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ORIGINAL PAPER

RISKS AND RESILIENT STRATEGIES IN AGRO-INDUSTRIAL SUPPLY CHAINS – A SCOPING REVIEW 2013–2023

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ABSTRACT. Background: Logistics chains operate in environments prone to a range of internal and external instabilities, necessitating the constant management of logistics risks and the reinforcement of resilience, particularly in the face of complex challenges like the COVID-19 crisis. Despite the perishable nature of agricultural commodities and their significant economic and social impacts, there is a noticeable scarcity of research on this topic, especially in the Latin American context. This study aims to bridge this gap by specifically concentrating on identifying prevalent risks, strategies, and methods to enhance the resilience of the agro-industrial supply chain (Agroindustrial-SC).

Methods: Scientific databases were reviewed under the guidelines of the PRISMA declaration; 59 studies from 2013–2023 were reviewed and synthesized to understand the current state of the methods and strategies for measuring resilience in Agroindustrial-SC. We focused on two main groups: before and after the COVID-19 crisis in Latin America, the US, and the other continents. We used Mendeley® and Vosviewer® software to organize and classify the information and build bibliometric maps.

Results: In 2018–2021, the highest job activity was identified in Europe and North America. Only six countries have contributed to this field of study in Latin America. In this period of study, the academic community has most frequently focused on reducing the impact of biological, environmental, and financial risks and on defining strategies for these impacts supported by deterministic and quantitative methods with a statistical approach and stochastic programming to assess the resilience and risk of Agroindustrial-SC, although in recent years the qualitative approach has been incorporated into heuristic methods.

Conclusions: These results are especially useful for the design of resilient infrastructure systems in the Agroindustrial-SC. To the extent that the Agroindustrial-SC incorporates the digital transformation, it will be able to open and evolve its production processes and business models towards new resilient forms of relationship with suppliers and customers.

Keywords: Resilience, Agrifood supply chain, supply chain resilience, supply chain risk.

INTRODUCTION

The supply chain (SC) connects operational and business functions from the sources of inputs to the delivery of products in the right quantity, at the right place, and at the right time [1], [2]. However, companies adapt their operations not only due to events in the global economy but also due to events that cause instability in their internal and external structures, including those in the social environment, public policies, natural disasters, and trade policies, among other risks which cause connectivity interruptions along the SC [3], [4]. Scholars [5]–[9] have identified five categories of risks that can impact the SC to varying degrees: raw material supply risk, production and processing risk, logistics, warehousing, transportation, sales and consumption, and government regulatory. For example, the health contingency and the Russia-Ukraine armed conflict have distorted the SC

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[10]. In this regard, recent research documents the logistical incapacity of small industries in emerging countries to address disruptive threats in the SC [3], [11], [12].

Risk management can be oriented to strengthen the resilience and response capacity of SCs based on quantitative models [13], [14], and to assess the risk of interruption in the face of disruptive events [10], [15]. In this field of study, [16] highlights that the deterministic models used to evaluate the resilience in the SC do not adequately represent the complexity of supply dynamics, because the analysis of these systems requires many factors to be taken into account simultaneously. The consideration of uncertainty and the consequent use of stochastic programming and fuzzy programming models subject to real-world uncertainty have increased to include the dynamics of firms [2], [16], [17]. Although mathematical modelling has proven to be useful to assess the resilience of the SC in the face of interruption risks, qualitative research is also required to complement risk assessment analysis [18]. With this goal, some research trends report the use of hybrid techniques combining mathematical models with meta-heuristics that include qualitative aspects [12], [16], [19].

Although some studies [20]–[22] address quantitative methods to assess resilience in SCs, these studies have been proposed in industrial sectors and in the context of manufactured goods, and their adaptation to micro, small, and medium-sized enterprises (SMEs) in the agro-industrial sector is complex due to the nature of supply in the agricultural field, and to the uncertainty inherent in agro-industrial dynamics [23], [24]. Changes associated with technologies and people, including changing food demand, volatile input and product prices, administrative regulation, and climate change, among others, frequently cause disruptions [25] in agro-industrial supply chains.

This Scope Review identifies articles from 2013–2023 related to risk management that assess resilience in Agroindustrial-SC. The objective of this research was to identify the quantitative methods and strategies used in the assessment of resilience in the Agroindustrial-SC. These results are especially useful for the design of resilient infrastructure systems in the Agroindustrial-SC.

