Clío América / Vol. 18 No. 36 – 2024 / 170 - 188
https://doi.org/10.21676/23897848.6059

Artículo De Revisión

Taxonomy of resilience strategies for addressing the impacts of covid-19 pandemic on food supply chains: insights from Latin America and Colombia

TAXONOMÍA DE ESTRATEGIAS DE RESILIENCIA PARA ENFRENTAR LOS IMPACTOS DE LA PANDEMIA COVID-19 EN LAS CADENAS DE SUMINISTRO DE ALIMENTOS: PERSPECTIVAS DESDE LATINOAMÉRICA Y COLOMBIA

Mónica Patricia Pelegrina-Romero[1], **Juan Camilo Vargas-Muñoz**[2], **Laura Palacios-Arguello**[3], **Richard Ríos-Patiño**[4] & **Wilson Adarme-Jaimes**[5]

Para citar este artículo: Pelegrina-Romero, M. P., Vargas-Muñoz, J. C., Palacios-Arguello, L., Ríos, R. & Jaimes, W. A. (2024). Taxonomy of resilience strategies in the food supply chains as mechanisms to face the impacts of COVID-19. *Clío América, 18*(36), 170 – 188. https://doi.org/10.21676/23897848.6059

Recibido: julio 26 de 2024.
Aceptado: octubre 18 de 2024.
Publicado en línea: 29 de noviembre de 2024.

ABSTRACT

Food supply chains (FSCs) in Latin America, including Colombia, were disrupted by measures implemented to control the spread of the COVID-19 pandemic. These measures led to disruptions such as labor shortages, export, and import restrictions, which exacerbated regional food insecurity and poverty. This study proposed a taxonomy of resilience strategies designed to address these disruptions, focusing on challenges and opportunities within Latin America. The review identified COVID-19 impacts, response strategies, and public policies developed by governments and institutions to mitigate these disruptions. Resilience strategies were classified into strategic fields, sustainability drivers, resilience capabilities, and supply chain stages. The strategic fields were defined using keywords extracted from the literature review. The research identified four key strategic fields where most resilience strategies were implemented: digital transformation, sustainable production, collaborative governance, and short FSC. This taxonomy contributes a decision-making framework to enhance FSC resilience in similar regional contexts, providing insights to prepare for future disruptions.

Keywords: Food Supply Chains; Economic Resilience; COVID-19; Taxonomy.

RESUMEN

Las cadenas de suministro de alimentos (FSC) en América Latina, incluyendo Colombia, se vieron afectadas por las medidas implementadas para controlar la propagación de la pandemia de COVID-19. Estas medidas provocaron disrupciones como escasez de mano de obra, y restricciones a las exportaciones e importaciones, aumentando la inseguridad alimentaria y la pobreza en la región. Este estudio propone una taxonomía de estrategias de resiliencia diseñadas para abordar estas disrupciones, con un enfoque en los desafíos y oportunidades únicos dentro de América Latina. La revisión identificó los impactos del COVID-19, las estrategias de respuesta y las políticas públicas desarrolladas por los gobiernos e instituciones para enfrentar estas disrupciones. Las estrategias de resiliencia fueron clasificadas en campos estratégicos, impulsores de sostenibilidad, capacidades de resiliencia y etapas de la SC. Los campos estratégicos fueron definidos utilizando palabras clave extraídas de la revisión de la literatura. La investigación identificó cuatro campos estratégicos clave donde se implementaron las estrategias de resiliencia: transformación digital, producción sostenible, gobernanza colaborativa y cadenas de suministro cortas. Esta taxonomía proporciona un marco de toma de decisiones para mejorar la resiliencia de las FSC en contextos regionales similares, ofreciendo perspectivas para prepararse ante futuras disrupciones.

Palabras clave: cadenas suministro de alimentos; resiliencia económica; covid-19; taxonomía

JEL: Q13; Q18; D81

[1] Msc. Universidad Nacional de Colombia Sede de Bogotá. Colombia. ***Email:*** mpelegrina@unal.edu.co. **ORCID:** https://orcid.org/0009-0003-6797-2330
[2] Industrial Engineering Degree. Universidad Nacional de Colombia Sede de Bogotá. Colombia. ***Email:*** jucvargasmu@unal.edu.co **ORCID:** https://orcid.org/0009-0008-2580-6330
[3] PhD. MIT Global SCALE Network. Luxemburgo. ***Email:*** laura.palacios@uni.lu. **ORCID:** https://orcid.org/0000-0002- 9512-1344
[4] PhD. Universidad Nacional de Colombia Sede de La Paz. Colombia. ***Email:*** rriospa@unal.edu.co. **ORCID:** https://orcid.org/0000-0002-0873-8945
[5] PhD. Universidad Nacional de Colombia Sede de Bogotá. Colombia. ***Email:*** wadarmej@unal.edu.co. **ORCID:** https://orcid.org/0000-0001-7401-223X

INTRODUCTION

The COVID-19 pandemic impacted industries and economies worldwide, mainly affecting individuals with lower education levels and those living in rural areas of developing countries with high poverty rates (Banco Mundial, 2022; Comisión Económica para América Latina y el Caribe – CEPAL, 2020, 2022; Cordeiro et al., 2022; Laborde et al., 2021; Mahler et al., 2021; Mumtaz et al., 2021). These socio-economic effects were mirrored in agricultural production, where farming systems faced challenges such as fluctuating market prices, trade conflicts, and adverse ecological impacts on agriculture. For instance, farmers encountered additional costs and logistical hurdles, including higher transportation costs and personal protective equipment for COVID-19 (Ali et al., 2023; Loker, 2020). Furthermore, commercial and civil establishment closures disrupted food supply chains (FSCs), underscoring the importance of local government efforts to restore and revitalize these systems (Zhou et al., 2020).

FSCs encompass the journey of food products from their origin to end consumers (Chitrakar et al., 2021). During the pandemic, FSCs faced significant challenges because of measures implemented to control the virus spread, including labor shortages, export, and import restrictions, among other disruptions (Cordeiro et al., 2022; Guido et al., 2020; Gu & Wang, 2020; Kumar & Kumar Singh, 2022; Loker, 2020; Mumtaz et al., 2021; Paganini et al., 2020; Quayson et al., 2020; Rivera-Ferre et al., 2021). These disruptions forced farmers to adapt, fostering the development of resilient food systems and agricultural practices while exploring new business models (Ali et al., 2023).

Several researchers have studied the COVID-19 disruptions on FSCs (Bechtsis et al., 2022; Hsu et al., 2021; Lagorio et al., 2021; Mohammed et al., 2021; Namdar et al., 2022). However, the existing literature lacks a comprehensive classification of these resilience strategies, particularly those that integrate resilience capacities, sustainability drivers, and supply chain stages. In this study we proposed a taxonomy of resilience strategies to address the COVID-19 pandemic's disruptions, focusing on challenges and opportunities within Latin America. The objective was to provide a framework for classifying and analyzing resilience strategies, offering insights to prepare for future disruptions. The study contributes to decision-making by identifying critical strategies for strengthening FSC resilience.

METHODOLOGY

Qualitative analysis of literature review

We conducted a qualitative analysis of secondary sources using content analysis, which provides a systematic approach for interpreting texts (Downe-Wamboldt, 1992). We performed a systematic review in three phases: planning, search and capture, and classification (Figure 1).

