

# **Problems and Response Actions of the Food Supply Chain Against Covid-19: A SLR**

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## **Abstract**

The aim of this study was to show what was caused by Covid-19 at all stages of the food supply chain, whose actors are: producers, processors, distributors, retailers and consumers. Likewise, it sought to identify the main problems and the response actions of each link in the face of the new conditions of the pandemic; for this, a systematic review of the literature was carried out, which was based on the collection of knowledge regarding Covid-19 and the food supply chain. As a result of this search, 67 papers from reliable databases were collected, databases such as Scopus and Web of Science; these papers were considered because they met the stipulated inclusion criteria. The selected papers allowed to identify that the main problems in the links are due to the shortage of labor / workforce, difficulty in the supply of materials or inputs, lack of transportation to distribute food and products, fluctuation in demand and price increases. Regarding the first links, it is identified that the majority of response actions were deeply linked to technology, innovation, IoT, automation and optimization, seeking to reduce the involvement of labor; and, in the case of the consumer link, the response actions were linked to the use of virtual platforms. These responses were adapted in various ways depending on the link, since each of them acted differently to each problem; despite this, the decisions to be made should consider the repercussions they would have on the next link.

## **Keywords**

Food, Supply Chain, Food Security, Pandemic, and Covid-19.

## **1. Introduction**

Supply chains are characterized by operating efficiently in the background, out of sight of end consumers (Sombultawee et al., 2022); however, this "silent" efficiency collapsed after the appearance of the contagious Corona Virus Disease, better known as Covid-19, because the restrictions, isolation, control and social distancing measures

implemented in order to stop the contagion and expansion of the virus, would end up paralyzing multiple activities carried out by producers, wholesalers, retailers, distributors and consumers (Cardoso et al., 2021).

Food industry supply chains are defined as a network that connects the farm to the consumer's table (Chen et al., 2020) involving intermediate processes such as processing, distribution and sale. The importance of this sector lies in the fact that it is in charge of delivering fundamental items to cover the basic needs of the population, being a vital part of human survival and an economic driver through food trade (Barman et al., 2021b). In that context, Chamola et al. (2020) identify the food sector as one of the sectors most affected by the Coronavirus outbreak, for which a more detailed evaluation and analysis is required in order to define how the supply chain of this specific sector behaved in the face of the interruption caused by Covid-19, taking into account the problems and response actions of each link.

There are 5 links that make up the supply chain: Producers, processors, distributors, retailers and consumers (Chen et al., 2020), and each link is essential to competitively satisfy the end customer, because as Perdana et al. (2020) say, each of them intervenes and affects the performance and costs of the subsequent one. For example, the quality of a final product will depend on whether or not its components meet the highest standards, as well as the final cost will depend on the costs of the raw material that was involved; on the other hand, the speed of arrival at the consumer will depend on the response of each of the links, in addition to having a fast distribution, efficient planning and adequate programming (Laborde et al., 2020). Since each link produces and develops a part of the product in sequence, it can be said that it adds value in each process. Although it is true there must be a balance between consumption, production and inventory, which denotes a linear performance; the pandemic generated an imbalance in the balances of these elements (Zielinska-Chmielewska et al., 2021).

This paper, unlike other multiple investigations, seeks to explain how the food supply chain was affected by Covid-19 and what were the response actions that were carried out in light of this scenario for each specific link, taking into account its particularities and characteristics; this allowed the reader a better understanding of all phases of the food supply chain, in order to provide a contribution to society so that it can be better prepared for future crises. One of the main difficulties presented for carrying out this research was the lack of guide material similar to the one proposed, which means, there were no investigations that addressed the Covid-19 problem and the response actions by link, but rather in a general way.

## **1.1 Objectives**

The first objective was identifying the problems that each link in the food supply chain had to face due to Covid-19, the second objective was show the response actions of each link in the supply chain regarding these dilemmas caused by the Covid, and finally, the third objective was analyzing if the responses of each link in the supply chain were the most appropriate.

## **2. Literature Review**

### **2.1 Overview of the Covid situation**

The pandemic caused by the Covid-19 affected many countries, because as the cases increased, the countries imposed control measures, restrictions, blockades and immobilization policies, in order to stop the contagion and generate recovery strategies based mainly on resilience to overcome this crisis (Barman et al., 2021a). The panorama of the Asian continent would provide an idea of how other countries could react, since they would be the first to implement response actions to the problems or obstacles caused by the recent Covid-19 (Fan et al., 2021; Zhang et al., 2020); in China, the first affected country, control measures described as "the strictest control measures since the founding of the People's Republic of China" were enacted (Min et al., 2020); for export and import dependent countries like Singapore and Malaysia, proactive and reactive measures were put in place to protect food supply chains from all kinds of disruptions and build a resilient and sustainable system, with a primary focus on hazard of closing borders, since they are countries with an open economy exposed to volatile global markets (Chin, 2020; Tortajada & Lim, 2021; Z. Xu et al., 2021). On the other hand, Western countries such as Canada and the United States identified supply-side disruptions, demand-side shocks, and long-term changes that would end up affecting the nature of food supply chains. paying special attention to consumer behavior and experience (Alsetoohy et al., 2021; Hobbs, 2020, 2021a).

## **2.2 Paper's Approach**

In this section, the papers that cover the main problems or obstacles will be grouped; as well as the most relevant response actions, regardless of the country or region of origin.

### **2.2.1 Problems or obstacles**

It was possible to identify that the main problems or obstacles were: the lack of labor / workforce, since the material that could not be processed was lost and production was delayed, incurring losses and reduced income; the difficulty in the supply of materials and inputs, since compliance with the production plan was compromised, unnecessary storage expenses were incurred, and delays were generated; the lack of transportation to transport food and supplies, which generated the loss of inputs and materials, since many of these were of a perishable nature and if they were not in the right place they were lost in days, incurring expenses and losses when paying for storage not used; the fluctuation of demand, essential in production planning, since it was affected by the change in the purchasing behavior of consumers, who initially oversupplied due to the uncertainty of the panorama offered by the pandemic, to subsequently, decrease their level of purchase in response to the reduction in wages and loss of jobs; and, finally, the price increasing, originated because the quantity of products offered did not increase to meet the increase in demand.

The authors who focus the most on these problems or obstacles are the following: Godrich et al. (2022); Tortajada & Lim (2021); Cardoso et al. (2021), Alsuwailem et al. (2022), Aday & Aday (2020) and Din et al. (2022).

### **2.2.2 Response Actions**

It was possible to identify that the principal response actions were mainly linked to topics such as: technological tools, such as the implementation of new equipment and drones that allow tasks previously performed by men; automation of processes, which allows to reduce the intervention of man in the operation of machinery; optimization of processes that allows the increase of efficiency in order to rise production by reducing costs related to materials and supplies; implementation of traceability, which will allow monitoring the route of each product, ensuring its safety and quality.

The authors who focus the most on response strategies or actions are the following: Achmad et al. (2021), Aamer et al. (2021), Nurul Eiman et al. (2021), Nesterenko et al. (2021), Ali et al. (2021), Knorr & Khoo (2020) and N. Xu et al. (2021).

