



Review

Do consumers care about environmentally sustainable attributes along the food supply chain? —A systematic literature review

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Abstract: The agri-food market has shown a clear signal of “green” consumption that drives an increasing interest in studying consumers’ willingness to pay (WTP) for food products with environmentally sustainable attributes, such as eco-friendly and carbon neutral. Whilst many existing studies have focused on a general idea of green attributes or on-farm practices that are regarded to be most relevant to the attributes, the agri-food industry has started to address consumers’ concerns about the negative environmental impacts of agri-food production across the whole supply chain, including the processing, transportation, and consumption process. It is therefore the purpose of this study to conduct a systematic review of the existing literature on consumers’ intentions of purchasing and WTP for food products with environmentally sustainable attributes, with a special interest in understanding the connections between consumer behaviours and different stages of the food supply chain. Results of the study revealed three main research gaps: the lack of clear definitions of environmentally sustainable attributes; ignorance of connections between the characteristics of environmentally sustainable attributes and different stages of the food supply chain; and lacking effective information processing among the key players along the supply chain, leading to inefficient communication between the supply and demand side. The findings of the study help form a conceptual framework for future studies to associate environmentally sustainable attributes to the whole food supply chain that helps the agri-food industry to effectively process market information, communicate with consumers, and satisfy the market demand.

Keywords: agri-food; environmentally sustainable attributes; food supply chain; systematic review

1. Introduction

The agri-food market has shown a trend of increasing demand for food products with credence attributes (CAs), such as “green”, organic, and good animal welfare [1,2]. Notably, one of the most discussed credence attributes is related to the environment in recent years [3,4], which is driven by the increasing awareness of the association between agricultural production, intensive use of resources (e.g., water and land), and nutrient pollution. For example, a 30% increase in milk production between 2005 and 2015 had greenhouse gas (GHG) emissions increased by 18% [5]. Hence, more and more consumers have moved from focusing on self-interests in food consumption (e.g., health benefits) to ethical consumption, for instance, purchasing food products labelled as environmentally friendly or carbon-neutral [6]. Note that, different from the traditional food attributes (e.g., taste and color) that are observable and identifiable, the environmentally sustainable attributes have abstract characteristics that cannot be observed and identified – consumers could not easily tell the difference from “green” foods and traditional foods by simply looking at food labels [1,7]. Therefore, there has been an increasing interest in studying the demand for food products with CAs, especially environmentally sustainable attributes to understand consumers’ attitudes toward and willingness to pay (WTP) for environmentally sustainable attributes [8–10]. Those studies find that consumers are willing to pay a higher price premium for food products with environmentally sustainable attributes. Notably, variations of WTP exist across types of food products and targeted markets regarding the demand for environmentally sustainable attributes of food products: consumers are more willing to pay a higher price premium for food products they consume daily (e.g., rice) than those they occasionally eat [3]; the Australasian and European markets show higher consumer WTP for “green” foods than the USA and Asian markets [2,11].

However, the existing studies barely provide clear definitions of environmentally sustainable attributes; and it is difficult to validate whether or not consumers’ understanding of the given environmentally sustainable attributes, such as eco-friendly, is the same as what producers provide. Although results of many studies show that consumers are willing to purchase food products with environmentally sustainable attributes, it is not clear whether or not they understand the attribute claims – food labels such as “green” and “environmentally friendly” can be vague and general [12]. It is often expected that most of the environmentally sustainable attributes of food products are related to the production stage, mainly within farm gates [13]. Although environmentally sustainable attributes are most closely related to on-farm production, the agri-food industry intends to reduce negative environmental impacts across the whole supply chain [12]. For example, some firms introduce new products with less packaging, such as reusable bottles [14], or environmentally friendly packaging materials, such as biodegradable plastics [15]; some others tend to reduce carbon footprints by using electric vehicles in transportation or selling locally [16,17]. When labelled as “green” products, the attribute “green” can be interpreted as less nutrient pollution on farm, and/or less packaging, and/or less footprint in transportation. Therefore, it is important to explore the market demand for environmentally sustainable attributes of food products from a whole supply chain perspective to understand whether or not consumers know and care about environmentally sustainable attributes across different stages of the food supply chain, which could turn to help better communication between the agri-food industry and the market regarding delivering the information about environmentally sustainable attributes. Although there is an intensive discussion about consumers’ attitudes toward and WTP for food products with environmentally sustainable attributes, the existing

literature lacks a comprehensive understanding of the relative topic from a whole supply chain perspective; those looking into both environmentally sustainable attributes and food supply chain mainly focus on supply chain management from the firm side whilst ignoring the market [18,19], i.e., how consumers value those attributes associated with the food supply chain.

Given the importance of the environmental impact of food production, there are review studies that attempted to address the issue of environmentally sustainable labels from both the producer and consumer side. As environmental footprints are the most concerned by-products of food production, the existing review papers, such as Clark and Tilman, estimated the environmental impacts of food products, based on four indicators including GHGs, land use, water stress, and eutrophication potential [20,21]. The researchers believe the environmental impacts of various farming systems that deliver environmentally sustainable attributes should be clearly communicated to the market. From a food nutrition perspective, Green, Nemecek, Chaudhary, and Mathys related environmental sustainability attributes to food nutrition to assess the environmental sustainability of food production under the framework of dietary quality metrics [22]. From the consumer side, the existing studies are mainly quantitative reviews using the meta-analysis method. For instance, Bastounis, Buckell, Hartmann-Boyce, Cook, King, et al. estimated consumer WTP for environmental sustainability labels by analysing results for studies adopting the discrete choice experiments [23] and found that the values of WTP varied across different labels, such as organic and ecolabels; Li and Kallas estimated consumer WTP across a wide range of sustainable food products and found factors, such as consumer characteristics, regions, types of products, and analysis methods influence the average WTP values [24]. One exemption from Poore and Nemecek seems to explore environmentally sustainable production from both the producer and consumer side. They associated the environmental impact of production with changes in consumers by looking into the dietary changes of consumers and how producers adopted good practices to meet environmental targets [25]. Hence, there is a clear gap in the existing review studies that the environmentally sustainable attributes have not been viewed and assessed from the whole supply chain perspective, i.e., how different players along the chain respond to and contribute to the market demand for environmentally sustainable attributes.

