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Reconfiguration of Agrifood Supply Chain Management in Latin America during COVID-19: A Brief Literature Review

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Abstract: This study aims to analyze the changes in the agrifood supply chain (AFSC) configurations in Latin America (LATAM) imposed by the markets as an effect of the COVID-19 pandemic. This paper analyzes the results of mobility trends, production rates, logistics performance, and the strategies developed by managers and decision makers of the organizations of the agro-industrial sector for supply chain configurations during the early stages of the pandemic in a food-exporting region that contributes 14% of the world's production of agricultural and fishery products. Through a literature review of reports and scientific articles on the behavior of the pandemic published by international organizations, research centers, and researchers around the AFSC in LATAM, the impacts on logistical disruptions, configuration strategies, and disruptive technologies applied in Latin American agrifood supply chains during the lockdown are identified. As a result of this reconfiguration of the AFSC, the development of short supply chains and the digitalization of supply based on electronic commerce were the most used strategies during COVID-19 in LATAM. The results of this study show that Mexico, Chile, and Brazil maintained a prominent position as leaders in the different logistics indicators for the AFSC by developing strategies that include short supply chains and the digitalization of supplies based on electronic commerce. Finally, this study also highlights the imminent need to address new research and theories on the reconfiguration of the AFSC, which allows expanding analytical capabilities in organizations to face future risks and challenges that will enable the reconfiguration of the supply chain in the face of catastrophic scenarios such as COVID-19.

Keywords: short supply chain; agro logistics; pandemic crisis; emerging markets; technology strategy; LATAM

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1. Introduction

The world of business and commerce has witnessed how the COVID-19 pandemic almost wholly stopped all supply chains worldwide. The need to radically and suddenly transform the forms of production and distribution forced companies to reconfigure their business processes, changing operating conditions on an unprecedented scale, locating resilience and supply chain (SC) configuration as a pressing need and focus of attention for analysis and research in organizations and academia [1–3]. Coupled with the pandemic, recent advances in information technology, the expansion of the internet, and the declining costs of disruptive technologies have fueled the rapid development of opportunities to implement new ways of creating, producing, and distributing value in configurations of SCs [4–6].

The configuration of the SC as a business strategy is recognized as a critical component to mitigate the joint impact of uncertainty in demand and supply caused by unexpected network interruptions [7,8]. The concept of reconfiguration has received considerable

attention at the strategic level of the company and in the literature on organizational structures. According to Chandra and Grabis [9], reconfiguration is a feature that gives SCs the flexibility to alter their configuration using few resources without losing their operational efficiency in response to changes in customer demand and the environment, including the application of new disruptive technologies in organizational systems.

The perspective for the management of the SC based on the concept of resilience, which includes the configuration of the supply and distribution network, has allowed organizations to face aspects of restrictions, shortages, or delays as a consequence of the drop in consumer demand [10]. At the international level, strategies were implemented to anticipate, adapt to, respond to, and recover from logistical interruptions for the administration of the SC. For example, the design of SCs based on nearshoring was one of the most used strategies to partially resume the operation of companies [11].

Strict confinement interrupted most logistics activities, affecting multiple economic sectors. The food production sector faced one of the most significant risks due to the inevitable shortage of inputs and labor, which augured a global food crisis [12,13]. In particular, food production is considered vital in agribusiness-based economies since numerous small and medium-sized enterprises (SMEs) depend on this sector [14].

In recent decades, the food supply and supply of the population worldwide have undergone substantial changes, either due to interruptions in the access and consumption of products in so-called short-circuit markets, as well as interruptions caused by the acquisition outside the production unit of ingredients needed in the different stages of food processing [15]. In addition, due to the importance it represents for humanity's development and food security, the agrifood supply chain (AFSC) is considered a strategic sector worldwide [16], which demands a profound reconfiguration of its SC as an effect of the environmental and social problems that originate from agricultural practices and food distribution [17].

The AFSC is a complex network that connects agricultural production systems, covering all aspects of production, packaging, distribution, and storage, from the farm and planting sites to food delivery to the final consumer [18,19]. The main challenge in the AFSC is to guarantee that food arrives in sufficient quantity and is safe and of quality for consumers, reducing the impact on the environment during production and distribution. According to the Food and Agriculture Organization (FAO), 135 million people worldwide suffered from acute food insecurity before the pandemic, complicated by the COVID-19 crisis [20].

Specifically, Latin America (LATAM), including the Caribbean, is considered a food-exporting region, responsible for 14% of the world's production of agricultural and fishery products [21]. Of the total population of LATAM, the rural population accounts for more than 30%, whose primary income comes from the production and commercialization of agrifood products, among which cereals stand out, as well as products such as coffee, sugar, and various fruits [22,23]. According to the FAO and the Economic Commission for Latin America and the Caribbean (ECLAC), before the pandemic's start, it was projected that by 2028, LATAM would double its contribution to production in the agrifood sector, growing by 28% to become the largest food exporting region in the world [24]. As a contribution to the gross domestic product in the countries in LATAM, agricultural and food systems are fundamental, generating jobs through the work of small producers and farmers since more than half of the food production in this region comes from small farms [24]. In April 2020, CEPAL [25] projections before COVID-19 indicated that LATAM, specifically Brazil, the Andean countries, and Mexico, would suffer their most significant economic contraction, calculated at least 5.3% in 2020. Given this pandemic scenario, ECLAC also projected that unemployment and poverty would worsen significantly in LATAM [25], figuring that the population in extreme poverty and with severe and persistent food insecurity would increase by 16 million to stand at 83.4 million people. Based on estimates from the FAO, before the pandemic, LATAM and the Caribbean have seen the number of people requiring food assistance almost triple [26], positioning small farmers as critical actors to

address these problems and challenges of food and nutritional insecurity that this region faces, while seeking to reduce the ecological impacts that production systems imply in the AFSC [27].

The AFSC in LATAM generally uses labor-intensive and relatively low-tech production systems, with some exceptions in countries where harvesters and irrigation technologies are intensified. Food production in this region also has a relative degree of specialization, where certain groups of producers or farmers are dedicated to producing a single or a small number of products, thereby reducing the diversity of consumption. This specialization of products contributes to the need to buy other foods in other markets; however, in the face of the pandemic, limitations arose not only for trade but also for operations within LATAM territories due to difficulties related to transport logistics [15]. Particularly for the supply and distribution of products, logistics supported by small producers have also been considered a critical factor in addressing the challenges of food and nutritional insecurity faced by different regions of LATAM.