## **3. Methods**

This paper was developed under the methodology of the Systematic Literature Review, which allowed evaluating and interpreting all the available research that contains relevant information and that allows the proposed objectives. To achieve the above, academic articles will be analyzed, academic articles that have as their main topic the problems or obstacles and the response actions of the food supply chain against Covid. For the realization of the SLR, 4 phases were taken into account that included important steps, as indicated by Aamer et al. (2021) the development of each of these steps was essential for the review to be scientifically rigorous. The phases are detailed below:

- **Planning phase:** In this phase, the objectives, the need and importance of carrying out this research, its contribution, the scope, the review strategy and the methodology to be used are defined. In addition, the inclusion criteria to be used are detailed.
- **Selection phase:** For an investigation to be selected, from among the population of articles to be reviewed, it must meet the following inclusion criteria: investigations belonging to reliable databases such as Scopus or Web of Science, as they contain reliable information that adds to the present investigation, investigations whose publication were between 2020 and 2022 (given the time of appearance of the pandemic), investigations that address response actions or problems related to Covid-19 and food supply chain, for this criterion the following keywords were defined: "Food", "Supply Chain", "Food Security", "Pandemic" and "Covid-19". These words were combined when placing them in search engines. This stage allowed the selection of 80 papers.
- **Extraction phase:** Initially, a total of 80 academic articles were examined; however, after reading the abstract and body of the same, 13 articles were eliminated because they did not contain information such as problems or response actions on the subject evaluated. Applying these filters, 67 articles were found, which were reviewed again to confirm their usefulness in the development of this work. Finally, in this last review, all the papers considered were accepted, since they met the inclusion criteria and provided relevant information based on the proposed objectives.

- Execution phase: This phase began with the analysis of the data extracted from all the papers, to later organize and classify the information according to the link to which it was focused, in such a way that it was understood how each actor in the chain dealt with the problems caused by the Covid-19. During the execution of this work, it was identified that the vast majority of papers addressed the problem and the response actions in a general way, without delving into how they reacted or what problems each link presented.

#### 4. Data Collection

After applying the inclusion filters, 80 papers were found, this amount corresponded to the selection phase; however, after rereading the information in these 80 papers, it was decided to eliminate all those that did not have data related to problems or response actions, or that did not contribute to this investigation; therefore, for the extraction phase, 67 papers were used.

Table 1 shows the percentage of papers reviewed, eliminated, and approved based on the initial number of 80 papers.

Table 1. Papers Approved

Classification	Number of Papers	Percentage of paper
Reviews	80	100%
deleted	13	16.25%
<b>approved</b>	<b>67</b>	<b>83.75%</b>

As previously mentioned in the methodology chapter, for the present investigation, reliable databases were used, such as Web Of Science and Scopus; however, other papers from databases such as Oxford Academic and Wiley Online Library were also considered, mainly due to the quality of their research and their great contribution. For a better understanding, the following graph is shown, which indicates the number of Papers per database consulted.

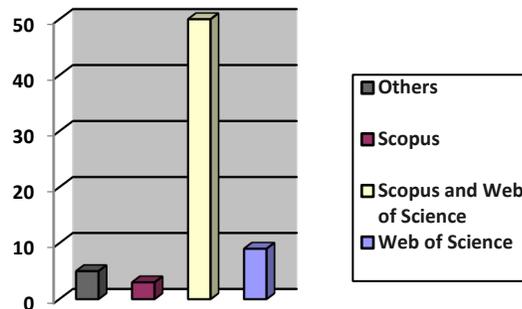


Figure 1. Number of Papers per Database

As Figure 1 indicates, the vast majority of papers consulted were from Scopus and Web of Science, with 50 being found in both databases; this demonstrates the reliability of the quality of the investigations. On the other hand, 9 were the papers found only in Web of Science, 3 in Scopus, and 5 in other databases (Oxford Academic and Wiley Online Library).

Regarding the years of publication of the papers collected, it was observed that 26 were from 2020, 28 belonged to 2021 and as for 2022, 13 were obtained, as shown in Figure 2.



better understand the different obstacles, they had to face and how they responded to them according to their own characteristics, it should be noted that these response actions must be aimed at guaranteeing the availability of food, food security and resilience capacity (Perdana et al., 2020; Sombultawee et al., 2022).

This section will be structured based on the 5 links of the food supply chain: Producers, Processors, Distributors, Retailers and Consumers (Chen et al., 2020); where first the definition or concept of each link will be mentioned, to continue with the presentation of the problems or obstacles and the response actions that were carried out or that should be carried out based on the reviewed literature.

### **5.1 First link: Producers**

Producers are all those who carry out activities with the aim of generating food materials; the general fluidity of the supply chain depends on these initial actors, since operational continuity in agricultural production is required to ensure the supply of products to consumers (Luckstead et al., 2021), safety, quality, freshness and state of the final foods (Din et al., 2022). Despite its great importance, in some cases they had difficulties facing the obstacles, which were mainly 5: scarcity of economic resources, limited responses due to the nature of the systems, difficulty in transporting equipment, materials, and supplies; reduction and lack of human workforce; and product losses.

Even though this link is essential, producers are vulnerable to unpredictable situations such as the COVID-19 pandemic, since their responses are usually limited mainly by their scarce economic resources (Xie et al., 2021); based on this problem, it was observed that the main response action was to seek support from Ministries and local governments, since it was identified that they provided monetary support through assistance programs; this aid served to react and face losses of a material, productive and economic nature (Zielinska-Chmielewska et al., 2021).

Another problem is identified in the limitation for decision-making, based mainly on the nature of the systems in which this link operates, since agricultural production processes have a certain speed, which, unlike the other links, can be altered by the presence of multiple factors such as: the reproduction cycle of farm animals, a cycle that varies depending on the species; planting time of the crops, where there are seasonal patterns for the crops, which would depend on the type of product; and the perishable nature of food from agriculture (Hobbs, 2020).

In addition, there were difficulties in the acquisition of equipment, inputs (fertilizers, seeds, fungicides, insecticides, among others), extension services, and veterinary services, caused by movement restrictions. Regarding the acquisition of inputs, the most appropriate response action was to establish solid relationships with suppliers, in such a way that the supply is assured; however, the same practice could not be carried out for relations with veterinary and extension services, because, despite its necessity, the absence generated ended up causing damage to crop harvests and animal health, reaching to cause their death (Mthembu et al., 2022).

Regarding the lack of labor, other sectors were able to allow their employees to work from home; however, this action could not be applied in the food industry and mainly in the first link, since the tasks related to agricultural production did not allow it (Nurul Eiman et al., 2021); in view of this panorama, it was identified that some countries and regions took drones implementation as a response action to replace human activity and even improve the efficiency and effectiveness of the processes, since these were capable of mapping fields, monitoring crops, verifying the irrigation efficiency, apply pesticides and perform other functions (Koshta et al., 2021). For this specific problem, the cases of countries such as the USA stand out, where it was observed that the human workforce that worked the crops was mainly undocumented or illegal, been this the reason of their extremely poor living condition; given this situation, the most outstanding response actions were: the implementation of state policies that facilitate the hiring of this type of workers (allowing them to have the social benefits of a documented and legal person), the application of social distancing by reducing shift workers, and the implementation of paid sick leave, as a way to ensure that workers report having symptoms, which allowed taking care of their other collaborators (Luckstead et al., 2021). Quite the opposite occurred in countries belonging to the African continent, since their economy and characteristics did not allow pay to the personnel who worked in the field, since the producers were victims of multiple losses of money and inputs, by not receiving any kind of help or advice from their governments (Mthembu et al., 2022).

