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# Application of Agile Methodologies in an Agribusiness Project Management: An Analysis from a Literature Review

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## Abstract

The application of agile methodologies for project management is a tool to address changes in the environment more quickly and efficiently. However, it is difficult to apply them in the agribusiness sector, which faces challenges such as climate variability, market fluctuations and the need to innovate in a sustainable manner throughout the production process. In this sense, we analyzed how agile methodologies can improve process efficiency, reduce costs and increase quality in agroindustrial projects. For this purpose, a methodology based on the systematic review of the existing literature was used, evaluating studies and cases of implementation in this sector. The results show that methodologies such as Scrum, Kanban and Lean Manufacturing are effective in optimizing logistic processes, improving collaboration in multidisciplinary teams and reducing waste in agroindustrial production. Scrum has proven to be useful in innovative project management, Kanban in supply chain optimization, and Lean in reducing operational costs in food production. It is concluded that, although agile methodologies can transform project management in agribusiness, their successful implementation requires specific adaptations to the context of the sector, such as continuous training and improvements in technological infrastructure.

**Key words:** Agile Methodologies, Project Management, Agribusiness, Innovation and Tools.

## Introduction

Agribusiness represents a strategic sector in global economic development, playing a key role in the value chain, food security and employment generation, especially in rural areas. In the last decade, this sector has undergone an accelerated transformation driven by digitalization, automation and the adoption of new technologies, which has significantly modified its operating and business models (Sotomayor et al., 2021).

The current context of agribusiness is characterized by a series of global-scale challenges that test its capacity for adaptation and resilience. These challenges include: the

increasing volatility of international markets, the pressure to implement more sustainable production practices, the effects of climate change on production systems, the progressive depletion of essential natural resources such as water and soil, and the specific demands of consumers and regulatory institutions (Vega, 2019). These factors have generated an environment of uncertainty that requires agribusiness companies not only to maintain their competitiveness, but also to constantly reinvent themselves to ensure their long-term sustainability.

In this complex and dynamic scenario, innovation emerges as a crucial element for business resilience. However, for innovation to be translated into concrete and sustainable actions, effective methodological tools are required to facilitate its management. This is where agile methodologies present themselves as a promising alternative to traditional project management approaches, characterized by their rigidity and sequential approach, which have demonstrated limitations in the face of the need for flexibility and adaptation demanded by the current agribusiness environment (Portilla, 2022).

Agile methodologies have their origin in software development, with the publication of the Agile Manifesto in 2001, which established four fundamental values: individuals and interactions over processes and tools, software running over comprehensive documentation, collaboration with the client over contractual negotiation, and responsiveness to change over following a plan (Highsmith, 2013). Although initially conceived for the technological field, these methodologies began to be applied in agribusiness from 2015, experiencing significant growth between 2019 and 2022, driven by the need for digitization and transformation of traditional business models. According to an ECLAC report, digitization and technological change in agricultural and agribusiness MSMEs accelerated significantly from 2019, creating an enabling environment for the adoption of new management approaches (Sotomayor et al., 2021). A study by Flórez (2022) identifies that approximately 35% of medium and large agroindustrial companies have implemented some type of agile methodology in their innovation and product development processes.

The agile methodologies most commonly used in the agribusiness sector are Scrum, Kanban and Lean, each with specific applications depending on the type of project and organizational context. Scrum has proven to be particularly effective in the management of technological innovation projects and the development of new agribusiness products, facilitating collaboration between multidisciplinary teams and allowing greater adaptability to changes in requirements (Schwaber and Sutherland, 2020). For its part, Kanban has found application in the optimization of logistics processes and agroindustrial supply chains, improving the visibility of workflows and reducing lead times (Castellano, 2020). Finally, Lean has been successfully implemented in food production, contributing to waste reduction and continuous improvement of production processes (Guanillo et al., 2021).

A relevant aspect of the current state of agile methodologies in agribusiness is their integration with Industry 4.0 technologies. The "AgriculTIC" project, developed by Chaparro (2019), implemented a responsive web platform for data acquisition, monitoring and control of agroindustrial processes using agile methodologies, demonstrating the feasibility and benefits of applying agile approaches in the development of technological solutions for the

sector. This and other studies evidence how the combination of agile methodologies with technologies such as Internet of Things (IoT), data analysis and automation is generating new business models in agribusiness, characterized by responsiveness to changing market conditions and optimization of available resources. This integration is enabling the development of innovative solutions in areas such as precision agriculture, food traceability and value chain optimization.

Despite the growing interest in the application of agile methodologies in agribusiness, there is a gap in the understanding of how these methodologies can be effectively adapted to the particularities of this sector and what factors determine their success or failure. This research addresses the need to establish an analysis to understand the contribution of agile methodologies to agribusiness project management.

