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Review

Circular Economy Models in Agro-Food Systems: A Review

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Abstract: Around the world, interest is growing in the circular economy in response to the current unsustainable model of production and consumption based on increased use and depletion of resources. This paper provides a review of the academic literature on the circular economy in agri-food systems, with the aims of understanding its main characteristics and perspectives, and summarizing and discussing the literature in this field. This review provides a deeper understanding of the opportunities provided by the circular economy as a solution to the current need to reduce the environmental impacts of business-as-usual economic systems and the state of the art of the circular economy in the academic debate. The results are discussed based on the chosen topic-core investigated in this review: business model and organization management, food loss and waste along the supply chain, analytical tools for the circular economy, stakeholder acceptance of the circular economy, and mitigation strategies and political approach. The findings show the need for the implementation of cleaner production models and consequent increases in stakeholder responsibilities and awareness, from both producers and consumers, as well as the need for the implementation of suitable policies and tools.

Keywords: circular economy; business model; sustainability; agro-food; sustainable; food waste; supply chain

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Citation: Hamam, M.; Chinnici, G.; Di Vita, G.; Pappalardo, G.; Pecorino, B.; Maesano, G.; D'Amico, M. Circular Economy Models in Agro-Food Systems: A Review. *Sustainability* **2021**, *13*, 3453. https://doi.org/10.3390/su13063453

Academic Editor: Alessandra Durazzo

Received: 8 February 2021
Accepted: 18 March 2021
Published: 20 March 2021

1. Introduction

During the last decade, the circular economy (CE) has received increasing consideration around the world as a method to overcome the present model of production and consumption, which is characterized by increased use and depletion of resources.

The CE is defined as "a production and consumption model, which involves sharing, renting, reusing, repairing, renovating and recycling existing materials and products for as long as possible [1] and reducing to the minimum of waste" [2], offering a better alternative to the current model of economic development, the "take, do and dispose of" model [3] with a view to economic, environmental, and social sustainability [4].

It was estimated that by 2050, the population will reach 9 billion, and our natural resources are limited. Following demographic and economic development and change in consumption patterns, the use of global resources has considerably increased [5]; in this context, the extractive industries are responsible for the main global carbon emissions, resource extraction, consequent loss of biodiversity, and water scarcity, having negative impacts on climate and natural systems [6].

The 21st century is facing increasingly important and complex challenges such as biodiversity loss, climate change, resource depletion, water scarcity, population growth, and economic issues. A circular economy makes it possible to overcome these challenges through economic and environmental development that preserves and enhances natural resources and renewable flows [7]. The advantages of CE systems are attributable to the reduction in the environmental impact through the minimization of waste, the increase in economic benefits, the redesign of products, the choice of materials [8], the reduction in price volatility, and increased job growth [9,10]. The EC therefore aims to reshape global industrial systems following the ideal goal of a zero-waste economy [11].

Nowadays, 8.6% of the world's economy is defined as circular [12]. The current goal is to move toward a circular, sustainable, and regenerative bioeconomy, which should consider direct and medium- and long-term factors that affect the environment.

The issues of agri-food industry by-products and the resulting generation of waste have pushed the European Union (EU) to promote a zero-waste economy by 2025, attracting the interest of researchers, regulators, industry, and consumers. The initiative promoted in December 2019 by the European Commission [13] for a Green Deal aims to make the climate challenge and the ecological transition an opportunity for a new development model, providing the EU with the opportunity to play a leadership role at the global level. The Green Deal constitutes an important framework for accelerating the transition to a CE, moving toward a more sustainable bio-economy. The European goal is to become the first climate-neutral continent by 2050, strengthening the competitiveness of European industry and ensuring a transition that is not only sustainable for the environment and the economy but also for society as a whole.

The discussion of the CE has also grown rapidly at the policy level and in the academic literature. Several academic authors have conducted studies on the theory and conceptualization of CE, the development of innovative CE models in the agri-food sector [14], definitions of food waste [15], strategies for the avoidance of food losses and waste (FLW) along the agro-food supply chain [16], strategies for the valorization of food waste, and emerging conversion tools through the analysis of the functionality of technologies and the management of agri-food waste in the context of the CE [17]. In the academic debate, the number of papers on CE has grown more than ten-fold in the last years [18], as many different CE studies have been published around the world [19–29].

Several scholars have evaluated the progress of CE strategies aimed to decrease the carbon footprint of the agri-food supply chain through the development of methodologies that assess both the upstream and downstream, such as material flow analysis (MFA), considered by Hamilton et al. [30], which is a methodology that translates into increased energy savings, food waste recycling strategies, and a cleaner production model. The results of our study showed the need to implement cleaner production models and a consequent increase in the responsibility and awareness of stakeholders, both producers and consumers, as well as the need to implement appropriate policies and tools. A cleaner production model is defined as the continuous application of an integrated preventive environmental strategy to processes, products, and services in order to increase overall efficiency and reduce risks to humans and the environment [30].

This paper provides a review of the academic literature with the aim of describing its main characteristics and perspectives. The objective is to understand if the CE could help reduce the environmental impacts of current agri-food economic systems.

The novel character of the paper is to present possible ways to implement CE principles in the agri-food sector, with a strong emphasis not only on technical and organizational aspects but also on political and social dimensions. The findings can help further transform the current economy into the CE model.

The topics investigated in the selected papers chosen for this study are discussed in five categories: business model and organization management, food loss and waste in the agro-food supply chain, analytical tools for the CE, stakeholder acceptance of the CE, and mitigation strategies and political approach.

The remainder of this paper is organized as follows: Section 2 describes the conceptual framework and Section 3 presents the materials and methods. Section 4 discusses the main findings of the literature review. The concluding remarks and limitations of this study are presented in Section 5.

2. Conceptual Framework: The Circular Economy in Agro-Food Systems

CE is defined as a "restorative or regenerative industrial system by intention and design, which implies the creation of opportunities that involve the transition from an 'end of life' concept to a 'cradle-to-cradle concept'", from the use of non-renewable energy to the use of renewable energy, from the use of toxic chemicals to their elimination, and from the production of large amounts of waste to its elimination, through the superior design of materials, products, systems, and even business models [31]. The CE is a model that offers several value creation tools that are disconnected from the consumption of limited resources [31]. The CE is defined as a regenerative scheme in which resource inputs, waste, by-products, energy losses, and emissions are reduced by slowing down, closing, and limiting material and energy circuits through better and more efficient design, maintenance, repair, reuse, durable regeneration, renovation, and recycling [18].

Kirchherr et al. [32] defined the circular system as an economic system based on business models that replace the concept of "end of life" with the reduction, alternative reuse, recycling and recovery of materials in the production, distribution and consumption processes, with the purpose of achieving sustainable development, which involves the creation of an environment of better quality and greater economic and social equity, to the advantage of current and future generations.

In practice, the CE can be encouraged and maintained through the establishment of innovative business models [7,33–35], which incorporate the principles of CE and their value propositions along value chains (CE business models). However, it is challenging for the CE to contribute to sustainability as a whole and doubt remains about the possible environmental impact of innovative circular business models [36–38].

The CE is seen as an engine of sustainability in the literature. The CE and sustainability are closely connected words [39]. However, CE focuses on environmental and economic benefits, including merely the implicit social aspects [18], whereas sustainability aims to benefit the environment, economy, and society. The CE improves traditional sustainability approaches based on eco-efficiency by combining economic gains, reducing input costs, mitigating supply risks, and reducing externalities [23] to achieve a greener economy through the promotion of a more appropriate and ecological use of resources and innovative business models [11,23]. As stated by Pavitt [40], innovation in the agri-food sector is mainly aimed at cost decreases. Several industries and companies have used the concept of sustainable business models to simultaneously achieve their economic, environmental, and social objectives.

The agri-food sector, in recent years, has paid considerable attention to issues such as food safety, traceability of production, product quality, and respect for the environment. This has led manufacturing systems to move toward more sustainable approaches. Waste generation along the world supply chain in 2019 totaled approximately 1.3 billion tonnes [41] due to mismanagement of resources and processes [42] and unsustainable consumer consumption patterns [43]. As such, promoting the development of new technologies to encourage a change toward waste recycling is of paramount importance [44].

In 2013, the Ellen MacArthur Foundation [9] presented the butterfly paper, which shows how two different cycles, technical and biological, can flow in the economic system. The biological cycle covers the flows of renewable materials, designed to re-enter the biosphere and organized in an open-cycle system of cascade resources, through successive phases of extraction, production of bio-based materials, energy recovery, and nutrient restitution to the biosphere in order to fuel the next cycle of primary products. This cascade phases aim to maintain the quality of resources over time by adhering to the bio-based value pyramid and the waste hierarchy. Biological nutrients can be organic or inorganic and are described as materials or products "designed to return to the biological cycle, being consumed by microorganisms in the soil and other animals" [45]. It is desirable for processes of this type to be increasingly applied to agri-food systems, but this remains conceptually distant from current realities. To date, some agri-food chains have aroused greater interest in implementing circular systems than others.