All the aforementioned limitations had a negative influence on the quality of the crops and livestock stocks, which caused them to be rejected for not meeting the quality standards when they wanted to be sent to the next link to continue with the process flow, this ended up generating an increase in the inventory level, and storage expenses (Mthembu et al., 2022), which is why multiple producers chose to discard, give away or spoil their crops (Nesterenko

et al., 2021). In view of this panorama, it is proposed to look for new alternative points of sale as markets, in order to offer the most perishable products and those with the highest storage cost (Hobbs, 2021b).

## **5.2 Second link: Processors**

The main objective of this link is to carry out a series of modifications to the raw material to transform it, in order to provide added value, offering to the consumers' products in optimal conditions that meet their needs; it should be noted that all of these processes must be carried out in compliance with health and safety standards (Usgame et al., 2007). Mobilization restrictions, control measures and distancing policies also affected the operations and process flow of this link (Hobbs, 2020), identifying 6 main problems: scarcity of raw materials, materials and inputs; closure of facilities, risk of contagion of workers and fear of contagion; staff reduction; food safety risk; and, difficulty paying their operating expenses.

Based on what was mentioned in the previous paragraph, the acquisition of raw materials is essential to ensure the continuity of operation of this link, therefore, when an event such as the one caused by the pandemic arises, one of the main challenges presented to the food supply chain would be obtaining raw materials, inputs and other materials (Din et al., 2022); in order to face this specific problem, it is identified the response action of seeking temporary alternative inputs that fulfill the same functions and have similar characteristics, while the situation was regulated, in order to continue processing the raw material and avoid its loss (Alsuwailem et al., 2022).

On the other hand, the Covid-19 caused many companies to be forced to partially or even totally close their facilities, or in other cases adopt strict restrictions regarding the health guidelines established by the government and authorized entities such as the OMS; in other words, the Covid forced to change the working conditions to maintain the health and safety of the employees, which was achieved by implementing strategic measures (Rashid et al., 2021); these measures are usually characterized by starting from the entrance to the facilities, where the temperature is checked through the use of calibrated thermometer guns, thus preventing the entrance of those with a temperature of 100.4° F/38°C or higher, as well as the ones with symptoms of Covid-19; inside the facilities, the operators had to respect social distancing while performing tasks (separators/barriers were used between employees at each workstation) and when they were having lunch breaks, they were divided into groups so that they had lunch at different times avoiding crowding in the dining room; likewise, the operators should use appropriate personal protective equipment (protective clothing, gloves, masks, hairnets), wash their hands frequently and avoid touching their faces, which was complemented by cleaning the most crowded surfaces and adequate ventilation. In addition, an important point was to calculate the optimal number of workers, since a smaller number of operators, unlike the normal one, would imply a lower amount of risk in the spread of Covid-19. Another factor to consider was the vaccination of employees, which was recommended and in some cases mandatory; finally, one of the last measures considered was to adopt restrictive policies for visitors, including suppliers and contractors, these measures included that each visit complete a record called a "health declaration form", which "assured" that the external visitor did not had symptoms of Covid-19 (Shahbaz et al., 2020; Trmčić et al., 2021).

Such measures helped ease workers' concerns about catching the virus. However, there was also a risk of indirect contagion, since as is known the virus is not only transmitted from person to person, but also through objects (objects that could have been handled by an infected employee); precisely one source of transmission were food packages, generally made from cardboard and plastic, according to Pressman et al. (2020) the virus remains on cardboard for up to 24 hours, and on plastic and stainless steel for up to 72 hours. This particular material, the plastic, was a challenge for food-related industries, who had to act by giving greater importance to the control of product safety, since they are responsible for guaranteeing that food is free of pathogens at the time it is delivered to customers, ensuring the safety of consumers and employees (Jawed et al., 2020).

Based on the previously mentioned, it is important to maintain food safety among those who handle food, as this should not be taken lightly in this type of sector (Nurul Eiman et al., 2021); in the same way, the workforce must be ensured, since production was reduced due to the fact that the workers were infected with COVID-19 or reacted with fear to the contagion, staying at home (Alsuwailem et al., 2022), this generated the implementation of previously mentioned protocols and measures, which would bring an increase in the cost of labor, since its execution would end up causing the speed in the processing lines to be reduced (Hobbs, 2020), which was an incentive for automation and digital transformation in the long term, tools that allowed reducing dependence on human workforce and making greater use of robotics in production and processing lines. Automation is commonly adapted to tasks that are executed in a uniform way, such as packaging and quality control, activities that also depend on the type of processed food, for example, in the case of meat, it is more complicated to define a homogeneous system, given the diversity of the size

of the animals (Hobbs, 2021b; Weersink et al., 2021), due to the aforementioned, many meat processing plants decreased their average production capacity, highlighting the case of the USA, a country that reduced the slaughter of cattle and pigs by approximately 40% in April 2020, compared to April 2019 (Ijaz et al., 2021). Otherwise, the digital transformation allowed them to manage, simulate and optimize various processes without having to carry them out in a tangible way, which made it possible to reduce time and eliminate multiple unnecessary expenses using virtualization and IoT (Hobbs, 2021b).

Another problem identified was the difficulty in paying its operating expenses, since there was already a budget that was made based on forecast sales, however, the appearance of COVID-19 caused sales to be lower than projected, causing difficulties to face operating expenses such as the payment of staff salaries; payment of factories, facilities, warehouses, and establishments rental; payment of interest on loans and credits; and other expenses that ended up paralyzing the activities related to the processing. Given this event, the search for governmental, regional or municipal help was observed as a response action, since the existence of state and regional programs that provide advice and financial support for these cases was identified (Chowdhury et al., 2022).

### **5.3 Third link: Distributors**

This link allows the distribution of the products from the processors to the retailers, which were directly affected by the measures implemented, since the movement restrictions prevented maritime, air and land transport, that is, the development of their activities was seen directly affected, being hit more aggressively compared to other links (Chari et al., 2022). However, these measures were necessary to reduce contagion and positive cases, since studies showed that, given a greater volume in terms of transport and operations, the level of contagion would be higher (Alsuwailam et al., 2022; Castro et al., 2021). Taking into account the previously mentioned, 4 main problems or obstacles can be identified: new safety and health measures, reduction of labor, changes in the amounts of food to be distributed, and changes in the distribution process.

Regarding safety and health measures, it was sought to implement strategies that can prevent the movement of the virus through food packaging, mainly frozen. Well, as observed in all stages, the healthiness of the products is essential, especially as they get closer to the final consumer. In response to this concern, traceability will be considered as a fundamental agent that helps maintain the quality and safety of food. To achieve this traceability, it is recommended, as a strategy, to create a tamper-proof audit record to verify the presence of parasites and viruses in packaged foods throughout the supply chain (Iftekhar & Cui, 2021).

