

Consumers behaviour towards carbon footprint labels on food: a review of the literature and discussion of industry implications

Article

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2 **Consumers behaviour towards carbon footprint labels on food: A**
3 **review of the literature and discussion of industry implications**
4

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28

29 **Abstract**

30 Carbon footprint labels allow manufactures to show information about the impact that their food
31 production has on the environment, as well as to help consumers make more sustainable choices.
32 Thus, investigating consumers' reaction towards carbon footprint labels is vital to understand their
33 effectiveness. The aim of this manuscript is to identify the state of the art and research gaps on this
34 topic, by conducting a literature review of published scientific article between 2011-2020. In total,
35 38 papers emerged. Findings show that females, adults, with higher income and educational level
36 have a more positive attitude towards carbon footprint labels. Furthermore, people expressing higher
37 environmental concern and those who are used to buy eco-friendly labelled foods are willing to pay
38 more for carbon footprint labelled foods. However, it also emerges that consumers still have poor
39 knowledge of carbon measurements and the existing carbon footprint label system is still unclear.
40 When carbon footprint labels are re-designed using consumers friendly symbols (e.g., traffic light
41 colours), their consumers' understanding significantly increases. Consumers from countries like
42 Egypt and China also show a positive attitude towards carbon footprint information, meaning that a
43 carbon footprint label system should be developed also in the emerging countries. Nonetheless, when
44 carbon footprint is presented with other labels (e.g., organic, Fair Trade etc.) consumers show the
45 lowest willingness to pay for carbon footprint information. It was also found that using a carbon
46 footprint label on environmentally sustainable produced foods (e.g., using upcycled ingredients)
47 increase willingness to pay. Food manufacturers should better inform consumers on carbon footprint
48 labels and policy makers are advised to develop a consumers friendlier carbon footprint label system
49 to incentivize more sustainable choices. This paper is the first to summarize existing literature on
50 consumers' behaviour for carbon footprint labelled foods, providing a discusses implication for food
51 manufacturers and policy makers, as well as future research avenues.

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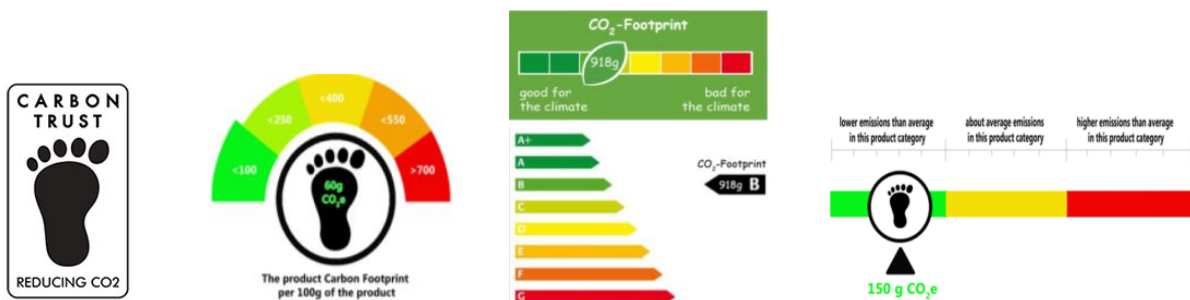
53 **Keywords:** Carbon footprint labels; Food; Consumer attitude; Behaviour; Willingness to pay;
54 Review.

55 **1. INTRODUCTION**

56 Agricultural activities are responsible alone for about 14% of global greenhouse gas (GHG) emissions
57 (FAO, 2016). With the increase of human population to up to 10 billion individuals by 2050, this is
58 expected to raise of further 10% (Hartikainen *et al.*, 2014). The importance of promoting and
59 developing sustainable activities has been promoted by several European projects and initiatives
60 (European Union, 2015; European Consumer Organisation, 2020). For example, engaging in a more
61 sustainable food consumption could help to significantly reduce the emissions of GHG (Poore and
62 Nemecek, 2018). Recently, consumers have shown to be increasingly concerned about the effects
63 that their daily activities could cause to the environment (Liu, Yan and Zhou, 2017). For these
64 reasons, over the last decade, several labels have been developed to facilitate consumers to make
65 more sustainable choices (Grunert, Hieke and Wills, 2014). One of the most well-known is the Carbon
66 Footprint (CF) labelling scheme, which was developed in the United Kingdom (UK) in 2007, and
67 was defined as “a measure of the total emission of carbon dioxide (and other greenhouse gases such
68 as nitrous oxide and methane) caused by a particular product throughout its life cycle” (Thøgersen
69 and Nielsen, 2016). The scope of these labels is to provide companies with a tool to inform consumers
70 about the carbon impacts of their food production (Kimura *et al.*, 2010). Since then, a series of
71 different CF labels have been developed, with the same aim of providing consumers with information
72 about the environmental impact of the food they purchase (see Fig. 1).

73

74 **Figure 1 - Examples of carbon footprint labels**



75 Although consumers have expressed a positive attitude towards CF labels, as shown by Li, Long and
76 Chen (2017) who found that 72% of European citizens supported the introduction of footprint
77 labelling and agreed that this should be mandatory, there is lack of clear understanding on how
78 consumers perceive and behave towards environmentally sustainable information indicated by
79 footprint labels, as well as on which are the factors that influence their attitude. Shedding light on the
80 current status of the literature on this topic could guide food producers and retailers, support
81 policymakers' efforts in providing a better regulation and ultimately better inform consumers.
82 Moreover, to the best of the authors' knowledge, a coherent overview of the factors that affect
83 consumers' behaviour, perceptions, and preferences towards CF labels is missed.

84

85 This review wants to fill this void by reviewing and discussing the academic consumer research on
86 footprint labels on food products from the last ten years aiming to (i) identify the main factors that
87 drive consumers' behaviour and willingness to pay (WTP) for CF labels; (ii) discuss implications for
88 industries and policy makers, and (iii) identify research gaps to be addressed in future studies.

89

90 To conceptualize and categorize literature findings on the topic under analysis, this review applied
91 the Alphabet Theory framework, which identifies the factors that influence consumers' behaviour,
92 which has already been used in the past in the context of food choice (Rivaroli, Baldi and Spadoni,
93 2020; Stampa, Schipmann-Schwarze and Hamm, 2020).

