Improvements in Farm Supply Chain Through Lean Manufacturing Concepts: A Literature Review

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Abstract--- *To enhance a process, it is necessary to reduce to a minimum the non-value adding activities involved in the process. Lean is a philosophy that aims at minimizing the non-value adding activities. The application of Lean thinking to all processes involved in the process or supply chain leads to what can be referred to as Lean Supply Chain. Different scholars have classified the various supply chain activities, while different lean tools have been employed to improve these processes. In this work, efforts will be made to review some of the works on this topic through structured content analysis. It will be seen that Lean contributes to several advantages in the supply chain such as reduced cost, high-quality, fast deliveries, and increased flexibility. The majority of the articles examined herein comprise case studies. Nevertheless, it appears that there is inadequate use of mathematical/statistical approaches. The manufacturing supply chain enjoys numerous researches, and thus, why it receives considerable attention than the services sector, whose case is just the opposite. Normally, the supply chain concentrates on the suppliers and manufacturers and overlooks the customers and distributors, an aspect that has not received sufficient attention. It follows that if each of the links of the chain receive proper attention, substantial improvements could be attained. The main objective of this research is to review the basics of Lean Supply Chain Management with regards to farming activities.*

Keywords--- *Lean, Supply Chain, Literature Review, Principles, Practices, Techniques*

I. Introduction

LEAN is a process whose aim is to enhance productivity through the elimination and reduction of non-value adding steps and inconsistencies in process improvement, thus emphasizing the activities that add value to consumers (Azadegan et al., 2013). Lean 4.0 utilizes technology to eliminate waste, making sure that no effort is exerted on non-value-adding tasks during the manufacturing process (Womack & Jones, 2017). The advantages of using the Lean approach are numerous (De Oliveira et al., 2020; Bonamigo et al., 2024; Rossini et al., 2023). Not only does it minimize wastage in the operation but also improves the quality of value added to consumers (Solano et al., 2022). Lean process assists in minimizing waste and enhancing efficiency, hence improving the performance of the organization while maximizing consumer satisfaction at the same time (Pearce et al., 2021). Elimination of products and/or services that are not value-added results in simplification of the entire buying process, hence better consumer satisfaction. Even though the concept of Lean originated from the auto-manufacturing industry and became popular in manufacturing organizations, it can be applied in other fields such as agriculture and logistics (Özcan & Kulaksız, 2026).

A. Supply Chain Concept

The supply chain consists of a set of actions necessary to convert raw materials into a product delivered to a consumer (Ayal, 2019). There is a growing tendency for organizations to streamline their processes and collaborate with both their customers and suppliers (Paul & Saha, 2025). Thus, collaboration not only with suppliers but also with customers has turned out to be one of the most efficient ways of increasing competitive advantage.

The farming supply chain is made up of a complex network of organizations and activities, from the beginning of the process, i.e., obtaining data on which crop to choose, to the end, with the product reaching the end customer at the right time (Sachdeva & Anand, 2025; Xue et al., 2025; Karimi, 2025).

II. Lean in the Supply Chain

The concept of Lean Supply Chain Management (LSCM) means the set of Lean principles that connect organizations through the exchange of goods, services, information, as well as money, between the supply chain participants moving up and down the chain. All these principles are aimed at reducing costs and eliminating waste by assuring that only necessary actions will be taken by producing or delivering exactly the things that customers need (Skarbek & Kowalski, 2023). Prior studies related to LM use within supply chains have proven some advantages in organizational operations (Mudda et al., 2017).

Nevertheless, the integration of LM concepts into SCM has received considerable interest and attention, but much is still to be done to make this integration more effective.

Consequently, organizations aiming to integrate their supply chain partners and operations can adopt lean management (Ugochukwu et al., 2012; Songkhwan et al., 2025). If lean processes are implemented at all stages in the supply chain, then it is said to be a lean supply chain (LSC).

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III. Lean in Agricultural Supply Chain

According to several research papers, there has been increasing interest in implementing the concept of lean management that originated in manufacturing into the farming industry and its supply chains (Toruan et al., 2025; Satolo et al., 2017). The reason behind the application of lean management can be explained by the need for increasing efficiency in performing operations due to strong competition and characteristics of the agribusiness industry (Toruan et al., 2025). In this regard, even though technologies are applied to enhance efficiency in agriculture, there has been increased attention towards lean management systems.

