

Agribusiness Searching for a Future

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The challenges facing the agri-food sector are many as are the responses to these challenges. Pandemics and wars that test supply chains, regulatory pressures that push towards sustainability and lenders interested in soil health, investors who betting on emerging technologies and others backing away; collaboration emerges as a central element for agri-food supply chains.

All the Ingredients of Supply Chain Resilience

by Marianna Lo Zoppo, Biagio Maria Amico*



The agri-food system is also permeated by the concept of resilience. If the components of the supply chain are resilient, the entire system will benefit. The characteristics of a resilient supply chain depend in part on strategic choices and in part on tactical decisions. Sustainability of the entire sector is the most important and tangible characteristic, as the transition to sustainable production processes implies the involvement of all components of a process of resilience, namely flexibility, change, and adaptability.

In the last ten years, we have heard a lot about resilience. The best-known use of this term is undoubtedly traceable to a well-known acronym, which is PNRR (National Recovery and Resilience Plan), the programmatic document developed by Italy to obtain the funding made available by the European Union under the Recovery Fund. We see this term appearing in event titles, conferences, and television programs when discussing virtuous objectives and goals that our businesses must and can aspire to. But what does it actually mean to be resilient, and how can a company or a supply chain achieve this? In physics, even before being considered an adjective in management manuals, the term was used to describe a property of some materials, which is the ability to withstand impacts without breaking. In ecology, resilience is defined as “the speed at which an ecological system returns to its

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initial state after being subjected to a disturbance that has moved it away from that state” (Trecani, 2020). In management, without straying far from these definitions applicable to other sectors, resilience represents the capacity of an organization or a supply chain to reduce the likelihood of facing sudden crises, to withstand the spread of such crises while maintaining adequate control over structure and functions, and to respond promptly with reactive and effective plans to overcome the disruption and restore the supply chain to a state of solid and reliable operation (Kamalahmadi and Parast, 2016). To this initial description of resilience, some wise individuals added: “within an acceptable timeframe and cost” (Ribeiro and Barbosa-Poiva, 2018) because, upon closer examination, a company has finite resources, and getting activity back on track on time and while limiting economic and reputational damage appears essential for its survival.

The reasons why so much attention to the topic of resilience has only started now can be easily explained. On the one hand, the Covid-19 pandemic caused delays in the delivery of essential goods, supply chain disruptions, demand volatility, substantial increases in raw material prices, and disruptions of processes due to staff shortages. These shocks simultaneously involved agricultural companies, industry, shippers, and logistics, but with different impacts depending on the actor and the scope of activity involved. For example, sectors highly dependent on external services, such as viticulture and floriculture, suffered significant financial losses. In contrast, for sectors whose products are highly perishable and non-storable (such as the fruit and vegetable sector), more than an economic problem, the slowdown in agricultural production activity generated serious forms of food waste related to the failure to use edible products for food purposes, as they remained unharvested and/or unsold. On the other hand, the Russia-Ukraine conflict, involving two countries that produce 30 percent of the world’s traded wheat and 12 percent of global calories (Byjoel, 2022), has significantly influenced the balance of international trade flows and agricultural product markets, leading to further price increases and undermining the food security of many countries that are net importers of agricultural products. In particular, the war has halted exports of wheat, corn, and barley, as well as a large portion of global fertilizer supplies, resulting in what the head of the World Food Programme recently referred to as the worst global food crisis since World War II. These events, born out of geopolitical tensions and globalized markets, have highlighted the need to rethink supply chains. The interdependence of nations in the production and distribution of products (both agricultural and non-agricultural) makes resilience

strategies and international cooperation crucial to ensuring food security and stabilizing global markets. So, while in recent decades we have seen globalization as a great opportunity to maximize business efficiency and developing countries as ideal places to relocate production, taking advantage of lower labor and raw material costs, the aforementioned crises have suddenly revealed the other side of the coin of these benefits. Complex global supply chains, composed of many critical nodes located in different parts of the world, bring with them high risks in the event of unexpected systemic events, often referred to as “disruptions.” And it is precisely “disruption” that most frequently accompanies the word “resilience,” and describes events that have such an impact as to block, at least in part, the activities at the heart of value creation, with consequences that traditional operational risks cannot cause.

