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Review

A Systematic Review of Sustainable Fresh Fruit and Vegetable Supply Chains

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Abstract: Fresh fruit and vegetables are crucial for human health. Their fibrous structure and high nutritional value are essential for people's well-being. This study aims to provide a review of the current state of knowledge and practices regarding fresh fruit and vegetable supply chains (FFVSC). The reviewed papers are divided into categories according to their findings, research purposes, tools and messages used. Our objective is to guide both academics and practitioners by pointing out significant streams of research with respect to these categories. For a better understanding, these subgroups are essentially based on their common research purpose, and the tools and methods they adopted are explained. Therefore, this study sheds light on research related to FFVSCs for those who are new to this area or planning to conduct in-depth research on directions suggested by studies in this area. The related literature was classified into eight categories: namely, (1) value chain indicators of FFVSCs, (2) food-related problems/postharvest losses along FFVSCs, (3) roles of parties involved in the FFV value chain, (4) review papers, (5) technological trends in FFVSCs, (6) packaging issues of FFVSCs, (7) logistics solutions of FFVSCs, and (8) sustainable FFVSCs. Details on the tools and methods employed in these studies are summarized in Appendix B. To the best of the authors' knowledge, the related literature lacks a comprehensive review that investigates different aspects of FFVVCs in detail. Thus, this study contributes towards a better understanding of the related literature and can be used as a guide for future studies.

Keywords: fresh fruits and vegetables; supply chain; value chain; perishable food

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1. Introduction

Fresh fruit and vegetables (FFVs) are necessary for a healthy diet due to their high nutritional value and fibrous structure [1]. The World Health Organization (WHO) announced that the majority of deaths per year worldwide are related to the lack of fruit and vegetable consumption [2]. This highlights the significance of these foods. In addition, the handling and preservation of fresh fruits and vegetables from farm to fork is another concern along the supply chain (SC) to maintain food quality and eliminate harvest losses. Lack of attention, especially during processing and storing, results in inefficient management of the supply chain and, thus, causes harvests to be lost [3].

The SC, which basically covers all the steps in production or services starting from the raw material until the end product reaches the final customer, is a result of strategic thinking in the industry. The objective of this concept is to govern enterprise activity in an efficient way [4].

The fresh fruit and vegetable supply chain (FFVSC) has a broad context and a wide impact area. Food safety, food waste, the freshness of food, production processes, the logistic activities of goods, and managerial competence among the actors are some areas that could be improved to enhance the chain. Furthermore, food integrity is studied by

examining data and information sharing among the actors in the SC, as described in [5]. In addition, the effect of social media and electronic word of mouth on new business approaches, such as e-commerce enterprises and startups, are considered, as examined in [6]. Therefore, we believe that this FFVSC literature review should serve both researchers and practitioners.

Changes in customer requirements result in the formation of food value chains. Customer preferences cause these to evolve into technology-enabled food value chains [7]. Fresh food supply chains are facing rapid changes in terms of digitalization in order to meet customer demands and compete effectively in the market. There are some steps suggested by Deloitte [8] for organizations to improve the future of their food value chains: namely, (1) applying lean methods to current operations, (2) improving legacy systems, (3) testing and unifying digital technologies, (4) structuring data and analytic capabilities, and (5) sustaining a culture of freshness.

The statements of institutions and organizations are essential for fresh food value chains to transform. The Food and Agriculture Organization (FAO) has a vision to make food and agriculture sustainable so that nutritious food can be accessible for everybody; in doing so, natural resources should continue to be managed to be able to sustain ecosystem functions [9]. The Organization for Economic Co-operation and Development (OECD) states that agricultural activities are rapidly changing into global food value chains and this results in some issues at the production, transformation and delivery stages [10].

In recent years, a rise in social awareness regarding the significance of food value chains has been observed. For instance, recent contributions by international organizations for the improvement of FFVSCs and on the food value chain issue include the following:

- contributions by international organizations to the literature to enrich the food value chain as a concept in academia [11,12];
- the Declaration of Sustainable Development Goals (SGDs) by the United Nations (UN) and solutions suggested by the UN to overcome current global problems, such as poverty and hunger [13]. In addition, the UN has announced 2021 as the International Year of Fruits and Vegetables [14].

This study proceeds as follows: In Section 2, we briefly explain the materials and methods used. In Section 3, the FFVSC papers considered are first classified into eight categories based on their relevance and content and then they are explained in detail. An overview of these categories is provided in Figure A1 as a thematic map in Appendix A, and the details regarding the tools and methods employed in the papers presented in this literature review are displayed in Tables A1–A8 in Appendix B. In Section 4, we summarize the results obtained from the literature reviewed. Subsequently, a conclusion is provided in Section 4, addressing possible avenues for future research.

2. Materials and Method

Using the Scopus database, this study surveyed the literature on fresh fruit and vegetable supply chains with a holistic approach. An in-depth investigation of FFVSCs revealed that the relevant literature lacks a comprehensive review of SC activities for this specific harvest type. The main objective of this paper is to fill this research gap and introduce FFVSC systems to the reader from the ground up.

The research methodology of this paper is as follows:

1. Using Scopus to gain statistical information about SC and FFVSC literature;
2. Scanning FFVSC literature by reading the abstracts, findings and concluding remarks, to separate and address only the appropriate papers;
3. Reviewing all parts of remaining papers after elimination and examining their research purposes, tools and methods used;
4. Plotting the data of published papers on graphs to create a visual overview;

5. Creating a thematic map of the research areas of the papers, which will help to form the categories, and also drawing a literature matrix; and
6. Concluding remarks and future directions.

First, to assess the importance of SC as a topic, the statistics for the SC literature were examined. The keyword "supply chain" was initially searched in the title and then keywords from all the identified papers available in the Scopus database were used. A total of 38,170 papers published between the years 2000 and 2020 were found. A line graph displaying the number of articles by year is shown in Figure 1. It is apparent that there has been an increasing interest in the topic and that increase in the number of documents from 2017 to 2020 has been marked.

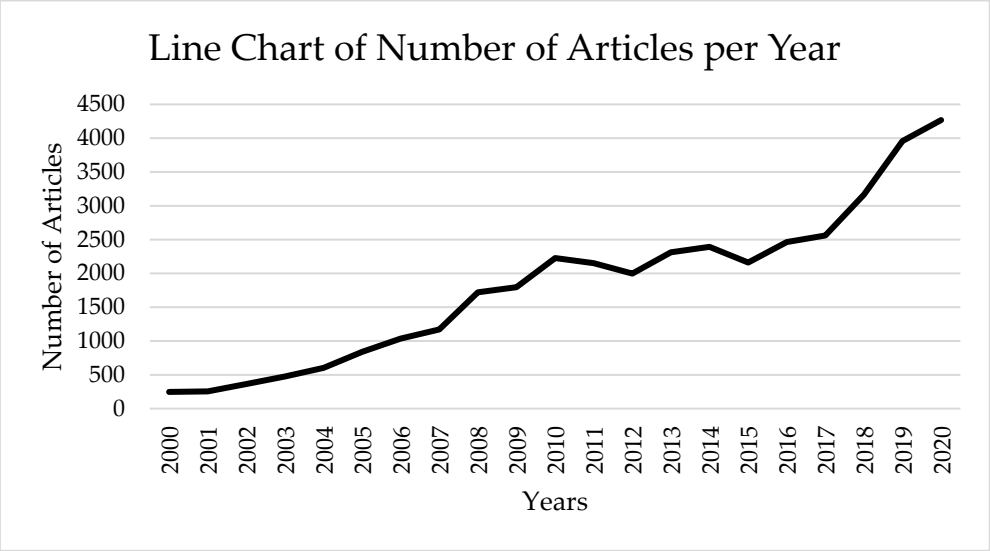

Figure 1. Line chart of the number of articles that studied "supply chain" in the years between 2000 and 2020.

Subsequently, articles focusing on the FFVSC and containing the phrase "supply chain" in their title and as one of their keywords, and the phrase "fresh fruits and vegetables" in all their fields were searched in the Scopus database. This search returned a total of 158 studies which were further scanned to identify the studies that best served the aim of this review. A total of 118 articles remained after this refinement; this is shown in a line chart organized by year in Figure 2. The graph shows that, following some fluctuations in the early 2000s, there has been a gradual increase in the number of studies that met the search criteria, starting in the year 2016.

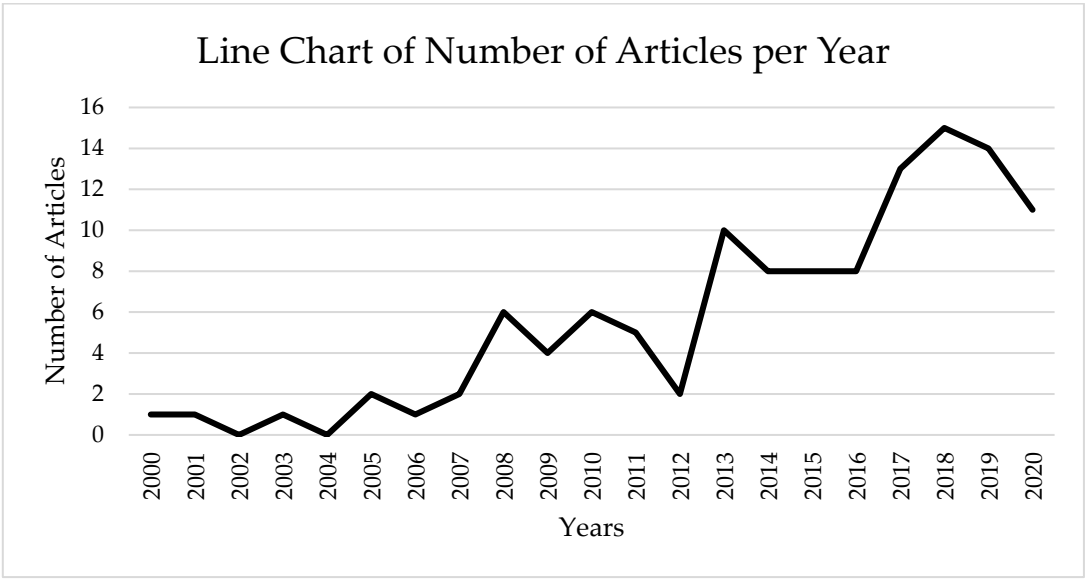

Figure 2. Line chart of the number of articles that studied FFVSC in the years between 2000 and 2020.

Lastly, the number of articles by journal is displayed in Figure 3. For the first 13 journals, those containing more articles than the others, are shown in this figure. Each of the other journals contained only one paper; therefore, they are not presented at this point to provide a clear and easy-to-understand illustration.

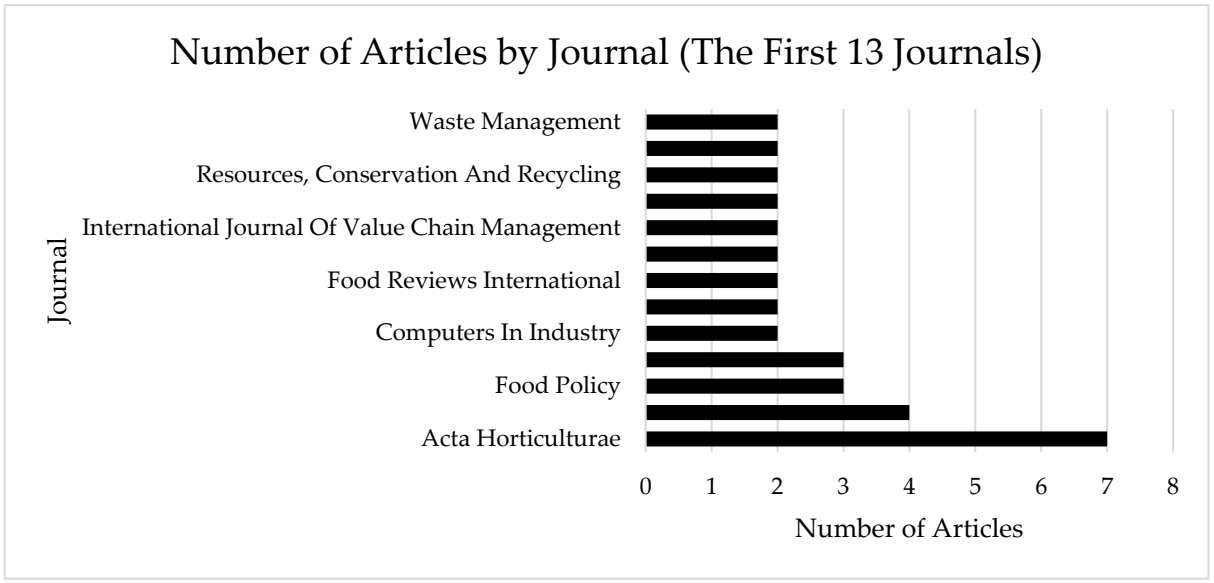

Figure 3. Number of articles published by journal (first 13 publication sources are listed).

