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(Article begins on next page)

The role of food waste hierarchy in addressing policy and research: A comparative analysis

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Abstract

The European Union is working towards reducing food waste by 30% by 2025. A pyramid of priorities to manage the food waste reduction is set by the Directive 2008/98/EC, where prevention is the first action to be implemented by the Member States. The objective of this paper is to identify the main trajectories followed so far by scientific research and two national laws against food waste, namely the Italian and the French laws. To do so, the two regulations are compared by analyzing and classifying each single measure according to the FUSIONS approach. Results are discussed with reference to the priorities expressed in the food waste pyramid. So far, it seems that the two national laws took a different direction, limiting the prevention activities to communication campaign addressed to final consumers and focusing on re-use and recovery especially at the final stages of the supply chain. Academic research shows a dominant focus on energy recovery and recycling.

2

3 1. Introduction

4 Food waste is recognized as a global issue and its reduction is considered a crucial element in
5 developing a sustainable food system (UN, 2015). After the first estimation conducted by
6 FAO in 2011 (Gustavsson et al., 2011), revealing that one-third of the food globally produced
7 is lost during the several stages of the supply chain, other studies confirmed that the amount
8 of food waste is very relevant (Stenmarck et al., 2016). Producing food that will never be
9 consumed causes the waste of environmental resources (Hall et al., 2009; Kummu et al.,
10 2012), hinders food security (Godfray, 2010) and raises social and economic problems
11 (Mourad, 2016; Cicatiello et al., 2016). In 2014, the UN set up a target specifically addressed

12 to food waste within the Sustainable Development Goal (SDG) n.12 (i.e. ensure sustainable
13 consumption and production patterns): SDG n.12.3 calls for halving per capita global food
14 waste at the retail and consumer level and reducing food losses along the production and
15 supply chains, including post-harvest losses, by 2030. This target is the main legal foundation
16 of policies against food waste all over the world.

17 A huge effort has been done, in the last years, to search and implement solutions against food
18 waste at different levels of the supply chain (Mourad, 2016). These solutions are supposed to
19 follow the priorities set for waste management, thus focusing firstly on prevention, and
20 seeking reusing and recycling solutions as secondary options (Papargyropoulou et al., 2014).

21 In the European Union, France and Italy approved specific laws addressing food waste, in a
22 comprehensive normative framework addressing the overall problem with multiple acts and
23 solutions.

24 This paper provides an analysis and appraisal of the measures designed by the French and
25 Italian laws against food waste and a discussion of their consistency with the current trends of
26 the research on food waste. The objective is to compare the trajectories followed by the
27 legislative framework and by the academic literature, to discuss the extent to which they are
28 able to contribute to the achievement of the targets set at the policy levels.

29 To do so, the paper adopts a twofold approach. First, the two national regulations against food
30 waste are analysed, by studying (i) how they are linked to the principles settled in the
31 European regulation and to the most recent evidences provided by international literature in
32 the field of food waste, and (ii) the type of measures implemented, to check whether there is a
33 difference in approach and methods and if there is coherence of actions with policy and
34 scientific agenda at global level. By doing so, the study aims to complement the work of
35 Vaque (2017) who proposed a first comparison between the two laws, commenting on the
36 potentiality of replication of the single sections/articles in other UE member states. Second,
37 the occurrence of the food waste hierarchy keywords in the extant literature on food waste is
38 studied, as well as the prevalence of studies dealing with different stages of the food chain.
39 The results are then compared in order to discuss where the current policy and research efforts
40 are moving. The article ends with some conclusions and suggestions to push the global
41 agenda toward a greater application of the food waste hierarchy in the implementation of
42 actions against food waste in Europe.

43

44 **2. Background on food waste policies**

45 *2.1 The EU approach to food waste prevention and reduction*

46 Latest researches state that in the EU-28, 89 million tons of food are wasted every year
47 (Stenmarck et al., 2016), corresponding to 173 kilograms of food waste per person. Among

48 this, households are estimated to be responsible of 53% of the total, followed by processing
49 (19%), public and private food service (12%), production (11%) and retail (5%) (Stenmarck
50 et al., 2016). Although some of these figures may be under or over-estimated – e.g. in the
51 retail sector (Cicatiello et al., 2020) and at households (Giordano et al., 2018; 2019) - the
52 issue of food waste is cross-cutting to all phases of the chain. This requires a global policy
53 approach to address the problem.