A. Key Lean Principles and Their Application in Agricultural Research

Many articles discuss the implementation of basic lean practices in agriculture:

- Value Stream Mapping (VSM): Many articles indicate that value stream mapping is the most frequently used approach in the analysis of agricultural production processes and identification of wastes in agricultural production in the countryside (De Steur et al., 2016). Application of the VSM technique in the analysis of processes or network chains from the beginning (input) to the end (customer) has been proposed (Toruan et al., 2025; Ganguly et al., 2019).
- Waste Reduction (TIMWOODS): Various sources analyze the problem of how seven wastes of lean (Transportation, Inventory, Motion, Waiting, Over-processing, Overproduction, Defects) appear in agriculture, such as overproduction, spoilage of products (inventory), transportation inefficiency, etc. (Toruan et al., 2025)
- Flow and Pull Systems: Creation of a smooth flow of processes and alignment of production with the needs (pull) is analyzed in the research as a means of avoiding overproduction and delays.
- Continuous Improvement (Kaizen): The principle of continuous improvement in the field of agriculture has been highlighted by many researchers as relevant due to constant changes in this sphere.

B. Examples of Lean Adoption in Agriculture Supply Chain Literature

Examples provided by research literature about how lean management principles and tools are being used in the agriculture supply chain include the following:

- Case Studies in Agribusiness: Several case studies within different fields of agribusiness investigate the extent to which lean production systems are applied based on certain techniques and taking into account the specificities of the agribusiness sector (Satolo et al., 2017).
- Lean Logistics in Crop Firms: Research concentrates on the optimization of logistic procedures in crop firms, making use of lean production in order to improve productivity and reduce losses and transport/storage costs.
- Waste Analysis through Value Stream Mapping: Research proposes systematic approaches such as Value Stream Mapping that allow for analyzing and identifying waste in agrifood chains, even waste related to carbon dioxide emissions.
- Lean Action Plans for SMEs in the Food Sector: Research has come up with lean action plans especially designed for small and medium-sized food firms to show that lean management can lead to substantial waste elimination in the sector through various case studies.

C. Benefits Indicated by Research

Research tends to highlight several possible benefits of adopting lean within farming supply chains. Among them are:

- Increased Efficiency/Productivity: Enhanced efficiency and minimizing waste have resulted in increased efficiency in production processes.
- Cost Savings: Optimizing resources and minimizing waste often lead to cost savings.
- Waste Reduction/Quality Improvement: The focus on preventing defects and optimizing process could help improve quality and reduce waste.
- Improved Collaboration: Implementation of the lean approach necessitates improved collaboration among all stakeholders (Toruan et al., 2025).
- Sustainability: Efficient use of resources and reduced waste make the lean approach more sustainable.

IV. Challenges and Future Research Directions

While studies have considered the potential of lean applications in agriculture, they also note that there is room for research into the challenges associated with variability and fragmentation within agriculture supply chains. Research will need to examine the development and application of frameworks for the application of lean in agriculture; the measurement of its effectiveness and how technology can play a role in making this happen (Caicedo Solano et al., 2020).

In summary, studies into lean applications in the agricultural supply chain have been evolving and increasingly concentrating on aspects such as application and adoption of lean in agriculture; illustrating its application in agricultural cases; and noting the benefits associated with it.

V. Research Purpose

The objective of this paper is to conduct a critical review of the literature surrounding lean implementations in the supply chain. This paper seeks to address three main objectives, which include: first, the summarization of the existing literature by noting the common themes and issues; secondly, the creation of a tool through which this literature can be efficiently analyzed; and third, the identification of the gaps that need to be filled.

To meet these objectives, this paper will look at the aspects of the lean supply chain, including the advantages and also the methods and techniques used in researching the topic.

VI. Methodology

Content analysis process for the literature review on the topic of lean in the agricultural supply chain included four stages suggested in the methodological framework by Mayring (2003, p. 54). First, the necessary literature for the analysis was identified through establishing the range of the research focus and performing an extensive search for the corresponding source materials. Second, during the descriptive analysis stage, the characteristics of the collected literature were analyzed, including its distribution among different journals, research methods used, and frequency of publications per year. Third, the classification of selected literature was conducted with the help of detecting key categories and dimensions in which they could be categorized. The fourth stage comprised material evaluation, when detailed sorting of collected materials was performed according to the established hierarchy. Thus, the literature review was performed for articles from 2000 to 2024 that touched upon the topic of lean in supply chains in the agriculture sector.

In an effort to identify relevant literature concerning lean in the supply chain, a thorough search was conducted using various sources such as Emerald, ScienceDirect, Scopus, SpringerLink, Ebscohost, Wiley, ISI, Business Source Premier, and Google Scholar. In addition, the bibliography of some articles was also used to identify additional articles. Keywords that were used to perform the search include "lean supply chain," "lean management," "lean enterprise," and "lean implementation." As a result, 1000 articles were obtained in response to the keywords. Further narrowing down of the search led to only articles that have "lean" and "supply chain" in the title or abstract. Articles whose title suggested that they were not relevant were then excluded from the search. Other keywords and databases were searched without identifying any new article. Out of the total of 1000 articles initially obtained, 136 were selected. By reading abstracts, introduction, and main body of the articles, those that do not discuss lean within at least two members of the supply chain were excluded. At the end of this process, there were only 64 articles. Reviewing all 64 articles resulted in 40 articles for this review.