Regarding the reduction of labor and personnel changes, it can be said that this link faced the reduction and shortage of human workforce, mainly caused by fear of non-compliance with the imposed government measures, rather than fear of contagion; this reflects that the immobilization policies, restrictions, and measures were more damaging than the recorded mortality rates (Chari et al., 2022). A response action for this type of problem was the implementation of technologies that reduce the need for human intervention, distribution channels adapted to the new requirements, for example, carrying out distribution optimization based on artificial Intelligence, which will bring benefits such as reduction of energy consumption by sharing information, minimizing energy use, optimizing truck routes, and reducing greenhouse gases and carbon footprint (Abideen et al., 2021).

In addition, the Covid-19 forced the implementation of new distribution processes, at this point greater importance was given to last-mile delivery, since the isolation of millions of people from all over the world generated the need to require distribution networks that reached the consumers, sometimes, for long periods of time. However, the high requirement would demand increasing the capacity quickly, not only increasing the number of people, but also improving the technological platforms, this caused the need to implement improvements to the existing distribution networks, which allow expanding a scope that makes it possible to respond quickly in an efficient manner (Hong et al., 2021). Based on this need to implement a direct distribution model, the problem of "how" to get basic food to this "last mile" in times of restrictions was identified. For this problem, the case of overcrowded cities such as New York in the US, and Mumbai and Delhi in India, whose inhabitants were in buildings in areas severely affected by the virus; to provide a solution to the previously mentioned problem, Singh et al. (2021) formulated a distribution model that adapts to the new conditions; however, this model had to be a hybrid, since initially food trucks would be used (for the transfer of food) and later drones would be used to deliver products to high-rise buildings. This action facilitated the delivery to the "last mile" in areas with high rates of infection, in which the shipment of basic necessities (food and medicine) was complicated; this hybrid delivery system helped to maintain social distance and significantly reduce delivery time in order to meet demand (Chamola et al., 2020). This formation of the hybrid distribution network was

a highly acclaimed solution, which could be taken advantage of in future crises, depending on consumer acceptance (Lin et al., 2022).

Moreover, the restriction policies not only caused circulation difficulties internally but also internationally (Barman et al., 2021a), which generated a reduction in the transport of food, mainly due to the closure of borders, a fact that made it difficult to carry out import activities (Al-Doori et al., 2021; Chari et al., 2022). Above all, these restrictive policies and measures affected developing countries that required imported products to ensure their survival (Chari et al., 2022), as in the case of Malaysia, a country that depends largely on food imports, which was seriously affected by these measures, even harming the majority of the inhabitants, since part of their basic diet came from products imported from neighboring countries, since its local production was scarce (Chin, 2020; Fan et al., 2021). However, not only developing countries were affected, as developed countries also faced certain difficulties, in the case of Canada, transporters had labor and logistical limitations to move vegetables (Richards et al., 2020) due to the measures of blockade implemented, so it is evident that the commercialization and distribution of fresh agricultural products was seriously affected (Chari et al., 2022). For issues of this type, the detailed response action is highlighted by Min et al. (2020), who indicates the implementation of a "green pass" or "exemption letters" that allow transporters and food distributors to carry out their activities in order to guarantee their supply, whether they are distributed within the country, or collected at the border as an import, likewise, it is emphasized that this facility is given to both large and small businessmen, seeking that everyone receives the same treatment and the same opportunities.

#### **5.4 Fourth link: Retailers**

The fourth link is made up of retailers, who are directly committed to the final consumer, since they are the ones who will provide them with food (Barman et al., 2021b). This link was also affected by the Covid-19 pandemic, which caused important changes in sales (Leone et al., 2020); however, it was observed that the retail sale of essential products (food), unlike the sale of non-essential ones, was not interrupted; but it did have to continue operating in difficult conditions, since, as formerly observed, the previous links had obstacles where delays were dragging, all this caused that the food did not arrive on time or that arrive in poor conditions at the time it was offered to the final customer. In addition, this link had to face 5 main problems: reduction in the availability of products, variation in the price of food, fluctuation in demand, loss of products, and adaptation to new ways of reaching the consumer.

Regarding the reduction in the availability of products caused by Covid-19, customers mentioned that they had to visit several stores to be able to find the foods of their choice (Belarmino et al., 2020; Niles et al., 2020), because there was a shortage in the assortment of stores (Richards & Rickard, 2020), this was due to the fact that consumers initially chose to stock up on large amounts of food, mainly to limit the number of times they needed to leave their homes and thus avoid being exposed to the contagion (Niles et al., 2020), leading to temporary shortages on store shelves, causing instability in the food supply; it should be noted that this purchasing behavior was more visible during the outbreak of the pandemic (Cardoso et al., 2021).

Regarding prices, a rise was observed caused by the increase in purchases and the lack of availability of products (Yang et al., 2022); this was caused at the beginning of the pandemic, by panic buying. This action caused consumers to have to pay higher prices for basic foods as the pandemic progressed (Chari et al., 2022; Vyas et al., 2021). Therefore, this link increased its sales, to the point of not being able to meet the high demand (Shahidi, 2020). This was the only link that benefited at the start of the pandemic, but as consumers stopped making purchases to store them, sales fell. Likewise, given the uncertainty of demand during the pandemic, Knorr & Khoo (2020) recommended the use of indicators that allow measuring these changes and progress, in addition, digital and analytical techniques allow understanding the needs of customers (Cardoso et al., 2021; Telukdarie et al., 2020).

The fluctuation in demand was generated by changes in consumer purchasing preferences, since, due to the pandemic, they decided to opt for foods that last longer, leaving aside foods that are short-lived. This is how many of the consumers stopped stocking up on fruits, vegetables, etc.; prioritizing the purchase of sealed, canned or packaged products that can be stored for much longer, given the uncertainty of what could happen (Ali et al., 2021). However, shelving short-lived products turned into losses for retailers, because they eventually ended up expiring on-premises. Well, prior to the pandemic, this link was supplied as normal, without considering the impact that Covid-19 would generate on consumer purchasing behavior and wages. Given this panorama, the following response action stands out: Carry out an analysis in order to understand the dynamics and psychology of consumer intake before and after the pandemic, identifying the main purchasing patterns and determinants of it, which will make it possible to predict the effects on long-term eating behavior in order to develop the best strategies.

Another change identified was the way to deliver the products to consumers, as new preferences appeared, such as home deliveries (implemented in order to maintain distance), so online platforms were used to allow consumers to place their orders without having to visit physical stores, this aspect shows that the appearance of Covid-19 boosted electronic commerce; therefore, the investment in online platforms, as well as the increase in personnel for delivery deliveries would be increasing. On the other hand, changes were also identified in the stores that continued to serve physically, since cuts in opening hours were implemented, in order to avoid crowds and give cleaning staff more time to carry out the corresponding disinfections (Shahbaz et al., 2020).

Finally, the literature showed that the measures implemented by each country were different in terms of retailers, identifying that some reacted more strictly than others, in the case of Wuhan-China, the local government only allowed five supermarkets to continue operating, which were: Wushang, Zhongbai, Zhongshang, Wal-Mart and Carrefour in Wuhan, which benefited them in a competitive aspect; however, small-scale retailers were affected by being forced to close their stores, which did not allow them to continue operating (Min et al., 2020); this action was also replicated in countries of the American continent, where companies such as Walmart and Target were able to remain open, unlike small retailers that were forced to close their doors (Leone et al., 2020).