Research on agile methodologies in agribusiness project management is relevant from multiple interrelated dimensions. From the economic perspective, these methodologies have been shown to reduce new product development times by 30% and improve responsiveness to market changes (Portilla, 2022), while in the social domain they contribute to food security and rural development through innovative solutions for efficient resource management, reduction of post-harvest losses and improved traceability (Vega, 2019). Academically, this study addresses a gap in the scientific literature on the application of agile methodologies in traditional non-technological sectors, generating knowledge on their adaptation to the particularities of agribusiness and providing a framework that can reduce the failure rate in their implementation, which currently reaches 40% (Morales and Pacheco, 2020). The research is aligned with the current trends of digital transformation, identified as a strategic priority in the CONPES Document 3975 of 2019.

Therefore, the objective of this article is to analyze the application of agile methodologies in project management in agribusiness, identifying the key factors that influence their effective implementation, through a systematic review of the published literature, in order to establish a frame of reference to guide researchers and professionals in the agribusiness sector in the adoption and adaptation of these methodologies.

## Theoretical Reference

To adequately understand the application of agile methodologies in project management in the agribusiness sector, it is essential to address the theoretical concepts that support this approach. The conceptual analysis provides a solid base that allows to adequately interpret and contextualize the methodological frameworks referred to in the specialized literature.

This theoretical reference addresses aspects inherent to current agile methodologies for project management, with emphasis on their application to the agribusiness context. The fundamentals, principles and practices of the main agile methodologies are analyzed, as well as their adaptation to the particularities of the agribusiness sector, characterized by its dependence on external factors such as climatic conditions, changing regulations and market fluctuations.

## Agile Methodologies

Agile methodologies are a set of approaches to project management that emerged in response to the limitations of traditional methods, especially in environments characterized by uncertainty and constant change. These methodologies are based on the 2001 Agile Manifesto, which established four core values: individuals and interactions over processes and tools; software working over comprehensive documentation; collaboration with the customer over contractual negotiation; and responsiveness to change over following a plan (Beck et al., 2001). Although originating in the field of software development, agile methodologies have transcended this field to be applied in various sectors, including agribusiness, where adaptability and the ability to respond quickly to external factors are crucial to the success of projects.

The Scrum method is the most widespread and is based on defined roles (Scrum Master, Product Owner and development team), structured events (sprints, daily meetings) and artifacts (backlogs, boards, burndown charts). Kanban, for its part, allows visual management of work through boards that help to limit the work in progress, favoring a continuous flow. Finally, Lean Startup, created by Eric Ries, promotes the rapid construction of minimum viable products, continuous validation with the customer and validated learning (Schwaber and Sutherland, 2020).

Kanban, initially developed as part of the Toyota Production System, was adapted as an agile methodology by David J. Anderson in 2010. Unlike Scrum, Kanban does not prescribe specific roles or fixed time events, which facilitates its implementation in organizations with established structures. The fundamental principles of Kanban include: visualizing the flow of work through boards, limiting work in progress (WIP), managing and optimizing the flow, making process policies explicit, implementing feedback loops, and improving collaboratively and evolving experimentally (Anderson, 2010).

Lean Startup, created by Eric Ries in 2011, combines agile development principles with lean manufacturing and customer development concepts. This methodology focuses on early validation of business hypotheses through rapid build-measure-learn cycles. The core Lean Startup cycle consists of building a minimum viable product based on hypotheses, measuring by collecting data on how users interact with the product, and learning by using this data to validate or refute hypotheses and make informed decisions (Ries, 2011).

Extreme Programming (XP), developed by Kent Beck in the late 1990s, is an agile methodology that emphasizes technical excellence and high quality programming. XP is characterized by practices such as pair programming, test-driven development (TDD), continuous integration, simple design and collective code ownership (Beck, 1999).

Crystal is a family of agile methodologies developed by Alistair Cockburn, one of the signatories of the Agile Manifesto. Crystal is distinguished by its focus on people and communication, rather than processes and tools. This methodology recognizes that each project is unique and therefore requires an approach tailored to its specific characteristics (Cockburn, 2004).

Feature Driven Development (FDD), created by Jeff De Luca and Peter Coad in the late 1990s, is an agile methodology that focuses on feature-based development. FDD follows an iterative process consisting of five main activities: develop an overall model, build a feature list, plan by feature, design by feature, and build by feature (Palmer and Felsing, 2002).

Dynamic Systems Development Method (DSDM), originated in 1994, is one of the oldest agile methodologies. DSDM provides a comprehensive framework for delivering business solutions that meet time and budget constraints while maintaining quality (Consortium, 2014).

Lean Manufacturing uses various tools and techniques to implement its principles, including 5S as a methodology to organize the workspace through Seiri, Seiton, Seiso, Seiketsu and Shitsuke; Kanban as a visual system to manage work flow and limit work-in-process; Just-in-Time to produce only what is necessary, when it is required and in the necessary quantity; Jidoka as automation with a human touch to detect and correct defects immediately; Poka-Yoke as error-proof devices that prevent defects; SMED as a technique to reduce tool changeover times; Kaizen as a philosophy of continuous improvement through small incremental changes; and Value Stream Mapping as a tool to visualize and analyze the flow of materials and information (Liker, 2004).

