

1 **Can nudging improve the environmental impact of food supply chain? A systematic** 2 **review**

3 4 **1. Introduction**

5 Feeding the growing world population with less environmental impact is one of the main
6 challenges of the 21st century. According to the Food and Agriculture Organization (FAO) the
7 world's population will increase by 34 percent in 2050 (FAO, 2011), when people will mostly
8 live in urban areas and become wealthier. This will imply a considerable increase of food
9 demand such that, according to FAO predictions, by then food supply must increase by almost
10 70 percent (FAO, 2009) with tremendous consequences in terms of land depletion, natural
11 resource use and greenhouse gas (GHG) emissions (Tubiello et al., 2014). Indeed, while the
12 population needs increase, available resources are finite and insufficient to cope with the
13 raising demand.

14 This emerging demand-supply imbalance highlights the overall inadequacy of the current
15 agri-food system, still based on a linear economic concept that is by nature wasteful and
16 polluting (Ellen MacArthur Foundation, 2018). There is need to reorient the food system onto
17 a more sustainable trajectory, with all agents involved to reduce the environmental impact of
18 both the production and consumption of food. Producers should pursue more conscious and
19 environmentally friendly practices while consumers could make a substantial contribution by
20 accounting for sustainability issues when making their daily food consumption decisions.

21 With regard to sustainability issues, governments started to take action over the last decade
22 by implementing various food and environmental policies targeting the actors of the food
23 chain at different levels, from stakeholders to consumers. Such policies are based on the
24 adoption of different policy instruments, namely "*tools used by governments to pursue a*
25 *desired outcome*" (Cairney, 2015). According to past studies (Cairney, 2015; Galle, 2014;
26 Helmer & Hespanhol, 1997), such instruments can be subdivided in three main categories,
27 that is, command-and-control, economic instruments, and information and education tools.
28 The former, i.e., command-and-control tools, include for instance permits to pollute (Cox,
29 2016; Holland & Moore, 2015). Economic instruments comprise taxes, subsidies (like agro-
30 environmental subsidies given to farmers), or incentives; whereas information and education
31 tools include interventions based on information provision at various levels, such as labelling
32 and public awareness campaigns. Furthermore, these tools include the so called 'nudges', that

33 is small signals implemented by choice architects aimed a gently push individuals towards a
34 desired behaviour.

35 This latter instrument represents the focus of the present review. As defined by Thaler and
36 Sunstein, a nudge is *“any aspect of the choice architecture that alters people’s behaviour in a
37 predictable way without forbidding any options or significantly changing their economic
38 incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges
39 are not mandates. Putting the fruit at eye level counts as a nudge. Banning junk food does not”*
40 (Thaler & Sunstein, 2008). The peculiar characteristic of nudging tools is that they aim at
41 changing people’s behaviours acting on their cognitive limitations, instead of enhancing their
42 abilities to make rational decisions. This is in contrast with the traditional policy approach
43 that uses instruments based on the underlying assumption that individuals behave rationally
44 (Schubert, 2017; Thaler & Sunstein, 2008). The nudging principle is based on the recognition
45 that, most of the times, individuals fail to be rational in the way they think and incur in
46 systematic cognitive biases. Such biases arise because individuals tend to refer to rules of
47 thumb (also called heuristics) when making judgements instead of rationally evaluating
48 events and contexts. While these rules of thumb are effective and useful in simplifying the
49 decision-making process, they lead to systematic cognitive biases, which ultimately affect
50 people’s behaviours (Tversky and Kahneman, 1974; Thaler and Sunstein, 2008).

51 In such context, by acting on individuals’ bounded rationality, nudging-based policies can be
52 surprisingly successful in changing human behaviours through simple and even apparently
53 insignificant changes to the choice architecture (Thaler and Sunstein, 2008).

54 Nudging-based interventions, which are gaining increasing attention in the international
55 policy debate, have been widely applied in the food context over the past years, especially to
56 promote more healthful food consumption patterns (e.g., to lead people consuming more fruit
57 and vegetables -Benson et al., 2018; Betty, 2013; Carroll, Samek, & Zepeda, 2018; Hollands et
58 al., 2018; Stämpfli, Stöckli, & Brunner, 2017; Thaler & Sunstein, 2008; Wilson, Buckley,
59 Buckley, & Bogomolova, 2016). However, evidence about the adoption of nudging in
60 promoting environmentally sustainable actions are still relatively sparse.

61 The goal of this systematic review is to gather existing evidence on nudging interventions
62 geared at leveraging more environmentally sustainable behaviours among the agents of the
63 food chain, from producers to the final consumers. In detail, we focus on the so called ‘green
64 nudges’, namely those nudges that aim at encouraging people to voluntarily contribute to
65 environmental protection (Schubert, 2017), which are gaining worldwide increasing attention
66 in the environmental policy debate. The results of the present review will contribute to this

67 field of research by providing an overview on the most effective nudging interventions, thus
68 providing insights for future research and application as well as guidance for future policy
69 formulation.

70

71 *1.1 Nudging tools*

72 Nudging methodologies have been developed since 1970s, but the term nudge, or libertarian
73 paternalism, was introduced in 2008 by the economist Richard Thaler and the law Professor
74 Cass Sunstein in their well-known book *'Nudge: Improving decisions about health, wealth and*
75 *happiness'* (Thaler & Sunstein, 2008). Nudging-based interventions are aimed at changing
76 people's behaviour by influencing their subconscious or habitual approach to choices, or by
77 modifying the environment in which their decisions usually occur (Wilson et al., 2016). In
78 essence, nudges are aimed at controlling people's behaviours by making use of their cognitive
79 limitations, instead of enhancing their abilities to make informed, rational and fully conscious
80 decisions (Schubert, 2017). Nudging avoids any imposition or coercive measure and people
81 are gently pushed in a specified direction exclusively by altering the surrounding choice
82 architecture. The choice architect is responsible for creating the nudge environment by
83 recognizing how the options and contexts can interfere with individual decision-making
84 process. Therefore, nudges stand in contrast to coercive policy tools geared at changing
85 behaviours through mandates or bans.

