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Identification of Opportunities for Applying the Circular Economy to Intensive Agriculture in Almería (South-East Spain)

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Abstract: The use of intensive high-yield agricultural systems has proved to be a feasible alternative to traditional systems as they are able to meet the objective of guaranteeing long-term sustainability in the supply of food. In order to implement these systems, it is necessary to replace the traditional model of “extract-use-consume-dispose” with a model based on the principles of the Circular Economy (CE), optimizing the use of resources and minimizing the generation of waste. Almería has become a paradigm of this type of high-yield agricultural system, with the largest concentration of greenhouses in the world. This study analyses the opportunities that the CE can offer the intensive agriculture sector in Almería in order to obtain long-term sustainability. The results show a wide variety of alternatives, both on an agricultural exploitation level and in the case of the product packaging and wholesale centers. The priority areas of action are waste management, the prevention of product waste and the improvement in the efficiency of the use of water and energy. The principal limitations for adopting circular practices are the large investment required, the limited transfer of knowledge between the different users and the lack of sufficient support from the government and the sector.

Keywords: circular economy; sustainable agriculture; intensive agriculture; horticultural production; greenhouse

1. Introduction

As a consequence of the increase in the population on a global scale, humanity is faced with a series of challenges. One of the most urgent is to ensure the supply of food [1]. Furthermore, global economic development has given rise to the expansion of the middle class with a greater availability of resources, generating changes in lifestyles and consumption patterns [2]. As a result, consumer preferences imply a greater use of resources, which represents a risk for the sustainability of the production system. It is estimated that in order to satisfy global demand for the year 2050, based on current consumption patterns, the resources equivalent to those of three planets would be necessary [3]. As the principal food suppliers, the focus is on the agricultural ecosystems [4,5]. These systems fulfil an essential function in the supply of resources such as food, fiber and other raw materials but they are also the largest consumers of freshwater on a global level [6,7]. Furthermore, together with food processing, agriculture is responsible for 21% of the planet’s greenhouse gas emissions, the second largest material footprint with 20,100 million tons and a carbon footprint of 6500 million tons of CO₂ equivalent [8]. Therefore, alternatives able to satisfy the demand for food are required that minimize the environmental impact and contribute to an equitable economic development.

The use of intensive high-yield agricultural systems has proved to be a feasible alternative, able to meet the objective described [9]. An example is the intensive agriculture model of Almería, considered a paradigm of these types of systems [10]. This region has the highest concentration of greenhouses in the world, with 32,048 hectares, where 3,525,187 tons of fruit and vegetables are produced, of which 80% are exported [11,12]. It represents 0.02% of the agricultural area of the European Union (EU), and 0.6% of its total agricultural production. Its productivity is 30 times higher than the European average [13]. The success of Almería's agricultural model is based on the use of simple yet highly efficient technologies, such as plastic greenhouses or the "enarenado" technique [14]. This could not have been possible without the parallel development of an extensive network formed by a marketing structure, different types of organizations (including farmers' associations, irrigation communities, credit unions, etc.) and different auxiliary industries [15,16]. However, this model is based on a linear approach of "extracting-using-consuming-disposing", which has generated an intensive use of natural resources and contributed to the current scarcity and pollution of water resources, the deterioration of the soil and climate change [17,18].

Contrary to this linear approach, the Circular Economy (CE) constitutes an alternative that seeks to establish a production model in which strategies are implemented to achieve sustainable development, based on the optimization of the resources used [19]. To do this, these resources need to maintain their value within the economic system for as long as possible, reducing the generation of waste and the use of new materials [20]. Kirchherr et al. [21] define the CE "as an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes". The CE is based on three principles [22]: the preservation and improvement of natural capital, the optimization of resource efficiency and the promotion of the efficiency of the system. The application of a CE strategy in agriculture seeks to reduce the use of external consumables in agricultural production, to close the nutrient cycles, minimize waste and recover agri-food residues [23,24].

The European Commission recently re-established its commitment to climate and the environment through the European Green Deal. Its objectives are to promote a more efficient use of resources through a cleaner and circular economy and to restore biodiversity and reduce pollution [25]. Within the framework of this Deal, a new Action Plan has been developed based on the CE which incorporates a series of priority areas directly related to Almería's intensive agriculture, such as the plastics, food waste, critical raw materials and biomass and biologically-based products [26]. On a national level, the Spanish CE Strategy, which defines the objectives of the sectors considered as strategic, has been recently approved. These include the agri-food sector, for which it establishes a reduction of 50% in the generation of food waste throughout the whole of the food chain per capita on a household and retail level and 20% in the production and supply chains from 2020 [27]. These plans and strategies are designed to contribute to the objective of Agenda 2030 for Sustainable Development [28].

There are different agricultural practices that can contribute to improving the circularity of agriculture. However, the design and adoption of a circular agricultural model requires a preliminary analysis in which the specific features of the area of study are defined in order to identify the aspects that can be improved with an assessment of the different alternatives in accordance with the preferences and interests of the interested parties. Therefore, the overall objective of this study is the identification of opportunities for adopting circular practices in the intensive agriculture of Almería. In order to fulfil this objective, a qualitative methodology has been used comprised of a literature review and the gathering of primary information obtained from different stakeholders through in-depth interviews and a workshop.

2. Methodology

The study has been carried out in two phases. The first phase has a triple objective—(i) to characterize the intensive agricultural model of Almería; (ii) to identify the principal limitations of the model and, (iii) to make a compilation of the possible solutions to these limitations based on the

application of the CE. In order to meet these objectives, first, a literature review has been carried out. Different sources were consulted including scientific articles, research projects on different levels (European, national, regional and local), reports elaborated by public institutions and research centers and websites of companies in the sector and specialized media. In order to complete, verify and update the information, different in-depth interviews were carried out with researchers specialized in different fields related to the topic of study (Agronomy, Environmental Science, Economics, Engineering). The interviews were conducted through telematic means. This phase took place during the months of April and May 2020.

During the second phase of the data compilation, a group of experts made up of researchers, farmers, company managers and directors and technical professionals in the sector were consulted. This consultation provided us with knowledge on an empirical and practical level. This second phase had a dual objective: (i) to identify the circular strategies that best adapt to Almería's intensive agriculture, (ii) to determine the current level of adoption of these strategies in order to establish the potential of the different proposals, distinguishing between not applied, under development, low level of implementation, in expansion or widely used. Given that one of the objectives of the methodology used was to reach consensus among the participants, this second phase had two rounds. The first contact was made through telematic means. In this first round, the project was presented to the participants, including the results of the previous phase and they were asked to provide a selection of the best proposals and their level of adoption. In the second round, the participants were invited to take part in a workshop. The objective of this meeting was to present the individual results in order to reach an agreement. This methodology has the advantage of generating a debate in which the participants from different professional backgrounds and disciplinary fields come together to consider different aspects [29,30]. In order to guarantee that the consensus is not directed by one of the parties, the meeting was appropriately moderated, following the indications of Campos-Climent and Chaves-Avila [31,32]. The second phase of compiling the data was carried out during the months of May and June 2020.

3. Results and Discussion

3.1. Agricultural Model of Almería: Characterisation, Limitations and Alternatives

3.1.1. Characterization of the Intensive Agriculture in Almería

In Almería's production model, the fruit and vegetable crops are grown by small family-run farms with an average size of 2.5 ha [33]. The average number of employees per farm is five workers, and in 35% of cases these workers are family members (the farmer, his or her spouse or children) [14]. The most common type of greenhouse is the "*raspa y amagado*" (75% of the total) where the roof of the greenhouse is divided into different sections with a slope, enabling rainwater to be evacuated and preventing the crops from getting wet [34]. The majority of the farmers are the owners of the farms (84%) [33]. Production is specialised in eight crops (peppers, tomatoes, courgettes, cucumbers, aubergines, green beans, watermelons and melons). The majority of the farmers are men (89%) with an average age of 44 and a basic level of education [33].

The production process in greenhouses begins with the preparation of the farm during the summer months after the previous crops have finished. On the one hand, the farmer prepares the soil by disinfecting it and adding organic material. The disinfection is carried out through the solarisation technique or a combination of this method with chemical disinfection. The solarisation of the soil is a hydro-thermal process in which a sheet of plastic ("*acolchado*") is used to naturally disinfect the pathogens of the crops through passive heating through solar radiation during the hottest part of the year [14]. On the other hand, the agricultural infrastructure is renewed and maintained. The greenhouse is made up of a plastic cover, laid over a wire support and metallic or wooden posts. On the soil, as well as a layer of sand, there is usually a plastic sheet called an "*acolchado*" which maintains the moisture of the soil as evaporation is reduced, improving the thermal conditions of the root area of

the plant [33]. It is also common to install an additional plastic cover in the form of a double ceiling in order to reduce and prevent the condensation water from falling on the crop. The elements that most commonly require maintenance are the plastic materials forming the roof and the permanent layer of plastic sheet covering the ground. In this respect, the roof plastic is easy to recycle. However, the plastics used for the “acolchado”, the double ceiling and disinfection, which are usually thin and become very dirty, are more difficult to treat.

The development and germination of the seeds of the plants is mostly carried out in seedbeds. This is because the structures the seedbeds are better adapted and can be heated to guarantee a homogeneous development of the plants. The seedlings remain in the seedbeds for between 20 and 50 days, depending on the crop. When the seedlings and the farm are ready, the seedlings are transported to the greenhouse to be planted. Then the growing phase in the greenhouse begins. This involves a series of tasks which enable the correct growth of the plants and the maturing of the fruits. These include the adding of consumables (water, fertilizers), disease and plague control, pruning and staking and climate control. With respect to the consumables, the correct irrigation is particularly relevant. This is carried out according to the needs of the crops and the climate conditions in the same way as the fertilizer. In order to combat plagues and diseases, the most common method is integrated control which consists in the joint use of different techniques such as phytosanitary treatments and biological control [14]. Biological control is a technique based on the use of live organisms that act as natural enemies to combat plagues. Pruning and staking are used to correct the growth of the plants. Parts of the plant are pruned, such as the leaves and stalks. The residues are stored in a container located on the farm. Staking consists in guiding the growth of the plant to facilitate the development and support of the fruits. To do this, materials such as raffia and staples or plastic clips are used. In order to control the climate conditions within the greenhouse, natural refrigeration techniques are mostly used. These include “whitewashing” which seeks to shade the ceiling of the greenhouse with a solution of water and calcium carbonate, reducing solar radiation. The opening of vents and windows enables the ventilation of the inside of the greenhouses. The humidification or nebulisation systems spray water at different pressures [34].