In general, the transformation process in the food trade in response to adaptation to catastrophic events such as the COVID-19 pandemic has propelled the AFSC towards new trends in technologies, product logistics, and distribution [28]. De Lucas Ancillo et al. [29] also add that in LATAM, there are limited studies on the application of technologies for innovation and the competitiveness of SMEs, which also allows for identifying the factors that affect the reconfiguration of the different supply chains. Based on this background, this study aims to carry out a descriptive analysis of the changes that took place in the configurations of some AFSCs in LATAM as an effect of COVID-19. The contribution of this research involves offering an overview of business strategies developed in the food sector and agribusiness, as well as analyzing the reconfiguration and critical parameters for the continuity of operations in the SC in the face of a catastrophic scenario. Through the review of reports on the behavior of the pandemic published by the FAO, the Organization for Economic Cooperation and Development (OECD), the Latin American Center for Rural Development (RIMISP), the International Labour Organization (ILO), the World Bank, and the Inter-American Institute for Cooperation on Agriculture (IICA), among others, this study also analyzes some of the impacts, logistical interruptions, and disruptive technologies used during confinement.

The hypothesis for this work was that the reconfiguration in the structure of the AFSC based on factors such as disruptive technologies, logistics strategies, and production systems used by the countries in LATAM helped mitigate the impact on the production and consumption of food during the COVID-19 pandemic.

The rest of the paper is organized as follows. Section 2 presents a brief review of the literature on AFSC disruptions and the strategies implemented to reconfigure this SC in response to the pandemic. Section 3 describes the methodology used for this study. Section 4 describes the initial impacts of the AFSC in some countries, including LATAM. Section 5 analyzes the logistics strategies and disruptive technologies used in LATAM to mitigate the effects of the pandemic. Finally, in Section 6, the discussion and conclusions are given, briefly describing the challenges and future work around agrifood chains.

2. Theoretical Background

This section examines the existing literature on the reconfiguration of supply chains. It considers various strategies and theoretical approaches and provides examples of applications in agribusiness. It also discusses practical approaches such as those of Al Naimi et al. [2] and Chandra and Grabis [9].

2.1. Reconfiguration in Supply Chains

The concept of reconfiguration of the SC has been used as an approach to disruptions and changes in the market and is defined as the ability of the SC to change and modify its structure and functions, adapting to new changes [4]. In addition, reconfiguration implies the design of profitable, responsive, sustainable, and resistant networks based on data that

dynamically adapt in physical and cyber spaces [30]. Reconfiguration is a strategy that identifies an SC's flexibility and agility to change its production and operations systems in response to global market trends, new technologies, and fluctuating demand. Napoleone et al. [31] and Zidi et al. [4] indicate that among the factors to be considered in building adaptable and reconfigurable SCs, analysis from operational levels to strategic levels and design based on cost efficiency and sustainability are included. For the implementation of the reconfiguration, aspects such as (1) decision making at a strategic level for monitoring must be analyzed, as well as (2) the physical implementation that includes building, opening, and operating facilities for manufacturing and services, and (3) the logical implementation that includes the execution of business processes related to the configuration of the SC and the support requirements of information technologies [9].

According to Al Naimi et al. [2], analyzing SC reconfiguration allows us to understand whether investing in resilience can reduce organizations' costs and risks, providing a clear vision of the SCs' processes before and after environmental disturbances.

Al Naimi et al. [2] suggest that analyzing the reconfiguration of supply chains can help us understand whether investing in resilience can reduce organizational costs and risks. The reconfiguration approach in the SCs as an element of strategic management has been addressed in the literature from different perspectives of the organizations. In the extensive literature review proposed by Al Naimi et al. [2], it is pointed out that the mechanisms for sharing information, the location and relocation, the selection of suppliers, and the design of production and distribution networks are the main characteristics of the reconfiguration of the SC, and were proposed and analyzed by different authors before the pandemic (Table 1). Among the contributions on reconfiguration, Sasson and Johnson [32] present an approach based on the implementation of so-called Direct Digital Manufacturing (DDM) as a scenario to evaluate the possible reconfigurations of the SC qualitatively; other approaches, such as that of Dev et al. [33], propose the combination of push (decentralized) and pull (centralized) inventory systems for the reconfiguration of networks with the purpose of satisfying customer demand.

Table 1. Proposals for reconfiguration in the SC.

Author	Approach/Tool	SC Reconfiguration Characteristics	SC Decision-Making Phase
Sasson and Johnson [32]	DDM	Capacity planning, production-distribution network design	Strategy
Dev et al. [33]	Agent-based simulation and decision tree learning	SC structure	Strategy
Guo et al. [34]	Optimization model	Cost/budget	Planning
Tian and Guo [8]	Graph-based cost model	Capacity planning	Planning

Source: Own elaboration.

Other recent proposals include those of Guo et al. [34] and Tian and Guo [8], who propose a graphical method and an optimization model to characterize similarities in manufacturing business systems and model the cost of reconfiguring the SC.

Remarkably, in the agribusiness sector, the reconfiguration of SCs has been proposed using different scenarios (Table 2). Anastasiadis and Poole [35] explore some emerging practices for SC management in an organizational context and efficient collaboration between agrifood companies. Through a critical literature review, Berti and Mulligan [6] present the strategy of regional and local food hubs as a configuration proposal in organizations to reduce the structural gaps between small producers and consumers. Considering a focus on sustainability and innovation in the agricultural industry, Meynard et al. [5] propose a reference framework for constructing renewed networks of actors in the AFSC. Esteso et al. [36] propose a conceptual framework for designing the AFSC through mathematical programming modeling considering different sources of uncertainty. Analyzing the technologies used in the agricultural system, Phillips et al. [37] propose a strategic

model of networks of competitors and upstream and downstream collaborators for the interoperability of SC through digital applications. Under a food security and sustainability approach, Loboguerrero et al. [16] analyze the reconfiguration of food systems and the impact of environmental footprint, risk, and organizational systems.

Table 2. Proposals for reconfiguration in the AFSC.

Author	Approach/Tool	SC Reconfiguration Characteristics	SC Decision-Making Phase
Anastasiadis and Poole [35]	Qualitative methods	SC structure including retail, wholesale, and production	Planning
Berti and Mulligan [6]	Qualitative framework	SC structure/hubs	Strategy
Meynard et al. [5]	Heuristic framework	Design of coupled innovations/information systems	Strategy
Esteso et al. [36]	Mathematical programming modeling	Production–distribution network design/optimization	Strategy
Phillips et al. [37]	Model through digital applications	SC structure including retail, wholesale, and production	Strategy
Loboguerrero et al. [16]	Qualitative framework	SC structure	Strategy
Zaridis et al. [38]	Qualitative framework	SC structure	Strategy
Bui et al. [17]	Qualitative framework	SC structure	Strategy

Source: Own elaboration.

Another AFSC reconfiguration proposal is presented by Zaridis et al. [38], who studied the impact of horizontal and vertical collaboration and customer participation as strategies to improve the performance of the SC. Finally, using a reference framework for the sustainability transition, Bui et al. [17] examine the reconfigurations of the entire agrifood system through a technological and innovative approach.

2.2. Context of the Agrifood Sector in the Face of the Pandemic

COVID-19, as an extreme interruption in demand and supply, forced companies to react by redesigning the configuration of their SCs and implementing new logistics solutions to reduce the negative impact on delivery delays of products, the loss of sales share, and the level of customer service [1,3]. Notably, the changing environment and high volatility that the agrifood sector presents have projected reconfiguration in the AFSC as a high-impact strategy to adjust food production and supply capacities. The COVID-19 crisis highlighted the close connection between humans and nature. The health and socioeconomic impacts of COVID-19 are linked directly or indirectly to the natural environment and how agrifood systems interact [39].