In their literature review, Esposito et al. [14] analyzed the circular economy in the agricultural supply chain, the state of the art, and the most commonly investigated products in the literature. In the scientific debate, the success of the circular economy concept is expressed in quantitative terms in the number of articles published on this topic. In recent years, the amount of CE documents has grown more than ten-fold and many different CE studies have been published around the world.

3. Materials and Methods

3.1. Literature Search Method

The review of the literature was conducted to select studies from the academic literature and to summarize the main findings on the CE in agri-food systems. The review was performed following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) method [46]. Figure 1 shows a flowchart in which the selection criteria are identified in a systematic and replicable technique with the intention of identifying the papers that explored the topic of the CE in the agri-food sector [47–49]. Scopus, Web of Science, and Science Direct databases were used to search for relevant literature on the topic under investigation. The research was carried out in November 2020 and was restricted to the years post-2013, which was considered appropriate to identify recent trends in the field. The search for the articles ended on 21 November 2020.

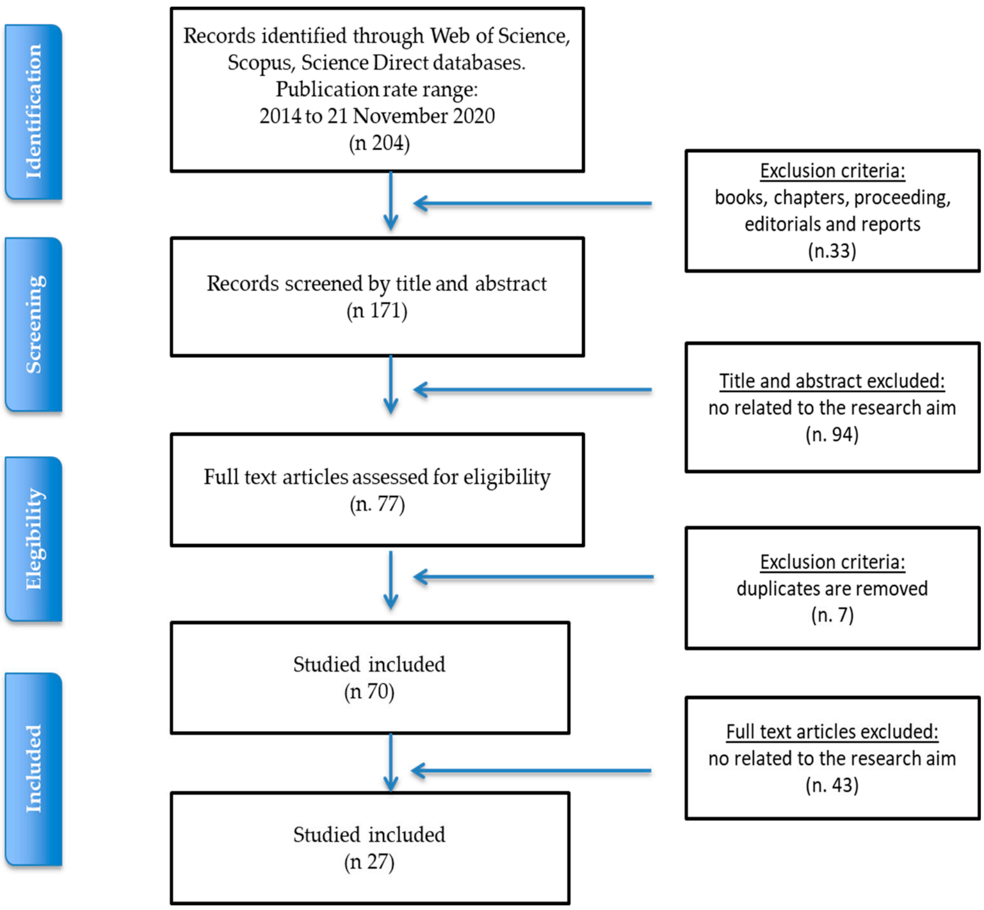

Figure 1. Flow chart diagram of the database literature search procedure. Exclusion criteria are indicated. (Source: authorsg).

The literature search criteria involved a combination of keywords in the databases. The keywords "circular economy" and "agri-food", or "agri-food" and "sustainable" and "food" and "waste" and "supply chain" were used.

First, the papers were selected based on the information contained in the title and abstract; then, duplicate articles extracted from different databases were subsequently excluded. Each of the remaining articles was further reviewed according to the information contained in the full text. The inspection of the full text was directed at the elimination of papers not dedicated to the CE or that did not deal with the agricultural economy. The identification phase was conducted to include relevant studies in different databases.

The process of the selection of the relevant literature occurred in two stages: screening and eligibility [47–49]. In the screening stage, the studies were selected and then subsequently reduced to 171 through the application of the primary exclusion criterion: only academic articles published in indexed journals were included in this review.

Subsequently, in the next phase, the papers were chosen based on the information in the title and then in the abstract. During this stage, the number of articles was reduced to 77, applying the exclusion criterion: only papers related to the research aims were included. In this stage, the analysis of the abstracts led to the deletion of 94 papers not dedicated to the circular economy or not in the field of agricultural economics.

In the next step, seven duplicate documents from different databases were removed; thus, only 70 documents were included in this phase. Each article was also further reviewed based on the information contained in the full text, and we chose whether the study met the eligibility criteria for review. In conclusion, after excluding the irrelevant documents for the study, a sample of 27 documents was selected to address our research question.

3.2. *Overview of Selected Papers*

Information regarding the author(s), title, year of publication, and journal of the papers chosen for this review are presented in Table S1. The papers chosen were categorized based on the core topic investigated:

- Business model and organization management ($n = 6$);
- Food loss and waste along the agro-food supply chain ($n = 9$);
- Analytical tools for the circular economy ($n = 5$);
- Stakeholder acceptance of the CE ($n = 4$);
- Mitigation strategies and political approach ($n = 6$).

The topics investigated are presented in Table 1. Several articles investigated more than one topic; therefore, the sum is greater than 27.

Table 1. Topics investigated in the review. CE, circular economy.

Topic	Reference
Business model and organization management	Barth et al., 2017 [50]; Evans et al., 2017 [51]; Franceschelli et al., 2018 [52]; Nosratabadi et al., 2019 [53]; Sehnem et al., 2019 [54]; Donner et al., 2020 [55].
Food loss and waste in thesupply chain	Naziri et al., 2014 [56]; Girotto et al., 2015 [57]; Corrado and Sala 2018 [58]; Boccia et al., 2019 [59]; Kyriakopoulos et al., 2019 [17]; Principato et al., 2019 [60]; Esposito et al., 2020 [14]; Bas-Bellver et al., 2020 [61]; Dora et al., 2020 [16].
Analytical tools for the CE	Pagotto and Halog, 2016 [62]; Corrado et al., 2017 [15]; Muradin et al., 2018 [63]; Belaud et al., 2019 [64]; Esposito et al., 2020 [14].
Stakeholder acceptance of the CE	Borrello et al., 2016 [65]; McCarthy et al., 2019 [66]; Atinkut et al., 2020 [67]; Coderoni and Perito, 2020 [68].
Mitigation strategies and political approach	Kristensen et al., 2016 [69]; Evans et al., 2017 [51]; Corrado and Sala, 2018 [58]; Lainez et al., 2018 [70]; Fava et al., 2021 [71]; Muscio and Sisto, 2020 [72].

As can be seen from Table 1, the topics most investigated in the literature and analyzed in this study refer to food loss and waste in the supply chain and the business model and organization management. This demonstrates the growing interest of agri-food enterprises in a circular transition. However, only a limited number of studies investigated the analytical tool, mitigation strategies and political approach, and the stakeholder's acceptance of CE still needs further investigation. In this context, consumer acceptance of food products with ingredients previously wasted in the agri-food supply chain is crucial for the success of the products on the market. In addition, the small number of articles demonstrates the need for further research on specific issues faced by the CE in the agro-food sector.

Figure 2 shows the journals in which articles were published. The most influential journal was *Sustainability*, in which six papers were published, representing approximately 23% of all published articles.

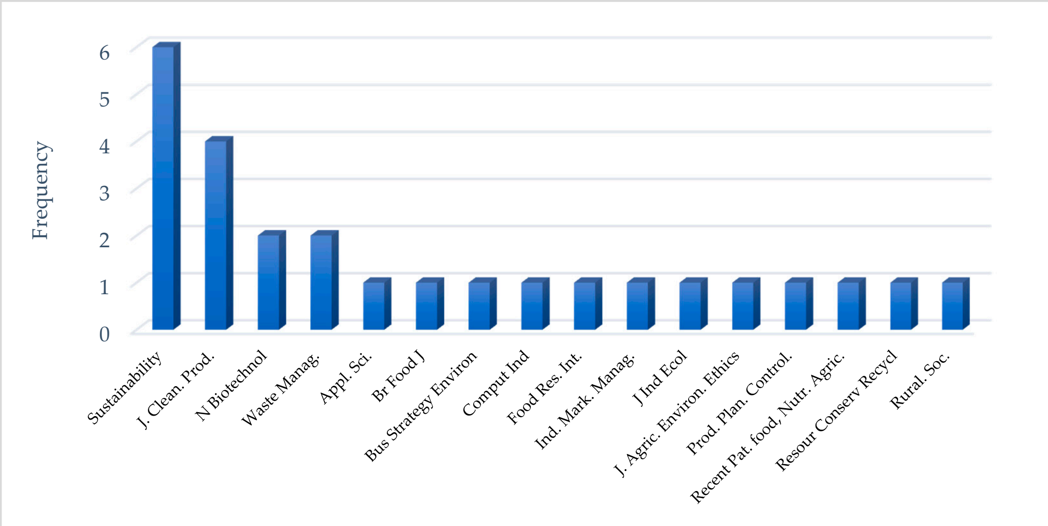

Figure 2. Journals in which selected papers were published.