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

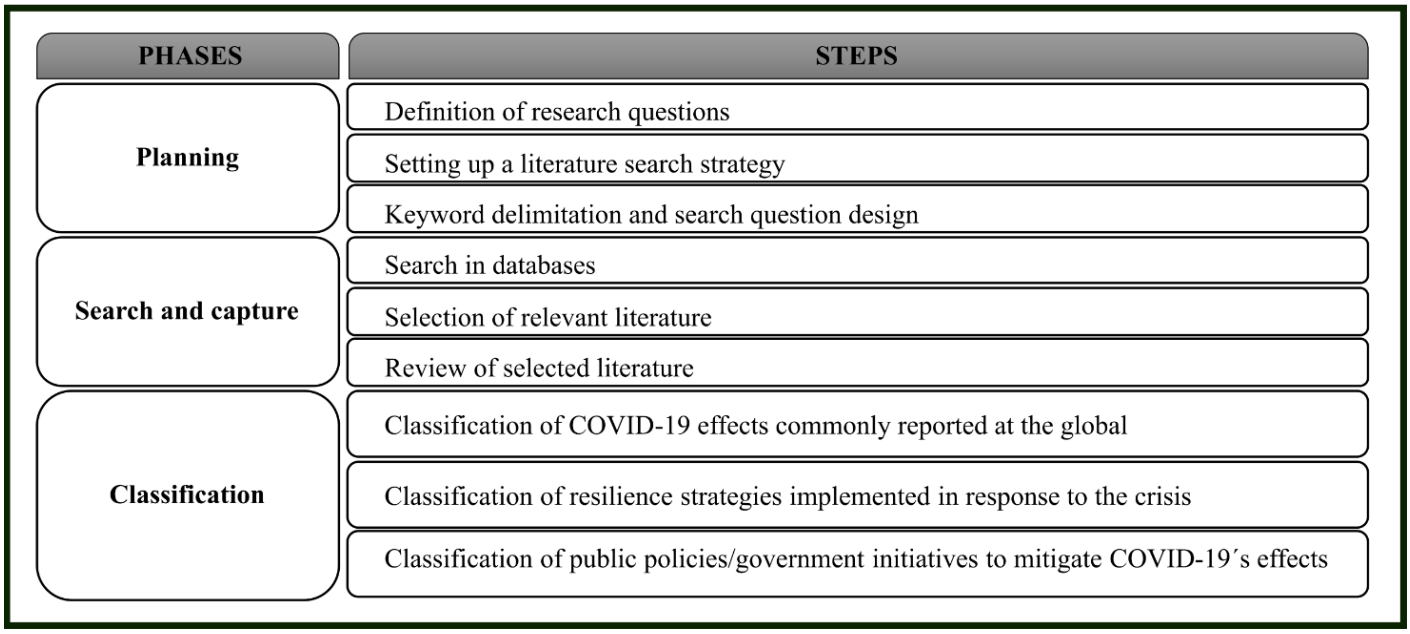

Figure 1. Workflow of the methodology used to review the state of the art.
Source: Own elaboration

In the planning phase (Figure 2), we defined three search fields to guide the analysis (Figure 2): (search field 1) identifying the COVID-19 impacts; (search field 2) examining strategies, initiatives, and practices within FSCs to cope with the pandemic; and (search field 3) exploring public policy actions aimed at mitigating the COVID-19 impacts. We then conducted a literature search using the following keywords: ("food supply chain" OR farmers) AND (COVID19 OR pandemic) AND (resilience OR adaptability). The search fields outlined above were used to categorize the collected information during the classification phase.

In the search and capture phase, we collected documents published between 2019 and 2022 from databases such as Scopus and ScienceDirect. After filtering the documents, 218 unique items were selected, along with reports from sources like the World Bank, CEPAL, and the Departamento Administrativo Nacional de Estadística (DANE). In the classification phase, we analyzed the documents to identify impacts, resilience strategies, and policies related to COVID-19. We examined their interconnections, cross-referenced key findings, and categorized them by impacts, resilience strategies, and policies.

Taxonomy of resilience strategies
We proposed a taxonomy for categorizing resilience strategies based on strategic fields, sustainability drivers, resilience capacities, and supply chain stages **(**Figure 3**).** The strategic fields were defined using keywords extracted during the classification of the resilience strategies.

Sustainabilitydrivers
Sustainability management integrates environmental and socio-economical dimensions to ensure long-term viability and minimize environmental impact (Seuring & Müller, 2008). A sustainability driver refers to factors that motivate companies to adopt sustainable practices (Lee & Klassen, 2008). These drivers are categorized as internal and external. Internal drivers include factors that save cost and produce positive environmental impacts (3P vision - Planet, People, Profit). Meanwhile, external drivers include factors beyond the company's capabilities (e.g. market dependency) (Sheffi, 2018).

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

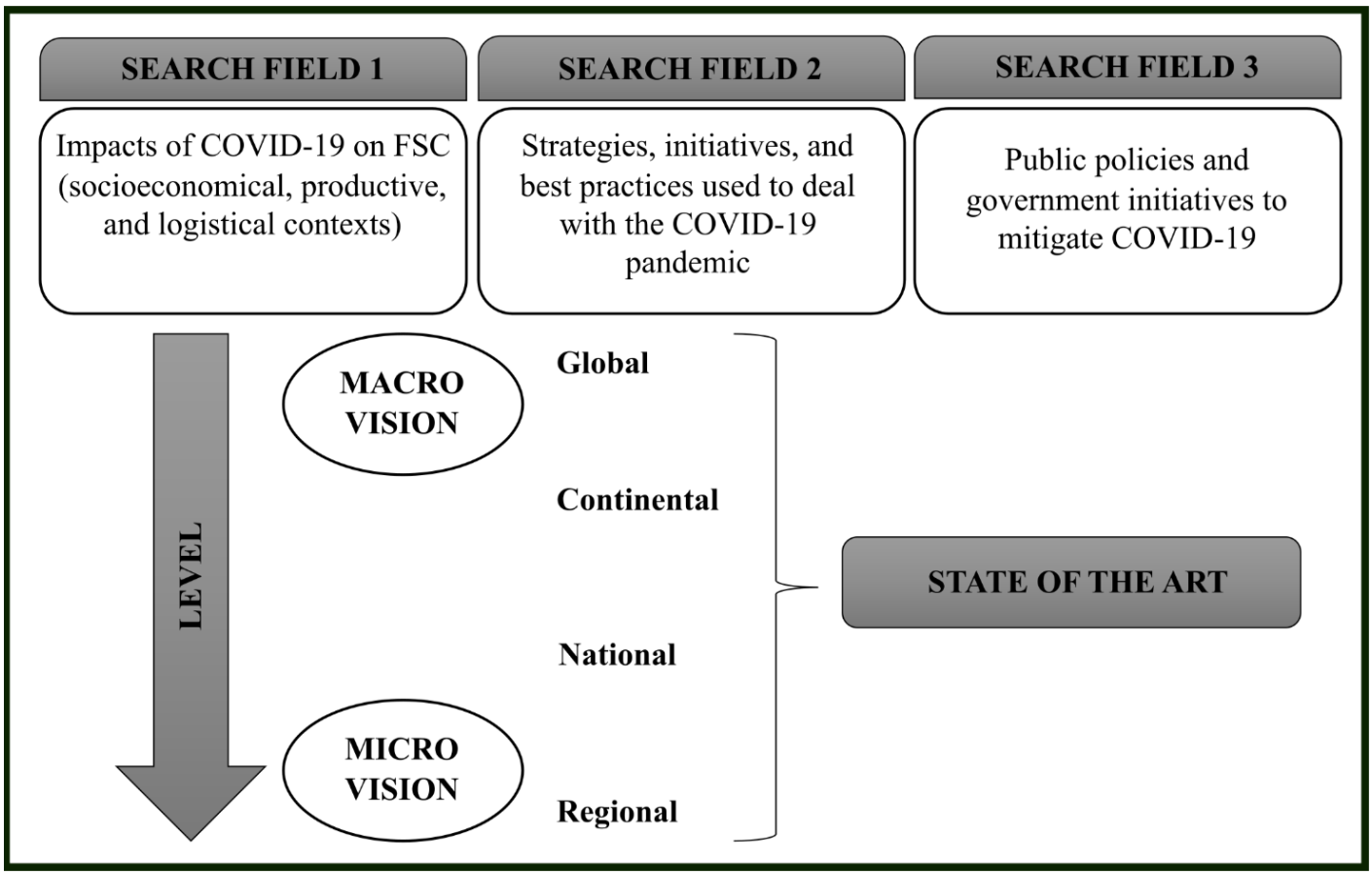

Figure 2. The strategy used for searching the literature.
Source: Own elaboration

Resilience capabilities

Resilience refers to a system's capacity to manage disruptions while preserving its organizational function, structure, and identity (Meuwissen et al., 2019). We consider the following resilience capabilities:

- Robustness. It refers the stakeholder's ability to absorb disruptions within the supply network by identifying and incorporating new suppliers (Meuwissen et al., 2019).
- Adaptability. It refers a stakeholder's ability to adapt to disruptions while maintaining feedback mechanisms and structures (Kazancoglu et al., 2021; Meuwissen et al., 2019).
- Transformability. It refers the stakeholder's ability to adjust core structure in response to disruptions (Grant et al., 2021; Meuwissen et al., 2019).
- Agility. It describes a stakeholder's ability to respond to small market opportunities through well-coordinated actions (Hosseini et al., 2019).
- Visibility. It refers the stakeholder's ability to access information from the supply chain's structure, processes, or products (Hosseini et al., 2019).
- Collaboration. It refers how stakeholders work jointly to perform supply chain operations with greater success than working individually (Hosseini et al., 2019).