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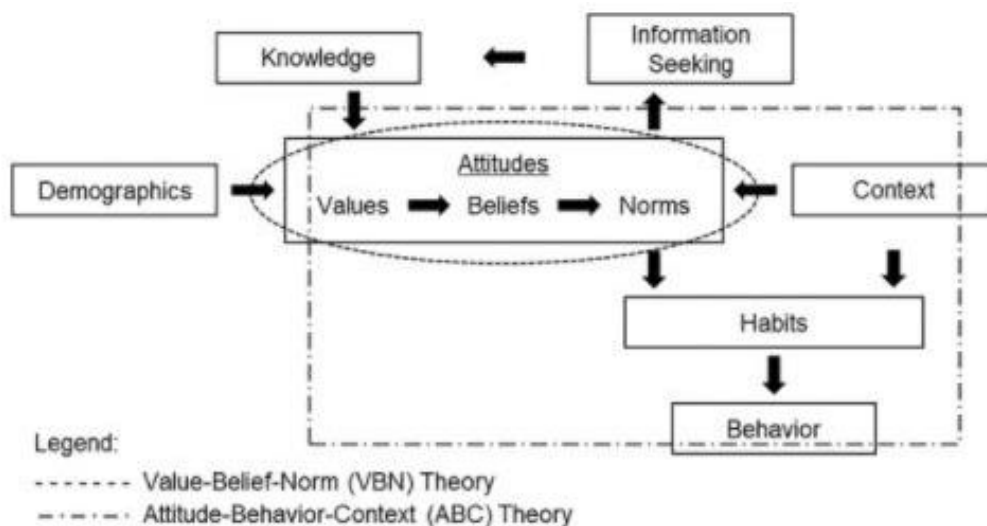
95 This review is structured as follows. First a brief description of the theoretical framework is provided.
96 Next the applied methodology followed for this review is illustrated together with an overview of the
97 selected studies. Then, the findings of the reviewed studies are structured in accordance with the
98 Alphabet Theory framework. Finally, a summary discussion and implications for industries, policy
99 makers, and future research avenues are provided.

100

101 **2. CONCEPTUAL FRAMEWORK**

102 Over the past decades, different scientific attempts were made to try to develop a framework that
 103 explained all the elements that could affect consumers pro-environmental behaviour. For example,
 104 Stern *et al.* (1999) developed the Value-Belief-Norm (VBN) theory which tells that pro-
 105 environmental behaviour is explained by five variables, personal values (PV), the New Ecological
 106 Paradigm (NEP), awareness of adverse consequences (AC), ascription of responsibility to self (AR),
 107 and personal norms (PN). Overall, the VBN is based on the idea that values directly affect beliefs,
 108 which in turn affects norms, and this affects beliefs (Stern *et al.*, 1999). Another example is the
 109 Attitude Behaviour Context (ABC) theory by Guagnano, Stern and Dietz (1995) which is based on
 110 three components, affect (which is the feeling that an individual has about something), cognition
 111 (which is people’s belief or knowledge towards something) and behaviour (which results from affect
 112 and cognition). According to the ABC theory, consumers behave based on the functional and
 113 psychological results that they can obtain from their actions (Guagnano, Stern and Dietz, 1995). For
 114 this manuscript, the Alphabet Theory model by Zepeda and Deal (2009) has been selected as
 115 conceptual framework to help structuring the findings of the literature review, which further develops
 116 from previous theories combining the VBN Theory and the ABC Theory with the addition of other
 117 components such as demographics, knowledge, information seeking and habits (see Fig. 2).

118



119

120 **Fig. 2 - The Alphabet Theory framework by Zepeda and Deal (2009).**

121

122 Particularly, the Alphabet Theory framework well fits in the context of consumers' pro-
123 environmental choices, and this is because socio-demographic factors, attitudes, information seeking,
124 knowledge and context (e.g., food availability, price product type etc.) were found to influence
125 decision makers (Vecchio and Annunziata, 2012; Van Loo, Hoefkens and Verbeke, 2017). Habits are
126 also an increasingly important factor as consumers are becoming always more aware of the effects of
127 their consumption habits on the environment, which has led to shifting towards more sustainable
128 choices over the years (Lazzarini, Visschers and Siegrist, 2017). Last, the appropriateness of the use
129 of the Alphabet Theory as framework to analyse consumers' behaviour towards environmentally
130 friendlier food has been proven by recent literature reviews on this topic (Feldmann and Hamm, 2015;
131 Schäufele and Hamm, 2017; Rivaroli, Baldi and Spadoni, 2020; Stampa, Schipmann-Schwarze and
132 Hamm, 2020).

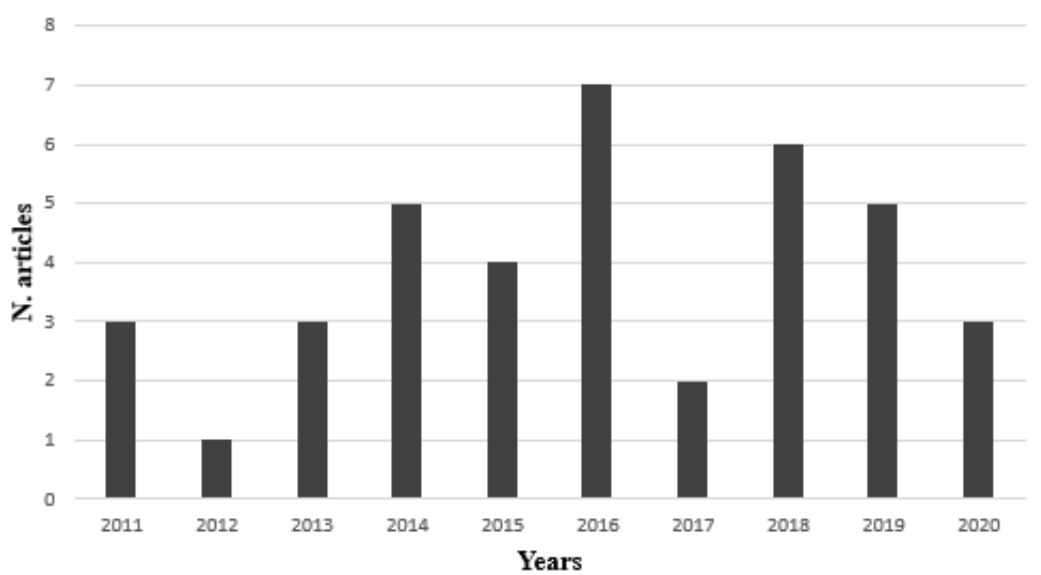
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134 **3. METHODOLOGY**

135 This review is based on published and peer-reviewed articles selected from the following four online
136 catalogues: Scopus, Science Direct, AgEcon Search, and Web of Science. Only those in English
137 language were considered for this analysis. In order to limit the results only to the area of interest, the
138 following keywords or keyword combinations have been digitized in the title or abstract: "food" AND
139 "carbon footprint labels" AND "consumers" AND "preferences" OR "attitude" OR "perception" OR
140 "choice" OR "behaviour" OR "purchase intention" OR "willingness to pay". Only empirical, per-
141 reviewed full-text papers written in English were examined for this literature review and excluding
142 review papers. Following this criterion, 38 articles have been selected, published between 2011-2020.
143 The full list of articles included in this review is presented in Table A1 in the Appendix A. The
144 selection process indicates that the number of articles on the reviewed topic has increased during the

145 last ten years, with a peak in 2016, whereas fewer articles were found between 2011 and 2013 (Fig.
146 3).