The number of selected papers on the topic under investigation per year from 2014 to 2020 is shown in Figure 3. Although the total number of articles was limited, there was an increasing trend in papers published in the later years. This attests to the growing attention paid to the topic under investigation.

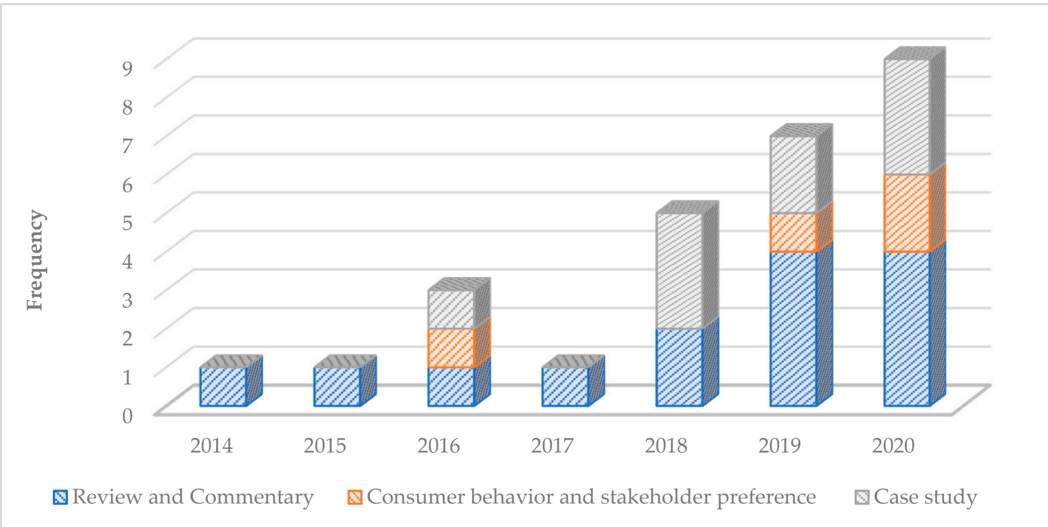

Figure 3. Type of article per year.

Regarding the type of article, the majority of the selected papers were reviews and commentary articles (n. 14), followed by case studies (n. 9) and consumer behavior and stakeholder preference analyses (n. 4). In detail, as shown in Figure 3, in 2014 and 2015, the selected papers were review and commentary papers; in 2016, the papers were a review and commentary (n. 1), consumer behavior and stakeholder analysis (n. 1), and a case study (n. 1); in 2017, the papers were reviews and commentaries (n. 3); in 2018, the papers were reviews and commentaries (n. 2) and a case study (n. 1); in 2019, the papers were review and commentary (n. 4), a consumer behavior and stakeholder analysis (n. 1), and case studies (n. 2); finally, in 2020, the papers were reviews and commentaries (n. 4), consumer behavior and stakeholder analyses (n. 2), and case studies (n. 3).

Concerning the databases from which the selected papers were obtained, as shown in Figure 4, the majority of selected papers were found in the Web of Science database (n. 16) and Science Direct (n. 15), and the rest in Scopus (n. 6). Several articles were identified in more than one database; therefore, the sum of the figures is greater than 27.

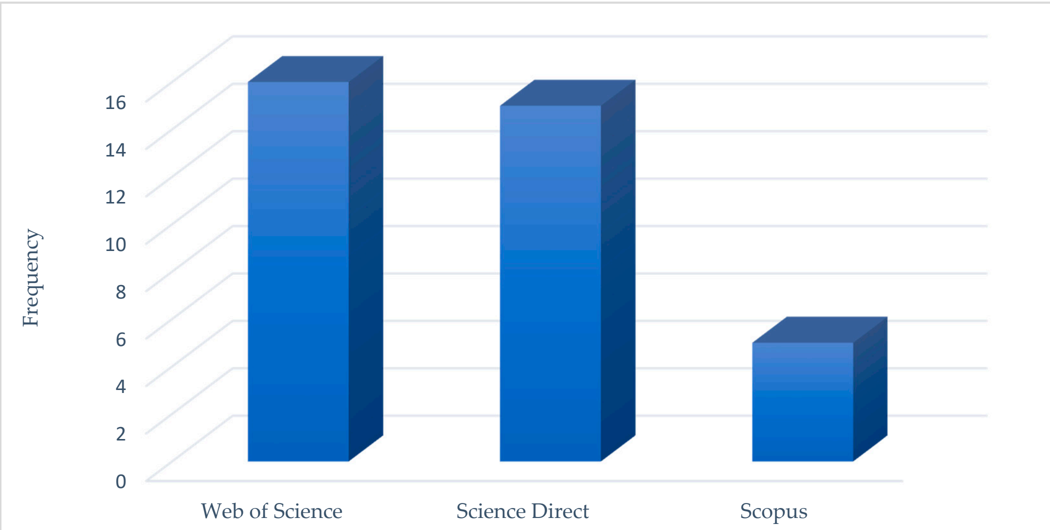

Figure 4. Number of articles selected in each searched database.

4. Results

4.1. Business Model and Organization Management

The realization, acceptance, and advancement of sustainable business models in diverse application fields are still not fully understood [53].

Franceschelli et al. [52] investigated how a food start-up improved innovations in the business model, considering the significance of social and environmental questions. The authors stated that the expansion of sustainable business model innovation in the agro-food sector is essential since the business is connected with the environmental and social dimension. Barth et al. [50], in a literature review, suggested a theoretical framework for sustainable business model innovation in the agro-food industry to address the challenges from a sustainable perspective. Evans et al. [51] developed a combined theoretical view to understand business model innovations that lead to improvements in the economic, environmental, and social performance of an organization. According to the authors, planning a sustainable business model requires the organization of sustainable value flows between various stakeholders. The authors concluded that considering the interests and responsibilities of stakeholders for the creation of mutual value is imperative to achieve a sustainable business model. Nosratabadi et al. [53] discussed sustainable business models in different sectors, considering the process of building a sustainable business model as an innovative part of a business strategy, to provide beneficial solutions to all stakeholders and meet the requirements of the environment and society. The outcomes revealed how the use of sustainable business models can be grouped into fourteen categories, four of which are the main methods used to design a sustainable business model: designing a sustainable value proposition, designing sustainable value creation, designing the offer of sustainable value, and the generation of sustainable partnership networks for the creation and delivery of sustainable value capable of providing social, environmental, and economic benefits.

The authors concluded that the realization of sustainable business models through all application fields increases with the growing usage of innovative technologies.

Donner et al. [55] highlighted the characteristics of circular business models for the valorization of agricultural waste and by-products, concluding that the cascading use of biomass to generate products with high added value plays a key role in the development of a CE. The authors analyzed 39 cases that translated agricultural waste and by-products into products with added value through a CE approach. The authors identified six types of circular business models: biogas plant, upcycling entrepreneurship, environmental biorefinery, agricultural cooperative, agro park, and support structure. The results of this study revealed the interconnectedness of the six different types of business model, highlighting the potential of using biomass first for higher value-added products before exploiting it as an energy source, according to the upcycling principle.

Sehnem et al. [54] analyzed how the maturity stages of the implementation of CE practices relate to the business models of the CE within an association that included twenty-eight wine producers. The results showed that the implementation of these business models satisfies the ReSOLVE model proposed by the Ellen MacArthur Foundation [73] and underlined how the principles of the CE are linked to the implemented business models.

4.2. Food Loss and Waste in the Supply Chain

In the last decade, FLW in the relationships between quality and quantity has become a main concern from both environmental and social viewpoints [74]. Consistent with the United Nations [75], one-third of all food in the world is estimated to be lost or wasted, leaving 800 million people undernourished [76]. Since the population worldwide continues to grow, increasing food production is not a desirable solution as it involves large costs and places pressure on scarce natural resources. Thus, a system-wide method is needed to add value along the supply chain while preserving nutritional benefits in the context of minimizing food loss and waste in production and consumption [77].

Several definitions of food loss and food waste are stated in the literature, creating difficulties for comparative studies and limiting the possibility of combining their outcomes in a shared approach to reduce FLW [78]. The main factors of food loss are the limitations of the infrastructure, climatic and environmental factors, and the classification by quality or safety standards [79]. In contrast, food waste arises when food for human feeding is wastefully removed or is not consumed by humans. This comprises food that is wasted prior to its disposal or is still consumable when thrown away [80]. In addition, food waste occurs mainly in the late phases of the supply chain (retail and final consumer) because of severe conditions for quality or safety principles [81].