86 Blumenthal-Barby and Burroughs (2012) identified in their review six techniques that can be
87 effective in nudging people, namely incentives, defaults, salience and affect, norms and
88 messages, priming, commitment and ego (Blumenthal-Barby & Burroughs, 2012). The former
89 are typically used to either reinforce a positive choice, or to punish a negative one
90 (Blumenthal-Barby & Burroughs, 2012). As underlined by authors, the use of incentives may
91 be controversial and should be carefully evaluated because if the incentives are too high, they
92 may work as a coercive measure, that is, as a "shove" instead of a nudge. For this reason, small
93 economic incentives can be categorized as nudging tools, while more sizeable incentives
94 should be regarded as economic policy instruments.

95 The second nudging technique analysed by the authors is based on the principle that
96 individuals tend to choose pre-set options, (i.e., defaults) to simplify their decision-making
97 process. As such, if defaults are implemented to drive positive behaviours, people would
98 easily go in that direction.

99 A third way in which nudging is used to change behaviours and decisions is by salience.

100 People are influenced by novel, personally relevant, and vivid examples, and the emotional
101 associations elicited by these items can shape decisions and behaviour. Norms and messages
102 are, instead, nudges based on the principle that individuals are strongly influenced by the
103 society and by others' behaviours, as well as by the information sources. One of the most
104 popular policy interventions developed using this nudging tool is probably represented by the
105 'Do not mess with Texas' campaign implemented in the American state to reduce littering
106 along highway roads. Thanks to this intervention, roadside litter decreased by 72 percent
107 over six years (Thaler & Sunstein, 2008).

108 Priming nudges are instead based on the fact that people's actions are influenced by
109 subconscious cues that can be used by choice architects as primers to leverage specific
110 behaviours (Blumenthal-Barby & Burroughs, 2012). For instance, to increase the visibility of
111 vegetarian items in restaurants' menu increases the probability that consumers choose these
112 options instead of meat plates (Bacon & Krpan, 2018).

113 Finally, there are commitments and ego nudging techniques. These latter are based on the
114 principle that individuals act in ways that make they feel better about their selves. These tools
115 are particularly applied with the aim of promoting health-related positive outcomes. Quite
116 popular examples are represented by websites allowing users to commit themselves to
117 achieving a certain goals, such as losing weight or quitting smoking (Blumenthal-Barby &
118 Burroughs, 2012).

119 Given the ease of implementation, its suitability to very diverse situations and contexts and
120 the limited economic resources needed for its application, nudging tools can be useful and
121 effective policy instruments to be applied to leverage people towards virtuous behaviours.

122

123 **2. Approach**

124 *2.1 Selection of relevant studies*

125 This review considers only studies that clearly want to nudge pro-environmental behaviours
126 in the agri-food chain. The first search process took place in November 2018 and to serve as
127 an exploratory phase in order to understand which databases and search terms were more
128 pertinent to the review process. The final research process, took place in May 2019 and
129 consisted in an extensive literature review conducted on four databases, namely, Web of
130 Science (WOS), Scopus, EconLit and CAB Abstracts (CAB). As a first step, we used the words
131 "nudge*" OR "choice architecture" as research strings in each database. The literature search
132 was then restricted to English-language research articles and to the past ten years (i.e., 2008-

133 2018), namely considering articles published after Thaler and Sunstein publication (Thaler &
 134 Sunstein, 2008). As a second step, the search results were filtered according to the databases'
 135 categories that could represent our fields of interest (Table 1). This screening method was
 136 not conducted in EconLit, because the specific structure of the database does not allow to
 137 select specific categories. In this latter case all records were checked.

Web of Science- categories	Scopus- categories	Cab Abstracts - categories
Agricultural Economics policy	Agricultural and Biological Sciences	Agricultural Economics
Agriculture Dairy Animal Science	Business Management and Accounting	Consumer Economics
Behavioral sciences	Decision Sciences	Crop Produce
Business	Earth and Planetary Sciences	Ecology general
Communication	Economics, Econometrics, Finance	Energy or Plant production
Ecology	Energy	Erosion Soil and Water Conservation
Economics	Environmental Sciences	Food Economics New March 2000
Environmental Sciences	Multidisciplinary	Health Economics New March 2000
Environmental Studies	Psychology	Human Wastes and Refuse
Food Science technology	Social Sciences	Land Resources
Green sustainable science technology		Marketing and Distribution
Health care science services		Meat Produce
Health Policy Services		Milk and Dairy Produce

Management	Natural Resource Economics New March 2000
Multidisciplinary sciences	Pesticides and Drugs Control New March 2000
Nutrition Dietetics	Policy and Planning
Political Science	Pollution and Degradation
Psychology	Soil Water Management
Psychology applied	Water Resource
Psychology Experimental	
Psychology multidisciplinary	
Psychology Social	
Public Administration	
Public Environmental occupational Health	
Social Issues	
Social sciences interdisciplinary	
Water Resources	

138 **Table 1. Databases categories**

139 Moreover, to be included in the review the articles *i)* must report empirical studies on
140 nudging-based interventions involving actors of the food chain at different levels, namely
141 farmers, food processors and/or distributors, and consumers, and *ii)* must be specifically
142 aimed at nudging environmentally sustainable behaviours.