MATERIALS AND METHODS

This Scoping Review uses the updated guide for the publication of PRISMA 2020 reviews [26] to identify the quantitative methods and strategies used to measure the resilience of the Agroindustrial-SC to disruptive risks. The research questions in this Scope Review were: What risks and strategies have commonly been reported in the literature that impact the Agroindustrial-SC? And what methods have been used to measure resilience in the Agroindustrial-SC? The literature search was limited to the period January 2013–February 2023, pre-post COVID-19 pandemic with relevance in the Agroindustrial-SC for Latin America and the US. In the second order of interest, for the same study period, articles were searched in the community from Europe, Asia, Oceania, and Africa. The documents included in this Scope Review were review articles, research articles, degree theses (master's and doctorate), conference articles. Books, encyclopedias, book chapters, conference abstracts, editorials, introductions, collections, and short communications were excluded. The consultation was carried out from October 2022 to February 2023 through Google Scholar, ScienceDirect Scopus, SpringerLink and Taylor & Francis. The search equations entered into the databases used the combination of keywords in English and Spanish described in Table 1. With these keywords from each of the databases, 1624 documents were initially collected. The collected articles were exported to Mendeley Desktop® for duplication review. The review process was supervised and verified by all the authors of this article. Figure 1 describes the selection of literature based on the PRISMA 2020 methodology guidelines and the established search criteria.

Finally, the database concentrated in Mendeley Desktop® was exported in RIS (Research Information Systems) format to Vosviewer® to identify research trends and the relationship between research topics, as well as to identify the field of study of greatest interest to researchers in the period January 2013–February 2023. Bibliometric maps were made based on the co-occurrence of terms in the titles and abstracts of the documents included in the Scope Review to include the metadata of 97% of the documents. The analysis considers a minimum of 3 occurrences per term.

Table 1. Search strategy 2013–2023

Search strategy	Database			
	Google Scholar †	Science Direct Scopus ††	Springer Link †††	Taylor & Francis †††
Resilience metrics and agribusiness and supply chain and risk management	32	81	51	43
Mathematical model and assessment and resilience and agribusiness and supply chain	212	40	14	10
Resilience measurement and agribusiness and supply chain and risk management	29	93	56	244
Resilience indicators and agribusiness and supply chain	45	204	126	296
Mathematical model and resilience and supply chain and agribusiness	19	0	0	0
Resilience metrics and supply chain	8	0	0	0
Indicators of resilience and supply chain	21	0	0	0
Subtotal	*366*	*418*	*247*	*593*
			Total	**1624**

† The search uses "…" for each word, e.g. "Resilience metrics" and "supply chain"
†† The search uses (…) for word chaining, e.g. (Resilience metrics) and (supply chain)
††† The search does not have any restrictions for each word
Source: own work.

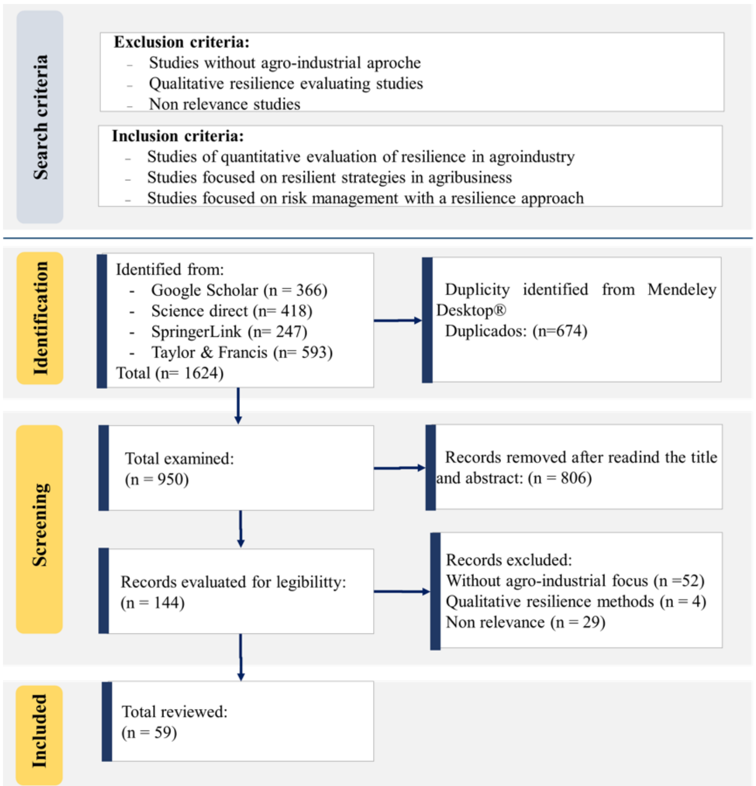

Fig. 1. Selection of literature based on PRISMA [26].