FFVSCs are of great significance since the characteristics of harvests and the supply of fresh fruits and vegetables makes the topic challenging; therefore, this is an interesting problem to be tackled by both academics and practitioners.

This study essentially sought to find answers to two questions: "What are the main streams of research in the FFVSC literature?" and "What are the most promising solution approaches?". The questions, objectives and methods used were aligned with the PRISMA 2020 checklist [15]. The overall objective was to provide enough information to the reader to comprehend the main aspects of SC activities for one of the basic food categories. Even though the FFVSC literature was found to be rich, it lacks a comprehensive survey that compiles various studies approaching the topic from different angles. Hence, this study

contributes to the existing literature, filling this research gap. For this purpose, we explored studies available in the Scopus database that were published between 2000 and 2020. The initial search resulted in a total of 158 studies, but an additional evaluation was required since there were duplications and some of the papers did not focus on FFVSCs. After the necessary eliminations and the examination of case studies (if there were any), experimental studies were reviewed. The purpose was to concentrate on various processes in the FFVSCs, where the harvest was handled fresh along the chain. A total of 118 papers, which were believed to provide readers with different views on the topic, were ultimately retained.

VOSviewer provides text mining functionality to build and visualize co-occurrence networks based on keywords obtained from the literature [16]. Therefore, it was employed to display the data of surveyed papers to create a visual overview. To do so, a map based on bibliometric data retrieved form SCOPUS was created and a co-occurrence analysis was performed using a full counting method. Finally, keywords that were meaningless were eliminated, such as "need" and "gap".

3. Literature Review

In this section, 118 scientific articles that were reviewed within the context of this study are classified based on their research topics. A total of eight main categories, namely, value chain indicators of FFVSVs, food/postharvest loss-related problems along FFVSCs, the role of parties involved in the FFV value chain, review papers, technological trends in FFVSCs, packaging issues of FFVSCs, logistics solutions of FFVSCs, and sustainable FFVSCs, are presented. The categories and the number of articles each of them contains are given in Table 1.

Table 1. Categories of the articles and the numbers of articles involved.

Categories of the Articles Considered	Number of Articles
Value Chain Indicators of FFVSCs	35
Food-Related Problems/Postharvest Losses along the FFVSC	29
Role of Parties Involved in the FFV Value Chain	14
Review Papers	13
Technological Trends in the FFVSC	8
Packaging Issues of the FFVSC	6
Logistics Solutions of the FFVSC	6
Sustainable FFVSCs	7
Total	118

The 35 studies falling into Section 3.1 examine the key performance indicators (KPIs) of supply chain (SC) processes. Issues related to performance, price, policy making, and others observed here are explained in detail in Section 3.1. Section 3.2 involves 29 studies that attempt to solve food-related problems, such as low quality, food waste, postharvest loss, the freshness of food, etc. Section 3.3 consists of fourteen studies seeking an answer to questions regarding the role of different parties in the system. A generic SC consists of the producer, wholesaler, retailer and consumer. Here in this category, SC-related problems are evaluated from the perspective of an actor. The articles in Section 3.1 examine FFVSC problems with a holistic approach; in contrast to this, the articles in Section 3.3 consider the problems from one party's perspective. For instance, the system is approached from a wholesaler's point of view in Section 3.3. Section 3.4 contains thirteen review articles; most of them fail to examine the SC of fresh fruits and vegetables using a multi-perspective approach. Although such research examines the related literature focusing on a particular aspect, such as location, product, or problem-specific concepts, we provide here a comprehensive overview of the topic considering its different aspects. Eight studies in Section 3.5 concentrate on solutions benefiting from technological trends

and smart applications. As a key problem for fresh fruits and vegetables, studies in Section 3.6 tackle packaging issues. Six studies in Section 3.7 seek to address logistic solutions for SC activities. Any transportation and routing studies fall into this category. The focus of articles in Section 3.8 is to establish sustainable FFVSCs. The seven studies involved in this category consider the three pillars of sustainability (i.e., economic, environmental, and social), while considering the research questions proposed in the respective studies.

The studies presented in this paper are also visualized utilizing the VOSviewer. In Figure 4, the studies are displayed in terms of the frequency of the occurrence of keywords. For this network visualization, keywords which are meaningless were eliminated, such as "need" and "gap". It can be seen that where keywords are located closer to each other that they form a circular network. Moreover, the figure demonstrates a cluster density based on occurrence by using random colors. For instance, the following keywords are mentioned at the top of the figure with a light blue color: "microbiology", "bacterial count", "food control", and "food handling". They clustered in the same color because they are used in the same studies together.

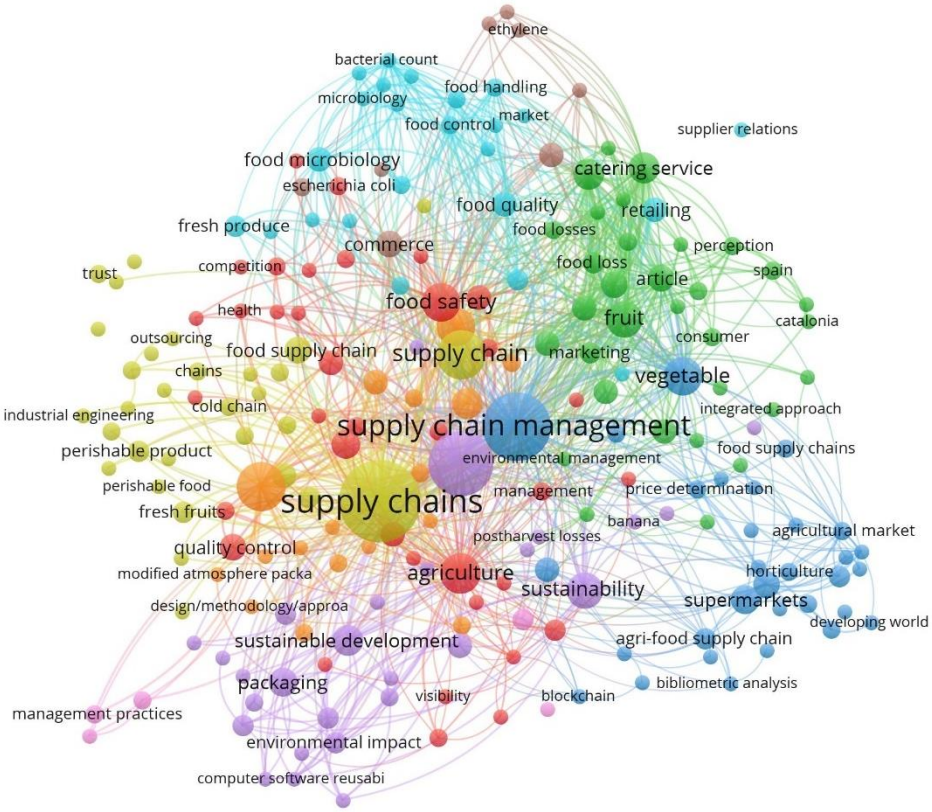

Figure 4. Network visualization of the studies where the co-occurrence of keywords is featured.

In Figure 5, an overlay visualization is shown in terms of the average number of publications per year. It is clear that the keywords shown in the figure are research areas that are substantially new. Light green and yellow colors are common, which means the studies were heavily published after 2015, according to the legend shown in the figure.

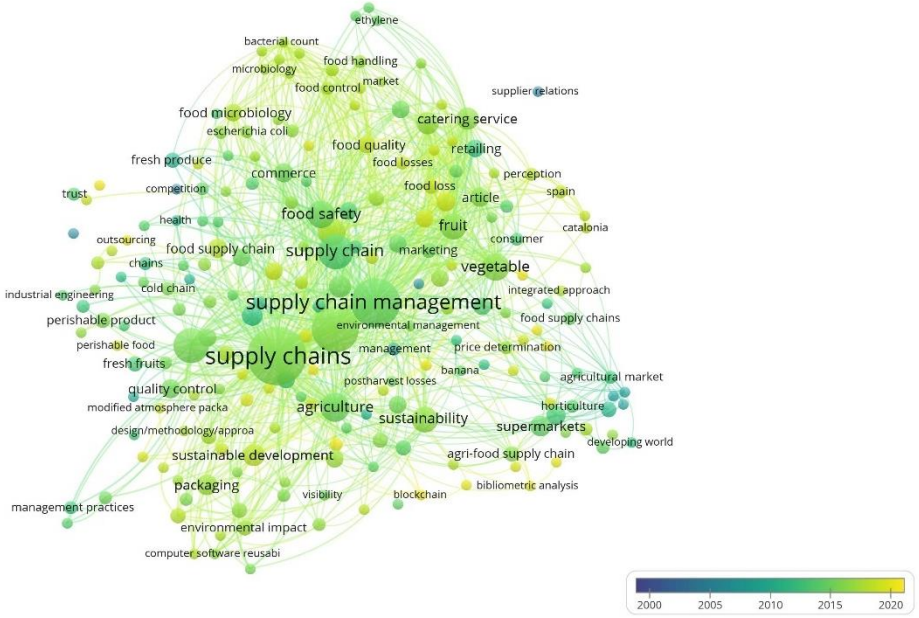

Figure 5. Overlay visualization of the studies by year.

Categorized in eight groups, the studies mentioned above highlighting different aspects of the FFVSC are explained in detail in the following subsections.

3.1. Value Chain Indicators of FFVSCs

In this subsection, studies examining problems related to key performance indicators (KPIs) of the FFVSC are explained. Among these indicators, the performance of the whole chain, strategy, pricing, policy, marketing, and the relationships between different levels strongly stand out. A common purpose of these studies is to understand the current performance of the value chain through developing evaluation methodologies with the help of surveys and methods of analysis.

Wermund and Fearne [17] identified the major difficulties, competition, and marketing opportunities in the cherry SC in the UK. Hewett [18] introduced some challenges to overcome in SC management to avoid risky situations in the near future. Hingley [19] worked on a fresh produce SC in the UK aiming to bridge the gap between business-to-business (B2B) vertical SC channels. Maruyama and Hirogaki [20] generated a three-level SC model that examined the effects of vertical coordination on the output, prices, and the welfare of various parties. The authors piloted the designed method in a Japan-based organization and showed the benefits of a vertical contract framework when compared with spot market transactions. Mergenthaler et al. [21] predicted the demand parameters that had an impact on variations in the purchase of fresh fruits and vegetables using household survey data for Vietnam's two major cities, Hanoi and Ho Chi Minh City. The results showed that the purchase of fresh fruits and vegetables was dependent on household expenditure.

Clements et al. [22] studied two cases of fresh produce SCs on the South Island of New Zealand. They examined the linkages in the SC functions within their framework and showed that the information exchange structure between parties had the biggest impact on the character of the relationship. Feng et al. [23] established a decision support system using price management and coefficient of variation methods. Zúñiga-Arias et al. [24] performed structured interviews and a laboratory analysis for the case of the mango SC of Costa Rica to provide a framework to describe managerial activities and their impact on product quality. Cadilhon et al. [25] worked on a tomato and butterhead lettuce SC in Ho Chi Minh City and defined the dominant factors in B2B relationships. Stringer et al. [26] performed a conjoint analysis on vegetable processors from China. The results of this

study indicated the importance of alternative SC characteristics, such as the sizing of producers and quality certification.