Food systems are strongly linked to international food supply chains, so any disruption in the different AFSCs directly affects food markets [40]. During the strict COVID-19 lockdown, most AFSC logistics activities were inevitably disrupted, projecting an impending food shortage [41,42]. Faced with this catastrophic scenario and to minimize the spread of the virus, multiple AFSCs reconfigured their SC networks to purchase, distribute, and sell food products [43]. The opening of centers for the purchase of products in the neighborhood of consumers, the restriction on the number of farmers in the distribution centers, and the enabling of technologies for the purchase of food were some of the strategies used worldwide during the beginning of the pandemic [20,24]. Regarding policies in response to the pandemic, according to OECD [42], in the food sector, the governments of various countries executed actions categorized as (1) labor measures, (2) facilitation of transport and logistics, (3) facilitation of market integration internal, (4) monitoring of agricultural markets, (5) reconfiguration of product flows, and (6) assistance and social security.

Specifically, according to the Food and Agriculture Organization, the main impact on agriculture was initially presented in two essential aspects: (1) the supply and (2) the demand for food [19,44].

To assess the initial effects of COVID-19 on food supply chains, Rejeb et al. [45] present a review of the literature examining the impact of the pandemic on the food industry and how the current crisis prompted the reconfiguration of food company operations, considering that food insecurity, logistics costs, consumer behavior, food waste, and self-grown food are factors that, due to their importance, are key to the performance of this food sector. Analyzing the resilience and management plans in the face of the health crisis, Lioutas and Charatsari [46] indicate that the different approaches to agriculture, such as small-scale and large-scale agriculture, high-input agriculture, agroecology, and industry-oriented agriculture, generate various levels of vulnerability that must be considered during the design and adaptation of management strategies and policies in the face of crisis or disaster.

Using the Resource-Based Theory and the Contingency Theory, Ali et al. [47] also offer a context for developing reactive strategies focused on small and medium-sized companies in the agrifood sector. Additionally, in the proposal by Ali et al. [47], a literature review is carried out to understand the effect of the pandemic on the AFSC, analyzing the capacities of the food sector to respond to the impacts of COVID-19 and suggesting approach-based strategies for SC resilience.

Among the proposals made to mitigate the effect of COVID-19 in the AFSC, Singh et al. [13] present a model based on a delivery system synchronizing trucks and drones to provide essential items and products; in a complementary manner, these authors develop a simulation model of an SC network considering different scenarios in pandemic circumstances. Sharma et al. [43] propose a mathematical model that considers government guidelines for acquiring food produced by farmers in pandemic emergencies such as the current health crisis.

Perdana et al. [48] discuss an optimization model to manage the impact of the pandemic based on a food supply network through regional food hubs. The proposal by Marusak et al. [49] explores how the AFSC can improve resilience against large-scale outages by studying best distribution and logistics strategies and practices. Using the Dynamic Capabilities Theory, Nisar et al. [50] assess the role of Big Data capabilities as an approach to supplying sustainable supply chains in post-pandemic situations.

In the specific case of the impacts of COVID-19 in LATAM, Lopez-Ridaura et al. [22] analyze the immediate effects of the pandemic on the agricultural systems of Central America and Mexico, presenting a descriptive analysis of the critical factors that initially affected various AFSCs, identifying some measures to improve the resilience and adaptability of different agricultural systems in regions belonging to LATAM. Another study on the main effects of the pandemic on the production and consumption of food in LATAM is presented by Tittonell et al. [51]; through surveys carried out with different key actors, these authors identify the nature, purpose, and scope of the first initiatives deployed by different AFSCs to face and adapt to the impacts of COVID-19. According to Tittonell et al. [51], the main strategies that were implemented or adjusted in response to the pandemic included (1) direct sales of food from the producer or farmer to the consumer through online communication, (2) short supply chain strategies, (3) support and training programs on sustainable production and self-consumption, and (4) support strategies focused on vulnerable populations.

3. Methodology

Considering the proposals of Al Naimi et al. [2], Chandra and Grabis [9], and Rowley and Slack [52], Figure 1 shows the scheme of the methodology used for this research. It was carried out using a descriptive approach through a systematic collection of databases and a review of reports and technical bulletins on the behavior of COVID-19 in LATAM carried out and published by FAO, OECD, ILO, World Bank, RIMISP, ECLAC, and IICA.

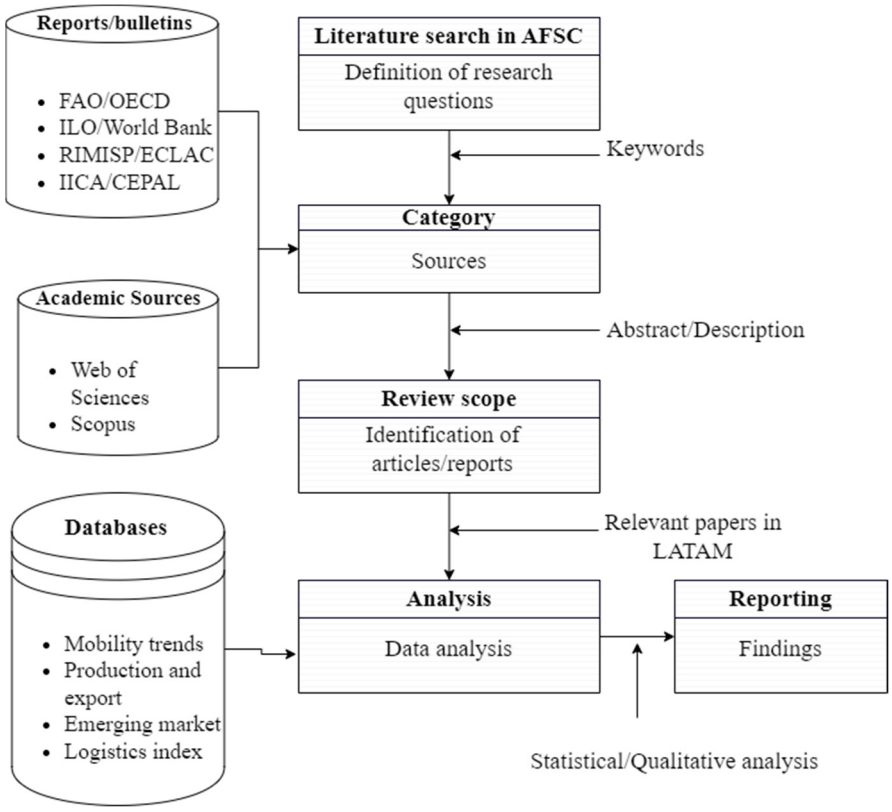

Figure 1. Proposed methodology.