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

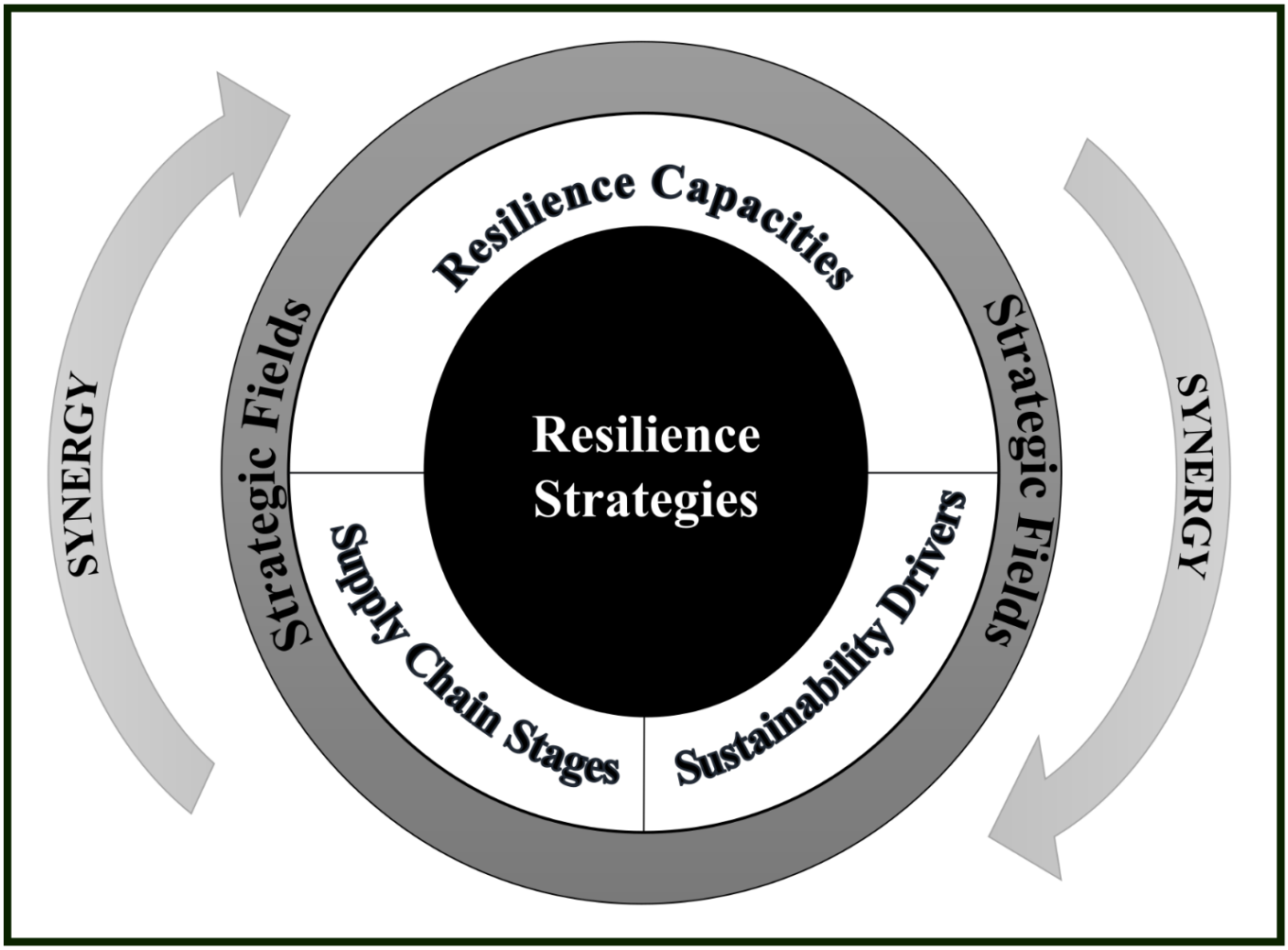

Figure 3. Taxonomy of Resilience Strategies: A visualization.
Source: Own elaboration

Supply chain stages

We considered the following stages: the *supply stage*, which ensures that the organization receives the necessary materials or services in the correct quantities and quality standards for efficient operation (Ballou, 2004); the *warehousing stage*, which involves storing products in logistics centers to maintain a continuous supply to the market or production lines (Lagorio et al., 2021); and the *distribution stage*, which refers to selecting the most effective system for delivering products based on their characteristics and market demand (Ballou, 2004). These stages represent the fundamental processes of logistics and are recognized as the core stages in supply chain management (Ballou, 2004).

RESULTS

Table 1 provides a summary of the impacts caused by the COVID-19 pandemic, categorized into socio-economic, productive, and logistical impacts.

Socio-economic impacts

After 20 years of decline, the COVID-19 pandemic caused a rise in extreme poverty. By 2020, approximately 100 million people were living on less than USD 1.90 per day (Banco Mundial, 2022). In January 2021, it was estimated 119-124 million people had been pushed into poverty worldwide due to the pandemic (Mahler et al., 2021), causing a 5 % average decline in global GDP (Laborde et al., 2021). Countries already struggling with

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

poverty faced worsened conditions, including limited access to basic services, school closures, and increased unpaid care work (CEPAL, 2022).

Table 1. Impacts on supply chains resulting from measures implemented to control the COVID-19 pandemic

Findings	**Impact**
A 20% rise in global poverty was recorded, alongside a 5% reduction in global GDP (Laborde et al., 2021; United Nations, 2021)	Increase in poverty and inequality levels
The pandemic caused the first increase in extreme poverty in over 20 years (Banco Mundial, 2022; Mahler et al., 2021)	
Poverty and social inequality worsened, affecting rural areas, populations with lower education levels, and Indigenous and Afro-descendant communities (CEPAL, 2020, 2022)	
Decline in educational conditions, healthcare access, employment opportunities, and housing availability (Sierra, 2021)	
Rising transaction and logistics costs driven by challenges in the transport network and services (Montoya-Torres et al., 2021)	Increase in logistics costs
Detailed disruptions to FSC, food security, and food waste (Kumar & Kumar Singh, 2022; Rivera-Ferre et al., 2021)	
Labor shortages, export/import trade barriers, transport constraints (Mumtaz et al., 2021)	
Strengthening of government regulations on food safety (Nesterenko et al., 2021)	
A 19% increase in the closure of companies across Latin America (CEPAL, 2020)	Reduction in formal employment
Reduction in job opportunities and disruption of food production and distribution channels (Thapa Magar et al., 2021)	
Increase in post-harvest losses because of transport shortages and the reduction of distribution networks (Middendorf et al., 2022)	Increase in restrictions for distributing products
Disruptions in demand and production because of the closure of markets and establishments (Loker, 2020; Perrin & Martin, 2021)	
Reduction of demand for fresh products because of restaurant closures, transport bottlenecks, and staff shortages (Rasul, 2021)	Fluctuations in demand for agricultural products
Closure of markets, supermarkets, schools, hotels, restaurants, and welfare centers (Rivera-Ferre et al., 2021)	
Disconnection between farmers and consumers due to the cessation of intermediaries' operations (Gupta & Singh, 2021; Loker, 2020)	
Labor shortage in production (Guido et al., 2020)	Increase in production costs
Changes in sales values and market volume (Gu & Wang, 2020; Zhou et al., 2020)	
Farm owners faced restrictions to access their land (Paganini et al., 2020)	

Source: Own elaboration

In Latin America, the economic recession resulted in a 7.7 % decline in GDP and a poverty rate of 33.7 %, with 78 million people falling into extreme poverty by the end of 2020 (CEPAL, 2020). In Colombia, more than 9 million people lived in multidimensional poverty in 2020, affecting education, health services, and housing (Sierra, 2021). According to Departamento Administrativo Nacional de Estadística – DANE, over 21 million Colombians were subsisting on less than USD 85 per month in 2021(DANE, 2021).

