Besides, SSCM is a tool to improve company effectiveness in terms of environmental management and social performance to gain added value. (Basuki 2021). Thus, a proposal to revamp the agricultural supply chain across Bangladesh by leveraging sustainable practices, reducing post-harvest losses, and empowering farmers.

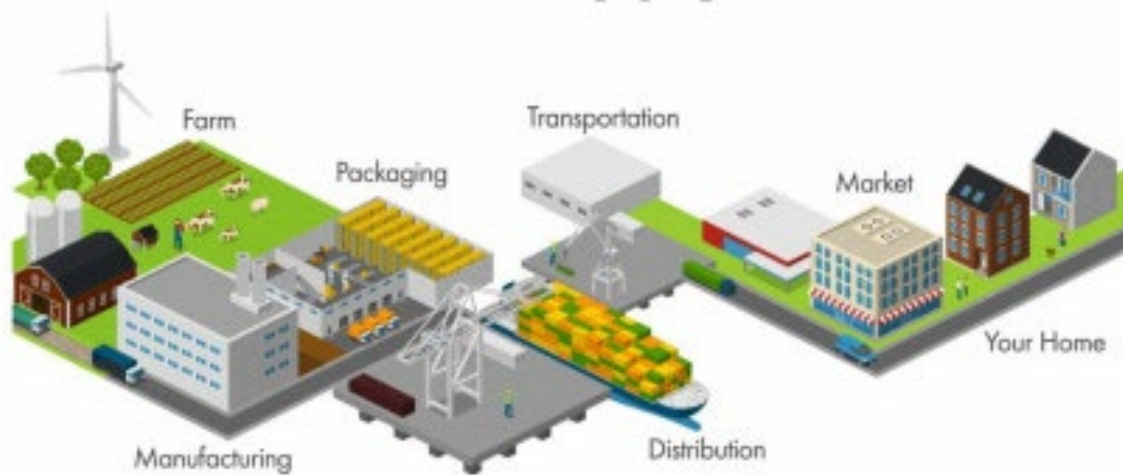


Figure 3. Concept of Sustainable Supply Chain

3. Methodology

A sustainable agricultural supply chain management roadmap was formed based on actionable strategies. It prioritized community involvement, government and private sector support, capacity building, and enhanced market access for improved sustainability, efficiency, and traceability.

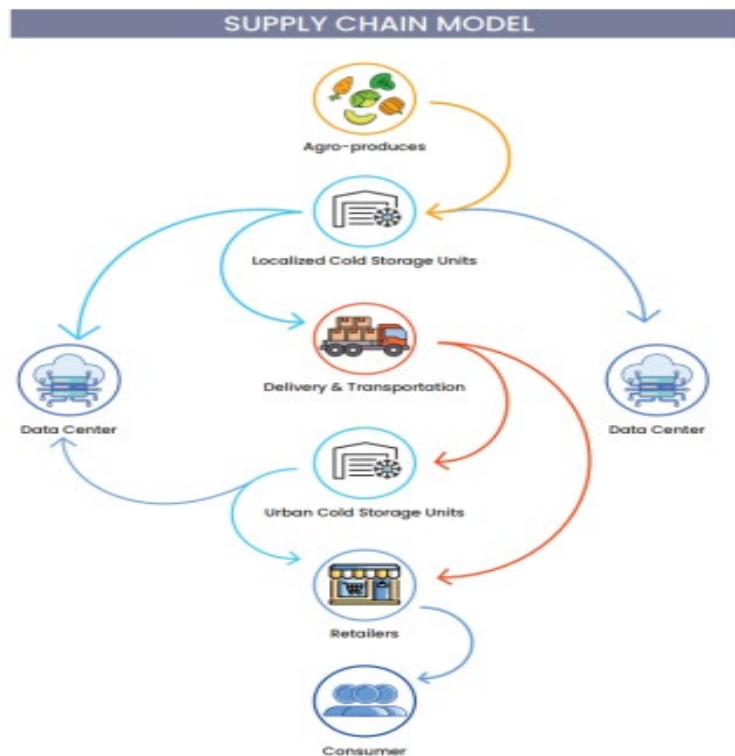


Figure 4. Proposed Supply Chain Model

By addressing infrastructure gaps, reducing middlemen interference, and optimizing logistics, the objective is to establish an effective, lucrative, and ecologically-friendly agricultural supply chain nationwide. This strategic supply chain framework aims at bolstering sustainability, efficiency, and traceability, ensuring a resilient and socially responsible agricultural ecosystem.