This study included the results presented by these reports for the most critical LATAM markets in Chile, Panama, Mexico, Brazil, Colombia, Argentina, Ecuador, Costa Rica, Paraguay, Peru, and Uruguay. The questions that were asked to start the search for information were as follows: (1) What were the initial impacts on the competitiveness and management of agrifood supply chains during the early stages of the health crisis caused by COVID-19? (2) What were the AFSC reconfiguration strategies used during the start of the COVID-19 pandemic in LATAM? (3) How were logistics strategies and technology managed to mitigate the impact on LATAM's operations and agrifood production systems?

The data were analyzed considering (1) the effects on the agrifood sector, (2) the effects on the AFSC and logistics, and (3) the technological implications and proposals implemented in the AFSC in response to COVID-19. Specifically, the technical bulletins published by FAO and ECLAC on the different impacts and opportunities of agrifood systems in LATAM and the Caribbean in the face of the pandemic were reviewed. In the same way, the perspective reports and response policies to COVID-19 focused on agriculture and rural development published by ECLAC, FAO, IICA, and OECD were reviewed.

This literature review also included an analysis of the COVID-19 situation reports in LATAM published by RIMISP and the reports on the labor outlook in the rural economy of Latin America published by the International Labor Organization. Based on Rowley and Slack [52], questions were considered for selecting reports: Who is the intended audience? What is the frequency of updates? Which organization is the publisher or website originator? What is the web resource developer's claim to expertise and authority?

In addition to these reports, using bibliographic databases of articles from scientific journals indexed in Scopus and Web of Science, studies carried out by researchers on the impact of the health crisis on the AFSC in Latin America were included. The search terms used were "agrifood", "COVID, "supply chain", "logistics", and "Latin America". We also used the following terms in Spanish: "agroalimentaria", "COVID", "cadena de suministro" "logistica", and "latinoamerica". The search was limited to the title, abstract, and keywords

of scientific articles published in English or Spanish, with restrictions on the subject areas of economics, management, and business. The information search was carried out during the first quarter of 2023.

Table 3 shows the reports, bulletins, and articles obtained for analysis of the AFSC during COVID-19. Our search yielded 24 reports and bulletins published by international organizations and 17 articles in indexed journals published during the early stages of the pandemic.

Table 3. Reports, bulletins, and articles on the behavior of COVID-19 in LATAM.

Research Approach			
Reports/Bulletins		**Articles**	
Source	**Reference**	**Journal**	**Reference**
Economic Commission of Latin America and the Caribbean	CEPAL [25], CEPAL, FAO and IICA [53]	*EuroChoices*	Deconinck et al. [54]
Food and Agriculture Organization	FAO [20], FAO [26], FAO and CEPAL [55], FAO and ECLAC [24], FAO [44]	*Food Security*	Heck et al. [56]
Organization for Economic Cooperation and Development	OECD [42], OECD [57]	*Global Food Security*	Loboguerrero et al. [16]
Latin American Center for Rural Development	RIMISP [58], RIMISP [59], Albacete et al. [60]	*Heliyon*	Perdana et al. [48]
International Labour Organization	Quicaña [61]	*Scientia Agropecuaria*	Siche [19]
World Bank	World Bank [62]	*Trends in Food Science & Technology*	Ali et al. [47]
Inter-American Institute for Cooperation on Agriculture	Ziegler et al. [63]	*Agricultural Systems*	Blazy et al. [27], Lioutas and Charatsari [46], Lopez-Ridaura et al. [22], Marusak et al. [49], Tittonell et al. [51]
Others	Borja et al. [64], Senesi et al. [65], Toldos and Ochoa-Jurado [40], Espinosa and Armijos [66], Parra-Peña et al. [67], Burki [68], Rodríguez Osiac et al. [69], Soto et al. [70]	*Portuguese Journal of Public Health*	Giordani et al. [15]
		Journal of Agrarian Change	Gras and Hernández [71]
		Food Policy	Gruère and Brooks [41]
		Supply Chain Management: An International Journal	Groot-Kormelinck et al. [72]
		Sustainability	Takavakoglou et al. [39]
		World Development Perspectives	Coral and Mithöfer [73]

Source: Own elaboration.

To identify the impact of AFSC logistics in the face of the pandemic, the databases on the indicators of local mobility trends proposed by Google [74] were reviewed. Google developed mobility indicators to provide information on the changes in people's mobility due to the policies established by countries to combat COVID-19.

The next stage analyzed the food production and export volumes in LATAM in 2020. The data collected on mobility, production, and exports were analyzed using time series statistical methods to capture trends and compare the values of the variables before and during the restriction period, highlighting potentially relevant differences due to the effects of the pandemic.

Subsequently, the strategies used in different countries to mitigate the effects of COVID-19 on the AFSC were identified and classified, critically comparing the impacts on the supply, production, distribution, and delivery of food to consumers.

Finally, to identify guidelines to improve the situation of the AFSC in LATAM, the technologies used for logistics were determined by analyzing trends in connectivity and the results obtained according to the Emerging Market Logistics Index, which integrates metrics on (1) domestic logistics opportunities, (2) international logistics opportunities, (3) business fundamentals, and (4) digital readiness.

4. Findings

This study analyzed the impact on the AFSC through different performance indicators, including local mobility trend indicators, the agricultural production index, food export levels, and the market logistics index.

4.1. Initial Impacts on AFSC

SC disruptions and lockdown measures were some of the first issues addressed by the AFSC. The restrictions on most logistics activities derived from the strict confinements gave rise to a possible and inevitable scenario of food shortages in the markets [13]. However, due to the agility and speed with which the different stakeholders, including farmers, producers, and distributors, were organized, the economic impacts on the AFSC were relatively limited [24,54,57].

Due to poor infrastructure, poverty, and isolated healthcare systems in developing countries in LATAM, the initial mitigation strategies adopted during the pandemic showed adverse effects, complicating distribution processes and food commercialization and intensifying the food crisis [68]. Another adverse effect of the advance of the pandemic was that the health of people involved in the value chain of agrifood systems and the regions related to food processing, distribution, and marketing were at greater risk [75].

According to data from Google [74], during 2020, the mobility trends in places such as supermarkets, food stores, agricultural product markets, pharmacies, and specialized food stores were drastically reduced (Figure 2), reaching a percentage average change below −50% in Chile (CHI); in Panama (PAN), Colombia (COL), and Peru (PER), it was between −40% and −30%; in countries such as Mexico (MEX), Argentina (ARG), Ecuador (ECU), Costa Rica (CR), Paraguay (PAR), and Uruguay (URU), the mobility trend was on average between −10% and −25%; finally, and contrary to the other LATAM countries, Brazil (BRA) presented a positive average mobility trend close to 10%.

Other impacts on the AFSC derived from the pandemic problem included aspects such as (1) the breakdown of SCs and logistical problems for distribution from suppliers, manufacturers, and consumers; (2) the contraction of supply and demand in local and export markets; (3) the variability of export prices of agrifood products; and (4) the reduction in marketing spaces [24].