This study aims to conduct a synthesis review of the literature on environmentally sustainable attributes of food products across different stages of the food supply chain and map a research agenda for future studies. Specifically, the study intends to: (i) conduct a comprehensive state of the art on how environmentally sustainable attributes of food products are placed in the food supply chain and perceived by the market, (ii) analyse it from the perspective of the definition of environmentally sustainable attributes (e.g., types) and the whole supply chain perspective, as well as (iii) identify the gaps in the literature and suggest potential directions for future research. The contributions of this study are threefold. First, the results of the study contribute to the literature on credence attributes of food products by understanding the different definitions of environmentally sustainable attributes from the market perspective: those studied the most in the existing studies may represent the most valued attributes by consumers. Second, the study is the first attempt to identify and associate environmentally sustainable attributes with different stages of supply chain management, given the existing studies either only focus on one stage of the food supply chain (e.g., on-farm practices [26–28] or simply see this from the perspective of firms regarding supply chain management (e.g., cost-sharing [19]). Third, the study further proposes a conceptual research framework for future studies: the study of environmentally sustainable attributes needs to consider avoiding vague and general definitions of the attributes by providing clear explanations of the attributes and how these attributes are related to

different stages of the food supply chain.

The rest of the paper is structured as follows. The systematic review method, including the literature retrieval and data inclusion/exclusion process are presented in Section 2. Section 3 presents the descriptive analysis of the qualified studies included in the review, followed by Section 4 to discuss the identified research gap and the conceptual model for future research agenda. Section 5 concludes the paper.

2. Materials and methods

The literature retrieval process follows the PRIMSA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) statement to select and report the relevant studies included in this study [29,30]. As it is shown in Figure 1, the process included four stages. The first stage is the identification stage. To adequately cover relevant literature on the present study, we searched literature from two dominant databases: the Web of Science (WOS) core collection and Scopus, on the title, abstract, or keywords of the articles. To attain maximum reliability of the data, all authors searched and evaluated literature from both databases separately using the same procedure. The identification stage yielded 444 articles, with 322 from WOS and 122 from Scopus. Three hundred and sixty-six (366) studies were recorded after removing the duplications: note that, to avoid duplication, articles already identified by one search engine were discarded when found the second time by another search engine (78 articles were identified). At the screening stage, we framed explicit inclusion and exclusion criteria to determine which studies should be reviewed. First, studies must possess the keyword(s) “green food”, “green-food”, eco-friendly”, “eco-friendly “environmental friendly”, “environmental-friendly”, organic, “carbon emission”, “carbon-emission”, “water quality”, “water-quality”, “environmental sustainability”, “environmental-sustainability”. These keywords are the most used words in describing the environmentally sustainable attribute of food products [2,6,31]. Second, to ensure the quality of the studies, we only considered peer-reviewed journal articles and excluded document types such as conference proceedings, book chapters, etc. Third, the original language of the articles must be English. Fourth, we considered articles published from 2001 to the present (November 2022) because environmentally sustainable attributes mainly emerged in the literature in 2001 [3,4]. Hence, 78 records were produced. The third stage is to check the eligibility by checking the full text of the 78 studies. We further placed restrictions on the 78 articles such that they should focus on consumers and the food supply chain using the keywords on consumer behaviour: “purchase”, “WTP”, “willingness to pay”, “willingness-to-pay”, “willingness to buy”, “willingness-to-buy”, “preference” and on food supply chain: “Food Supply Chain”, “Food”, “Supply Chain”. Following these criteria, we manually assessed the relevance of the included articles by reviewing the full paper, including the title, abstract, keywords, and main text. We then got 94 records, with 5 review studies and 6 studies with no full texts removed; following the new PRIMSA statement, we also reviewed the 5 review studies and identified 27 more studies that were not retrieved from the previous steps¹. Lastly, we got a total of 94 articles to be used in the analysis of the systematic review (the details of the articles are included in the Appendix).

¹ Missing of the 27 studies can be due to the exclusion of other database. Note that we did search other database such as AgEcon and Google scholar, with 168 more studies identified. However, following most of review studies, we stick to the original plan, i.e., only focusing on WOS and Scopus to ensure the quality of studies included in the analysis.