Corrado and Sala [58] found that current estimates of food loss and waste generation vary between 194 and 389 kg per person per year on a global scale and between 158 and 298 kg per person per year on a European scale. The authors suggested that more efforts are required to promote suitable strategies related to food loss and waste. Options for exploiting food waste (FW) include, for example, the extraction of high-value compounds, using it as animal feed, the production of biomaterials, and the generation of biofuels.

Valorization is generally more appropriate when there is consistency in waste streams [57]. So, given the challenges faced by the agri-food chain, it is almost idealistic to define a single CE prototype for the entire sector [14]. The solutions supported by Girotto et al. [57] suggest the interconnection between biotechnological procedures and the co-production of biofuels and bioproducts as a strategic key directed to maximizing the use of food waste and to increasing the income of the production sector.

The improvement in sustainable solutions for food waste management is one of the main challenges for society. In a review, Girotto et al. [57] provided an overview of the present discussion on the definitions of food waste, reduction strategies, and conversion technologies that have emerged from the concept of biorefinery. The paper highlights several solutions implemented in the management of food waste, such as donating edible fractions to social services or for the production of biofuels or biopolymers, and providing food for nutrient recovery and carbon fixation by composting; less desirable options are incineration and landfilling. The identified solutions should be able to exploit the valuable resources represented by food waste to obtain social, economic, and environmental benefits.

Dora et al. [16] identified the key causes of FLW in the supply chain of both developed and developing countries. Mitigation strategies were identified by systematically analyzing and synthesizing the existing research in the field of food loss and waste in the supply chain. According to their findings, in high-income countries, most FLWs occur at the distribution and consumption stage, whereas in low-income countries, FLWs are focused in the production and post-harvest stages [16].

Principato et al. [60], through an analysis of global food loss and waste, for the first time quantified the main FLWs and their origins along the food supply chain of pasta production, concluding that these FLWs can be reused in line with the CE. They analyzed the life cycle of pasta production and showed that, along this supply chain, FLW mainly occurs in the cultivation and consumption stages, and that it could be efficiently reused for other purposes. Their outcomes demonstrated that the pasta supply chain is a virtuous model of the CE: the food losses in the field are restricted (less than 2%), while the straw produced during harvesting is usually employed as feed. Consistent with earlier literature, most FLW occurs during cultivation and consumption, indicating that more research is needed to decrease FLW in these two phases of the supply chain.

The tomato industry is another key sector of the food industry, suited to demonstrating the potential of the CE, as it produces enormous quantities of waste. These residues negatively influence the sustainability of the food industry, as their disposal has environmental and economic impacts. However, it represents an economic and renewable biomass that, in the context of the biorefinery model, can be exploited for the production of chemical and energy products, thus contributing to the sustainability of this supply chain. Boccia et al. [59] also investigated the potential of tomato waste biorefinery in Italy regarding possible reuse tactics and existing cases of converting tomato waste into merchandisable products. The analysis of the tomato sector in Italy showed that the recycling of tomato waste in is limited. According to the authors, some key aspects are required: improvement in innovative technologies and processes, the identification of renewable raw materials that do not compete with other production chains, the establishment of innovative markets and enhancing of competitiveness, and driving the policy makers and stakeholders.

Food by-products and waste valorization practices have recently gained attention as a means of sustainable management, which can simultaneously increase profits for local economies. To highlight new trends and show the potential of regional economies, Naziri et al. [56] focused on a Greek region that generates large amounts of diverse kinds of by-products and waste from the production of olive oil, wine, and rice. According to the authors, the transition to a CE should aim to involve stakeholders, who should take greater notice of the know-how developed by academia and research institutes in terms of tools for the recovery of by-products to contribute to the objective of a zero-waste society.

To implement the principles of the CE in the agri-food sector, some authors have proposed methods of valorization and management of biomass. Bas-Bellver et al. [61] proposed a method for enhancing vegetable waste, such as carrots, leeks, celery, and cabbage, from fresh and ready-to-eat lines, aimed at the production of functional powders as functional food ingredients. Plant residues are effectively converted into functional ingredients by hot-air-drying or freeze-drying, and variables such as storage environments and grinding intensity prior to drying were measured. According to the authors, vegetable waste powders might be used in the food industry as coloring and flavoring ingredients or natural preservatives, or they can be used to reformulate processed foods to improve their nutritional properties. Kyriakopoulos et al. [17] provided an update on existing technological advances and their implementation. The authors conducted a multi-parameter approach to study the functionality of technologies in wastewater treatment, organic waste management, agricultural development, and food waste in the context of the CE. Through a critical approach, environmental, marketing, economic, governmental, and procedural points of view were assimilated. The authors noted the complexity of the implementation of the CE norm and the necessity for a specific forecast in each case. The proposed approaches were formulated from the perspective of socio-environmental impact.

4.3. Analytical Tools for the Circular Economy

The adoption of models and tools when considering CE is fundamental to overcoming the difficulties posed by food waste and loss and to achieve sustainable development objectives. From this viewpoint, the life cycle assessment (LCA) methodology represents the most commonly used instrument to estimate "the potential environmental impacts associated with all phases of a product, process, or service" [82]. LCA is an adaptable tool that can be used to assess environmental impacts to improve production, to optimize resource management, and to support intervention managers in order to identify drivers toward reducing the environmental burden of agriculture and food systems [83]. In this sense, LCA is a tool that allows a more accurate assessment of the balance between efforts and benefits in the implementation of CE solutions at the micro level [84].

LCA has been widely useful in measuring the environmental impact of food and in finding diverse opportunities for improving food systems management, including the recovery of potential long-lasting waste. However, in LCA case studies, suitable accounting for food losses is still lacking. A divergence was observed in both the definition of food loss and the approaches adopted towards the environmental burden of food loss. These features can lead to misleading and, at times, contradictory outcomes, limiting the reliability of LCA as a decision support tool for the evaluation of food production systems. Within published studies on food LCA, the assessment of food loss along the supply chain is frequently only partially or inconsistently achieved [85], limiting the effectiveness of LCA as a process to support instrument decision-making.

Esposito et al. [14] examined the state-of-the-art research related to the implementation of CE models and tools along the agri-food chain. The paper highlights that, due to the complexity of the agri-food chain, it is utopian to define a single CE model for the entire sector. They called upon academics to increase the quantity and reproducibility of LCA data to guide the sustainable development of products and services. Belaud et al. [64] assessed environmental impacts by combining the concepts of Industry 4.0, sustainability, and agri-food to choose which pre-treatment to apply to the lignin cellulosic biomass in the rice supply chain. They used the LCA method to support scholars in selecting a sustainable procedure to improve the pre-treatment of rice straw.

Corrado et al. [15] provided a preliminary analysis to highlight which models in the LCA studies of food loss have been evaluated in the literature. They suggested considering possibly avoidable and inevitable food loss separately, and, through a discussion of the strengths and weaknesses of the diverse methods, they provided recommendations on how to manage food loss. They proposed the development of a shared methodological framework to increase the robustness and comparability of LCA studies. The most important recommendations concerned the systematic accounting of food losses produced along the food chain, the modeling of waste management based on the specific features of food, sensitivity analysis of the modeling methods adopted to model multifunctionality, and the need for transparency in the description of the patterns of the generation and management of food loss.

Muradin et al. [63] conducted a comparative assessment of the eco-efficiency of biogas production from the food industry for waste-to-energy in biogas plants depending on the type of raw material used, its transport, and the possibility of using the heat generated. The environmental impact of the plants was assessed by applying LCA and the impact on costs was determined using the leveled cost of electricity (LCOE) method. The results showed that high eco-efficiency can be achieved by installing a biogas plant near a food processing plant.

Pagotto and Halog [62] assessed the eco-efficiency performance of various subsectors in Australian agri-food systems using input–output-oriented approaches to data envelope analysis and material flow analysis. They analyzed the required (desirable and undesirable) inputs and outputs for the entire food supply chain in Australia using material flow analysis (MFA). The environmental impacts produced by the food chain were evaluated, and the economic and environmental efficiency performance of various subsectors in the Australian food system was calculated using data envelope analysis (DEA). The authors also discussed inefficiencies during the life cycle of food production, and how the application of the principles of industrial ecology could increase efficiency through the reductions in negative impacts and non-renewable sources.

4.4. Stakeholder Acceptance of the Circular Economy

The integration of sustainability into business models needs a systemic vision that contemplates n overall viewpoint of the diverse features of the system and their interrelationships [86]. Value network analysis provides this information and can determine changes in a company's business model [87,88]. To achieve a balanced system, deliberate interaction, partnership, networking, and learning from multiple and diverse stakeholders are essential [89]. Greater stakeholder engagement, coupled with better confidence and innovation in their business models, is among the major changes that companies must undertake to pursue a long-term sustainability goal [90–92].

The analysis of value flows within the network shows how different choices influence the mutual satisfaction of the stakeholders and, therefore, the sustainability of the network [93]. Furthermore, the creation of mutual value requires the systemic consideration of a large group of stakeholders who have an interest and a responsibility in the value creation system. The literature on consumer acceptance of foods resulting from by-products is limited because this area of research is fairly new and there are few products already developed that can be tested [94–96].