**Agribusiness Project Management**

Agile project management has established itself as a flexible and value-focused approach that represents a significant evolution from traditional project management methods (PMI, 2021). Unlike traditional management, which follows a sequential and predictive approach based on initial exhaustive planning, agile management proposes an adaptive planning where projects are developed in iterative cycles that allow evaluating partial results and continuously adjusting to the changing environment. This approach is relevant in the agribusiness sector, where uncertainty and variability are inherent characteristics that require rapid and adaptive responses (Dong et al., 2021).

In this context, decision making is distributed among multidisciplinary teams, who assume collective responsibility for delivering functional results on a regular and systematic basis (Yeshwanth, 2022). This decentralized approach significantly improves communication between the different actors in the agribusiness value chain, reduces product and service delivery times, and allows for the constant incorporation of feedback from the customer and other relevant stakeholders. Transparency in processes is another key component of this approach, which is achieved through the implementation of visual management tools and accountability in daily or weekly meetings that facilitate the monitoring of progress and the early identification of obstacles (Mesaros et al., 2022).

This methodological approach is particularly useful for agroindustrial projects that involve technological innovation, development of new products, or implementation of disruptive processes, since these projects are usually characterized by high levels of uncertainty, require continuous validation with end users, and are subject to variable external factors such as climatic conditions, market fluctuations, regulatory changes, or

variations in soil conditions and other natural resources (Fasciolo et al., 2022). Thus, agroindustrial projects present distinctive characteristics that differentiate them from projects in other industrial sectors, highlighting the inherent complexity derived from the interaction of multiple biological, environmental, technological, social and economic factors that operate simultaneously and interdependently. This complexity is manifested in the need to coordinate activities ranging from research and development of new crop varieties, to the implementation of industrial processing systems, to the management of supply chains involving multiple actors with different levels of technification and capabilities (Dong et al., 2021).

In this sense, innovation management in agribusiness projects requires a systematic approach that integrates multiple technological, organizational and strategic dimensions (Mühl et al., 2022). The adoption of Industry 4.0 technologies in the agricultural sector has generated new opportunities for innovation, but has also introduced additional challenges in terms of project management. Successful implementation of technological innovations in this sector requires an understanding of the interactions between biological and technological systems, as well as the ability to manage the resistance to change that can arise in organizations with entrenched traditions.

**Application of Agile Methodologies in Agribusiness**

Agile methodologies have proven to be effective tools for managing innovation projects in various sectors, and agribusiness is no exception (Yeshwanth, 2022). These methodologies, originating in software development, are characterized by their iterative, adaptive and value-focused approach, which makes them suitable for complex and changing environments such as agribusiness. The adoption of agile approaches enables agribusiness companies to adapt quickly to changing market demands, improve operational efficiency and foster collaboration between multidisciplinary teams that integrate agronomic, technological and commercial expertise.

In this sense, agile principles, such as early and continuous delivery of value, acceptance of change even at late stages of development, day-to-day collaboration between business people and developers, and building projects around motivated individuals, provide a solid conceptual framework for agribusiness project management (Dong et al., 2021). These principles facilitate adaptation to the particularities of the sector, such as seasonality, dependence on climatic factors, and the inherent variability of biological processes.

Within the framework of these principles, the implementation of Scrum in agribusiness projects implies the adaptation of its roles, events and artifacts to the specific context of the sector (Yeshwanth, 2022). The Product Owner role can be played by agricultural managers or cooperative representatives who have a deep understanding of market needs and product requirements. The Scrum Master acts as a facilitator, helping the team overcome obstacles and ensuring that agile principles are correctly applied in the agribusiness context. The Development Team, in this context, is usually multidisciplinary, including agronomists, agricultural engineers, technology specialists, logistics experts and

marketing professionals. In addition, Scrum events also require adaptations for the agribusiness context (Mesaros et al., 2022). Sprints, which are work cycles with fixed durations (typically 2 to 4 weeks), should be aligned with the natural cycles of agricultural processes whenever possible. For example, in new crop development projects, Sprints could be aligned with the phenological stages of the plants. Sprint planning should consider factors such as expected weather conditions, seasonal resource availability, and windows of opportunity for specific activities.

Another approach being adopted in agribusiness is the use of Kanban to manage the agribusiness value chain, which starts with the visualization of the workflow through boards that represent the different stages of the process, from primary production to final distribution (Vásquez et al., 2022). These dashboards can be physical, located in production or processing facilities, or digital, accessible to geographically distributed teams. Each column of the board represents a stage of the process (e.g., "To Do," "In Progress," "In Verification," "Completed"), and the cards represent specific units of work, such as production batches, processing orders, or customer shipments. A fundamental principle of Kanban is work-in-process (WIP) limitation, which helps prevent overloading of systems and resources (Widiwati et al., 2022). In the agribusiness context, this is important for perishable products, where excess inventory can result in significant losses. Setting WIP limits for each stage of the process helps to maintain a constant flow and avoid bottlenecks that could compromise product quality or freshness.