As the fruits start to mature, the harvesting phase begins. This is done several times a week, depending on the maturing process of the fruits, which will vary in accordance with the climate. Plastic reusable crates are used for collecting the fruit, which are provided to the farmers by the handling and packaging centres. It should be taken into account that the actions carried out in the different phases of the production process may vary depending on the characteristics of each type of crop and the planning undertaken by the farmer. When the harvesting period has finished, the plant residues are removed from the greenhouse. These residues can be re-used on the same farm or transported to an authorised management centre. In the cases where two crop cycles are carried out in the same season, after removing the plant residues, the new crop is planted immediately. Figure 1 shows a representation of the growing process in greenhouses.



Figure 1. Growing process in greenhouses.

Once the products have been grown and harvested they are taken to the wholesale companies’ handling and packaging centres. The first phase in these centres is called “handling”. There are basically two types of companies: traditional auction houses and farmers’ associations [34]. The traditional auction houses, with the legal status of public or private limited companies, are trading centres at the place of origin where buyers and sellers meet and where the price is established through descending-price auction, with the physical presence of the goods. The farmers’ associations usually take the form of cooperatives or agricultural transformation companies (SATs), and provide a wide

range of services to their members, such as the provision of supplies and technical assistance. This gives rise to the formation of close collaboration ties between the members, which enables crops to be planned and a better monitoring of agricultural production. In some cases, there are also independent commercial agents, who acquire part of the output from the traditional auction houses or the producers for its subsequent sale. Approximately 37% of farmers prefer cooperatives and 21% the SATs, while the public and private limited companies represent 36% and 4% respectively [33].

Usually, the farmers take the harvested fruit in their own vehicles to the handling and packaging centres. Upon arrival the produce is unloaded at the bays with electric forklift trucks. After unloading, the reception, identification and initial validation of the quality of the horticultural products is carried out. After the goods are received, accepted and weighed, they are identified with a packing slip with a traceable number which is assigned to them for the whole process. Then the produce is stored in refrigerated chambers before being taken to the handling lines. Generally, the FIFO (first in, first out) system is used, that is, the first product to enter is the first product to leave, so that the produce is handled in accordance with its date of entry. After the produce has been taken to the handling line the cleaning, sorting and classification activities are carried out. The unloading of the produce at the handling line is conducted manually or automatically using depalletisers. During this phase the produce is frequently knocked. Therefore precaution should be taken given that mechanical damage is one of the principal causes of product loss. The sorting is performed manually. The non-sellable sized pieces are discarded as are those that have defects and will not be accepted by the consumers. Next, the produce is cleaned with cloths, sprayed or immersed in a washer (depending on the product) and then dried using tunnels and/or brushes.

The next step is the sizing of these products, which have previously undergone complementary operations (removal of the flower, cutting of the stalk, etc.), which is done with electronic calibrating machines that separate the produce into homogeneous groups according to weight, size or colour. Then the produce is packaged, generally by hand although the automation of this task is becoming more frequent. The different types of packaging include loose packaging when the product is placed directly in the box or pre-packaging in tubs, flow-packs, nets, and so forth, which are then also grouped into boxes. These boxes are supplied to the packaging lines on conveyor belts (commonly known as “air conveyors” or “slides”). Once the product is packaged it is placed on finished product evacuation belts which take it to the palletising area, where each package is labelled. After the pallet is completed it is strapped and identified and then stored in the exit refrigerated chambers. This storage is carried out at the temperature indicated in the guidelines established in the company’s storage regulations which vary according to each specific product. The final operation is the loading of the pallets on refrigerated lorries that take the goods to the customers. It should be take into account that, depending on the product, type of packaging or even the characteristics of the handling facilities, some of the phases described are not carried out or are performed in a different order. Figure 2 shows a representation of the handling process of horticultural products. Figure 3 shows images of a greenhouse and a handling center.

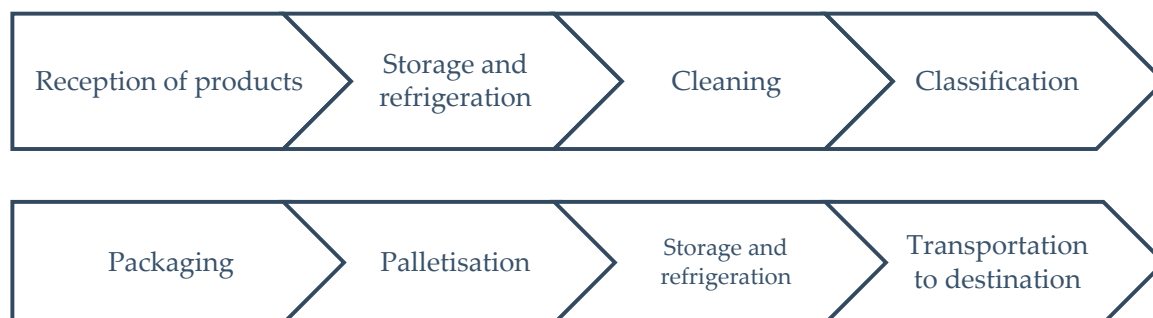


Figure 2. Handling process of horticultural products.

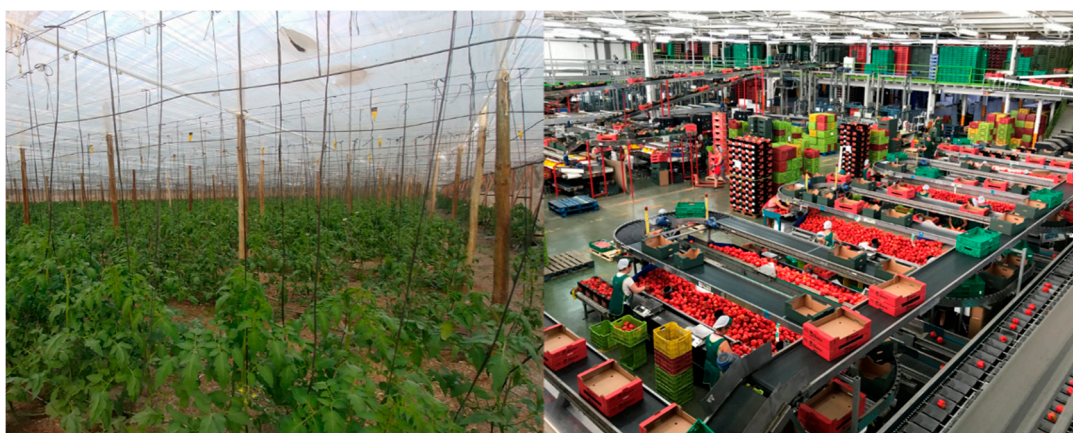


Figure 3. A greenhouse and the handling area of a distributing company.

3.1.2. Characterization of the Intensive Agriculture in Almería

1. Growing phase

A. Waste management

It is estimated that in Almería 90,738 tons of waste derived from horticultural production is generated each year, with a volume of 187,050 m³ [35]. With respect to the composition of this waste, approximately 94% is organic while 6% is plastic [36].

The plant debris is formed by stalks, leaves, discarded fruit and whole plants. It usually has a high moisture and mineral content and is, on the whole, easily biodegradable [37]. The main problem identified in relation to organic waste is the large volume that it occupies [38]. The poor management of this waste can generate environmental damage through leaching into the aquifers and the generation of plagues and diseases [37].

The principal inorganic residue generated by agriculture is plastic [36]. The plastics used for the roof and disinfection at the end of the crop cycle (solarization) are the largest in terms of weight, 42% and 23% respectively [35]. Other materials such as raffia, staples or clips used as fixing elements during the growing phase represent around 5%. Furthermore, there are also plastic containers of other consumables which are used during the campaign to carry out phytosanitary treatments or biological control, the irrigation systems (filter equipment, valves and irrigation emitters), and crates and other material used for harvesting the fruit. The main problem detected is related to the generation of a large amount of waste of different plastic materials which have different characteristics, and therefore require different management processes at the end of their useful life.

B. Water resources

One of the principal problems with Almería's production model is the scarcity of water resources, due to the low rainfall and over-exploitation of underground sources [39,40]. It is estimated that Almería has a water deficit of 191 Hm³ [41]. This, together with the salinization and pollution generated by the use of fertilizers and phytosanitary products, could put the survival of the sector in danger [42,43].

C. Use of energy

Finally, the climate variability inside the greenhouses has been identified as a limitation. This is because, on the whole, natural ventilation techniques are used which can negatively affect the crop yields [14]. Furthermore, the experts consider that, although the greenhouses in Almería enable high output levels to be obtained without a very high energy demand, there is also a high dependency on non-renewable energy sources.

2. Handling phase

A. Non-sellable products and surpluses

Horticultural companies report an overall loss in commercialization that fluctuates between 2% and 10% of the handled product. This is due to different factors such as the discarding or elimination of produce due to market share, external defects or insufficient size [44]. This practice has significant economic repercussions for the companies and gives rise to the generation of a large amount of residues and the wasting of food.

B. Packaging

The advantages of using plastic in the distribution of agricultural products are that it protects the produce and reduces waste [45]. This has led to its widespread use. In fact, around 40% of the world's plastic production is used for packaging [46,47]. The handling and wholesale companies in Almería use a large quantity of plastic containers when packaging the produce (film, flow-pack, tubs, crates, straps and pallet netting), the characteristics of which depend on the preferences of the clients (mainly supermarket chains). Therefore, this sector makes a significant contribution to the global problem related to the management of this waste.