King et al. [27] investigated 15 cases with different food categories, including fruits and vegetables, to discover the determinants of local food SCs. Structure and size factors were identified as essential SC performance indicators for local markets to compete with mainstream markets. Based on a case study in four European countries, namely, The Netherlands, Spain, Poland, and Greece, Verdouw et al. [28] proposed a reference model for demand-driven fruit SCs in which business processes were designed in a way to establish a clear information basis between information systems and managers. Jiao and Shen [29] analyzed the market share, price and profit in sealed SCs. Certain quantitative relationships between market share, equilibrium price and equilibrium profit were defined. Samuel et al. [30] compared SC models with various examples around the world to provide insights into their evolution, procurement and marketing strategies. The relationships between these SCs were also investigated in this study.

Fizzanty et al. [31] studied two cases in the mango industry of Indonesia to determine the problems that occur in the SCs of a developing country. The necessity of commitment among the stakeholders and decreasing the opposition of the system environment were learned using a complex adaptive systems (CAS) perspective, sustainability–acceptability–feasibility–efficiency (SAFE) framework, and cross-case analysis. Cai et al. [32] focused on pricing issues when outsourcing logistic activities. The effect of third-party logistics on SC performance was found to be significant, and an incentive scheme was proposed. Kundu and Kar [33] worked on a physical distribution model. Using the traditional retail model and the reliance value chain business model, the authors developed a revised model to establish a growth strategy for building a value chain. Götz et al. [34] considered competitiveness and price transmission in the case of Israeli grapefruit growers. The seasonal losses of citrus growers were found to stem from asymmetric price transmission.

Bahinipati [35] focused on routine SC activities, namely, business planning, supply and demand management, inventory, transportation and logistics. Information and communication technologies (ICT) were referred to as one of the crucial needs to ensure customer satisfaction. Conducting open-ended interviews with banana traders in Lampung Province, Sumatra Island and Banten, Java Island, Obeth et al. [36] identified the risks the smallholders considered when joining modern SCs. The perceived risk, additional workloads and current state of comfort were indicated as factors affecting why smallholders were not willing to join modern SCs. Chen et al. [37] evaluated system performance using optimization and colored Petri net methods. With the help of this evaluation, robust strategies to sustain the system performance of agricultural SCs were found. Aysoy et al. [38] employed quasi-experimental methods to display policy reforms in the wholesale market and showed that the reforms resulted in a decrease in prices.

Karyani et al. [39] concentrated on the financing problems of mango farmers in West Java and employed value stream mapping and descriptive analysis. The authors identified the significant pillars of the financing scheme as being contracts and agreements and the security of credits, which were provided by the guarantor institution. Gamboa et al. [40] evaluated the performance of three organic tomato SCs in Spanish and Catalan contexts. Trade-offs due to the integrated assessments were identified to characterize the performance of food SCs. Webb [41] examined changes in consumer culture and showed that the critical points in SCs shifted from the processor/retailer to the retailer/consumer boundary. Negi and Anand [42] analyzed the case of a tomato SC in India and identified labor charges and operational factors as the two most important factors leading to inefficiency in the SC.

Siddh et al. [43] evaluated perishable food supply chain quality (PFSCQ) and presented a research model to ensure sustainable organizational performance that had an impact on PFSCQ. The authors analyzed the Indian food industry to create a performance measure model using various tools and methods, such as survey study, structural equation modeling (SEM), and exploratory factor analysis with varimax rotation. The

proposed model revealed that producer performance had a positive impact on supplier performance, processor performance, and distributor performance. Shashi et al. [44] studied the overall food supply chain performance (FSCP) and in what way it is dependent on the performance of partners in a sustainable and energy-efficient SC. For this reason, a five-stage performance measurement model is presented. Arshinder and Balaji [45] investigated a case in an Indian metropolitan city to understand the difficulties in FFVSCs. The study found that excursive margins determined by SC agents caused double marginalization at each interface of the SC.

Concerning strategy, Nakandala and Lau [46] worked on 12 urban local fresh food retailers in Sydney and identified the dominant strategies in different parts of the SC. For time efficiency in downstream activities, maximizing the product's freshness and taste were the predominant strategies. Cao and Mohiuddin [47] investigated price formation using the elastic model of price conduction and Granger causality analysis. Based on the findings, it was concluded that the price of fresh and raw vegetables is determined in the wholesale market. Negi and Anand [48] examined the wholesale stage of a mango SC in India using factor analysis. Various factors affecting cost, lead time and quality and, therefore, causing inefficiency in the system, were eventually identified. Pavez et al. [49] performed their study on contracts chosen during the exportation of Chilean apples. The results of the economic analysis conducted within the context of this study revealed that free consignment and minimum guaranteed arrangements were preferred by the exporters of Chilean apples when they exported to a country with a safe business environment. Nedumaran et al. [50] proposed an SC model to connect farmers directly and efficiently with customers. The model also has as an aim to reduce postharvest losses. In addition, a market information system is implemented within the proposed SC model to balance the information asymmetry along the FFVSC in India. Waqas et al. [51] studied SC risks which affect agropreneurs of fresh fruits and vegetables in Malaysia; five SC risks are determined (supply, process, demand, environmental and financial risks) and the level of these risks are measured.

Section 3.1 provided details on the FFVSC studies that essentially focus on the managerial aspects of the main topic. Most of these studies conducted surveys and questionnaires to collect data and analyze cases. With the help of studies concerning the managerial aspect of FFVSCs, new approaches for businesses to run in an efficient way are developed such that both the end customer and the internal customers along the food SC can benefit from the system. The ultimate aim of the studies categorized under Section 3.1 is to create a systematic approach to measure the current performance of the value/supply chain to improve it. There will be continuous demands placed on performance measurement systems because change is integral to the systems and will always be pertinent.

3.2. Food-Related Problems/Postharvest Losses along the FFVSC

Studies in Section 3.2 focus on food-related problems. The most frequent keywords that were encountered within this category included food quality, food waste, food loss, postharvest loss, and the freshness of food. The common goal of these papers is to develop a better value chain and address points where losses primarily occur with the use of statistical methods.

Digal [52] built a price asymmetry model based on food quality and performed a case study in the vegetable industry in the Southern Philippines. Various types of vegetables and their attributes with respect to the role of quality grades and standards are explained. Russell et al. [53] investigated the loss of vitamin C in cold SCs for fresh strawberries and found that there was a difference in vitamin C content between strawberry trials along the SC. Cai et al. [54] tracked efforts to keep perishable products fresh. Thus, the authors proposed a model to examine problems, such as order quantity, freshness level, and pricing. They stated that joint decisions taken by producers and distributers had a significant effect on the freshness of the product. Jacxsens et al. [55] performed comprehensive research on fresh-cut vegetables to analyze and assess the effects of climate change on food safety. For

this purpose, a knowledge-based model was developed to prevent microbiological food safety risks at all stages of the SC. Another study on food safety that was conducted by Diez-Valcarce et al. [56] analyzed viruses in food SCs. The authors developed an amplification control to be employed in routine analyses of food viruses.

Li and Qiao [57] presented a preservation behavior decision-making model for the three parties of the SC, namely, farmers, wholesaler markets, and supermarkets. Performing a case study for the litchi SC, the authors concluded that actions to be taken to support preservation behavior depended on factors such as the relationship between price and the freshness of product, the preservation technology, and the circulation time. Jraisat and Sawalha [58] investigated the drivers of quality control operations in the FFVSC in Jordan using a case study approach. Thirteen determinants, including timely delivery, information quality, and commitment were defined as quality control factors. Macheka et al. [59] worked on the banana SC in Zimbabwe to understand the reasons for mechanical defects in the chain and specified the critical control points to minimize such effects. Based on their findings, handling activities can be acknowledged as one of the primary reasons for the mechanical defects.

Sivakumar and Wall [60] and Bill et al. [61] both provided a fruit-oriented quality management scheme for the postharvest SCs of papaya and avocado fruits, respectively. Since both of these fruits have high importance in terms of perishability, nutrition density, and price, quality issues during their exportation are critical. Different factors, such as temperature and storage, were identified as pivotal in the SCs of these cases. Blanke [62] studied apples to decrease their waste during SC activities and highlighted that reducing ethylene (the ripening gas) had an important effect on reducing food loss. Janssen et al. [63] also focused on ethylene gas, comparing three measurement systems (μGC, NDIR, and ETH1010) in the fruit SC. The authors claimed that this three-measurement system was cost-efficient and robust enough to be used in a container or a controlled atmosphere.

LeBlanc et al. [64] presented a database that contained the nationwide trade data for packaged ready-to-eat lettuce and leafy greens in Canada using an integrated simulation tool. The purpose of establishing this database was to sustain food safety and assess the risks that could be dangerous for public health due to contaminated food. The volumetric flow and the time–temperature data in this database can be used to assess the risks that occur along the SC. Hou et al. [65] worked on the Moroccan fruit and vegetable SC to meet the food safety standards that were introduced during the exportation of goods. This study employed principal component analysis and offered a linkage between food SC organization, target markets and commercialization channels. The results indicated that buyer-driven channels had more linkages between the upstream and downstream operators.

With the purpose of reducing food loss, Haoran et al. [66] used Fuzzy TOPSIS to optimize and improve the fresh agriculture product SCs. Zoellner et al. [67] performed several microbiological analyses to identify the safety risks. Accordingly, the authors studied the Roma tomato SC between Mexico and the USA. The study demonstrated that packaging houses and supermarkets were risky places in terms of food safety. Vegetable retail stores in four locations of Tamil Nadu, India were examined in Ramanathan et al. [68] to identify the main reasons for food waste in the SC. The authors reported that long travel distances, lack of labor, poor packing methods, damage due to handling during cleaning, sorting and grading should be primarily addressed. Gardas et al. [69] developed an interpretive structural model (ISM) to find the determinants of postharvest loss in the case of Maharashtra State, India. The authors identified the lack of linkages between organizations (e.g., industry, government institutions), the lack of technology/technique, and the lack of linkage between farmers and processing units, as critical factors.

Jacxsens et al. [70] performed a study aiming to analyze potential threats regarding food safety. Basil, strawberry, and butterhead lettuce were studied using a quantitative exposure model to forecast the number of pathogens on products. A probabilistic quantitative exposure assessment model was also developed with the purpose of examining the

distribution of contaminated food. Orjuela-Castro and Adarme-Jaimes [71] concentrated on the SC dynamics of Colombia. The model constructed in this study was able to identify food loss due to life cycle or logistic activities in contrast to other models in the literature. Fabbri et al. [72] studied ultrasonic humidification and described its potential to reduce postharvest losses. It was found to be more likely to have a positive effect on the environment, including climate change, when compared to conventional SCs. Mercier and Uysal [73] trained a neural network using a heat transfer model to estimate temperature accurately so that food quality along the SC could be ensured. Zoellner et al. [74] simulated a model for the microbial dynamics of fresh products using a postharvest SC using the microbial travelers (PSCMT) tool. The tomato SC from Mexico to the USA was examined and a PSCMT model was proposed. Hernández-Rubio et al. [75] performed a study on Spanish and French intermediaries to determine the critical factors for food safety in the fruit and vegetable SC. It was found that big retailers were essential players to establish stricter safety controls.

Kelly et al. [76] studied each level of the SC focusing on food quality. For this purpose, the strawberry SC from Fancy Farms, USA was examined using instrumental color and texture analysis, ascorbic acid analysis, and two-way analysis of variance. The results showed that providing a constant optimum temperature through the SC was crucial to decrease food loss. Using the Delphi method and in-depth interviews, Diaz-Ruiz et al. [77] extracted 48 prevention methods which were the most effective measures to avoid food waste. These prevention measures were identified according to the diverse stages throughout the food SC: (1) primary production wholesalers, (2) industry, (3) distribution, (4) small stores, (5) consumers, (6) redistribution, and (7) along the food SC. Using mass flow analysis, Caldeira et al. [78] studied how to approximately forecast food waste in the EU for the main food groups that were highly consumed, namely, sugar beet, oil crops, potatoes, vegetables, fruit, cereals, meat, fish, dairy, and eggs, and found that cereals, fruits and vegetables were among the most wasted food groups. Zhang et al. [79] built a mixed integer linear programming model and structured an improved kernel search-based heuristic aiming to demonstrate the flows of perishable food while considering food quality. A food manufacturer in China was studied as the focal case and the proposed model was stated to have improved manufacturers' profit by 10%. Xu et al. [80] established a step-by-step analytical framework that consists of (1) a data-driven quality degradation prediction model, (2) preliminary planning model, and (3) an optimized supply chain network design. With the help of this framework, quality degradation along the supply chain could be tracked; necessary measurements might be taken, for instance, to ensure initial environment conditions in delivery vehicles.