On the other hand, the application of Lean Startup in agribusiness ventures has promoted the continuous validation of products and services, reducing the risk of failed investments and accelerating the innovation process (Calafat et al., 2022). Startups in the sector have used this approach to validate new food products, urban agriculture models, e-commerce platforms for agricultural products, and precision agriculture systems, among others. A particularly valuable aspect of Lean Startup in the agribusiness context is its emphasis on continuous learning and adaptation, which enables entrepreneurs to effectively navigate an environment characterized by uncertainty and change (Hassoun et al., 2022). This adaptability is crucial in an industry where factors such as climate change, evolving consumer preferences and technological innovations are constantly transforming the competitive landscape.

Finally, Lean Manufacturing, also known as Lean Production, has been successfully adapted to the agribusiness sector, applying its principles of waste elimination and process optimization to create more value with fewer resources (Carrijo et al., 2022). The identification and elimination of the seven types of waste (muda) constitutes a central aspect of Lean Manufacturing that is effectively applied in agroindustrial processes (Widiwati et al., 2022). In the agro-industrial context, overproduction can manifest as excess crops exceeding market demand or processing capacity, resulting in post-harvest losses.

## Materials and Methods

The focus of the study was qualitative, aimed at understanding agile methodologies applied in agribusiness projects, as well as best practices in the implementation of these

methodological approaches in that sector. According to Creswell (2014), qualitative approaches focus on understanding the nature of phenomena and provide a detailed and in-depth view of the specific contexts in which they are applied.

The scope of the research employed an analytical-descriptive method to conduct an analysis of the most widely used agile methodologies in the field of agribusiness. According to Hernández, et al (2014), this method allows an understanding of the phenomena, as it combines data analysis with a description of the contexts studied, which facilitates the identification of patterns and trends.

The research design was systematic in the review and collection of data from the existing literature on the subject. A content analysis was used to examine the key factors related to the adoption of agile methodologies and their effects on improving efficiency in agribusiness projects.

**Techniques and Instruments**

This research implemented a methodology focused on the analysis of secondary sources and the collection of qualitative data. Through this approach, it was possible to conduct an objective evaluation of the existing literature on the impact of agile methodologies in agribusiness projects. This methodology allowed the integration of a diversity of perspectives and approaches, providing a comprehensive view of the economic benefits of implementing agile methodologies in this sector.

The analytical processing of the information was structured through defined thematic categories, facilitating the coherent organization of the findings around conceptual axes identified during the literature review. This methodological strategy made it possible to identify recurrent patterns and determining factors in the relationship between the application of agile methodologies and increased efficiency in agroindustrial projects. The inherent flexibility of this analytical method favored a holistic interpretation of the phenomenon studied, providing a comprehensive view of the contribution of agile methodologies to the development of the sector.

To systematize the information, analytical matrices prepared using Microsoft Excel software were used to organize the studies reviewed according to various variables, such as the objectives of each investigation, the problems addressed, the methodologies applied and the results obtained. This tool not only facilitated effective information management, but also made possible a comparative evaluation of the findings, highlighting the main challenges and opportunities related to the adoption of agile methodologies in the agribusiness sector.

The review process began with the definition of strict inclusion and exclusion criteria to ensure adequate selection of relevant studies. Through searches in academic databases such as Scopus and Google Scholar, articles and studies were identified that addressed the interrelationship between agile methodologies and the improvement of agribusiness projects. Each of the selected studies was subjected to a detailed analysis, using previously defined criteria to ensure the relevance and quality of the information collected.

## Research Phases

The research process was structured in three fundamental phases that allowed gathering, analyzing and synthesizing relevant information on the topic. Through these phases, we sought to provide a comprehensive view of how agile methodologies can improve project management in the agribusiness sector and contribute to the sustainable development of rural communities. The three phases of the research process are detailed below.

## Phase I Literature Search

To ensure the review, a systematic approach is used to identify articles published in scientific journals, conferences and specialized books. The selection criteria is based on the five years of prior research and related to the application of agile methodologies in agribusiness project management, especially in terms of efficiency, innovation and results in project quality. The selected articles come from recognized academic databases, such as Scopus and Google Scholar, which allowed a consolidated documentation of 105 studies relevant to the research topic.

## Phase II. Documentary Analysis

The second phase consisted of a comprehensive analysis of the selected articles and papers. The main objective was to identify key patterns and emerging themes that emerged from the reviewed studies, and then to classify them into thematic categories. Key activities included the evaluation of the research methods used, the quality of the data presented and the results obtained in relation to agile methodologies applied in agribusiness projects. The studies were organized according to key variables, such as the type of agile methodology used (Scrum, Kanban, Lean), the effects observed in the projects (efficiency improvement, cost reduction, quality increase) and the satisfaction of the beneficiaries. This allowed a clearer vision of the results and challenges in the application of agile methodologies in this sector.

## Phase III. Recommendations

The final phase focused on proposing specific recommendations to improve agribusiness project management through the use of agile methodologies. The recommendations were oriented to optimize the planning, execution and monitoring of agroindustrial projects, favoring interdisciplinary collaboration and adaptability in the face of changing challenges.

## Results

This section presents the results of each phase of the research. A literature search was conducted to identify key articles on agile methodologies in agribusiness. Then, a documentary analysis was carried out to evaluate the most applied methodologies and their effects.