C. Water resources

The fruit and vegetables usually undergo a washing process before they are packaged in order to eliminate dirt, remnants of plant tissue or treatments brought from the fields, which implies a high consumption of water. Given the importance of this resource and the scarcity problems encountered by Almería, it is necessary to find solutions that improve the efficiency of its use.

D. Use of energy

The handling centers consume a large amount of energy to carry out the whole production process, particularly the heating and cooling systems. The principal problems identified in relation to energy are the failure to take advantage of the energy generated in some of the processes and the dependence on non-renewable energies that have a greater environmental impact.

E. Refrigeration chambers

The refrigeration chambers are fundamental for the correct conservation of the fruit and vegetables, as the majority of the reactions and development of molds and bacteria are stopped or reduced by low temperatures. One of the main problems of the refrigeration chambers is their high consumption of energy and the use of harmful materials. These systems make a considerable contribution to the emission of greenhouse gases, having an impact on global warming and climate change [48].

F. Transport from the handling center to the destination

In the case of Almería, the transport of fruit and vegetables to the destination is almost exclusively conducted by road. This mode of transport has advantages such as being the cheapest option, it enables good temperature control and traceability and it is very flexible; but it also generates major impacts such as air pollution. A study carried out by Reference [49] concludes that between 58 and 130 tons of CO₂ are emitted in the storage and transport of 1000 tons of produce by road from Almería to the principal European markets. Furthermore, the increase in transport costs and future scenarios with greater restrictions (green taxes, limitations to the transit of lorries) are obliging the sector to look for alternatives to their current dependence on road transport [50].

3.1.3. Best Environmental Management Practices

The literature review has given rise to a compilation of the best environmental management practices recommended by the European Union for the agricultural sector and the food and drinks production sector. These recommendations have the objective of improving the sustainability of these

sectors, incorporating responsible environmental practices [51,52]. The practices that can be applied to our case study are included in Tables 1 and 2. These practices were taken as a starting point on which the proposal of solutions was constructed, based on the application of the CE for the intensive agriculture of Almería.

Table 1. Best environmental management practices in greenhouse agriculture.

Scope	Measures
Waste	Composting of residual biomass
	Sending of biomass to an adjacent anaerobic digestion plant
	The replacement of conventional plastic elements with bioplastic alternatives
	The separation and appropriate storage of waste and packaging of phytosanitary products so as to avoid possible leachings and indirect contact with the soil, plants and water
	The sending of all the materials that are contaminated to authorised companies specialised in their treatment
Water resources	The transfer of all non-contaminating plastics to recycling plants
	Correctly determining the water needs of the crops
	Incorporating irrigation programming systems that contemplate the water demands of the crops and the availability of water in the root area
Energy efficiency	Using irrigation practices that maximise the efficiency indices in the consumption of water such as micro-irrigation or closed circuit systems
	Using energy from renewable sources
	Applying a dynamic control of the climate parameters in the inside of the greenhouse taking into account the external climate conditions
	Choosing the right lining materials to improve the covering of the greenhouse
	Taking into account the orientation and position of the windows in new facilities and of the existing ones in the case of replacement
	Incorporating cooling measures in the greenhouses located in dry and warm climates (whitewashing to reduce solar radiation, installing evaporation techniques such as evaporation screens or nebulisation)
	Using natural ventilation
Installing geothermal heating systems for greenhouses located in cold climates where necessary	
	Using appropriate illumination equipment, taking into account the local climate conditions and the influence of this equipment on the inside temperature

Source: Adapted from Commission Decision (EU) 2018/813 of 14 May 2018 [51].

Table 2. Best environmental management practices in the food and drinks production sector.

Scope	Measures
Food waste	Undertaking total production maintenance
	Applying the Kaizen method
	Elaborating a Value Stream Map
Packaging	Ecological design to simulate the environmental behaviour of the packaging during the design
	Researching options to reduce the weight of the packaging without losing its protective characteristics
	Opting for more loose produce packaging
	Using reusable and returnable packages
	Producing packages using recycled or bioplastic materials

Table 2. Cont.

Scope	Measures
Energy efficiency	Implementing an integrated energy management system (for example, ISO regulation 50001)
	Incorporating metres in each of the processes in order to guarantee a precise control of the energy used
	Carrying out periodic audits and energy monitoring to identify the principal sources of energy consumption
	Introducing appropriate energy efficiency solutions in the different processes considering the possible synergies in the demand for heat, refrigeration and steam
	Studying and, if feasible, exploiting synergies for the production and use of electricity, heat, refrigeration and steam with neighbouring facilities (industrial symbiosis)
Refrigeration chambers	Selecting the appropriate temperatures in accordance with the product needs
	Previously cooling the hot/warm products before placing them in the cooling facilities
	Reducing the volume of products or ingredients in cool storage
	Preventing thermal leaks by sealing doors
	Systematically compiling data on the heat load, energy consumption and leak rates and implementing a periodic maintenance and inspection plan
	Replacing the hydrofluorocarbons (HFCs) with refrigerants with a lower global warming potential (natural refrigerants)
	Agreeing with the supplier of the equipment a guarantee of an absence of leaks for several years
Recovering and reusing the residual heat generated by the refrigeration unit or other processes that produce residual heat	
Transport from the wholesale company to the destination	Selecting equipment, control systems and a factory design that enable a minimum energy consumption and prevent thermal losses and leaks, in the cases where new facilities are constructed
	Green procurement and the establishment of environmental requirements for transport companies
	Monitoring the efficiency and information related to all of the transport and logistics activities
	Considering the efficiency of the transport in the decision on the origin of the products and the design of the packaging
	Opting for more efficient modes of transport (rail, sea)
	Optimising the storage and transport routes
	Minimising the environmental impact of the road transport vehicles through decisions on the supply and retrofitting of the equipment (conversion of engines to natural gas or biogas in the case of the large lorries)

Source: Adapted from Commission Decision (EU) 2017/1508 of 28 August 2017 [52].

3.2. Identification of Opportunities for Applying the Circular Economy

3.2.1. Growing Phase

A. Organic waste management

According to the participants in the workshop, the circular alternatives for organic waste management include its use as a raw material in other production processes. Currently, the majority of farmers send their plant waste to an authorised management company where it is turned into compost. In the province of Almería, there are different plants that undertake this activity (Ejido Medio Ambiente, S.A.; Albaida Residuos, S.L.; Transportes y Contenedores Antonio Morales, S.A.;

and Servicios Ambientales Las Chozas, S.L.). Furthermore, other companies make compost by mixing plant waste with other materials, such as worm humus (Tecomsa S.L. Reciclados Almerienses 2005, S.L.; Ecotech Valoriza, S.L.). This is known as vermicompost, and enables the product to be obtained more quickly and with a higher quality than conventional compost.

On the other hand, in Almería, projects have been developed related to the transformation of plant waste into compost and other products. The bioREFINA project was completed in 2018. Its objective was the development of biorefinery processes based on agricultural and livestock residual biomass in order to obtain self-consumption bioproducts (which are products derived from renewable biological resources) in horticultural crops. As a result, high quality compost was obtained from the plant waste, using the leachings of the compost to cultivate microalgae, the biomass of which produced fertilizer to apply to other crops [53]. The Task Force AGRIREFIN is developing an agricultural biorefinery project for the use of plant debris in the production of compost, bioethanol and other bioproducts, which will culminate in the construction of an industrial scale plant in Almería [54]. Another solution proposed was the generation of bioenergy using plant waste. This alternative is currently in the development phase, being carried out by the company ENCE. This company is undertaking a project for the construction of a plant to transform the biomass generated by the greenhouses of Almería into electrical energy. The planned capacity of the plant is 31.5 MW. It will produce 250 million kWh/year using 650,000 tonnes of biomass per year [55].

However, several factors have been identified that hinder the management of plant waste in the processing plants [37]. The principal limitation is the seasonality in the supply of organic waste, which is concentrated in the months of May and June when the spring crops have finished and in the month of February when the autumn-winter crops have finished. In this respect, the companies responsible for its management do not have the capacity for such large quantities of waste due to the high volume that it occupies and the limited available space. Furthermore, there may also be difficulties involved in transporting the waste from the greenhouses to the treatment plants. Another of the main disadvantages is the plastic, usually non-biodegradable polypropylene raffia, used to stake the crops, as it hinders the management process and increases the cost.

Another possibility is the use of this waste for animal feed. The delivery of plant waste directly to livestock farmers is not a common practice because in the area of the greenhouses, livestock farming is not a very relevant activity and there is no livestock sector close by that demands this waste. One alternative, which is currently not implemented, could be the manufacture of animal feed for livestock using this plant waste.

Finally, waste management on the farm itself constitutes another option of circular management which could close the cycle of organic material by reincorporating nutrients into the soil. To do this, the farmer could use green manure or self-composting. The former consists in the grinding of the plant waste and its incorporation into the soil. The latter consists in the elaboration of compost on the farm itself [56]. According to the experts, there are different factors that explain why waste management on the farms is not a common practice. These include the high cost of separating the plastic elements from the organic waste or the lack of space on the farm. Table 3 shows the main solutions based on the CE for plant waste.

Table 3. Main solutions based on the Circular Economy (CE) for plant waste.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study
Large volume Pollution Plagues and diseases	Transformation into other products	Recycling by authorised management companies	Widely used
		BioREFINA AGRIREFIN	Under development
	Generation of bioenergy	AGRIREFIN ENCE	Under development
		Animal feed	Delivered directly to livestock farmers
	Production of animal feed		Not applied
	Re-use on the farm	Green manure Self-composting	Low level of implementation

B. Inorganic waste management

Following the CE approach, one of the principal solutions for inorganic waste management would be the re-use of the materials for the same use or as an input in another production process, lengthening the time that these resources are used in the economic cycle. In Almería, at the end of their useful life, the plastics are usually sent to a company specialised in the management of this kind of waste. These companies recycle them for their subsequent use as raw materials in the elaboration of other products, both in the agricultural activity and in other sectors [35]. However, in many cases these companies reject the plastics used for the “*acolchado*”, double ceiling and disinfection as their management is very costly and reduces their profitability. In the case of phytosanitary packaging, in Spain the SIGFITO initiative has been implemented, thanks to which collection points were set up where farmers can take their empty agricultural containers [57]. These containers are treated so that they can be re-used and recycled.