54 The EU Waste Directive encourages Member States to develop “*waste prevention*
55 *programmes, concentrating on the key environmental impacts and taking into account the*
56 *whole life-cycle of products and materials*” (EU, 2008; p. 312/6). A section of these waste
57 prevention plans should be specifically focused on food waste, although this is not mandatory.
58 Among others, Italy (PINPAS, 2013-2015), France (ANTI-GASPI, currently ongoing) and
59 Spain (Mas Alimentos, Menos Desperdicio, currently ongoing) approved a National Plan for
60 Food Waste Prevention and Reduction. Italy and France have also approved national
61 comprehensive laws against food waste in 2016. Instead, in other EU countries, initiatives
62 against food waste have been implemented through more fragmented actions, for example
63 waste management plans at the municipal level (Austria, Czech Republic and Poland), action
64 plans for food loss and waste reduction (Netherlands, Sweden and Scotland) or laws targeting
65 specific issues of the food waste problem (UK, with the “Groceries Code Adjudicator Act”).
66 Large cities across Europe¹ are also implementing urban policies promoting initiatives for
67 waste reduction along the supply chain.

68 The focus of food waste prevention at the EU level is on reducing the resources to be used for
69 food production and to lower the environmental impact of food production and consumption,
70 consistently with new Circular Economy Package. Food waste is also mentioned in most

¹ The 2018 Eurocities Working Group Food Report counts 43 urban initiatives on food waste prevention and reduction.

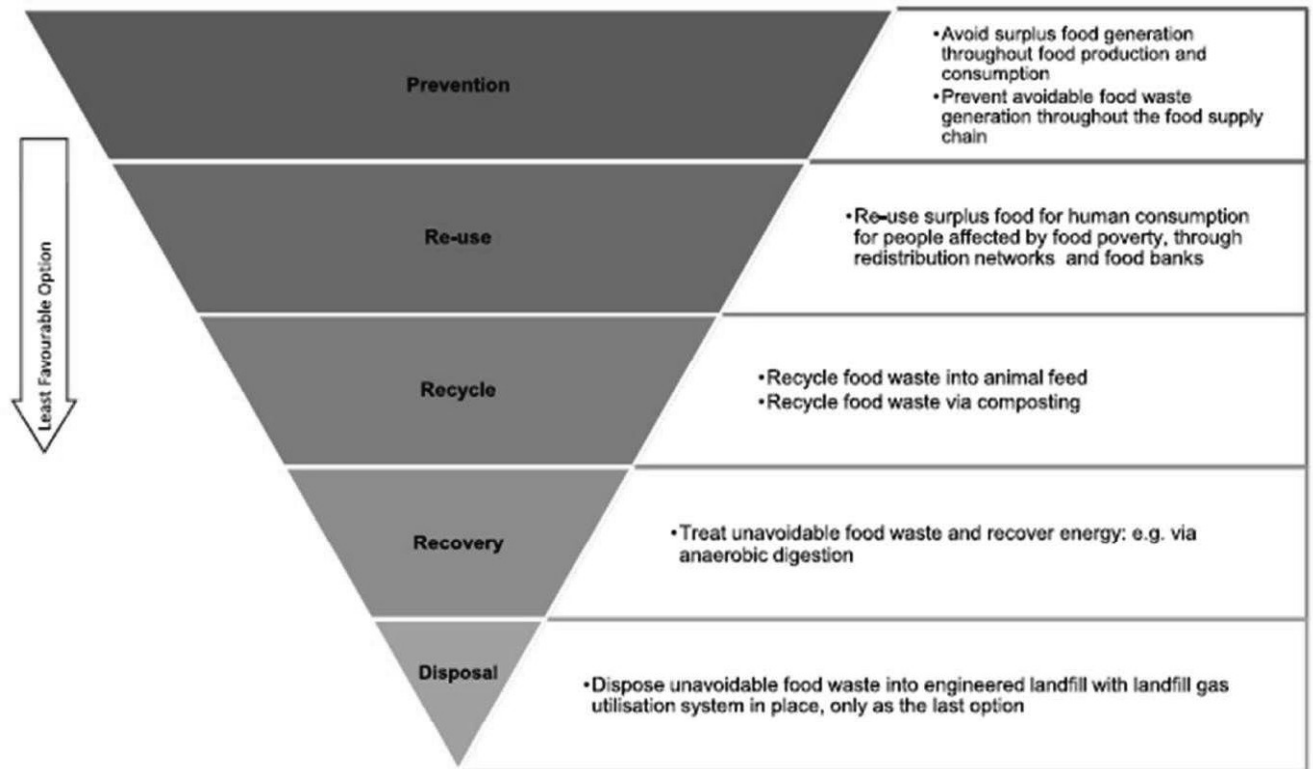
71 recent Directive (EU) 2018/851 concerning waste management, as EU countries are requested
72 to take action to reduce food waste at all stages of the supply chain, to monitor food waste
73 levels and to report whether the targets are reached. An official methodology for
74 quantification, to be used for this purpose, has been adopted by the European Commission on
75 the 3rd of May 2019 (EC delegated decision 3211 Final).