**Phase I. Literature Search**

In the first phase of the study, a specific search equation was developed in order to retrieve relevant research articles on the application of agile methodologies in the agribusiness sector. The search equation was constructed using key terms such as "agile methodologies", "Scrum", "Kanban", "agribusiness" and "project management". The search was conducted mainly in the SCOPUS and Google Scholar databases, selected for their broad coverage of academic literature and their high indexing of impact scientific journals.

Rigorous inclusion criteria were established to ensure the relevance and quality of the retrieved documents. The inclusion criteria contemplated research articles published between 2018 and 2022 to ensure the contemporaneity of the data and the relevance of the methodologies applied in the current context. Priority was given to studies specifically addressing the implementation of agile methodologies, including Scrum, Kanban and Lean related methodologies, in the agribusiness context. The search was limited to articles in English and Spanish. Additionally, only publications in indexed journals in categories related to project management, agribusiness, agricultural technology, and innovation studies were considered, in order to ensure the thematic relevance and scientific rigor of the sources consulted.

At the same time, exclusion criteria were defined to discard documents that were not relevant or of low academic quality. Research whose main topic was not the application of agile methodologies in the agribusiness sector was excluded, such as those studies focused exclusively on other industrial sectors or on traditional management methodologies. Opinion articles, editorials, and non-systematic reviews that did not provide empirical evidence or rigorous data-based analysis were also discarded. Documents that were not accessible in full text were also excluded, as they prevented detailed analysis and the extraction of relevant information. Finally, studies that did not present empirical results or concrete case studies, such as theoretical or methodological proposals without direct application in the agroindustrial sector, were eliminated.

Based on the search equation that combined the terms “project management” and “agribusiness”, 105 potentially relevant articles were initially identified in the databases consulted. This initial number reflected the breadth of the search and the diversity of approaches in the literature on the intersection between project management and the agribusiness sector. After the systematic application of the previously established inclusion and exclusion criteria, each article was evaluated in detail, considering its thematic relevance, methodological quality and contribution to knowledge on agile methodologies in agribusiness.

The selected articles were classified into five main thematic categories that emerged from the content analysis. The first category covered studies on the specific application of Scrum in agribusiness, including research that analyzed the implementation of this methodology in agribusiness projects, its necessary adaptations to the context of the sector, and the results obtained in terms of efficiency and project management. The second category focused on agile methodologies applied to the development of agricultural technologies,

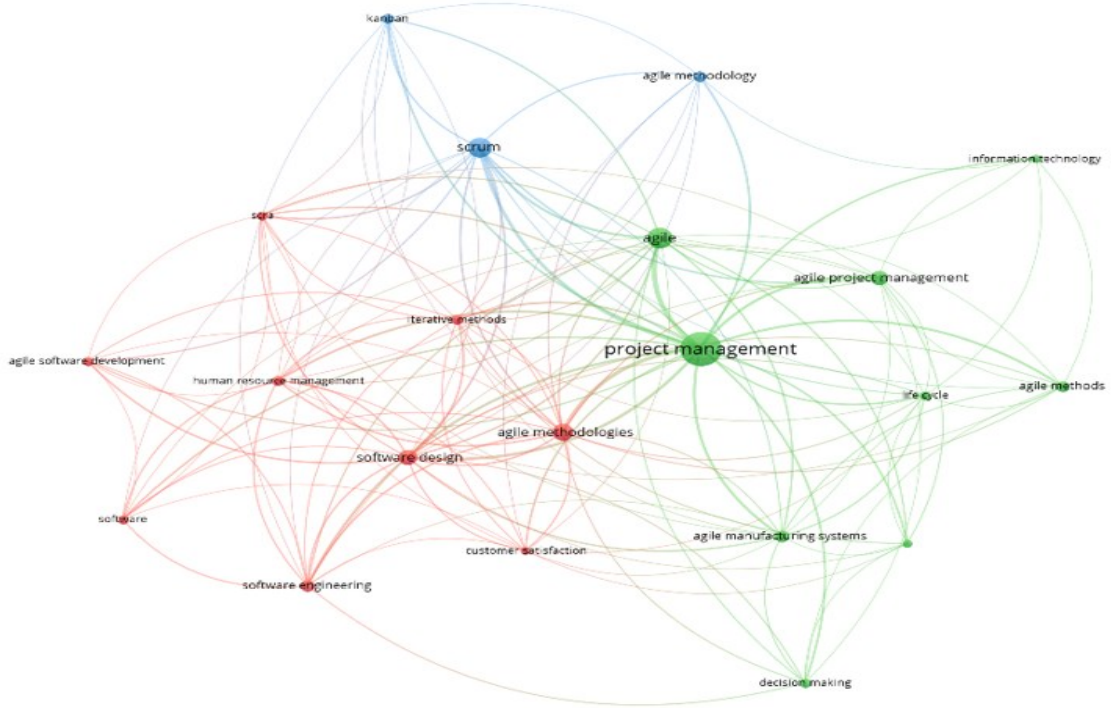
encompassing research on the use of agile approaches in the development and implementation of innovative technological solutions for the agricultural sector, including information systems, mobile applications and precision agriculture technologies.