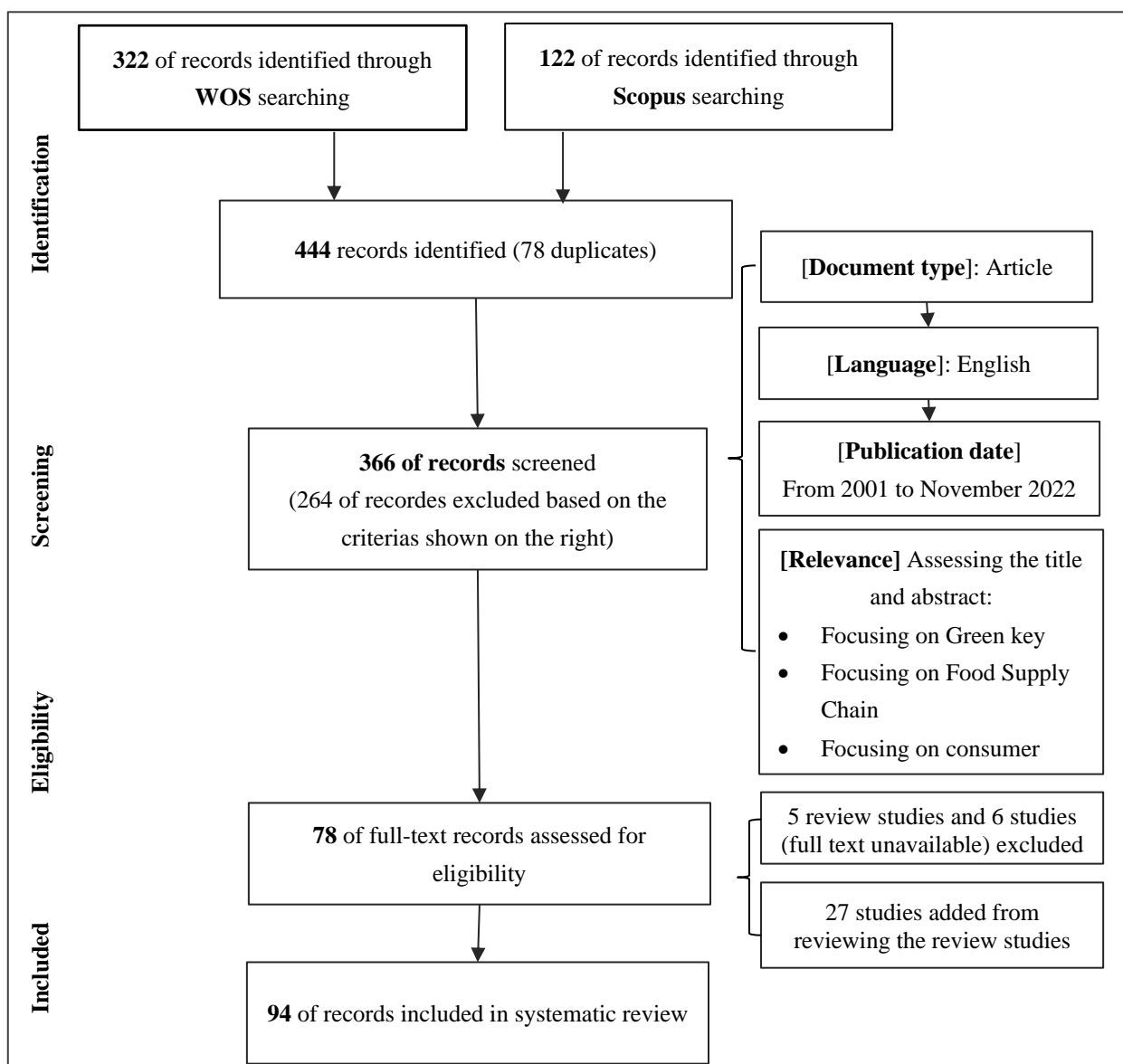


Figure 1. Literature review retrieval process for systematic review data².

3. Results

3.1. Distribution of articles over time

As expected, there is a steady increase in the number of articles on the two concepts, i.e., “environmentally sustainable attributes” and food supply chain, over time. As is shown in Figure 2, amongst the 75 articles included in this study, the number of journal articles increased from one in

² The full codes used in searching the literature are as follows: (TITLE-ABS-KEY ({green food} OR {green-food} OR eco-friendly OR {eco friendly} OR {environmental friendly} OR {environmental-friendly} OR organic OR {carbon emission} OR {carbon-emission} OR {water quality} OR {water-quality} OR {environmental sustainability} OR {environmental-sustainability})) AND TITLE-ABS-KEY (purchas* OR wtp OR {willingness to pay} OR {willingness-to-pay} OR {willingness to buy} OR {willingness-to-buy} OR preference*) AND TITLE-ABS-KEY ({Food Supply Chain} OR food {Supply Chain})) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")).

2001 to 13 in 2021 and 11 in 2022. This result is consistent with the results of extant studies on credence attributes regarding the increasing trend of publications over time [3,4,12,32]. Note that, although the number of studies on environmentally sustainable attributes of food products was not scarce during the first decade (2001–2010) (e.g., [33–38]), they mainly explored the issue from the market side regarding consumers' attitudes and perceptions of the attributes, with no relations built between the market and the food supply chain. Additionally, the increasing trend is presented in the types of environmentally sustainable attributes: we found that organic was the main attribute of food products addressed in the literature before 2010, whilst more types of environmentally sustainable attributes, such as “green” food, water quality, and eco-friendly emerged in the market and attracted the interest of researchers. There is another trend that the studies moved from exploring a general or vague idea of environmentally sustainable attributes, such as “green” and “environmentally friendly” to focusing on a specific environmental issue, such as water quality and carbon emission in recent years. These findings align with the results of the study by Yang and Fang [3] that both the number of articles and the types of “green” attributes addressed in the articles increased over time, and notably, researchers intend to specify the environmentally sustainable attributes according to the contemporary environmental issues (e.g., ecosystem and climate change)[3].