76 A clear hierarchy of priorities to manage the generation of waste is set by Directive
77 2008/98/EC (EU, 2008): “*the following waste hierarchy shall apply as a priority order in*
78 *waste prevention and management legislation and policy: (a) prevention; (b) preparing for re-*
79 *use; (c) recycling; (d) other recovery, e.g. energy recovery; and (e) disposal*” (Art.4).

80 Therefore, the directive strongly supports the concept of waste prevention as a first and
81 necessary step for waste management, with landfilling being the least preferable option under
82 the strong environmental perspective adopted in the directive. This hierarchy, which applies
83 to all waste categories, has been specifically applied to the food waste issue by
84 Papargyropoulou et al. (2014), who designed a food waste prevention pyramid (Figure 1).
85 Here, the best option is to reduce the generation of food waste by preventing the production of
86 surplus food (upstream in the food chain) and the disposal of avoidable food waste
87 (downstream). When this is not possible, the reuse of surplus food for human consumption -
88 e.g. through redistribution initiatives - is advised. The subsequent levels of the food waste
89 hierarchy envisage the recycle and the energy recovery of food waste, with the aim to avoid
90 landfilling, which stands as the least desirable option.

91

92 Figure 1 - Food waste prevention pyramid



93

94

Source: Papargyropoulou et al., 2014, adapted from European Parliament Council 2008

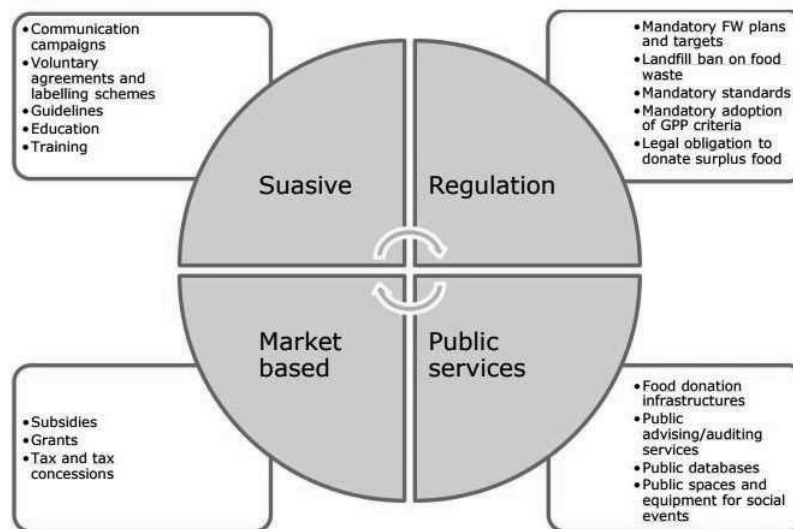
95

96 2.2 Evaluations of food waste policies

97 Each policy initiative - aimed, in this case, to address the issue of food waste - is based on a
 98 specific policy approach, which can be more or less strong in fostering the desired behaviour
 99 by citizens, institutions and business organizations. The effectiveness of a policy depends on
 100 the mix of policy approaches used in the interventions. However, in the case of policies
 101 against food waste it is still unclear which combination of initiatives can achieve best results,
 102 as evaluations of food waste prevention policies are scarce (Thyberg & Tonjes, 2016). In
 103 FUSIONS (2016) such complexity of policy approaches is interpreted according to the
 104 classification scheme in figure 2. The policy approach is classified as suasive or regulatory,
 105 while instruments can be market based or public goods. A suasive approach encourages
 106 behavioural changes through the provision of information, while a regulatory approach

107 introduces penalties. Under both policy approaches, different types of instruments can be
 108 conceived. Market-based instruments encourage behavioural change through market signals
 109 rather than through traditional regulations; examples include environmentally related taxes,
 110 charges and subsidies. Instead, other instruments are characterized by the provision of public
 111 goods or services to achieve the goal.