Coderoni and Perito [68] assessed the relative importance of all factors influencing consumers' purchasing intentions for value-added foods (waste to value (WTV)). The authors assessed how socio-demographic and psychological characteristics influence the extent to which consumers engage in the CE by purchasing WTV foods enriched with ingredients otherwise wasted in the supply chain. Through the use of two different purchase intentions, the results showed that more than half of the interviewees declared their willingness to buy food based on environmental sustainability issues to reduce the environmental impact of production, assigning importance to the origin and nutritional values of the products. They also found that the likelihood of declaring positive purchase intention decreased with food neophobia and food technology neophobia. An important aspect that can influence the acceptance of novel food products, especially if enriched with by-products, is trust in the food system. Consumers are not always capable of deciding if novel foods produced by new technologies are associated with possible risks, as they have limited knowledge of new technologies [97].

Atinkut et al. [67] assessed the current status of agricultural waste management (AWM), farmer availability willingness to pay (WTP), and factors influencing WTP for AWM in a region of Ethiopia. The authors found that the most influential WTP factors were age, education, family size, income, land, livestock, and perception. The outcomes showed that the value of supply in working days, environmental perception, state subsidies, the shortage of farms, economic conditions, living in harmony with nature, and knowledge of the AW strongly influenced the degree of the amount paid by farmers. The findings are useful for understanding farmers' attitudes toward rural quality and WTP for environmentally friendly AWMs, as well as the need for public and private tools in AWM for policy development and for turning waste into a resource.

Borrello et al. [65] illustrated through six circular interactions involving seven actors (grain farmers, bread producers, retailers, compostable packaging producers, insect farmers, cattle breeders, and consumers) an alternative to the traditional bread chain based on principles of the CE considering two innovations: insects used as animal feed and compostable packaging with polylactic acid. The results highlight the main challenges faced in the implementation of the new supply chain and patents related to the production of sustainable bread. Based on the results, consumers are expected to change their habits regarding the end of the product's life cycle, for example, by collecting leftover bread and used packaging and returning them to retailers. Some studies have evaluated consumer behavior toward approaches related to sustainability and the CE. McCarthy et al. [66] assessed the willingness of Australian households to purchase foods derived from underutilized biomass. According to their results, half of the sample was willing to buy value-added food. The awareness of the problem of food waste is important in distinguishing consumers who are willing to buy value-added food from those who are not.

4.5. Mitigation Strategies and Political Approach

The goal to move to a CE has been particularly strong in Europe. The European Union (EU) has embraced the CE as a social and political goal by stating that in "a world with increasing pressures on resources and the environment, the EU has no choice but to make the transition to a CE efficient in terms of resources and, ultimately, regenerative" [98].

The European Commission considered action on the FLW issue by introducing its new CE package to inspire Europe's transition to a CE, which will increase global competitiveness, encourage sustainable growth, and generate new opportunities. However, the existing business models for the CE are not very dynamic and inclusive and seem unable to support any type of company in the design of a circular business model [7].

Policy makers need to better comprehend which business model features lead to true sustainability, and which operational, behavioral, and policy interventions might be needed to facilitate such innovations. Policy can create effects at the individual firm level as well as at the broader industrial system level, consequently transforming stakeholder behavior through appropriate policy interventions such as regulation, legislation, taxation, education, and incentives [51].

Corrado and Sala [58] analyzed existing studies on the generation of food waste at the global and European scales, and described and compared the approaches adopted, and then analyzed their potential in supporting European interventions and policies related to food waste. The authors analyzed the potential of the approaches adopted to support food waste, highlighting that although the available data provide an overall picture of the generation of food waste at the global and European levels, in reality only two of the ten studies provided information on interventions related to the consumption phase in Europe.

Lainez et al. [70] presented a review of the bioeconomy in Spain, considering its characteristics and the strategy that needs to be implemented through annual action plans. They also described the indicators used to assess the implementation of the strategy. Fava et al. [71] provided an overview of the implementation of bioeconomy strategies in Italy, introducing the strengths and weaknesses of the sectors involved and the measures, regulatory initiatives, and monitoring actions undertaken. The authors concluded that the bioeconomy is a central pillar of the Italian economy and an enabling element of the new Italian Green Deal. Research and innovation (R&I) play an important role; therefore, the European Commission (EC) has recently promoted dedicated research activity tools in this area. Muscio and Sisto [72] discussed current public R&I regulations in support of the transition to the CE model, opening a critical debate on the actual relevance of the EC in current R&I policy regarding its main research policy frameworks in the 2007–2013 and 2014–2020 program periods. The results showed that the desire to favor a socio-technical transition toward circularity in support of agri-food sustainability appears evident but is not yet particularly relevant.

Kristensen et al. [69] outlined the current interrelated challenges faced by the agri-food system in relation to environmental degradation, economic crises, and social problems, considering how these challenges are addressed in agri-food studies. The authors highlighted examples from the literature of rethinking the future of the agri-food system, concluding that the eco-economy and the integrated territorial agri-food paradigm share a common goal, but the CE stands out from the actors who are emphasizing collaborations and partnerships with existing agri-food companies.

5. Conclusions

Within the current context of resource scarcity, global climate change, environmental degradation, and increased food demand, the CE represents a promising strategy to support sustainable, restorative, and regenerative agriculture. The problem created by agri-food industry by-products and waste generation has garnered the attention of academics, regulators, industry, and consumers.

The reduction in food waste requires an integrated approach in the management of the food supply chain [99], highlighting the need for strong cooperation between the various stakeholders [100]. Furthermore, waste prevention requires changes in people's behavior, both at the corporate and individual levels [80]. National circumstances and cultural diversities have also been linked to food waste patterns [16], which can differ from region to region and from country to country. This indicates that effective approaches to food waste prevention may also differ [101].

Prior to 2015, there was no political applicability of the CE concept to the entire EU agri-food system. In 2015, the European Commission [2] launched an important initiative to support the transition to a more CE in European countries. It is therefore essential to maintain momentum at all levels, collaborating with multiple stakeholders and understanding the barriers and drivers to facilitate that transition, as well as the role of industries, professionals, and academics to help reach the full potential of the CE model [16]. Dissemination of CE implementation good practices can help academics and companies to gain knowledge about sustainable circular economy business models [102] as well as sustainable consumption and production patterns. Furthermore, scholars should contribute by publishing relevant results obtained by applying the CE principles [103], thus helping producers to reduce food losses and waste.

In the food sector, new frontiers of research aim at the production of innovative WTV products to reduce resource depletion and facilitate waste management.

From a political point of view, two synergistic directions of action have emerged: the information provided by the producers, and the set of individual beliefs. Policy makers and producers should focus their efforts on realizing more desirable and shorter cycle conservation options, such as regeneration, refurbishment, and reuse, considering overall system feasibility and effects [103].

In this context, the acceptance by consumers of new food products with ingredients previously wasted in the supply chain is fundamental for the final absorption of all products on the market [68]. One of the main challenges in this evaluation is trying to elicit consumer preferences for such products considering their food neophobia, food technology neophobia, or their possible general distrust, because all these elements could influence the acceptance of the specific food product.

The circular economy, like all other sustainable models, not only requires innovative concepts but also innovative actors; often, its implementation must be supported by stakeholders who allow changes in policies and decision-making tools [104,105]. The adoption of strategies by companies to improve the circularity of the production system also requires collaboration with other companies along the entire supply chain to achieve a circular model that is as effective as possible [31,106]. The implementation of a circular economy is not always easy to undertake, as it often encounters biophysical limits, including the high-energy requirement for resource recovery and loss in the quality of resources [107,108].

Kirchherr et al. [109] recently found that in Europe the lack of interest and awareness on the part of consumers is a "main obstacle to the transition to CE", as previously pointed out by Rizos et al. [110], who noted the same complaint from small- and medium-sized enterprises trying to move to business models and circular solutions. Kirchherr et al. [102] found that the scientific literature in this area is insufficient, reporting that only 19% of documents defining the circular economy consider consumption and there is no evidence as to why consumers choose to participate or not in the circular economy. Conversely, Ghisellini et al. [4], found that the existing literature views consumers as passive and rational recipients, influenced by labels and other signals from the production side in making decisions. Therefore, it is essential to involve consumers since, as suggested by Hobson et al. [111], the circular economy could result in a significant change in the whole of society [112].

The scientific community should consider the growth in the bioeconomy in its research goals. Enterprises could increase added value by innovating and developing technology to develop business projects, bringing products and services to market with efficiency and sustainability as guiding principles. Society must be conscious that the bioeconomy, in the context of the CE, suggests the application of sustainability and efficiency principles and needs innovative technologies that should be recognized and integrated into buying choices when goods enter the market. The CE offers the opportunity to reinvent the economy, thus making it more sustainable and competitive. The use of new and innovative products, processes, and business models can produce increased incomes for producers by maintaining affordable consumer prices and improving environmental and social benefits. Ghisellini and Ulgiati [113] discussed that legislative and government support is essential in the early stage of implementing a CE. Furthermore, the lack of government support is one of the main obstacles that companies, especially small- and medium-sized ones, must overcome to adopt a circular approach [114]. In this direction, given the sustainable economic, social, and environmental dimensions of the CE, circular agriculture should become a pillar of the economy, rather than a subsidized sector, guaranteeing economic sustainability, the conservation of biodiversity, and productivity over time in its own agro-ecosystems, environmental sustainability and, in general, helping to ensure food security, while also improving social sustainability.

