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Fruit Juice Industry's Transition Towards Sustainability from the Viewpoint of the Producers

Aintzane Esturo [1,2,*], Erlantz Lizundia [2,3] and Estibaliz Sáez de Cámara [4]

[1] International Fruit and Vegetable Juice Association (IFU), 23 Boulevard des Capuchines, 75002 Paris, France
[2] Life Cycle Thinking Group, Department of Graphic Design and Engineering Projects, University of the Basque Country (UPV/EHU), Plaza Ingeniero Torres Quevedo 1, 48013 Bilbao, Spain
[3] BCMaterials—Basque Center for Materials, Applications and Nanostructures, UPV/EHU Science Park, 48940 Leioa, Spain
[4] Atmospehric Research Group, Department of Chemical and Environmental Engineering, University of the Basque Country (UPV/EHU), Plaza Ingeniero Torres Quevedo 1, 48013 Bilbao, Spain
* Correspondence: aintzane@ifu-fruitjuice.com

Abstract: The fruit juice industry needs to ensure that its business is carried out within the planetary boundaries. Accordingly, this work aims to provide the views towards sustainability of the worldwide fruit juice industry, as key stakeholders in the food industry supply chain. This research identifies the current sustainability priorities within the sector and provides insights on the existing information gaps. A questionnaire was launched during spring 2022 among the International Fruit Juice and Vegetable Association members to obtain a current overview of the sector. The data shown here includes key fruit juice stakeholders from 20 countries across the globe, ranging from quality assessment to economic/social/environmental sustainability and general managers. A set of answers on the perceived meaning of sustainability and the possible measures to reduce the environmental impacts are gathered and classified. According to the results of this questionnaire, carbon footprint and social aspects emerge as the main hotspots. Overall, results show an increasing concern in the fruit juice industry towards holistic sustainability (environmental/social/economic) and clearly point to customers as a main driver to implement sustainability measures rather that complying with regulations. With this set of information, this work is ready to lay the groundwork for future studies in the area of sustainability in the food sector, while it may guide industry in its efforts to fulfil 2023 and 2050 climate targets.

Keywords: fruit juice; food processing; circular economy; environmental sustainability

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1. Introduction

Sustainable development seeks to achieve economic and social development and environmental preservation [1,2]. These dimensions of sustainable development are key to ensuring the future of the fruit juice sector.

The fruit juice industry is generally aware of its environmental footprint. For this reason, in 2013 the fruit juice industry created the Fruit Juice CSR Platform, an initiative specifically established for the fruit juice industry led by the European Fruit Juice Association (AIJN) [3]. The platform was endorsed and co-funded by the European Commission for its first 18 months of operation. After that period, the platform is self-financed and integrated by European companies. The platform aims to give visibility of the sustainability actions performed by the fruit juice sector.

Ten years after the creation of the Fruit Juice CSR Platform, the "Decade for action" started in 2020, initially by analysing existing gaps and asking the stakeholders to set priorities for the coming years. This works aims to fill this knowledge gap, to extend the geographical scope and to ask the global juice supply chain how future sustainability challenges are understood in terms of climate change, use of natural resources and waste

generation. As part of this task, a questionnaire was developed in spring 2022 to gather information among International Fruit and Vegetable Juice Association (IFU) members to identify the existing gaps and propose actions to improve the sustainability of the sector. This information assists in understanding the pace of progress towards realizing the 2030 agenda and to contribute to the achievement of the United Nation's SDGs.

There are several definitions and concepts for the term "sustainability". The general definitions of sustainability refer to all environmental, social and economic dimensions [4] or only to some of the dimensions [5]. The three dimensions were presented in 2002 at the UN Conference, World Summit on Sustainable Development (WSSD), and were intended to be interdependent and mutually reinforcing. It is important to assess what the fruit juice industry understands as "sustainability" so that future priorities and actions to comply with regulation and customer demands are defined.

In 2022, the global juice market reached an economic value of USD 141 billion, with a production volume of 67.6 billion litres [6]. With an estimated compound annual growth rate (CAGR) of 5.4% for the period 2022–2027 [7], the market value of global fruit industry will reach USD 189.9 billion by 2028 [8]. In this sense, the rising consumer awareness towards the nutritional benefits of fruit juices fully free from added sugar, flavourings and preservatives is the primary driving force [6]. Europe dominates the market with 16.3 billion litres of fruit juice and an estimated economic value of USD 30.5 billion. Orange juice is the most consumed flavour worldwide [9], with an average of 7.01 and 9.90 L per capita in the United States and Germany, respectively [10,11]. Brazil is the world's largest orange juice producer [12,13] and dominates orange juice export markets [14]. The second biggest orange juice producer is the United States, where 90% of the production is consumed internally [15]. On top of the mentioned fruit juice sector economic value, the sector offers nutritious juices with healthy effects ready to consume, for example, orange juice with vascular protective effects [16] and hyperglycaemia protection effect [17], berries juice with positive effect on cardiovascular disease risks [17,18] and apple juice with positive effects on gut microbiota [19], cardiovascular protective effects [20] and general health [21].