The pandemic also destabilized FSCs, leading to disruptions in primary food production, labor shortages, and

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

rising unemployment (Mumtaz et al., 2021; Rivera-Ferre et al., 2021; Wang et al., 2023). Labor shortages further exacerbated poverty and inequality, particularly in rural areas with lower education levels.

Impacts on production and logistics

The COVID-19 pandemic led to global disruptions in the FSC because of movement restrictions and the closure of commercial establishments, impacting the production, distribution, and marketing of products (Guido et al., 2020; Gu & Wang, 2020; Kumar & Kumar Singh, 2022; Loker, 2020; Paganini et al., 2020; Quayson et al., 2020; Surni et al., 2021). These disruptions led to challenges such as border restrictions, a lack of transportation, and higher logistical costs (Lopez-Ridaura et al., 2021; Sharma et al., 2022). These challenges hindered farmers from bringing products to local markets, leading to post-harvest losses (Kumar & Kumar Singh, 2022; Middendorf et al., 2022).

Production costs increased because of labor shortages, especially affecting smallholder farmers reliant on migrant labor. This led to lower efficiency, changes in sales prices, and less food volume in markets (Guido et al., 2020; Gu & Wang, 2020; Meuwissen et al., 2019; Montoya-Torres et al., 2021; Paganini et al., 2020). Smallholder farmers also faced high supplier prices and changing consumption patterns (Gu & Wang, 2020; Kumar & Kumar Singh, 2022; Quayson et al., 2020; Surni et al., 2021). For instance, small coffee and cocoa farmers in Colombia suffered operating losses due to declining demand (Guido et al., 2020; Quayson et al., 2020).

Logistical efficiency in food transport was further compromised by additional inspections, which negatively affected farmers, intermediaries, and consumers (Ali et al., 2023; Gu & Wang, 2020; Paganini et al., 2020; Surni et al., 2021).

Taxonomy of resilience strategies

We identified 33 resilience strategies and four strategic fields from the literature: digital transformation, sustainable production practices, collaborative governance mechanisms, and short FSC. Tables 2, 3, and 4 present the taxonomy of resilience strategies.

Digital transformation

In FSC, Industry 4.0 technologies were implemented to enhance food transportation and extend the freshness of perishable products through smart packaging, cold chain technologies, and monitoring systems (Chitrakar et al., 2021; Kazancoglu et al., 2021; R. Sharma et al., 2021). Technologies like Blockchain and AI were employed to process large volumes of data, identify complex patterns, and make reliable decisions aimed at improving production, reducing food waste, and managing sustainable practices (Amentae & Gebresenbet, 2021; R. Sharma et al., 2021). During and after the COVID-19 pandemic, e-commerce platforms gaigned widespread adoption, enabling farmers to trade products online, implement digital payments, and mitigate supply chain disruptions (Quayson et al., 2020; Surni et al., 2021; Zhou et al., 2020). This digital shift reduced middlemen and facilitated the integration of all stakeholders within the supply chain (Lopez-Ridaura et al., 2021; Rivera-Ferre et al., 2021). Additionally, data-driven and AI tools were developed to simulate scenarios in the supply chain, considering threats and food safety factors (Kazancoglu et al., 2021; Perdana et al., 2020). The pandemic accelerated digital transformation and the adoption of Industry 4.0 technologies in FSC (Ali & Govindan, 2021; Galanakis et al., 2021; Yadav et al., 2021).

Sustainable production practices

The COVID-19 pandemic prompted farmers to diversify products and reduce reliance on foreign supplies (Lopez-Ridaura et al., 2021; Perrin & Martin, 2021). In FSC, stakeholders adopted production methods rooted on circular economy, lean manufacturing, and green supply chain management to enhance performance and

ensure food safety (Amentae & Gebresenbet, 2021; Gupta & Singh, 2021; Lopez-Ridaura et al., 2021; Nesterenko et al., 2021; Sharma et al., 2021). For instance, they adopted practices such as reusing and recovering food waste to replace synthetic fertilizers (Nesterenko et al., 2021). Similarly, traceability of logistical processes was encouraged to facilitate visibility across the supply chain (Galanakis et al., 2021; Montoya-Torres et al., 2021; Sharma, R et al., 2021), (table 2)

Table 2. Taxonomy of resilience strategies for dealing with COVID-19 disruptions on digital transformation

<table>
<tr><th colspan="5">Digital transformation</th></tr>
<tr><th rowspan="2">Resilience Capacities</th><th rowspan="2">Sustainability Drivers</th><th colspan="3">Supply chain stage</th></tr>
<tr><th>Supplying</th><th>Warehousing</th><th>Distribution</th></tr>
<tr><td rowspan="8">Robustness, Adaptability, Transformability, Agility, Visibility, Collaboration</td><td rowspan="5">Internal</td><td colspan="3">Adopt Internet of Things (IoT) technology to facilitate information exchange, monitor crop quality, and optimize the storage and distribution of products (R. Sharma et al., 2021)</td></tr>
<tr><td colspan="3">Utilize smart packaging technologies to extend the shelf life of fresh food (Chitrakar et al., 2021)</td></tr>
<tr><td colspan="3">Utilize intelligent cold chain technologies and detection systems to monitor the physical characteristics of food (Chitrakar et al., 2021)</td></tr>
<tr><td colspan="3">Adopt "Agriculture 4.0" to boost productivity through autonomous machines, AI tools, and ubiquitous agricultural sensing technologies Chitrakar et al., 2021; R. Sharma et al., 2021)

Implement monitoring and traceability of products to support decision-making (e.g. Blockchain) (Chitrakar et al., 2021)

Utilize Wireless Sensor Networks (WSN), Big data, and Cloud computing to detect and analyze parameters of agricultural products

Adopt frequency Identification (RFID) technologies</td></tr>
<tr><td></td><td></td><td>Deploy Artificial Intelligence (AI) systems, autonomous vehicles and intelligent routing (Chitrakar et al., 2021; Mumtaz et al., 2021)</td></tr>
<tr><td>External</td><td colspan="3">Apply bio-analytical tools to detect COVID-19 virus in food, surfaces, and people (Chitrakar et al., 2021)</td></tr>
<tr><td>Internal/external</td><td colspan="3">Implement mechanisms to facilitate the adoption of digital technologies, enable real-time information exchange, foster cooperation, identify supplier networks, and support hybrid business models and omnichannel platforms

Enhance e-commerce to support local and regional food operations

Design adaptive supply chains to market disruptions

Digitalize and automate all processes in supply chain (Industry 4.0) (Kazancoglu et al., 2021)

Redefine and restructure production scenarios to assess the behavior of FSC

Adopt AI and Digital Twins to simulate scenarios based on COVID-19 disruptions to support decision-making (Burgos & Ivanov, 2021)</td></tr>
</table>

Source: Own elaboration

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

In addition, stock security policies and diversification of raw material storage were proposed to increase production robustness and improve inventory management. These strategies included selecting agile and flexible suppliers with extensive geographical coverage and product support capabilities (Perdana et al., 2020; Sharma, R et al., 2021). Together, these practices strengthened supply chain design, flexibility, and transparency, minimized environmental impact and promoted sustainability over time, (table 3).