112 Figure 2- FUSIONS' classification approach for the policy measures.



113
 114 *Source: FUSIONS, 2016, p.22*
 115

116 Another classification framework is proposed by Muraud (2016), basing on the evaluation of
 117 the strength of the prevention measures. In this framework, a clear distinction is made
 118 between “weak” actions, focusing on achieving a higher efficiency in food supply operations,
 119 and “strong” actions, which instead aim to push holistic changes in the food systems, e.g.
 120 reducing the levels of production and/or consumption. Under this classification, most of the
 121 measures usually included in food waste policies at different levels, namely recovering,
 122 recycling and awareness raising campaigns, have to be considered weak actions.

123

124 **3. Methodology of the study**

125 To discuss the trajectories of the laws against food waste in force in the EU in comparison
126 with the most recent trends of the current research in the field of food waste, this paper uses a
127 twofold methodology. First, an analysis and classification of the measures included in the
128 laws against food waste are provided, according to a functional method for comparative law
129 analysis (Michaels, 2006); second, the current scientific literature dealing with food waste
130 reduction is systematized. Both methodologies are engaged with the layers of the food waste
131 hierarchy, which is used as a common framework to compare the results from the two parts of
132 the study.

133

134 3.1 Methodology of the policy analysis

135 The policy analysis concerns the two national laws in force in EU countries:

- 136 • the Italian law against food waste, number 166, passed on August 19th, 2016;
- 137 • the French law against food waste, number 138, passed on February 11th, 2016.

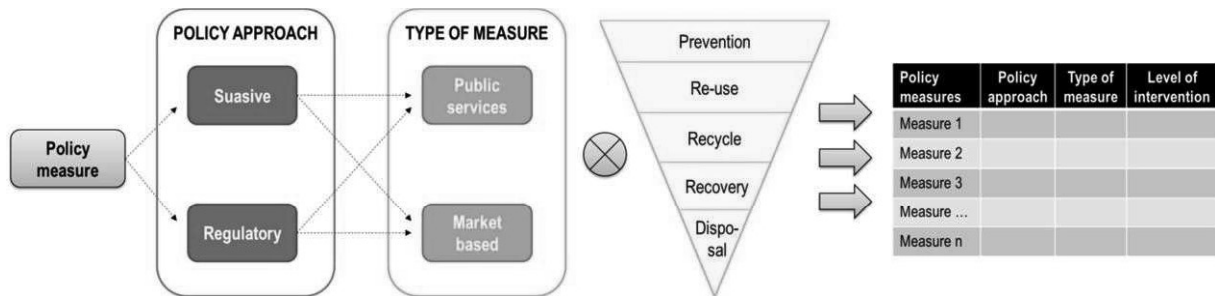
138 Both laws are analysed through a functional approach (Michaels, 2006), used as an evaluative
139 criterion to assess their implications on the reality. Namely, this functional approach focuses
140 not (only) on rules, rather on their effects on the society, i.e. in this case, on the way they can
141 actually contribute to food waste prevention and reduction. The methodology is based on
142 FUSIONS (2016), so that each measure is first classified along a 2x2 scheme, where the
143 policy approach could be considered either *suasive* or *regulatory*, while the instruments
144 provided could belong to the *market based* or *public service* class type. Second, a further
145 classification is made, based on the layers of the food waste hierarchy (Papargyropoulou et
146 al., 2014), by specifying whether they are intended to the prevention, reuse, recycle or
147 recovery of food waste. As a third step of the methodology, the actors addressed by the

148 measures and the funding provided are also noted. This further classification is inspired to
 149 stakeholders mapping and analysis tools (Eden and Ackermann 2013) and it is used to
 150 extrapolate information about: (i) the actors in charge of implementing the measure, (ii) the
 151 actors impacted by its implementation (positively or negatively), and (iii) whether the
 152 measure is financed or not. This is helpful to detect the potential effects of the measures, in
 153 line with the functional approach (Michaels, 2006).

154 A diagram of the resulting classification framework is represented in Figure 3.

155

156 Figure 3- Classification framework adopted for policy measures' analysis.



157

Source: authors' elaboration

158

159

160 As a result of this classification, a table is compiled for each of the laws analysed where, for
 161 each of the measures listed in the rows, the following information is reported:

- 162 1. Code of the measure: each measure was assigned a code, reporting IT for the Italian
 163 law and FR for the French law, followed by a sequence number; this code is used
 164 throughout the paper to refer to the single measure analysed.
- 165 2. Number of the article where the measure is established, as it appears in the law itself.
- 166 3. Number of the clause, as it appears in the law itself.
- 167 4. Policy approach: suasive (SUA) or regulatory (REG), as previously defined in
 168 subsection 2.2.