143 The evaluation process of all titles, abstracts and full-texts was made independently by two
144 researchers, such that the selection procedure was duplicated by two independent coders and
145 their coding outcomes were compared according to the inter-coder agreement, which assured

146 the validity of the research results (Cohen's Kappa was 98.2%). The remaining differences
147 were resolved through personal consultation between the researchers.

148 Using the selection criteria and procedure described above, the first search on WOS, Scopus,
149 Econlit and CAB led to the identification of 9,975 records. After screening for year of
150 publication and language, the search was restricted to 6,041 research articles. After selecting
151 following the database categories, records were limited to 3,071, which were then manually
152 sifted. After title screening, 2,912 records were excluded because they did not meet the
153 inclusion criteria and the remaining 159 titles were checked by abstract. Through this process
154 121 articles were excluded because their abstract content did not meet the inclusion criteria.
155 This screening procedure resulted in 38 articles that were full-text screened: 15 articles were
156 excluded because they did not meet the established criteria and, finally, 23 articles were
157 selected to be included in the review. As an additional step, we also checked the article
158 references to verify whether it was possible to retrieve other studies. The search ended up
159 with two additional research papers such that, finally, 25 were included in the systematic
160 review. The flow chart summarizing the whole selection process is illustrated in Figure 1.

161 Of the selected studies, 13 articles were focused on farmers, while 12 studies were focused on
162 consumers. It is worth highlighting that one of the thirteen studies on farmers, although
163 resulting from the literature research, did not specifically mention the terms 'nudging',
164 'nudge' or 'choice architecture' (Clot et al., 2017). However, after carefully reading the paper,
165 we decided to include it in the literature review because the experiment explicitly worked as a
166 nudge.

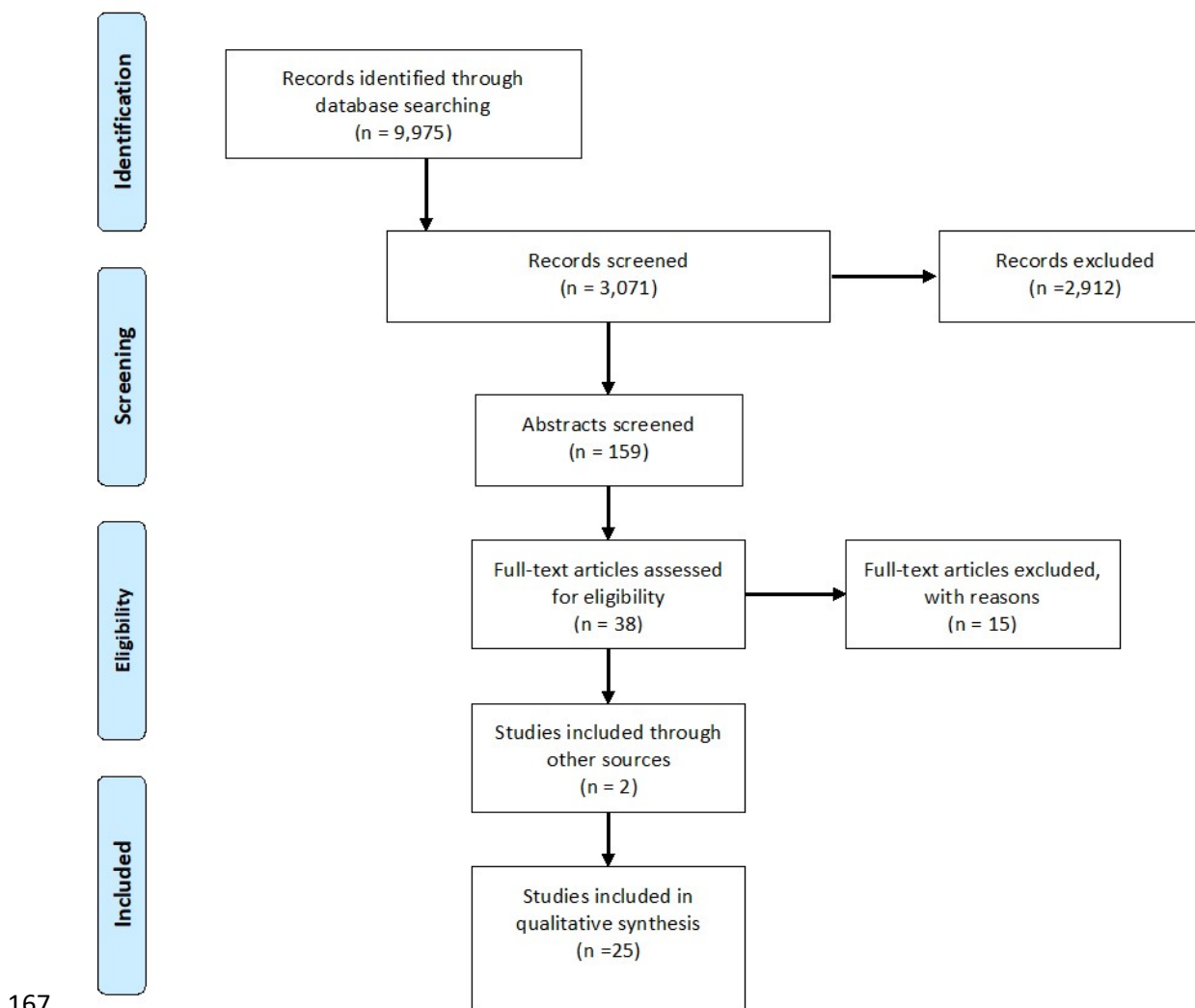


Figure 1. PRISMA flow chart

3. Major Outcomes

3.1 Overview of the selected studies

172 Twenty-three articles included in the systematic review reported original primary data, while
 173 two articles used secondary data (Brown, 2018; Mills et al., 2017). Most of the selected studies
 174 were entirely quantitative, except for three that adopted a qualitative approach (Mills et al.,
 175 2017; Torma, Aschemann-Witzel, & Thøgersen, 2018; von Kameke & Fischer, 2018).