147



148

149 **Fig. 3 - Number of research articles included in the topic of consumer behaviour towards**
150 **carbon footprint labels from Scopus, Science Direct, AgEcon Search, and Web of Science**
151 **databases.**

152

153 Table 1 shows an overview of the top 5 journals conducting empirical studies on consumers behaviour
154 towards CF labelled food in the past ten years ranked by number of publications. Journal of Cleaner
155 Production is the dominant source, followed by Ecological Economics.

156

157

158

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161

162 **Table 1 - Top 5 academic journals by number of publications on consumers behaviour towards**
163 **CF labelled food.**

164

Academic Journal	N. of publications	%
Journal of Cleaner Production	8	20.5
Ecological Economics	6	15.3
Food Policy	4	10.2
Food Quality and Preferences	3	7.7
Sustainability	2	7.1

165

166 In terms of geographical coverage, the majority of the studies were conducted in emerging countries
167 such as Germany (11 articles), UK (5 articles), Italy (4 articles), United States (US) (4 articles),
168 France (3 articles), Spain (2 articles), Sweden (2 articles), Finland (2 articles), Netherlands (1 article),
169 Denmark (1 article) and Japan (1 article). Fewer articles were found in emerging countries, such as
170 China (3 articles), Chile (1 article), Egypt (1 article) and South Africa (1 article). In regard to the
171 methodologies used in these studies, most applied a quantitative approach (32), mainly employing
172 choice experiments. Only five studies used qualitative methodologies, such as focus groups or in-
173 depth interviews, and one used a mixed method approach, including both quantitative and qualitative
174 techniques.

175

176 **4. RESULTS**

177 This paragraph provides a description of the results from the review of the literature following the
178 factors influencing consumers' behaviour as indicated Alphabet Theory framework. Table 2 below
179 provides a short summary.

Table 2. Overview of the literature review findings

Factors from the Alphabet Theory framework	Findings	Authors
1) Demographics	<ul style="list-style-type: none"> Consumers' <i>gender, age, education, income, and region of provenience</i> influence their behaviour. 	Canavari and Coderoni (2020); Grunert, Hieke and Wills (2014); Hartikainen <i>et al.</i> (2014); Koistinen <i>et al.</i> (2013)
2) Attitudes	<ul style="list-style-type: none"> The higher consumers' concern towards environmental condition, the more positive their attitude towards carbon labelled foods. 	Canavari and Coderoni (2019); Grebitus, Steiner and Veeman (2015); Van Loo <i>et al.</i> (2015)
3) Information seeking	<ul style="list-style-type: none"> Consumers still anticipate other information to the CF labels (e.g., price, expiry dates etc.) when grocery shopping. Different positioning of CF labels on products' packaging influences consumers' behaviour. 	Canavari and Coderoni (2020); Steiner, Peschel and Grebitus, (2017); Zhou <i>et al.</i> (2019)
4) Knowledge	<ul style="list-style-type: none"> Consumers show little knowledge of the CF system which negatively influences their behaviour. 	Canavari and Coderoni (2019); Feucht and Zander (2018); Guenther, Saunders and Tait, (2012); Onozaka and McFadden (2011); Zhou <i>et al.</i> (2019)
5) Context	<ul style="list-style-type: none"> When CF labels are presented with other labels (e.g., Fair Trade labels) consumers are less willing to pay for it. 	Akaichi <i>et al.</i> (2016); Grunert <i>et al.</i> (2018); Onozaka and McFadden (2011); Thøgersen and Nielsen (2016)
6) Habits	<ul style="list-style-type: none"> Consumers who used to buy eco-labelled foods showed higher willingness to pay for CF labelled foods. Consumers who usually bought ethical, local, and organic foods, were also more inclined to pay more for CF labelled foods. 	Canavari and Coderoni (2019); Gadema and Oglethorpe (2011); Rööös and Tjärmemo (2011); Vecchio and Annunziata (2015)
7) Behaviour	<ul style="list-style-type: none"> Consumers are willing to pay more for CF labelled milk chocolate bars and upcycled food products labelled. 	Echeverría <i>et al.</i> (2014); Grasso and Asioli (2020); Onozaka and McFadden (2011); Vecchio and Annunziata (2015)

181 **4.1 Demographics**

182 Socio-demographic factors, such as gender, age, education, income, and region of provenance were
183 found to influence consumers behaviour towards carbon footprint labelled food products.

184 *Gender*

185 Females were shown to place greater attention to carbon footprint labels on food than men. For
186 example, Hartikainen *et al.* (2014) found that Finnish female consumers prioritized environmental
187 food attributes (e.g., carbon footprint labels) to others such as taste, quality and price in their decision-
188 making. On the contrary, both adults and young males from Finland were more price-conscious and
189 less willing to pay a premium for carbon labels than females (Koistinen *et al.*, 2013). Egyptian
190 females, instead, were significantly more willing to pay for CF labels than male (Mostafa, 2016).
191 Similarly, Canavari and Coderoni (2020) found that female Italian consumers were inclined to pay
192 more for carbon labelled milk than male, however only slightly more. Also, Italians who were more
193 sensitive to price when buying products, tend to be willing to pay less for products with a lower CF
194 label (Canavari and Coderoni, 2019). In a study by Wong, Chan and So (2020), green advocates in
195 the male group had comparatively more significant influences on the acceptance of low carbon
196 emission products than the consumers in the female group.

197

198 *Age*

199 Wong, Chan and So (2020), also showed that Chinese aged over 50 tended to accept low carbon
200 emission products more easily than younger people (Wong, Chan and So, 2020). Similarly, older
201 Finnish consumers showed a more positive attitude towards carbon footprint labels, as environmental
202 concern increased with age (Hartikainen *et al.*, 2014). However, the level of understanding and use
203 of eco-friendly labels did not increase with age among consumers from the United Kingdom, France,
204 Germany, Spain, Sweden, and Poland (Grunert, Hieke and Wills, 2014).