With regard to the limitations of this study, we highlight that, due to the limited number of studies examined, the results should be generalized with caution. In addition, the relatively small number of articles demonstrates the need for further research on specific issues faced by the CE in the agro-food sector.

Future researchers could address the applicability of a CE model through a holistic, interdisciplinary, and integrated approach to the full use of FLW in waste reduction and recovery of valuable by-products, thus moving toward total cleaning (zero waste).

Supplementary Materials: The following are available online at https://www.mdpi.com/2071-1050/13/6/3453/s1, Table S1. Overview of selected papers.

Author Contributions: Conceptualization, M.H., G.C., G.D.V., G.M. and M.D.; methodology, M.H., G.C., G.D.V., G.M. and M.D.; software, M.H., G.C. and G.M.; validation, G.D.V., G.P. and B.P.; formal analysis, G.D.V., G.P. and M.D.; investigation, M.H. and G.M.; resources, G.C. and M.D.; data curation, G.C. and G.M.; writing-original draft preparation, M.H., G.C., G.M. and M.D.; writing-review and editing, G.C., G.D.V. and G.M.; visualization, G.P. and B.P.; supervision, G.C. and M.D.; project administration, G.C. and M.D.; funding acquisition, G.C. and M.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received a grant from the Project PRIN DRASTIC "Driving The Italian Agri-Food System Into A Circular Economy Model," PRIN-MIUR (2017 JYRZFF), funded by the Italian Ministry of Education, University and Research (MIUR), and project MODESTI by Starting Grant "PIAno di inCEntivi per la RIcerca di Ateneo 2020/2022 (Pia.ce.ri.)" UNICT (5A722192150). Project leader: Gaetano Chinnici.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. European Parliament. *Circular Economy: Definition, Importance and Benefits*; European Parliament: Brussels, Belgium, 2015.
2. European Commission. *Closing the Loop—An EU Action Plan for the Circular Economy. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*; European Commission: Brussels, Belgium, 2015.
3. Ness, D. Sustainable urban infrastructure in China: Towards a factor 10 improvement in resource productivity through inte-grated infrastructure systems. *Int. J. Sustain. Dev. World Ecol.* **2008**, *15*, 288–301.
4. Ghisellini, P.; Cialani, C.; Ulgiati, S. A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *J. Clean. Prod.* **2016**, *114*, 11–32. [CrossRef]
5. United Nations Environment Programme (UNEP). *Global Material Flows and Resource Productivity. An Assessment Study of the UNEP International Resource Pane*; Secretariat of International Resource Panel (IRP): Paris, France, 2016.
6. International Resource Panel. Global resources Outlook 2019: Natural resources for the future we want. In *A Report of the International Resource Panel*; Oberle, B., Bringezu, S., Hatfield-Dodds, S., Hellweg, S., Schandl, H., Clement, J., Cabernard, L., Che, N., Chen, D., Droz-Georget, H., et al., Eds.; United Nations Environment Programme: Nairobi, Kenya, 2019.
7. Lewandowski, M. Designing the business models for circular economy—Towards the conceptual framework. *Sustainability* **2016**, *8*, 43. [CrossRef]
8. Lieder, M.; Rashid, A. Towards circular economy implementation: A comprehensive review in context of manufacturing in-dustry. *J. Clean. Prod.* **2016**, *115*, 36–51. [CrossRef]
9. Ellen MacArthur Foundation. *Towards the Circular Economy. Opportunities for the Consumer Goods Sector*; EMF: Cowes, Island of Wight, UK, 2013.
10. Jabłoński, A. Design and Operationalization of Technological Business Models. *Acta Univ. Agric. Silv. Mendel. Brun.* **2015**, *63*, 927–935. [CrossRef]
11. Stahel, W.R. The circular economy. *Nature* **2016**, *531*, 435–438. [CrossRef]
12. Circle Economy. *The Circularity Gap Report*; Circle Economy: Ruparo, Amsterdam, 2020.
13. European Commission. *A New Circular Economy Action Plan for a Cleaner and More Competitive Europe*; European Commission: Brussels, Belgium, 2020.
14. Esposito, B.; Sessa, M.; Sica, R.D.; Malandrino, O. Towards Circular Economy in the Agri-Food Sector. A Systematic Literature Review. *Sustainability* **2020**, *12*, 7401. [CrossRef]
15. Corrado, S.; Ardente, F.; Sala, S.; Saouter, E. Modelling of food loss within life cycle assessment: From current practice towards a systematisation. *J. Clean. Prod.* **2017**, *140*, 847–859. [CrossRef]
16. Dora, M.; Biswas, S.; Choudhary, S.; Nayak, R.; Irani, Z. A system-wide interdisciplinary conceptual framework for food loss and waste mitigation strategies in the supply chain. *Ind. Mark. Manag.* **2020**, *93*, 492–508. [CrossRef]
17. Kyriakopoulos, G.L.; Kapsalis, V.C.; Aravossis, K.G.; Zamparas, M.; Mitsikas, A. Evaluating circular economy under a mul-ti-parametric approach: A technological review. *Sustainability* **2019**, *11*, 6139. [CrossRef]
18. Geissdoerfer, M.; Savaget, P.; Bocken, N.M.P.; Hultink, E.J. The Circular Economy—A new sustainability paradigm? *J. Clean. Prod.* **2017**, *143*, 757–768. [CrossRef]
19. Yap, N.U. Towards a circular economy: Progress and challenges. *Green Manag. Int.* **2005**, *50*, 11–24.
20. Andersen, M.S. An introductory note on the environmental economics of the circular economy. *Sustain. Sci.* **2007**, *2*, 133–140. [CrossRef]
21. Feng, Z.; Yan, N. Putting a circular economy into practice in China. *Sustain. Sci.* **2007**, *2*, 95–101.
22. Charonis, G. Degrowth, steady state economics and the circular economy: Three distinct yet increasingly converging alternative discourses to economic growth for achieving environmental sustainability and social equity, World Economic Association. Sustainability—Missing Points in the Development Dialogue. In Proceedings of the WEA Conference, Bristol, UK, 24 September–21 October 2012.
23. Ellen Macarthur Foundation. *Towards the Circular Economy*; EMF: Cowes, Island of Wight, UK, 2012; Volume 1.
24. Preston, F. *A Global Redesign? Shaping the Circular Economy*; Chatcham House: London, UK, 2012.
25. Su, B.; Heshmati, A.; Geng, Y.; Yu, X. A review of the circular economy in China: Moving from rethoric to implementation. *J. Clean. Prod.* **2013**, *42*, 215–277. [CrossRef]
26. Lett, L.A. Las amenazas globales, el reciclaje de residuos y el concepto de economía circular. *Rev. Argent. Microbiol.* **2014**, *46*, 1–2. [CrossRef]
27. Naustdalslid, J. Circular economy in China—The environmental dimension of the harmonious society. *Int. J. Sustain. Dev. World Ecol.* **2013**, *21*, 303–313. [CrossRef]
28. Prendeville, S.; Sanders, C.; Sherry, J.; Costa, F. *Circular Economy: Is it Enough?* Ecodesign Centre (EDC): Cardiff, UK, 2014; pp. 1–18.
29. Chinnici, G.; Zarbà, C.; Hamam, M.; Pecorino, B.; D'Amico, M. A model of circular economy of citrus industry. In Proceedings of the 19th International Multidisciplinary Scientific GeoConference SGEM, Vienna, Austria, 9–12 December 2019; Volume 19.
30. Hamilton, S.H.; ElSawah, S.; Guillaume, J.H.; Jakeman, A.J.; Pierce, S.A. Integrated assessment and modelling: Overview and synthesis of salient dimensions. *Environ. Model. Softw.* **2015**, *64*, 215–229. [CrossRef]