Due to its intrinsic characteristics and the challenges it faces, the agribusiness sector represents a crucial field of study for the theme of supply chain resilience. Indeed, agribusiness is a fundamental sector for ensuring food security for the population. Food is an essential and vital good for people’s survival, and during catastrophic events, such as natural disasters or pandemics, it is of vital importance to ensure the continuous production and distribution of food and other primary goods produced by this sector to meet the needs of individual countries and communities. Secondly, agriculture (and consequently the entire agri-food supply chain) is highly susceptible to the influence of external variables, including extreme weather events, climate change, plant or animal diseases, and unpredictable natural phenomena. Such factors can have significant impacts on all phases of the agri-food supply chain, from agricultural production to processing, from distribution to marketing of products. Finally, as mentioned earlier, the recent events mentioned above, which we have all experienced directly, have further drawn attention to the sector, highlighting the need to rethink agricultural supply chains on multiple fronts, from technological innovation to choices regarding the number and location of suppliers, to ensure a stable supply of essential goods such as food, fiber, and energy.

THE STUDY CONDUCTED BY THE INVERNIZZI AGRI LAB

In order to explore the characteristics of resilient supply chains in the agribusiness sector, a systematic review of the literature was conducted with the ultimate goal of identifying the crises referred to when discussing resilience in agribusiness and extracting a list of properties of resilient supply chains in this sector. The study allowed for an in-depth examination of

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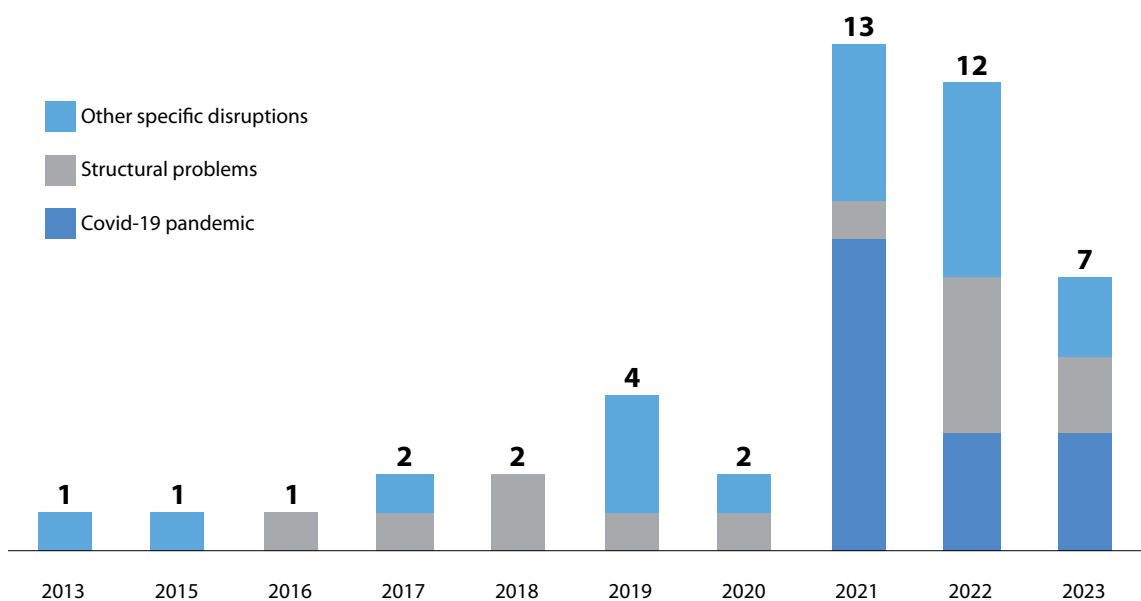
more than fifty publications on the subject, developed between 2013 and 2023. What emerged first and foremost is that the field of research on resilience in the agribusiness sector has generated increasing interest over the years. In 2021 alone, a number of works were published equal to those published in the previous seven years, demonstrating that the theme was strongly influenced by the pandemic crisis. However, with the increased attention to the subject, studies exploring the resilience of the agri-food supply chain concerning specific disruptions (such as the USA-China conflict) and structural issues in the sector (food safety and fraud, cold chain interruption, etc.) have also increased since 2021.