The fruit juice sector faces several challenges to meet the United Nation's Sustainability Development Goals (SDG), such as providing healthy and safe working conditions (related to SDG 8), reducing waste from production (related to SDG 12) and rational use of natural resources for ecosystem preservation (related to SDG 14 and 15). The Food and Agriculture Organization (FAO) projections indicate that by 2050, a 70% increase in food production will be required to meet the expanding demand for food, thus increasing the environmental impact of food production. The food sector accounts for nearly 30% of the world's total energy consumption, which in turn results in 22% of the total greenhouse gas (GHG) emissions [22]. In addition, it is responsible of food loss and waste totalling nearly 1.3 billion tons of foodstuffs annually [23], which is about one third of the yearly world food output loss [24]. About 13.3% of total food loss occurs directly after harvesting, corresponding to 931 million metric tons [25]. At the consumer level, an average of 20% of food is lost, which is about 158 to 298 k/year/capita in the European Union (EU) [26,27].

Likewise, fruit juice production is responsible for significant water and energy consumption. In the fruit juice sector, agriculture's water consumption accounts for 70%, followed by the industrial sector at 20% water consumption [28,29]. Importantly, water demand is different if the juice is produced at the facility or if it is imported as juice. A much lower water and energy demand is observed for the latter case. However, water footprints ranging from 0.6 to 1.48 L per litre of juice have been reported [30]. Regarding energy consumption, it depends on the processing time and temperature. At juice bottling facilities, the energy consumption originates principally from juice pasteurization, bottle cleaning and refrigeration. As a mean value, 0.71 MJ per litre of juice are required [30].

The food waste generation by the fruit juice industry during the processing phase should also be considered. The processing operations of fruits and vegetables yield wastes or by-products that vary depending on the type of fruit. The waste is composed mainly of

seed, skin, rind and pomace, which contains potentially valuable bioactive compounds such as carotenoids polyphenols, dietary fibres, vitamins, enzymes and oils, among others [31]. These phytochemicals can be utilized by the food industry for the development of functional or enriched foods and the health industry, among others [32]. For instance, by-products such as apple pomace and grape pomace contain significant amounts of dietary fibre (pectin, hemicelluloses and cellulose) that can be upcycled for healthy food or feed [33,34]. In citrus, the waste produced reaches 50–59% of the whole fruit weight (30–34% peel and 20–25% seeds) [35], and, in the case of apple juice production, the waste can be 10–30% of the fruit weight [36].

Increasing consumer awareness regarding a healthy lifestyle and wellbeing is driving the consideration of aspects related to environmental sustainability and food production's impact on the planet. These consumer preferences during purchase, reinforced by the establishment of sustainability certifications and labels [37,38], are pushing companies to meet sustainability goals by reducing their energy costs and prioritising environmental, social and governance (ESG) policies.

To implement the necessary changes to address the roots of inequality, degradation of ecosystems and climate change, institutional changes are needed. Those changes should contribute to merging environment and economics during decision-making and to enforce the common interest through greater public participation, both locally and internationally [39].

The Division for Sustainable Development Goals (DSDG) in the United Nations' Department of Economic and Social Affairs (UNDESA) provides substantive support and capacity-building for the 17 SDGs and their related thematic issues and 169 targets. Policy makers and authorities define targets and regulations aligned with the SDG to reduce carbon emissions, preserve natural resources, transform food systems, create better jobs and advance the transition to a greener, more inclusive and just economy [40].

Considerable progress has been made in the availability of internationally comparable data for SDG monitoring: the number of indicators included in the global SDG database increased from 115 in 2016 to 217 in 2022 [40]. However, significant data gaps still exist making it difficult to understand the progress towards the SDG of the 2030 Agenda. For eight of the 17 SDGs, fewer than half of the 193 countries or areas have internationally comparable data from 2015 or later.

Governments in the Western countries have included a range of legislation to realise changes to improve resource efficiency, reduce waste and pollution and shape a new circular economy. Some of those key sustainability-related regulations include the following: In the United Kingdom, the Climate Change Act 2008 [41], in the United States, the Clean Water Act [42] and Energy Policy Act of 2005 [43] and in Australia the Environmental Sustainability Policy [44]. In Europe the European Green Deal [45] was unveiled to transform the EU's economy through a growth agenda that will allow Europe to be the first climate-neutral continent. This plan included targets to be met by 2030 and 2035 and obligations of biowaste separation. The Farm to Fork Strategy (F2F) is at the centre of the European Green Deal, by specifically addressing the challenges of sustainable food systems and recognising the connecting links between healthy people, healthy societies and a healthy planet. The F2F strategy is key to achieving the SDGs. The commission considers measures to increase the sustainability of the food value chain and will support sustainable and circular bio-based sectors through the implementation of plans to accelerate the transition towards a regenerative growth model that gives back to the planet. To achieve those targets, the commission will grant EUR 10 billion under Horizon Europe (2021–2027) to be invested in research and innovation related to food, bioeconomy, natural resources, agriculture, fisheries, aquaculture and the environment [46].