176 The selected studies provided evidence from six European countries (United Kingdom,
 177 Germany, Sweden, Denmark, France, and Belgium) and from the US, while only one study was
 178 carried out in Africa (Madagascar). Of these, the ones involving farmers were conducted in the

179 US, Madagascar, UK, Germany, France, while those on consumers were conducted in the
180 United Kingdom, Germany, Sweden, France, Denmark, Belgium and the US. Only two articles
181 did not specify where the experimental data were collected. Moreover, the literature review
182 highlighted that most of the studies were published recently (2016- 2018), suggesting that the
183 application of nudging for sustainability-related purposes represents a relatively new field of
184 research, which has gained increasing attention over the last few years. The oldest selected
185 research papers were published in 2013 (Barnes, Toma, Willock, & Hall, 2013; Kallbekken &
186 Sælen, 2013).

187 Table 2 summarizes the type of nudges applied in each study, distinguishing between those
188 involving farmers and consumers respectively. The most used nudging tools both for farmers
189 and consumers are represented by norms, mostly named as social norms and messages.

190

191 **Table 2.** Classification of articles based on the type of nudge applied

NUDGE	FARMERS	CONSUMERS
Default		(Campbell-Arvai et al., 2014)*; (Kallbekken & Sælen, 2013)*; (Torma et al, 2018); (Vandenbroele et al., 2017)
Salience	(Brown, 2018)*; (Pellegrin et al., 2018); (Czap et al., 2015); (Sheeder & Lynne, 2015); (Czap et al., 2014); (Banerjee, 2018)*;(Clot et al., 2017)*; (Barnes et al., 2013)* .	
Norms and Messages	(Peth et al., 2018)*; (Banerjee, 2018)*; (Brown, 2018)*; (Mills et al., 2017); (Wallander et al., 2017); (Clot et al., 2017)*; (Kuhfuss et al., 2016b); (Barnes et al., 2013)*.(Kuhfuss et al., 2016a)*.	(von Kameke & Fischer, 2018)*; (Linder, et al., 2018); (Kristensson et al., 2017); (Shearer et al., 2017); (Demarque, Charalambides, Hilton, & Waroquier, 2015); (Kallbekken & Sælen, 2013)*; (Campbell-Arvai et al., 2014)*; (Filimonau et al.,2017); (Peth et al., 2018)*.
Priming		(Bacon & Krpan, 2018); (Kurz, 2018); (von Kameke & Fischer, 2018)*.
Incentive	(Kuhfuss et al., 2016a)*.	

192 (*) indicates those research papers that used more than one nudge.

193

194 3.2 *Nudging-based studies on farmers*

195 Overall, thirteen articles were found that nudged farmers to undertake pro-environmental
196 actions (Table 3). These articles were subdivided in three main categories according to their
197 specific aim, that is *i*) nudging practices to improve management of natural resources, *ii*)
198 nudging a responsible use of pesticides, and *iii*) nudging the subscription in pro-
199 environmental schemes. Specifically, four studies focused on implementing best practices in
200 the management of water, one article focused on a better management of the land, while one
201 study was focused both on land and water management. One research paper focused on
202 implementing best practices when using pesticides in order to improve biodiversity
203 conservation and, finally, six studies nudged the subscription in pro-environmental schemes.
204

205 3.2.1 Nudging practices to improve management of natural resources

206 Peth et al. (2018) used nudging to leverage farmers to adopt a more responsible nitrogen
207 fertilization to limit water pollution. Nudges were based on messages and salience.
208 Additionally, authors used a social comparison treatment (Peth et al., 2018). They found an
209 overall positive effect of both messages and social comparison in reducing nitrogen pollution
210 when farming, but contrary to what the authors expected, the impact of social comparison
211 was not stronger than that of messages alone (Peth et al., 2018).

212 Barnes et al. (2013) used salience and social norms to nudge farmers choosing water quality
213 management techniques to reduce nitrate pollution (Barnes et al., 2013). According to the
214 results, changing farmers' behaviour through nudging produced mixed effect. Indeed, because
215 of the different perception that farmers had about the link between water pollution and
216 nitrates presence in water, nudging was not sufficient to shape farmers' behaviour and
217 stronger measures were required. These results suggest that nudging interventions could
218 present some limitations, however authors concluded that a sharing-information approach
219 may be helpful in reaching positive outcomes (Barnes et al., 2013). Czap et al. (2014)
220 investigated differences in individual response to salience (N. V. Czap et al., 2014). The
221 framework of the study was based on agricultural activities, but, in this case, the experiment
222 was conducted in a lab with students instead of directly involving farmers. Results indicated
223 that the nudge was more efficient on female than on male in improving environmentally-
224 friendly behaviour (Czap et al., 2014). In a subsequent study, Czap et al. (2015) focused on the
225 use of salience and financial incentives to nudge water conservation and farmers'
226 environmentally conscious behaviour. Also in this case, the authors conducted the experiment
227 in a lab recruiting students. The study demonstrated that salience worked well in promoting