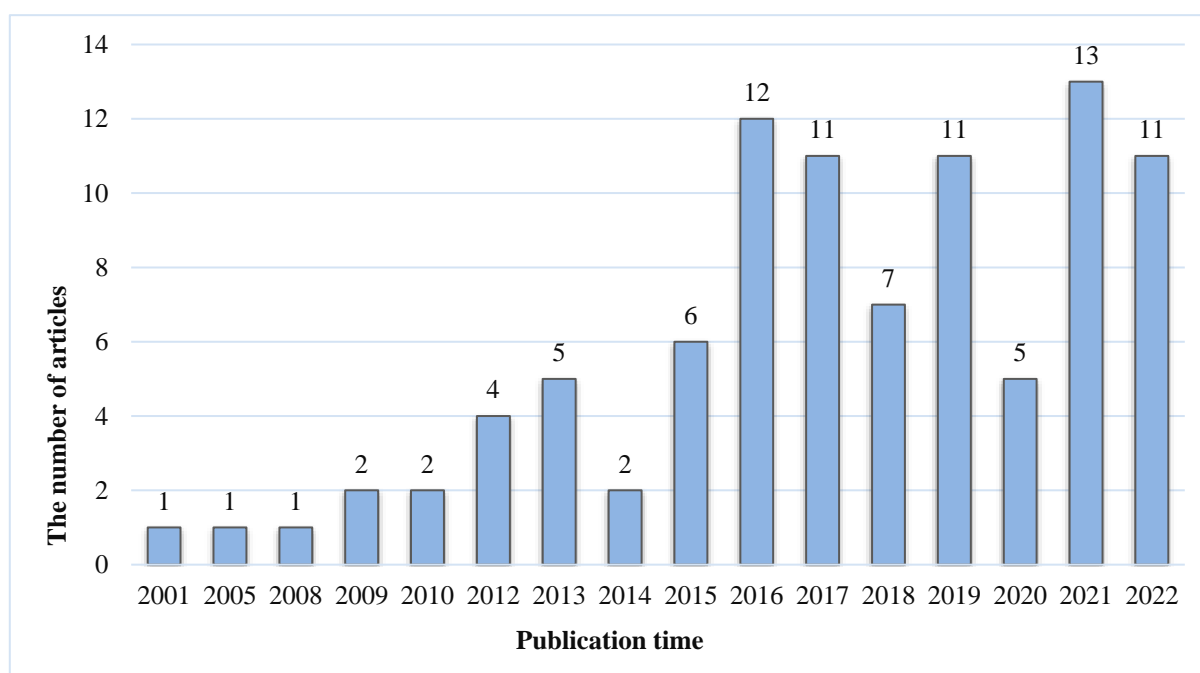


Figure 2. Distribution of journal articles by publication time.

3.2. Types of environmentally sustainable attributes

One of the main focuses of the study is to explore the definition of environmentally sustainable attributes of food products because the understanding of environmentally sustainable attributes may differ across consumers: some consumers may have a general idea of what environmentally sustainable attributes are and simply relate them to good environmental practices adopted by producers whilst others could have a specific concern about the environment and associate environmentally sustainable

attributes with a clear environmental protection practice, such as protecting water quality and reducing carbon emissions [11,39]. Different understandings of environmentally sustainable attributes could be reflected in the literature, and the results of the relevant studies indicate the market response to consumer preference [6]. Figure 3 presents the results of researchers' interests by types of environmentally sustainable attributes. As shown in the figure, most of the researchers were interested in understanding consumers' purchasing behaviours toward organic, with 55% of the included articles targeting the attribute of organic. The attribute of organic has been well marketed and sustained in the market since early 2000, and it has the characteristics of less intensive use of natural resources and artificial inputs (e.g., chemical fertiliser and pesticide) [40]. Although organic consumption is regarded to be ethical [41], a large proportion of organic consumers prefer organic foods due to the belief in the association between organic farming practices and health and safety foods [42,43]. There are, indeed, many other consumers who take organic consumption as a means of achieving social responsibility as such the natural resources are better utilised, and less pollution is expected in agricultural production [41,43]. Therefore, when interpreting the largest representation of organic foods in the included studies, it cannot be guaranteed that all organic consumers are driven by the "expected" (i.e., environmental-related) characteristics of environmentally sustainable attributes. Notably, the proportion of attributes that are vaguely defined, including environmental friendly (14%), environmental sustainable (8%), eco-friendly (3%), and green food (4%), takes a total of 29% of the included articles, indicating that the market is lack of clear understanding of environmentally sustainable attributes, and that is, although consumers are willing to purchase food products with the so-called environmentally sustainable attributes, they may not know what these attributes are. This finding also indicates that, though difficult to be verified by simply reading the label, the wording "environmentally friendly" or "green" might be a successful marketing strategy and easy for consumers to accept [44]. There are 14% of articles that focused on attributes related to carbon emissions, such as low carbon and carbon neutrality [45]. Different from the above attributes that are vaguely defined, the consumption of zero-carbon or low-carbon foods is more straightforward and can be directly related to consumers' awareness of the environment. Lastly, only 2% of the articles were interested in the attribute of water quality protection—compared to climate change, water issues might be less concerned for consumers.

3.3. Distribution across the food supply chain

Environmentally sustainable attributes can be related to different stages of the food supply chain, and the players along the food supply chain have to contribute to achieving this goal [13]. Based on the analysis of the included articles, we found that most studies associated environmentally sustainable attributes with the consumption stage of the food supply chain, with 38.7% on "green" consumption. Consumers play a crucial role in driving the delivery of environmentally sustainable attributes of food products [6]—many innovative practices of the food supply chain are driven by the market [19]. It is believed that consumer preference and WTP for environmentally sustainable attributes motivate producers to change their ways of production and operation [13,46]. Currently, however, green consumption not only requires efforts from the producer side but also the consumer side. Specifically, food waste as a global issue needs the contribution of the agri-food industry as well as every single consumer [18,47]. That is, it is expected that green consumption of food products followed by no or little food waste—consumers consist of the last but important link of the "green" food supply chain [48,49].

However, the review results show that only a small number of articles addressed the role of consumers in the food supply chain as a key to achieving environmentally sustainable—most of the existing studies only see consumers as drivers rather than actors. On-farm practices (21.1%) are also regarded to be closely related to environmentally sustainable attributes. The attention to farmers' contributions to environmentally sustainable attributes is as expected: when seeing the food labels of environmentally sustainable attributes, consumers may easily relate those to good farming practices, such as the improvement of resource use efficiency, the reduction of negative outputs (e.g., carbon emission and nitrate leaching) [11,13]. Interestingly, there are 21.1% of articles that look into the relationship between environmentally sustainable attributes and the food supply chain from the perspective of retailers, mainly due to the position of retailers along the food supply chain (i.e., they are at the front line facing the market directly). In particular, small-scale retailers tend to show interest and gain the associated benefits of selling food products with environmentally sustainable attributes [50]. Compared to large-scale retailers (e.g., supermarkets), small retailers usually work closely with farmers and/or processors and deal with consumers directly, and hence they are more likely to build trust and share knowledge with consumers regarding environmentally sustainable attributes [51]. Processors, however, gained less attention in the literature, only taking 13.1% of the included articles. This trend might change due to the increasing concerns about overpacking and high carbon emissions of transportation [52]. It is, indeed, the processors' responsibility to address these issues and get back to the market with food products that are regarded to be environmentally sustainable: some processors reduce the use of plastics in packaging while others adopt new packaging materials, such as usable containers and biodegradable plastics [15]; also, selling locally is regarded to be another means of contributing to reducing carbon footprints of long-haul transportation [45,50,53]. Lastly, a few researchers aimed to link environmentally sustainable attributes to the whole supply chain (6 % of articles), and these articles mainly fell into the field of operation research [18,19].