In Section 3.2, studies focusing on how to solve food-related problems in the FFVSC are explained. Various methods and analyses have been employed to overcome the issues in this field and most of the research investigated performed case studies to test their findings. With the help of these studies, problems caused by biological factors were attempted to be overcome with a view to prolonging the life of harvests. Every single decision affects the whole system in terms of food waste, quality, safety, etc.; for example, a new decision on replenishment may have an impact on the freshness of the fruits and vegetables. The joint effect of decisions can be taken into account before action. This issue is directly addressed in Section 3.3 as well.

3.3. Role of Parties Involved in the FFV Value Chain

In this subsection, studies concerning SC activities from a particular point of view, such as that of farmers, wholesalers, retailers, and cooperatives, are presented. The primary objective of these studies is to reveal the weaknesses of selected parties in the value chain by conducting questionnaires.

Hingley [81] examined the fresh produce market of the UK using the multi-case, multi-site method. The purpose of this study was to examine SC activities from the perspective of the suppliers for small- and medium-sized enterprises (SMEs). This study

found that the elimination of some SC members from the system is a current trend. The partnership approach was also noted as an essential determinant to help relationships within the system prosper. Louw et al. [82] focused on the South African agri-food chain and small producers in mass consumer markets. The study showed that there was a need for a multi-actor approach such that farmers were successfully involved in the SC. Arumugam et al. [83] focused on Malaysian farmers and employed factor analysis to identify the determinants that cause farmers to get involved in contract farming. The results revealed that market stability, access to marketing information and technology, the transfer of technology to improve farming practices, access to inputs, and indirect benefits were key factors considered by farmers.

Schipmann and Qaim [84] concentrated on farmers linked to modern SCs in developing countries. Thailand's sweet pepper SC was chosen as a case study. In this study, the most important determinant for farmers was found to be trade with a familiar person due to trust issues. Sayın et al. [85] performed a SWOT analysis for wholesale markets and observed that producers earned less due to cutbacks and consumers paid more because of procurement and transfer expenses. Adopting a value-chain approach, Guarín [86] examined the Colombian market by conducting in-depth interviews with producers, wholesalers, urban consumers, and other key actors. In this study, smallholders' heterogeneous production patterns were identified as a crucial factor, in contrast to their inefficient characteristics, since they supply food for poor local consumers at affordable prices.

Schuster and Maertens [87] studied the Peruvian asparagus export sector using fixed effects and generalized method of moments estimators. The importance of certification for vertical integration was explained by means of reduction in the share of produce from external producers. Wahyudin et al. [88] presented an agriculture SC model using a multi-integer linear programming approach to consider a corporate social responsibility (CSR) program, which aims to strengthen farmers by providing capital and funding. It was eventually found that CSR was beneficial for retailers for the sake of quality improvement. Jacob-John and Veerapa [89] focused on small- and medium-sized retailers to assess them in terms of ethics and responsibilities from the customer's point of view. The study specified fairness as an important topic for suppliers and business customers. Michelson et al. [90] studied the case of Walmart China to examine intermediaries in the FFVSC of China. Food safety and quality were found to be critical issues in recent years according to the insights provided by the study. Devin and Richards [91] investigated the Australian FFVSC by conducting interviews with the purpose of decreasing food waste through CSR. The authors stated that strong government regulations and interventions were a necessity to ensure a responsible system. Elder [92] analyzed cooperatives in Nicaragua to discover their relationships with supermarkets. It was found that their performance depended on the type of interaction between farmers and the supermarkets. Salvia [93] used a global value chain perspective to tackle labor contracting. For this reason, in-depth interviews were conducted between 2015 and 2016 with key informants, mainly workers, labor contractors, farmers, labor organizations and unions, supermarket buying agents, and representatives of the agricultural organizations. This study identified the new strategies that the producers are adopting in order to resolve their problems. One of these strategies is to decentralize labor management to labor contractors. Gunarathna and Bandara [94] examined the intermediaries along the vegetable SC and described the main reasons for postharvest losses. The results showed that improper packaging, malpractices during transportation, careless handling, and unsuitable harvesting practices were the main reasons for postharvest losses.

Most of the studies highlighted above adopted a farmer- or a cooperative-oriented approach. This is mainly because these two parties face various challenges in SC activities. In an organized business/retail environment, small producers tackle problems, such as sustaining standard food quality and safety, ensuring cash flow, contracting with other stakeholders, reaching the global/bigger market channels, adopting technology, and lack of scientific information. Cooperatives also deal with problems, such as labor shortage,

lack of technological employment, and operational obstacles. Therefore, the studies described have focused on challenges along the SC and sought to address the circumstances in which they arise. There are obviously some issues that need to be handled in the FFVSC. We may infer that the design of an SC, or the relationship between parties, are root causes of the majority of the problems that occurred. At the design stage, all parties in the chain should jointly discuss problems for efficient integration. Research reviewed in this category clearly defines the existing problems and proposes solution approaches for them.

3.4. Review Papers

In this subsection, review articles in the FFVSC are presented. These survey studies examined the literature considering only location, product or problem-specific issues of the chain and thus provide a relatively narrow perspective.

Rajurkar and Jain [95] reviewed food SC management by analyzing journal papers published between 1994 and 2009. Kong et al. [96] discussed auction-oriented logistics operations. Aung and Chang [97] focused on traceability studies and concluded that radio-frequency identification (RFID) and sensor-based tracking systems would be widely used in the near future. Sibomana et al. [98] examined postharvest handling within the context of the tomato SC of Sub-Saharan Africa and emphasized the importance of food loss as an avenue for future research. Siddh et al. [99] studied agri-fresh food supply chain quality (AFSCQ), considering research published between 1994 and mid-2016 and drew attention to the insufficiency of studies that have been conducted in developing countries. Routroy and Behera [100] provided a review on the agriculture supply chain (ASC) for the period 2000–2016 and concluded that inventory policy, demand forecasting, and ASC integration topics were not investigated thoroughly. Raak et al. [101] reviewed the literature on food loss and conducted interviews with 13 German companies. Saitone and Sexton [102] examined food chain evolution and evaluated its performance. Gharehgozli et al. [103] investigated the field of food transportation. Luo et al. [104] reviewed the agri-food supply chain management (ASCM) literature through a bibliometric analysis and a citation analysis. Corrado and Sala [105] investigated the topic of food waste. Lezoche et al. [106] examined the future of agri-food and asserted that adopting new technologies would improve various components of the system. Priyadarshi et al. [107] reviewed post-harvest supply chain losses. Articles published between 1989 and 2020 were considered in this review paper.

The review papers mentioned here provide insights into the current state of the FFVSC literature, specify the gaps and point out possible avenues for future research. With the exception of one, all of these studies are somewhat limited in providing a review of the related literature since they tackle specific sub-problems of the FFVSCs. Moreover, the one excepted paper does not discuss recent trends.

3.5. Technological Trends in FFVSCs

In Section 3.5, studies that considered the formation of the FFVSC and presented technological solutions for the proposed problems are described. Their primary objective is to propose new technological solutions and applications for the improvement of fresh fruit and vegetable value chains by considering the point of contact (POC).

Duan et al. [108] conducted interviews and studied cases to characterize the usage of the Internet in fresh produce SCs involving SMEs. The proper training and education of agribusiness managers were stated as important factors in employing the Internet. Hu et al. [109] presented an intelligent decision support system built on genetic algorithms and neural networks to manage price risk. The proposed system helps detect the sources of risks easily and generates the most effective price risk management method for the user. Solanki and Brewster [110] focused on data traceability and proposed a framework that used an electronic product code (EPC) which provides traceability and information for products along the SC. Liu et al. [111] researched the Internet of Things (IoT) technologies and asserted that providing the storage and retrieval of information for harvests was five

times faster using the IoT Name Service (IoTNS). It was also possible for the IoTNS to track the harvest from the farm to the market. La Scalia et al. [112] studied the smart logistics unit (SLU) to meet food safety and quality requirements in the case of strawberries. A shelf-life equation based on volatile organic compounds (VOCs) was eventually provided which guaranteed food safety and shelf life, satisfying logistic efficiency from farm to fork and ensuring a sustainable system. Borrero [113] concentrated on the use of blockchain technology and smart contracts in the Spanish agri-food SC. A concept involving smart contracts and permissioned ledgers was proposed and its feasibility was demonstrated. Pal and Kant [114] conducted a comprehensive survey to determine the most prominent factors affecting the integration of intelligent technologies into the SC system and their utilization. It was stated that the future of this formation would depend on low-cost packaging technologies. Goisser et al. [115] focused on portable food scanners and the implementation of this innovation in the German fruit and vegetable supply chain in order to enhance food quality along the SC. Semi-structured interviews were conducted with different actors along the SC and the results indicated that the adoption of food scanners can improve quality at different stages of the SC.

Studies covered in this subsection were selected using the keywords blockchain, data integration, data traceability, and smart systems. The number of papers is much lower low than for other categories; however, one can expect the number to rise in the following years since these research fields have been showing an increasingly positive trend.

The studies in this subsection differ from the other categories, not only because of the problem in the FFVSC they focused on, but also due to the solution approach they adopted. Upgrading technology makes a positive impact on agriculture, and the employment of new technological tools, such as sensors and robotic systems, enables scientists and practitioners to solve complex problems in a shorter amount of time so that agribusinesses can become more productive, beneficial, secure, and environmentally friendly [116]. Therefore, this emerging research field is expected to progress in the near future. This subsection shows that technology can be employed, not only for decreasing the level of problems, but also for eliminating and furthermore, proactively preventing them. In this rapidly changing environment, all parties in the VC, including small farmers and the end customer, should learn about and adopt these technologies in their daily lives.

3.6. Packaging Issues of FFVSCs

Due to the nature of fresh fruits and vegetables, the role of packaging in their SC processes is pivotal. The main purpose in the packaging of fresh fruits and vegetables is to meet customer requirements regarding the quality and freshness of the product and to eliminate food loss so that farmers and firms do not suffer financial losses [117]. The material used for packing is also an essential point to consider [118]. To meet sustainability requirements, various issues, such as the packing procedure, the chosen material, recycling and/or reuse of the material, must be addressed. The main objective of the related research has been to increase food quality and to make a positive impact on the shelf life by developing packaging systems while controlling expenses.

Attempting to generate an integrated food packing and distribution network, Accorsi et al. [119] proposed a conceptual framework that provided an assessment for both the financial and the environmental impact of fresh food. The purpose was to establish a generalized framework which could be implemented for any type of food. The performance analysis of this framework was carried out using life cycle assessment (LCA) and life cycle costing (LCC) evaluation. An Italian fresh food catering chain was studied as the focal case and their fruit and vegetable packing and distribution were evaluated. A what-if multi-scenario approach was adopted and the proposed system was ultimately shown to reduce CO_2 emissions. In contrast to the benefits it could provide for the environment, the proposed system did not lead to financial success and resulted in a price increase of €0.06 per kg.

Employing critical analysis, Battini et al. [120] analyzed two different packaging solutions (i.e., corrugated fiberboard boxes and re-usable plastic containers) from an economic and environmental perspective. A corrugated fiberboard box with removable plastic films and a reusable plastic container with a corrugated fiberboard bottom were introduced, aiming to overcome the constraints of existing solutions. These new packages were then tested to compare their performance with the original ones. It was concluded that the new packaging solutions were convenient to adopt from an economic and environmental point of view based on the outcomes of the scenarios applied.

In an effort to find the possible benefits and disadvantages of reusable plastic containers (RPCs) from an economic point of view, Singh et al. [118] gathered data from grocery retailers and performed a time-driven activity-based costing (TD-ABC) analysis. Subsequently, process times and product damage were observed and compared with the typical deployment of bulk containers in the grocery retailers' distribution centers (DC), retail stores, and asset recovery centers of the SC. It was concluded that RPC application was highly recommended due to creating less waste and loss during the distribution of fresh products.

Giuggioli et al. [121] examined the case of Portola strawberries in Italy to assess the products packed in green films. Performing various analyses, such as total soluble solids (TSSs) analysis, nutraceutical analysis, statistical analysis (two-way analysis of variance), and principal components analysis, the authors found that selecting green films was more convenient for providing a sustainable improvement in the postharvest industry when using modified atmosphere package (MAP) technology.