2. Methodology

2.1. The Questionnaire

A questionnaire was designed to identify how the fruit juice producing sector perceives and understands sustainability-related aspects worldwide. With this information, this work highlights the main concerns and strategic priorities currently faced by main stakeholders in the sector.

The questionnaire was composed of 18 questions, from which, eight were designed to offer a close-ended response. The close-ended questions were YES/NO questions to facilitate the treatment of the results. However, in some questions where an open-ended answer could add value, the information could be further developed in the next question. We combined close-ended and open-ended questions to expand the information. The remaining questions were aimed at rating preferred sustainability aspects by multiple choice questions and to identify the priorities for the respondents by open-ended questions [47]. The combination of close-ended, open-ended and multiple-choice responses allows a better understanding of the sustainability-related involvement and concerns by the stakeholders.

The questionnaire was sent to all the members (200 organisations) of IFU, corresponding to industries and industrial associations located in 77 countries across five continents. The recipients of the questionnaire were directors, managers and senior managers in the juice processing industry, bottling industry, national beverage and fruit juice associations and research centres.

The questionnaire was aligned with the structure and methodology used by AIJN to map the sector in Europe and identify alignment levels with the sustainability requirements of the European Union. The main differences between the two studies are, on one hand, the scope. The IFU targets the global fruit juice industry, and AIJN targets the European producers. On the other hand, there is a difference in the methodology to obtain the answers. While this study gathered information through the survey, AIJN used targeted interviews of selected main European juice producers and bottlers. In addition, the questionnaire form used enables us to collect data that can be compared by future follow-on works while maintaining respondent's confidentiality and obtaining an information analogous to what could be obtained during written interviews. This study focuses not only on European companies but also on businesses located out of Europe to understand whether or not the main understandings and concerns on sustainability are comparable. The questionnaire was launched using the Survey Monkey platform and it was open from 26 April 2022 until 4 May All the surveys were carried out anonymously. However, the IP of the participants of the computers were known to avoid double answering by the same company. The questions of the questionnaire and expected answer types are gathered in Table 1.

Table 1. Questions and type of answers in the questionnaire.

Number	Question	Answer Type
1	General information: Country and type of IFU membership	Multiple-choice
2	In your opinion sustainability is related to: Multiple selections are possible	Multiple-choice
3	Which do you estimate the main source for impacts along the fruit juice value chain? Please, chose only one	Multiple-choice
4	What aspects are the most relevant for you or your organization? Select the 5 most appropriate	Multiple-choice
5	Have you completed any carbon footprint analysis?	Close-ended
6	Have you completed any water footprint analysis or any other footprint analysis?	Close-ended
7	Do you have an operational procedure for managing or treating your solid and water waste, including hazardous and non-hazardous waste?	Close-ended

Table 1. *Cont.*

Number	Question	Answer Type
8	Does your company set targets regarding the reduction of solid and water waste?	Close-ended
9	Have you or your organization implemented a system to reduce your environmental impact in terms of energy consumption?	Close-ended
10	Have you or your organization implemented a system to reduce your environmental impact in terms of material consumption?	Close-ended
11	Have you established targets regarding the reduction, reuse and recycling of the packaging of your products?	Close-ended
12	Do you have any environmental requirements from your suppliers?	Close-ended
13	Do you have any environmental requirements from your customers?	Close-ended
14	Do you think that having an accredited sustainability certification is relevant?	Close-ended
15	If yes, which one?	Open-ended
16	How should the sector approach sustainability?	Open-ended
17	Please provide a brief definition of sustainability	Open-ended
18	Any other comments you wish to make	Open-ended

Overall, the questions in the questionnaire aimed to address identification of the understanding of sustainability for the juice producing sector ("what" questions, describing the sustainability), identification of the aspects to be considered ("how" question to describe the aspects related to sustainability) [48] and strategies and tactics to improve the sustainability of the fruit juice sector ("which" question) [49].

The multiple-choice options given to answer question 4 are presented in Table 2: What aspects are the most relevant for you or your organization?

Table 2. Options to select as most important aspects in the organisation.