A series of projects is being developed for the recovery of plastic waste. The European project REINWASTE seeks to promote a more sustainable agri-food system through the introduction of innovative waste management models (such as containers, packaging, plastics, sacks, bottles, etc.) [58]. Almería’s sector participates in this project in which the recycling and use of new biological materials is promoted. On the other hand, work has recently begun on the RECOVER project, managed by the University of Almeria. This project will study the use of micro-organisms, new enzymes, worms and insects in the elimination of plastics, and their transformation into new products for agricultural use and food containers [59]. Another project is AP-WASTE, subsidised by the Spanish Ministry of Agriculture, Fishing and Food. Its objective is to show the potential of exploiting and recovering the plastics used in agriculture (principally low and very low density polyethylenes) [60]. To do this, a biodegradation process is used through insects and micro-organisms, obtaining compounds for different biotechnological uses such as biofertilizers.

Another alternative proposed during the workshop was the generation of fuel based on plastic waste. In this respect, the company Plastic Energy has been operating a plant located in Almería since 2017. In this plant, 8000 tonnes of plastic waste are transformed each year into six million litres of fuel [61]. Furthermore, the Almería-based company Hintes Oil Europa sells an alternative biofuel to Diesel C, which is obtained through the pyrolysis of the greenhouse plastics that cannot be recycled [62]. Currently, this fuel is used in hotels, bakeries and livestock farms for their boilers and ovens.

The replacement of conventional plastics with alternative compostable or biodegradable ones could constitute a turning point in the generation of waste. The main efforts in this respect are aimed at finding feasible alternatives to replace the current raffias and “*acolchados*” as they are difficult to

manage. However, the participants in the workshop indicated that, although it is now possible to find alternatives on the market, they do not fulfil their function correctly and/or are too expensive. Therefore, the REINWASTE project is conducting a series of pilot tests in Almería to test new biodegradable and compostable materials that could substitute these plastics [58]. Moreover, the European project BIOMULCH has already obtained its first results from developing an agricultural “acolchado” that degrades in less than three months [63].

Another option to increase the circularity of the model is the extension of the useful life of the plastics, particularly those of the greenhouse roofs, which are usually renewed approximately every three years due to the deterioration caused by solar radiation and the incidence of certain substances such as chlorine or sulphur [35]. The farmers make the decision regarding the roof option that they consider appropriate according to the alternatives available on the market and the specific conditions of the area in which their farm is located (incidence of wind or solar radiation) and their cost structure. However, no initiatives related to the development of more durable products have been found. With respect to other plastic materials such as the crates for harvesting, widely-used re-use systems are in place. Table 4 shows the main solutions based on the CE for plastic waste.

Table 4. Main solutions based on the CE for plastic waste.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study	
High volume Pollution	Transformation into other products	Recycling through a management company	Widely used	
		REINWASTE	Under development	
		RECOVER		
	Generation of fuel	AP WASTE	Widely used	
		SIGFITO		
	Use of more efficient materials	Extension of useful life	Plastic Energy	Widely used
			Hintes Oil Europa	
		Reuse	REINWASTE	Under development
BIOMULCH				
		Return systems	Widely used	

C. Water resources

With respect to the management of water resources, the greenhouses in Almería have been incorporating technological improvements in order to guarantee the efficiency of water use, which have converted it into a benchmark on a global level [64]. These improvements include the automation of irrigation, which has enabled farmers to gain greater control over the quantity and frequency of the water applied to the crops. Localised irrigation systems consist in the slow and regular application of water at a low pressure, directly in the root area of the crops, through a network of valves, tubes and emitters. The automated ferti-irrigation systems enable an efficient supply of fertilizers through irrigation. The use of tensiometers enables the level of humidity in the root area to be known and automatic irrigation is applied according to these measurements. With the introduction of these technologies and the high productivity of Almería’s greenhouses, the use of water is six times lower than in the rest of Spanish agriculture and its water footprint per capita is 20 times lower than the national average [65]. The results of the workshop enabled us to determine that all of these technologies are widely used in the intensive farming in Almería, but that it is still necessary to continue working on possible advances. In this respect, there is the project iGUESS-MED. Its objective is to develop a decision support system that enables the efficient management of ferti-irrigation and the prevention of

diseases and plagues in the tomato crops of the Mediterranean region [66]. Moreover, the Regional Task Force “Efficient use of water in greenhouse horticultural crops” [67] has carried out a study of the different irrigation strategies to minimise the cost of water in crops, using low-cost sensors.

Another alternative proposed during the workshop to increase the circularity of the water resources was the use of treated water. Currently, 80% of the water resources of Almería are drawn from underground sources, while the remaining 20% come from other sources including reused water plants [41]. According to the experts, the regulatory restrictions, the lack of water treatment infrastructure and the prejudices within the sector and markets act as limiting factors to its more widespread use. The recent approval of the new European Regulation regarding the minimum requirements for water reuse, which contemplates that the reuse of water for agricultural irrigation can contribute to promoting the CE as it recovers nutrients from regenerated water and its subsequent application to the crops through ferti-irrigation, could boost the use of this water source [68]. In this respect, the project REUSAGUA, which is being carried out in the neighbouring region of Murcia, could constitute a stimulus. This project seeks to contribute to the development of the knowledge and management practices necessary for the use of regenerated waters in agricultural production efficiently and safely [69]. A further project being developed is LIFE-ENRICH which is being carried out in different parts of Spain and seeks to efficiently recover the nitrogen and phosphorous contained in waste water for their subsequent use as fertilizers for crops [70]. Table 5 shows the main solutions based on the CE for water resources.

Table 5. Main solutions based on the CE for water resources.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study	
Water scarcity Water pollution	Improvement in the efficiency of irrigation	Automatic irrigation	Widely used	
		Localised irrigation		
		Use of tensiometers		
		Recirculation systems		
	Use of treated water		Efficient use of water in greenhouse horticultural crops	Under development
			iGUESS-MED	
		REUSAGUA	In expansion	
		LIFE-ENRICH		

D. Use of energy

In order to improve the use of energy in farming the climate control systems within the greenhouse need to be improved. Therefore, work is being done on the implementation and improvement of the passive heating and cooling systems. The Andalusian Institute of Research and Training in Agriculture, Fishing, Food and Ecological Production (IFAPA) is developing a project in this field that analyses the integration of the different greenhouse sustainable technologies in the Mediterranean area, reducing the climate stress on horticultural production [71]. First, it is studying the possibility of installing flexible polythene sleeves filled with water in the greenhouses that accumulate heat during the day which is emitted at night. Second, it will test a passive refrigeration system comprising textile screens made of hydrophilic material installed parallel to the crop lines, enabling the evaporation of water and increasing humidity and reducing the temperature. Finally, this is complemented with mobile shade netting which is activated in accordance with the temperature and solar radiation.

The participants in the workshop consider that, although the greenhouses in Almería enable high output levels to be obtained without a very high energy demand, there is also a high dependency on non-renewable energy sources. In this respect, it is particularly relevant to take solar energy

into account, as Almería has more than 3000 h of sun per year. A research project conducted by the University of Almería revealed that the installation of photovoltaic panels on the surface of the greenhouses could reduce the solar radiation inside them, and this is feasible from a technical and economic point of view [72]. According to this study, installing the panels on just 10% of the greenhouse surface area in south-east Spain, a production of 8507 GWh/year could be obtained. This exceeds the needs of the agricultural farms. On the other hand, Almería has mild winters. Therefore, it is not essential to implement heating systems, and such systems are installed in only 4% of the total surface area of the greenhouses [33]. However, having a clean energy source could promote the use of these systems and also artificial refrigeration alternatives, enabling a greater control of the climate conditions inside the greenhouse. Accordingly, the company Cardial Recursos Alternativos has implemented a project that seeks to supply geothermal energy for controlling the climate inside Almería's greenhouses. This would enable them to be as efficient as watertight glass greenhouses but with a much lower energy consumption and without the emission of CO₂ into the atmosphere [73]. Table 6 shows the main solutions based on the CE for energy.

Table 6. Main solutions based on the CE for energy.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study
Low level of control of climate conditions in the greenhouse Dependence on non-renewable energy	Energy efficiency	Renewable energy sources	Under development
		Whitewashing	Widely used
		Natural ventilation	
		Nebulisation	Under development
		New systems	Under development

3.2.2. Phase of Handling

A. Non-sellable products and surpluses

A widely used measure in Almería's intensive agricultural sector to prevent the generation of surpluses is the planning of a planting calendar among the farmers. Technical consultancy is also carried out, beginning with the recommendation of the varieties to plant, which is maintained throughout the campaign in order to guarantee the quality of the output. These actions help to ensure a continuous supply of good quality products and to reduce surpluses. Furthermore, a clear improvement is obtained in terms of both the margins and income of the farmers and wholesale companies [74]. However, the implementation of these measures is currently limited.

In the case of the circular solutions, the participants in the workshop proposed the transformation of non-sellable products and surpluses into sub-products that would serve as raw materials in other processes. The BIOVEGE project, led by an Almería-based company, has given rise to the development of a shrink film and biodegradable netting produced with discarded material and the residues of the horticultural harvest [75]. The NATURPICK project, also developed in Almería, has the objective of enriching foods through bioactive substances obtained from non-sellable products from the horticultural industry, generating products in different formats such as energy bars [76].