Table 3. Taxonomy of resilience strategies for dealing with COVID-19 disruptions on sustainable production

<table>
<tr><td colspan="5">Sustainable production</td></tr>
<tr><td rowspan="2">Resilience Capacities</td><td rowspan="2">Sustainability Drivers</td><td colspan="3">Supply chain stage</td></tr>
<tr><td>Supplying</td><td>Warehousing</td><td>Distribution</td></tr>
<tr><td rowspan="6">Robustness
Adaptability
Transformability
Agility
Collaboration</td><td>Internal</td><td>Select flexible and responsive suppliers that have reliable product support and extensive geographical coverage</td><td></td><td></td></tr>
<tr><td>External</td><td colspan="3">Enhance production and inventory management by implementing stock security

Implement backup and diversify strategies for raw materials storage</td></tr>
<tr><td rowspan="4">Internal/external</td><td colspan="3">Adopt circular economy production methods to enhance the organization's environmental, economic, and social performance (Gupta & Singh, 2021)</td></tr>
<tr><td colspan="3">Enhance the traceability of logistics processes at each stage in the supply chain to improve the visibility of the supply chain</td></tr>
<tr><td colspan="3">Design flexible supply chains that enable dynamic scheduling of its processes (Perrin & Martin, 2021)

Promote vertical and horizontal integration in the supply chain to enable direct sales to customers (Lopez-Ridaura et al., 2021)</td></tr>
<tr><td>Promote home gardens to ensure food Security (Perrin & Martin, 2021)</td><td></td><td>Promote direct-to-customer distribution (Lopez-Ridaura et al., 2021)</td></tr>
</table>

Source: Own elaboration

Collaborative governance mechanisms

Several countries developed strategies to support FSC during the COVID-19 pandemic. Collaborative governance mechanisms were introduced to promote flexibility, collaboration, and transparency across FSC supported by information exchange and shared decision-making (Burgos & Ivanov, 2021; Hosseini et al., 2019; Kazancoglu et al., 2021). For instance, a digital governance model was proposed to enhance competitiveness by coordinating governmental entities and private organizations (Perdana et al., 2020; Yadav et al., 2021).

In China, price insurance and subsidies were implemented to stabilize the vegetable supply and reduce losses for farmers (Gu & Wang, 2020; Wang et al., 2023). In Latin America, governments in countries like Mexico, Brazil, and Argentina focused on health, education, and digital inclusion to address the social and economic crisis post-pandemic (CEPAL, 2020). In Colombia, the government launched initiatives that provided financial support and promoted collaboration within the community and digital transformation of the agricultural sector (CEPAL, 2020).

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

Short FSC

During the COVID-19 pandemic, consumers preferred to purchase food directly from farmers to minimize infection risk (Grant et al., 2021; Nesterenko et al., 2021). In response, farmers quickly adapted by exploring new business opportunities, leveraging online platforms and direct sales to trade directly with consumers (Cámara de Comercio de Cali, 2021; Perrin & Martin, 2021; Tripathi et al., 2021), (table 4).

Table 4. Taxonomy of resilience strategies for addressing COVID-19 disruptions on collaborative governance mechanisms and short FSC

Collaborative governance mechanisms				
Resilience Capacities	**Sustainability Drivers**	**Supply chain stage**		
		Supplying	***Warehousing***	***Distribution***
Adaptability, Transformability, Agility, Visibility, Collaboration	Internal	Enhance collaboration in forecasting, customer data collection, and information exchange (Kazancoglu et al., 2021) Enable integration of logistics capabilities among strategic local supply chain partners		
	External	Establish alliances among stakeholders to bolster agricultural marketing and production (Kazancoglu et al., 2021) Design contingency and reactivation plans, insurance procurement, and strategic public-private partnerships		
		Encourage flexibility, collaboration, and transparency throughout the supply chain to mitigate risk		
	Internal/external	Develop policies that support alliances among farmers to improve their decision-making power in the supply chain Establish digital governance models that enable the coordination among governmental entities, and public and private organizations (Perdana et al., 2020)		
		Promote social self-regulation, reflective learning, and autonomy in the agricultural sector		
Short FSC				
Robustness, Adaptability, transformability, Agility, Collaboration	Internal	Diversify supply routes by adopting a dual-sourcing strategy (Perrin & Martin, 2021) Diversify delivery routes by adopting direct-to-customer distribution (Perrin & Martin, 2021)		
	Internal/external	Establish Food Hubs to bridge the gap between farmers and consumers (Grant et al., 2021) Promote direct supply chain between farmers and consumers (Perrin & Martin, 2021)		

Source: Own elaboration

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

In Colombia, the government implemented mechanisms to connect farmers and consumers while minimizing contact and product contamination. These included the creation of websites and digital tools for e-commerce, promoting entrepreneurship, providing financial aid, transferring technology, improving road infrastructure, and expanding rural public goods and services (Castro, 2021; Ministerio de Agricultura y Desarrollo Rural, 2020).

Long-distance FSC were strongly affected by the safety measures implemented during the COVID-19 pandemic. To address this, regional and local food hubs were promoted to connect production with urban and rural consumers, while preventing the spread of the virus and encouraging the growth of short FSCs (Palacios-Argüello et al., 2017, 2020).

Public policies in Colombia

The Colombian government declared a state of emergency, launching programs to maintain food supply and security. These included economic incentives, recovery loans, debt repayment support, and assistance for renting or purchasing equipment for harvesting and post-harvest processes (Decreto 796, 2020). Public policies, such as Consejo Nacional de Política Económica y Social - CONPES 4023, proposed a reactivation plan involving the private sector, integrating logistical perspectives in supply, warehousing, and distribution across productive sectors, including agriculture (CONPES, 2021).

The Agencia de Desarrollo Rural (ADR) and the Ministry of Agriculture proposed initiatives such as the Proyectos Integrales de Desarrollo Agropecuario y Rural (PIDAR) to enhance production capacity and competitiveness in the rural sector. Meanwhile, the Autoridad Nacional de Acuicultura y Pesca (AUNAP) promoted aquaculture and fishing cooperatives, while the Unidad de Restitución de Tierras (URT) implemented projects aimed at promoting land use for agricultural purposes.

DISCUSSION

We conducted literature review using content analysis to identify the pandemic's impacts and the strategies and public policies implemented by stakeholders in the region to adapt to these challenges. Latin America, with its significant agricultural potential and systemic vulnerabilities in FSC, provides an ideal context for studying resilience strategies. The identified strategies were categorized based on their resilience capabilities, sustainability drivers, supply chain stages, and strategic fields. Our taxonomy offers a valuable framework for supporting decision-making in response to future disruptions. It facilitates the identification of tailored resilience strategies for specific supply chain stages, resilience capabilities, or sustainability drivers, particularly in regions facing similar challenges.

The COVID-19 pandemic affected local and global FSCs, impacting countries and stakeholders across all socio-economic roles. These disruptions produced similar effects at global, regional, and local scales. Industry 4.0 technologies played a crucial role for supply chain stakeholders in adapting to new challenges. These technologies bolstered supply chain visibility, agility, and adaptability, enabling stakeholders to overcome disruptions such as distancing protocols and increased production costs. Traceability systems, for instance, tracked the production and delivery process, providing accessible and transparent information to all stakeholders (Ali & Govindan, 2021; Galanakis et al., 2021; Yadav et al., 2021). Developed countries led in digital transformation and sustainable production practices, while Latin America, Africa, and Asia focused on Short FSC and collaborative governance mechanisms. In Colombia, the national government proposed a digital governance model to promote the digital transformation of public institutions. This model aimed to strengthen the citizen-state relationship by enhancing service provision and fostering trust in public administration and institutions using digital tools (Decreto 767, 2022).