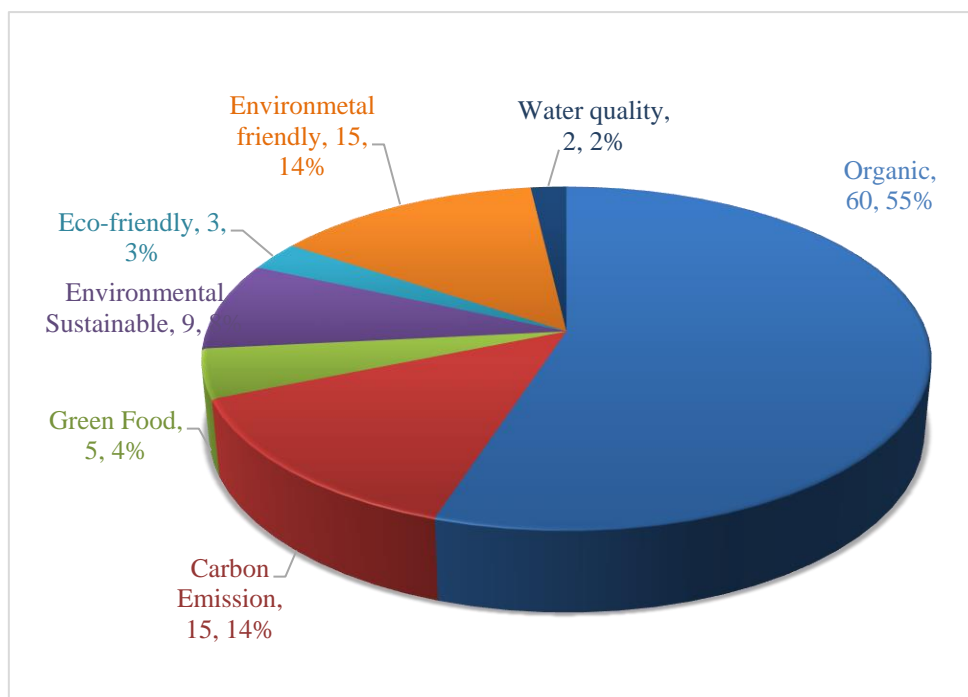


Figure 3. Distribution of types of environmentally sustainable attributes.

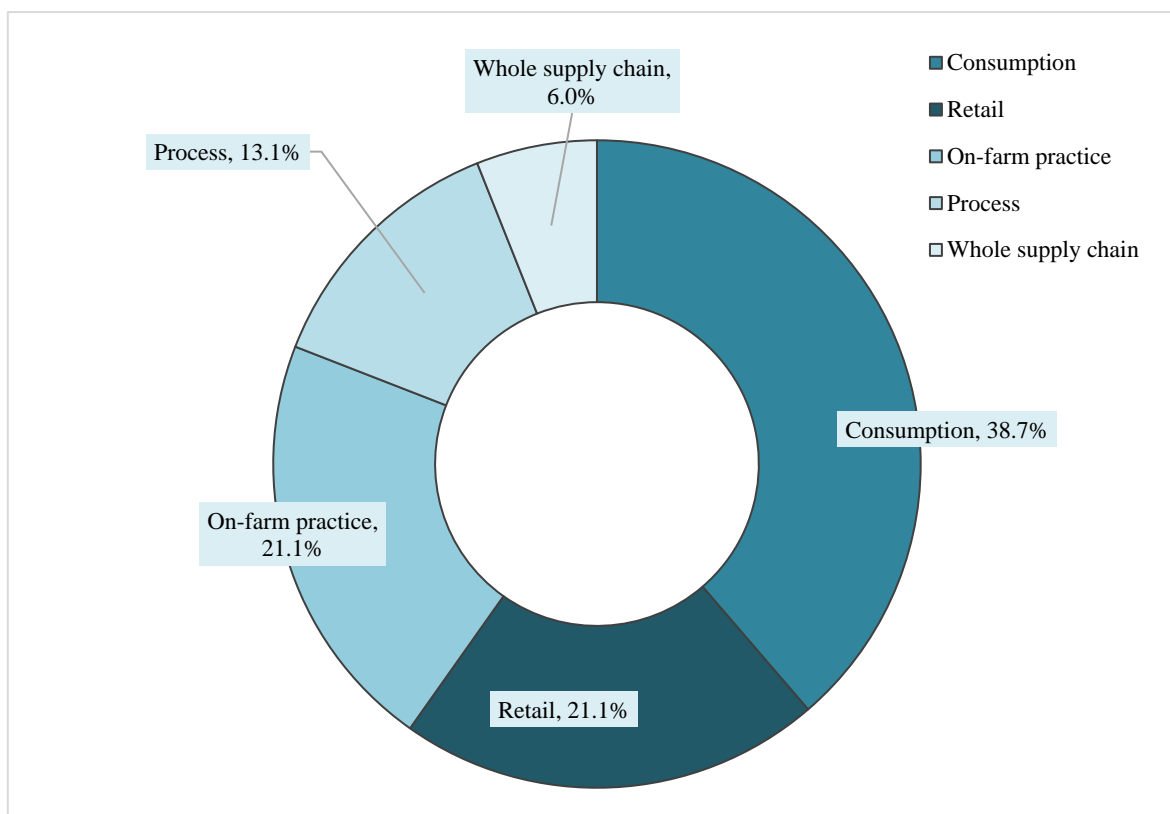


Figure 4. Distribution by different stages of a food supply chain.