Number	Sustainability Aspects Considered in the Organisation
1	Purchasing from sustainably managed and certified sources
2	Eliminating/reducing harmful agricultural chemicals
3	Having an environmental management system
4	Biodiversity and land use
5	Employee health, safety and welfare
6	Operational efficiency (energy consumption, use of renewables)
7	Fruit supply chain management
8	Human rights of workers (absence of child labour, right to join unions, etc.)
9	Circular economy
10	Water and effluent management
11	Waste management
12	Packaging
13	Product transparency and traceability
14	Legislative developments on sustainability
15	Sustainable corporate reporting (CSR) and due diligence
16	Regenerative agricultural practices
17	How should the sector approach sustainability

2.2. The Data Analysis Method

The answers corresponding to the close-ended questions (yes/no format) were transformed to 1/0 type to measure the frequency of each answer and develop further analysis. With the multiple-choice answers, the number of responses for each given option was counted, and Pareto and comparative bar diagrams were elaborated for analysis. The answers corresponding to the open-ended questions were analysed following the open

coding analytic process, as mentioned in the grounded theory method [50,51]. The received expressions were transformed in key words with Texalyzer to obtain relevant annotations and concepts from the participants [52]. Texalyzer is a free software that helps to understand a text by mining the text for data on readability, word count, frequency and density. We considered this tool, which is also used for SEO keyword analysis, the most appropriate one. With the tool, we were able to list the most mentioned words

3. Results and Discussion

IFU was selected as the channel to launch the questionnaire because it is the exclusive representative of the global juice-based industry. Although solely 35 responses are analysed, it should be considered that certain answering organizations such as the Verband der deutschen Fruchtsaft-Industrie e. V. is composed of 185 juice producers and 141 manufacturers throughout the German regional associations. Therefore, we consider the answers obtained representative of the field. About 70% of the answers were originated by industrial members of all sizes: small and medium enterprises (SME), multinational companies and micro-SMEs, thus representing in a proportional manner the industrial sector. The other 30% of the answers correspond to national associations representing the industry at their national policy makers and research institutes. The data resulting from the questionnaire were firstly separated by different types of stakeholders, which are: industrial companies classified (including the corporate, SMEs, multinational and micro-SMEs), national juice producer associations and research centres and universities. Most of the answers were provided by participants from industrial companies (11 multinational, 15 corporate, 4 micro SMEs), but also answers from national associational and research centres working directly with the fruit juice industry were gathered: four and two questionnaires were completed, respectively. This distribution is shown in Figure 1.

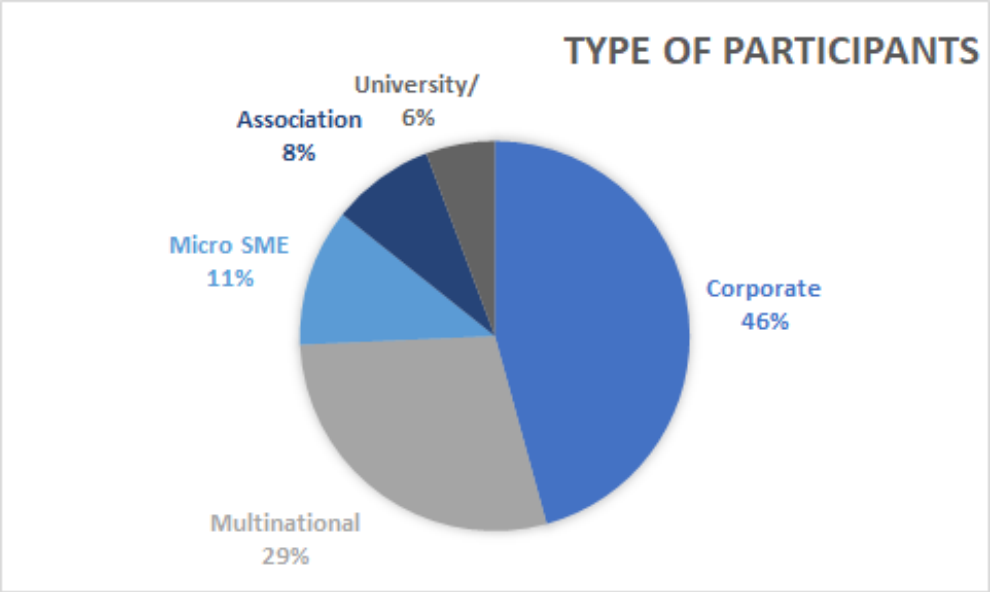

Figure 1. Type and relative contribution of participants in the questionnaire.

The mentioned 11% corresponds to micro-SMEs, companies with fewer than 10 employees and an annual turnover below EUR 2 million. This category in the questionnaire was identified as the category "Friends". In Figure 1, the corporate number contains the SMEs. The definition of SMEs by the EU corresponds to businesses with fewer than 250 employees and a turnover of less than EUR 50 million. Altogether, micro-SMEs and SMEs sum 57% of the participants (without counting the representation of the industrial national associations).

Answers from the major juice producing countries (Brazil, USA, South Africa, Turkey, Argentina) as well from major juice consuming countries (USA, Germany) were received, therefore representing adequately the entire fruit juice sector. The responses received originated from Africa (South Africa), America (Argentina, Brazil, Chile, Ecuador, Peru, Uruguay, United States), Europe (Germany, Greece, Italy, Norway, United Kingdom, Spain, Switzerland, Sweden) and Asia (Israel, Thailand, Turkey, Vietnam), which are important fruit juice producing and/or consuming areas. The geographical location of the participating companies is shown in Figure 2.