Bortolini et al. [122] intended to create a SC network while considering the disposable and reusable packaging containers. Since the problem the authors tackled involved the best selection of packaging containers, the location of storage/handling nodes, and flow allocation, they built a bi-objective mixed integer linear programming model to inform the decision-making stage. A high level of attention was paid to the disposal and re-use of packaging containers due to their frequent use during the distribution of fresh fruits and vegetables in real life. A case from Emilia-Romagna, Italy was studied, and the authors found that both the disposable and the reusable packaging containers should be utilized in a balanced way to address the environmental and economic needs of the problem. To obtain the optimal outcome, which corresponded to decreasing the CO_2 emissions while preventing cost increases, it was shown that 47.1% of the packaging containers should be reusable and the rest should be disposable.

Zhao et al. [123] designed a consolidated cold and MAP system for fresh fruits. With the purpose of presenting the advantages of cold chain adoption, fresh strawberries were studied as the focal case. The results confirmed the positive effect of the consolidated package system.

Packaging activities are crucial for the protection and transportation of items; however, they also cause a high amount of waste [119]. Packaging issues deserve a subsection of their own. This subsection touches on almost every issue regarding the VC: freshness of food, safety of food, transporting and stocking processes, sustainability concerns, etc. Studies covered in this subsection reveal that the main challenge for packaging problems is to satisfy both environmental and economic constraints. With the help of these studies, different aspects of the packaging state along the FFVSC are highlighted, and system improvements are recommended. Thus, attempts are made to optimize the freshness of food and the economic and environmental impacts.

3.7. Logistics Solutions of FFVSCs

This subsection describes studies seeking to solve logistic problems associated with FFVSCs. The main purpose of these studies is to increase the efficiency of logistic operations with the help of optimization and routing methodologies and to make an impact on the freshness of products while decreasing logistics costs.

To solve different transportation problems, Busato and Berruto [124] presented a simulation model, which enables forecasting of the quality loss of the harvest on the way from the packer to the consumer. Yan [125] focused on a fruit e-commerce website and its logistics demands. The study is based on the fruit SC's logistics management of the corresponding e-commerce website. A system to run SC logistics and a structural framework is presented to manage the e-commerce SC activities. The fruit e-commerce website (FECW) which serves as a fourth-party logistics (4PL) provider, was considered to provide a basis for future studies. Etemadnia et al. [126] formulated a mixed integer linear programming model to create a network for the U.S. fruit and vegetable industry. The effect of changing a model's parameters when deciding the optimal network was examined. Chandrasekaran and Ranganathan [127] analyzed the Indian traditional agriculture SC using genetic algorithms. The closed transportation method the authors proposed was found to be convenient for short-purpose domestic distribution. Ghezavati et al. [128] focused on maximizing profit during the distribution of tomatoes in Iran. A mixed integer programming model alongside the Benders decomposition method was employed. Mejjaouli and Babiceanu [129] examined the case of strawberries distributed from California to Dallas. The results showed that significant savings could be achieved if the logistics decision model proposed was used in the SC of perishable products.

The purpose of logistic studies in the FFVSC has been to maintain food quality, minimize distribution costs, and reduce CO_2 emissions. Most of the studies in this subsection adopted analytical tools, such as mathematical models and simulation, to establish their formulations.

3.8. Sustainable FFVSCs

The eighth subsection describes studies concentrating on how to develop a better FFVSC in terms of sustainability. Sustainability acts as an umbrella issue. When we consider the SDGs, both public and private sectors try to engage with these goals. We expect that this issue will grow and will be encountered frequently in forthcoming years.

Smith [130] examined the ways in which it is possible to make SC activities more sustainable, and consequently identified the most essential determinants for this purpose, such as the responsibility for product quality. Styles et al. [131] presented a framework for retailers and established a hierarchy of eight best environmental management practices (BEMPs) to define and improve the environmental impact of SCs using performance benchmarking and the dissemination of better management practices. Naik and Suresh [132] studied the main problems in maintaining a sustainable SC and for meeting the requirements for food safety and food quality. Apart from retailers, corporations were also found to have a significant role in generating a sustainable agri-food SC. Blanc et al. [133] studied raspberry SCs in northwestern Italy using life cycle assessment (LCA), life cycle costing (LCC), and externality assessment (ExA). Sustainability was combined with the use of bio-based plastics, which were eventually claimed to be the best choice due to their lower environmental and social impacts compared to conventional plastics. Using an empirical methodology based on analyses of energy fluxes and non-biodegradable materials, De Corato and Cancellara [134] focused on Italian firms and cooperatives to define the measures and technologies of energy efficiency, savings, and agro-waste recycling for the development of a feasible SC. Slamet et al. [135] focused on sustainable food supply chain management. The objective of this study was to find enablers to facilitate sustainable food supply chain management while engaging small-scale farmers in modern retail channels. Interpretive structural modelling was applied, and the results showed that collaboration and work among supply chain members were determined to be fundamental driving forces in SFSCM. Jabarzadeh and Yamchi [136] tackled an optimization problem for a fruit supply chain to achieve the three pillars of sustainability. The research problem was structured as a multi-objective, mixed-integer linear programming model. The results showed that the proposed model can also be applied to vegetable supply chains.

As can be seen, the sustainability concept needs to be focused on more and paid more attention to since this category comprises the least number of studies. In terms of the FAO definition, sustainable food value chains involve three pillars, which are (1) economic sustainability where it is profitable, (2) social sustainability where it is beneficial for society, and (3) environmental sustainability where it is compatible with nature [137]. The Commission on Sustainable Agriculture Intensification (CoSAI) emphasized that financial incentives reinforce sustainable agriculture. Currently, financial incentives are mainly public-sourced. Although over a short time period their environmental and social advantages have not been clearly defined, public and private sectors still undertake innovative initiatives and funding [138].

The studies listed in this subsection evaluate the FFVSC in terms of sustainability, which concerns the economic, social, and environmental impacts of activities and the solutions. With the help of these studies, a better food SC can be defined from a holistic point of view so that food SC activities can be tackled in a continuously effective way.

4. Conclusions and Future Research

An in-depth investigation of the FFVSC literature reveals that some serious problems exist that must be solved.

1. The problem of establishing an effective value chain throughout the system while keeping KPIs in check has been widely studied. It is a common concern for both academics and practitioners, as underlined in Section 3.1. Because of the rapid changes at this time, the value chain and its performance should be evaluated or assessed in a very simple and understandable way. This will encourage involvement of almost all parties in the chain.
2. Overcoming food-related problems along food SCs, especially postharvest losses, is also a significant topic according to information provided in Section 3.2, and still needs further research. At the moment, it appears that postharvest losses differ by country and crop. To the authors' knowledge, there is no specific example which has a zero postharvest loss. We may employ a design thinking approach to find smart ways to handle this issue; different actors from different areas of expertise focusing on the same problem for their shared goal presents significant opportunities.
3. Ensuring productivity for all parties in the value chain, reflecting the different parties involved in the system, is discussed in Section 3.3. The studies examined here consider different steps in the food SC, such as retail and wholesale. We need to conduct research considering small but impactful productivity gains across the chain.
4. The review articles presented in Section 3.4 sought to cover the lack of resources relating to collective technical information.
5. The difficulty in prioritizing technological innovations and solution approaches to existing SCs is described in Section 3.5. An innovative perspective is introduced to overcome the existing problems in the FFVSC. Sustainable innovation frameworks can be adopted for the FFVSC. It is a unique system because of the actors in the chain who have different expertise and backgrounds. It is also unique due to its issues of perishability and hard to manage inventories and has a major impact on our future in terms of nutrition and poverty.
6. Inefficient postharvest processes that need to be improved in terms of packaging (Section 3.6) and shipment (Section 3.7) are also stressed. All these activities should be performed in a more environmentally conscious manner while maintaining or increasing their effectiveness. Processes along the food value chain can, thus, contribute to the world in terms of sustainability (Section 3.8).

These six highlights correspond to the categories presented earlier. They mainly cover different stages of the food chain. Most of these categories intersect in two or more ways. They address similar problems in the areas that require improvement. As there are strong interactions among the chains, even a small amount of development can have an

indirect or direct impact on other fields. Following the investigation of FFVSC systems, possible directions for future research are clustered in five groups (Section 4.1) and associated limitations are listed as well (Section 4.2).

This review paper contributes theoretically to the FFVSC literature in terms of its visibility, agility and leanness.

4.1. Future Research

The present paper provides a comprehensive review of the FFVSC literature from a managerial point of view. Suggestions for future work highlighted during the examination of studies under consideration are provided in this subsection.

First, there is a shift from the SC management approach to the value chain (VC) concept [11,139]. It is highly possible that the SC concept will be more often interpreted as a VC and that this will be acknowledged more than the SC management concept in the near future. Even though the SC concept provides a comprehensive perspective, it is not possible to hear the customer's voice using it. The downstream flow from raw material to the end customer, which is expressed as the SC, differs from the VC. According to the VC concept, "value-added" actions are provided for customers that are willing to pay for the product, whereas "non-value added" activities are simply a waste for enterprises [140]. Although the SC monitors the system from the raw material phase to the end customer, the VC starts with the voice of the customer and ends with customer satisfaction. Therefore, examining the system as a VC may provide a better understanding. Although we design and develop a system, we should always work with the customer instead of assuming their needs. This review article has also emphasized that the actors in the VC should be ready to work together for integrated efficiency. Thus, every party should first understand the underserved customer needs and that their customer is the next party in the chain not just the end customer.

Secondly, academics and practitioners around the world encourage all parties to collaborate with each other in conducting multidisciplinary research. We may employ partnership frameworks based on empiricism and teamwork between academics, practitioners, entrepreneurs, technology developers, government organizations and non-governmental organizations, etc. Faced with the pandemic, we learnt that we need to act fast and together. Since the frequency of global food traffic may increase in the near future, as the COVID-19 pandemic has proven, there is a need for large-scale global studies. Future food scenarios are diverse. Some focus on hunger whereas others defend the circular economy [141,142]. Conducting further work on endemic products or harvests that can only be planted in a limited geographical area may also extend the boundaries of the existing literature. As described in [60,61], case-specific studies for harvests that are produced in limited geographical areas due to the climate can be more suitable for this purpose to better understand the managerial implications during the distribution of such products. As mentioned in [34,49], apart from the logistics side of these studies, regulations regarding the import and export processes may be examined to understand various performance and strategy indicators more closely. Furthermore, women's involvement in FFVSC activities is a suggested area of study, as underlined in [143]. As discussed in Sections 3.2, 3.6–3.8, such developments in the current literature would mainly improve food quality, food safety and the freshness of food.

Thirdly, there is a gap in the literature regarding e-commerce models. Due to the COVID-19 pandemic, the rate of use of e-commerce has grown substantially. There is abundant room for further progress in this aspect of FFVSCs. To the best of our knowledge, there is only one study that specifically considered this topic [125]. Most of the e-businesses do not build retail stores to reach the customer. In this model, orders are carried from storage to customers. These orders are specifically designed based on customer selections and shipped to their preferred addresses. Thus, harvests are not carried in bulk, but they can be packed in customized packages. On the other hand, the distribution of these goods introduces another concern since there is a larger network and the

allocation of these packages is not standardized. Regardless of economic concerns, the importance of home delivery was strongly emphasized during the COVID-19 pandemic. Therefore, both the quantity and operational area of entrepreneurial e-businesses are expected to increase. These entrepreneurial businesses and startups can be evaluated if their business model is profitable. In addition to these, some countries were faced with the failure of agricultural activities, since farmers had difficulties reaching the markets during the pandemic [144]. Therefore, new trading schemes should be studied for small producers to reach the market. Based on the details provided in Sections 3.3, 3.5, and 3.7, future studies on the current topic are recommended.

In addition to e-business firms, there is another highly promising model that needs to be studied. In this newly proposed business model, there are no intermediaries between the producers (farmers/cooperative societies) and the receivers (retailers/marketplaces/e-business firms). Discarding the mediators, receivers can buy harvests directly from producers. In this way, data traceability systems can be integrated into SC systems. An online platform seeking to bring both producers and big buyers together in the same virtual environment has recently been adopted in Turkey for agricultural operations. This project, called the Digital Agriculture Bazaar (Dijital Tarım Pazarı–DİTAP), aims to bring producers and receivers together on the same platform and to help them collaborate with each other [145]. Data received during production will, therefore, be tracked; non-value adding costs, such as commissions paid to intermediaries will be eliminated and customers will be served in a safe and fast way. Such applications should especially be studied due to their promising business models and their potential to extend the boundaries of the existing literature.