228 water conservation, especially when associated with financial incentives (Czap et al., 2015).
229 Sheeder and Lynne (2015) focused on two important farming activities, that is, water and
230 land management. Specifically, their results highlighted that the salience intervention pushed
231 the adoption of conservation tillage, which consequently improved the water management
232 (Sheeder & Lynne, 2015). Banerjee (2018) focused his study on land spatial coordination
233 among neighbouring producers. The authors implemented social comparison and information
234 nudges and, similar to Czap et al. (2014) and Czap et al. (2015), they conducted the
235 experiment recruiting students in a lab setting. In detail, the experiment mimicked a real-life
236 situation in which farmers had to decide whether to adopt land conservation practices.
237 Students, had to identify themselves with farmers and decide about land conservation
238 practices after being informed about their neighbours decisions (Banerjee, 2018). The results
239 provided evidence that this intervention worked in coordinating actions among neighbour
240 farmers, thus improving spatial coordination (Banerjee, 2018).

241

242 3.2.2 Nudging a responsible use of pesticides

243 An article analysed whether nudging tools could promote the subscription in agglomeration
244 bonus (AB) schemes to create refuges for pesticide resistance management among farmers
245 who cultivated Bt-corn (Brown, 2018). The paper empirically analysed secondary data of a
246 social marketing campaign, which adopted a salience-based intervention involving messages
247 and social comparison to promote the creation of refuges (Brown, 2018). Nudging
248 interventions worked in improving the subscription to AB schemes, and the effect was
249 especially positive in the short-run (Brown, 2018).

250

251 3.2.3 Nudging the subscription in pro-environmental schemes

252 Participation in pro-environmental schemes was nudged with norms and messages, salience
253 and social comparison. An example of messages is be represented by reminder letters sent to
254 farmers such as the ones used by Wallander et al. (2017). They found that the effect of
255 nudging farmers to take part in pro-environmental measures through such messages was
256 strongly affected by farmer's past behaviour. In detail, if farmers had already taken part to
257 such schemes, messages were effective in nudging them to subscribe again, while the effect
258 was weaker when they had never been part of such programmes (Wallander et al., 2017).
259 Kuhfuss et al. (2016b) examined whether farmers could be pushed to maintain the
260 subscription to environmental management schemes by means of interventions based on
261 social comparison (i.e., by informing them on their peers' behaviour). According to their

262 results, these interventions worked well in maintaining producers enrolled in such schemes
263 in the long-run (Kuhfuss, et al., 2016b).

264 Mills et al. (2017) investigated whether farmers could be nudged to voluntarily adopt pro-
265 environmental practices and to maintain these practices in the long-run. Their findings
266 highlighted that social norms were able to influence producers in deciding to manage their
267 activity more sustainably. However, they found that farmers may respond to nudges in an
268 heterogeneous manner, based on their specificities (Mills et al., 2017). Kuhfuss et al. (2016a)
269 investigated whether collective bonus given to farmers could increase the total land enrolled
270 in agro-environmental schemes and obtained positive results. Moreover, their results also
271 highlighted that this outcome was reached thanks to the generation of a social comparison
272 mechanism within farmers that influenced each other behaviour (Kuhfuss et al., 2016a). Clot
273 et al. (2017) examined whether using different words (i.e., 'compensation' vs 'payment') could
274 differently affect farmers' behaviour. They implemented a lab experiment with students and
275 provided evidence that the term 'compensation' was more effective than 'payment', thus
276 suggesting that words are not neutral but may exert different responses (Clot et al., 2017).

277 Contrary to the main evidence provided in the above mentioned studies, Pellegrin et al.
278 (2018) found that salience was not effective in nudging farmers to subscribe in pro-
279 environmental schemes.

AUTHOR/S, YEAR	AIM OF THE STUDY	INTERVENTION (NUDGE)	SAMPLE SIZE/ COUNTRY	DATA COLLECTION	METHODOLOGY	RESULTS
(Brown, 2018)	To analyse the effect of a behavioural nudge on farmers' insect resistance management (IRM) practices.	Salience, social norms, social comparison	Data are collected from Monsanto for corn seed sales by Monsanto in North Carolina for 2013–2016-US	Data from Monsanto panel	Difference-in-differences, fractional regression, discrete changes-in-changes. Author focused on estimating the average treatment effect of the program in terms of changes in refuge adoption.	The nudge intervention had a significantly positive effect in the first year following the program.
(Banerjee, 2018)	To promote coordination of land uses among neighbouring farmers.	Social comparison	144 students*-country not specified	Laboratory experiment	Within-subject treatment, information treatment, random effects logistic regressions.	Results shown that having information from another community improves spatial coordination rates in both communities.

(Peth et al., 2018)	To investigate the how nudges affect compliance with the minimum-distance-to-water rule.	Information, social comparison	163 farmers-Germany	Online survey	Multi-period business management game.	Nudging reduced area that is illicitly fertilised and the share of noncompliant participants, but also the total area that is illicitly fertilised. Social comparison is not stronger than information.
(Pellegrin et al., 2018)	To examine whether individual identified victims effect increases farmers' participation in a conservation program.	Saliience	328 farmers-France	Mail survey	Quasi-experimental design	Identified victim effect (saliience) did not work.