Figure 2. Locations and number of questionnaire responses received.

The first research question related to the sustainability concept provided results comparable to those observed by Arena et al. [5]: sustainability is perceived as much more than just the environmental dimension. The participants (100%) considered that sustainability is related to the environment, and 95% of the answers indicated that sustainability affects not only environmentally related issues but also impacts social and economic areas (Table 3). Two of the answers referred to solely two of the three dimensions (environment/society, economy/society or environment/economy). Therefore, as all participants selected in all cases the environment, it can be concluded that sustainability is clearly linked with the environmental dimension, but it is related to other dimensions too. The results show that the worldwide fruit juice industry is aligned with the three-dimensional sustainability concept.

The question referring to the supply chain stage that holds the larger share in impacts was given a multiple-choice option, being participants able to select all options. Figure 3 summarizes the stages in the fruit juice value chain with potential impacts on sustainability to be selected.

The supply chain stage includes agriculture, fruit processing, juice bottling, retail and transport of materials between stages. The circularity in the supply chain could be reached by upcycling and recovering the materials produced at fruit processing and juice bottling stages.

Table 3. Dimensions included in the conception of sustainability of interviewed juice fruit producers and their countries.

	Environmental	Social	Economic
Argentina	■	■	■
Argentina	■	■	■
Argentina	■	■	■
Brazil	■	■	■
Chile	■	■	
Ecuador	■	■	■
Germany	■	■	■
Germany	■	■	■
Germany	■	■	■
Germany	■	■	
Germany	■	■	■
Germany	■	■	■
Germany	■	■	■
Germany	■	■	■
Greece	■	■	■
Greece	■	■	■
Israel	■	■	■
Italy	■	■	■
Italy	■	■	■
Norway	■	■	■
Peru	■	■	■
South Africa	■	■	■
Spain	■	■	■
Sweden	■	■	■
Switzerland	■	■	■
Thailand	■	■	■
Turkey	■	■	■
Uruguay	■	■	■
United Kingdom	■	■	■
United Kingdom	■	■	■
United States	■		■
United States	■	■	■
United States	■	■	■
United States	■	■	■
Vietnam	■	■	■

The answers regarding the value chain stages with larger impacts on sustainability and obtained from different countries are summarized in Table 4. According to the participants, the phases with the largest impact on sustainability are agriculture (95% of answers), processing (71%), transport (62%), packaging (62%) and bottling (24%). When the above results are represented in a bar chart (Figure 4), it is clearly seen that the industry estimates that agriculture is the largest contributor. This is in agreement with recent results disclosed for the carbon footprint of orange juice, where the orange crop is responsible for 60% of the total carbon footprint [53]. Three answers were gathered under the stage "other". One of the responses referred to the transport in vessels, which is of special importance in transporting the orange juices from Brazil. In fact, transportation-related GHG emissions associated with fresh produce in general can increase by a factor larger than two of the cradle-to-market carbon footprint [54]. Vessels dedicated to transporting fruit juices and related products from the producers (usually Brazil) to consumer markets in Europe and America include climate-controlled chamber tanks, which further increase their energy consumption [54]. The second comment highlighted the sourcing of raw materials as a key parameter, suggesting the processing of unsold fruit at the retailers in Germany, as an example. Finally, the interviewed producers also pointed out the impact of the policies in force in each country.

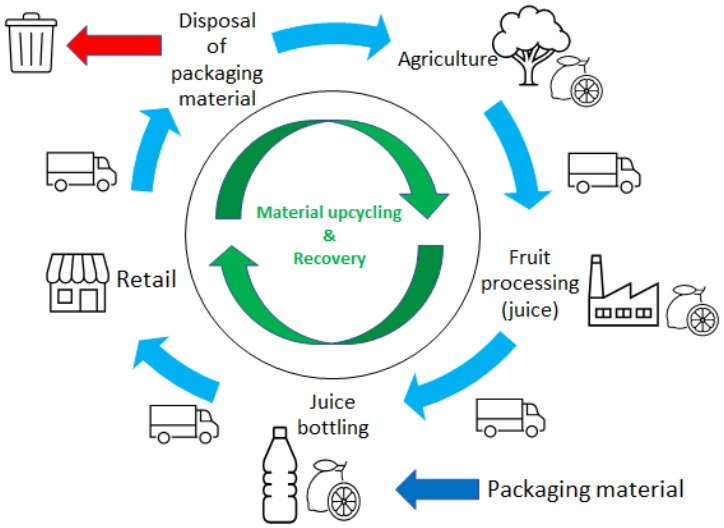

Figure 3. Stages considered in the value chain regarding the fruit juice industry with impact on sustainability. Visuals are taken from Microsoft 365.

Table 4. Value chain stages bearing the largest impacts on sustainability according to the questionnaire.