RESULTS

Figure 2 highlights that studies of resilience in Agroindustrial-SC have focused on food systems [27], the supply of perishable products, [18] adaptability in farming systems [28], and metrics and mathematical programming models to measure resilience [29]. These studies have been used in research fields related to agriculture, the food industry, climate change, and recent events related to the impact of COVID-19 on Agroindustrial-SC.

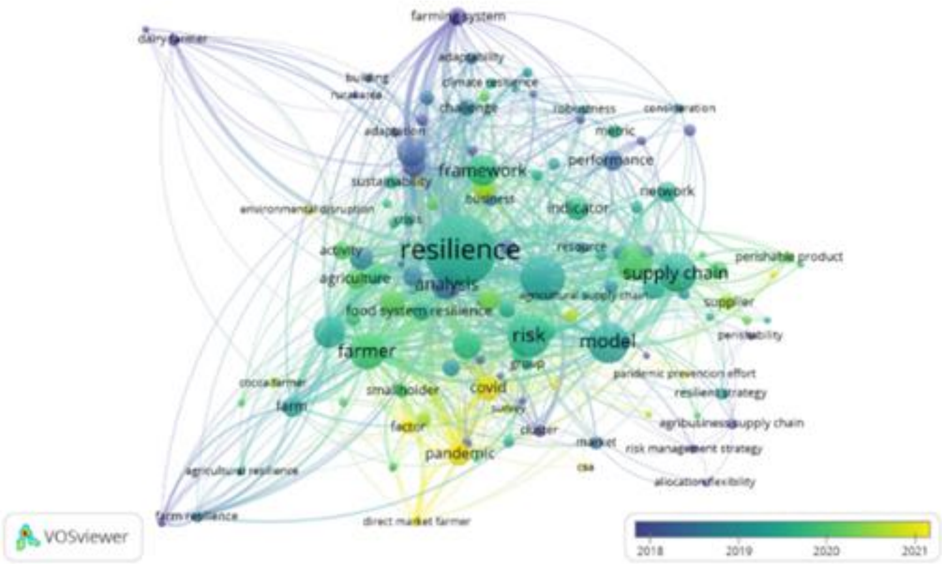

Fig. 2. Co-occurrence of research on resilience studies in agroindustry.

Although the study period extends from January 2013 to February 2023, the literature found on resilience in Agroindustrial-SC was mainly concentrated in the period 2018–2021. The interest of the scientific community in studies of resilience in agro-industrial systems has promoted studies of risk management and strategies for the creation of resilient systems [30], [31]. In this context, some studies focusing on risk management in the Agroindustrial-SC measure resilience to assess the ability to react effectively and quickly to the impact of disruptive events internal or external to the Agroindustrial-SC. The studies reported in this research period model the resilience of the Agroindustrial-SC through evaluation frameworks designed based on components of absorption, adaptation, and recovery (transformation) capacity, and through mathematical models and heuristics that incorporate qualitative elements and statistical analysis to model the interruptions that are potential sources of risk in the Agroindustrial-SC. In this sense, the documents analyzed in this study show that resilience and risk management in Agroindustrial-SC are addressed jointly to reduce the impact of risks that may arise in Agroindustrial-SC. Figure 3 shows the number of documents generated throughout the period 2014–2023. Although this review considers the period January 2013–February 2023, in 2013 no document was found that met the parameters and inclusion criteria established for this research.

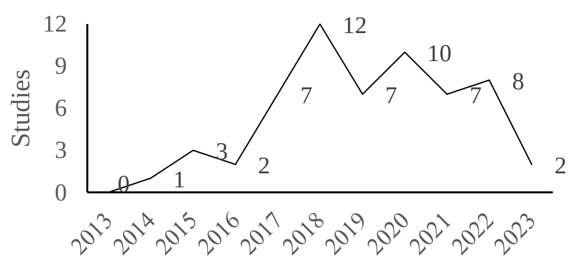

Fig. 3. Evolution of resilience studies between January 2013–February 2023.