In particular, to categorize the crises investigated in the articles studied, we classified disruptions based on the risks they entail, adopting the classification developed by Leat et al. (2013), which distinguishes two categories of risks: (i) risks at the individual organization level, and (ii) risks at the supply chain level. In general, the risks identified for individual businesses (e.g., market volatility or institutional risks) have the potential to influence every actor within a supply chain. When one or more of these risks materialize, they have a collective impact on the entire supply chain, leading to the simultaneous or consecutive emergence of demand,

supply, control, and process risks at the supply chain level. For example, production risks faced by agricultural producers become a component of the procurement risk experienced by actors downstream in the food supply chain. Furthermore, it is worth specifying that environmental risks¹ exert a systemic influence, such that in most cases, events such as pandemics or wars typically affect all nodes of the supply network simultaneously. Finally, during the process of analysis and categorization of the literature, the need arose to create an additional category called “Structural Issues” to include all the structural problems and vulnerabilities characterizing the agribusiness sector, which have frequently been investigated in relation to the concept of resilience.

Regarding the actors and types of supply chains analyzed, the study does not focus on specific supply chains but tends to be more general and examines the entire agri-food sector without clear differentiations based on the area of production. Similarly, 78 percent of the studies consider multiple actors in the supply chain without limiting the analysis to individual links in the chain. This indicates that the research on supply chain resilience is primarily concerned with the interactions among supply chain actors, recognizing that the resilience of the system depends largely on the re-

FIGURE 1 | ANNUAL FREQUENCY AND BREAKDOWN BY TYPE OF DISRUPTION OF THE PUBLICATIONS ANALYZED



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relationships between the various parties involved. The attention to the interaction among supply chain actors reflects the importance of understanding the flows of information, materials, and resources along the entire production process, from production to consumption. This holistic approach allows for the identification of challenges and opportunities that arise at the systemic level and the identification of the best strategies to create supply chains capable of absorbing unexpected crises and returning to a new normalcy afterwards.

THE PROPERTIES OF RESILIENT SUPPLY CHAINS

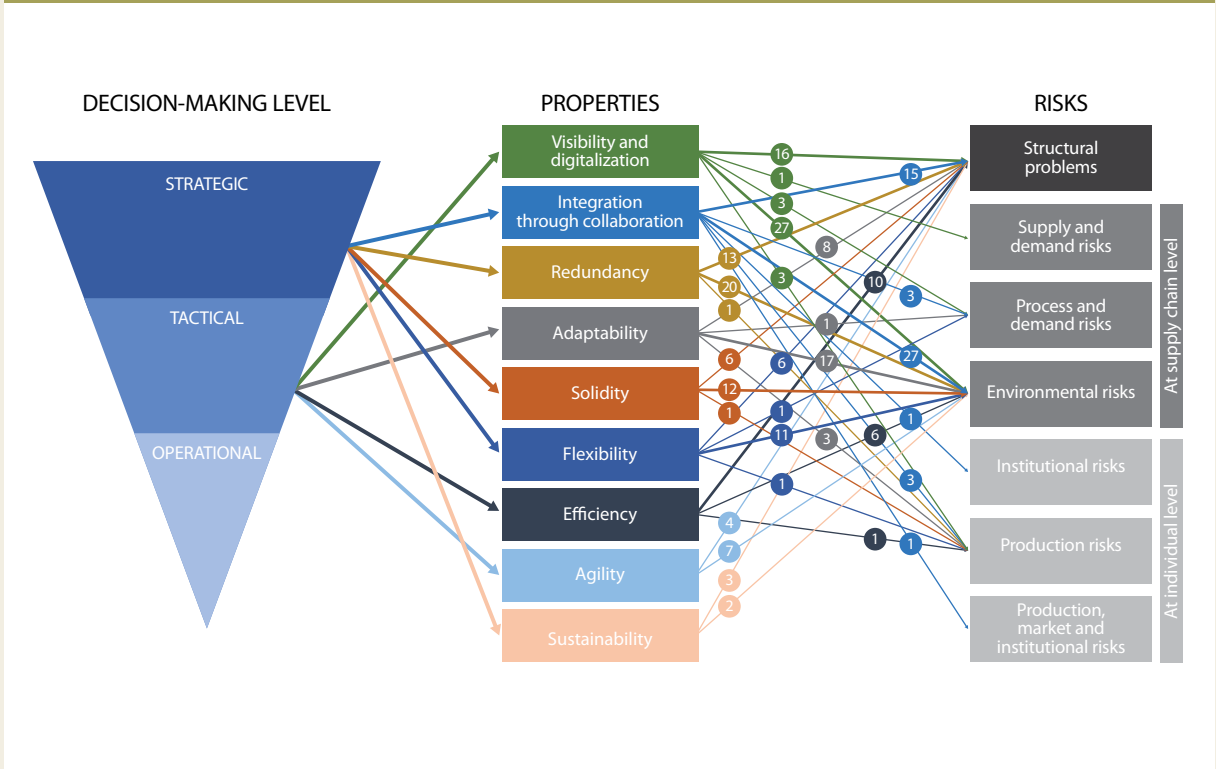
As previously mentioned, as organizations become more complex, the risks to which they are exposed tend to increase. However, it is precisely through understanding vulnerabilities that resilience can be nurtured and specific capabilities can be developed to cope with crises, whether more or less unexpected.