In this study, we reviewed 118 articles, but topics on sustainability, the circular economy, and the use of food waste in biorefineries, were not featured areas in the scientific literature. This observation may imply that these issues should be studied in future research.

Finally, the number of studies involving blockchain and other smart technologies are expected to grow exponentially with the emergence of Industry 4.0 applications. Various new technologies and platforms have recently been introduced to agricultural businesses to provide data traceability, data integration, etc. In such projects, both producers and receivers take part. First, the involvement of farmers should be examined through survey studies since changes in the habits of farmers can pose a new concern. Second, money transactions in virtual environments should be observed. Since these transactions can be executed using blockchain technology, future research should pay more attention to data traceability and integration.

4.2. Limitations

All the studies in the relevant literature were limited by the absence of a holistic approach that would provide better insights on all aspects of the food SCs. Different cultures, backgrounds, countries, and climates may lead to different types of SCs; however, the literature fails to account for behavioral differences in different parts of the world. In particular, the number of case studies addressing food SCs which consider all their aspects is insufficient.

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Appendix A

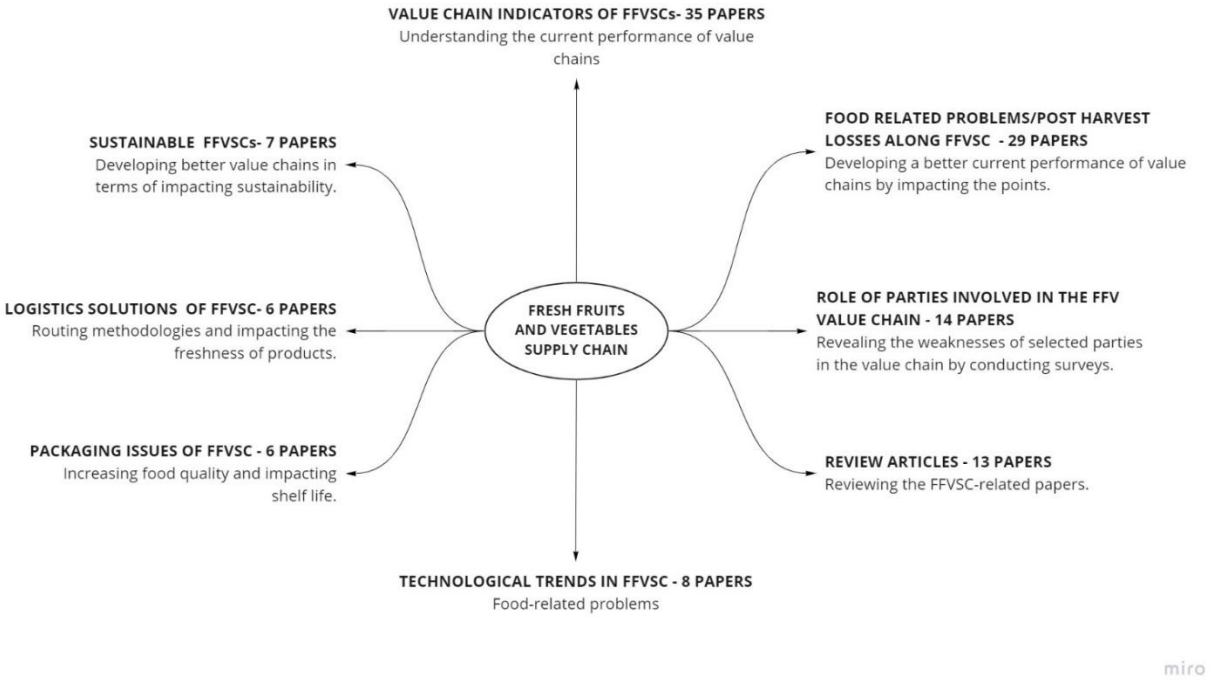

Figure A1. Thematic Map of Fresh Fruit and Vegetable Supply Chains.

Appendix B

Table A1. Studies Presented in the Category of Value Chain Indicators in Section 3.1.

ID	Authors	Year	Title	Keywords	Method Used	Case Study/Test
17	Wermund and Fearne	2000	Key challenges facing the cherry supply chain in the UK	Competition, cherries, market opportunity, supply chain	* Qualitative research	Cherry supply chain in the UK
18	Hewett	2003	Perceptions of supply chain management for perishable horticultural crops: An introduction	Fruits and vegetables, supply chain, management, logistics, quality, kiwifruit, apples, apricots, consumer satisfaction		Stone fruit industry from New Zealand
19	Hingley	2004	Relationship development in the UK fresh produce supply chain	Relationships, supply chain, power and dependency, trust, fresh produce		Multiple leading UK food retailers
20	Maruyama and Hirogaki	2007	The evolution of fresh produce supply chains: From spot markets to contracts	Supply chain, fresh produce, vertical co-ordination transformation, food systems, supermarkets, food safety, non-traditional imports, modern supply chain		Japanese marketing chain
21	Mergenthaler et al.	2008	Consumer demand for fruits and vegetables from modern supply chains in Vietnam		* Two-stage budgeting framework	Vietnam's two major cities, Hanoi and Ho Chi Minh City
22	Clements et al.	2008	Relationship connectors in NZ fresh produce supply chains	Fresh foods, supply chain management, supplier relations, New Zealand	* Case study approach	Two case studies of fresh produce supply chains in the South Island of New Zealand
23	Feng et al.	2008	VegRisk: A decision support system for risk management of vegetable supply chain	Decision support systems, risk management, supply chains, educational institutions, uncertainty, production, crisis management, agricultural engineering, protection,	* Price risk management method * Coefficient of variation model	Xinfadi Agricultural Products Co., Ltd.

				international trade		
24	Zúñiga-Arias et al.	2009	Managing quality heterogeneity in the mango supply chain: evidence from Costa Rica	-	*Structured interviews *Laboratory analysis of mango quality	Mango supply chain from Costa Rica
25	Cadilhon et al.	2009	Market linkages: Characterizing business-to-business relationships in Vietnamese vegetable supply chains	B2B relationships, marketing, supply chain management, Viet Nam	*In-depth interviews	The tomato and butterhead lettuce supply chains in Ho Chi Minh City (HCMC)
26	Stringer et al.	2009	Producers, processors, and procurement decisions: The case of vegetable supply chains in China	Supply chains, vegetable markets, supermarkets, China	*Conjoint analysis	Vegetable processors from Laiyang County, Shandong province, China's largest horticultural production and export region
27	King	2010	Comparing the structure, size, and performance of local and mainstream food supply chains (Book Chapter)	-	*Case study approach	Fifteen case studies in five metropolitan areas with the products of apples, blueberries, spring mix leafy greens, beef, and milk
28	Verdouw et al.	2010	Process modelling in demand-driven supply chains: A reference model for the fruit industry	Business process modelling, supply chain management, reference models, fruit industry	*Reference process models	In four European countries (The Netherlands, Spain, Poland, Greece)
29	Jiao and Shen	2010	Study on market equilibrium of sealed supply chain based on willingness to pay for food safety	-	*Classical Hotelling analytical framework	
30	Samuel et al.	2012	An insight into agri-food supply chains: A review	Agri-food supply chain, organised and unorganised retailing, value chain management, procurement and marketing strategies, international business, India, China, USA, UK, Australia, Southeast Asia		
31	Fizzanty et al.	2013	Learning from failed supply chains: The application of complex adaptive systems and a	Supply chain management, fruit supply chains, developing country, complex	*Complex adaptive systems (CAS) perspective *Sustainability,	Two case studies set in the mango industry of Indonesia

			modified SAFE framework in evaluating proposed system improvements	adaptive systems, CAS, systems improvement, buyer–supplier relationships, agile systems	acceptability, feasibility, efficiency (SAFE) framework *Cross-case analysis	
32	Cai et al.	2013	Fresh-product supply chain management with logistics outsourcing	Perishable product, supply chain management, multiple-party coordination, Third-party logistics, coordination contracts		NONE
33	Kundu and Kar	2013	Identifying the physical distribution form and supply chain issues in marketing F&V products by organised supermarkets: A case on reliance distribution model	Fruits and vegetables, retailing, physical distribution model, supply chain, contract farming, supermarkets, distribution centers	*Traditional retail model *Reliance value chain business model	
34	Götz et al.	2014	Vertical price transmission in the international fresh fruit and vegetable supply chain: Israeli grapefruit exports to the EU after export liberalisation	International fresh fruit and vegetable supply chain, vertical price transmission, export liberalization, market power, Israel, citrus	*Cointegration approach *Engel–Granger representation theorem *Augmented Dickey–Fuller (ADF) Test	Israeli grapefruit growers.
35	Bahinipati	2014	The procurement perspectives of fruits and vegetables supply chain planning	Food industry, supply chain planning, information sharing, collaborative practices		The supermarket (SM) venture
36	Obeth et al.	2014	Non-attractiveness of modern supply chains	Banana, modern supply chain, traditional supply chain, risk	*Open-ended interviews	Banana traders in Lampung Province, Sumatra Island and Banten, Java Island
37	Chen et al.	2015	Investigating the robustness of the agricultural supply chain based on colored Petri nets	Agricultural supply chain, simulation, colored Petri nets, robustness, optimization method	*Optimization method *colored Petri nets	

38	Aysoy et al.	2015	How does a shorter supply chain affect pricing of fresh food? Evidence from a natural experiment	Supply chain reform, fresh food prices, incomplete pass-through, quasi-experimental design	*Quasi-experimental methods	NONE
39	Karyani et al.	2016	Mango agricultural supply chain: Actors, business process, and financing scheme	Economic globalization, mango, supply chain financing, inclusive agribusiness, and value stream mapping.	*Value stream mapping *Descriptive analysis	Mango farmers in West Java
40	Gamboa et al.	2016	The complexity of food systems: Defining relevant attributes and indicators for the evaluation of food supply chains in Spain	Food systems, food supply chains, narratives, integrated assessment	*Integrated assessment *Content analysis *Lexicometric analysis	Three organic tomato supply chains in Spanish and Catalan contexts
41	Webb	2017	Towards an agri-food 'culture': Managing the impact on agricultural supply chains of changes in consumer culture (Book Chapter)	Agriculture, consumer culture, environment, food, public health, supply chains	*Critical theory	NONE
42	Negi and Anand	2018	Factors leading to supply chain inefficiency in agribusiness: Evidence from Asia's largest wholesale market	Supply chain inefficiency, wholesale market, food supply chain, tomato supply chain, food losses and wastages	*Factor analysis	Tomato supply chain in India at Asia's largest wholesale fruits and vegetable market (Mandi) in Azadpur, Delhi
43	Siddh et al.	2018	Structural model of perishable food supply chain quality (PFSCQ) to improve sustainable organizational performance	Supply chain, quality, perishable food supply chain quality (PFSCQ), perishable food supply chain quality (PFSCQ) practices, sustainable organizational performance	*PFSCQ practices	
44	Shashi et al.	2018	Evaluating partnerships in sustainability-oriented food supply chain: A five-stage performance measurement model	Sustainable and energy-efficient supply chain, food supply chain performance, partners' performance, performance measurement,	*Survey study *Structural equation modeling (SEM) *Kaiser–Meyer–Olkin (KMO) test	Indian food industry

				operations management, structural equation modeling	*Exploratory factor analysis with the varimax rotation method	
45	Arshinder and Balaji	2019	Understanding the models of Indian fruit and vegetable supply chains-A case study approach	F&V supply chains, food supply chains, wholesale markets, price variability, India	* Case study approach	A typical Indian metropolitan city
46	Nakandala and Lau	2019	Innovative adoption of hybrid supply chain strategies in urban local fresh food supply chain	Efficiency, supply chain management, agility, supply chain strategy, trust, legality, local fresh food, collaboration and relationships, urban food systems	*Multiple case study method *Thematic analysis	Twelve urban local fresh food retailers in Sydney
47	Cao and Mohiuddin	2019	Sustainable emerging country agro-food supply chains: Fresh vegetable price formation mechanisms in rural China	Supply chain, fresh and raw vegetables, price conduction, granger causality test	*Elastic model of price conduction *Stationarity test *Co-Integration test *Granger causality analysis	Greenhouse cucumber supply chain in China
48	Negi and Anand	2019	Wholesalers' perspectives on mango supply chain efficiency in India	Food supply chain, cold chain, food losses and wastages, fruit supply chain, smart mandi, supply chain efficiency, wholesale market	*Factor analysis	Wholesale stage of the mango supply chain in India, at Asia's largest and the world's second largest fruits and vegetable wholesale market (Mandi) in Azadpur, Delhi.
49	Pavez et al.	2019	Biosecurity institutions and the choice of contracts in international fruit supply chains	-	*Econometric analysis	Chilean apple exports
50	Nedumaran et al.	2020	Digital integration to enhance market efficiency and inclusion of smallholder farmers: A proposed model for fresh fruit and vegetable supply chain	Supply chain, fresh fruits and vegetables, primary processing centers, market information system, India		The main FFV-producing states in India

51	Waqas et al.	2020	Underlying dimensions of supply chain risks amongst agropreneurs of fresh fruits and vegetables in Malaysia	Supply chain risks, agropreneurs, agri-fresh supply chain of fresh fruits and vegetables.	* Questionnaire survey * Snowballing and convenience sampling method	Malaysia

Table A2. Studies Presented in the Category of Food-Related Problems/Postharvest Loss in Section 3.2.