In the 2013–2019 pre-pandemic period, studies assessed resilience in agro-industrial systems focused on climatic, biological, economic, production, distribution, and supply and demand disruption risks. During and after the COVID-19 pandemic, research focused on studying resilience to climatic and economic events. From this period, it is observed that 25% of the studies were aimed at evaluating the impacts caused by the COVID-19 pandemic in the Agroindustrial-SC to assess resilience and establish resilient strategies. Although the COVID-19 pandemic promoted the study of resilience, these studies have a greater presence in supply chains of goods, the health sector, and electronic commerce. Figure 4 shows the origin of studies on resilience in Agroindustrial-SC, by publication and by origin of the author. It demonstrates that most of this research has been published in European journals within the first second and third quartiles. Table 2 describes the objectives of the research and shows that work in Latin America has been focused on assessment while studies in other countries have preferred quantitative tools. Table 3 describes the journals that published the studies in this Scoping Review. The researchers do not have any Journal preference.

Country of Publication	
North America	
Country	**Quantity**
United States	10
Latin America	
Colombia	1
Ecuador	1
Mexico	1
Dominican Republic	1
Europa	
United Kingdom	20
Netherlands	12
Switzerland	4
Germany	2
Asia	
Iran	2
India	2
Malaysia	1
Africa	
Ethiopia	1
Zimbabwe	1
Total	**59**

Author's country of origin	
North America	
Country	**Quantity**
United States	8
Canada	1
Puerto Rico	1
Latin America	
Colombia	2
Brazil	1
Ecuador	1
Jamaica	1
Mexico	1
Peru	1
Asia	
China	5
India	4
Iran	3
United Arab Emirates	1
Indonesia	1
Malaysia	1
Europa	
Netherlands	3
Italy	3
United Kingdom	2
Austria	1
Spain	1
Finland	1
Lithuania	1
Russia	1
Switzerland	1
Oceania	
New Zealand	7
Australia	1
Africa	
Egypt	1
Ethiopia	1
Ghana	1
Kenya	1
Zimbabwe	1
Total	**59**

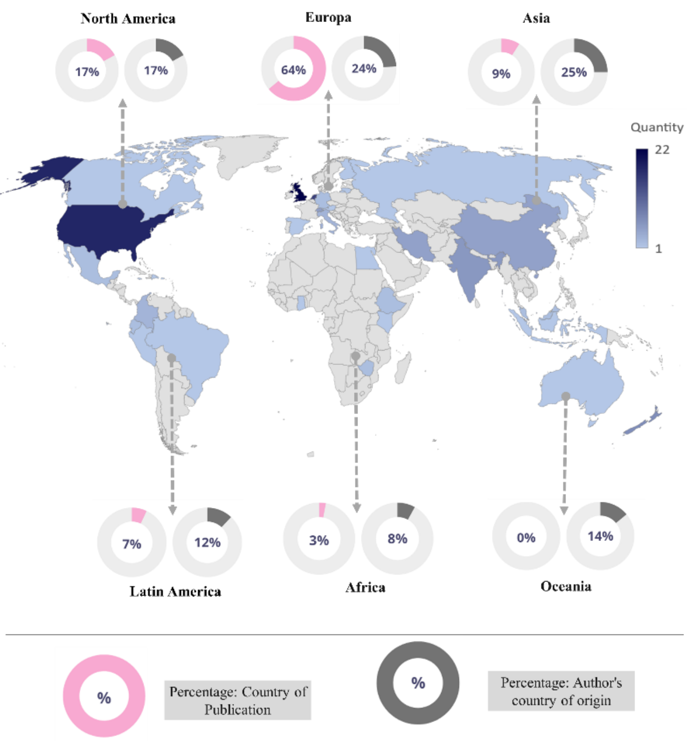

Fig. 4. Geographical distribution of studies on risk management that measure resilience in the Agroindustrial-SC.