According to the Latin American Center for Rural Development [58], in a study on the initial condition of the effects of COVID-19 on the food supply in Colombia, Chile, and Mexico, it was concluded that in 2020, there were no significant disruptions in the food supply, especially in large cities. In Argentina, in the metropolitan area of Buenos Aires, where 29% of the population lives, 20% of households experience food insecurity [71].

As shown in Figure 3, to the levels of global volumes of agricultural production during 2020 compared to 2019 and 2018, the Agricultural Production Index (IPA) maintained positive trends in Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, and Peru, while in Argentina, Costa Rica, Panama, and Uruguay, the trend in the IPA was negative.

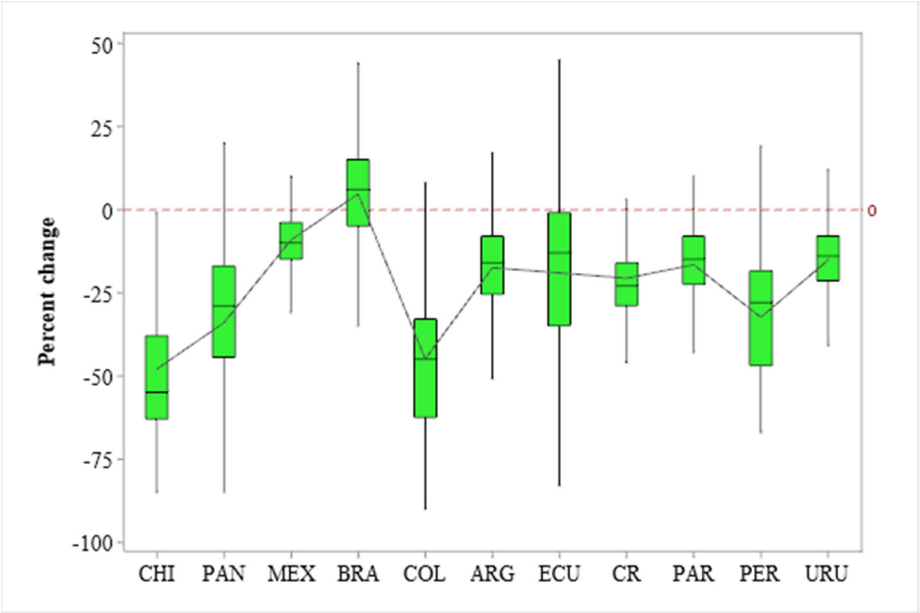

Figure 2. Grocery mobility trends in 2020 for LATAM. Source: Own elaboration with data from Google [74].

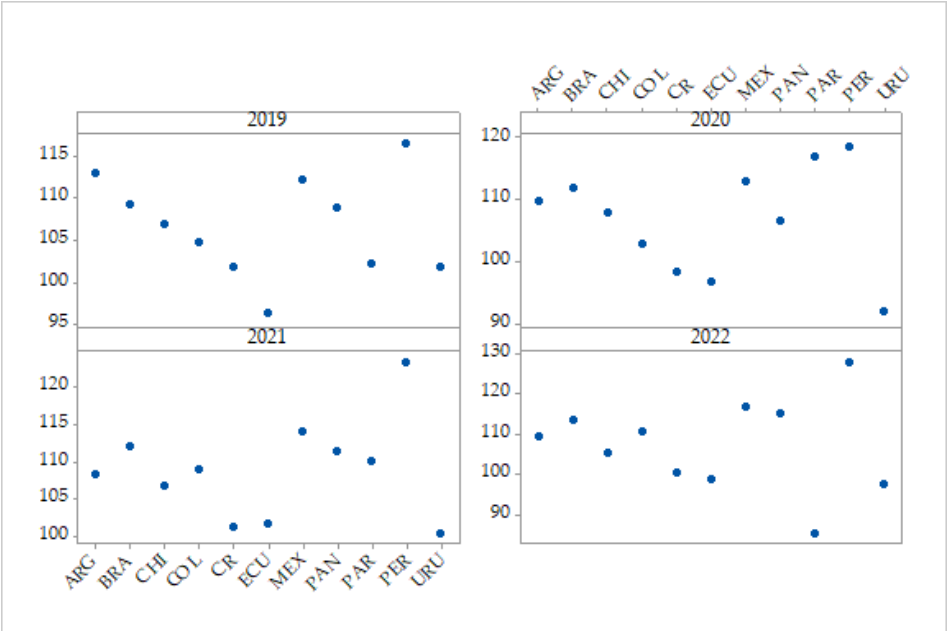

Figure 3. Production. Source: Own elaboration based on data from FAO [76].

Sustained price increases for essential agricultural inputs for crops and uncertainty in the markets have also been some of the economic effects in LATAM [77]; however, AFSCs in this region have shown to be more resilient than other supply chains in terms of growth trends in production [53]. The agrifood sectors that grew the most during the pandemic were soybeans, sugar, and their derivatives. At the same time, other food products with intensive labor and perishable products such as fruits, vegetables, and live animals became more vulnerable to the health crisis [24].

According to the FAO [44], agrifood exports reported by different countries in LATAM increased by an average of 2.7% in 2020 compared to 2019 (Figure 4), while total merchandise exports registered a 9.1% drop.

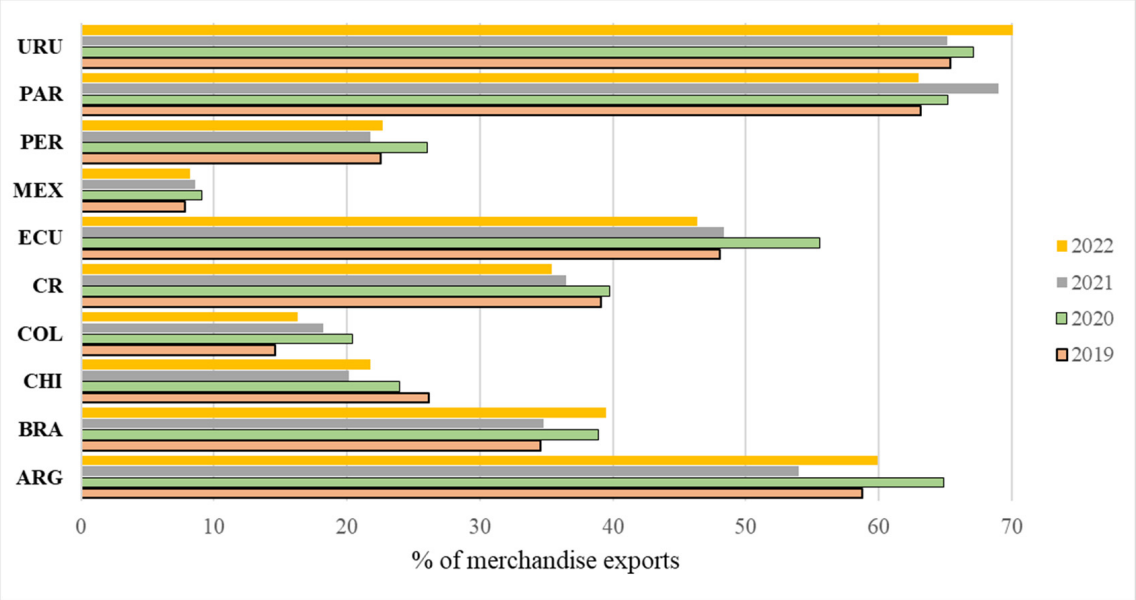

Figure 4. Food exports. Source: Own elaboration based on World Bank data [62].