ID	Authors	Year	Title	Keywords	Method Used	Case Study/Test
52	Digal	2005	Quality grading in the supply chain: The case of vegetables in Southern Philippines	Quality grading, price asymmetry, search cost, supply chain	*A model is employed which shows that grading provides information that lowers the search cost of buyers.	Vegetable industry in the Southern Philippines
53	Russell et al.	2009	Losses of vitamin C from fresh strawberries in a commercial supply chain	Cold chain, distribution, moisture, strawberries, supply chain, temperature, transportation, vitamin C	*HPLC method *Standard drying oven method *Statistical analysis (analysis of variance, multiple linear regression)	NONE
54	Cai et al.	2010	Optimization and coordination of fresh product supply chains with freshness-keeping effort	Supply chain management, perishable products, cold chains, freshness-keeping effort, pricing		NONE
55	Jacxsens et al.	2010	Simulation modelling and risk assessment as tools to identify the impact of climate change on microbiological food safety-The case study of fresh produce supply chain	Climate change, food safety management system, fresh produce, microbiological food safety	*Risk assessment studies *Advanced simulation models *Mathematical models	Fresh-cut vegetables
56	Diez-Valcarce et al.	2011	construction and analytical application of internal amplification controls (IAC) for detection of food supply chain-relevant viruses by real-time PCR-based assays	Enteric virus, false negatives, food, internal amplification control, real-time PCR	*Real-Time PCR	NONE
57	Sivakumar and Wall	2013	Papaya fruit quality management during the postharvest supply chain	Carica papaya, fruit quality, health-promoting compounds,	*Postharvest management practices	Papaya fruit

				postharvest management practices, tropical fruit		
58	Li and Qiao	2013	Preservation behavior decision of fruits and vegetables supply chain	Fruits and vegetables supply chain, iterative relationship preservation behavior,		Litchi supply chain
59	Jraisat and Sawalha	2013	Quality control and supply chain management: A contextual perspective and a case study	Supply chain management, quality control, exports, fruit and vegetable industry, Jordan	*Case study approach	Fresh fruit and vegetable supply chain in Jordan
60	Macheka et al.	2013	Identifying causes of mechanical defects and critical control points in fruit supply chains: An overview of a banana supply chain	Postharvest losses, mechanical defects, banana, supply chain, critical control point		Banana fruit supply chain in Zimbabwe
61	Bill et al.	2014	Avocado fruit quality management during the postharvest supply chain	Atmosphere modification, fruit softening, packaging, *Persea americana*, postharvest diseases		Avocado fruit
62	Blanke	2014	Reducing ethylene levels along the food supply chain: A key to reducing food waste?	ethylene, ethylene absorber, ethylene inhibitor, ethylene scrubber, sensor technology, supply chain, waste, whole crop purchase (WCP)		Apple fruit
63	Janssen et al.	2014	Ethylene detection in fruit supply chains	Electrochemical sensors, ethene, ethylene, gas analytics, gas chromatography, non-dispersive infrared	*Several measuring methods for the detection of ethylene	NONE
64	LeBlanc et al.	2015	A national produce supply chain database for food safety risk analysis	Relational database, food supply chain, logistics, food safety risk assessment, simulation, *Escherichia coli* O157:H7	*Integrated simulation tool	Lettuce and leafy greens in Canada
65	Hou et al.	2015	Food safety standards and international supply chain organization: A case study of the Moroccan fruit and vegetable exports	Morocco, fruits and vegetables, food safety, supply chains, supermarket-channel, wholesaler-channel	*Principal components analysis	Moroccan fruit and vegetable supply chain (Souss Massa Region)

66	Hoaran et al.	2016	Fuzzy TOPSIS-based supply chain optimization of fresh agricultural products	Expert evaluation methods, fresh agricultural products, loss, supply chain network optimization, TOPSIS	*Fuzzy TOPSIS	NONE
67	Zoellner et al.	2016	Microbial dynamics of indicator microorganisms on fresh tomatoes in the supply chain from Mexico to the USA	Tomatoes, indicator microorganisms, postharvest, supply chain, safety	*Microbiological analyses *Statistical analyses (Analysis of variance, Tukey–Kramer honestly significant difference (HSD) test)	Roma tomatoes in the supply chain between Mexico and USA
68	Ramanathan et al.	2017	A study on sources of vegetable supply chain wastage with specific reference to retail outlets in Tamil Nadu	Food wastage, retail wastage, vegetable supply chains, transport wastage, vegetable wastage, vegetables, retail outlets, Tamil Nadu, India, vegetable retailers, travel distances, labour shortage, poor packing, handling damage		Vegetable retail stores in four locations of Tamilnadu such as Chennai, Dindugul, Coimbatore and suburban areas of Chennai, India
69	Gardas et al.	2017	Modeling causal factors of post-harvesting losses in vegetable and fruit supply chain: An Indian perspective	Post-harvesting losses (PHL), vegetable and fruit supply chains, critical causal factors, interpretive structural modeling (ISM) methodology	*Interpretive structural modeling (ISM) approach *MICMAC analysis	In Maharashtra state, India
70	Jacxsens et al.	2017	Food safety management and risk assessment in the fresh produce supply chain	-	*Mathematical model *Fragmented microbiological analysis *Information of cultivation practices	Basil, strawberry and butterhead lettuce to which Belgian and Spanish consumers are exposed per year
71	Orjuela-Castro and Adarme-Jaimes	2018	Evaluating the supply chain design of fresh food on food security and logistics	Supply chain design, fresh food, food security, logistics		Three SCs of fresh fruits in Colombia

72	Fabbri et al.	2018	Improving environmental performance of post-harvest supply chains of fruits and vegetables in Europe: Potential contribution from ultrasonic humidification	Humidification, life cycle assessment, food supply, food loss, food waste, ultrasonic	*Life cycle assessment	Strawberries, peaches, table grapes, and asparagus supply chains in Europe in terms of transportation distances and direction of the supply (with the general trend from the South of Europe to other European countries). between 2015 and 2016
73	Mercier and Uysal	2018	Neural network models for predicting perishable food temperatures along the supply chain	Perishable food, cold chain, quality-driven distribution, temperature prediction, neural network, heat transfer	*Heat transfer model *Neural network	NONE
74	Zoellner et al.	2018	Postharvest supply chain with microbial travelers: A farm-to-retail microbial simulation and visualization framework	Fresh produce, microbial dynamics, postharvest, supply chain	*Postharvest supply chain with the microbial travelers (PSCMT) tool	Tomato supply chain from Mexico to the United States
75	Hernández-Rubio et al.	2018	Determinants of food safety level in fruit and vegetable wholesalers' supply chain: Evidence from Spain and France	Food safety, fruits and vegetables, wholesaler, importer, long supply chain	*Hypotheses of analysis	Spanish and French intermediaries working in key wholesale markets and in the southeast of Spain
76	Kelly et al.	2019	A novel approach to determine the impact level of each step along the supply chain on strawberry quality	*Fragaria x ananassa*, supply chain, waste, temperature, bioactive compounds, sugars	*Instrumental color and texture analysis *Ascorbic acid analysis *Statistical analysis (two-way analysis of variance)	Strawberry supply chain from Fancy Farms, USA
77	Diaz-Ruiz et al.	2019	Food waste prevention along the food supply chain: A multi-actor approach to identify effective solutions	Barcelona, food losses, Delphi, food waste prevention, food redistribution, reduction	*Delphi method *In-depth interviews	Barcelona metropolitan region
78	Caldeira et al.	2019	Quantification of food waste per product group along the food supply chain in the European Union: a mass flow analysis	Food waste, mass balance, food groups, by-products, systematic accounting, food value chain	*Mass flow analysis	Major EU food groups: sugar beets, oil crops, potatoes, vegetables, fruit, cereals, meat, fish, dairy, and eggs
79	Zhang et al.	2019	Novel model and kernel search heuristic for multi-period closed-loop	Closed-loop food supply chain, perishable food, returnable	*Mathematical problem	A food manufacturer in China

			food supply chain planning with returnable transport items	transport item, mixed integer linear programming, kernel search		
80	Xu et al.	2020	A real-time decision support framework to mitigate degradation in perishable supply chains	Perishable supply chains, real-time decision making, vehicle routing, inventory allocation, quality control, optimal environment factors	* Integer programming model * Quality index method	Fresh apple supply chain

Table A3. Studies Presented in the Category of the Role of Parties in the Value Chain in Section 3.3.

ID	Authors	Year	Title	Keywords	Method Used	Case Study/Test
81	Hingley	2001	Relationship management in the supply chain	Buyers, relationship marketing, retailing, supplier relations, supply-chain management	*Multiple depth interviews *Multi-case, multi-site	UK fresh produce market
82	Louw et al.	2008	Alternative marketing options for small-scale farmers in the wake of changing agri-food supply chains in South Africa	Agri-food supply chains, small-scale farmers, alternative marketing channels		South African agri-food chain
83	Arumugam et al.	2010	Supply chain analysis of fresh fruits and vegetables (FFV): Prospects of contract farming	supply chain, contract farming, contract farmers, factor analysis	*Factor analysis *Descriptive and inferential statistics	Malaysia
84	Schipmann and Qaim	2011	Supply chain differentiation, contract agriculture, and farmers' marketing preferences: The case of sweet pepper in Thailand	Choice experiment, contract design, farmers' stated preferences, modern agricultural supply chains, Thailand	*Lancaster's model *Random parameters logit (RPL) model	Sweet pepper in Thailand
85	Sayın et al.	2011	The role of wholesale markets in the supply chain for fresh fruit and vegetables in Turkey	supply chain management, distribution, domestic market, wholesale market, producer unions, European Union	*SWOT analysis	Supply chain for fresh fruit and vegetables in Turkey

86	Guarín	2013	The value of domestic supply chains: Producers, wholesalers, and urban consumers in Colombia	Colombia, smallholders, supermarkets, supply chains, wholesale markets	*Value chain approach *In-depth interviews *Semi-structured interviews	Perishables in Colombia, including fruits, vegetables, roots and tubers, and beef.
87	Schuster and Maertens	2013	Do private standards create exclusive supply chains? New evidence from the Peruvian asparagus export sector	Global supply chains, horticulture, Peru, private standards, small-scale farming	*Fixed effects *GMM estimators	Peruvian asparagus export sector
88	Wahyudin et al.	2015	An agri-food supply chain model for cultivating the capabilities of farmers in accessing capital using corporate social responsibility program	Agri-food supply chain, corporate social responsibility, multi-integer linear goal programming, small-scale vegetables farmers	*Multi-integer linear programming (MILP)	NONE
89	Jacob-John and Veerapa	2016	Perception of fairness within organic fresh produce supply chains: The case of small and medium fresh produce retailers	Fairness, ethics, retailers, supply chain, trust, B2B	*Multiple case study approach *Semi-structured interviews	Small and medium fresh produce retailers
90	Michelson et al.	2018	Connecting supermarkets and farms: The role of intermediaries in Walmart China's fresh produce supply chains	Vertical integration, supply chains, small farmers, supermarkets, Walmart, agricultural development, China	*In-depth descriptive analysis	Walmart China
91	Devin and Richards	2018	Food waste, power, and corporate social responsibility in the Australian food supply chain	Corporate social responsibility (CSR), food supply chain, food waste, power, supermarkets	*Interviews *Document analysis	Australian fresh fruit and vegetable supply chain
92	Elder	2019	The impact of supermarket supply chain governance on smallholder farmer cooperatives: the case of Walmart in Nicaragua	Agricultural supply chains, cooperatives, Nicaragua, smallholder farmers, supermarkets, Walmart	* Interviews	Supermarkets and cooperatives in Nicaragua
93	Salvia	2020	The restructuring of Italian agriculture and its impact upon capital–labour relations: Labour contracting and exploitation in the fresh fruit and vegetable supply chain of the Lazio Region, Central Italy	Central Italy, agricultural labour, fresh fruit and vegetable production, labour contracting, value chains	* In-depth interviews	Lazio, Central Italy.