The analysis of literature dedicated to these topics had a dual objective: on one hand, to identify the specific capabilities that characterize resilient supply chains and identify them as a result of strategic, tactical, and operational choices made within Supply Chain Management (SCM);² on the other hand, to investigate which characteristics (or properties) of supply chains are most useful in the presence of a particular type

of crisis. Indeed, while Covid-19, due to its complexity and scope, generated shocks from all standpoints (supply, processes, demand volatility), there are crises (such as an earthquake or a flood) that may only impact the supplies of a supply chain. In the image below, you can see the relationship between strategic, tactical, and operational choices made within SCM (on the left), the properties of resilient supply chains identified through the review of the literature in the sector (in the center), and the risks with which these properties are most associated (on the right). The thickness of the arrows indicates the number of results that emerged in the review of the literature, with thicker arrows indicating a relationship mentioned multiple times in the papers under study.

Looking at this image, it is easy to notice that the fundamental decisions to create resilient supply chains are primarily of a strategic and tactical nature. Furthermore, the analysis of the literature has revealed that certain decision-making levels have a greater impact on the activation of specific properties associated with supply chains capable of preventing, resisting, and adapting to unexpected crises. In particular, collaboration, redundancy, robustness, and flexibility are predominantly influenced by strategic decisions, while visibility and digitalization, adaptability, efficiency, agility, and sustainability are most useful in the presence of a particular type

FIGURE 2 | RELATIONSHIP BETWEEN DECISION-MAKING LEVELS OF SCM, PROPERTIES OF RESILIENT SUPPLY CHAINS, AND THE RISKS ASSOCIATED WITH THOSE PROPERTIES



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and agility are preliminarily enabled by decisions of a tactical nature. Strategic decisions that lead to greater flexibility and redundancy in supply chains include, for example, multiple suppliers located in different areas and subject to appropriate risk assessments (Al Naimi et al., 2022; Alikhani et al., 2021) and the presence of reserve production capacity (Munch et al., 2022). On the other hand, additional stock reserves, information sharing, the development and updating of emergency plans, and the decision to pay particular attention to the maintenance of critical assets are examples of tactical decisions associated with greater resilience in production supply chains.

The two properties of resilient supply chains mentioned the most in the literature on the agribusiness sector are collaboration-enabled integration and visibility. Collaboration, which can be both vertical and horizontal, implies the ability of organizations to work together effectively, sharing some of the risks and benefits of their activities, and responding quickly to supply chain disruptions by leveraging coordination, cooperation, and the sharing of information and decisions (Tukamuhabwa et al., 2015). Visibility, on the other hand, involves the ability to have a complete view of the supply chain and is essential for preventing and promptly stopping the spread of crises. The digital technologies available today are crucial for developing this property. In particular, the combination of artificial intelligence and Big Data analysis can improve the responsiveness of the supply chain, facilitate adequate decision-making based on data, allow for effectively assessing the risks from suppliers and their potential impact on processes, as well as support the identification of critical points and the re-planning of activities when necessary (Zamani et al., 2022).