In Colombia, there was a slight increase in domestic supply, with imports of agricultural products increasing by 13.8% in January 2020 compared to the same period in 2019, dominated by oilseeds and corn. In addition, small producers reported price increases for inputs, low consumer demand, and transportation difficulties, and additional problems arose with the displacement of rural labor due to the effects of the declaration of quarantine in this country [58]. In Argentina, between January and November 2020, agro-industrial exports increased by 5.2% in volume, and exports of soybean, corn, wheat, and meat products contributed 53% of exports [71]. In Panama, no information was reported for the period consulted.

In Chile and Mexico, food production remained stable during the beginning of the pandemic, with effects on some distribution channels such as the so-called "ferias libres" (free fairs) or street markets, in addition to the activities of food markets, supermarkets, as well as small stores and food services, which were considered essential sectors. In Chile, imports of agricultural products increased by 11% to 13% in March 2020 compared to the same month of the previous year, while in Mexico, exports of agricultural products increased in February 2020 compared to the same period of the previous year [58,78]. In Argentina, sanitary restrictions reduced the number of available workers by half, which caused difficulties in the production and distribution of food in some provinces, as well as in Costa Rica and Nicaragua, which depend on immigrant labor [24]. Natural resource-based industries faced the threat of crop vulnerability, and the paralysis and blockade of some import markets forced companies to slow down production and, when that was not possible, to urgently seek alternative markets [70]. In the Caribbean, the COVID-19 crisis had a substantial impact on farmers, some of the main ones being the loss of income due to the impossibility of selling the production and the difficulty accessing inputs and labor [27,44]. In Paraguay, some measures to contain the impacts on the AFSC included declaring all workers linked to logistics as essential [59].

Due to the fall in the commercial movement of agricultural products, the port and shipping sector decreased its dynamism in LATAM seaports, registering 5% less activity than in 2019 [61]. Food container restrictions in countries like Chile affected the trade of products such as cherries, blueberries, wine, and seafood [24].

Regarding the perception of consumers regarding the availability and prices of food, in the study carried out in Argentina, Brazil, Chile, and Colombia, Toldos and Ochoa-Jurado [40] indicated that confinement had an impact on the perception from an increase in factors such as price and a decrease in aspects such as the variety and quantity of food

available. Consumer perception of the pandemic also contributed to increased consumption of fresh products, improving the image of AFSCs and integrating new protocols and information technologies to guarantee the origin and quality of products [65].

4.2. AFSC Configuration Strategies

The LATAM countries established different measures to guarantee the production and supply of food. Through the Ministry of Agriculture of the Mexican Government, a website called "Mexico Solidario" was created, in which SMEs promoted products derived from agriculture, livestock, and fishing. According to Quicaña [61], in Uruguay, Costa Rica, Colombia, and Brazil, campaigns and social enterprises were carried out to promote the direct marketing of agricultural products, in addition to establishing protocols between the public and private sectors to provide support and protection of workers' health and safety.

Strategies for implementing the so-called "mercados moviles" (mobile markets), whose approach is based on avoiding crowds in markets and supply centers and facilitating the transport of small producers to urban centers, were implemented in countries such as Bolivia, Argentina, and Chile [61,67,69]. In LATAM, the short supply chain strategy, where farmers received support through government policies and technical, financial, and market assistance, was used to deliver food products to customers through local markets and e-commerce (Figure 5).

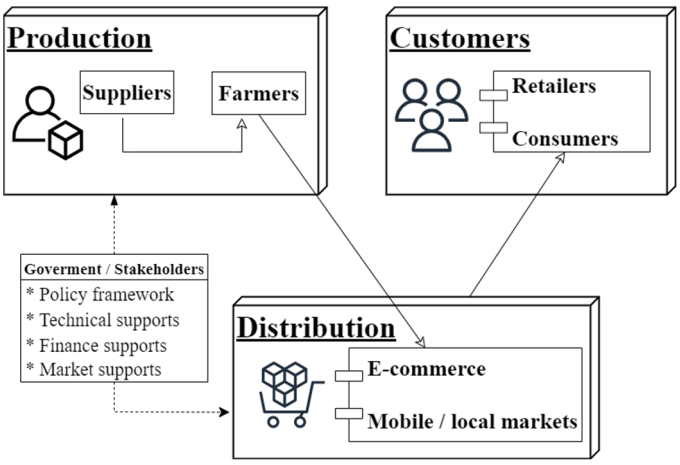

Figure 5. Short supply chains during COVID-19 in LATAM.

Additionally, the implementation of "short marketing circuits", the redistribution of fair points, and subsidy schemes for families and vulnerable people to solve logistical problems related to the distribution and storage of food was proposed in Chile [69]. The short SC strategy was implemented in Brazil to improve the food supply between farmers and consumers in the same locality [23]. In Colombia, the strategy used included the digitization of service delivery channels and the implementation of virtual modalities to ensure continuity in the distribution of products and services, in addition to carrying out actions to reconfigure operating models adapted to emerging needs such as the delivery of inventories of planting material and supplies to food producers; additionally, close coordination was carried out between the government and the Colombian private sector to keep SCs active and monitor the supply of raw materials and food [67]. Other strategies implemented at the government level in LATAM included support for farmers for production, policies called "guarantee prices" in which product purchase prices are set, and the promotion of productivity in the different AFSCs.

Table 4 presents the relationship between the stakeholders, the problems, and the strategies implemented in the AFSC.

Table 4. Strategies implemented by the different AFSC stakeholders.

Stakeholder	Problematic	Strategies
Supplier	• Disruptions in the input market • Disruptions in the raw material market	• Digital marketplaces • Digital procurement
Farmer	• Limited workforce • Difficulties in accessing markets • Lack of imported inputs	• Digitization and promotion of channels for the acquisition of raw material • Electronic commerce • Direct sale of products • Digital financial services
Government	• Disruptions in the food supply • Job losses	• Declare food production and all of AFSC as a priority activity • Deliver inventories of planting material and inputs such as fertilizers • Guarantee price policy • Relocate and establish temporary markets in rural, urban, and peri-urban areas to facilitate consumer access to fresh food products
Manufacturer/processors	• Limited workforce • Increase in demand • Sanitary risks within the company • Delays in transporting production to ports	• Reconfigure production models • Increase operating hours in factories • Hire additional employees • Reduce the variety of products to focus on the most popular types
Distributor	• Difficulties in transporting products • Increased food consumption in households • Lower demand at points of consumption (restaurants)	• Mobile markets • Short marketing circuits • Digitization and promotion of channels for the distribution of products • Development of last-mile delivery mechanisms
Customer	• Limitations for the purchase of goods, services, and consumer products • Sanitary risks inside stores • Reduced access and availability of fresh food	• Electronic commerce • Digitization of purchases • Shopping at local/mobile markets and fairs

Source: Own elaboration.