94	Gunarathna and Mahinda Bandara	2020	Post-Harvest Losses and the Role of Intermediaries in the Vegetable Supply Chain	intermediaries, post-harvest losses, vegetable supply chain	* In-depth personal interview	Vegetable supply chain in Sri Lanka

Table A4. Studies Presented in the Category of Review Papers in Section 3.4.

ID	Authors	Year	Title	Keywords	Method Used	Case Study/Test
95	Rajurkar and Jain	2011	Food supply chain management: Review, classification and analysis of literature	Food supply chains, literature reviews, literature classification, literature analysis, global competition, codification, roadmaps, research, integrated supply chains, SCM, supply chain management	*Literature reviews *Literature classification *Literature analysis	–
96	Kong et al.	2013	Auction logistics in perishable supply chain trading: A research agenda	Physical Internet, auction logistics, perishable supply chain trading, planning, scheduling and execution	*Literature reviews *Literature classification *Literature analysis	–
97	Aung and Chang	2014	Traceability in a food supply chain: Safety and quality perspectives	Traceability, safety, quality, food supply chain, identification, food contamination	*Literature reviews *Literature classification *Literature analysis	–
98	Sibomana et al.	2016	A review of postharvest handling and losses in the fresh tomato supply chain: a focus on Sub-Saharan Africa	Postharvest losses, tomatoes, packaging, temperature control, disinfection, transportation	*Literature reviews *Literature classification *Literature analysis	–
99	Siddh et al.	2017	Agri-fresh food supply chain quality (AFSCQ): a literature review	Agri-fresh food, agri-fresh food supply chain quality, literature review, supply chain quality	*Literature reviews *Literature classification *Literature analysis	–
100	Routroy and Behera	2017	Agriculture supply chain: A systematic review of literature and implications for future research	Agricultural products, agriculture, supply chain management	*Literature reviews *Literature classification *Literature analysis	–

101	Raak et al.	2017	Processing- and product-related causes for food waste and implications for the food supply chain	By-products, expert interview, food losses, food processing, food waste, literature review, suboptimal food	*Literature reviews *Literature classification *Literature analysis	–
102	Saitone and Sexton	2017	Agri-food supply chain: evolution and performance with conflicting consumer and societal demands	Food quality, modern agricultural markets, supply chain, vertical coordination	*Literature reviews *Literature classification *Literature analysis	–
103	Gharehgozli et al.	2017	Trends in global E-food supply chain and implications for transport: literature review and research directions	E-business solutions, food supply chain management, new trends, research agenda, transport	*Literature reviews *Literature classification *Literature analysis	–
104	Luo et al.	2018	Agri-food supply chain management: Bibliometric and content analyses	Agri-food supply chain, bibliometric analysis, citation analysis, co-citation analysis, content analysis	*Literature reviews *Literature classification *Literature analysis *Bibliometric analysis *Citation analysis	–
105	Corrado and Sala	2018	Food waste accounting along global and European food supply chains: State of the art and outlook	Circular economy, estimation, food loss, food waste, Sustainable Development Goal 12, waste framework directive	*Literature reviews *Literature classification *Literature analysis	–
106	Lezoche et al.	2020	Agri-food 4.0: A survey of the supply chains and technologies for the future agriculture	Agri-Food 4.0, Agriculture 4.0, artificial intelligence, big data, blockchain, Internet of Things, supply chains	*Literature reviews *Literature classification *Literature analysis	–
107	Priyadarshi et al.	2020	Postharvest supply chain losses: a state-of-the-art literature review and bibliometric analysis	Agriculture supply chain losses, bibliometric analysis, postharvest supply chain losses, rural entrepreneurship, value addition, vertical integration	*Literature reviews *Literature classification *Literature analysis *Bibliometric analysis	–

Table A5. Studies Presented in the Category of Technological Trends in Section 3.5.

ID	Authors	Year	Title	Keywords	Method Used	Case Study/Test
108	Duan et al.	2007	Accelerating internet adoption in China's fresh produce supply chain: A vegnet approach	China, fresh produce supply chain, Internet adoption, Internet technologies, supply chain management	*Interviews *Case studies	China
109	Hu et al.	2011	AgriRiskIDSS: Development of an intelligent decision support system for price risk management of agricultural product supply chain	China, IDSS (intelligent decision support system), intelligent information process, price risk management, vertical search engine	*Intelligent decision support system *Genetic algorithm *Wavelet analysis coefficients *Neural network	NONE
110	Solanki and Brewster	2014	Enhancing visibility in EPCIS governing agri-food supply chains via linked pedigrees (Book Chapter)	-		Fresh fruit and vegetables supply chain in the agri-food sector.
111	Liu et al.	2015	Enterprise-oriented IoT name service for agricultural product supply chain management	-	*IoT architecture	Five cities of China.
112	La Scalia et al.	2017	An innovative shelf-life model based on smart logistic unit for an efficient management of the perishable food supply chain	-	*Volatile organic compounds *microbiological analysis	Strawberries
113	Borrero	2019	Agri-food supply chain traceability for fruit and vegetable cooperatives using Blockchain technology	Agriculture supply chain, blockchain, cooperatives, food traceability, proof of concept, smart agriculture, smart contract, trust-building	* Blockchain *Smart contract	Spain
114	Pal and Kant	2020	Smart sensing, communication, and control in perishable food supply chain	Communication infrastructure, data analytics, food quality sensing, food supply chain, physical Internet, privacy, security	*Arrhenius equation *Michaelis–Menten kinetics equation *Kinetic modeling *Gompertz model	
115	Goisser et al.	2020	Food-scanners as a radical innovation in German fresh produce supply chains	Food-scanner, fruit and vegetable supply chain, qualitative research, quality measurement	* Semi-structured interviews * Qualitative content analysis	German fruit and vegetable supply chain

Table A6. Studies Presented in the Category of Packaging in Section 3.6.

ID	Authors	Year	Title	Keywords	Method Used	Case Study/Test
119	Accorsi et al.	2014	Economic and environmental assessment of reusable plastic containers: A food catering supply chain case study	Food supply chain (FSC), life cycle assessment (LCA), packaging, sensitivity analysis, sustainability	*Life cycle assessment (LCA) *Life cycle costing (LCC)	An Italian fresh food catering chain
120	Battini et al.	2016	Sustainable packaging development for fresh food supply chains	economic analysis, environmental analysis, fresh food distribution, fresh food packaging, sustainability	*Critical analysis	
118	Singh et al.	2016	Packaging's role in sustainability: Reusable plastic containers in the agricultural-food supply chains	Agricultural-food supply chains, one-way and reusable packaging, sustainability		
121	Giuggioli et al.	2017	Sustainable supply-chain: evolution of the quality characteristics of strawberries stored in green film packaging	Films, freshness quality, fruits, modified atmosphere, packaging, temperature	*Total soluble solids analysis *Nutraceutical analysis *Statistical analysis (two-way analysis of variance) *Principal components analysis	Portola strawberries in Italy
122	Bortolini et al.	2018	Bi-objective design of fresh food supply chain networks with reusable and disposable packaging containers	Bi-objective optimization, fresh food distribution network, packaging, supply chain design, sustainability		
123	Zhao et al.	2019	Consolidated cold and modified atmosphere package system for fresh strawberry supply chains	Cold storage, expanded polystyrene box, package, phase change materials, polyethylene film	*Statistical analysis (analysis of variance (ANOVA) and Duncan's multiple range test	Fresh strawberries

Table A7. Studies Presented in the Category of Logistics in Section 3.7.

ID	Authors	Year	Title	Keywords	Method Used	Case Study/Test
124	Busato and Berruto	2006	FruitGame: Simulation model to study the supply chain logistics for fresh produce	Fresh fruits, fresh vegetable, logistics, modeling, supply chain	*Object-oriented simulation	
125	Yan	2009	The research of supply chain logistics management on fruit E-commerce website	-		Fresh fruits in Sichuan Province
126	Etemadnia et al.	2015	Optimal wholesale facilities location within the fruit and vegetables supply chain with bimodal transportation options: An LP-MIP heuristic approach	Operation research, optimal hub location bimodal transportation, supply chain	*Mixed integer linear programming (MILP)	An application is made to the U.S. fruit and vegetable industry
127	Chandrasekaran and Ranganathan	2017	Modelling and optimisation of Indian traditional agriculture supply chain to reduce post-harvest loss and CO2 emission	Carbon dioxide emission, post-harvest losses, respiration, supply chain planning, transportation	*Genetic algorithm *The closed transportation method	Indian traditional agriculture SC
128	Ghezavati et al.	2017	A Benders' decomposition algorithm for optimizing distribution of perishable products considering postharvest biological behavior in agri-food supply chain: A case study of tomato	Agri-food supply chain, Benders' decomposition, fair pricing, fresh products, mixed integer programming, postharvest maturity behavior	*Mixed integer programming model *Benders' decomposition method	A case study of tomatoes in Iran
129	Mejjaouli and Babiceanu	2018	Cold supply chain logistics: System optimization for real-time rerouting transportation solutions	Cold supply chain, RFID monitoring system, system optimization, transportation rerouting	*RFID-WSN logistics model	Strawberries from California to Dallas

Table A8. Studies Presented in the Category of Sustainability in Section 3.8.

ID	Authors	Year	Title	Keywords	Method Used	Case Study/Test
130	Smith	2008	Developing sustainable food supply chains	Corporate social responsibility, food manufacture, food retail, food supply chains, sustainable agriculture		
131	Styles et al.	2012	Environmental improvement of product supply chains: Proposed best practice techniques, quantitative indicators and benchmarks of excellence for retailers	Benchmarking, ecolabels, green procurement, lifecycle assessment, retail, supply chains, sustainability	*Performance benchmarking *Dissemination of better management practices	
132	Naik and Suresh	2018	Challenges of creating sustainable agri-retail supply chains	Agri-food supply chains, horticulture, organized retail, regulation, social impact, sustainability		
133	Blanc et al.	2019	Use of bio-based plastics in the fruit supply chain: An integrated approach to assess environmental, economic, and social sustainability	Bio-based materials, green economy, life-cycle assessment, life-cycle costing, social impact	*Life cycle assessment (LCA) *Life cycle costing (LCC) *Externality assessment (ExA)	Raspberry supply chains in northwestern Italy
134	Corato and Cancellara	2019	Measures, technologies, and incentives for cleaning the minimally processed fruits and vegetables supply chain in the Italian food industry	Bio-based material, energy consumption and management, energy efficiency and saving, food processing, renewable source, waste recycling	*Analysis of the energy fluxes *Analysis of un-biodegradable materials	Italian MPFV companies (firms/cooperatives)
135	Slamet et al.	2020	Making food supply chain sustainable: Participating smallholder farmers in modern retail channels	ISM, enabler, interpretive structural modelling, modern retail, smallholder farmer, sustainable food supply chain	* Interpretive structural modelling	
136	Jabarzadeh et al.	2020	A multi-objective mixed-integer linear model for sustainable fruit closed-loop supply chain network	Closed-loop network, multi-objective optimization, reverse logistics, sustainable supply chains	* Multi-objective mixed-integer Linear programming model *LP-Metric and weighted Tchebycheff method	NONE

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