3.4. Research methodologies applied

The last important aspect this review aims to explore is the research methods adopted in the included articles. Table 1 summarises the number of articles by five main groups of research methods, including theoretical study, case study, and empirical study. As shown in Table 1, most studies used empirical analysis methods to explore consumer purchasing behaviours, including a) consumer intention to purchase food products with environmentally sustainable attributes (e.g., [54–57]), b) consumer WTP for the given environmentally sustainable attributes (e.g., [52,58–60]), c) factors affecting consumer purchasing behaviour (e.g., [61–63]), and d) types of consumers based on the demographic and social-economic characteristics (e.g., [48,56,64,65]). Choice modelling methods, such as choice experiments and contingent analysis, were the most used empirical analysis methods in analysing consumer behaviours: participants are offered a comprehensive questionnaire (and choice card for choice experiments) and the answers can be fed into the choice modelling framework to explore consumer purchasing decision based on utility maximisation. Choice modelling has the advantage of considering the heterogeneity of consumers and the estimation of consumer WTP, and hence has been widely applied in economics studies [66]. Factor analysis (and cluster analysis) also takes the lead in empirical analysis studies, which is mainly used in marketing studies that aim to understand consumer behaviours by market segments [48,67]. Similar to choice modelling, factor analysis needs to gather information via surveys regarding the demographic and social economic characteristics of consumers. About one-fourth of studies used descriptive analysis. Being a relatively simple empirical analysis method, the descriptive analysis may provide basic facts about the sample

of consumers but not give depth understanding of consumer and consumer behaviour [58]. A small number of researchers used other empirical analysis methods, such as lifecycle analysis to model the environmental impacts of green food consumption along the food supply chain [49]. Most operation research studies intended to build a theoretical framework to analyse the food supply chain, considering the delivery of “green” food products to the market. Most of the theoretical studies built mathematical models, mainly optimisation, to understand the impact of providing environmentally sustainable attributes on supply chain management, such as cost, risk, and market share (e.g., [19,68–71]); a couple of other studies used simulation (agent-based model) and conceptual model to model the value of supplying food products with environmentally sustainable attributes [72,73]. There are also case studies that mainly focused on one region or country, based on qualitative analysis methods [74,75].

Table 1. List of research methods of the included articles.

		Research method							
		Empirical analysis (76)				Theoretical modelling (11)			Case study
		Choice modelling	Factor analysis	Descriptive analysis	Others	Optimisation	Simulation	Conceptual model	
No. of research articles	40	21	17	3	10	1	1	10	

4. Discussion

4.1. Research gaps in the existing literature

4.1.1. What is an environmentally sustainable attribute

The general and vague definitions of environmentally sustainable attributes may lead to poor communication between producers and consumers. The above results revealed different environmentally sustainable attributes in the literature. Given the increasing trend in the types of environmentally sustainable attributes over time, we assume that this finding reflects the emergence of many different environmentally sustainable attributes in the market. However, the majority of attributes, such as environmentally friendly, environmentally sustainable, and green, do not carry enough information for consumers regarding what the attribute is; though in some cases, consumers are provided with certificates for those attributes. For example, a study on the palm oil industry in Germany explored consumers’ intentions and WTP for the so-called sustainable palm oil [77], and another study on organic food estimated consumers’ WTP for organic olive oil [78]. Both studies adopted a choice experiment that simply provided information about the sustainable certificate and organic certificate (with two levels, YES or No) for consumers to make their purchasing decision-making. Hence, they simply assumed that consumers know about sustainable or organic attributes, and most importantly consumers are assumed to trust the certificates provided. Although organic seems to be a well-defined attribute, one may not tell if organic means all or part of the food ingredients follow the expectation of organic, and whether or not different organic certificates may place different requirements for producers [55,76]. When it comes to the “sustainable” or “green” certificates, things

can be even more complex. Therefore, it may not be fair for consumers to buy food products with environmentally sustainable attributes that they do not understand, even if they are willing to purchase them. The results of those studies could not satisfy the needs of the agri-food industry regarding what attributes consumers truly prefer and are willing to buy. Fortunately, we found that an increasing number of environmentally sustainable attributes offer information about specific environmental problems, such as eco-system, carbon emission, and water quality [45,79,80]. It is worth noting that researchers have to give clear information about, for instance, low carbon emissions: if “low” emissions mean lower emissions than that of conventional food products, then 10% lower or 90% lower emissions could make it very different for purchasing decisions. To educate consumers and promote green consumption, the agri-food industry needs to educate consumers with clear explanations about being environmentally sustainable and how the whole supply chain could contribute to achieving that goal [72,81].

4.1.2. The connection between environmentally sustainable attributes and the food supply chain

Another gap identified by the review is the lack of connection between environmentally sustainable attributes and the food supply chain. To various degrees, the researchers mentioned the importance of linking environmentally sustainable attributes to the food supply chain. However, the existing studies have two main limitations. First, many studies addressed the association between environmentally sustainable attributes and the food supply chain by introducing it as a contextual concept, and hence they lacked depth analysis of the association. For example, when presenting the “green” attitude to participants, the studies did not specify how many and how different players contribute to “green” foods. Indeed, this situation is often what consumers encounter when making purchasing decisions - they simply assess the “green” label by using their knowledge about the attribute or relying on the trust of the certificate. Second, those studies that attempted to incorporate the impact of environmentally sustainable attributes into food supply chain analysis often focused on firm side decisions whilst ignoring the market side story [19,82]. For some CAs, such as health and nutrition, it is relatively easy for consumers to know about the “good” characteristics. For example, consumers could understand what is “no hormone”, “no pesticides”, or “cage-free” by reading the food labels [83]. The environmentally sustainable attributes are abstract, and hence simply having the slogan of “caring about the earth” would not help explain the attributes. Therefore, agri-food companies need to consider the effective means of incorporating all the relevant information along the chain and delivering it to the market efficiently. The evident connection between the environmentally sustainable attributes (specifically how they are viewed by consumers) and different stages of the food supply chain may lead to the adoption of the systems thinking [84]: the agri-food industry may consider implementing strategies based on systems mapping to facilitate collaborations among the key players along the food supply chain so that relevant information can be created and shared transparently; policy makers may provide support to accelerate systems changes by designing policy instruments that incorporate the configuration of key players and their contributions to environmentally sustainable production.