In the specific case of farmers, the direct sale of products in conjunction with electronic commerce was used most frequently, thus eliminating some operations with intermediaries and resellers. According to Investchile.gob [79], direct sales through websites or even WhatsApp and social networks were strategies widely used by farmers. In countries like Guatemala, logistics strategies include shared transport services for distributing food products under a door-to-door delivery scheme [64].

4.3. Technologies Used for AFSC in LATAM

The COVID-19 crisis prompted technological and system changes that fostered innovation while promoting the development of resilience across different economic sectors [56]. Before the start of the pandemic, technology was already positioned in logistics for distri-

bution; however, the study by Ziegler et al. [63] on the state of digitization of LATAM in the face of the COVID-19 pandemic points out the different conditions of countries in terms of infrastructure and connectivity. At the beginning of 2022, according to the GSMA Mobile Connectivity Index, Uruguay, Chile, and Brazil were the leading countries in digitization and adoption of Internet and mobile services, while Colombia, Ecuador, and Paraguay had the lowest rates [80].

These differences in terms of connectivity were more significant between urban and rural areas, so according to ECLAC [57], this was one of the main limitations in LATAM for access to markets and productive resources such as water, land, and financing to farmers and food producers; however, contrary to this scenario, during the pandemic, the various AFSC stakeholders managed to integrate different technologies applied for operations from supply to delivery to the final consumer.

In Colombia and Chile, the digital food purchasing platforms Rappi and Cornershop were among the most used applications for the delivery and distribution of food during the pandemic period [79]. Digital tools such as WhatsApp, Facebook, and Instagram were also used to make online sales. According to RIMISP [59], in Mexico, Guatemala, Colombia, Ecuador, and Chile, there was an increase in households that made purchases of fresh food at home; between 15% and 37% of households would have made this type of purchase, many of which had never done so before the pandemic [60]. The main effects perceived with the inclusion of technologies based on electronic commerce in LATAM were (1) the exclusion of small players, (2) the support and logistical facilities, (3) the organization between farmers and consumers for direct marketing and the development of short supply chains, and (4) cost reduction.

Following the lessons learned from European countries where AFSC actors expanded the use of new delivery methods through the use of technological and digital platforms to sell products [54], according to the FAO and ECLAC [24], strategies were implemented in different LATAM countries for the development of digital marketing capabilities for agrifood companies to develop and install logistics and technological capacity based on digital systems. In Honduras, during the health crisis, a digital platform for farmers called "Trazar Agro" was proposed to identify, locate, and collect information for prospecting the productive potential of the AFSC, including the identification of the different actors (technical assistance services, input suppliers, food processors, collection centers, logistics operators, etc.) that are linked to the operation of this SC [57].

Table 5 identifies some examples of strategies to mitigate the effects of COVID-19 on the AFSC, as well as the proposed technologies. For instance, in Colombia and Chile, plans were developed based on home deliveries and the connection between farmers and customers using technologies such as web platforms, while Ecuador and Costa Rica saw the supply of inputs in urban markets and the promotion of the development of capacities of small and medium-sized farmers through the use of information sharing with WhatsApp.

Additionally, through the "agricultura tecnologica" (technological agriculture) (AgTech) agenda promoted by the Inter-American Development Bank in Argentina, measures were applied in terms of market regulation and technical support to encourage exports; the proposed model is based on the integration of social and territorial aspects of market technologies that include (1) blockchain, (2) genetic editing, (3) digitalization of ecosystems, and (4) automation of physical processes [71]. Under this trend of technology application in the AFSC, studies by Borja et al. [64] indicate that a high percentage of actors in the SC ventured into or adapted their activities to the use of mobile applications to carry out purchase and sale operations.

Finally, concerning the logistics performance achieved as an effect of the application of strategies and technologies in the AFSC to face COVID-19, as shown in Figure 6, the results according to the Emerging Market Logistics Index (EMLI) developed by AEMLI [81] confirm that Mexico, Chile, and Brazil maintained a potentially attractive potential for foreign investment in their national logistics markets, positioning themselves as leaders in

this indicator in LATAM; in the case of Panama, there are no records during this period according to the EMLI.

Table 5. Applied technologies.

Country	Example of the Implemented Strategy	Technology					Authors
		E-Commerce	Web Platform	Whats App	Social Networks	Other Apps	
CR	Urban supply market	*	*	*			Rodríguez Osiac et al. [69]
COL	Home delivery		*			*	Parra-Peña et al. [67]
CHI	Connect family farming producers with potential customers	*	*			*	Quicaña (2020) [61]
ARG	Connect companies with customers	*	*		*	*	Borja et al. [64]
BRA	Monitor activities based on a production standard and good practices, short circuits	*	*				Recine et al. [23]
ECU	Promote the capacity development of small and medium-sized farmers by sharing information		*	*		*	Espinosa and Armijos [66] Coral and Mithöfer [73]
PAN	Sell products directly to consumers	*		*	*	*	FAO and ECLAC [24]
MEX	Increase competitiveness among micro, small, and medium-sized enterprises	*	*			*	RIMISP [59]
URU	Facilitate purchasing processes	*			*		Groot-Kormelinck et al. [72]

Source: Own elaboration. * indicates that this technology was used

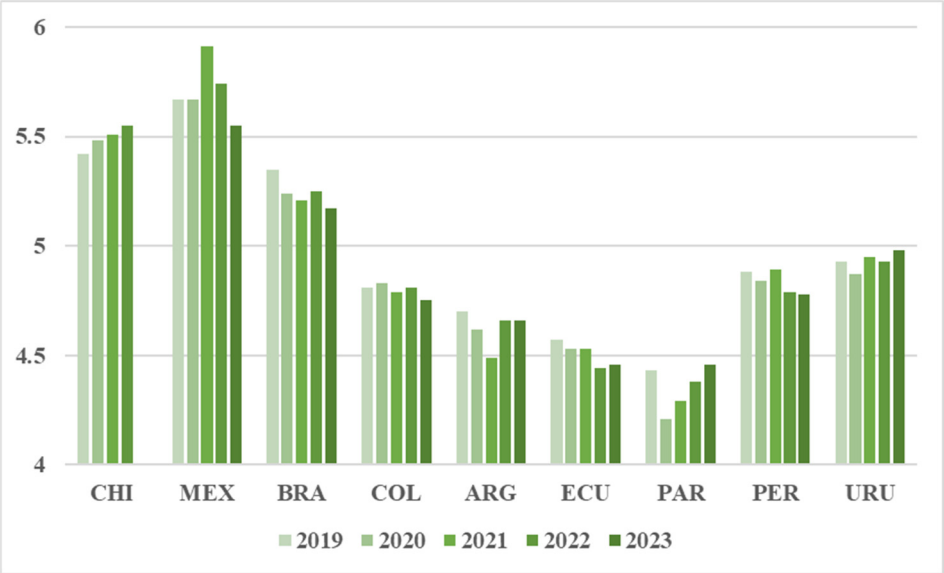

Figure 6. Market Logistics Index. Source: Own elaboration with data from [81].