### **5.5 Fifth link: Consumers**

Last link in the food supply chain, made up of all those who consume or buy the products that were made in the previous links. These actors are of great importance in the chain, because it is precisely for these that various types of food products are produced so that they can have access to choose the one of their greatest convenience, need and preference. In addition, the role played by consumers is essential to ensure the existence of the supply chain, since the changes of this actor have repercussions on all the predecessor links, however minimal they may be (Aday and Aday, 2020), changes that occur due to various crises, as well as the Covid-19. For this link, 4 main problems or obstacles are identified: changes in purchasing behavior; new ways of accessing/purchasing food; unemployment and decreased income; and decreased food security (Cardoso et al., 2021).

Regarding the change in consumer behavior caused by Covid-19, we can identify different scenarios, initially, consumers overstocked, which was caused by the uncertainty of the virus that caused the famous "panic buying", here many families purchased a large number of products, leaving the shelves, aisles of stores and supermarkets empty; later, when the pandemic was already worsening and the world economy was already compromised, a different scenario was identified, where consumers stocked up only on strictly necessary items; likewise, they adopted preferences for non-perishable products and for ready meals, given the risk of wasting them due to the pandemic, among the main foods consumed are canned food (Aday and Aday, 2020). As can be seen, situations can change customer decisions, since consumer behavior is complex and depends on various factors, which end up affecting the purchase decision (Ali et al., 2021; Cranfield, 2020); even, the Covid-19 caused consumers to change certain perceptions linked mainly to the value of food, food safety and healthy diets, an example of what is indicated is exposed by Rodriguez-Perez et al. (2020) who, in the case of Spain, comment that consumers chose to follow healthy diets to protect themselves and strengthen their immune system, which increased the demand for foods that contain bioactive ingredients.

On the other hand, consumers decreased the number of times they went to buy, but in turn increased the amount purchased per trip, this in order to reduce their exposure to Covid-19 (Knorr and Khoo, 2020). Therefore, another alternative was to make purchases online. However, at the beginning of the pandemic, it was not so easy to trust virtual platforms (such as shopping websites and mobile applications), as consumers feared making payments online, distrusted deliveries, and fear that their data is mismanaged (because in order to make the purchase effective they had to provide data such as: addresses, cell phone numbers, names, etc.); although it is true, this new modality would bring with it benefits such as: reduction of contagion risk, wide selection, ease of purchase, reduction in purchase time, convenience, among others; consumers were already accustomed to physically seeing what they needed to buy, so changing this perception and placing their trust in online purchases (Chari et al., 2022; Mussell et al., 2020); it was mainly for this reason that the platforms were improving as the pandemic passed, becoming friendlier and more practical in order to provide the consumer with all the necessary facilities and increase their credibility in the face of this form of purchase (Hong et al., 2021); the above detailed are summarized in the boost effect of Covid-19 in E-commerce (Din et al., 2022), opening the doors to a market that, although it is true, already existed, now, faced with this new reality, would achieve its consolidation; in view of this panorama, it was identified that consumers reacted by training and paying more interest to virtual platforms, since they took it for granted that as the pandemic progressed,

they would gain more strength and increase their reach; this is why it can be said that the consumer reacted by giving more importance to technological developments and innovations.

Another problem identified was the reduction in income and the increase in unemployment, caused by the execution of the immobilization and confinement measures, which had an impact on the stoppage of money-generating activities, negatively impacting the economy of families (Mahajan and Tomar, 2020); this problem caused food security to be increasingly compromised, since families did not have sufficient economic capacity to obtain food that covered the nutritional needs of their members, they could not enjoy a stable availability of food, nor access prompt; likewise, by not having a fluid supply of food, malnutrition would be another problem that would not take long to appear (Sukhwani et al., 2020), a fact that represented a threat to people's health, especially in times of crisis and pandemics where health is vital (Din et al., 2022). Given this scenario, the increase in awareness on the part of consumers about a correct diet is identified as a response action, therefore, they reduced the amount of food discarded.

On the other hand, consumers were afraid of accessing food and catching Covid-19, since it was known that the virus was quite prone to being transmitted through food packaging, becoming demanding with the industries of this sector, as they needed to be guaranteed a product free of pathogens. This made it begin to give greater importance to food safety, freshness and quality of the products, in addition, it generated new hygiene practices in relation to food handling, since many times a manipulated food was no longer acquired by no consumer (Alsetoohy et al., 2021; Nurul Eiman et al., 2021).

### 5.1 Graphical Results

The purpose of this section will be to show the number of papers obtained per link, so that the reader can have a better understanding of the data processed and found. After analyzing the information collected in the search for problems and response actions, the following were found: 8 papers focused on the producer link, 11 papers focused on the processing link, 9 papers focused on the distributor link, 9 papers focused on the retailer link, 12 papers focused on the consumer link and 18 paper with a general approach. These findings show that the largest amount of data processed was evaluated under a general approach, that is, the problems and response actions were not classified by actors or links in the supply chain, but rather it was taken as a single flow, without making an evaluation of the factors that could interrupt the flow of each link. On the other hand, it is also identified that the links that received the most attention from the researchers were Consumers and Processors, since they were the links with the highest number of papers found, this is mainly the product of the implementation of technology, automation and virtual platforms, topics that were promoted in the pandemic, and that found opportunities to develop in the problems presented.

To identify the papers by links, we proceeded to read the data in order to determine which link their content responded to, and what approach it presented (Figure 4).

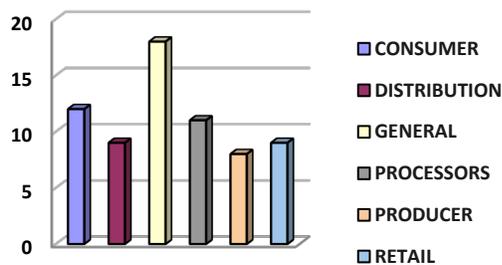


Figure 4. Number of papers per classification

### 5.2 Proposed Improvements

As could be seen in the proposed graphs, of the total papers evaluated, 26.87% are papers with a general focus, so the main proposal would be to continue with the investigation of this event, delving into each link, inviting other researchers to develop works that serve as a guide for readers and companies looking for information on how to react,

what actions to take and what to take into account in the face of a pandemic of this caliber, likewise, future researchers are invited to prepare papers that specify the actions of response to be executed by link, since the coming years will be crucial to determine if the reactions and measures taken by governments and companies were the most optimal to ensure their subsistence. Finally, a call is made to them to implement solutions based on automation, I or T and digital transformation, since technology will be the best ally to face the panorama that Covid-19 left to the world.

Likewise, with respect to the present investigation, it was observed that the papers collected provided a great contribution in terms of problems or obstacles and response actions. However, as mentioned in the previous paragraph, increasing the research will allow us to have more information that contributes to this article, which will allow us to provide a better understanding, since by collecting a greater amount of literature, the impacts can be covered more deeply. and response actions of each link. Therefore, one of the proposals for improvement would be to collect a greater number of papers according to the inclusion criteria, since there are currently 67 papers. On the other hand, it was observed that of the 67 accepted papers, 12 from the year 2022 were obtained, therefore, another improvement in the study.

