Chapter 3
Advanced Computational Forecasting for Agri-Business Supply Chain Resilience

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ABSTRACT

This chapter focuses on using advanced statistical methods to improve predictions in the agri-business sector. It integrates cutting-edge computational techniques and statistical models to address supply chain disruptions in agriculture. The main goal is to create a robust forecasting framework that predicts market trends, demand fluctuations, and enhances supply chain resilience. The novelty lies in combining advanced statistical methodologies like time series analysis, predictive modeling, and data-driven insights for a comprehensive approach. This aims to improve supply chain management in agri-business by fostering adaptability and resilience in changing market conditions.

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INTRODUCTION

In India, the agri-business sector faces daunting challenges amidst global dynamics. Climate change brings erratic weather, shifting rainfall, and rising temperatures, directly affecting agricultural productivity. Resource scarcity, especially water, land, and energy, further strains farming practices, particularly in water-stressed and degraded regions, increasing farmers' vulnerability [Carayannis et al. (2018); Ulvenblad et al. (2020)] . Market volatility, influenced by domestic and international factors, poses additional uncertainty, impacting the profitability and sustainability of agri-businesses throughout the value chain.

India urgently needs to address food security amid a burgeoning population of over 1.3 billion people, with surging demand for food staples, straining the agricultural sector and necessitating adaptable supply chains to balance production and consumption amidst fluctuating patterns and evolving preferences [Kumar et al. (2023); Pandey & Pandey (2023) ; Shetty (2018)].Supply chain disruptions, environmental uncertainties, and risks from extreme weather events, pest outbreaks, and disease epidemics compound challenges in the agri-business sector, hindering efficient movement of goods and exacerbating vulnerability[Belhadi et al. (2024) ; Xu et al. (2021)].

Advanced computational forecasting strengthens India's agri-business supply chains by leveraging data analytics, AI, and predictive modeling for proactive decision-making, optimizing resource allocation, logistics, and demand fluctuations, enhancing operational efficiency and profitability [Kagalkar et al. (2023) ; Roy et al. (2023) ; Sarkar et al. (2023)].

Utilizing advanced computational forecasting, this chapter delves into enhancing coordination within India's supply chain, benefiting smallholder farmers with timely guidance and market insights. Novelty of the work reflects by integrating cutting-edge methodologies with agricultural expertise, it proposes tailored solutions employing AI and machine learning to tackle climate change, resource scarcity, and market fluctuations, thus bolstering the resilience of India's agri-business.

This chapter highlights how advanced computational forecasting empowers smallholder farmers in India by providing timely information and tools. It emphasizes inclusive strategies and collaborative partnerships among academia, industry, and government to drive innovation and address challenges in the agricultural sector. Its contextualized approach offers actionable insights for building resilience and fostering sustainable development.

METHODOLOGY

This study's methodology rigorously examines how advanced computational forecasting strengthens agri-business supply chain resilience in India. It combines theoretical frameworks, empirical analysis, and practical applications for a comprehensive understanding of the research problem.

A comprehensive literature review focuses on theoretical foundations, conceptual frameworks, and empirical evidence of advanced computational forecasting in agri-business supply chains, emphasizing computational modeling, predictive analytics, machine learning, and optimization. Assessing their relevance in the Indian agricultural context illuminates their potential to address supply chain challenges. Case studies offer real-world insights into computational forecasting's impact, spanning diverse commodities, supply chains, and regions, while empirical analysis evaluates performance in predicting demand, optimizing inventory, and managing disruptions, using statistical techniques and computational tools to derive actionable insights for improved supply chain efficiency and resilience.