205

206 *Education*

207 Grunert, Hieke and Wills (2014) also showed that higher *level of education* was found to lead towards
208 higher concern about environmental issues, which however did not translate in a more positive
209 attitude towards CF labels (Grunert, Hieke and Wills, 2014). The same result emerged from a study
210 with Chinese consumers (Zhao *et al.*, 2018). On the contrary, Canavari and Coderoni (2020) did not
211 show any influences of age and education on Italian consumers' WTP for carbon labelled milk in
212 Italy.

213

214 *Income*

215 Higher income Chinese (Zhao *et al.*, 2018), Belgian (Van Loo *et al.*, 2014a) and Italian (Canavari
216 and Coderoni, 2019) shoppers were found to be willing to pay a higher price for foods with CF labels
217 than lower income people. Income differences was also found to have effects on the level of
218 understanding of CF labels among consumers from the United Kingdom, France, Germany, Spain,
219 Sweden, and Poland (Grunert, Hieke and Wills, 2014). In South Africa middle-class and upper-class
220 consumers were heterogeneous in their preferences for water and carbon footprint labels on beef steak
221 and some were more conservative than others regarding environmentally sustainable products
222 (Owusu-Sekyere, Mahlathi and Jordaan, 2019).

223

224 *Region of provenience*

225 The United Kingdom and German citizens showed high level of concern, understanding and use of
226 CF labels on food, whereas Polish and Swedish reported the lowest level of concern and Spanish the
227 lowest level of use (Grunert, Hieke and Wills, 2014). This may be due to the fact that north European
228 countries have started earlier to promote eco-sustainable consumption (e.g., the United Kingdom was
229 the first that released carbon and water footprint labels), compared to other south and east-European
230 countries like Spain and Poland (Baldo *et al.*, 2009). In addition, ecologically oriented consumers
231 were found to more likely come from rural areas than urban and this may be due to the fact that social

232 interactions in less developed zones are more developed than in highly industrialized places (Steiner,
233 Peschel and Grebitus, 2017). However, it is worth mentioning that despite the development of a
234 system of carbon labeling is still at a very initial stage in countries like China, people still showed
235 high ecological human values (e.g., ‘preventing pollution’ and ‘protecting the environment’)
236 probably due to the collectivistic nature of its society where the common welfare is more important
237 than the individual (Liu, Yan and Zhou, 2017).

238

239 **4.1 Attitudes**

240 Human values are activated during the pre-decisional step of the behavioral process and therefore
241 serve as good predictors of people behavior (de Boer, Hoogland and Boersema, 2007). In most of the
242 available studies on the topic of consumers preferences for environmentally friendly food (Moser,
243 2016; Steiner, Peschel and Grebitus, 2017; Laureti and Benedetti, 2018), attitude was investigated by
244 analysing their self-reported level of concern for environmental conditions, as a proxy to predict their
245 behaviour towards more or less sustainable choices. The principle behind this is that moral
246 considerations and personal norms influence people’s behaviour, and therefore that a higher
247 propensity in safeguarding the environment is supposed to lead to an eco-friendlier purchasing
248 behaviour (Jansson, Marell and Nordlund, 2010). Findings show a high level of self-reported concern
249 towards environmental conditions (Grunert, Hieke and Wills, 2014) and partially confirm the
250 assumption that the higher the sensibility towards the environment, the more positive the attitude
251 towards food products labelled with lower carbon and water footprint is (Grebitus, Steiner and
252 Veeman, 2015). Similarly, Italian consumers who believed that buying environmentally friendlier
253 foods could help mitigating climate change were willing to pay more for carbon labelled milk
254 (Canavari and Coderoni, 2019). UK environmentalist consumers expressed the highest willingness
255 to pay for biscuits made with upcycled ingredients and labelled with CF information than other more
256 traditionalist groups (Grasso and Asioli, 2020). Grebitus, Steiner and Veeman (2015) reported that
257 German consumers showing a strong social orientation were more likely to choose foods labelled

258 with lower carbon and water footprints. Furthermore, it was found that the higher the concern in
259 sustainability aspects of food production, the higher the value and the time spent by consumers in
260 checking sustainability information during food choice (Van Loo *et al.*, 2015). These findings are in
261 line with Canavari and Coderoni (2020) who revealed that sustainability concern, as well as the belief
262 that buying products with lower environment impact could combat climate change, positively
263 influenced Italian consumers willing to pay. However, it is worth mentioning that some other studies
264 also reported a dissonance between consumers' attitude towards environmental conditions and actual
265 purchase behavior and this was mainly due to the perceived higher price of these products (Röös and
266 Tjärnemo, 2011; Grunert, Hieke and Wills, 2014; Canavari and Coderoni, 2020).

267

268 **4.2 Information seeking**

269 Existing academic literature showed that the tendency of consumers to check and read CF labels has
270 an effect on their purchasing behavior. For example, Steiner, Peschel and Grebitus (2017) found that
271 German consumers who scored higher in ecological orientation were more likely to read CF labels
272 when purchasing for their foods. On the contrary, price-sensitive people scored low in ecological
273 concern and showed to be less motivated in reading labels and less willing to pay more for CF food
274 products (Steiner, Peschel and Grebitus, 2017). Emberger-Klein and Menrad (2018) found that
275 German consumers looked at carbon labels on the products' packaging only when instructed to do
276 so. Similarly, Italian shoppers said to give little importance to labels when buying foods, but pay
277 more attention to other aspects like sensory properties or expiry date (Canavari and Coderoni, 2020).
278 This may be caused by the still ongoing controversies behind a commonly accepted system of
279 calculation of the CF label itself (Baldo *et al.*, 2009) which may lead to inability in expressing its
280 message. Uncertainty on how to interpret CF labels and lack of information were found to limit the
281 purchase of CF labelled food also by UK consumers (Gadema and Oglethorpe, 2011). Interestingly
282 Zhou *et al.* (2019) found that placing the CF on different positions on the packaging can influence
283 Chinese consumers, showing that if the CF label was on the right side of the packaging they were

284 more interested and inclined to pay more for both milk and rice than when it was positioned on the
285 left.

286

287 **4.3 Knowledge**

288 Consumers' knowledge and understanding of labels on products consciously drive their decision-
289 making process (Gadema and Oglethorpe, 2011). However, the CF labels have been shown to be
290 challenging to understand by consumers (Kimura *et al.*, 2010). Between the carbon and the water
291 footprint labels, German consumers seem to be more familiar with the carbon rather than with the
292 water footprint label (Greibitus, Steiner and Veeman, 2016). In the context of environmentally-
293 friendly labels, Danish consumers were found unable to make purchasing decisions based on footprint
294 labels as they found the messages they try to provide hard to understand (Thøgersen and Nielsen,
295 2016). Hartikainen *et al.* (2014) showed that while Finnish consumers were familiar with the term
296 'product carbon footprint', only few were able to describe it accurately. The majority thought that it
297 was referred to environmental impacts in general or use of natural resources, but nobody mentioned
298 the assonance with concepts such as 'climate change', 'global warming' or 'greenhouse gases'
299 (Hartikainen *et al.*, 2014). In a survey in the US, most consumers self-reported a lack of knowledge
300 about carbon measures (Onozaka and McFadden, 2011). The authors provided information on the
301 meaning of carbon labels during the choice experiment and reported a positive valuation of the
302 concepts by consumers.