	Agriculture	Processing	Transport	Packaging	Bottling	Retailing	Other
Argentina	■	■					
Argentina	■	■	■	■	■	■	■
Argentina	■	■	■	■			
Brazil	■	■	■	■	■	■	■
Chile	■	■		■			
Ecuador	■	■	■	■			
Germany	■	■					
Germany	■	■	■				
Germany	■	■	■	■	■		■
Germany	■		■	■			
Germany	■	■					
Germany	■	■					
Germany	■		■	■			
Germany	■			■			
Greece	■	■	■	■	■	■	
Greece	■	■	■	■			
Israel	■		■	■			
Italy	■	■	■	■	■	■	
Italy	■	■	■				
Norway	■	■	■	■	■		
Peru	■	■	■	■			
South Africa	■			■			
Spain	■						
Sweden	■						
Switzerland		■	■	■			
Thailand	■	■	■	■	■	■	
Turkey	■	■	■				
United Kingdom	■	■		■		■	
United Kingdom	■						
United States	■		■	■			
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United States	■	■	■	■	■		
United States	■	■	■				
Uruguay			■	■			
Vietnam	■	■					

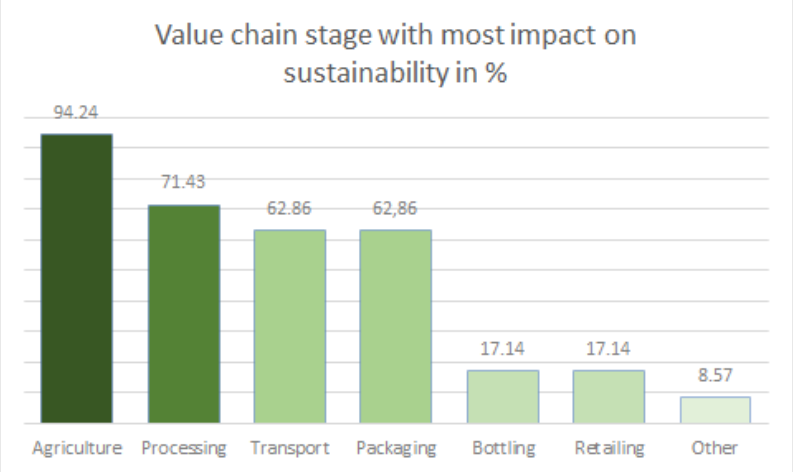

Figure 4. Relative impact of different stages of the value chain with most impact on sustainability (%), according to the interviewed producers.

Question number four addressed the most relevant aspects for the organization. The questionnaire provided 16 options, from which the respondents had to select a maximum of five.

The most relevant aspects and thus the priorities for the fruit juice industry are presented in a Pareto diagram (Figure 5). In equal value, number 6 "operational efficiency" that considers "energy consumption and use of renewables", and number 1 "purchasing from sustainably managed and certified sources", are the most selected options. The third most important aspect considered is number 5 "employee health, safety and welfare". A second group of aspects achieved a similar overall ranking (between 13 to 11 votes). These aspects are number 10, "water and effluent management", number 11, "waste management", number 13, "product transparency and traceability", number 2, "elimination and/or reduction of harmful agricultural chemicals", and number 9, "circular economy". These mentioned aspects classified in the second group are not high in the agendas but are at least considered by most of the surveyed companies even if they are not identified as the most relevant.

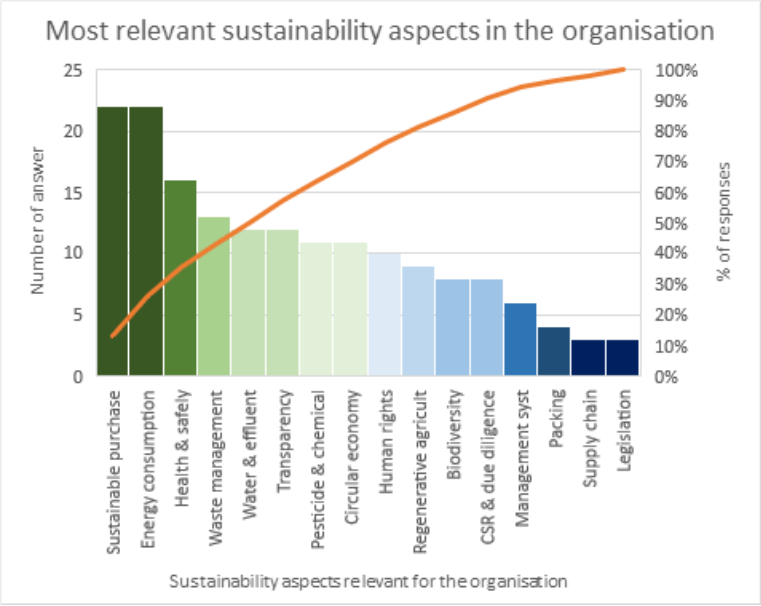

Figure 5. Most relevant aspects in the organisation according to the interviewed juice producers (%) presented as a Pareto diagram.