The use of these residues for animal feed was another of the options proposed. Recently, a plant has begun to operate in Almería engaged in the transformation of discarded produce and horticultural surpluses from the food processing and packaging companies into sheep fodder (Frutilados del Poniente) [77]. Another alternative is the use of these surpluses by food companies such as canning firms or frozen food companies. Finally, the possibility of generating bioenergy based on these residues was considered. No projects have been found that consider the specific use of the surpluses of the wholesale companies. However, they could be managed in the same way as the organic waste from the greenhouses. Table 7 shows the main solutions based on the CE for non-sellable products and surpluses.

Table 7. Main solutions based on the CE for non-sellable products and surpluses.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study
Economic losses Food waste Generation and management of waste	Planning and consultancy	Planting calendar	Widely used
		Selection of varieties	
		Technical consulting	
	Transformation into other products	Naturdev	Under development
		BIOVEGE	Low level of implementation
		NATURPICK	Under development
		Animal feed	Frutilados del Poniente
Sold as raw material	Canning firms/frozen food companies	Widely used	
Generation of bioenergy		Not applied	

B. Packaging

In 2018, the European Commission adopted the European Strategy for Plastics in a Circular Economy in order to address the problems incurred by the production, use and consumption of plastic. In particular, this strategy establishes that all of the plastic containers in the EU must be recyclable by the year 2030, with a reduction of single-use plastics and restrictions on the use of microplastics [78]. The use of biodegradable and compostable plastics is one of the most developed and promising alternatives to replace conventional plastic [79,80]. The European project YPACK has developed a compostable container, made with industrial sub-products (cheese whey and almond shell microcells) which degrade in a period of 90 days [81]. Therefore, there are already biodegradable alternatives on the market such as the compostable and renewable packaging film marketed by the company Futamura [82]. Currently, the horticultural companies in Almería are undertaking projects in this field. However, these containers are not widely used in the sector due to their high cost. Therefore, other solutions have been proposed. On the one hand, there has been an increase in loose packaging formats. On the other hand, individual product packaging is being replaced with a plastic sheet or bag that acts as protection in loose packaging formats.

Another factor to take into account in terms of packaging are the boxes in which the containers are transported from the handling centre to the clients. There are two main options: single-use cardboard boxes made with renewable and recyclable material; or reusable plastic crates, managed by pooling companies responsible for their cleaning, inverse logistics and recycling. Factors such as the type of product to be packaged, the destination of the goods, the format and rotations mean that one of the options can be more sustainable than the other in each specific case. Therefore, it should be the company itself that analyses the life cycle and carbon footprint in order to select the right option [83,84]. Finally, another solution is the recycling of the plastic containers and packaging for the generation of sub-products. The REINWASTE [58] and RECOVER [59] projects are working on the generation of new products made from plastic food containers. In this respect, the role of the final consumers is fundamental in order to promote the implementation of sustainable measures, but this is not yet a priority for them [85]. Table 8 shows the main solutions based on the CE for packaging.

Table 8. Main solutions based on the CE for packaging.

Problems	Theoretical Solution	Practical Solution	Level of Implementation in the Area of Study
High consumption of plastic materials Pollution	Use of biodegradable containers	YPACK Futamura	Low level of implementation
	Replacement with loose produce packaging or other formats that use less materials		Low level of implementation
	Reuse	Returnable container system	Widely used
	Transformation into other products	REINWASTE RECOVER	Under development

C. Water resources

The proposal made to improve the circularity of this resource was the incorporation of water recycling and recirculation systems. This practice is becoming more widespread due to the development of technologies that can be integrated with the already existing washing systems in the handling centres. For example, the company Vam Watertech offers this service, which can save as much as 95% of the water used in the cleaning of the products [86]. Also noteworthy is the technology developed by agroTITANIUM which, through advanced oxidative photocatalysis has reduced the frequency with which the renewal of water for cleaning is performed, bringing consumption down by 60% [87]. Table 9 shows the main solutions based on the CE for water resources.

Table 9. Main solutions based on the CE for water resources.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study
Water scarcity Water pollution	Water recycling and recirculation	Vam Watertech agroTITANIUM	In expansion

D. Use of energy

Among the CE-based solutions proposed during the workshop to improve the use of energy, we found the recovery of heat in those processes where it was possible, for example, of the combustion gases in the air compressors. However, this practice is not common as the facilities are not designed for it and its incorporation would incur a large economic cost. Opting for the use of more efficient and renewable energies is another solution. In the case of the more efficient energies, an example is the Alhóndiga La Unión, which has installed a cogeneration plant in order to produce electricity using natural gas [75]. Furthermore, the residual heat generated in the production of this electricity is processed through an interchanger that enables cold to be obtained for the refrigeration chambers. On the other hand, the installation of solar panels on the roofs of the handling centres could cover a large part of the energy needs. However, both practices are not widespread due to the high cost of installing them.

Within the framework of the European project TeSLA, studies were carried out to improve energy efficiency in different agri-food environments [88]. The results of this project include a manual on Energy Efficiency in Horticultural Centres. The proposed measures include the installation of frequency ventilators and inverter technology to improve food storage, the use of thermal flows obtained for heating the water for cleaning, the renewal of machinery with more efficient equipment, the production of heat with local biomass and the recovery of heat from the exhaust gases and the correct design of the power of the high-efficiency electric motors [89]. Table 10 shows the main solutions based on the CE for energy.

Table 10. Main solutions based on the CE for energy.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study
Loss of energy in the processes Non-renewable energies	Recovery of heat in the processes where it is possible	TeSLA	Low level of implementation
	Use of more efficient energies	TeSLA Cogeneration plant	Low level of implementation
	Clean energies	Photovoltaic panels	Low level of implementation

E. Refrigeration chambers

The proposals made in the workshop to improve the management of the refrigeration chambers included, first, the need to correctly regulate the temperatures according to the needs of the products, both to improve the energy efficiency and to avoid cold damage to the products [90]. It is also important to avoid possible leaks. Therefore, the installation of automatic doors and air curtains in the handling and packaging centres has become common practice. On the other hand, the reuse of residual heat generated by the refrigeration unit also contributes to improving energy efficiency and increasing circularity. However, currently these systems are not widely used as they are usually installed when it is necessary to renew the facilities due to deficiencies in their functioning. With respect to their high energy consumption, the installation of photovoltaic panels would allow the energy demand of these systems to be covered in a cleaner way.

Another measure proposed was the replacement of the harmful materials used to run these systems, specifically hydrofluorocarbons, with natural refrigerants. This practice is expanding due to the approval of the EU Regulation in 2014 whereby periods of prohibition were established in relation to the hydrofluorocarbons according to their calorific value that affects these installations [91]. Table 11 shows the main solutions based on the CE for refrigeration chambers.

Table 11. Main solutions based on the CE for refrigeration chambers.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study
High energy consumption Use of harmful materials	Energy efficiency	Temperature regulation	Widely used
		Preventing leaks	
	Use of renewable energy sources	Reusing residual heat generated by the refrigeration unit	Low level of implementation
		Photovoltaic panels	Low level of implementation
	Replacement of harmful materials with non-harmful ones	Replacement of hydrofluorocarbons (HFCs) with natural refrigerants	In expansion

F. Transport from the handling centre to the destination

The solutions proposed include the use of more efficient transport alternatives. Pérez-Mesa et al. [50,92] analyse the benefits of using short-distance maritime transport within an intermodal transport framework for horticultural products from Almería to European destination markets. Furthermore, they provide a quantitative analysis of strategic decisions to promote the search for alternatives. Along these lines, the Fresh Fruit and Vegetables Logistics project has been implemented. It seeks to promote an intermodal transport service for the distribution of fruit and vegetables originating in south-east Spain throughout Europe. Specifically, this project consists in replacing the route currently used by road with a lorry-ship combination which would reduce the

carbon footprint [93]. However, according to the experts, the principal limitations to implementing this project are the increase in the transport time and cost with respect to the current transport option of only road. In terms of rail transport, there is insufficient infrastructure. The rail connection of Almería, known as the “Mediterranean Corridor” is in the planning phase. It is a high-speed railway line that rapidly connects the economies of the Spanish Mediterranean with the rest of Europe [94]. The implementation of this corridor would benefit Almería’s intensive agricultural sector as the transport costs and carbon footprint would be reduced.

Another option considered was the development of logistics planning systems that avoid lorries returning to their destination empty. To do this, synergies between companies of the sector or even of other sectors can be developed. However, in many cases, the supermarket chains organise the transport to their facilities, contributing to the improvement of efficiency in transport. Table 12 shows the main solutions based on the CE for transport from the handling center to the destination.

Table 12. Principal solutions based on the CE for transport from the handling center to the destination.

Problems	Theoretical Solution	Practical Experience	Level of Implementation in the Area of Study
Pollution Dependence on one mode of transport	More efficient alternatives	Fresh Fruit And Vegetables Logistics	Low level of implementation
		Mediterranean Corridor	Not applied
	Logistics planning	Synergies between companies	Low level of implementation

4. Discussion and Conclusions

Intensive food production systems constitute one of the principal alternatives to ensure the supply of food in the coming decades. These systems have already proved their efficiency but are not exempt from limitations. Almería’s intensive agriculture is a paradigm of this type of system, but, it is also a testing ground where know-how is developed and exported to other regions of the world. This study has carried out an analysis of the current status of Almería’s intensive agriculture to identify its limitations and the alternative able to contribute to its sustainability. The results of this study show that different solutions exist based on the CE approach in each of the production phases, both on a greenhouse level and also in the case of the handling and packaging centres.

In the case of the greenhouses, measures have been implemented that enabled farmers to correctly manage both organic and inorganic agricultural waste. However, it has been found that there is a wide variety of opportunities that are still in the development stage or have a low level of implementation, including the use of more efficient materials. For example, the development of biodegradable and compostable alternatives for the fixing elements used in the growing phase would not only reduce the amount of plastic waste generated but would also facilitate the management of the plant waste. This strategy is a doubly beneficial alternative because it allows the substitution of mineral fertilizers with organic fertilizers. A relevant issue related to the waste generated in the greenhouse is that its management is carried out exclusively by the farmer. It is important to reflect on this, as carrying out a correct waste management involves a cost for the farmer, in terms of money and time, even though it is a practice that benefits the whole of the sector and society in general. With respect to water resources, the opportunities to increase the circularity in this field are based on promoting the use of reused water. In terms of the use of energy, there is a great opportunity to increase the energy efficiency of farms through the use of solar energy.