4.1.3. Information processing—transparency along the supply chain

There exists information asymmetry in delivering food products with environmentally sustainable attributes to the market. As stated above, food labels may not carry sufficient information about what

an environmentally sustainable attribute is as well as how that is related to different players along the food supply chain. In that way, the information process between producers and consumers could be inefficient. On the one hand, consumers cannot get the information that producers would like to deliver, which leads to uncertainties during the purchasing process [76]. On the other hand, producers may misinterpret the market signals, assuming the current labelling strategy meets the market demand. Our results showed that different players along the supply chain contribute to the delivery of environmentally sustainable attributes. Thus, a good understanding of the contributions at different stages of the chain could help the communication between the supply and demand side: producers can effectively decode the market signal regarding what consumers want, and consumers have the opportunity to gain accurate information about the products—trust can be built amongst the players [55,76]. The literature on supply chain management shows that transparency of a supply chain is the extent to which all its stakeholders have a shared understanding of and access to the product-related information, without loss, noise, delay, and distortion [85,86]—it is essential to guarantee food quality in the food supply chain. A food supply chain with transparency, for instance, supported by information systems or technologies, may help solve the information asymmetry between the supply and demand side of the agri-food market. Information comes at a cost, and so it is crucial that agri-food companies first identify the knowledge gap of consumers regarding environmentally sustainable attributes and whether or not they care about the linkages between the attributes and the food supply chain. For instance, are they more willing to pay for the attitudes associated with on-farm practices, such as good environmental practices, and/or they care more about the processing and transportation stages, such as packing and energy usage? Given the advancement of technology development, new technologies, such as QR codes and blockchain, may help processing and delivering the information along the chain and achieve the goal of transparency [78–80].

4.2. The conceptual model for future research themes

Based on the research gaps discussed above, we have identified two research themes for future studies, as shown in Figure 5. First, future studies should consider investigating consumers' understanding of environmentally sustainable attributes before asking about their purchasing intentions and WTP. In particular, on the one hand, the types of existing environmentally sustainable attributes should be carefully defined. For instance, it could be significantly different if consumers are asked about environmentally sustainable attributes in two ways as follows:

- 1) Environmentally sustainable attributes are regarded to be associated with food products with less environmental pollution (or, good to the environment).
- 2) Environmentally sustainable attributes are regarded to be associated with food products with less environmental pollution (or, good to the environment), having the characteristics of less input of chemical fertiliser and pesticide, fewer carbon emissions, and less nutrient pollution to waterways.

Here, future studies may ask about consumers' preferences for the two statements and get to know if one is preferred. Also, researchers may consider designing experiments to allocate consumers into two groups: one with a general definition of environmentally sustainable attributes (e.g., question 1), and the other provides more specific definitions. It would be interesting to see how consumers respond to the two statements regarding their purchasing intentions and WTP. On the other hand, environmentally sustainable attributes need to be associated with different stages of the food supply chain. The effectiveness of obtaining and processing market information is key for firms to succeed in

the agri-food market. Hence the collection, analysis, and sharing of market information play a vital role to determine effective communication with the market [90]. In addition, information processing along the food supply chain is the process of building trust among different players along the supply chain [51,65,76]. From a market perspective, it is vital to understand, to what extent consumers know and care about the associations between environmentally sustainable attributes and different stages of the food supply chain, as shown in the middle of Figure 5. For example, researchers could ask consumers about their intentions and WTP for environmentally sustainable products after reading the following statements:

- 1) Food products with the given environmentally sustainable attribute are associated with less input of chemical fertiliser and pesticides, fewer carbon emissions, and less nutrient pollution to waterways.
- 2) Food products with the given environmentally sustainable attribute are associated with locally produced and fewer carbon footprints and simple packaging with biodegradable plastics.
- 3) Food products with the given environmentally sustainable attribute are associated with funds raised by the retailer (supermarket) to support restoring and maintaining the local ecosystem.

The second research theme lies in improving the transparency of information processing and sharing along the food supply chain. As it is shown in Figure 5, effective communication is an important determinant of green consumption [51]. It, on the one hand, helps send the market signal to drive the agri-food industry to produce toward environmental sustainability. A food supply chain built with transparency for information sharing can facilitate the delivery of market demand and reduce the cost of information asymmetry [71]. On the other hand, firms should introduce the “right” products to the market by accurately processing the information about consumer behaviours. In response to “what consumers really want”, firms can position environmentally sustainable attributes in a way that consumers can easily access and understand. That is, they may consider introducing digital technologies to change the credence attributes into “search” attributes that consumers could check directly through real-time, automated data collection and analysis [91]. A food supply chain with high transparency may bring benefits for the key players of the chain, in particular, smallholder farmers and consumers regarding data access and use, and direct connection between producers and consumers [91,92].