303

304 *Lack of a common CF label*

305 The lack of people's understanding towards carbon footprint labels can be attributed to the fact that
306 a commonly accepted carbon label does not exist yet in many countries globally, as well as to the still
307 limited adoption of the CF label itself by food manufacturers (Van Loo *et al.*, 2014b), which may
308 limit consumers' ability of associating the CF label with its meaning. In fact, largely available labels
309 in the market were found to allow consumers to easily associate their meaning with the products'

310 characteristics and to provoke some associations in consumers' mind, like the European Union (EU)
311 organic label, which is often associated with claims such as 'healthy' and 'local' (Feucht and Zander,
312 2018). This is also confirmed by Canavari and Coderoni (2019) who found that the knowledge of CF
313 labels seemed not to affect Italian consumers' behaviour, whereas the knowledge towards
314 sustainability parameters and the effect of food consumption on the environment had stronger effects.
315 In countries like China where a CF label system does not exist yet, Zhao *et al.*, (2018) found that
316 consumers have a very limited understanding of the concept of CF labels. However, Wong, Chan
317 and So (2020) showed that communication of pro-environmental beliefs positively influenced
318 Chinese shoppers' green awareness, which in turn influenced their attitudes and acceptance of green
319 products. Similarly, Guenther, Saunders and Tait (2012) showed that Japanese consumers had no
320 knowledge of CF, whereas UK consumers were much more familiar with it. Similar to what
321 mentioned above, this may be explained by the fact that a CF label system in Japan is still missing.
322 The authors also found that consumers' adoption or rejection of low carbon beverages can be
323 influenced by persuasion, therefore they recommend large scale campaigns and public education
324 programs by the government to achieve positive results (Wong, Chan and So, 2020). In a similar way,
325 Owusu-Sekyere, Mahlathi and Jordaan (2019) in a study involving South African consumers,
326 concluded that their awareness on water saving has a significant impact on the choice of sustainable
327 beef products, therefore the authors recommend an expansion in the governmental campaigns on
328 water to reach the majority of people. Interestingly, Shewmake *et al.* (2015) found that knowledge
329 on environmental impact of different food products affected people's attitude towards carbon labels.
330 For example, the presence of CF information on rice, which was believed not to have a big effect on
331 the environment, did not increase its sales as consumers were unable to understand its benefits
332 (Shewmake *et al.*, 2015).

333

334 *Development of consumers' friendlier CF labels*

335 Some research tried to develop consumers friendlier CF labels and showed that they can make a
336 significant impact on consumers' decision-making. For instance, Thøgersen and Nielsen (2016)
337 showed that by re-designing the CF label and making it similar to the more commonly used traffic
338 lights, assessing the green color for low GHG products' emissions, the yellow for slightly acceptable
339 ones and the red for those with higher environmental impact, Danish consumers significantly drove
340 their purchase to more sustainable food products. Similarly, Vlaeminck, Jiang and Vranken (2014)
341 found that a color-graded scale accompanied with a numeric symbol from 1 to 10 indicating the grade
342 of product's 'environmental friendliness' could better drive Belgian consumers' behavior towards
343 more sustainable food choices. Also, it helped to eliminate some incorrect beliefs, such as the the
344 thought that local-organic foods are more eco-friendly than conventional foreign ones (Vlaeminck,
345 Jiang and Vranken, 2014). The positive effect of implementing a similar system to traffic light to
346 indicate CF was showed by Brunner *et al.* (2018) who reported that the green labelled meat dishes
347 increased in sales by 11.5% at restaurants, whereas red label dishes reduced in sales by 4.8%.
348 Meyerding, Schaffmann and Lehberger (2019) compared six different CF labels to evaluate the most
349 preferred by German consumers and found that labels with colour-coded traffic lights were superior
350 to both those that claim neutrality or impact reduction and to those that provide details on the climate
351 impact of product and company. Similarly, other claims like 'we have committed to decrease our
352 climate impact' or an URL webpage with information about the Climate Certification of Food, have
353 been found to help increasing in-store milk sales of approximately 6%-8% (Elofsson *et al.*, 2016).
354 Caputo, Nayga and Scarpa (2013) in the USA investigated if ecological footprint of food transport is
355 better communicated by using carbon dioxide emission (CO₂ label) or by food miles label and showed
356 that the former is more familiar to consumers even though they are still uncertain on its actual
357 meaning. A similar study in Italy reported that a label showing the number of kilometers and time
358 traveled is expected to have greater positive impact on consumers' welfare than a CF label containing
359 information about the CO₂ emissions, probably because people might understand and relate better to
360 time and distance information than to CO₂ emissions (Caputo, Nayga and Scarpa, 2013). Comparing

361 GHG emissions with a more commonly known unit of measure (e.g., light-bulb minutes) was found
362 to be another way to shift to low-emission options, when both high and low choices are available
363 (Camilleri *et al.*, 2019).

364

365 **4.4 Context**

366 In regard to CF labels label positioning (e.g., when are placed together with other sustainability
367 indications like Fair-Trade² or other product information) and product type were found to influence
368 consumers behaviour.

369

370 *CF labels with other sustainability labels*

371 Regardless of the general positive concern towards environmental conditions, when other sustainable
372 labels are presented (Fair Trade) consumers were willing to pay the lower price for CF information
373 as Italian consumers showed higher concern towards aspects such as child exploitation and poor
374 working conditions than for the environmental impact of chocolate (Vecchio and Annunziata, 2015).
375 Similarly, CF label received less visual attention compared to other labels such as USDA organic
376 and Fair-Trade on coffee by United States consumers (Van Loo *et al.*, 2015). This may be due to the
377 fact that the former is largely more available in the market and therefore consumers are more used to
378 them (Grunert, Hieke and Wills, 2014). In a study by Colantuoni *et al.* (2016) on potatoes, the
379 presence of the CF logo reduced the German and Italian total WTP, while the ethical certification
380 logo, on the other hand, was considered very important for consumers of both nationalities, given
381 their large WTP for this attribute. The authors explained that probably these differences are due to
382 the fact that CF has been less debated and considered unnecessary when coupled with other attributes,
383 like origin or organic certification. Onozaka and McFadden (2011) showed a positive interaction

² The Fair-Trade certification guarantees principles of ethical purchasing such as banning child and slave labour, guaranteeing a safe workplace and a fair price that covers the cost of production, facilitating social development, and protecting the environment (Akaichi *et al.*, 2016).