With respect to the handling centres, a high disparity has been observed in terms of the application of the circular alternatives in the different processes analysed. Food waste is a serious problem for society as not only is food lost but also all of the resources that have been used to produce it have also been wasted. In the case of Almería, although a production plan is elaborated in an attempt to prevent product surpluses, large quantities of waste are generated throughout the campaign. There are

alternatives such as the manufacture of preserves or animal feed. The main problem found in relation to packaging is the high consumption of plastics. The capacity to improve in this field is limited as, on the one hand, the clients demand a specific type of packaging and, on the other hand, the recycling of these products is the responsibility of the consumers who are the final link in the chain. One of the most promising options in this sense is the use of biodegradable containers but this practice is not common, mainly due to the high cost. The need to subject the fruit to a cleaning process involves a high consumption of water, which can be reduced by implementing water recirculation systems, a practice that is currently being expanded. Energy efficiency constitutes one of the areas with the greatest room for improvement, as these centres consume a large amount of energy which is currently drawn from non-renewable sources. In this respect, the installation of photovoltaic panels on the roofs of the handling centres could cover the majority of their energy needs. On the other hand, the recovery and reuse of heat in those processes in which it is possible can also help to reduce energy consumption, while preventing the loss of a valuable resource. In the case of the refrigeration chambers, the most urgent aspect to take into account is the replacement of the current harmful refrigerants with natural ones, in accordance with the European regulations in force. Finally, the transportation of the produce to the destination is primarily conducted by road which generates a high carbon footprint. There is considerable room for improvement in this aspect as, although projects are being carried out to expand the supply of modes of transport, to date, very little progress has been made.

Among the principal barriers found to the implementation of circular actions, the economic limitations are particularly salient. Both the development and use of sustainable materials imply large investments and cost increases which have to be assumed by the sector. On the other hand, the improvement of any current process also implies a large investment. Therefore, both the farmers and the handling centres usually prioritise those investments that can facilitate the production process and improve its efficiency, putting off those that do not generate an immediate benefit. Another of the principal obstacles is the constant need to undertake research related to the new technology and processes, giving rise to the development of continuous improvement programmes, the elaboration of action plans with the regulations and incentives in order to implement them. Furthermore, there is a lack of connection between the different links in the chain. This hinders the transmission of information, slowing down the process of incorporating innovative and sustainable technologies. Therefore, it is necessary for the public bodies to develop specific strategic plans related to the CE and promote cooperation between technology and innovation developers and the users and to design financing and incentive plans that facilitate the implementation of these actions.

Finally, the concept of “Circular Bioeconomy” is being recently developed. This term is coined to reflect the meeting point between Bioeconomy and Circular Economy. Both concepts complement each other in terms of common objectives and goals, but they have their own entity, principles and differentiated strategies. Carus and Dammer [95] indicate that the enormous volumes of organic side and waste streams from agriculture and organic process waste can only be integrated into the CE through Bioeconomy processes, whereas the Bioeconomy will benefit greatly from the adoption of circular processes. We believe that the intensive agriculture sector in Almería is the ideal breeding ground where the development of a “Circular Bioeconomy” can be an effective strategy to achieve the sustainability of the model.

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References

- Fróna, D.; Szenderák, J.; Harangi-Rákos, M. The Challenge of Feeding the World. *Sustainability* **2019**, *11*, 5816. [CrossRef]
- Oberle, B.; Bringezu, S.; Hatfield-Dodds, S.; Hellweg, S.; Schandl, H.; Clement, J. *Global Resources Outlook 2019: Natural Resources for the Future We Want*; International Resource Panel, United Nations Environment Programme: New York, NY, USA, 2019.
- Ceratti, M. *Dos Planetas Más Para Poder Vivir En Este*; World Bank: Washington, DC, USA, 2016. Available online: <https://www.bancomundial.org/es/news/feature/2016/08/09/objetivo-desarrollo-sostenible-ods-12-consumo> (accessed on 14 April 2020).
- Aznar-Sánchez, J.A.; Velasco-Muñoz, J.F.; Belmonte-Ureña, L.J.; Manzano-Agugliaro, F. The worldwide research trends on water ecosystem services. *Ecol. Indic.* **2019**, *99*, 310–323. [CrossRef]
- Aznar-Sánchez, J.A.; Piquer-Rodríguez, M.; Velasco-Muñoz, J.F.; Manzano-Agugliaro, F. Worldwide research trends on sustainable land use in agriculture. *Land Use Policy* **2019**, *67*, 104069. [CrossRef]
- De Corato, U. Agricultural waste recycling in horticultural intensive farming systems by on-farm composting and compost-based tea application improves soil quality and plant health: A review under the perspective of a circular economy. *Sci. Total Environ.* **2020**, *738*, 139840. [CrossRef] [PubMed]
- Velasco-Muñoz, J.F.; Aznar-Sánchez, J.A.; Batlles-de-laFuente, A.; Fidelibus, M.D. Rainwater Harvesting for Agricultural Irrigation: An Analysis of Global Research. *Water* **2019**, *11*, 1320. [CrossRef]
- Circle Economy. The Circularity Gap Report. 2019. Available online: https://bfc732f7-80e9-4ba1-b429-7f76cf51627b.filesusr.com/ugd/ad6e59_ba1e4d16c64f44fa94fbd8708eae8e34.pdf (accessed on 14 April 2020).
- Aznar-Sánchez, J.A.; Velasco-Muñoz, J.F.; López-Felices, B.; Román-Sánchez, I.M. An Analysis of Global Research Trends on Greenhouse Technology: Towards a Sustainable Agriculture. *Int. J. Environ. Res. Public Health* **2020**, *17*, 664. [CrossRef]
- Aznar-Sánchez, J.A.; Galdeano-Gómez, E.; Pérez-Mesa, J.C. Intensive horticulture in Almería (Spain): A counterpoint to current European Rural Policy strategies. *J. Agrar. Chang.* **2011**, *11*, 241–261. [CrossRef]
- Conserjería de Agricultura, Ganadería, Pesca y Desarrollo Sostenible de la Junta de Andalucía. Cartografía de Invernaderos en Almería, Granada y Málaga. 2019. Available online: https://www.juntadeandalucia.es/export/drupaljda/producto_estadistica/19/06/Cartografia%20inv_AL_GR_MA_190926.pdf (accessed on 14 April 2020).
- Cajamar. Análisis de la Campaña Hortofrutícola de Almería. Campaña 2018/2019. Cajamar. 2019. Available online: <https://www.publicacionescajamar.es/series-tematicas/informes-coyuntura-analisis-de-campana-analisis-de-la-campana-hortofruticola-de-almeria-campana-2018-2019> (accessed on 14 April 2020).
- Egea, F.J.; Torrente, R.G.; Aquilar, A. An efficient agro-industrial complex in Almeria (Spain): Towards an integrated and sustainable bioeconomy model. *New Biotechnol.* **2018**, *40*, 103–112. [CrossRef]
- Valera, D.L.; Belmonte, L.J.; Molina, F.D.; López, A. *Greenhouse Agriculture in Almería: A Comprehensive Techno-Economic Analysis*; Cajamar Caja Rural: Almería, Spain, 2016.
- Aznar-Sánchez, J.A.; Sánchez-Picón, A. Innovation and District around a “Miracle”: Configuration of the local productive system in intensive agriculture in Almeria. *Rev. Hist. Ind.* **2010**, *42*, 157–193. Available online: <https://www.raco.cat/index.php/HistoriaIndustrial/article/view/184437> (accessed on 15 April 2020).
- De Pablo Valenciano, J.; Uribe Toril, J.; Milán García, J.; Ruiz Real, J.L.; Torres Arriaza, J.A. Auxiliary companies of the horticultural sector as a competitiveness element: The case of Almería (Spain). *Int. J. Environ. Res. Public Health* **2019**, *16*, 2575. [CrossRef]
- Sánchez-Picón, A.; Aznar-Sánchez, J.A.; García-Latorre, J. Economic cycles and environmental crisis in arid southeastern Spain. A historical perspective. *J. Arid Environ.* **2011**, *75*, 1360–1367. [CrossRef]
- Castro, A.J.; López-Rodríguez, M.D.; Giagnocavo, C.; Gimenez, M.; Céspedes, L.; La Calle, A.; Gallardo, M.; Pumares, P.; Cabello, J.; Rodríguez, E.; et al. Six Collective Challenges for Sustainability of Almería Greenhouse Horticulture. *Int. J. Environ. Res. Public Health* **2019**, *16*, 4097. [CrossRef] [PubMed]
- Suárez-Eiroa, B.; Fernández, E.; Méndez-Martínez, G.; Soto-Oñate, D. Operational principles of circular economy for sustainable development: Linking theory and practice. *J. Clean. Prod.* **2019**, *214*, 952–961. [CrossRef]