(Wallander et al., 2017)	To investigate whether nudge could improve land owners' willingness to participate into USDA's Conservation Reserve Program.	Information, norms	27,488 farmers-US	Mail survey	Experimental design, two treatments.	Authors found that for the most well-informed group, intervention nudged farmers' participation to the program. Results were not statistically significant for low information group.
(Kuhfuss et al., 2016b)	To identify the effect of social norm in driving farmers' decisions to maintain pro-environment practices; to examine whether behaviour of other producers mattered to individual's stated intention.	Norms, social comparison, framing	395 farmers-France	Online survey	Farmers are divided into three treatment groups and one control group.	Social comparison influenced a farmer's stated decision whether to maintain the pro-environment practices. Framing do not influenced decisions.

(Czap et al., 2015)	To explore the effectiveness of implementing an empathy nudge vs a financial incentive in the context of conservation compliance on farming land.	Empathy nudge (salience) vs Financial incentive	400 students*- US	Framed laboratory experiment	Students were grouped in three treatment groups and one control groups. One group was treated with an empathy nudge.	Salience could counterbalance the cut of financial incentives, despite it is less effective. Authors found that applying both empathy nudge and financial incentive was particularly effective in initial cases.
(Clot et al., 2017)	To investigate how words used to describe an environmental program count on individual opinions.	Message	746 students*- Madagascar	Survey	Survey, ordered probit regression.	Wording could influence the perception on environmental conservation programs.
(Barnes et al., 2013)	To explore the voluntary adoption of	Social comparison, salience and default vs Regulation	376 farmers- UK	Telephone survey	Likert scale.	Authors reported that shifting from

	water quality management techniques.					regulation to a nudge could lead to uptake social optimal solutions.
(Mills et al., 2017)	To understand producers' willingness and ability to undertake environmental management schemes.	Personal and social norms	60 farmers- UK	Qualitative questionnaire	Qualitative analysis, data coded into categories.	Personal and social norms affected farmer environmental behaviour.
(Sheeder & Lynne, 2015)	To explore whether empathy counts in deciding if adopting conservation tillage practice.	Saliience	498 farmers-US	Mail survey	Logit model.	Farmers with empathy-sympathy interests were more likely to use conservation tillage.
(Czap et al., 2014)	To examine how different genders response to self-interest and empathy stimuli	Saliience	432 students*- US	Framed lab experiment	Author implemented a game to understand how farmers interacted.	Empathy nudging (saliience) worked more on female than male when increasing environmentally-friendly behaviour.

(Kuhfuss et al., 2016a)	To explore whether a monetary bonus nudges farmer to enrol land in agro-environmental schemes	Incentive, social norm	317 farmers-France	Face to face survey	Choice Experiment.	Incentives worked in increasing subscription in pro-environmental schemes and reduced pesticide usage.
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281 (*) Scholars implemented a lab experiment with students to understand how nudging methodologies could work.

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283 3.3 Nudging-based studies on consumers

284 Overall, the review process identified twelve articles that examined whether nudging
285 interventions could induce consumers to have a more sustainable approach with regard to
286 their eating habits and behaviours (Table 4). These studies mostly focused on nudging
287 consumers in changing consumption habits when *i*) eating out of home *ii*) when purchasing at
288 supermarkets, and *iii*) in improving their food waste management. Specifically, four articles
289 were focused on food consumption choices when eating out, four articles investigated
290 whether nudging could drive food purchasing, and four studies focused on improving food
291 waste management.

292

293 3.3.1 Nudging consumers when eating out

294 Consumers' behaviour at the restaurant was usually nudged with priming techniques, that is,
295 changing menu designs to test if consumers could be nudged towards more environmentally-
296 friendly choices (Bacon & Krpan, 2018; Filimonau & Krivcova, 2017; Kurz, 2018). In detail,
297 these studies tested whether consumers could be nudged to choose vegetable options instead
298 of meat dishes. Taken together, these results highlighted that priming was effective in
299 increasing the consumption of vegetarian over meat dishes. Moreover, Kurz (2018) showed
300 that by increasing the saliency of plant-based dishes by modifying their visibility on the menu
301 could lead people to ask for more information. Bacon and Krpan (2018), found that changing
302 the menu design (i.e. increasing the saliency of vegetarian plates) can be effective to shape
303 food choices, although consumers' likelihood of selecting vegetarian items was strongly
304 dependent on their past behaviour. Furthermore, Filimonau et al. (2017) nudged an
305 environmental-friendly behaviour in a restaurant by inserting messages and information on
306 the menu, like the origin of ingredients and the carbon footprint of the items. Their results did
307 not report strong positive effects in nudging food choices. Campbell-Arvai et al. (2014) tested
308 how an appealing and an unappealing meat-free menu worked in nudging participants in
309 choosing meat-free options, by examining the effectiveness of different nudging-based
310 treatments and combinations. Their results suggested that if menus were described in an
311 appealing manner, default and information nudges combined were the most effective
312 interventions, while for the unappealing menus, the default menu was the most chosen option
313 (Campbell-Arvai et al., 2014).

314

315

316

317 3.3.2 Nudging consumers at supermarkets

318 Some studies focused on how to promote sustainable behaviours when purchasing food at the
319 supermarket. Kristensson et al. (2017) explored how both verbal and written cues influenced
320 consumers purchasing behaviour, and results highlighted that both nudges encouraged
321 customers to buy more environmentally friendly products, with verbal signs being more
322 effective (Kristensson et al., 2017). Demarque et al. (2015) conducted a lab experiment with
323 students to test the effectiveness of norms on online grocery shopping behaviour and found
324 positive effects in terms of increased eco-product purchasing. In a recent study, Torma et al.
325 (2018) explored consumers' ability to nudge themselves in buying organic food by
326 subscribing to 'organic box schemes' consisting in substituting small daily vegetables
327 purchases with larger organic orders delivered at home weekly. The authors considered the
328 subscription to the 'organic box scheme' as 'self-default' nudge. Results reported that such
329 self-nudging concretely helped consumers in acting more sustainably, with effects persisting
330 also in the long-run (Torma et al., 2018). Finally, Vandebroele et al. (2017) tested the effects
331 of varying (i.e., reducing) food portion sizes sold at supermarkets and found that the
332 availability of smaller portions nudged consumers to opt for these latter, discarding standard
333 sizes. As suggested by the authors, this may also indirectly result in food waste reduction.