In the period 2013–2023, disruptions in the Agroindustrial-SC originated from external risks: environmental, biological, social, financial or legal [5], [28], [30], [32]–[42]. Internal risks, such as supply and demand risk, created both upstream and downstream disruptions in the enterprise [22], [23], [43]. Logistics risks caused downstream disruptions in distribution centers and in supply transportation [29], [44]–[46]. Finally, the interruption of operations in companies was reported due to causes attributable to the production system itself [6]. In this context, Figure 5 describes the internal and external risks reported in the literature from January 2013 to February 2023 in the Agroindustrial-SC.

Table 2. Contribution to the literature on resilience studies in Agroindustrial-SC

Country(s)	Themes	Research objective
Colombia, Brazil Ecuador, Jamaica, Mexico, Peru.	Risk analysis and design of tools to assess agro-industrial resilience capacity.	Resilience assessment
USA	Risk management and resilience in agribusiness against natural disasters and climate change, analysis of resilience in food systems, risk management due to economic crises and the COVID-19 pandemic in crops through evaluation frameworks, quantitative methods, and scenario simulation.	Resilience evaluation and construction of resilient systems supported by mathematical programming and statistical methods.
China, India, Iran, United Arab Emirates, Indonesia, Malaysia.	Analysis of the resilience of food systems to climate risk and COVID-19, risk management in agriculture, and risk management in the dairy industry.	Resilience evaluation and construction of resilient systems supported by mathematical programming and statistical methods.
Germany, Netherlands, Switzerland, UK, and others.	Risk analysis and management for economic risks, climate change, COVID-19. Analysis of resilience in agriculture.	Resilience evaluation and construction of resilient systems supported by quantitative methods.
New Zealand, Australia.	Management of environmental risks, demand and supply in agricultural SC, and livestock SC.	Resilience evaluation and construction of resilient systems supported by mathematical programming and statistical methods.
Egypt, Ethiopia, Ghana, Kenya, Zimbabwe.	Analysis of the resilience of food systems.	Resilience evaluation supported by statistical methods.

Table 3. Journals Q1, Q2, Q3. January 2013 – February 2023

	Q1					Q2	Q3
Journals	IJPE	Prev Vet Med.	Agric. Food Security.	Food Security.	Clim. Risk Manager.	Sustainability	J. Risk Finance. Mgr.
	J. Clean. Prod.	Agricultural Human Values	Supply Chain Manager. J.	Land Use Policy	Environ. Res. Lett.	J. Food Qual	Cogent Economics Finance
	Globe. Food Sec.	Int. J. Prod. Res.	World Development	Int. J. Logist. Res. Appl.	J. Sci. Food Agric.	Reg. Environ. Change	
	CAIE	Omega	PPP	PLOS One	Environ. Syst. and Decisions	Strategic Change	
	Agric. Systems	Sci. Total Environ.	Eur. J. Oper. Beef.	Technol. Soc.	ECHO Ind.	IJMOM	
						Sci.World J	

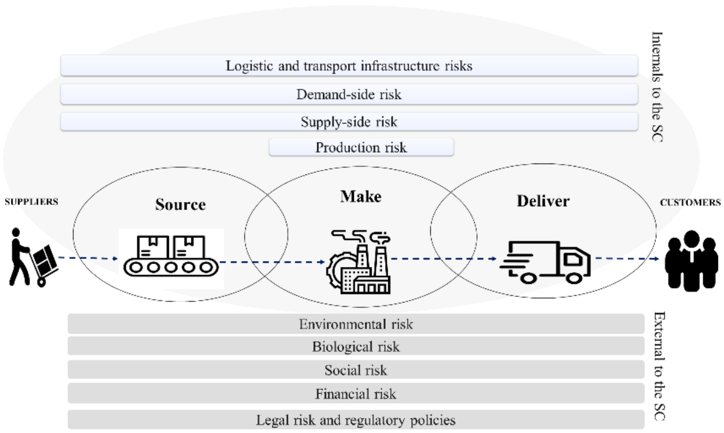

Fig. 5. Internal and external risks to the agro-industrial supply chain.

Risk management in the Agroindustrial-SC has received more attention from the scientific community due to the highly changeable and demanding economic environment, which increases the vulnerability of companies to disruptive events [13], [23] and the need to implement actions that protect their operations [47], [48]. The literature reports resilience assessment methods in Agroindustrial-SC to measure resilience and define strategies that ensure the sustainability of systems [13].