384 between the CF label and the Fair-Trade label on tomatoes and apples, reporting that fair trade
385 certification can mitigate concerns about a higher CF. Similarly, Akaichi *et al.* (2016) found that
386 French, Dutch and United Kingdom consumers were willing to pay more for bananas presenting the
387 CF, the Fair-Trade and the organic labels together than separately. Van Loo *et al.* (2014) found that
388 shoppers were willing to pay a premium about 40% smaller for ecological footprint labels than what
389 they would pay for free range and animal welfare labels. A similar scenario was presented by Chen
390 *et al.* (2018), where consumers were willing to pay the highest price for information such as ‘less
391 pesticides in production’, giving the idea that consumers are intentioned to pay more for those benefits
392 that are directly related to their health. Similarly with the findings above, Chinese consumers were
393 willing to pay higher price for carbon emission information when this was presented alone (Li *et al.*,
394 2016).

395

396 *CF labels with other product information*

397 When ecological footprint labels are presented alone, German consumers preferred the alternative
398 with the lower level of water and carbon emissions (Greibitus, Steiner and Veeman, 2015). However,
399 when other information is displayed, such as price, best before date, origin and production method,
400 information regarding the product’s environmental impact is the least considered by German shoppers
401 (Emberger-Klein and Menrad, 2018). These results were also confirmed by Lampert, Menrad and
402 Emberger-Klein (2017) who found that German consumers food choice behaviour is more likely to
403 be driven by the factors such as price and production method rather than by CF information. Other
404 findings show that Danish consumers also prioritize health benefits information and perceived taste
405 over environmental-safety (Thøgersen and Nielsen, 2016). This was found particularly evident in the
406 case of countries like China, where food security is a foremost dilemma among consumers due to the
407 frequent food scandals happening in the country (Zhao *et al.*, 2018). In a study in the Belgian market,
408 consumers paid lower attention to ecological footprints, compared to other sustainable labels, such
409 as free range and animal welfare (Van Loo *et al.*, 2014a). Consumers from Germany and Poland

410 prioritized individual beneficial information (e.g., less antibiotics, GMO-free feed, no microbial
411 contamination), as well as meat origin over the fact that the production reported a CF of zero (Grunert
412 *et al.*, 2018).

413

414 *Product type*

415 Echeverría *et al.* (2014) found that Chilean consumers were willing to pay 29% over the average price
416 of milk but only 10% over the average price of bread if the CF label was present. The authors
417 concluded that the willingness to pay was product dependent, the higher the share of a product on the
418 monthly household expense, the lower the willingness to pay for that product. Italian consumers were
419 willing to pay an average premium of 30% for carbon labeled fresh milk (Canavari and Coderoni,
420 2019), however, the WTP was lower for carbon labeled chocolate bars (Vecchio and Annunziata,
421 2015). In a US study on apples and tomatoes (Onozaka and McFadden, 2011), a significant proportion
422 of consumers were willing to pay a premium for reducing their CF or requested a discounted price
423 for products with higher CF. Similarly, in a South African study (Owusu-Sekyere, Mahlathi and
424 Jordaan, 2019), 86% of the respondents (middle and upper class only) were willing to pay premiums
425 for the reduction in both water usage and carbon emission in beef, displayed through the use of food
426 labels. CF label was the second element that mostly affected UK purchasers WTP for biscuits made
427 with upcycled ingredients (Grasso and Asioli, 2020). This study also confirms that using a CF label
428 on food products which are environmentally sustainable in their nature can increase WTP, as for
429 example upcycled foods, which are made through ingredients that would not have been used for
430 human consumption otherwise, like coffee cherries for example, and therefore help decreasing food
431 waste and emissions (Roth, Jekle and Becker, 2019).

432

433 **4.5 Habits**

434 Food purchasing habits were also found to influence consumers' behaviour towards CF labelled
435 food. For example, United Kingdom consumers who normally purchased eco-sustainable labelled

436 foods (e.g., organic, fair-trade etc.) were found to have a more positive attitude towards CF food
437 products (Gadema and Oglethorpe, 2011). Similarly, Italian consumers who were used to buy eco-
438 labelled foods showed higher willingness to pay for CF labelled foods (Canavari and Coderoni,
439 2019). Green purchase behaviour habits also influenced Egyptians' WTP for carbon footprint labels
440 (Mostafa, 2016). A study from Hartikainen *et al.* (2014) showed that Finnish consumers who usually
441 bought ethical, local, and organic foods, were also more inclined to choose and pay more for foods
442 showing CF claims. Other habits, such as engaging in voluntarism activities positively impacted
443 consumers' WTP for chocolate bars (Vecchio and Annunziata, 2015). On the contrary, repetitive
444 purchasing, as well as low willingness to try new food products negatively affect consumers attitude
445 and WTP for carbon labelled food products (Röös and Tjärnemo, 2011).

446

447 **5. DISCUSSION**

448 The following section provides a discussion of the results from the literature on consumers' behavior
449 towards CF labels on foods products, followed by a summary of the implications for food
450 manufacturers and policy makers. Based on the Alphabet Theory framework by Zepeda and Deal
451 (2009), it emerged that demographics, attitudes, information seeking, knowledge, context, and habit
452 factors affect consumers behaviour towards CF labels on foods.

453

454 About demographics, females, older in age, and with higher educational level and income, had a more
455 positive attitude and higher willingness to pay for CF labels on foods. Similar elements also emerged
456 in the literature review by Rödiger and Hamm (2015) about consumers' behaviour for organic foods.
457 However, findings differed from ours from country to country in relation to some factors. For
458 example, females in the US had a higher WTP for organic foods, whereas males were WTP more in
459 Nepal. Similar to our results, both older and higher income people were WTP more for organic food
460 products. In terms of attitude, findings from existing academic literature showed that consumers
461 reporting higher levels of environmental concern, also showed a more positive attitude towards CF

462 labelled foods. In terms of information seeking, consumers showed little propensity to search for and
463 read CF labels, unless instructed to do so. Regarding knowledge, this literature found that consumers
464 still have a limited understanding of CF labels. This is also corroborated by another literature review
465 on consumers' behaviour towards organic foods by who found that the knowledge about the organic
466 logo was limited among consumers from several European countries, such as Denmark, Germany,
467 Italy etc. (Hemmerling *et al.*, 2013). This might lead to the conclusion that consumers have generally
468 poor knowledge of sustainable food labels. About context, existing academic literature showed that
469 when CF labels are examined together with other labels, like organic labels, the latter are preferred
470 more compared to the former (Onozaka and McFadden, 2011). In addition, it emerged that
471 consumers' WTP for CF labelled food is higher for those products that are perceived to be more
472 harmful for the environment. Similarly, the literature review on consumers' behaviour towards
473 organic foods by Rödiger and Hamm (2015) shows that people are WTP more for food categories
474 like poultry and meat than for cereals and potatoes, because the organic logo increases their
475 confidence in regard to the safety of the former. In terms of habits, the literature showed that
476 consumers who were already used to buy environmentally sustainable foods had a more positive
477 attitude towards CF labelled foods. This is confirmed also by Rödiger and Hamm (2015) who found
478 that those with a more positive attitude towards organic foods had a higher WTP for these products.