A common resilience strategy promoted by local governments involved the use of IoT technologies to connect

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

agricultural farmers directly with consumers through digital channels (e.g. *Fincaya!,* or *ComproAgro*) or establish collaborative mechanisms. These technologies helped to remove unnecessary intermediaries, overcame distancing protocols, and encouraged modernization in the agricultural sector. In Colombia, the government and stakeholders should collaborate to accelerate the digitalization of the agricultural sector, particularly in rural areas where digital illiteracy, lack of connectivity, and inadequate infrastructure hinder the adoption of modern agricultural methods (Esquivel & Toro-García, 2024). The agricultural industry currently faces challenges such as increasing resource demands and extreme climate events, which require the design of resilience strategies to maintain production levels while ensuring food security (Arrubla-Hoyos et al., 2022). Digital and IoT technologies enable the anticipation and monitoring of adverse scenarios.

Resilience strategies vary across countries with different levels of economic development. In Europe and the U.S., real-time information sharing and robust collaborative practices were adopted to enhance stakeholder collaboration (Burgos & Ivanov, 2021; Hosseini et al., 2019; Kazancoglu et al., 2021). However, in Latin America, Africa, and Asia, challenges such as mistrust of digital technologies and insufficient digital literacy limited opportunities to establish collaborative practices. The pandemic accelerated the adoption of Industry 4.0 technologies in agriculture, marking the beginning of a digital revolution across supply chains (Chitrakar et al., 2021; Kazancoglu et al., 2021; Mumtaz et al., 2021; Sharma et al., 2021). National and local governments should address these issues to fully capitalize the benefits of Industry 4.0, particularly when designing and implementing strategies that promote sustainable and collaborative practices in supply chains (Christopher & Peck, 2004; Grant et al., 2021; Kazancoglu et al., 2021). Governments should prioritize policies aimed at improving infrastructure and digital literacy training to facilitate the comprehensive digitization and automation of supply chains, ensuring the efficient delivery of goods and services to communities.

Regarding groundwork, our taxonomy links resilience capabilities, strategic fields, and sustainability drivers. It serves in identifying resilience strategies, whether for the entire supply chain or tailored to specific stages (Hsu et al., 2021; Lagorio et al., 2021). In short SCs, for instance, stakeholders could design and implement direct-to-customer distribution methods to manage disruptions in supply routes. This resilience strategy would enhance the robustness and adaptability of the supply chain while achieving sustainable operations by reducing intermediaries, lowering carbon footprints, and promoting local sourcing. The synergy between these elements could significantly improve the design and implementation of resilience strategies in supply chains.

This study primarily incorporated secondary sources from Latin American and Colombian contexts to emphasize the unique challenges and resilience strategies employed in these regions during the COVID-19 pandemic. FSC in Latin America, including Colombia, face distinct and acute challenges, such as infrastructure vulnerabilities, limited market access, and socio-economic inequalities, which were exacerbated by the pandemic (CEPAL, 2020; United Nations, 2021). The selection of Latin American and Colombian sources was a strategic choice to ground the study in a region with pre-existing vulnerabilities and structural challenges, while the taxonomy proposed in this study was designed to be globally applicable to other regions with similar socio-economic and supply chain challenges, such as those in Africa, where disruptions and food security issues have also been pronounced during the pandemic (Burgos & Ivanov, 2021; Hosseini et al., 2019).

CONCLUSION

We proposed a taxonomy of resilience strategies to facilitate strategic thinking among stakeholders in addressing supply chain disruptions, with a focus on Latin America and Colombia. We classified the impacts of the COVID-19 pandemic, along with the measures enacted by governments and institutions to mitigate its effects. Extreme poverty, food insecurity, and unemployment were the most significant socioeconomic impacts, while higher logistical and production costs, as well as restrictions on reaching consumers, were the key challenges faced by FSC. Our study identified four key strategic fields where most of the resilience strategies were implemented: digital transformation, sustainable production, collaborative governance, and

Clío América / ISSN Impreso: 1909-941X / ISSN Web: 2389-7848 / Vol. 18 No. 36 julio – diciembre de 2024
https://doi.org/10.21676/23897848.6059

short FSC. These strategic fields were integrated with resilience capabilities, sustainability drivers, and supply chain stages to propose a comprehensive framework. This framework serves as a roadmap for identifying resilience strategies tailored to supply chain disruptions in regional contexts. Furthermore, our methodology is replicable and can be applied to categorize resilience strategies in other supply chains.

Currently, growing concerns about supply chain's environmental impacts have prompted a reexamination of its environmental and social sustainability. However, sustainability goals may sometimes conflict with resilience capabilities, such as balancing local/organic production with redundancy through backup suppliers. Future research should expand this taxonomy to include environmental and social sustainability, providing a more holistic framework for identifying resilience strategies to address unexpected disruptions. Additionally, future studies should explore how contextual factors, such as infrastructure, cultural dynamics, or sector-specific characteristics, influence the selection of certain strategies. For example, regional challenges—such as infrastructure gaps, market access limitations, or differing consumer behavior—may drive the adoption of strategies in Latin America. Understanding these contextual influences could offer deeper insights into how resilience strategies can be tailored to the specific needs and challenges of diverse regions and supply chain contexts.

Conflict of interest

The authors declare no conflicts of interest. The funders had no role in the study design; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

This research was funded by grant BPIN 2020000100730 “Fondo de Ciencia, Tecnología e Innovación” from Sistema General de Regalias (SGR) de Colombia.

Author contributions

Monica Patricia Pelegrina-Romero: conceptualization, methodology, formal analysis, investigation, writing-original draft presentation, visualization; **Juan Camilo Vargas-Muñoz**: conceptualization, methodology, formal analysis, investigation, writing-original draft presentation; writing and editing, visualization; **Laura Palacios-Arguello:** conceptualization, methodology, formal analysis, investigation, writing-original draft presentation; writing and editing; **Richard Rios:** writing and editing, supervision, funding acquisition, project administration; **Wilson Adarme-Jaimes:** investigation, writing and editing, supervision, funding acquisition.

REFERENCES BIBLIOGRAPHIES

Ali, I. & Govindan, K. (2021). Extenuating operational risks through digital transformation of agri-food supply chains. *Production Planning & Control*, 1–13. https://doi.org/10.1080/09537287.2021.1988177

Ali, I., Sadiddin, A. & Cattaneo, A. (2023). Risk and resilience in agri-food supply chain SMEs in the pandemic era: a cross-country study. *International Journal of Logistics Research and Applications*, *26*(11), 1602–1620. https://doi.org/10.1080/13675567.2022.2102159

Amentae, T. K. & Gebresenbet, G. (2021). Digitalization and Future Agro-Food Supply Chain Management: A Literature-Based Implications. *Sustainability: Science Practice and Policy*, *13*(21), 12181. https://doi.org/10.3390/su132112181

Arrubla-Hoyos, W., Ojeda-Beltrán, A., Solano-Barliza, A., Rambauth-Ibarra, G., Barrios-Ulloa, A., Cama-Pinto, D., Arrabal-Campos, F. M., Martínez-Lao, J. A., Cama-Pinto, A. & Manzano-Agugliaro, F. (2022). Precision Agriculture and Sensor Systems Applications in Colombia through 5G Networks. *Sensors* , *22*(19). https://doi.org/10.3390/s22197295

Ballou, R. H. (2004). *Logística: administración de la cadena de suministro: Vol. Quinta edición* (E. Q. Duarte (ed.)). Pearson Educación de México, S.A. de C.V. https://books.google.com/books/about/Log%C3%ADstica.html?hl=es&id=ii5xqLQ5VLgC

Banco Mundial. (2022, January 20). *Resumen del año 2021 en 11 gráficos: la pandemia de la desigualdad*. World Bank; Banco Mundial. https://www.bancomundial.org/es/news/feature/2021/12/20/year-2021-in-review-the-inequality-pandemic