In this regard, Tables 4.1 to 4.6 describe for Latin America, as well as for other regions, the quantitative methods used in the study period to assess resilience and for the design of resilient SCs in Agroindustrial-SC. In these studies, the use of stochastic programming equations and models is common, as is the use of deterministic models to measure resilience. Multi-objective optimization and statistical models were frequently used, and evaluation frameworks that measured the absorption, adaptation, and recovery capacity of the agro-industrial company were used less often. However, although studies from Colombia, Brazil, Ecuador, Jamaica, Mexico, and Peru have contributed to the literature on resilience studies in Agroindustrial-SC, this scoping review reveals that only studies from Peru and Ecuador have proposed a mathematical approach to assess resilience.

Table 5 concentrates on the strategies reported in the scientific literature from January 2013 to February 2023 to prevent or mitigate the impact of risks in Agroindustrial-SC. These strategies address the use of quantitative methods that assess resilience in the SC to estimate the ability of an SC to recover and continue to function normally in the face of potential disruption risks.

Table 4.1 Quantitative studies to evaluate resilience in the Agroindustrial-SC of Latin America

Country	Method	SC echelon	Author
Peru	Heuristic that defines and weighs indicators to evaluate the speed of response and the organizational culture in terms of resilience in agro-industrial companies.	Production	[49]
Ecuador	Assessment framework for community resilience against COVID-19 of cocoa farmers through Base Resilience Indicators for Communities (BRIC) under 6 dimensions, from social to environmental. The data is processed in RStudio ®, SPSS25® and Excel®.	Production	[50]

Table 4.2 Quantitative studies to evaluate the resilience or design of Agroindustrial-SC in the US

Method	SC echelon	Author
Evaluation of the resilience of agricultural farms in the face of economic crises through an equation that considers the level of performance before the impact, the minimum level of performance after the impact, and the level of performance after recovery. In addition, a "fractional logit" model was proposed that incorporates variables for three capacities: damping, adaptation, and transformation.	Production	[33]
Redesign of a food-resilient SC. The model uses multi-objective deterministic optimization that minimizes the total cost of the SC and maximizes its connectivity.	Distribution	[51]
Statistical complex network framework to assess the relationship between efficiency and resilience analyzes resilience to the impact of risk and targeted attack on trading nodes; the study demonstrated that the efficiency of the global food web is directly proportional to the resilience of disruptive events.	Distribution	[27]
Logistic regression model to understand factors associated with farmer resilience during the first year of the COVID-19 pandemic. The information collection was carried out through surveys and the data analysis was carried out in Rsoftware® (version 4.0.3).	Distribution	[36]

Table 4.3 Quantitative studies to assess the resilience or design of Agroindustrial-SC in Asia

Country	Method	SC echelon	Author
India	Deterministic model to quantify the resilience of the SC using graph theory. This method collects information from the literature and surveys to identify the enablers of SC resilience and their interrelationships and then develop an interdependence matrix that calculates the SC resilience index.	Supply-Production-Distribution	[52]
	Design of a resilient SC of perishable products of the dairy industry under conditions of demand, supply and interruptions in transport and facilities. The two-stage stochastic scheduling model optimizes start-up costs and determines the optimal distribution flow.	Supply-Production-Distribution	[45]
	Framework to quantify the vulnerability and resilience of small farmers to adapt and respond to climate risk (drought). The equation for both contemplates the productivity index and the crop income index.	Production	[28]
Indonesia	Evaluation of the resilience of the plantations of small farmers in the face of social, environmental, and economic dynamics. Data were collected through Likert scale surveys, and resilience was quantified in binary through an equation that weights each capacity dimension (adaptability, recoverability, anticipation, and innovation).	Production	[53]
Iran	Design of a resilient Agroindustrial-SC based on a two-stage stochastic model that maximizes the expected benefit, selects resilient risk mitigation strategies, and makes an optimal decision considering disruption scenarios in suppliers and distribution centers.	Supply-Production-Distribution	[29]
	Design of resilient green closed-loop SC of perishable dairy products in the face of the risk of interruption of the electrical network. The model uses bi-objective mixed integer linear programming that minimizes the cost and carbon dioxide emissions of the utility grid and the power system grid.	Supply-Production-Distribution	[46]