334

335 3.3.3 Nudging food waste reduction and recycling

336 Past literature implemented several types of nudges such as default, messages and social
337 norms to reduce and/or recycle household food waste. All interventions gave positive results
338 and were useful to reduce food waste or improve food recycling. Specifically, two studies were
339 focused on improving food waste management through the use of messages, as visual
340 prompts and information flyers (Linder et al., 2018). Both studies found that these nudges
341 significantly contributed to improve households' food waste management, although Linder et
342 al. (2018) found that the effect decreased in the longer run. Von Kameke and Fischer (2018)
343 hypothetically tested the effectiveness of different kind of nudges (for example, tips on
344 shopping planning via email or pictures) in leading the households to shop less in order to
345 reduce food waste. The results showed that the nudges played a significant role in reducing
346 food waste, at least in the hypothetical context of their study (von Kameke & Fischer, 2018).
347 Furthermore, nudging was useful also in reducing food waste in hotel restaurants. Kallbekken
348 and Sælen (2013) decided to provide smaller plates at the buffet (that is, they changed the
349 default) and to show messages that invited hotel guests to take more food from the
350 restaurant's buffet. This controversial combination of signs was aimed at nudging consumers

351 to load less food on their plates when visiting the buffet (Kallbekken_&_Sælen, 2013). The
352 experiment results demonstrated that the combination of these nudging interventions was
353 effective in reducing food waste (Kallbekken_&_Sælen, 2013).

AUTHOR/S, YEAR	AIM OF THE STUDY	INTERVENTION (NUDGE)	SAMPLE SIZE/ COUNTRY	DATA COLLECTION	METHODOLOGY	RESULTS
(Bacon & Krpan, 2018)	To study if the effectiveness of menu design in nudging pro-environmental food choice depends on the vegetable's habit consumption of consumers (that is, their past behaviour).	Priming	853 students*- UK	Online study	Online scenario. Three different restaurant menu designs as treatments and one control design. Participants were randomly assigned to four different restaurant menu conditions.	Consumers' past behaviour plays an important role in nudging food choices. That means that personalized interventions are needed to achieve sustainable eating habits.

(von Kameke & Fischer, 2018)	To nudge planning behaviour for preventing domestic food waste and to predict the potential effectiveness of a nudging treatment by focusing on consumers' perceptions and evaluations.	Message	101 residents-Germany	Semi-structured questionnaire containing both open-ended and closed questions	Analysis consists in descriptive statistics.	Nudging intervention can contribute to the reduction of household food waste.
(Linder et al., 2018)	To test whether a nudge can be effective in promoting recycling of food waste in an urban area.	Social norm, message	474 households-Sweden	Waste was weighted during each collection.	Natural field experiment, difference-in-difference analysis. Authors studied both the short- and	The increase of the recycled food waste increase in food waste recycled compared to

					long-term effects of the intervention.	a control group in the research area.
(Kurz, 2018)	To explore if nudging can increase the consumption of vegetarian food to mitigate GHG emissions by reducing meat consumption.	Priming	192 dishes (average)-Sweden	Sales data collected through the restaurants' register.	Field experiment, difference-in-difference analysis.	Consumers adopted a more pro-environmental diet. The change in behaviour is partly persistent.
(Kristensson et al., 2017)	To examine what influences consumer behaviour toward making more environmentally friendly choices.	Message	400 grocery consumers-Sweden	Face-to-face survey	Survey to understand how people perceived the likelihood that consumers in general would change their behaviour.	There is a discrepancy between what consumers think should influence behaviour and what actually

						does influence behaviour.
						Nudge intervention increased the choice of environmentally friendly offerings.
(Shearer et al., 2017)	To examine if a sticker prompt would significantly increase the capture of food waste for recycling among households in the long-term.	Message	64,284 households-UK	Waste was monitored and weighted.	Randomized control trial	Authors found a significant increase in recycling food waste in the treatment group. The behaviour persisted in the long-term.

(Torma et al., 2018)	To describe how consumers conceive of their decision to buy organic box ("self-nudging").	Default	10 consumers-Denmark	Face-to-face interview	Phenomenological approach, qualitative research.	Self-nudging worked well on consumers with strong interest in protecting the environment.
(Demarque et al., 2015)	To explore how to promote green consumption through nudging.	Message, social comparison	122 students*-France	Lab experiment	Authors subdivided sample in four groups, one control group, and three treatment groups.	Implemented nudges helped in improving green consumption.
(Kallbekken & Sælen, 2013)	To reduce food waste in hotel restaurant.	Default, message	52 hotel restaurants, 45,000 observations-Norway	Hotels recoded the daily food waste's weight.	Difference-in-difference using a fixed effects panel regression to analyse the	Reducing the plate size by 3 cm reduces food waste by approximate