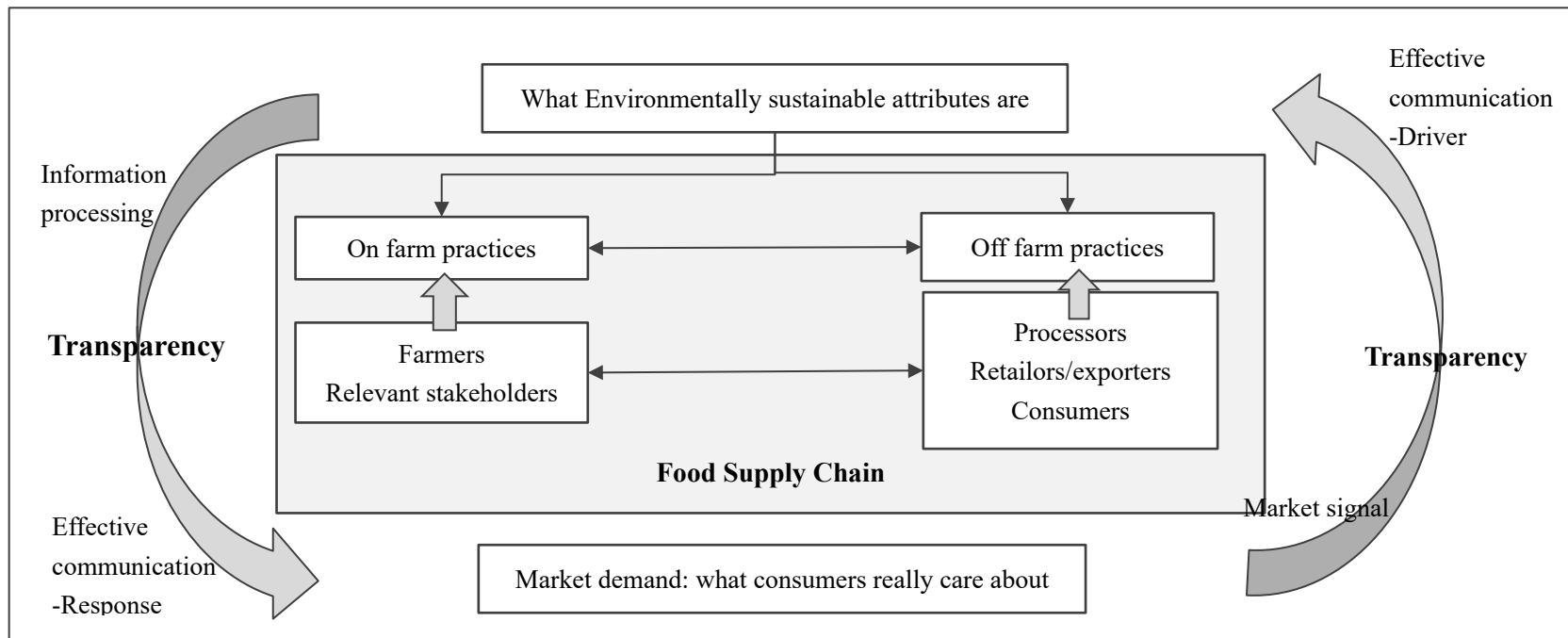


Figure 5. The conceptual model for future study agenda.

5. Conclusions

This study conducted a comprehensive review of the literature on environmentally sustainable attributes and their connections to the food supply chain. It is the first attempt that explored consumer purchasing behaviours for food products with environmentally sustainable attributes from a whole supply chain perspective. The results of the review show a steady increase in the number of relevant studies, indicating the importance of environmentally sustainable attributes in the agri-food industry. Organic is found to be the most popular “green” attribute of food products, which may attract consumers with the demand for “green” and healthy consumption. Carbon emission is another top-rated “green” attribute in the literature, indicating the importance of climate change to the current society. Interestingly, our results show that whilst many studies have focused on relating environmentally sustainable attributes to on-farm practices and understanding the market response, a lot more intend to investigate consumers’ responses to environmentally sustainable attributes that are related to the retailing stage. Our findings identified three main research gaps: the lack of a clear definition of environmentally sustainable attributes; ignorance of connections between the characteristics of environmentally sustainable attributes and different stages of the food supply chain; and lacking effective information processing among the key players along the supply chain, leading to inefficient communication between the supply and demand side. The findings further help lead to two research themes: future studies should explore consumers’ understanding of environmentally sustainable attributes prior to analysing their purchasing intentions and WTP – to do so, they need to have clear definitions of environmentally sustainable attributes and their associations to different stages of the food supply chain; they could also consider conducting research on how to process and share information and among the key players of the food supply chain, increase the transparency of the chain, and improve communication efficiency between the supply and demand side. Lastly, our findings may provide some policy implications.

This study comes with three main limitations. First, the study used the most adopted PRIMSA statement to conduct the literature retrieval, but there is an updated 2020 PRIMSA statement published in 2021 [30]. Though sharing similarities in the searching and reporting process in the two versions of statements, the new statement suggests a more detailed report of each screening and validating process. Most importantly, the new statement requires the identification of studies from non-academic sources, such as websites and organisation reports, which we could not fully follow. Second, the study did not review the reference lists of all the included studies, and only the reference lists of review studies identified in the literature retrieval process were reviewed. It would be good for future studies to adopt the application of “snowballing” such that the reference lists of all studies included in the final sample are reviewed to identify any papers missed in the previous steps. Third, we did not consider studies that focus on other credence attributes, such as animal welfare and local food. Although these attributes are not directly related to environmentally sustainable attributes, positive spillover effects are expected in the production of good animal welfare or local chains. Future studies may consider addressing this issue by reframing the literature-searching strategy to consider the contribution of other credence attributes to environmentally sustainable production. Last, besides specifying the definition of environmentally sustainable attributes, future studies may consider digging into 1) how the attributes are framed, which could affect consumer purchasing decisions; and 2) how many attributes are studied in one study to check and summarise the synergies across different labels, if any, in the same products.

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Conflict of interest

The authors declare that they have no known competing financial interests, or personal relationships that could have appeared to influence the work reported in this paper.

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