Table 4.4 Quantitative studies to assess Agroindustrial-SC resilience in Europe

Country	Method	SC echelon	Author
Russia	Algorithm to assess the economic resilience of agricultural companies in the face of external shocks. Historical data from financial statements are used and resilience is calculated using an equation that considers the income per year of the companies. Subsequently, the resilience is correlated with profitability factors of business volume, debt, territorial affiliation, type of property, and legal form to analyze interrelationships.	Production	[54]
Austria	The economic resilience capacity in agriculture is assessed by individually calculating the value of financial flexibility, stability in following the path of development, diversification of activities and diversification of export markets. The total sum of the indicators makes it possible to obtain the resilience index for each year.	Production	[55]
Italy	An agent-based model of a generic food chain network of producers, traders, and consumers; the resilience and efficiency of the network are quantified using adapted mathematical equations that consider the flow of information.	Supply-Production-Distribution	[56]

Table 4.5 Quantitative studies to assess resilience or design Agroindustrial-SCs in Oceania: New Zealand

Method	SC echelon	Author
Measurement of the buffer capacity of milk-producing farms through liquidity (latitude), efficiency (resistance) and solvency (precariousness), which are subdivided into indicators. Principal Component Analysis (PCA) was applied to identify and rank the most relevant key performance indicators. The results of this analysis made it possible to calculate the resilience index through a mathematical equation.	Production	[18]
The two-stage stochastic programming model for the SC of Kiwis integrates an exponential expiration function. The model maximizes expected profit by selecting optimal risk management strategies and making tactical sourcing, inventory, distribution, and sales decisions; it also considers two supply-side disruption scenarios.	Supply-Production-Distribution	[23]
The two-stage stochastic programming model for the design of a resilient SC for perishable products under the risk of interruption due to port closures. The model maximizes the expected profit and the level of recovery while minimizing the loss of profit.	Supply-Production-Distribution	[44]

Table 4.6 Quantitative Methods to assess resilience in Agroindustrial systems in Africa

Country	Method	SC echelon	Author
Ethiopia	Equation involving risk, practices and resources used by dairy farmers. The score represents the capacity for adsorption, adaptation, and transformation as resilience factors. Data is captured in Microsoft® Excel® 2010 and plotted on a radar chart. Statistical analysis is performed in STATA® version 12 software to measure the difference in resilience levels between types of dairy farmers.	Production	[57]

Table 5. Risks and resilient strategies reported in the literature January 2013–February 2023

Risk	Strategies	Articles
Environmental	• Decentralized structure. • A wider range of national and local connections. • Diversity of suppliers and customers. • Multiple crops. • Agroecological production methods. • Flexible modes of delivery and food sourcing. • Local integration. • Establishment of relations between producers and consumers. • Creative communication solutions. • Promotion of investment and public-private partnerships. • Quality and operations management. • Connectivity of information networks. • Best agricultural and livestock Practices.	[28], [32], [34], [37], [40], [41], [53], [58]–[60]
Biological	• Solidarity between the actors. • Fostering public-private partnerships. • Network cohesion. • Management of access to professional education. • Collaboration and coordination. • Facilitation of access to financial resources. • Technological innovation.	[57], [61]
Social	• Public-private collaboration. • Production diversification. • Supplier diversification. • Production of organic fertilizers. • Technological innovation and digitization efforts. • Ease of acquisition/rental of land for young farmers. • Regulatory and institutional support for farmers. • Plan demand, production, inventory, operations, and quality control.	[31], [38], [62]–[64]
Financial	• Integrating processes. • Increasing the scale of production and its profitability. • Export diversification. • Production diversification. • Increasing production volume. • Reducing dependence on equipment imports. • Improving the quality of business management. • Facilitating access to financial resources.	[54], [55]
Legal and regulatory policies	• Implementation of regulatory standards. • Social responsibility.	[60]
Demand and Supply, Logistics, and transport infrastructure	• Diversified demand (sell to more markets). • Support of demand market (for contingency). • Flexible redirection (re-routing). • Backup supply. • High-tech production systems. • Multiple providers. • Scenario modelling.	[23], [29], [45], [46]

It can be seen in Table 5 that 14% of the strategies reported in the review period relate to the agricultural field; 6% to supply; 10% to sourcing strategies; 6% to strategies for access to financial resources; 34% to overcoming operational, production and quality management risks; 10% to the distribution of merchandise; 6% to information and communication flow strategies; 6% to strategies to diversify the market and customers; and 8% to strategies to reduce risks through national and international collaboration. These strategies focus on improving the performance of the agricultural field, diversification of processes, distribution mechanisms, and strategies to anticipate demand.