VII. Benefits of Lean in the Supply Chain

However, apart from the numerous advantages associated with the lean approach in farming, there are certain difficulties associated with it:

Complexity Due to Variability of Biological Systems: Unlike manufacturing systems that work with static processes, farming involves living organisms and, thus, is affected by many random and unexpected factors.

Seasonal Effects: Agriculture tends to be dependent on specific seasons, which affects planning and logistics.

Resistance to Change: Being a new concept in management, lean faces opposition from those who are used to conventional management systems.

Lack of Knowledge: Being relatively new for agriculture, the introduction of the lean process may be hindered by the lack of knowledge and expertise to implement the system.

Initial Costs: Implementation of some lean principles may involve costs of training, technology or other equipment. Value Definition: Determination of customers' value in agriculture is complicated by many factors.

VIII. Conclusions

Agriculture that practices lean has emerged as one of the viable ways through which farms can increase their productivity levels and ensure their sustainability as businesses. This is because it offers them an opportunity to adopt the same concepts utilized in lean production in order to address issues such as waste in the processes and ultimately increase the value of goods delivered to their consumers. The challenges associated with the nature of agricultural business aside, it becomes apparent that this concept holds much promise in terms of improving farm efficiency and hence its profitability. It therefore deserves further studies in this regard.

Initially, lean thinking was an effective model of efficient production operations. The principles of lean thinking have become more popular in the SCM (Lean SCM) in order to gain a competitive advantage. Nevertheless, despite the increased interest since 1997, the research on lean thinking in the SCM in terms of agro-related SCM remains rather underdeveloped. First, one should note that the lean thinking principles can be applied equally well in any industry and not only in manufacturing. However, most of the studies were carried out within the automotive industry and were based primarily on the case study approach, providing profound analysis, but hindering the process of generalizing the results. In addition, the research shows the preferences for qualitative approaches and for studying manufacturing processes only, rather than focusing on the whole supply chain management and involving such aspects as suppliers and distributors.

Interconnection Between Lean and I4.0: I4.0 refers to the more recent revolution making use of digital technologies which provides some advantages in terms of quality, flexibility, and productivity. The key issue to address here is the compatibility between Lean and I4.0. It is believed that they complement each other in that:

- From a strategic perspective, LSCM drives I4.0 towards sustainability, while diverse customer needs call for Digital LSCM;
- From an operational perspective, I4.0 facilitates LSCM with Big Data, Augmented Reality, Digital Products, CloudChain, Blockchain, and Additive Manufacturing.

Responding to Disruption: Dairy Farms Case Study: COVID-19 pandemic clearly exposed the importance of the agility and resilience of the supply chains. The dairy farm industry was negatively impacted, showing the significance of the adoption of new methodologies in their operations and supply chain management. The isolated nature of the farm-based industry is becoming irrelevant due to the changes in customers' needs and increased competition. The proposed solution is the incorporation of lean, agile, and DevOps methods in their operations. Such an integrated approach will help to analyze changes in customers' behavior, anticipate and prevent risks, organize the process of information and assistance distribution, effectively manage time, and focus on

quality in deliveries. Integration of such methodologies can provide specialists of the future with more understanding of the business environment.

Summing up, these topics combined can be seen as a synergy, with the core principles of lean methodology improved through the technological capacities of Industry 4.0.

IX. Future Research

Lean is a highly flexible approach that can be applied in every facet of business or personal endeavors. More empirical and quantitative analysis in agricultural research may provide added benefits in lean-based supply chains in agriculture. The results from such a study may further provide evidence on the effectiveness of applying lean and also help develop strategies and policies. Predictive modeling in particular, can help prove the claims.

Expanding the scope of application of lean management to other under-researched industries, such as the Agri-Food industries, construction, healthcare, and other service sectors, will show the universal applicability of lean to every sector.

Supply Chain Implementation will result in impact through lean implementation of the entire supply chain, including the suppliers and the customers. This is critical to assessing the benefits of Lean management and ensuring full participation in the adoption process.

A. Deepening LSCM and I4.0 Understanding

- Case studies: Focus on case studies that examine organizations that are actually implementing LSCM and/or I4.0 or that have moved from one system to another. In this way, one will be able to derive useful information and verify theoretical links.
- Applicability Contextually: Use analytical frameworks already available, but contextualize the context in terms of industry, organization size (SMEs vs. big companies), and geographical location because these variables have been seen to affect implementation processes drastically.
- Replication analyses: Replicate analyses for a few years since this is an emerging field that requires tracking progress and validating long-term trends in LSCM and/or I4.0 integration.
- Align Industry & Academia: Conduct research involving case studies that compare industry realities and academics' analysis of the latter.

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