- 169 5. Type of measure: public service (PS) or market-based (MB), as previously defined in
170 subsection 2.2.
- 171 6. Level of the food waste pyramid concerned.
- 172 7. Actor in charge of implementation of the measure, as it can be deduced from the text
173 of the article.
- 174 8. Actor to whom the measure is addressed, i.e. the subject which will take advantage (or
175 will be affected) by the implementation of the measure.
- 176 9. Financing: whether the measure is clearly financed or not, as it can be deduced from
177 the text of the article.

178 To compare the two laws, a graphical representation is provided, with the aim to detect
179 differences in their approaches, type of interventions and allocated resources.

180

181 3.2 Systematization of the scientific literature on food waste reduction

182 In the systematization of the literature dealing with food waste reduction, the food waste
183 hierarchy (Papargyropoulou et al., 2014) was used as a framework to allow consistency with
184 the methodology of the policy analysis. A search in Scopus was conducted on all journal
185 articles that mentioned among the keywords the term “food waste” or "food loss". The search
186 was limited to the period 2008-present², with most of the studies being published very
187 recently: out of the total 2,908 papers returned by the search, 698 were published in 2018 and
188 533 in 2017. A database containing all the documents’ information was extracted and
189 elaborated in Microsoft Excel.

² The search was conducted on March 29th2019.

190 The analysis assessed the occurrence of the keywords related to the food waste hierarchy
191 among the abstracts of the papers included in the database. Namely, the occurrence of the
192 following terms related to the different layers of the food waste hierarchy was detected:

- 193 • Layer on prevention: “prevent” or “prevention” or “awareness”;
- 194 • Layer on reuse for human consumption: “reuse” or “re-use” or “redistribution” or
195 “donation”;
- 196 • Layer on recycling: “recycling” or “recycle” or “animal feed” or “compost”;
- 197 • Layer on energy recovery: “energy” or “digestion” or “recovery”.

198 For each article, the presence of at least one term per layer of the food waste hierarchy was
199 noted, as a proxy of the article’s link with the discussion on food waste reduction. The
200 occurrence of terms related to each layer of the food waste pyramid was illustrated through
201 descriptive statistics and analysed through correlations.

202

203 **4. Results: trajectories of actions against food waste in the Italian and French laws**

204 *4.1 Structure of the laws*

205 The Italian law against food waste (number 166 passed on August 19th, 2016) is made up of
206 18 articles, 15 of which deal with principles and initiatives set by the law itself, while 3
207 introduce modifications and/or additions to existing regulations; while the French law
208 (number 138 passed on February 11th, 2016) is made up of 4 articles, all introducing
209 modifications to existing regulations, namely the environmental, civil, education and
210 commerce codes.

211 In article 2, the Italian law includes several definitions that are later recalled throughout the
212 text. First, the concept of food waste is defined as “*food products discarded at different steps*
213 *of the agro-food chain [...], still edible and potentially suitable for human consumption that,*

214 *in the absence of a possible alternative use, are destined to be disposed of*. This definition
215 excludes food scraps and food industry by-products that are often included in other definitions
216 used in the literature, under the category of “*unavoidable food waste*” (Beretta et al., 2013;
217 Quested and Johnson, 2009; European Commission, 2019). Another relevant definition
218 included in the Italian law against food waste concerns the so-called “*food service providers*”,
219 i.e. public or private actors involved in the food production, transformation, packaging,
220 retailing and supply, to whom several measures of the law are specifically addressed. Instead,
221 the French law does not include any definition of the terms and actors concerned by the
222 initiatives against food waste, coherently with its structure which looks much more concise
223 than the Italian one.

224 For what concerns the implementation of the food waste prevention hierarchy, some
225 differences can be noted. Article 1 of the French law states that actions against food waste
226 should be implemented along the following priority order: (1) prevention; (2) donation or
227 transformation of food waste which is still suitable for human consumption; (3) valorisation
228 of food waste for animal feeding purposes; (4) production of compost or energy valorisation.
229 This recalls very closely the hierarchy of interventions of the food waste pyramid.

230 The Italian law, instead, does not include any direct reference to the food waste pyramid. In
231 article 1 the main purposes of the law are established, including: fostering the collection and
232 donation of edible food waste for human consumption purposes; reducing the negative
233 environmental impact of food waste through recycle and reuse; improving the research on
234 food waste and pushing awareness campaigns addressed to consumers and institutions.