The third thematic category included papers focused on the use of Kanban for the optimization of agroindustrial processes, including studies that documented the use of Kanban systems to improve efficiency in production, logistics and inventory management processes in the agroindustrial sector. The fourth category focused on the agile management of agroindustrial supply chains, including research that examined the application of agile principles in the management of supply chains in the sector, considering aspects such as traceability, coordination among actors and response to variations in demand.

Finally, the fifth thematic category covered case studies on the implementation of agile methodologies in agricultural projects, including research that documented concrete implementation experiences, analyzing results obtained, challenges faced and lessons learned during the process. This thematic classification made it possible to identify the main research trends and areas of application of agile methodologies in the agribusiness context, facilitating subsequent qualitative analysis and providing a solid basis for understanding the current state of knowledge in this area of research.

This process served to select a final corpus of research articles that met all the established parameters and provided valuable information on the application of agile methodologies in agroindustrial contexts that allowed the mapping of coincidences through the VOSviewer software as shown in Figure 1.

Figure 1
Map of Bibliographic Coincidences.



Source: VOSviewer

**Phase II. Documentary Analysis**

An analysis of the articles selected to evaluate how agile methodologies, such as Scrum, Kanban and Lean, affect efficiency, quality and profitability in agribusiness projects is performed. Through a detailed and systematic analysis, the studies are grouped into categories that address the agile methodologies used, their effects on the agribusiness operation and the results observed in different application contexts.

In several studies reviewed, Scrum has been identified as a key framework for project management in multidisciplinary teams in the agribusiness sector. According to the article by Gomez, A. (2020), Scrum helps to improve collaboration between the different parties involved in agribusiness projects, such as farmers, technicians and managers. This is important in projects that require rapid decision making and adaptations to changing conditions, characteristics inherent to the agricultural sector where climatic, seasonal and market factors can significantly alter the course of a project.

Hasan's (2022) research on the implementation of agile methodologies in agricultural artificial intelligence projects demonstrates how Scrum facilitates the integration of emerging technologies in the sector. The study highlights that the principles of iterative planning, Scrum methodology, continuous improvement, flexibility, and collaboration are critical to the success of complex technology projects in agriculture. This perspective extends the traditional understanding of Scrum by showing its applicability in the implementation of AI solutions for farm management and agricultural process optimization.

In the case of Productiviza (2020), it shows how Scrum can reduce lead time and improve adaptability to market demands in agricultural sectors that rely on constant technological innovation. The methodology enables teams to respond quickly to changes in market conditions, adjusting priorities and approaches according to emerging needs. Research by Endres (2022) brings an additional dimension by showing how Scrum can be used to develop sustainable frugal innovations in the agricultural sector. This study, based on semi-structured interviews with Scrum practitioners, provides the first insights into the development of frugal innovations using this methodology, demonstrating that Scrum not only improves operational efficiency, but can also contribute to sustainability goals in agribusiness projects.

The Kanban methodology has been highlighted in the optimization of agribusiness production, especially in inventory and workflow management. According to Castellano (2020), Kanban helps reduce bottlenecks by allowing better visual control of available resources and lead times at each stage of the production process. This visualization capability is valuable in agribusiness operations where coordination between multiple simultaneous processes is crucial to maintain product quality and freshness.

Krstić's (2022) research on Logistics 4.0 towards circular economy in the agri-food sector demonstrates how Kanban integrates with advanced technologies to optimize supply

chain management. The study shows that the application of Big Data and data management technologies facilitates supply chain management in the agri-food sector by supporting the management of various segments of the chain, including order management, where Kanban plays a key role in visualizing and controlling the workflow.

According to Tovar and Morales (2021), Kanban has improved efficiency in agribusiness by reducing in-process inventories and improving continuous workflow, especially in the management of perishable products, where response time is crucial. This improvement translates into a significant reduction in waste and optimization of available resources, which are critical in an industry where profit margins can be tight and product quality is directly related to speed of processing.

The study by Yeni et al. (2022) on the implementation of the Kanban system to achieve a reliable and manageable agricultural supply chain provides empirical evidence of the benefits of this methodology. The research focuses on addressing challenges related to long lead times in a hazelnut company, mainly attributed to product quality issues. The results demonstrate that the implementation of Kanban not only reduces cycle times, but also improves traceability and quality control throughout the supply chain.

The Lean Manufacturing approach has been key in improving production processes within agribusiness, focusing on waste elimination and continuous improvement. The article on Lean Manufacturing in food production explains how Lean has enabled agribusiness companies to reduce operational costs by optimizing resources and improving product quality. This methodology has been specifically adapted to the unique characteristics of the agri-food sector, considering factors such as product perishability, seasonal variability and stringent food safety requirements.

Ema's (2022) research provides a descriptive analysis of the evolution of Lean Manufacturing in agri-food processing and identifies important research gaps. The study synthesizes previous research on waste reduction tools such as Lean Manufacturing in the agri-food processing industry, highlighting that this methodology has proven to be effective in addressing multiple types of waste simultaneously, from overproduction to quality defects.