479

480 **5.1 Implications for food producers and policy makers**

481 Several implications for food producers can be derived from the outcomes of this review. First,
482 because a diversity of factors has been demonstrated to influence consumers behaviour, these should
483 be all taken into consideration when adopting the CF label for their products and targeting them to
484 different consumer segments. Second, females, higher in age, with higher educational level and
485 income seem to be the most appropriate target for carbon labelled food products, together with
486 consumers who are already used to purchase environmentally friendlier foods. However, because of
487 the limited knowledge that consumers showed towards CF labels, manufacturers are advised to also

488 provide some more information on this regard, so that people will be able to better understand their
489 meaning. Doing so, it is also more likely that consumers will drive towards environmentally friendlier
490 choices, increasing the demand and sales of these products. In addition, because consumers could
491 sometimes feel overwhelmed by the amount of information on food packaging, manufacturers are
492 advised to carefully select those few they believe are more appropriate in order to avoid increasing
493 the level of confusion. In addition, because the food product itself has been found to influence
494 consumers behaviour towards CF labels, we advise manufacturers to consider the environmental
495 impact of their products before adopting CF label. Last, as different positions of the CF on the
496 packaging seem to affect consumers behaviour and WTP, manufacturers are advised to investigate
497 on this matter when designing the packaging of their products.

498

499 Given the challenges that consumers have in understanding CF labels (Hartikainen *et al.*, 2014;
500 Thøgersen and Nielsen, 2016), policy makers and governments should take initiatives aimed at
501 educating consumers on this topic to help them making more informed choices. Also, the
502 development of a commonly recognized footprint system is needed. In addition, it is important for
503 policy makers and governments to promote initiatives that could facilitate consumers towards a more
504 sustainable consumption (e.g., placing in-store sign placed close to climate-certified food products
505 (Elofsson *et al.*, 2016). Finally, policy makers should also aim to support measures that allow a
506 reduction of prices for CF labelled foods, in order to allow all consumers to afford to purchase them.

507

508 **6. CONCLUSIONS**

509 This study contributes to the existing knowledge being the first to conduct a review of the literature
510 on consumers' attitude towards CF labelled foods. Overall, we see that people's behaviour is complex
511 and it is affected by several factors, such as demographics, habits, context etc. It also emerges that
512 there is need for a commonly recognizable CF system, as consumers seem unable to interpret the
513 current available labels and thus, are limited in making more sustainable choices. Having a familiar

514 CF labels will increase the likelihood that food manufacturers will adopt these instruments to
515 communicate to their consumers and that the latter will make more informed and sustainable choices.
516 At the same time, however, policy makers should implement new policies to educate people about
517 CF labels and promote initiatives to encourage sustainable eating and purchasing behaviour.

518

519 This paper also highlights several areas for future research. First, future studies should investigate
520 consumers from emerging countries, like Asia and South America for example, given the
521 predominant focus on developed countries so far (Hertwich and Peters, 2009). Second, more research
522 on consumers' willingness to pay for CF labels together with other labels (e.g., animal welfare,
523 sustainability labels etc.) and packaging information (nutritional values, country of origin etc.) is
524 needed, in order to evaluate consumers' behaviour in a more 'chaotic' informational environment,
525 which better recreates a real purchasing environment (Vecchio and Annunziata, 2015). Third, further
526 application of experimental design techniques such as choice experiment in combination with new
527 neuroscientific instruments, like eye-tracking and mouse-tracking is needed to better measure
528 consumers' attention towards CF labels (Van Loo *et al.*, 2015). Fourth, because past studies found
529 that location, size and colour influenced consumers' attention to labels (Bialkova *et al.*, 2014), as well
530 as design features (Becker *et al.*, 2015), future studies should investigate whether positioning CF
531 labels in different section of the packaging, or playing with the shape or their size, will influence
532 shoppers' behaviour and understanding. Fifth, consumer tests using real products, as well as
533 consumers' research on actual point of purchase or intervention are recommended using non-
534 hypothetical choice experiments or experimental auctions in real market contexts (e.g., stores) (Lusk
535 and Shogren, 2007; Khachatryan *et al.*, 2018). Sixth, more research combining the impact of CF
536 labels with sensory analysis (e.g., tasting) should be conducted to see people's reaction (Chen *et al.*,
537 2018). Sixth, future studies may apply nudging or peer effects in investigating consumers' change
538 towards more sustainable consumption patterns, which may favourably drive their behaviour
539 (Greibitus, Steiner and Veeman, 2015). Seventh, whether information on the amount of gCO₂e saved

540 in food production in absolute or per cent terms (Medici, Canavari and Toselli, 2020) would have an
541 impact on consumers' behaviour should be further explored. Eight, the role of alternative
542 chains/networks in favouring/hindering CF labels in a farm-to-fork strategy (Michel-Villarreal *et al.*,
543 2019) needs further explorations. Ninth, given the growing importance that sustainable labels have
544 in informing people's food choices (Grunert, Hieke and Wills, 2014), further literature reviews on
545 consumers' behaviour towards environmentally sustainable labels (e.g., rainforest alliances, organic,
546 fair trade etc.) should be conducted to provide the academia and the industries with an updated of the
547 status of knowledge on similar topics.

548

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552

553 **References**

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Appendix A

Table A1

Overview of the selected papers (n= 38) about consumers behavior towards carbon footprint labels.