20. Bourguignon, D. *Closing the Loop: New Circular Economy Package*; European Parliamentary Research Service: Brussels, Belgium, 2016. Available online: [https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573899/EPRS_BRI\(2016\)573899_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573899/EPRS_BRI(2016)573899_EN.pdf) (accessed on 15 April 2020).
21. Kirchherr, J.; Reike, D.; Hekkert, M. Conceptualizing the circular economy: An analysis of 114 definitions. *Resour. Conserv. Recycl.* **2017**, *127*, 221–232. [[CrossRef](#)]
22. MacArthur, E. *Delivering the Circular Economy: A Toolkit for Policymakers*; Ellen MacArthur Foundation: Cowes, UK, 2015. Available online: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_PolicymakerToolkit.pdf (accessed on 15 April 2020).
23. Toop, T.A.; Ward, S.; Oldfield, T.; Hull, M.; Kirby, M.E.; Theodorou, M.K. AgroCycle—Developing a circular economy in agriculture. *Energy Procedia* **2017**, *123*, 76–80. [[CrossRef](#)]
24. Muscio, A.; Sisto, R. Are Agri-Food Systems Really Switching to a Circular Economy Model? Implications for European Research and Innovation Policy. *Sustainability* **2020**, *12*, 5554. [[CrossRef](#)]
25. European Commission. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The European Green Deal*; COM(2019) 640 Final; European Commission: Brussels, Belgium, 2019. Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX:52019DC0640> (accessed on 15 April 2020).
26. European Commission. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A New Circular Economy Action Plan For a Cleaner and More Competitive Europe*; COM(2020) 98 Final; European Commission: Brussels, Belgium, 2020. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:98:FIN&WT.mc_id=Twitter (accessed on 15 April 2020).
27. Gobierno de España. España Circular 2030. Estrategia Española de Economía Circular. 2020. Available online: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/economia-circular/espana-circular2030_def1_tcm30-509532.PDF (accessed on 14 April 2020).
28. United Nations. *General Assembly. Resolution Adopted by the General Assembly on 25 September 2015: 70/1. Transforming Our World: The 2030 Agenda for Sustainable Development*; United Nations: New York, NY, USA, 2015.
29. Ghazali, Z.; Lim, M.R.T.; Jamak, A.B.S.A. Maintenance performance improvement analysis using Fuzzy Delphi method: A case of an international lube blending plant in Malaysia. *J. Qual. Maint. Eng.* **2019**, *25*, 162–180. [[CrossRef](#)]
30. Hood, G.; Hand, K.S.; Cramp, E.; Howard, P.; Hopkins, S.; Ashiru-Oredope, D. Measuring Appropriate Antibiotic Prescribing in Acute Hospitals: Development of a National Audit Tool Through a Delphi Consensus. *Antibiotics* **2019**, *8*, 49. [[CrossRef](#)]
31. Campos-Climent, V.; Chaves-Avila, R. The Role of Cooperatives in the Agrarian Crisis. An Empirical Study on Mediterranean Spanish Agriculture. *Cuad. Desarro. Rural* **2012**, *9*, 175–194.
32. Aznar-Sánchez, J.A.; Velasco-Muñoz, J.F.; López-Felices, B.; del Moral-Torres, F. Barriers and Facilitators for Adopting Sustainable Soil Management Practices in Mediterranean Olive Groves. *Agronomy* **2020**, *10*, 506. [[CrossRef](#)]
33. García-García, M.; Céspedes López, A.; Pérez Parra, J.; Lorenzo Mínguez, P. El Sistema de Producción Hortícola Protegido de la Provincia de Almería. Junta de Andalucía: IFAPA. 2016. Available online: https://www.juntadeandalucia.es/export/drupaljda/noticias/16/07/160708_El%20Sistema%20de%20Producci%C3%B3n%20Hort%C3%ADcola%20de%20la%20Provincia%20de%20Almer%C3%ADa.pdf (accessed on 14 April 2020).
34. Céspedes López, A.J.; García García, M.C.; Pérez-Parra, J.J.; Cuadrado Gómez, I.M. *Caracterización de la Explotación Hortícola Protegida de Almería*; Fundación Cajamar: Almería, Spain, 2009; ISBN 84-88246-32-5.
35. Sayadi-Gmada, S.; Rodríguez-Pleguezuelo, C.R.; Rojas-Serrano, F.; Parra-López, C.; Parra-Gómez, S.; García-García, M.C.; García-Collado, R.; Lorbach-Kelle, M.B.; Manrique-Gordillo, T. Inorganic Waste Management in Greenhouse Agriculture in Almeria (SE Spain): Towards a Circular System in Intensive Horticultural Production. *Sustainability* **2019**, *11*, 3782. [[CrossRef](#)]

36. Sayadi-Gmada, S.; Torres-Nieto, J.M.; Parra Gómez, S.; García-García, M.C.; Parra-López, C. Critical point analysis in solid inorganic waste production in the protected cultivation systems in Almeria—approaches to reduce the impact. In Proceedings of the ISHS Acta Horticulturae 1268: XI International Symposium on Protected Cultivation in Mild Winter Climates and I International Symposium on Nettings and Screens in Horticulture, Tenerife, Spain, 27–31 January 2019; Volume 1268, pp. 205–212. [[CrossRef](#)]
37. Pesca y Desarrollo Rural—Consejería de Medio Ambiente y Ordenación del Territorio. *Líneas de Actuación en Materia de Gestión de Restos Vegetales en la Horticultura de Andalucía*; Consejería de Agricultura, Pesca y Desarrollo Rural—Consejería de Medio Ambiente y Ordenación del Territorio: Sevilla, Spain, 2016.
38. Pesca y Desarrollo Rural—Consejería de Medio Ambiente y Ordenación del Territorio. *Evaluación de la Campaña 2017 /18. Hortícolas Protegidos de Almería*; Consejería de Agricultura, Pesca y Desarrollo Rural—Observatorio de Precios y Mercados: Sevilla, Spain, 2018.
39. Sánchez-Martos, F.; Pulido-Bosch, A.; Molina-Sánchez, L.; Vallegjos-Izuierdo, A. Identification of the origin of salinization in groundwater using minor ions (Low Andarax, Southeast Spain). *Sci. Total Environ.* **2002**, *297*, 43–58. [[CrossRef](#)]
40. Casas, J.; Bonachela, S.; Moyano, F.J.; Fenoy, E.; Hernández, J. Agricultural practices in the mediterranean: A case study in Southern Spain. In *The Mediterranean Diet: An Evidence-Based Approach*; Preedy, V.R., Watson, R.R., Eds.; Academic Press: London, UK, 2015; pp. 23–36. [[CrossRef](#)]
41. Caparrós-Martínez, J.L.; Rueda-López, N.; Milán-García, J.; De Pablo, J. Public policies for sustainability and water security: The case of Almeria (Spain). *Glob. Ecol. Conserv.* **2020**, *23*, e01037. [[CrossRef](#)]
42. Custodio, E.; Andreu-Rodes, J.M.; Aragón, R.; Estrela, T.; Ferrer, J.; García-Aróstegui, J.L.; Manzano, M.; Rodríguez-Hernández, L.; Sahuquillo, A.; del Villar, A. Groundwater intensive use and mining in south-eastern peninsular Spain: Hydrogeological, economic and social aspects. *Sci. Total Environ.* **2016**, *559*, 302–316. [[CrossRef](#)] [[PubMed](#)]
43. Aznar-Sánchez, J.A.; Belmonte-Ureña, L.J.; Velasco-Muñoz, J.F.; Valera, D.L. Aquifer Sustainability and the Use of Desalinated Seawater for Greenhouse Irrigation in the Campo de Níjar, Southeast Spain. *Int. J. Environ. Res. Public Health* **2019**, *16*, 898. [[CrossRef](#)] [[PubMed](#)]
44. Domene Ruiz, M.A. Productos de Alto Valor Añadido a Partir de Destríos Hortofrutícolas. Agricultura 2000. 3 November 2016. Available online: https://issuu.com/laprovinciaaldia/docs/041116a2000_noviembre/23 (accessed on 26 May 2020).
45. Paziienza, P.; De Lucia, C. For a new plastics economy in agriculture: Policy reflections on the EU strategy from a local perspective. *J. Clean. Prod.* **2020**, *253*, 119844. [[CrossRef](#)]
46. Groh, K.J.; Backhaus, T.; Carney-Almroth, B.; Geueke, B.; Inostroza, P.A.; Lennquist, A.; Leslie, H.A.; Maffini, M.; Slunge, D.; Trasande, L.; et al. Overview of known plastic packaging-associated chemicals and their hazards. *Sci. Total Environ.* **2019**, *651*, 3253–3268. [[CrossRef](#)]
47. PlasticsEurope. An Analysis of European Latest Plastics Production, Demand and Waste Data. Plastics—The Facts. 2019. Available online: www.plasticseurope.org (accessed on 15 April 2020).
48. Cascini, A.; Gamberi, M.; Mora, C.; Rosano, M.; Bortolini, M. Comparative Carbon Footprint Assessment of commercial walk-in refrigeration systems under different use configurations. *J. Clean. Prod.* **2016**, *112*, 3998–4011. [[CrossRef](#)]
49. Lo-Iacono-Ferreira, V.G.; Viñoles-Cebolla, R.; Bastante-Ceca, M.J.; Capuz-Rizo, S.F. Transport of Spanish Fruit and Vegetables in Cardboard Boxes: A Carbon Footprint Analysis. *J. Clean. Prod.* **2020**, *244*, 118784. [[CrossRef](#)]
50. Pérez-Mesa, J.C.; García-Barranco, M.; Piedra-Muñoz, L.; Galdeano-Gómez, E. Transport as a limiting factor for the growth of Spanish agri-food exports. *Res. Transp. Econ.* **2019**, *78*, 100756. [[CrossRef](#)]
51. Official Journal of the European Union L 145/1. COMMISSION DECISION (EU) 2018/813 of 14 May 2018 on the Sectoral Reference Document on Best Environmental Management Practices, Sector Environmental Performance Indicators and Benchmarks of Excellence for the Agriculture Sector under Regulation (EC) No. 1221/2009 of the European Parliament and of the Council on the Voluntary Participation by Organisations in a Community Eco-Management and Audit Scheme (EMAS). Available online: <http://data.europa.eu/eli/dec/2018/813/oj> (accessed on 14 April 2020).