3.1 Data Collection

Drawing on a comprehensive dataset comprising both quantitative and qualitative data collected from 100 farmers through questionnaires and interviews, we highlight issues such as low agricultural yields, post-harvest losses, inadequate storage facilities, expensive transportation, crop damage during transit and storage, limited market opportunities, and poor information exchange. These questionnaires are designed to gather both quantitative and qualitative data. The questionnaires consist of a combination of closed-ended questions, which generate quantitative data, and open-ended questions, which yield qualitative insights.

Table 1. Qualitative Analysis

Challenges	Data/ Findings	Decision
Production	Low yields, soil issues, technology	Enhance yield, soil and adopt new technology
Storage	Post-harvest losses, inadequate storage	Upgrade storage, address and reduce losses
Transportation	Costly, slow transport, limited services	Investment in efficient transport solutions
Marketing	Insufficient channels and market opportunities	Expand market, diversify channels
Information	Communication gap between stakeholders and gap of information	Improve information flow, bridge channels

In summary, the key challenges include low crop yields due to poor soil quality, inadequate irrigation, and limited access to technology, post-harvest losses, transportation difficulties, packaging issues, limited marketing opportunities, and poor information sharing

4. Results & Discussions

The proposed sustainable agricultural supply chain management framework tackles challenges in production, storage, transportation, and marketing across the entire terrain. Besides, solutions involve improving irrigation systems, enhancing seed quality, and distributing cutting-edge agricultural methods to boost production. Climate-controlled storage facilities are recommended to reduce post-harvest losses. Enhancing road infrastructure, introducing economical transportation options, and employing freezer vans that can address transportation challenges. Sturdy and protective packaging materials are suggested to safeguard crops during transit and storage. Market research, cooperative marketing, and improved marketing channels are proposed to enhance market opportunities. Implementing digital platforms and demand forecasting can improve information sharing and transparency in the supply chain. Furthermore, the concept of traceability is introduced as a means to track a product's journey from production to the final consumer, enhancing transparency and accountability throughout the supply chain.



Figure 5. Future of Agricultural Industry

5. Conclusion

The envisioned sustainable agricultural supply chain management framework offers comprehensive solutions to the pressing challenges spanning production, storage, transportation, packaging, marketing, and information dissemination across the entire terrain. Besides, the execution of SCM methods must ensure that the flow of data and information between suppliers, distributors, manufacturers, and customers to be completely transparent. (Tajwar et al. 2022). This roadmap seeks to fortify a more resilient and profitable agricultural supply chain by championing sustainability, efficiency, and traceability. It aims to overcome equipment inadequacies, reduce food wastage, and improve efficiency. Neighborhood-based cold storage hubs with frozen vans promise to maintain perishable goods' quality and enable direct delivery. Leveraging railways during challenging weather and a strategic network for transportation minimizes costs and optimizes delivery within the terrain. Integration of proper packaging and traceability ensures freshness and allows for data-driven issue resolution. This approach benefits farmers and consumers alike, enhancing the supply chain's efficiency and satisfaction. Overall, implementing these methodologies promises a transformative impact, fostering sustainable growth and prosperity for all stakeholders involved.

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Biographies

Quazi Monjur E-Elahi, is a newly graduate student of Industrial and Production Engineering (IPE) under the Department of Mechanical and Production Engineering (MPE) at the Ahsanullah University of Science and Technology (AUST). His research interest includes the area of Industrial Management, Manufacturing process, Supply Chain Management, Quality Assurance & Control, Advanced Material Processing, Lean Manufacturing, Technology Management and Industry 4.0. He has vast experience in content writing and research, documentation management process, content research, content quality assurance & control (QAC), team management. He has proficiency in Microsoft Word and Excel. He is also focused in the research of the aerospace industry and wants to work within such an industry. He also participated in a multiple number of engineering & business case competitions showcasing his ability to solve complex problems and work collaboratively in a team. He was also the former Vice President of IEOM Society AUST Student Chapter. Furthermore, he was also the former Chief Advisor and President of Josephite Chess Club.

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