235

236 *4.2 Trajectories of actions against food waste in the Italian law*

237 The 18 articles of the Italian law against food waste address 12 different measures that were
238 considered in the analysis. Indeed, not all the articles concern specific interventions against
239 food waste; rather some of them state general principles or amendments to previous laws.
240 General principles include the list of priorities to be considered for the food donation (human
241 consumption, only whether food does not pass the expiration date; use for animal feeding, as
242 a second option; composting as last option). They also specify that *gleaning* is allowed, and
243 sanitary issues related to the collection are responsibility of the charities themselves.

244 Among the interventions provided by the Italian law, several concern food donations. Food
245 donation is defined as a “voluntary” act. As written in the article 3 of the law, clauses 1, 2, 3
246 and 4, food “can be” donated (1), for free (2), and whether it does not fit the sanitary
247 standards for human consumption, it can be donated for animal feeding or composting (3);
248 food products showing irregularities in labelling can be donated for human consumption as
249 well (4).

250 Much effort is put on measures targeting awareness- raising and communication campaigns.
251 Article 9, clauses 1, 2 and 3, proposes three types of communication campaigns: the first
252 (coded as measure IT01) to be broadcasted to the general public through the three national TV
253 channels. Public funding has been foreseen to accomplish the target. On the other side,
254 clauses 2 and 3 invite the ministries of Environment, Agriculture and Work (measure IT02)
255 and Health (measure IT03) to divulgate data on food waste and promote awareness campaigns
256 specifically addressed to promote the use of doggy bag at restaurant. No funding has been
257 foreseen for such activities, at this stage. Finally, Ministries of Education, Environment,
258 Health and Agriculture are invited to formulate awareness raising initiatives both for food
259 waste and inequality in food access; the awareness raising initiatives are addressed to primary
260 and secondary schools; however, no funding has been foreseen for such activities either. All

261 these measures have been therefore classified as suasive initiatives, to be implemented
262 through public services.

263 In article 9, clause 4 (measure IT04), Regions are invited to stipulate agreements with
264 packaging operators in order to provide restaurants with sustainable doggy bag (realized in
265 recyclable material). Also, the article invites Municipalities to promote such a measure in
266 their web-sites. Given the absence of obligations and the involvement of regional institutions
267 for the implementation of the measure, it has been classified as SUA/PS as well. The measure
268 is financed; specifically, packaging company associations have been invited to propose
269 innovative solutions for doggy bag.

270 Article 9, clause 5 (IT05) foresees the development of an education programme for schools
271 with reference to food sustainability, even included food waste. The programme should be
272 developed by the four ministries of School and University, Health, Agriculture and
273 Environment. The measure is not financed.

274 Measure IT06 concerns the invitation to the Ministry of Health to produce guidelines to
275 reduce food waste and foster donations in public food services, especially school canteens.
276 This is a suasive and public service measure, with no funding foreseen in the law.

277 Art 17 (measure IT07) allows Municipalities to establish tax exemptions for those subjects
278 who donate food - the tax exemption is granted prior to certification of donated food and is
279 proportional to the quantity donated. This measure does not foresee any obligation and
280 therefore it is classified under the suasive approach. Although no direct financing for this
281 measure is foreseen by the law, its implementation requires an indirect fiscal support,
282 sustained by the Municipalities (in charge of setting up rules and collecting the waste tax) and
283 affects retailers' business with a potential gain, due to the reduced waste tax; considering the
284 mentioned reasons, the approach to this measure was classified as market-based.

285 The law also establishes a stakeholders' committee on food waste (article 8) that will meet
286 under the coordination of the Ministry of Agriculture. Such committee has many functions.
287 This committee actually inherits the functions of the working group that drew the National
288 Plan for Waste. The functions are: proposing projects to be financed by the specific fund for
289 food donation; proposing improvements for the normative system of food donation;
290 monitoring of food waste and food donation; enhancing cooperation among actors that are
291 dealing with food donation. The committee is composed of representatives of the government
292 and the civil society. Governmental stakeholders are representative of the Ministries of:
293 Agriculture, Work and Social Affairs, Economy, Environment (of which, one part of the
294 National Plan for Waste Prevention committee) and Economic Development. Furthermore,
295 the following stakeholders are foreseen: civil society representatives' part of retail
296 associations, associations recorded as "recipient" from the AGEA granting (AGEA is the
297 Italian governmental agency in charge of distribution of funding in Agriculture, even included
298 Common Agricultural Policy funding), food transformation associations, catering and
299 restaurant services, agricultural associations, autonomous regions and municipalities, National
300 Association of Italian Municipalities (ANCI), major wholesale companies and agricultural
301 cooperation. Representatives of the potential beneficiaries of campaigns against food waste -
302 such as charities or consumers - are not included in the committee. The institution of this
303 committee is classified as measure IT08, but it cannot be recognized as having neither a
304 suasive nor a regulatory approach; rather, it represents an implementing measure (IP), i.e. it
305 establishes how other measures have to be implemented. Activities implemented by the
306 committee will be reported to the Parliament annually. No funding has been foreseen for such
307 an activity either.