Burgos, D. & Ivanov, D. (2021). Food retail supply chain resilience and the COVID-19 pandemic: A digital twin-based impact analysis and improvement directions. *Transportation Research Part E: Logistics and Transportation Review*, *152*, 102412. https://doi.org/10.1016/j.tre.2021.102412

Castro, F. G. (2021, August 4). *El reto del E-Commerce en Colombia en plena pandemia*. Universidad El Bosque. https://www.unbosque.edu.co/centro-informacion/noticias/el-reto-del-e-commerce-en-colombia-en-plena-pandemia

Chitrakar, B., Zhang, M. & Bhandari, B. (2021). Improvement strategies of food supply chain through novel food processing technologies during COVID-19 pandemic. *Food Control*, *125*, 108010. https://doi.org/10.1016/j.foodcont.2021.108010

Christopher, M. & Peck, H. (2004). Building the Resilient Supply Chain. *The International Journal of Logistics Management*, *15*(2), 1–14. https://doi.org/10.1108/09574090410700275

Comisión Económica para América Latina y el Caribe - CEPAL . (2020). *Panorama Social de América Latina 2020* (CEPAL (ed.)). CEPAL. https://hdl.handle.net/11362/46687

Comisión Económica para América Latina y el Caribe - CEPAL. (2022). *Panorama Social de América Latina 2021* (CEPAL (ed.)). CEPAL. https://hdl.handle.net/11362/47718

Consejo Nacional de Política Económica y Social - CONPES. (2021). *Documento CONPES 4023. Política para la reactivación, la repotenciación y el crecimiento sostenible e incluyente: nuevo compromiso por el futuro de Colombia.* https://colaboracion.dnp.gov.co/CDT/Conpes/Económicos/4023.pdf

Cordeiro, M. C., Santos, L., Angelo, A. C. M. & Marujo, L. G. (2022). Research directions for supply chain management in facing pandemics: an assessment based on bibliometric analysis and systematic literature review. *International Journal of Logistics Research and Applications*, *25*(10), 1313–1333. https://doi.org/10.1080/13675567.2021.1902487

Departamento Administrativo Nacional de Estadística – DANE. (2021). *Pobreza Multidimensional Colombia -*

2020. Boletín Técnico Anual. https://www.dane.gov.co/index.php/est

Decreto 767. (2022). Por el cual se establecen los lineamientos generales de la Política de Gobierno Digital y se subroga el Capítulo 1 del Título 9 de la Parte 2 del Libro 2 del Decreto 1078 de 2015, Decreto Único Reglamentario del Sector de Tecnologías de la Información y las Comunicaciones. Gobierno de Colombia. https://www.funcionpublica.gov.co/eva/gestornormativo/norma.php?i=186766

Downe-Wamboldt, B. (1992). Content analysis: method, applications, and issues. *Health Care for Women International*, *13*(3), 313–321. https://doi.org/10.1080/07399339209516006

Esquivel García, C. L. & Toro-García, G. L. (2024). Multidimensional energy poverty in Colombia: A department-level review from 2018 to 2022. *Heliyon*, *10*(14), e34395. https://doi.org/10.1016/j.heliyon.2024.e34395

Galanakis, C. M., Rizou, M., Aldawoud, T. M. S., Ucak, I. & Rowan, N. J. (2021). Innovations and technology disruptions in the food sector within the COVID-19 pandemic and post-lockdown era. *Trends in Food Science & Technology*, *110*, 193–200. https://doi.org/10.1016/j.tifs.2021.02.002

Grant, D. B., Banomyong, R. & Gibson, B. J. (2021). A brave new world for retail logistics and SCM in the 2020s and beyond. *International Journal of Logistics Research and Applications*, 1–14. https://doi.org/10.1080/13675567.2021.1986477

Gu, H.-Y. & Wang, C.-W. (2020). Impacts of the COVID-19 pandemic on vegetable production and countermeasures from an agricultural insurance perspective. *Journal of Integrative Agriculture*, *19*(12), 2866–2876. https://doi.org/10.1016/S2095-3119(20)63429-3

Guido, Z., Knudson, C. & Rhiney, K. (2020). Will COVID-19 be one shock too many for smallholder coffee livelihoods? *World Development*, *136*, 105172. https://doi.org/10.1016/j.worlddev.2020.105172

Gupta, A. & Singh, R. K. (2021). Applications of emerging technologies in logistics sector for achieving circular economy goals during COVID 19 pandemic: analysis of critical success factors. *International Journal of Logistics Research and Applications*, 1–22. https://doi.org/10.1080/13675567.2021.1985095

Hosseini, S., Ivanov, D. & Dolgui, A. (2019). Review of quantitative methods for supply chain resilience analysis. *Transportation Research Part E: Logistics and Transportation Review*, *125*, 285–307. https://doi.org/10.1016/j.tre.2019.03.001

Kazancoglu, Y., Sezer, M. D., Ozbiltekin-Pala, M., Lafçı, Ç. & Sarma, P. R. S. (2021). Evaluating resilience in food supply chains during COVID-19. *International Journal of Logistics Research and Applications*, 1–17. https://doi.org/10.1080/13675567.2021.2003762

Kumar, P.,& Kumar Singh, R. (2022). Strategic framework for developing resilience in Agri-Food Supply Chains during COVID 19 pandemic. *International Journal of Logistics Research and Applications*, *25*(11), 1401–1424. https://doi.org/10.1080/13675567.2021.1908524

Laborde, D., Martin, W. & Vos, R. (2021). Impacts of COVID-19 on global poverty, food security, and diets:

Insights from global model scenario analysis. *Agricultural Economics* , *52*(3), 375–390. https://doi.org/10.1111/agec.12624

Lagorio, A., Cimini, C., Pirola, F. & Pinto, R. (2021). A Taxonomy of Technologies for Human-Centred Logistics 4.0. *NATO Advanced Science Institutes Series E: Applied Sciences*, *11*(20), 9661. https://doi.org/10.3390/app11209661

Lee, S. & Klassen, R. D. (2008). Drivers and Enablers That Foster Environmental Management Capabilities in Small- and Medium-Sized Suppliers in Supply Chains. *International Journal of Operations & Production Management*, *17*(6), 573–586. https://doi.org/10.3401/poms.1080.0063

Loker, A. (2020). COVID-19 and the US Lettuce Supply Chain: Implications for Farmworker Health and Safety and a Secure Supply. *Journal of Agricultural & Food Industrial Organization*, *18*(2). https://doi.org/10.1515/jafio-2020-0029

Lopez-Ridaura, S., Sanders, A., Barba-Escoto, L., Wiegel, J., Mayorga-Cortes, M., Gonzalez-Esquivel, C., Lopez-Ramirez, M. A., Escoto-Masis, R. M., Morales-Galindo, E. & García-Barcena, T. S. (2021). Immediate impact of COVID-19 pandemic on farming systems in Central America and Mexico. *Agricultural Systems*, *192*, 103178. https://doi.org/10.1016/j.agsy.2021.103178

Mahler, D. G., Yonzan, N., Lakner, C., Andres Castaneda Aguilar, R. & Wu, H. (2021, June 24). Updated estimates of the impact of COVID-19 on global poverty: Turning the corner on the pandemic in 2021? *World Bank Blogs*. https://blogs.worldbank.org/en/opendata/updated-estimates-impact-covid-19-global-poverty-turning-corner-pandemic-2021

Meuwissen, M. P. M., Feindt, P. H., Spiegel, A., Termeer, C. J. A. M., Mathijs, E., Mey, Y. de, Finger, R., Balmann, A., Wauters, E., Urquhart, J., Vigani, M., Zawalińska, K., Herrera, H., Nicholas-Davies, P., Hansson, H., Paas, W., Slijper, T., Coopmans, I., Vroege, W., … Reidsma, P. (2019). A framework to assess the resilience of farming systems. *Agricultural Systems*, *176*, 102656. https://doi.org/10.1016/j.agsy.2019.102656