No.	Author	Topic	Region	Sample Size	Methodology
1	Akaichi <i>et al.</i> (2016)	Investigate whether consumers' preferences and willingness to pay (WTP) for fair trade products are affected by the presence of other ethical food attributes.	Scotland, the Netherlands, and France	247	Choice experiment
2	Brunner <i>et al.</i> (2018)	To analyse the effects of implementing a label with greenhouse gas emission information on dishes at a restaurant.	Sweden	300-600 servings a day	In restaurant experiment
3	Camilleri <i>et al.</i> (2019)	Whether associating GHG emissions with more consumers-friendly energy emissions (e.g., light-bulb minutes) may shifts their purchase choices.	USA	120	Focus groups and menu-based questionnaire
4	Canavari and Coderoni (2019)	To estimate consumer's WTP for the purchase of 1 L of fresh milk with a lower carbon footprint label.	Italy	178	Choice experiment
5	Canavari and Coderoni (2020)	Analyse the factors determining a positive stated WTP.	Italy	178	Online survey
6	Caputo, Nayga and Scarpa (2013)	Whether consumers prefer the ecological footprint of food transport to be communicated using carbon dioxide or food miles label.	USA	200	Choice experiment

7	Caputo <i>et al.</i> (2013)	Consumer welfare effects of two food miles labels: “carbon dioxide (CO ₂) emission” label and “time and number of kilometers” label.	Italy	200	Survey and choice experiment
8	Chen <i>et al.</i> (2018)	WTP for strawberries produced using different environmentally friendly techniques.	USA	2525	Focus groups and survey
9	Colantuoni <i>et al.</i> , (2016)	Heterogeneous preferences for domestic potatoes in the German and Italian markets.	Germany and Italy	1004 Italian 1009 German	Randomized Questionnaire Design
10	Echeverría <i>et al.</i> (2014)	To elicit consumers’ willingness to pay (WTP) for the carbon footprint of food products (fluid milk and bread).	Chile	774	Choice experiment
11	Elofsson <i>et al.</i> (2016)	Whether voluntary carbon labelling affects milk demand.	Sweden	-	A randomized controlled field trial (RCT) carried out in 17 grocery stores
12	Emberger-Klein and Menrad (2018)	The effect of information provision on supermarket consumers.	Germany	379	A focus group and two in-store surveys
13	Feucht and Zander (2018)	Explore which label design would be the most appropriate and compare the preferences for carbon labels with preferences for the indications of organic and local production.	France, Germany, and UK	6007	Choice experiment
14	Gadema and Oglethorpe (2011)	Examining whether carbon facilitate consumers to make greener food purchasing decisions.	UK	428	Online survey
15	Grasso and Asioli (2020)	Estimating consumers WTP for biscuits made with upcycled ingredients.	UK	106	Choice experiment

16	Grebitus, Steiner and Veeman (2016)	Consumers' preferences for sustainable products as indicated by water and carbon footprint labels	Germany and Canada	1579 in Germany and 1551 in Canada	Choice experiment
17	Grebitus, Steiner and Veeman (2015)	Identify differences in consumers' choices as determined by trust and human values	Canada and Germany	1579	Focus group and online survey
18	Grunert, Hieke and Wills (2014)	Investigates the relationship between consumer motivation, understanding and use of sustainability labels on food products (fair trade, rainforest alliance, carbon footprint, and animal welfare).	UK, France, Germany, Spain, Sweden, and Poland	4408	Questionnaire
19	Grunert <i>et al.</i> (2018)	Comparing the effect on consumers between pig production attributes (e.g., ecological footprint, animal welfare and health-related aspects) and traditional attributes (e.g., fat content, color, origin, and price).	Germany and Poland	1007 in Germany and 988 in Poland	Choice experiment
20	Guenther, Saunders and Tait (2012)	Assessing knowledge and preferences towards carbon footprint labels.	UK and Japan	880	Online survey
21	Koistinen <i>et al.</i> (2013)	Consumers' preferences towards meat type, method of production, fat content, price, and presence of carbon footprint information.	Finland	1623	Questionnaire
22	Hartikainen <i>et al.</i> (2014)	Explore how Finnish consumers perceive the communication of carbon footprints for food products.	Finland	1010	Five semi-structured focus groups and an online- survey
23	Lampert, Menrad and Emberger-Klein (2017)	Analyse whether information on the product	Germany	232	Information display matrix (IDM)

		carbon footprint is a relevant factor within the search process of purchase decision.			
24	Meyerding (2016)	Consumer preferences for origin, price, and food labels (organic, carbon label, locally grown).	Germany	645	Choice Experiment
25	Meyerding, Schaffmann and Lehberger (2019)	Consumer preferences for different designs of carbon labels on tomatoes.	Germany	598	Choice experiment
26	Mostafa (2016)	Estimating consumers WTP for carbon footprint labels on different products.	Egypt	1260	Single-bound and double-bound dichotomous choice models
27	Onozaka and McFadden (2011)	Interactive effects of sustainable labels (organic, fair trade, and carbon footprint) and location claims.	USA	1052	Survey-Conjoint choice experiment
28	Owusu-Sekyere, Mahlathi and Jordaan (2019)	South African consumers' preferences and market potential for products with low water and carbon footprints.	South Africa	402 households	Face to café interviews, questionnaire, and choice experiment
29	Shewmake <i>et al.</i> (2015)	Estimate how consumers respond to information from carbon footprint label on 42 different products.	-	-	EI-CCD model
30	Steiner, Peschel and Grebitus (2017)	Identifying consumer segments regarding pro-environmental choices.	Germany	1579	Choice experiment
31	Thøgersen and Nielsen (2016)	A test a version of the Carbon Trust labeling scheme was administer to consumers with the aim to create a more easily readable label.	Denmark	359	Choice-based conjoint analysis
32	Van Loo <i>et al.</i> (2014)	Consumers' preferences and WTP for a set of sustainability claims on chicken breast (free range	Belgium	359	Choice experiment

		claims, organic labels, welfare label and carbon footprint labels).			
33	Van Loo <i>et al.</i> (2015)	Investigate consumers' visual attention paid by consumers to the sustainability information on food.	Belgium	6500	Cross-sectional consumers survey
34	Vecchio and Annunziata, (2015)	Analyses the determinants of their willingness to pay (WTP) for chocolate bars with different sustainability labels.	Italy	80	Experimental auction
35	Vlaeminck, Jiang and Vranken, (2014)	Evaluate whether consumers' food consumption is eco-friendlier when the information about a product's environmental impact is more easily accessible.	Belgium	230	Questionnaire
36	Wong, Chan and So (2020)	Consumer perceptions on product carbon footprints and carbon labels of beverage merchandise in China (Hong Kong).	China	1000	Survey
37	Zhao <i>et al.</i> (2018)	Explore consumers' perception, their purchase intention and willingness to pay for carbon labels.	China	1132	Choice experiment
38	Zhou <i>et al.</i> (2019)	Investigate whether the position of carbon labels on package can influence consumers choice.	China	602	Laboratory experiment using survey and physical stimulus