The EMLI examines three key dimensions: (1) business fundamentals, (2) national logistics opportunities, and (3) international logistics opportunities; therefore, based on this indicator, Ecuador and Paraguay obtained the last places in the classification.

5. Discussion

COVID-19 is causing severe disruption to the AFSC locally and globally in a way never experienced before [82]. The health crisis added to the problems of the limited size of logistics structures, competition from imports, and climate risks that LATAM faces. Although mobility trends for the food sector remained negative in most countries, production and logistics performance indices reached positive figures in 2020. The trend in the post-pandemic era is heading toward the digitalization of agriculture and food distribution, with great attention on product sustainability [83].

The results of this study indicate that the AFSC's resilience based on technologies, logistics strategies such as direct delivery to the consumer, and the development of production systems with a focus on short supply chains made it possible to reduce the impact on food production and consumption during the health crisis. Our study reinforces contributions from Coral and Mithöfer [73], who also conclude that the main drivers, such as market dynamics, the organization of actors in the supply chain, and digital and technological innovation, are critical to adaptation to COVID-19. The findings observed in this research confirm the role of technology as an element for the reconfiguration of the SC and fundamental support for the competitiveness of the AFSC in the face of the logistical challenges that arose at the beginning of the pandemic. Specifically, strategies for managing short supply chains through monitoring agricultural markets, facilitating logistics and transport operations, and granting facilities for integrating internal markets were instrumental in mitigating adverse effects on the food supply.

Based on the indicators of production and export indexes, a positive trend is observed in the performance of the AFSC in the long term, which reveals the potential and profitability to implement financial investments in companies in this sector, even in the face of catastrophic scenarios [77]. Our results indicate that concerning the market logistics index, the trends during the start of the pandemic have remained constant and growing in cases such as Chile, Brazil, and Mexico.

From the perspective of the agrifood sector and analyzing the strategies implemented by the different stakeholders, we can affirm that the technological solutions used by companies to react to extreme changes in demand and supply downstream and upstream favored the adaptation of the supply chain and its reconfiguration. The need to link and identify the ideal strategies for new scenarios was also recognized, as Al Naimi et al. [2] suggested through a comprehensive supply chain resilience framework.

Our research confirms and extends previous studies by Albacete et al. [60], Blazy et al. (2021) [27], and Ivanov [10] on the imminent need to design strategies for the reconfiguration of the AFSC to maintain its business development and the viability of the sector on which millions of people in LATAM depend. The analysis of the AFSC also impacts food security as a critical factor of social development that can be seriously affected by the effects of the pandemic [84].

The closure of locations for consumption, restrictions on the entry and exit of products, and interruptions in communication routes were determining factors for the transit of food from the field to the markets, causing a considerable loss in transport logistics operations [24], positioning the factors of difficulty for the mobilization of workers and marketing difficulties as the most frequent. As mentioned by Deconinck et al. [54], the resilience of the AFSC in the face of disruptions such as COVID-19 shows the importance of reconfiguring SCs supported by an open commercial environment, where companies can access new sources of supply when existing sources are limited or even unavailable. Factors such as diversification in products and markets favor the resilience of agrifood systems, mainly in LATAM, where there is a dependency on the importation of essential foods.

In scenarios where the number of workers employed in the different production operations is drastically reduced, technology based on autonomous systems, robots, and drones are positioned as an alternative for change in food systems [46], also altering how food is processed and distributed, as well as the form of communication and interactions between the different AFSC actors, including the consumer. As a result of social distancing and health measures promoted by governments in LATAM, digital tools increased considerably, helping to facilitate information, transactions, and new business models in the AFSC.

Although technology and connectivity increased in the AFSC due to COVID-19, a marked inequality still prevails in small farmers' access to and use of digital technologies. Only 37% of the rural population in LATAM has Internet access, and only 17% have developed digital skills [53].

6. Conclusions

In contrast to the reports, bulletins, and literature published on the initial problem of COVID-19 in the AFSC in LATAM, our study provides a comprehensive perspective on the problems and solutions implemented in the agrifood sector from the supply chain management approach, which benefits both academics and companies for the development of new research and theories on the reconfiguration of the AFSC and its elements, thus expanding the analytical capabilities in organizations to address future risks in this SC.

The AFSC and food production strategies are vital for generating transportation and logistics services. In the face of future disruptions, strengthening short supply chains emerges as a strategy to ensure supply and minimize possible food losses. The nearshoring approach based on favoring locations closer to the final consumer markets is also an alternative that can generate positive impacts on sectors such as health and food. Strengthening the regional integration of AFSCs in LATAM can benefit from increasing a better supply of food from nearby sources, shortening the supply chain stages, and reducing risks to food safety. Government policies and business strategies based on the installation and operation of storage in urban and rural centers and the facilitation of electronic commerce have proven effective in achieving food availability while avoiding shortages.

Our study confirms the need to expand the research on the impact of the reconfiguration of the SC on agrifood systems to generate a reference framework that contributes knowledge to identify critical factors for collaboration between stakeholders in the face of future crises.

According to the FAO and ECLAC [24], the current agricultural production processes in LATAM are responsible for 46 percent of the greenhouse gases in the region, so the reconfiguration of the AFSC is positioned as a vital issue not only in the economic or pandemic aspect but also for sustainability and the preservation of the planet's biodiversity.

Faced with possible impacts on food distribution and marketing, the AFSC must be sufficiently adaptable to react to difficulties by implementing components and strategies based on the application of technologies for connectivity between suppliers and customers. During the pandemic, technologies have significantly reduced uncertainty, providing new opportunities for companies to react more quickly to changes in the SC.

In LATAM, the AFSC has proven to be resilient and adaptable in the face of the initial effects of COVID-19; however, given the imminent progress in the development of the pandemic, it is necessary to maintain a constant analysis of consumer perceptions, technology, and changes in markets that affect food distribution. As future work, this contribution may be considered a reference to expand the literature on reconfiguring agrifood supply chains in the face of catastrophic scenarios. In the scenario of a health crisis, the need to link local and regional agricultural supply with logistical strategies for food distribution is confirmed, resulting in benefits for all participants in the supply chain. Efforts should be made to take advantage of the lessons learned based on the results obtained from the different strategies carried out for the supply and distribution of food.

As future work, this research should be extended to other LATAM regions since our study particularly identifies only the main LATAM food export markets in Argentina, Brazil,

Chile, Colombia, Costa Rica, Ecuador, Mexico, Panama, Paraguay, Peru, and Uruguay. Additionally, it is necessary to explore the resilience mechanisms and the factors that contribute to understanding, anticipating, cushioning, and adapting to the disturbances and risks faced in the agrifood sector.

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