31. Ellen MacArthur Foundation. *Towards a Circular Economy: Business Rationale for an Accelerated Transition*; EMF: Cowes, Island of Wight, UK, 2015.
32. Kirchherr, J.; Piscicelli, L.; Bour, R.; Kostense-Smit, E.; Muller, J.; Huibrechtse-Truijens, A.; Hekkert, M. Barriers to the Circular Economy: Evidence from the European Union (EU). *Ecol. Econ.* **2018**, *150*, 264–272. [CrossRef]
33. Stahel, W.R. *The Performance Economy*; Palgrave Macmillan: London, UK, 2010.
34. Bakker, C.A.; Wang, F.; Huisman, J.; Hollander, M.C. Products That Go Round: Exploring product life extension through de-sign. *J. Clean. Prod.* **2014**, *69*, 10–16. [CrossRef]
35. Bocken, N.; Miller, K.; Evans, S. Assessing the environmental impact of new Circular business models. In Proceedings of the New Business Models—Exploring a Changing View on Organizing Value Creation, Toulouse, France, 16–17 June 2016.
36. Mont, O. Clarifying the concept of product–service system. *J. Clean. Prod.* **2002**, *10*, 237–245. [CrossRef]
37. Mont, O. Institutionalisation of sustainable consumption patterns based on shared use. *Ecol. Econ.* **2004**, *50*, 135–153. [CrossRef]
38. Tukker, A. Product services for a resource-efficient and circular economy—A review. *J. Clean. Prod.* **2015**, *97*, 76–91. [CrossRef]
39. Antikainen, M.; Valkokari, K. A framework for sustainable circular business model innovation. *Technol. Innov. Manag. Rev.* **2016**, *6*, 5–12. [CrossRef]
40. Pavitt, K. Sectoral patterns of technical change: Towards a taxonomy and a theory. *Res. Policy* **1984**, *13*, 343–373. [CrossRef]
41. Food and Agriculture Organization of the United Nations. *The State of Food and Agriculture, Moving Forward on Food Loss and Waste Reduction*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2019.
42. Proto, M.; Malandrino, O.; Supino, S. Sistemi e strumenti di gestione per la qualità. In *Percorsi Evolutivi e Approcci Manageriali. University of Salerno*; Giappichelli Editore: Turin, Italy, 2008.
43. Taghikhah, F.; Voinov, A.; Shukla, N. Extending the supply chain to address sustainability. *J. Clean. Prod.* **2019**, *229*, 652–666. [CrossRef]
44. Homrich, A.S.; Galvão, G.; Abadia, L.G.; Carvalho, M.M. The circular economy umbrella: Trends and gaps on integrating pathways. *J. Clean. Prod.* **2018**, *175*, 525–543. [CrossRef]
45. Braungart, M.; McDonough, W. *Cradle to Cradle*; Random House: New York, NY, USA; Vintage Books: London, UK, 2009.
46. González-Rubio, J.; Navarro-López, C.; López-Nájera, E.; López-Nájera, A.; Jiménez-Díaz, L.; Navarro-López, J.D.; Nájera, A. A Systematic Review and Meta-Analysis of Hospitalised Current Smokers and COVID-19. *Int. J. Environ. Res. Public Health* **2020**, *17*, 7394. [CrossRef] [PubMed]
47. Giacomarra, M.; Galati, A.; Crescimanno, M.; Tinervia, S. The integration of quality and safety concerns in the wine industry: The role of third-party voluntary certifications. *J. Clean. Prod.* **2016**, *112*, 267–274. [CrossRef]
48. Leonidou, E.; Christofi, M.; Vrontis, D.; Thrassou, A. An integrative framework of stakeholder engagement for innovation management and entrepreneurship development. *J. Bus. Res.* **2020**, *119*, 245–258. [CrossRef]
49. Golbabaei, F.; Yigitcanlar, T.; Paz, A.; Bunker, J. Individual Predictors of Autonomous Vehicle Public Acceptance and Intention to Use: A Systematic Review of the Literature. *J. Open Innov. Technol. Mark. Complex.* **2020**, *6*, 106. [CrossRef]
50. Barth, H.; Ulvenblad, P.O.; Ulvenblad, P. Towards a conceptual framework of sustainable business model innovation in the agri-food sector: A systematic literature review. *Sustainability* **2017**, *9*, 1620. [CrossRef]
51. Evans, S.; Vladimirova, D.; Holgado, M.; Van Fossen, K.; Yang, M.; Silva, E.A.; Barlow, C.Y. Business Model Innovation for Sustainability: Towards a Unified Perspective for Creation of Sustainable Business Models. *Bus. Strat. Environ.* **2017**, *26*, 597–608. [CrossRef]
52. Franceschelli, M.V.; Santoro, G.; Candelo, E. Business model innovation for sustainability: A food start-up case study. *Br. Food J.* **2018**, *120*, 2483–2494. [CrossRef]
53. Nosratabadi, S.; Mosavi, A.; Shamshirband, S.; Kazimieras Zavadskas, E.; Rakotonirainy, A.; Chau, K.W. Sustainable business models: A review. *Sustainability* **2019**, *11*, 1663. [CrossRef]
54. Sehnem, S.; Ndubisi, N.O.; Preschlack, D.; Bernardy, R.J.; Junior, S.S. Circular economy in the wine chain production: Maturity, challenges, and lessons from an emerging economy perspective. *Prod. Plan. Control.* **2019**, *31*, 1014–1034. [CrossRef]
55. Donner, M.; Gohier, R.; de Vries, H. A new circular business model typology for creating value from agro-waste. *Sci. Total. Environ.* **2020**, *716*, 137065. [CrossRef] [PubMed]
56. Naziri, E.; Nenadis, N.; Mantzouridou, F.T.; Tsimidou, M.Z. Valorization of the major agrifood industrial by-products and waste from Central Macedonia (Greece) for the recovery of compounds for food applications. *Food Res. Int.* **2014**, *65*, 350–358. [CrossRef]
57. Girotto, F.; Alibardi, L.; Cossu, R. Food waste generation and industrial uses: A review. *Waste Manag.* **2015**, *45*, 32–41. [CrossRef] [PubMed]
58. Corrado, S.; Sala, S. Food waste accounting along global and European food supply chains: State of the art and outlook. *Waste Manag.* **2018**, *79*, 120–131. [CrossRef] [PubMed]
59. Boccia, F.; Di Donato, P.; Covino, D.; Poli, A. Food waste and bio-economy: A scenario for the Italian tomato market. *J. Clean. Prod.* **2019**, *227*, 424–433. [CrossRef]
60. Principato, L.; Ruini, L.; Guidi, M.; Secondi, L. Adopting the circular economy approach on food loss and waste: The case of Italian pasta production. *Resour. Conserv. Recycl.* **2019**, *144*, 82–89. [CrossRef]
61. Bas-Bellver, C.; Barrera, C.; Betoret, N.; Seguí, L. Turning Agri-Food Cooperative Vegetable Residues into Functional Powdered Ingredients for the Food Industry. *Sustain. J. Rec.* **2020**, *12*, 1284. [CrossRef]