52. Official Journal of the European Union L223/1. Commission Decision (EU) 2017/1508 of 28 August 2017 on the Reference Document on Best Environmental Management Practice, Sector Environmental Performance Indicators and Benchmarks of Excellence for the Food and Beverage Manufacturing Sector under Regulation (EC) No. 1221/2009 of the European Parliament and of the Council on the Voluntary Participation by Organisations in a Community Eco-Management and Audit Scheme (EMAS). Available online: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017D1508> (accessed on 15 April 2020).
53. The Person Responsible for the Cajamar Project. Personal communication, 15 May 2020.
54. AGRIREFIN. Biorefinería Agrícola Para Valorización de Bioresiduos. 2020. Available online: <https://biovegen.org/actividades/grupos-operativos-biovegen/go-agrirefin/> (accessed on 25 May 2020).
55. ENCE. 2020. Available online: <https://ence.es> (accessed on 25 May 2020).
56. Duque-Acevedo, M.; Belmonte-Ureña, L.J.; Plaza-Úbeda, J.A.; Camacho-Ferre, F. The management of agricultural waste biomass in the framework of circular economy and bioeconomy: An opportunity for greenhouse agriculture in Southeast Spain. *Agronomy* **2020**, *10*, 489. [CrossRef]
57. Puras, V.M. SIGFITO, un Sistema que Contribuye a que la Agricultura Sea Más Competitiva y Sostenible. Phytoma España: La Revista Profesional de Sanidad Vegetal. 2013. Available online: https://www.asaja.com/files/revista/31072019213327_revista-junio-2019_compressed.pdf (accessed on 25 May 2020).
58. REINWASTE. Remanufacture the Food Supply Chain by Testing INNovative Solutions for Zero Inorganic WASTE. 2020. Available online: <https://reinwaste.interreg-med.eu/> (accessed on 25 May 2020).
59. RECOVER. Development of Innovative Biotic Symbiosis for Plastic Biodegradation and Synthesis to Solve their End of Life Challenges in the Agriculture and Food Industries. 2020. Available online: <https://cordis.europa.eu/project/id/887648> (accessed on 25 May 2020).
60. AP-WASTE. Valorization of Agricultural Plastics through Insects and Microorganisms. 2020. Available online: <https://ap-waste.es/> (accessed on 25 May 2020).
61. Plastic Energy. 2020. Available online: <https://plasticenergy.com/> (accessed on 25 May 2020).
62. The Person Responsible for the Hintes Oil Europa. Personal communication, 20 May 2020.
63. BIOMULCH. Integrated Solution for Innovative Biodegradation Control of Agricultural Plastic Mulches. 2020. Available online: <https://biomulch.eu/> (accessed on 26 May 2020).
64. Garcia-Caparros, P.; Contreras, J.I.; Baeza, R.; Segura, M.L.; Lao, M.T. Integral Management of Irrigation Water in Intensive Horticultural Systems of Almería. *Sustainability* **2017**, *9*, 2271. [CrossRef]
65. Piedra-Muñoz, L.; Vega-López, L.L.; Galdeano-Gómez, E.; Zepeda-Zepeda, J.A. Drivers for efficient water use in Agriculture: An empirical analysis of family farms in Almería, Spain. *Exp. Agric.* **2018**, *54*, 31–44. [CrossRef]
66. iGUESS-MED. Sistema Innovador de Apoyo a Los Invernaderos en la Región Mediterránea. 2020. Available online: <https://www.cajamar.es/es/agroalimentario/innovacion/investigacion/agrosostenibilidad/proyectos/iguess-med/> (accessed on 26 May 2020).
67. Grupo Operativo Regional “Utilización Eficiente del Agua en Cultivos Hortícolas Bajo Invernadero”. 2020. Available online: <http://www.usoeficientedelagua.com/> (accessed on 26 May 2020).
68. Official Journal of the European Union L 177/32. Regulation (EU) 2020/741 of the European Parliament and of the Council of 25 May 2020 on Minimum Requirements for Water Reuse. Available online: <http://data.europa.eu/eli/reg/2020/741/oj> (accessed on 15 April 2020).
69. REUSAGUA Gestión Integrada de la Regeneración y Reutilización Eficiente y Segura de Aguas Residuales Urbanas en la Agricultura. 2020. Available online: <https://idearm.imida.es/reusagua/index.html> (accessed on 26 May 2020).
70. LIFE ENRICH. Enhanced Nitrogen and Phosphorus Recovery from Wastewater and Integration in the Value Chain. 2020. Available online: <http://www.life-enrich.eu/> (accessed on 26 May 2020).
71. Instituto Andaluz de Investigación y Formación Agraria, Pesquera, Alimentaria y de la Producción Ecológica (IFAPA). IFAPA Leads a Research Project for Improving Greenhouse Production with Passive Heating and Cooling Systems. 20 April 2020. Available online: <https://www.juntadeandalucia.es/agriculturaypesca/ifapa/web/noticias/ifapa-lidera-una-investigacion-para-mejorar-la-produccion-bajo-invernadero-con-sistemas> (accessed on 15 April 2020).
72. Carreño-Ortega, A.; Galdeano-Gómez, E.; Pérez-Mesa, J.C.; Galera-Quiles, M.D.C. Policy and Environmental Implications of Photovoltaic Systems in Farming in Southeast Spain: Can Greenhouses Reduce the Greenhouse Effect? *Energies* **2017**, *10*, 761. [CrossRef]

73. Cardial Recursos Alternativos. 2020. Available online: <https://www.cardialra.es/> (accessed on 26 May 2020).
74. Pérez-Mesa, J.C.; Galdeano-Gómez, E.; Aznar-Sánchez, J.A. Management system for harvest scheduling: The case of horticultural production in southeast Spain. *Int. Food Agribus. Manag. Rev.* **2011**, *14*, 145–164.
75. La Unión. 2020. Available online: <http://www.launioncorp.com/> (accessed on 26 May 2020).
76. Grupo Agroponente. 2020. Available online: <https://www.grupoagroponente.com/> (accessed on 26 May 2020).
77. The Person Responsible for the Frutilados del Poniente. Personal communication, 25 May 2020.
78. Official Journal of the European Union C 433/136. European Parliament Resolution of 13 September 2018 on a European Strategy for Plastics in a Circular Economy (2018/2035(INI)). Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2019.433.01.0136.01.ENG&toc=OJ:C:2019:433:FULL (accessed on 26 May 2020).
79. Guillard, V.; Gaucel, S.; Fornaciari, C.; Angellier-Coussy, H.; Buche, P.; Gontard, N. The Next Generation of Sustainable Food Packaging to Preserve Our Environment in a Circular Economy Context. *Front. Nutr.* **2018**, *5*, 13. [CrossRef]
80. Han, J.W.; Ruiz-Garcia, L.; Qian, J.P.; Yang, X.T. Food packaging: A comprehensive review and future trends. *Compr. Rev. Food Sci. Food Saf.* **2018**, *17*, 860–877. [CrossRef]
81. YPACK. Innovative Circular Bioeconomy Food Packaging Solutions. 2020. Available online: <https://www.ypack.eu/> (accessed on 27 May 2020).
82. Futamura. 2020. Available online: <http://www.futamuragroup.com/en/> (accessed on 27 May 2020).
83. Albrecht, S.; Brandstetter, P.; Beck, T.; Fullana-i-Palmer, P.; Grönman, K.; Baitz, M.; Deimling, S.; Sandilands, J.; Fischer, M. An extended life cycle analysis of packaging systems for fruit and vegetable transport in Europe. *Int. J. Life Cycle Assess.* **2013**, *18*, 1549–1567. [CrossRef]
84. Abejón, R.; Bala, A.; Vázquez-Rowe, I.; Aldaco, R.; Fullana-i-Palmer, P. When plastic packaging should be preferred: Life cycle analysis of packages for fruit and vegetable distribution in the Spanish peninsular market. *Resour. Conserv. Recycl.* **2020**, *155*, 104666. [CrossRef]
85. Pérez-Mesa, J.C.; Piedra-Muñoz, L.; García-Barranco, M.C.; Giagnocavo, C. Response of fresh food suppliers to sustainable supply chain management of large European retailers. *Sustainability* **2019**, *11*, 3885. [CrossRef]
86. Vam Watertech. 2020. Available online: <https://www.vam-watertech.com/> (accessed on 27 May 2020).
87. agroTITANIUM. 2020. Available online: <https://agrotitanium.es/> (accessed on 27 May 2020).
88. TeSLA. An Adaptive Trust-Based E-Assessment System for Learning. 2020. Available online: <http://teslaproject.chil.me/> (accessed on 27 May 2020).
89. Latini, A.; Viola, C.; Scoccianti, M.; Campiotti, C.A. *Handbook on Efficient Fruit and Vegetables Processing Plants*; TESLA (Transferring Energy Save Laid on Agroindustry); ENEA: Rome, Italy, 2014. Available online: <http://teslaproject.chil.me/download-doc/63991> (accessed on 27 May 2020).
90. Carvajal, F.; Palma, F.; Jamilena, M.; Garrido, D. Preconditioning treatment induces chilling tolerance in zucchini fruit improving different physiological mechanisms against cold injury. *Ann. Appl. Biol.* **2014**, *166*, 340–354. [CrossRef]
91. Official Journal of the European Union L 150/195. Regulation (EU) No. 517/2014 of the European Parliament and of the Council of 16 April 2014 on Fluorinated Greenhouse Gases and Repealing Regulation (EC) No. 842/2006. Available online: <http://data.europa.eu/eli/reg/2014/517/oj> (accessed on 26 May 2020).
92. Pérez-Mesa, J.C.; Galdeano-Gómez, E.; Salinas-Andújar, J. Logistics network and externalities for short sea transport: An analysis of horticultural exports from southeast Spain. *Transp. Policy* **2012**, *24*, 188–198. [CrossRef]
93. Representative of the Project. Personal communication, 2020.
94. Corredor Mediterráneo. 2020. Available online: <https://elcorredormediterraneo.com/> (accessed on 28 May 2020).
95. Carus, M.; Dammer, L. The “Circular Bioeconomy”—Concepts, Opportunities and Limitations, Hürth. 2018. Available online: www.bio-based.eu/nova-papers (accessed on 23 September 2020).