If the characteristics mentioned above are related to the structure of supply chains, some elements mentioned in the literature that are positively associated with resilience are external to typical SCM choices. Among these, we find soft aspects related to corporate culture, such as human capital and the trust that binds the different links in the supply chain and their partners, as well as elements such as the industry in which the organization operates, its positioning and strategy, size, and age. It goes without saying that stronger companies, both financially and in terms of business and brand recognition, will be more resilient in the face of unexpected disruptive events.

THE RELATIONSHIP BETWEEN SPECIFIC RISKS AND SUPPLY CHAIN PROPERTIES

The complex, global, and dynamic nature of modern supply chains requires constant vigilance to identify vulnerabilities, as well as exceptional agility and flexibility in the event of shocks, to the point that sometimes resilience does not mean returning to a normal state of operations but changing processes to adapt to risks and changing external conditions.

From the analysis conducted, it emerges that crises related to environmental risks (including the recent pandemic) can be best addressed if the supply chain has sufficient visibility, integration, redundancy, adaptability, flexibility, and robustness. These characteristics, necessary for supply chains to prevent and survive unexpected events, are the same ones that the literature suggests are necessary to address the “structural problems” of the sector, i.e., the challenges that the agri-food system must face to grow sustainably and ensure global food security.³

This seemingly obvious result actually tells us something important. First of all, the concept of resilience goes hand in hand with sustainability because the transition to a more sustainable food system is also the path to make current agribusiness supply chains more resilient, with the word resilience meaning, among other things, the ability to survive in a changing and often challenging external environment. Secondly, to date, we now know that the recent pandemic, that was sudden and traumatic for businesses, has prompted a more radical reevaluation of supply chains than the one triggered by the structural challenges of the agribusiness sector, which although always present, did not have the same immediate resonance. It is therefore appropriate to ask why trends and the challenges they bring, even when alarming as in the case of climate change and its consequences, only partially drive management to prepare and make changes. Unfortunately, as happened in the case of the recent crises caused by the pandemic first and the

Russia-Ukraine conflict later, changes only begin after the real risks have become evident, and even more so, following the consequences of extreme and unexpected events. A rather well-known author, Nassim N. Taleb, in his book “The Black Swan,” had warned

us in advance about this (unhealthy) attitude, writing that “our world is dominated by the extreme, the unknown, and the very improbable ... and all the while we spend our time engaged in small talk, focusing on the known, and the repeated.”

- ¹ These include the external risks associated with social, political, economic, and technological events in the environment in which the supply chain must operate. Various sources contribute to environmental risk, including political instability, terrorism, war, epidemics, natural disasters, and economic recessions.
- ² Within Supply Chain Management (SCM), managerial decisions are distinguished into three fundamental levels of planning and action: 1) The strategic level deals with long-term decisions that establish the foundations of the supply chain; these decisions concern the optimal location of operational facilities, the choice of production technologies, and plant capacity. 2) The tactical level focuses on translating strategic directives into tangible operational plans; specific objectives are carefully defined here, priorities are established, and strategies are developed to achieve these objectives within the context of strategic decisions. 3) The operational level translates the directives coming from the tactical level into action. This level focuses on the practical implementation of tactical plans, requiring close coordination among various departments and the implementation of supporting systems and procedures.
- ³ The main challenges of the agri-food system are: a) improving agricultural productivity and reducing food waste; b) efficiently using natural resources and enhancing ecosystem services; c) ensuring food security and public health; and d) the equitable distribution of what is produced, in terms of volumes and calories, and the value produced, in economic terms. See Gatti, S., Chiarella, C., Fiorillo, V. (eds.), *Agriculture as an Alternative Investment: The Status Quo and Future Perspectives*, Springer, 2023, pp. 17-18.

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SYNOPSIS

- Studies on the resilience of agri-food supply chains tend to consider the entire chain, recognizing that the resilience of the system largely depends on interactions among the actors within the chain and the relationships they establish.
- Strategic and tactical decisions made within SCM are crucial in creating resilient supply chains. Among the capabilities that make supply chains resilient, it has been found that collaboration, redundancy, robustness, and flexibility are primarily influenced by strategic decisions, while visibility, adaptability, efficiency, and agility are preliminarily enabled by tactical decisions.
- Sustainability is closely linked to resilience in agribusiness supply chains. The transition to more sustainable food systems contributes to making agribusiness supply chains more resilient since resilience also involves the ability to survive and adapt to a changing and challenging environment.