According to Guanillo et al. (2021), Lean is successfully applied in food production, improving quality, reducing processing time and, above all, ensuring a more efficient use of resources. This efficiency is particularly important in the current context where sustainability and environmental responsibility are key considerations for agribusiness companies. The implementation of Lean principles contributes not only to corporate profitability but also to broader sustainability goals.

Widiwati et al.'s (2022) study on the implementation of the Lean Six Sigma approach to waste reduction in the food manufacturing industry proposes an integrated methodology that combines the waste elimination principles of Lean with the statistical tools of Six Sigma. This combination has proven particularly effective in food industries where both efficiency and quality consistency are critical to business success.

Cusiatado's (2022) research presents a systematic review of Lean Manufacturing in food industry productivity, analyzing the impact of this methodology on the sector's productivity. The study identifies Lean Manufacturing as a set of tools aimed at reducing costs, increasing sales and optimizing processes, with specific tools including 5S, Kaizen, Just-in-Time, and Value Stream Mapping, all adapted to the specific context of the food industry.

Vasquez et al. (2023) document the application of Lean tools in the food industry, showing how the implementation of Lean Manufacturing practices has become increasingly relevant in the food industry, given the need for greater efficiency, waste reduction and quality improvement. His research provides empirical evidence of the tangible benefits of these implementations in terms of reduced operating costs and improved customer satisfaction.

**Effects of Agile Methodologies on Agribusiness Operation**

**Improved Operational Efficiency**

The articles analyzed consistently show that the implementation of Scrum and Kanban has resulted in significant improvements in the operational efficiency of agribusiness companies. The use of Scrum enables faster delivery of results in agribusiness projects, while Kanban optimizes processes by reducing lead time and balancing the workload. The study by Rodriguez, L. (2021) on the optimization of agribusiness production using Kanban shows that productivity increases considerably when implementing this methodology to manage the workflow in the supply chain.

Dong et al.'s (2021) research on sustainable agile project management in complex agricultural projects from an institutional theory perspective provides evidence that agile methodologies not only improve efficiency, but also contribute to the long-term sustainability of projects. This study is relevant because it examines how agile methodologies can adapt to the institutional and regulatory complexities of the agricultural sector while maintaining their effectiveness in improving operational efficiency.

**Significant Reduction in Operating Costs**

The adoption of Lean Manufacturing has proven to be effective in reducing waste and costs in the agribusiness sector. Perez, R. (2021) states that Lean has helped reduce production costs by optimizing resource utilization, minimizing equipment downtime and eliminating excess inventories. In agribusiness companies, where cost control is essential to maintain competitiveness in global markets, Lean has been a key factor in increasing profitability and ensuring long-term economic viability.

Kowalska's (2022) research on food insecurity and whether “leagility” (combination of Lean and Agile) is a potential remedy demonstrates that supply chain leanness has been shown to increase profits through cost and waste reduction, while the ability to be agile, when needed, increases customer service and market responsiveness. This strategic

combination allows agribusiness companies to keep costs low while retaining the flexibility needed to respond to market changes.

**Substantial Increase in Product and Process Quality**

Both Scrum and Kanban contribute significantly to continuous quality control, which improves customer satisfaction and product consistency. Gomez, A. (2020) states that Scrum facilitates quality control through continuous feedback during each sprint, allowing early detection of problems and implementation of corrections before they affect the final product. This continuous feedback capability is particularly valuable in agribusiness processes where quality can be affected by multiple environmental and operational variables.

In the case of Kanban, improving workflows has also enabled companies to improve quality by making processes more consistent and reliable, as described in Villanueva, E. (2020). The workflow visualization provided by Kanban allows to quickly identify bottlenecks and quality problems, facilitating timely interventions that maintain the required quality standards.

Widiwati et al.'s (2022) research on Lean Six Sigma implementation demonstrates that combining Lean principles with Six Sigma statistical tools results in significant improvements in both efficiency and quality. The study shows that this integrated methodology can reduce variability in food manufacturing processes, resulting in more consistent and higher quality products, while simultaneously reducing waste and operational costs.

Ema's (2022) analysis of driving factors in the use of waste reduction tools such as Lean Manufacturing in the food processing industry identifies that quality improvement is one of the most consistent benefits of implementing these methodologies. The study provides a descriptive analysis of how the evolution of Lean Manufacturing in agri-food processing has contributed not only to waste reduction but also to substantial improvements in final product quality.

**Phase III Recommendations**

In this phase, the proposed recommendations have been developed considering the characteristics of the agribusiness sector, the lessons learned from successful implementations documented in the specialized literature, and the specific challenges faced by the organizations of the sector in the adoption of agile methodologies.

The evidence analyzed strongly supports the need to implement comprehensive continuous training programs in agile methodologies that cover all organizational levels, with special emphasis on middle management and operational personnel. Hasan's (2022) research on the implementation of agile methodologies in agricultural artificial intelligence projects highlights that the principles of iterative planning, Scrum methodology, continuous improvement, flexibility, and collaboration require a deep and shared understanding across the organization to be effective.