308 The first fund “Refinancing of fund foreseen by Article 58 paragraph 1, 22 June Decree 83 of
 309 2012, refinanced 2 million euro for 2016” is not clearly addressed to a specific activity
 310 (IT11).

311 The second fund is granted in order to improve food packaging and increasing the shelf life of
 312 fresh products (“Funding of projects aimed at improving packaging and shelf-life of products,
 313 1 million euros per year (2016, 2017, 2018”). The third fund is granted to foster initiatives
 314 aimed at promoting the use of doggy bag (“Funding granted by art. 2 clause 323 law 24
 315 December 2007 n.244 addressed to reduce waste will be incremented of 1 million euro per
 316 year (2017 and 2018), in order to include initiatives to promote the use of doggy bag at
 317 restaurants”). This fund is originally financed with 20 million euros per year (IT09 eIT10).

318 Clauses 1-7, article 16, define the exact procedures for the donation of food products at fiscal
 319 and bureaucratic level. These measures are coded as IT12 and classified as implementing
 320 provisions as well.

321 The final classification of the measures included in the Italian law against food waste is
 322 reported in Table 1.

323

324 Table 1 - Table of measure of the Italian law against food waste³
 325

Cod e	Article	Comma	Policy approach	Type of measure	Food waste pyramid	Actor in charge	Actor addressed	Funding
IT01	9	1	SUA	PS	Prevention	National Tv Channel	General public	Yes
IT02	9	2	SUA	PS	Prevention	Ministries of Env, Agr and Work	General public	No
IT03	9	3	SUA	PS	Prevention	Ministries of ENV, AGR and HEALTH	General public	No
IT04	9	4	SUA	PS	Prevention	Regional authorities and Municipalities, packaging producers	Restaurants	Yes

IT05	9	5	SUA	PS	Prevention	Ministries of	Primary and	No
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³IP is the acronym for Implementing Provisions; SUA refers to suasive measure; REG stands for regulatory; MB means Market Based.

						education, environment, health, agriculture	secondary schools	
IT06	10	1	SUA	PS	Re-use	Ministry of health	Canteens	No
IT07	17	1	SUA	MB	Re-use	Municipalities	Retailers, canteens	No
IT08	8	1-3	IP		Prevention	Ministry of agricultu re	Selected food- chain stakeholders	No
IT09	11	2	IP		Prevention	Ministry of Environment	-	Yes
IT10	12	1-2	IP		Prevention	Ministry of Environment	-	Yes
IT11	11	1	IP		-	Government	-	Yes
IT12	16	1-7	IP		Re-use	Retail sector	Recipients (NGO, charities)	No

326

Source: authors' elaboration

327

328 4.3 Trajectories of actions against food waste in the French law

329 The 4 articles included in the French law against food waste concern 9 measures to be
330 implemented at different levels. Most of them concern the setting of a regulatory framework
331 on food donations by retailers, while others concern awareness and education campaigns
332 addressed to different recipients.

333 Namely, article 1 foresees the insertion of an additional sub-section in the Environmental
334 Code. This sub-section starts with measure FR01, setting of a clear prioritization among
335 interventions against food waste, recalling the food waste pyramid. This measure is addressed
336 to all actors of the supply chain, which are recommended to follow the prevention - donation -
337 reuse for animal feeding - composting and energy recovery hierarchy while taking actions
338 against food waste. Since no obligation is foreseen, this is classified as a suasive measure,
339 while public services are in charge of pushing food chain actors to follow such prioritization.