						treatment effects.	ly 22percent.
(Filimonau et al., 2017)	To investigate the determinants of consumers choice when dining out and how to nudge people to take more sustainable choices.	Priming	340 consumers-UK	Face to face consumer survey		Field experiment. Authors implemented a menu intervention approach.	Authors found that next to price, food provenance and nutritional value determined consumer choice when dining out.
(Campbell-Arvai et al., 2014)	To explore the role of a nudge in pushing choices with positive environmental outcomes.	Default	316 consumers-US	Focus group and interview		Choice experiment.	Default-based interventions can be important tools in pushing green behaviour

						also in the long-term.
(Vandenbroele et al., 2017)	To test whether adding smaller portion sizes in supermarkets encouraged consumers to buy smaller portions. Smaller sausage portion sizes generate positive outcomes both on the environment and on health.	Default	1,365 purchasers - Belgium	Changes in purchasing before and after the treatment and between the control and treatment supermarkets.	Field experiment (consumers were not aware that they were involved in the experiment).	52% of sausage sold were small or medium. Thanks to default choice, authors highlighted that 13% less meat (in kg) was sold with regards previous purchasing. During the same period, the treated store sold fewer sausages than the

control
store.

355 (*) indicates those research papers that used more than one nudge.

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4. Discussion

The present review gathers existing evidence on green nudges applications involving the actors of the food chain with the goal of leveraging more environmentally sustainable practices and behaviours. Specifically, evidence was collected to examine whether and to what extent the implementation of different type of green nudges could be effective in leading the food chain agents to refashion their behaviours towards more sustainable models, thus voluntarily contributing to environmental preservation.

The first main evidence emerging when analyzing the results of the selected studies is that green nudging can be surprisingly effective in directing people towards the desired direction. Almost all studies on farmers as well as on consumers, indeed, reported significant results, thus strengthening the potential of this tool to be used for environmental policy formulation. Moreover, consistent evidence was obtained in several EU and extra-EU countries, which suggests that nudging implementation is not particularly affected by cultural or socio-economic specificities. It is also worth noticing that the studies included in this review are all very recent (the oldest dated 2013). This stresses that the use of green nudging in relation to food-related production and consumption is expanding and raising attention. Overall, this documents the increasing significance that behavioural interventions are assuming as possible solutions to be adopted in order to effectively cope with the complexity of environmental problems (Kunreuther & Weber, 2014; van der Linden et al., 2015).

Despite the results essentially go in the same direction, differences emerged with regard to the type of nudges used with farmers and with consumers. In the former case, indeed, the review highlighted that the most used nudges were based on norms and messages, followed by interventions designed to exploit salience. As for consumers, norms and messages still constitute the most adopted technique, together with priming and default. To investigate the reasons behind the implementation of one nudge or another was out of the scope of this review, but this aspect deserves a more in-depth investigation. In fact, to understand whether different nudges may act differently on specific food chain agents would make a substantial contribution to successfully develop future environmental policy.

Furthermore, no studies were found in which nudges were targeted at the food industry or the distribution sectors. Given the relevant role that both these sectors play in terms of environmental impact, it would be crucial to extend available evidence on nudging effectiveness with studies involving these agents.

This review presents some limitations. As explained in the Approach section, we focused our research on 'nudge*' and 'choice architecture' words. However, there could be some studies

390 that implemented green nudging interventions without mentioning the specific words in the
391 manuscript. If so, they were not included in the review. Indeed, we were able to select an
392 article that did not include the above-mentioned terms, but its intervention worked like a
393 nudge (Clot et al., 2017). In other words, we cannot exclude with certainty that we some
394 pertinent articles were avoided.

395 Taken together evidence suggest that, at least from a policy standpoint and contrary to other
396 policy instruments, nudging has at least two advantageous characteristics. The first is that
397 nudging applications are generally relatively inexpensive and the second main advantage is
398 the ease of implementation and the possibility to adapt the nudge to various context (Thaler &
399 Sunstein, 2008). As such, this tool may be particularly suitable to be applied in those contexts,
400 such as agriculture, that suffer from geographical or economic specificities that make it
401 difficult to strictly adjust a single policy to all producers. Nudging applications could be
402 helpful to foster pro-environmental practices that could be more in line with the specific
403 needs of the agents involved. However, in line with the suggestion of Lehner et al.(2016), we
404 claim that nudges should not be meant to replace more strict environmental and food policies,
405 but rather they should be regarded as potential complements to be implemented with the aim
406 of gradually moving society in a direction that might benefit all.

407 Despite these anticipated benefits and evidence indicating the effectiveness of this tool, there
408 are critical aspects that needs to be acknowledged. As emerging from the results of this
409 review as well as from previous literature, it is still unclear whether green nudges are able to
410 generate robust and durable behavioural change (Schubert, 2017). Furthermore, nudging use
411 is actually at the core of a lively debate in which opponents argue about the partly
412 manipulative way in which they attempt to shape human behaviours. Indeed, as explained by
413 Thaler and Sunstein (2008) nudges are meant to alter people's behaviour by taking advantage
414 of individual cognitive biases or by responding to them, instead of acting on them to improve
415 their capability to make informed, rational and conscious choices (Grüne-Yanoff, 2015;
416 Schubert, 2017; Thaler & Sunstein, 2008). This has generated concerns regarding the
417 legitimate application of this tool and, although the authors of the libertarian paternalism
418 defend that nudges should shape behaviours in a transparent manner, the boundaries of the
419 underlying manipulations are not so univocal. Hence, while recognizing the significant
420 potential that nudging may have in re-orienting behaviours towards a more sustainable
421 trajectory, future studies should take these issues into account to provide further knowledge
422 which could be used as guidance for successful policy formulation.

423

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