The strategies of the companies for the management of resilience in the SC (although they address various dimensions; see Table 5) can be classified into two main categories, reactive or proactive, depending on whether the orientation is prevention or risk mitigation [9].

DISCUSSION

Risks are inherent to any dynamic system, and these can occur throughout the SC and involve different economic actors [65]. Two main categories of risks are identified: internal and external, related to demand, supply, transportation, environmental, biological, social, and financial risks [28], [30], [36]–[38], [41], [42]. In Latin America, heuristic tools and evaluation frameworks have made it possible to evaluate the resilience capacity of agro-industrial systems in the face of various risks, such as natural disasters, shortages, strikes, terrorist attacks, unforeseen demand, transport service failures, illegal activities, technological failures, financial failures and, recently, COVID-19 [49], [50]. In the US, the use of quantitative methods with a statistical approach to assess the resilience of agricultural systems in the face of economic risk factors and the COVID-19 pandemic stands out, to which are added multi-objective deterministic optimization models for the design of resilient [27], [33], [36] SC in food companies [51]. Similarly, in Asia, deterministic models are proposed to design resilient networks or to evaluate the resilience of the SC [46], [52]. However, the dynamic nature of the SC, together with factors typical of agro-industrial systems, such as long delivery times, seasonality, and expiration, encourages countries in Asia and Oceania to implement stochastic programming models that integrate uncertainty into the design and simulation of SCs that are resilient to supply and demand risks [23], [29], [44], [45]. Equations that are complemented with statistical methods are also used to assess the resilience of food systems in Africa, Asia, Europe and Oceania in the face of social and environmental disruptions and economic dynamics [18], [53], [54]. Although the literature reports quantitative methods to assess resilience to various risks, qualitative assessment frameworks [35], [42], [66], [67] and simulation of disruption scenarios [38], [58] complement the resilience analysis. Cost of implementation is a pressing issue in agro-industrial supply chains [9] and a topic that must be considered in the context of socio-environmental impacts, where qualitative methodologies could become more relevant.

CONCLUSIONS

In the study period of this research, there were a number of studies on resilience in SCs, although Agroindustrial-SCs were not the focus of most works. In the study of resilience, industrialized countries stand out for their consideration of the strategic relevance of SCs in economic activity. Resilience has been studied mainly to evaluate alterations in the supply of perishable products in the Agroindustrial-SC and to establish response or mitigation strategies to financial events, among which stand out multiple crops, agroecological production methods, flexible modes of delivery and supply of food, local integration, and the establishment of relationships between producers and consumers, although in recent years sustainability strategies have been incorporated.

During the study period, environmental, biological, social, financial, and legal risks, as well as uncertainty in supply and demand, were critical factors in the generation of interruptions in Agroindustrial-SC. In response to these challenges, exacerbated by increasing economic volatility and business vulnerability in emerging economies, the scientific community promoted approaches based on mathematical methods, equations, and stochastic and deterministic programming models to quantify and improve resilience. Resilience studies have focused on evaluating and measuring the impact of disruptions, and since 2013, they have also addressed the design of strategies for their prevention and mitigation, seeking the sustainability of companies.

Although the adoption of improved mathematical methods for the evaluation and improvement of resilience will be essential to ensure the adaptability and long-term sustainability of supply chains in an increasingly challenging context, the importance of qualitative research is also recognized, as it can provide a better understanding of risks, although the adaptation of models or strategies from the goods industry to micro, small and medium-sized companies in the agro-industrial sector is a challenge. However, in general, this research highlights the need to comprehensively address the risks in the logistics processes of the Agroindustrial-SC and improve the synchronization between its economic agents to ensure its sustainability and adaptability.

Agroindustrial-SC resilience strategies emphasize the environmental, social, and logistical dimensions. Legal and regulatory policies have rarely been explored. Complexity studies will gain relevance in the future because of the need to understand the relationships within the dimensions of resilience. On the other hand, qualitative studies could improve the reliability of complex models and facilitate stakeholders' visions.

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