Remaining aspects can be grouped in a third group, where number 8, "human right of workers", is the most voted aspect in this block. This fact highlights the sensitivity of the industry to this topic, most probably due to the pressure made in the past by certain non-governmental organizations on this specific value chain [55]. The agriculture sector is clearly identified in the questionnaire (option number 2, "Eliminating/reducing harmful agricultural chemicals") as a key aspect of the value chain. The fact that the regenerative agriculture practices (number 16) are not ranked high might be because the fruit juice industry has little direct influence on agriculture. Similarly, despite the fact that biodiversity and land use (number 4) are important, the industry is seeing these aspects not under the direct control of their operations. Regarding sustainable corporate responsibility and due diligence (number 15), according to the results, it is important but not a big priority.

The implementation of an environmental management system (option 3) is not considered the most relevant fact, solely scoring six votes. This result might be due to the global aspect of the fruit supply chain that cannot be covered by the individual environmental management system of a particular company. It is especially noticeable that companies do not consider packaging (option 12) a relevant aspect, even when juices are necessarily commercialized in packs. Similarly, fruit supply chain management (number 7) is not considered a relevant aspect. As mentioned before, the reason could be that the industry is not closely involved in the agricultural stage. Another interesting result is that the legislative developments on sustainability (option 14) are regarded as less of a priority. At this point, there is not enough sensitization on the packaging aspect or the implications of the legislative developments on that area. However, European companies face the challenge to meet the targets set by the new European legislation, such as the Packaging and Packaging Waste Directive (PPWD), the amending Directive that sets specific targets for 2025 and 2030, the Waste Framework Directive [48] and Decision (EU) 2019/665, introducing new rules regarding calculation of the attainment of recycling targets.

From the other side, more than half of the participants (55%) have performed a carbon footprint analysis, whereas only a bit more than a third (34%) have completed a water footprint analysis. A total of 23% of the participants have performed carbon footprint and water footprint analysis. Therefore, the number of companies that still need to perform these analyses is significant. In analysing the results by country, in many countries, the footprint analysis is a pending exercise.

The questions regarding waste management were designed to identify the procedures and targets for wastewater and solid wastes. Most of the participants (88.23%) answered that they have recently implemented procedures to manage the generated waste. In addition, 64.70% of the participants confirm they set objectives to reduce waste generation at their facilities. More than half of the answering companies (55.88%) have implemented both: protocols to manage generated wastes and wastewater/solid waste generation-reduction targets. However, the setting of reduction objectives can be improved. In this sense, the implementation of the circular economy paradigm to reduce the generation of bio-based waste could be very helpful.

The questions related to the use of resources were focused on the implementation of systems to reduce energy and material use, as well as the setting of targets for the reduction, reuse and recycling of packaging materials in particular. Here, it should be highlighted that the questionnaire was sent in March 2022, shortly after the Russo–Ukrainian War started, when prices and the cost of energy were not at the peak price. Still, in terms of energy consumption reduction, companies seem to be very motivated to implement systems to reduce energy use. Almost 80% of the surveyed companies have implemented procedures to reduce energy consumption and 70% of the surveyed companies have similar plans to reduce consumption of materials. These results indicate the fruit juice industry is already taking actions towards the implementation of measures to reduce the use of resources. However, when asking about the target implementation, 67% of the companies responded in a positive way. Accordingly, there is still room for improvement in target setting. However, only 44.11% of the surveyed companies answered that they have implemented

energy and material use reduction systems as well as measurable targets for the reduction, reuse and recycling of packaging materials. According to the data, companies implement some measures to cover the priority aspects (energy, materials or packaging), but few of them have a holistic approach to tackle the reduction, reuse and recycling as a unique strategy. This is particularly relevant considering the dominant impact of plastic-based packaging in food products. In this sense, eco-designed packaging [56] and transport choices [57], or systems based on returnable glass bottles or easily recyclable materials such as aluminium, are envisaged as future improvements.

As for the block of questions regarding the demands coming upstream or downstream in the value chain, results indicate that there is an increasing pressure coming from the customer´s side (Figure 6). In fact, 55.88% of the surveyed companies declared receiving environmental requirements from their customers, while only 44.11% of the answers indicated such a requirement from the suppliers´ side. This confirms that the request to improve environmental aspects principally originates from customers, and it is translated upstream.