## **6. Conclusion**

The measures taken by governments around the world to prevent the spread of the virus were quarantine, border closures, social distancing and immobilization policies. These measures profoundly affected the flow and performance of the food supply chain, since they caused problems such as: labor shortages, difficulties in the supply of materials, stoppage of activities, lack of transportation to move food and products, demand fluctuation and price increases. These general problems were accompanied by problems specific to each link, because, depending on their specific characteristics, more difficulties arose, which denoted the need to identify response actions for each link.

To respond to these identified problems, each link developed multiple strategies that adapt to their own nature. These can be grouped into 4: strategies linked to the implementation of technology and innovation (automation, drones, internet of things, artificial intelligence, traceability and digital transformation), strategies linked to government or state policies (green pass, exemption letters, authorization letters, certificates, subsidies, food aid distribution programs, tenders, benefits, etc.), strategies related to the implementation of safety and health protocols (distancing, cleaning, disinfection, implementation of equipment that reduces the risk of infection, etc) and strategies related to changes in the management of the chain (new distribution networks, increase in workers, etc); each of these response actions or strategies must be adapted to the nature and specifications of each link, in order to be able to face the identified problems.

With this evaluation of the problems and the response actions, it was possible to conclude that the food supply chain was able to cope surprisingly well with the interruptions produced by Covid-19 in the short term (Hobbs, 2021a). However, resilience in supply chains must be built to improve responses in the event of another global crisis. According to Walker et al., (2010) resilience is "the ability of a system to absorb disturbances and reorganize itself while undergoing changes to maintain the same function, structure, identity, and feedback". Which was put to test because of the virus, where adaptability and flexibility are key components (Hobbs, 2021b).

## **References**

- Aamer, A. M., Al-Awlaqi, M. A., Affia, I., Arumsari, S., & Mandahawi, N., The internet of things in the food supply chain: adoption challenges. *Benchmarking*, 28(8), 2521–2541, 2021. <https://doi.org/10.1108/BIJ-07-2020-0371>
- Abideen, A. Z., Sundram, V. P. K., Pyeman, J., Othman, A. K., & Sorooshian, S., Food Supply Chain Transformation through Technology and Future Research Directions—A Systematic Review. *Logistics*, 5(4), 83, 2021. <https://doi.org/10.3390/logistics5040083>
- Achmad, A. L. H., Chaerani, D., & Perdana, T., Designing a food supply chain strategy during COVID-19 pandemic using an integrated Agent-Based Modelling and Robust Optimization. *Heliyon*, 7(11), e08448, 2021. <https://doi.org/10.1016/j.heliyon.2021.e08448>
- Aday, S., & Aday, M. S., Impact of COVID-19 on the food supply chain. *Food Quality and Safety*, 4(4), 167–180, 2021. <https://doi.org/10.1093/FQSAFE/FYAA024>
- Al-Doori, J. A., Khdour, N., Shaban, E. A., & al Qaruty, T. M., How COVID-19 Influences the Food Supply Chain: An Empirical Investigation of Developing Countries. *International Journal of Technology*, 12(2), 371–377, 2021. <https://doi.org/10.14716/IJTECH.V12I2.4391>
- Ali, M. H., Suleiman, N., Khalid, N., Tan, K. H., Tseng, M. L., & Kumar, M., Supply chain resilience reactive strategies for food SMEs in coping to COVID-19 crisis. *Trends in Food Science & Technology*, 109, 94–102,

2021. <https://doi.org/10.1016/J.TIFS.2021.01.021>
- Alsetoohy, O., Ayoun, B., & Abou-Kamar, M., Covid-19 pandemic is a wake-up call for sustainable local food supply chains: Evidence from green restaurants in the USA. *Sustainability (Switzerland)*, 13(16), 2021. <https://doi.org/10.3390/su13169234>
- Alsuwailam, A. A., Salem, E., Saudagar, A. K. J., Altameem, A., Alkhatami, M., Khan, M. B., & Hasanat, M. H. A., Impacts of COVID-19 on the food supply chain: A case study on Saudi Arabia. *Sustainability (Switzerland)*, 14(1). 2022. <https://doi.org/10.3390/su14010254>
- Barman, A., Das, R., & De, P. K., Logistics and supply chain management of food industry during COVID-19: disruptions and a recovery plan. *Environment Systems and Decisions*, 1, 3.2021a. <https://doi.org/10.1007/s10669-021-09836-w>
- Barman, A., Das, R., & De, P. K., Impact of COVID-19 in food supply chain: Disruptions and recovery strategy. *Current Research in Behavioral Sciences*, 2, 1–5. 2021b <https://doi.org/10.1016/J.CRBEHA.2021.100017>
- Belarmino, E., Bertmann, F., Wentworth, T., Biehl, E., Neff, R., & Niles, M., Early COVID-19 Impacts on Food Retail and Restaurants: Consumer Perspectives from Vermont. *College of Agriculture and Life Sciences Faculty Publications*. 2020. <https://scholarworks.uvm.edu/calsfac/24>
- Butu, A., Brumă, I. S., Tanasă, L., Rodino, S., Vasiliu, C. D., Doboş, S., & Butu, M., The Impact of COVID-19 Crisis upon the Consumer Buying Behavior of Fresh Vegetables Directly from Local Producers. Case Study: The Quarantined Area of Suceava County, Romania. *International Journal of Environmental Research and Public Health*, 17(15), 1–25. 2020. <https://doi.org/10.3390/IJERPH17155485>
- Cardoso, B., Cunha, L., Leiras, A., Gonçalves, P., Yoshizaki, H., de Brito Junior, I., & Pedroso, F., Causal impacts of epidemics and pandemics on food supply chains: A systematic review. *Sustainability (Switzerland)*, 13(17), 1–28, 2021. <https://doi.org/10.3390/su13179799>
- Castro, A. N., White, M. A., Ishdorj, A., Thompson, D., & Dave, J. M., The impact of the covid-19 pandemic on food distribution at emergency food assistance organizations in the southwestern united states: A qualitative investigation. *Nutrients*, 13(12), 4267, 2021. <https://doi.org/10.3390/NU13124267/S1>
- Chamola, V., Hassija, V., Gupta, V., & Guizani, M., A Comprehensive Review of the COVID-19 Pandemic and the Role of IoT, Drones, AI, Blockchain, and 5G in Managing its Impact. *IEEE Access*, 8, 90225–90265, 2020. <https://doi.org/10.1109/ACCESS.2020.2992341>
- Chari, F., Muzinda, O., Novukela, C., & Ngcamu, B. S., Pandemic outbreaks and food supply chains in developing countries: A case of COVID-19 in Zimbabwe. *Cogent Business and Management*, 9(1), 2022. <https://doi.org/10.1080/23311975.2022.2026188>
- Chen, S., Brahma, S., Mackay, J., Cao, C., & Aliakbarian, B., The role of smart packaging system in food supply chain. *Journal of Food Science*, 85(3), 517–525, 2020. <https://doi.org/10.1111/1750-3841.15046>
- Chin, C., The Impact of Food Supply Chain Disruptions amidst COVID-19 in Malaysia. *Journal of Agriculture, Food Systems, and Community Development*, 9(4), 1–3, 2020. <https://doi.org/10.5304/jafscd.2020.094.031>
- Chowdhury, M. T., Sarkar, A., Paul, S. K., & Moktadir, M. A., A case study on strategies to deal with the impacts of COVID-19 pandemic in the food and beverage industry. *Operations Management Research*, 15(1–2), 166–178, 2022. <https://doi.org/10.1007/S12063-020-00166-9/TABLES/4>
- Cranfield, J. A. L., Framing consumer food demand responses in a viral pandemic. *Canadian Journal of Agricultural Economics*, 68(2), 151–156, 2020. <https://doi.org/10.1111/CJAG.12246>
- Din, A. U., Han, H., Ariza-Montes, A., Vega-Muñoz, A., Raposo, A., & Mohapatra, S., The Impact of COVID-19 on the Food Supply Chain and the Role of E-Commerce for Food Purchasing. *Sustainability (Switzerland)*, 14(5), 2022. <https://doi.org/10.3390/su14053074>
- Fan, S., Teng, P., Chew, P., Smith, G., & Copeland, L., Food system resilience and COVID-19 – Lessons from the Asian experience. *Global Food Security*, 28, 100501. 2021. <https://doi.org/10.1016/j.gfs.2021.100501>
- Godrich, S. L., Macau, F., Kent, K., Lo, J., & Devine, A., Food Supply Impacts and Solutions Associated with the COVID-19 Pandemic: A Regional Australian Case Study. *International Journal of Environmental Research and Public Health* 2022, 19(7), 4116. 2022. <https://doi.org/10.3390/IJERPH19074116>
- Hobbs, J. E., Food supply chains during the COVID-19 pandemic. *Canadian Journal of Agricultural Economics*, 68(2), 171–176, 2020. <https://doi.org/10.1111/cjag.12237>
- Hobbs, J. E., Food supply chain resilience and the COVID-19 pandemic: What have we learned? *Canadian Journal of Agricultural Economics/Revue Canadienne d'agroeconomie*, 69(2), 189–196, 2021a. <https://doi.org/10.1111/CJAG.12279>
- Hobbs, J. E., The Covid-19 pandemic and meat supply chains. *Meat Science*, 181, 108459, 2021b. <https://doi.org/10.1016/J.MEATSCI.2021.108459>
- Hong, C., Choi, H. (Hailey), Choi, E. K. (Cindy), & Joung, H. W. (David), Factors affecting customer intention to