62. Pagotto, M.; Halog, A. Towards a Circular Economy in Australian Agri-food Industry: An Application of Input-Output Oriented Approaches for Analyzing Resource Efficiency and Competitiveness Potential. *J. Ind. Ecol.* **2016**, *20*, 1176–1186. [CrossRef]
63. Muradin, M.; Joachimiak-Lechman, K.; Foltynowicz, Z. Evaluation of Eco-Efficiency of Two Alternative Agricultural Biogas Plants. *Appl. Sci.* **2018**, *8*, 2083. [CrossRef]
64. Belaud, J.-P.; Prioux, N.; Vialle, C.; Sablayrolles, C. Big data for agri-food 4.0: Application to sustainability management for by-products supply chain. *Comput. Ind.* **2019**, *111*, 41–50. [CrossRef]
65. Borrello, M.; Lombardi, A.; Pascucci, S.; Cembalo, L. The Seven Challenges for Transitioning into a Bio-based Circular Economy in the Agri-food Sector. *Recent Pat. Food Nutr. Agric.* **2016**, *8*, 39–47. [CrossRef] [PubMed]
66. McCarthy, B.; Kapetanaki, A.B.; Wang, P. Circular agri-food approaches: Will consumers buy novel products made from vegetable waste? *Rural Soc.* **2019**, *28*, 91–107. [CrossRef]
67. Atinkut, H.B.; Yan, T.; Arega, Y.; Raza, M.H. Farmers' willingness-to-pay for eco-friendly agricultural waste management in Ethiopia: A contingent valuation. *J. Clean. Prod.* **2020**, *261*, 121211. [CrossRef]
68. Coderoni, S.; Perito, M.A. Sustainable consumption in the circular economy. An analysis of consumers' purchase intentions for waste-to-value food. *J. Clean. Prod.* **2020**, *252*, 119870. [CrossRef]
69. Kristensen, D.K.; Kjeldsen, C.; Thorsøe, M.H. Enabling sustainable agro-food futures: Exploring fault lines and synergies be-tween the integrated territorial paradigm, rural eco-economy and circular economy. *J. Agric. Environ. Ethics* **2016**, *29*, 749–765. [CrossRef]
70. Lainez, M.; González, J.M.; Aguilar, A.; Vela, C. Spanish strategy on bioeconomy: Towards a knowledge based sustainable innovation. *New Biotechnol.* **2018**, *40*, 87–95. [CrossRef]
71. Fava, F.; Gardossi, L.; Brigidi, P.; Morone, P.; Carosi, D.A.; Lenzi, A. The bioeconomy in Italy and the new national strategy for a more competitive and sustainable country. *New Biotechnol.* **2021**, *61*, 124–136. [CrossRef] [PubMed]
72. Muscio, A.; Sisto, R. Are Agri-Food Systems Really Switching to a Circular Economy Model? Implications for European Research and Innovation Policy. *Sustain. J. Rec.* **2020**, *12*, 5554. [CrossRef]
73. Ellen MacArthur Foundation. *Completing the Picture how the Circular Economy Tackles Climate Change*; EMF: Cowes, Island of Wight, UK, 2019.
74. Secondi, L.; Principato, L.; Laureti, T. Household food waste behaviour in EU-27 countries: A multilevel analysis. *Food Policy* **2015**, *56*, 25–40. [CrossRef]
75. Food and Agriculture Organization of the United Nations (FAO). *Save Food: Global Initiative on Food Loss and Waste Reduction. Definitional Framework of Food Loss*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2014.
76. Gustavsson, J.; Cederberg, C.; Sonesso, U. *Global Food Losses and Waste—Extent, Causes and Prevention*; Food and Agriculture Organization of The United Nations: Rome, Italy, 2011.
77. Hawkes, C.; Ruel, M.T. Value chains for nutrition. *Reshaping Agric. Nutr. Health* **2012**, 73–82. Available online: https://www.ifpri.org/publication/value-chains-nutrition-1 (accessed on 20 March 2021).
78. Williams, I.D.; Schneider, F.; Syversen, F. The "food waste challenge" can be solved. *Waste Manag.* **2015**, *41*, 1–2. [CrossRef] [PubMed]
79. Dora, M. Collaboration in a circular economy: Learning from the farmers to reduce food waste. *J. Enterp. Inf. Manag.* **2019**, *33*, 769–789. [CrossRef]
80. Thyberg, K.L.; Tonjes, D.J. Drivers of food waste and their implications for sustainable policy development. *Resour. Conserv. Recycl.* **2016**, *106*, 110–123. [CrossRef]
81. Parfitt, J.; Barthel, M.; Macnaughton, S. Food waste within food supply chains: Quantification and potential for change to 2050. *Philos. Trans. R. Soc. B Biol. Sci.* **2010**, *365*, 3065–3081. [CrossRef]
82. Zhang, X.X.; Ma, F.; Wang, L. Application of Life Cycle Assessment in Agricultural Circular Economy. *Appl. Mech. Mater.* **2012**, *260-261*, 1086–1091. [CrossRef]
83. Gava, O.; Bartolini, F.; Venturi, F.; Brunori, G.; Zinnai, A.; Pardossi, A. A Reflection of the Use of the Life Cycle Assessment Tool for Agro-food Sustainability. *Sustainability* **2019**, *11*, 71. [CrossRef]
84. Haupt, M.; Zschokke, M. How can LCA support the circular economy? 63rd discussion forum on life cycle assessment, Zurich, Switzerland. *Int. J. Life Cycle Assess.* **2017**, *22*, 832–837. [CrossRef]
85. Cerutti, A.K.; Beccaro, G.L.; Bruun, S.; Bosco, S.; Donno, D.; Notarnicola, B.; Bounous, G. Life cycle assessment application in the fruit sector: State of the art and recommendations for environmental declarations of fruit products. *J. Clean. Prod.* **2014**, *73*, 125–135. [CrossRef]
86. Stubbs, W.; Cocklin, C. Conceptualizing a Sustainability Business Model. *Organ. Environ.* **2008**, *21*, 103–127. [CrossRef]
87. Kothandaraman, P.; Wilson, D.T. The future of competition: Value-creating networks. *Ind. Mark. Manag.* **2001**, *30*, 379–389. [CrossRef]
88. Allee, V.; Schwabe, O.; Babb, M.K. *Value Networks and the True Nature of Collaboration*, Kindle Edition; Babb, M., Ed.; Meghan-Kiffer Press: Tampa, FL, USA, 2015.
89. Winn, M.; Kirchgeorg, M. The siesta is over: A rude awakening from sustainability myopia. In *Corporate Environmental Strategy and Competitive Advantage*; Sharma, S., Starik, M., Eds.; Elgar: Northampton, MA, USA, 2005; pp. 232–258.
90. Jeffery, N. *Stakeholder Engagement: A Road Map to Meaningful Engagement, Doughty Centre 'How to do Corporate Responsibility' Series*; Cranfield University: Cranfield, UK, 2009.
91. Krantz, R. A New Vision of Sustainable Consumption. *J. Ind. Ecol.* **2010**, *14*, 7–9. [CrossRef]

92. Bolton, D.; Landells, T. Reconceptualizing power relations as sustainable business practice. *Bus. Strategy Environ.* **2015**, *24*, 604–616. [CrossRef]
93. Shaw, D.R. Value Creation in Multi-Level Networks: A Development of Business Model Theory. In Proceedings of the Pacific Asia Conference on Information Systems, PACIS 2010, Taipei, Taiwan, 9–12 July 2010.
94. Bhatt, S.; Lee, J.; Deutsch, J.; Ayaz, H.; Fulton, B.; Suri, R. From food waste to value-added surplus products (VASP): Consumer acceptance of a novel food product category. *J. Consum. Behav.* **2017**, *17*, 57–63. [CrossRef]
95. Aschemann-Witzel, J.; Peschel, A.O. How circular will you eat? The sustainability challenge in food and consumer reaction to either waste-to-value or yet underused novel ingredients in food. *Food Qual. Prefer.* **2019**, *77*, 15–20. [CrossRef]
96. Perito, M.A.; Di Fonzo, A.; Sansone, M.; Russo, C. Consumer acceptance of food obtained from olive by-products: A survey of Italian consumers. *Br. Food J.* **2019**, *122*, 212–226. [CrossRef]
97. Vega-Zamora, M.; Torres-Ruiz, F.J.; Parras-Rosa, M. Towards sustainable consumption: Keys to communication for improving trust in organic foods. *J. Clean. Prod.* **2019**, *216*, 511–519. [CrossRef]
98. European Commission. *Manifesto for a Resource-Efficient Europe*; European Commission: Brussels, Belgium, 2012.
99. Priefer, C.; Jörissen, J.; Bräutigam, K.-R. Food waste prevention in Europe—A cause-driven approach to identify the most relevant leverage points for action. *Resour. Conserv. Recycl.* **2016**, *109*, 155–165. [CrossRef]
100. Lipinski, B.; Hanson, C.; Lomax, J.; Kitinoja, L.; Waite, R.; Searchinger, T. *Reducing Food Loss and Waste. Creating a Sustainable Food Future, Instalment Two*; World Resource Institute: Washington, DC, USA, 2013.
101. Buzby, J.C.; Hyman, J.; Stewart, H.; Wells, H.F. The value of retail-and consumer-level fruit and vegetable losses in the United States. *J. Consum. Aff.* **2011**, *45*, 492–515. [CrossRef]
102. Kirchherr, J.; Reike, D.; Hekkert, M. Conceptualizing the circular economy: An analysis of 114 definitions. *Resour. Conserv. Recycl.* **2017**, *127*, 221–232. [CrossRef]
103. Reike, D.; Vermeulen, W.J.V.; Witjes, S. The circular economy: New or Refurbished as CE 3.0?—Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options. *Resour. Conserv. Recycl.* **2018**, *135*, 246–264. [CrossRef]
104. Golinska, P.; Kosacka, M.; Mierzwiak, R.; Werner-Lewandowska, K. Grey Decision Making as a tool for the classification of the sustainability level of remanufacturing companies. *J. Clean. Prod.* **2015**, *105*, 28–40. [CrossRef]
105. Küçüksayraç, E.; Keskin, D.; Brezet, H. Intermediaries and innovation support in the design for sustainability field: Cases from the Netherlands, Turkey and the United Kingdom. *J. Clean. Prod.* **2015**, *101*, 38–48. [CrossRef]
106. Winkler, H. Closed-loop production systems—A sustainable supply chain approach. *CIRP J. Manuf. Sci. Technol.* **2011**, *4*, 243–246. [CrossRef]
107. Brown, M.T.; Buranakarn, V. Emergy indices and ratios for sustainable material cy-cles and recycle options. *Resour. Conserv. Recycl.* **2003**, *38*, 1–22. [CrossRef]
108. Castro, M.; Remmerswaal, J.; Brezet, J.; Reuter, M. Exergy losses during recycling and the resource efficiency of product systems. *Resour. Conserv. Recycl.* **2007**, *52*, 219–233. [CrossRef]
109. Kirchherr, J.; Hekkert, M.; Bour, R.; Huibrechtse-Truijens, A.; Kostense-Smit, E.; Muller, J. *Breaking the Barriers to the Circular Economy*; Utrecht University: Utrecht, The Netherlands, 2017.
110. Rizos, V.; Behrens, A.; Van Der Gaast, W.; Hofman, E.; Ioannou, A.; Kafyeke, T.; Flamos, A.; Rinaldi, R.; Papadelis, S.; Hirschnitz-Garbers, M.; et al. Implementation of Circular Economy Business Models by Small and Medium-Sized Enterprises (SMEs): Barriers and Enablers. *Sustain. J. Rec.* **2016**, *8*, 1212. [CrossRef]
111. Hobson, K.; Lynch, N. Diversifying and de-growing the circular economy: Radical social transformation in a resource-scarce world. *Futures* **2016**, *82*, 15–25. [CrossRef]
112. Hopkinson, P.; Zils, M.; Hawkins, P.; Roper, S. Managing a Complex Global Circular Economy Business Model: Opportunities and Challenges. *Calif. Manag. Rev.* **2018**, *60*, 71–94. [CrossRef]
113. Ghisellini, P.; Ulgiati, S. Circular economy transition in Italy. Achievements, perspectives and constraints. *J. Clean. Prod.* **2020**, *243*, 118360. [CrossRef]
114. Preziosi, M.; Merli, R.; D'Amico, M. Why Companies Do Not Renew Their EMAS Registration? An Exploratory Research. *Sustain. J. Rec.* **2016**, *8*, 191. [CrossRef]