It is essential that training includes specific modules on adapting agile methodologies to the unique challenges of the agribusiness sector, such as the management of perishable products, climate variability, sector-specific regulations, and coordination with multiple stakeholders in the value chain. Training should be continuous and evolving, adapting to new trends and developments in the field of agile methodologies and their application in agribusiness contexts.

It is important to implement a hybrid framework that uses Scrum for strategic planning and management of development and innovation projects, while Kanban is used for day-to-day operational management and control of production workflows. This combination leverages Scrum's strengths in managing complex projects and Kanban's ability to optimize continuous workflows, both of which are critical in agribusiness operations.

The incorporation of digital technologies to improve task visibility, workflows and facilitate data-driven decision making emerges as a critical recommendation supported by multiple analyzed studies. Krstić's (2022) research demonstrates that the application of Big Data and data management technologies significantly facilitates the implementation of digital Kanban systems that provide real-time visibility into processes.

Systematic implementation of Lean tools specifically adapted to agribusiness processes is recommended, including Value Stream Mapping to identify waste in the value chain, 5S to organize workspaces and improve operational efficiency, and Kaizen to establish a culture of continuous improvement. As documented by Vasquez et al. (2022), the application of Lean tools in the food industry has proven to be effective in increasing efficiency, reducing waste and improving quality.

**Discussion**

The results obtained in this study show that the implementation of agile methodologies, such as Scrum, Kanban and Lean Manufacturing, has proven to be beneficial in several key aspects of agribusiness, although significant challenges were also identified.

First, the use of Scrum has been effective in technological innovation projects within the agribusiness sector. This methodology, which emphasizes collaboration among multidisciplinary teams, has facilitated the development of new products and technological solutions, such as monitoring platforms and agricultural management systems. In projects involving technological innovation, Scrum's flexibility has enabled teams to adapt quickly to changes in market requirements or crop conditions, which is crucial in such a dynamic sector.

On the other hand, Kanban has proven to be useful for logistics process optimization and supply chain management. The visibility provided by the Kanban board allows to efficiently manage workflows, minimizing lead times and improving efficiency in production phases. In particular, Kanban's ability to limit work-in-process (WIP) has been crucial in inventory management in agribusiness companies, reducing the risk of losses, especially in perishable products, which in turn reduces the waste of resources.

The Lean Manufacturing methodology has had a significant positive impact on the continuous improvement of production processes. The use of Lean tools, such as 5S, Kaizen and Value Stream Mapping, has enabled agribusiness companies to identify and eliminate waste, optimizing the use of resources and improving product quality. This methodology has been effective in reducing operational costs, especially in food production, where efficiency is crucial to maintaining competitiveness. Lean's ability to generate small incremental changes has facilitated the implementation of improvements on an ongoing basis, which has had positive effects on both productivity and sustainability.

However, the implementation of these methodologies has not been without challenges. The main barrier encountered is resistance to change within agribusiness organizations, which generally operate with more traditional and hierarchical processes. Agile methodologies require an open and flexible mindset, which is not always found in companies accustomed to more rigid work models. In addition, the lack of technological infrastructure in many rural areas is a major obstacle. Agile methodologies rely heavily on digital tools for project management and real-time collaboration, so lack of access to advanced technologies can hinder their effective implementation.

Another challenge is the lack of specific training in agile methodologies within the agribusiness sector. Although some companies have begun to adopt these methodologies, many others lack the necessary knowledge to implement them effectively. To overcome this, it is essential that organizations invest in continuous education and training of their teams, especially in the agribusiness context, where the particularities of the sector require a specific adaptation of agile principles.

## Conclusions

Agile methodologies, such as Scrum, Kanban and Lean Manufacturing, have proven to be highly effective in improving project management within agribusiness, a sector that faces unique challenges such as variability in climatic conditions, market fluctuations and pressures to innovate in a sustainable manner. These methodologies enable agribusiness companies to adopt a more flexible and adaptive approach, resulting in a greater ability to respond to rapid change and improve operational efficiency. Through practices such as multidisciplinary collaboration, incremental value delivery and workflow optimization, they have been able to improve lead times, reduce operational costs and raise the quality of end products.

However, the implementation of these methodologies is not without obstacles. One of the main challenges is the resistance to change within organizations, especially in those with rigid hierarchical structures and a traditional mindset that prioritizes more conventional management methods. In addition, the lack of adequate technological infrastructure, especially in rural areas, limits the effectiveness of agile methodologies, as they rely heavily on digital tools for project management and constant communication between teams.

To overcome these challenges, it is crucial for agribusiness companies to invest in continuous training of their staff, particularly in agile methodologies such as Scrum, Kanban and Lean. This will help create an organizational culture open to change and innovation. In addition, adapting these methodologies to the specific context of agribusiness, combining agile approaches with emerging technologies such as precision agriculture and the internet of things (IoT), will allow for a smooth integration of these frameworks into the daily operation. In summary, agile methodologies have great potential to transform agribusiness project management, but their success depends on proper implementation, backed by organizational commitment and investment in infrastructure and training.

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