- use online food delivery services before and during the COVID-19 pandemic. *Journal of Hospitality and Tourism Management*, 48, 509–518. 2021. <https://doi.org/10.1016/J.JHTM.2021.08.012>
- Iftekhhar, A., & Cui, X., Blockchain-Based Traceability System That Ensures Food Safety Measures to Protect Consumer Safety and COVID-19 Free Supply Chains. *Foods* 2021, 10(6), 1289, 2021. <https://doi.org/10.3390/FOODS10061289>
- Ijaz, M., Yar, M. K., Badar, I. H., Ali, S., Islam, M. S., Jaspal, M. H., Hayat, Z., Sardar, A., Ullah, S., & Guevara-Ruiz, D., Meat Production and Supply Chain Under COVID-19 Scenario: Current Trends and Future Prospects. *Frontiers in Veterinary Science*, 8, 432. 2021. <https://doi.org/10.3389/FVETS.2021.660736/BIBTEX>
- Jawed, I., Tareen, F. R., Cauhan, K., & Nayeem, M., Food safety and COVID-19: Limitations of HACCP and the way forward. *The Pharma Innovation Journal*, 9(5), 01–04. 2020. <https://doi.org/10.22271/TPI.2020.V9.I5A.4616>
- Knorr, D., & Khoo, C. S. H., COVID-19 and Food: Challenges and Research Needs. In *Frontiers in Nutrition*, 7, 598913.2020. <https://doi.org/10.3389/fnut.2020.598913>
- Koshta, N., Devi, Y., & Patra, S., Aerial Bots in the Supply Chain: A New Ally to Combat COVID-19. *Technology in Society*, 66, 101646. 2021. <https://doi.org/10.1016/j.techsoc.2021.101646>
- Laborde, D., Martin, W., Swinnen, J., & Vos, R., COVID-19 risks to global food security. *Science*, 369(6503), 500–502. 2020. <https://doi.org/10.1126/science.abc4765>
- Leone, L. A., Fleischhacker, S., Anderson-Steeves, B., Harper, K., Winkler, M., Racine, E., Baquero, B., & Gittelsohn, J., Healthy Food Retail during the COVID-19 Pandemic: Challenges and Future Directions. *International Journal of Environmental Research and Public Health*, 17(20), 7397. 2020. <https://doi.org/10.3390/IJERPH17207397>
- Lin, Y., Marjerson, R. K., Choi, J., & Chae, C., Supply Chain Sustainability during COVID-19: Last Mile Food Delivery in China. *Sustainability (Switzerland)*, 14(3), 1–27. 2022. <https://doi.org/10.3390/su14031484>
- Luckstead, J., Nayga, R. M., & Snell, H. A., Labor Issues in the Food Supply Chain Amid the COVID-19 Pandemic. *Applied Economic Perspectives and Policy*, 43(1), 382–400. 2021. <https://doi.org/10.1002/AEPP.13090>
- Mahajan, K., & Tomar, S., COVID-19 and Supply Chain Disruption: Evidence from Food Markets in India†. *American Journal of Agricultural Economics*, 103(1), 35–52, 2020. <https://doi.org/10.1111/AJAE.12158>
- Min, S., Zhang, X., & Li, G., A snapshot of food supply chain in Wuhan under the COVID-19 pandemic. *China Agricultural Economic Review*, 12(4), 689–704, 2020. <https://doi.org/10.1108/CAER-04-2020-0056>
- Mthembu, B. E., Mkhize, X., & Arthur, G. D., Effects of COVID-19 Pandemic on Agricultural Food Production among Smallholder Farmers in Northern Drakensberg Areas of Bergville, South Africa. *Agronomy* 2022, 12(2), 531.2022. <https://doi.org/10.3390/AGRONOMY12020531>
- Mussell, A., Bilyea, T., & Hedley, D., Agri-Food Supply Chains and Covid-19: Balancing Resilience and Vulnerability. *Agri-Food Economic Systems*, 29, 1–6. 2020. <https://doi.org/10.4324/9781315144122-1>
- Nesterenko, N., Vetrova, M., & Ivanova, D., The influence of the pandemic COVID-19 on the food supply chain management. *IOP Conference Series: Earth and Environmental Science*, 782(2).2021. <https://doi.org/10.1088/1755-1315/782/2/022040>
- Niles, M. T., Bertmann, F., Belarmino, E. H., Wentworth, T., Biehl, E., & Neff, R., The Early Food Insecurity Impacts of COVID-19. *Nutrients*, 12(7), 1–23. 2020. <https://doi.org/10.3390/NU12072096>
- Nurul Eiman, M. S., Aida, F. M. N. A., Mahmudiono, T., & Raseetha, S., Systematic Review on Food Safety and Supply Chain Risk Assessment Post Pandemic: Malaysian Perspective. *Frontiers in Sustainable Food Systems*, 5, 460. 2021. <https://doi.org/10.3389/FSUFS.2021.682263/BIBTEX>
- O’Hara, S., & Toussaint, E. C., Food access in crisis: Food security and COVID-19. *Ecological Economics*, 180, 106859. 2021. <https://doi.org/10.1016/J.ECOLECON.2020.106859>
- Perdana, T., Chaerani, D., Achmad, A. L. H., & Hermiatin, F. R., Scenarios for handling the impact of COVID-19 based on food supply network through regional food hubs under uncertainty. *Heliyon*, 6(10), e05128, 2020. <https://doi.org/10.1016/J.HELIYON.2020.E05128>
- Pressman, P., Naidu, A. S., & Clemens, R., COVID-19 and Food Safety: Risk Management and Future Considerations. *Nutrition Today*, 55(3), 125–128. 2020. <https://doi.org/10.1097/NT.0000000000000415>
- Rashid, S. M. R. A., Hassan, F., Sharif, N. M., Rahman, A. A., & Mahamud, M. A., The Role of Digital Marketing in Assisting Small Rural Entrepreneurs Amidst Covid-19 Movement Control Order (MCO): A Case Study in Peninsular Malaysia. *Academic Journal of Interdisciplinary Studies*, 10(4), 70. 2021. <https://doi.org/10.36941/ajis-2021-0099>
- Richards, T. J., & Rickard, B., COVID-19 impact on fruit and vegetable markets. *Canadian Journal of Agricultural Economics*, 68(2), 189–194. 2020. <https://doi.org/10.1111/CJAG.12231>
- Rodríguez-Pérez, C., Molina-Montes, E., Verardo, V., Artacho, R., García-Villanova, B., Guerra-Hernández, E. J., &