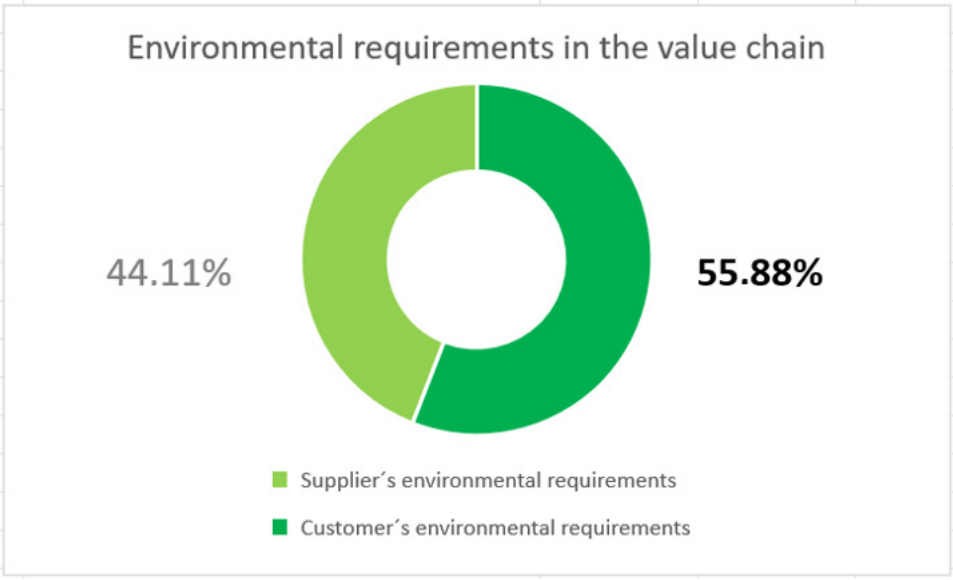

Figure 6. Environmental requirements in the value chain from the supplier and customer point-of-view, according to interviewed juice companies.

Regarding the question related to relevance and identification of sustainability certification, the majority of the participants (90.62%) consider it relevant to have an accredited sustainability certification. The main sustainability certifications applied in the fruit juice industry depend on the sustainability dimension they assess. For the social dimension, the most known are Sedex, SMETA and Fair Trade, whilst the environmental aspects are assessed by SAI FSA, ISO 14001 and Rainforest Alliance. Some of the certifications are business to business (B2B) (such as ISO 14001) and others are B2C (such as Rainforest Alliance) that allow having the logo on the final product to be purchased by the consumer. The answers obtained to which certifications were mentioned by participants are summarized in Table 5. Certain participants indicated that there is not a specific certificate for sustainability, and another mentioned certificates for carbon footprint but without specifying which particular certification. An additional answer openly mentioned that there is no decision taken yet regarding the third-party certification for sustainability (neither environmental nor social dimension). In addition, one of the respondents highlighted the fact that the certification provides credibility and impartiality on the management carried out.

The questionnaire finished with three open-ended questions. These open-ended questions were aimed at obtaining more elaborate responses and generating additional information and insights from the respondent. In this sense, more than 70% of the surveyed

gave an answer in RQThe analysis of the responses was performed through the screening of key words. Overall, the participants highlighted the importance of sustainability and investment in the fruit juice sector, which should be tackled in a global way across the supply chain.

Table 5. Most mentioned sustainability certifications by the interviewed fruit juice industry companies.

Sustainability Certifications	Mentioned by Participant (%)
SAI FSA	22.58
Fair Trade	16.13
Rainforest Alliance	12.90
ISO 50001 (Energy management system)	9.68
SMETA	6.45
Sedex	6.45
Ecovadis	6.45
ISO 14001 (Environmental management system)	6.45
ISO 45001 Occupational health and safety management systems	3.23
Organic certification	3.23
Global GAP	3.23
IFS	3.23

However, when a block of three words is analysed, the most mentioned word is "investment", mentioned twice as much compared to any other word. The next ones are "guideline", "shared success cases" and "projects", closely followed by "requirements", which is aligned with the need for having guidelines, setting common targets and approaches, sharing success cases and cooperating. The answers regarding sustainability definition do not show any dissonance compared to the usually used definitions, and, once again, it reinforces that the fruit juice industry is aware of the importance of sustainability. The participants were also allowed to write additional comments in the last answer, but no outstanding comments were gathered in this section.

4. Conclusions

In spite of the long tradition and large market penetration that the fruit juice industry has in our day-to-day life, the environmental, economic and social sustainability challenges the industry is currently facing have not received the deserved attention from the scientific community. In this scenario, this work aims to bridge the existing information gap, so current hotspots can be identified. To do so, a questionnaire consisting of 18 questions was prepared and submitted to relevant international stakeholders in the field. Results showed a growing awareness towards carbon footprint and social aspects in the fruit juicy supply chain. Obtained responses reveal the request to improve environmental aspects is principally originated and driven by customers and translated upstream. Moreover, the sector is well aware of the need to set common sustainability targets so that climate targets can be achieved. With this new information, this work identifies the priorities in the fruit juice industry towards environmental, social and economic sustainability. However, and given the need to adopt a multi-stakeholder perspective to obtain a holistic view, we estimate further research is needed to map the myriad of sustainability initiatives within the sector, including different tiers of the supply chain up to consumers.

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