Middendorf, B. J., Traoré, H., Middendorf, G., Jha, P. K., Yonli, D., Palé, S. & Prasad, P. V. V. (2022). Impacts of the COVID-19 pandemic on vegetable production systems and livelihoods: Smallholder farmer experiences in Burkina Faso. *Food and Energy Security*, *11*(1), e337. https://doi.org/10.1002/fes3.337

Ministerio de Agricultura y Desarrollo Rural. (2020). *Plan Nacional de Agrologística. Versión para discusión*. Minagricultura. https://sioc.minagricultura.gov.co/DocumentosContexto/S3877-Plan%20Nacional%20de%20Agrologística.pdf

Montoya-Torres, J. R., Muñoz-Villamizar, A. & Mejia-Argueta, C. (2021). Mapping research in logistics and supply chain management during COVID-19 pandemic. *International Journal of Logistics Research and Applications*, 1–21. https://doi.org/10.1080/13675567.2021.1958768

Mumtaz, M., Hussain, N., Baqar, Z., Anwar, S. & Bilal, M. (2021). Deciphering the impact of novel coronavirus

pandemic on agricultural sustainability, food security, and socio-economic sectors-a review. *Environmental Science and Pollution Research International*, *28*(36), 49410–49424. https://doi.org/10.1007/s11356-021-15728-y

Nesterenko, N., Vetrova, M. & Ivanova, D. (2021). The influence of the pandemic COVID-19 on the food supply chain management. *IOP Conference Series: Earth and Environmental Science*, *782*(2), 022040. https://doi.org/10.1088/1755-1315/782/2/022040

Paganini, N., Adinata, K., Buthelezi, N., Harris, D., Lemke, S., Luis, A., Koppelin, J., Karriem, A., Ncube, F., Nervi Aguirre, E., Ramba, T., Raimundo, I., Sulejmanović, N., Swanby, H., Tevera, D. & Stöber, S. (2020). Growing and Eating Food during the COVID-19 Pandemic: Farmers' Perspectives on Local Food System Resilience to Shocks in Southern Africa and Indonesia. *Sustainability: Science Practice and Policy*, *12*(20), 8556. https://doi.org/10.3390/su12208556

Palacios-Argüello, L., Morganti, E. & Gonzalez-Feliu, J. (2017). Food hub: Una alternativa para alimentar las ciudades de manera sostenible. *Revista Transporte Y Territorio*, (17), 10–33. https://www.redalyc.org/articulo.oa?id=333053372002

Palacios-Argüello, L., Sanchez-Diaz, I., Gonzalez-Feliu, J. & Gondran, N. (2020). The Role of Food Hubs in Enabling Local Sourcing for School Canteens. In E. Aktas & M. Bourlakis (Eds.), *Food Supply Chains in Cities: Modern Tools for Circularity and Sustainability* (pp. 233–263). Springer International Publishing. https://doi.org/10.1007/978-3-030-34065-0_8

Perdana, T., Chaerani, D., Achmad, A. L. H. & Hermiatin, F. R. (2020). Scenarios for handling the impact of COVID-19 based on food supply network through regional food hubs under uncertainty. *Heliyon*, *6*(10), e05128. https://doi.org/10.1016/j.heliyon.2020.e05128

Perrin, A. & Martin, G. (2021). Resilience of French organic dairy cattle farms and supply chains to the Covid-19 pandemic. *Agricultural Systems*, *190*, 103082. https://doi.org/10.1016/j.agsy.2021.103082

Quayson, M., Bai, C. & Osei, V. (2020). Digital Inclusion for Resilient Post-COVID-19 Supply Chains: Smallholder Farmer Perspectives. *IEEE Engineering Management Review*, *48*(3), 104–110. https://doi.org/10.1109/EMR.2020.3006259

Rasul, G. (2021). A Framework for Addressing the Twin Challenges of COVID-19 and Climate Change for Sustainable Agriculture and Food Security in South Asia. *Frontiers in Sustainable Food Systems*, *5*. https://doi.org/10.3389/fsufs.2021.679037

Rivera-Ferre, M. G., López-i-Gelats, F., Ravera, F., Oteros-Rozas, E., di Masso, M., Binimelis, R. & El Bilali, H. (2021). The two-way relationship between food systems and the COVID19 pandemic: causes and consequences. *Agricultural Systems*, *191*(103134), 103134. https://doi.org/10.1016/j.agsy.2021.103134

Seuring, S. & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain

management. *Journal of Cleaner Production*, *16*(15), 1699–1710. https://doi.org/10.1016/j.jclepro.2008.04.020

Sharma, M., Joshi, S., Luthra, S. & Kumar, A. (2022). Managing disruptions and risks amidst COVID-19 outbreaks: role of blockchain technology in developing resilient food supply chains. *Operations Management Research*, *15*(1), 268–281. https://doi.org/10.1007/s12063-021-00198-9

Sharma, R., Shishodia, A., Kamble, S., Gunasekaran, A. & Belhadi, A. (2021). Agriculture supply chain risks and COVID-19: mitigation strategies and implications for the practitioners. *International Journal of Logistics Research and Applications*, 1–27. https://doi.org/10.1080/13675567.2020.1830049

Sheffi, Y. (2018). Sustainability in practice. *Journal of Business Logistics*, *39*(3), 160–163. https://doi.org/10.1111/jbl.12193

Sierra, C. S. (2021, September 3). *En 2020, nueve millones de colombianos quedaron en pobreza multidimensional*. Diario La República. https://www.larepublica.co/economia/en-2020-nueve-millones-de-colombianos-estuvieron-en-pobreza-multidimensional-3226731

Surni, Roy Nendissa, D., Abdul Wahib, M., Haryulin Astuti, M., Arimbawa, P., Miar, M. J. Kapa, M. & Feronika Elbaar, E. (2021). Socio-economic impact of the Covid-19 pandemic: Empirical study on the supply of chicken meat in Indonesia. *AIMS Agriculture and Food*, *6*(1), 65–81. https://doi.org/10.3934/agrfood.2021005

Thapa Magar, D. B., Pun, S., Pandit, R. & Rola-Rubzen, M. F. (2021). Pathways for building resilience to COVID-19 pandemic and revitalizing the Nepalese agriculture sector. *Agricultural Systems*, *187*, 103022. https://doi.org/10.1016/j.agsy.2020.103022

Tripathi, H. G., Smith, H. E., Sait, S. M., Sallu, S. M., Whitfield, S., Jankielsohn, A., Kunin, W. E., Mazibuko, N. & Nyhodo, B. (2021). Impacts of COVID-19 on Diverse Farm Systems in Tanzania and South Africa. *Sustainability: Science Practice and Policy*, *13*(17), 9863. https://doi.org/10.3390/su13179863

United Nations. (2021, April 19). *Comprehensive Study on the Impact of COVID-19 on the Least Developed Country Category*. United Nations. https://www.un.org/development/desa/dpad/publication/comprehensive-study-on-the-impact-of-covid-19-on-the-least-developed-country-category/

Vargas, A. R. P. (2020). *Las iniciativas que acercan los productos del campo a las principales ciudades del país*. Diario La República. https://www.larepublica.co/responsabilidad-social/las-iniciativas-que-acercan-a-los-productos-del-campo-a-las-principales-ciudades-3055265

Wang, Y., Yan, F., Jia, F., & Chen, L. (2023). Building supply chain resilience through ambidexterity: an information processing perspective. *International Journal of Logistics Research and Applications*, *26*(2), 172–189. https://doi.org/10.1080/13675567.2021.1944070

Yadav, S., Luthra, S., & Garg, D. (2021). Modelling Internet of things (IoT)-driven global sustainability in multi-tier agri-food supply chain under natural epidemic outbreaks. *Environmental Science and Pollution Research*

International, *28*(13), 16633–16654. https://doi.org/10.1007/s11356-020-11676-1

Zhou, J.-H., Han, F., Li, K., & Wang, Y. (2020). Vegetable production under COVID-19 pandemic in China: An analysis based on the data of 526 households. *Journal of Integrative Agriculture*, *19*(12), 2854–2865. https://doi.org/10.1016/S2095-3119(20)63366-4