- Ruíz-López, M. D. Changes in dietary behaviours during the COVID-19 outbreak confinement in the Spanish COVIDiet study. *Nutrients*, 12(6), 1–19. 2020. <https://doi.org/10.3390/nu12061730>
- Shahbaz, M., Bilal, M., Akhlaq, M., Moiz, A., Zubair, S., & Iqbal, H. M. N. , Strategic measures for food processing and manufacturing facilities to combat coronavirus pandemic (COVID-19). *Journal of Pure and Applied Microbiology*, 14(2), 1087–1094. 2020. <https://doi.org/10.22207/JPAM.14.2.01>
- Shahidi, F., Does COVID-19 Affect Food Safety and Security? *Journal of Food Bioactives*, 9. 2020. <https://doi.org/10.31665/JFB.2020.9212>
- Singh, S., Kumar, R., Panchal, R., Manoj, &, Tiwari, K., & Tiwari, M. K., . Impact of COVID-19 on logistics systems and disruptions in food supply chain. *International Journal of Production Research*, 59(7), 2021. <https://doi.org/10.1080/00207543.2020.1792000>
- Sombultawee, K., Lenuwat, P., Aleenajitpong, N., & Boon-itt, S., COVID-19 and Supply Chain Management: A Review with Bibliometric. *Sustainability*, 14(6), 1–21.2022. <https://doi.org/10.3390/su14063538>
- Sukhwani, V., Deshkar, S., & Shaw, R., COVID-19 Lockdown, Food Systems and Urban–Rural Partnership: Case of Nagpur, India. *International Journal of Environmental Research and Public Health*, 17(16), 1–23. 2020. <https://doi.org/10.3390/IJERPH17165710>
- Telukdarie, A., Munsamy, M., & Mohlala, P., Analysis of the Impact of COVID-19 on the Food and Beverages Manufacturing Sector. *Sustainability*, 12(9331), 1–22, 2020. <https://doi.org/10.3390/SU12229331>
- Tortajada, C., & Lim, N. S. W., Food Security and COVID-19: Impacts and Resilience in Singapore. In *Frontiers in Sustainable Food Systems*, 5. Frontiers Media S.A. 2021. <https://doi.org/10.3389/fsufs.2021.740780>
- Trmčić, A., Demmings, E., Kniel, K., Wiedmann, M., & Alcaine, S., Food Safety and Employee Health Implications of COVID-19: A Review. *Journal of Food Protection*, 84(11), 1973–1989, 2021.
- Usgame, D., Usgame, G., & Valverde, C. , AGENDA PRODUCTIVA DE INVESTIGACIÓN Y DESARROLLO TECNOLÓGICO PARA LA CADENA PRODUCTIVA DE LA TILAPIA MINISTERIO DE AGRICULTURA Y DESARROLLO RURAL PROYECTO TRANSICIÓN DE LA AGRICULTURA. *Ministerio de Agricultura y Desarrollo Rural : Proyecto Transición de La Agricultura*, 1–143, 2007.
- Vyas, S., Chanana, N., Chanana, M., & Aggarwal, P. K. , From Farm to Fork: Early Impacts of COVID-19 on Food Supply Chain. *Frontiers in Sustainable Food Systems*, 5, 424, 2021. <https://doi.org/10.3389/FSUFS.2021.658290/BIBTEX>
- Weersink, A., von Massow, M., Bannon, N., Ifft, J., Maples, J., McEwan, K., McKendree, M. G. S., Nicholson, C., Novakovic, A., Rangarajan, A., Richards, T., Rickard, B., Rude, J., Schipanski, M., Schmitkey, G., Schulz, L., Schuurman, D., Schwartzkopf-Genswein, K., Stephenson, M., ... Wood, K, COVID-19 and the agri-food system in the United States and Canada. *Agricultural Systems*, 188, 2021. <https://doi.org/10.1016/J.AGSY.2020.103039>
- Xie, Y., Sarkar, A., Hossain, M. S., Hasan, A. K., & Xia, X. , Determinants of farmers' confidence in agricultural production recovery during the early phases of the covid-19 pandemic in China. *Agriculture (Switzerland)*, 11(11). 2021. <https://doi.org/10.3390/agriculture11111075>
- Xu, N., Huang, Y. F., Weng, M. W., & Do, M. H. , New Retailing Problem for an Integrated Food Supply Chain in the Baking Industry. *Applied Sciences* 2021, 11(3), 946. 2021. <https://doi.org/10.3390/APP11030946>
- Xu, Z., Elomri, A., El Omri, A., Kerbache, L., & Liu, H. , The compounded effects of COVID-19 pandemic and desert locust outbreak on food security and food supply chain. *Sustainability (Switzerland)*, 13(3), 1–17, 2021. <https://doi.org/10.3390/su13031063>
- Yang, B., Asche, F., & Li, T. , Consumer behavior and food prices during the COVID-19 pandemic: Evidence from Chinese cities. *Economic Inquiry*, 60(3), 1437–1460, 2021. <https://doi.org/10.1111/ECIN.13067>
- Zhang, Y., Diao, X., Chen, K. Z., Robinson, S., & Fan, S., Impact of COVID-19 on China's macroeconomy and agri-food system – an economy-wide multiplier model analysis. *China Agricultural Economic Review*, 12(3), 387–407, 2020. <https://doi.org/10.1108/CAER-04-2020-0063>
- Zielińska-Chmielewska, A., Mruk-Tomeczak, D., & Wielicka-Regulska, A., Qualitative research on solving difficulties in maintaining continuity of food supply chain on the meat market during the COVID-19 pandemic. *Energies*, 14(18), 2021. <https://doi.org/10.3390/EN14185634>

## Biographies

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