340 Another article is added to the Environmental Code, specifically addressed to retailers. This is
341 coded as measure FR02, where retailers are called to recover the value of the food they are
342 not able to sell following the priority hierarchy set in measure FR01. The following measure

343 FR03 establishes that no contracts or agreements between retailers and their suppliers can

344 prevent the application of strategies against food waste. In the same article, measure FR04
345 establishes that all supermarkets larger than 400 m² have to sign an agreement with a charity
346 where the donation of the edible food which remains unsold is foreseen. All these measures -
347 FR02, FR03 and FR04 - include the setting of obligation and regulatory standards for
348 retailers, so they are classified under a regulatory approach. As fines are foreseen for retailers
349 which do not apply these provisions, these measures are subsequently classified as market
350 based. Indeed, although no incentives are provided to retailers to foster the application of the
351 measures, fines can harm their businesses.

352 The following measure FR05 describes the structure and timing of the agreements that
353 supermarkets have to sign with charities to start donating the edible food, which remains
354 unsold in their shelves. Such agreement has to be signed within one year from the approval of
355 the law, or one year after their opening. Fines are foreseen for those who fail to fulfil this
356 obligation. It is therefore clear that this measure has to be classified as a regulatory/market-
357 based action as well as the previous ones.

358 More details about the structure and the content of the agreement between supermarkets and
359 charities are included in a decree - approved few months after the French law against food
360 waste - that has become part of the provisions settled by the law itself. In our study, such
361 provisions are classified under measure FR06, which assumes again a regulatory approach to
362 define how products intended for donation to charities can be identified and treated within
363 supermarkets and within charities. The main indications to this regard concern: the timing of
364 donation, which should be completed at least 2 days before the expiration date (with some
365 exceptions); the exclusion of unpacked meat and unpacked animal products in general, for
366 safety reasons; the responsibility of charities in accepting or not the products offered by

367 supermarkets; the traceability of donated food products through transport documents and
368 related invoices; the safety issues to be fulfilled in the taking and transport of products.

369 Article 2 of the French law against food waste concerns the definition of the responsibility of
370 retailers in the donation of food products. Indeed, by introducing a new article in the Civil
371 Code, retailers are compared to producers when they donate own-brand products. This is
372 classified as measure FR07, still with a regulatory approach.

373 The subsequent measure, classified as FR08, concerns the insertion of a new article in the
374 French Education Code, where the inclusion of nutrition and food waste related information
375 in school programs is foreseen. This is a suasive measure, since it aims to increase pupils'
376 awareness on the issue of food waste. Public services - schools in this case - are the
377 instruments foreseen by the law to apply this measure.

378 The fourth article of the law concerns the modification of one article in the Commercial Code,
379 where actions against food waste are listed among the information that firms can provide in
380 their social reporting, thus informing stakeholders on the way they address the social and
381 environmental challenges arising from their commercial behaviour. This measure (coded as
382 FR09) has a clear suasive approach, and is classified under the MB category, as social
383 reporting can improve the image of businesses, thus potentially generating higher revenues on
384 the market.

385 All the four articles of the French law do not explicitly foresee direct funding to implement
386 the measures established. Moreover, it should be noted that few of them charge institutions to
387 implement the measures, rather most of them are addressed to private actors of the food chain.

388 The final classification of the measures included in the French law against food waste is
389 reported in Table 2.

390

Table 2 - Table of measure of the French law against food waste⁴

Code	Article	Insertion ⁵	Policy approach	Type of measure	Food waste pyramid	Actor in charge	Actor addressed	Funding
FR01	1	Code Environnement 541-15-4	SUA	PS	Prevention	Ministry of Environment	Producers, food industry, retailers, consumers, charities	No
FR02	1	Code Environnement 541-15-5	REG	MB	Prevention	Retailers	Retailers	No
FR03	1	Code Environnement 541-15-5	REG	MB	Re-use	Retailers	Retailers, charities	No
FR04	1	Code Environnement 541-15-5	REG	MB	Re-use	Retailers	Retailers, charities	No
FR05	1	Code Environnement 541-15-6	REG	MB	Re-use	Retailers	Retailers, charities	No
FR06	1	Code Environnement 543-306/7	IP		Re-use	Retailers, charities	Retailers, charities	No
FR07	2	Code Civil 1386-6	IP		Re-use	Retailers	Retailers	No
FR08	3	Code Education 312-17-3	SUA	PS	Prevention	Ministry of Education, Schools	Pupils	No
FR09	4	Code Commerce 225-102-1	SUA	MB	Prevention	Businesses in general	Businesses in general	No

392

Source: authors' elaboration

393

394 5. Results: trajectories of food waste scientific research

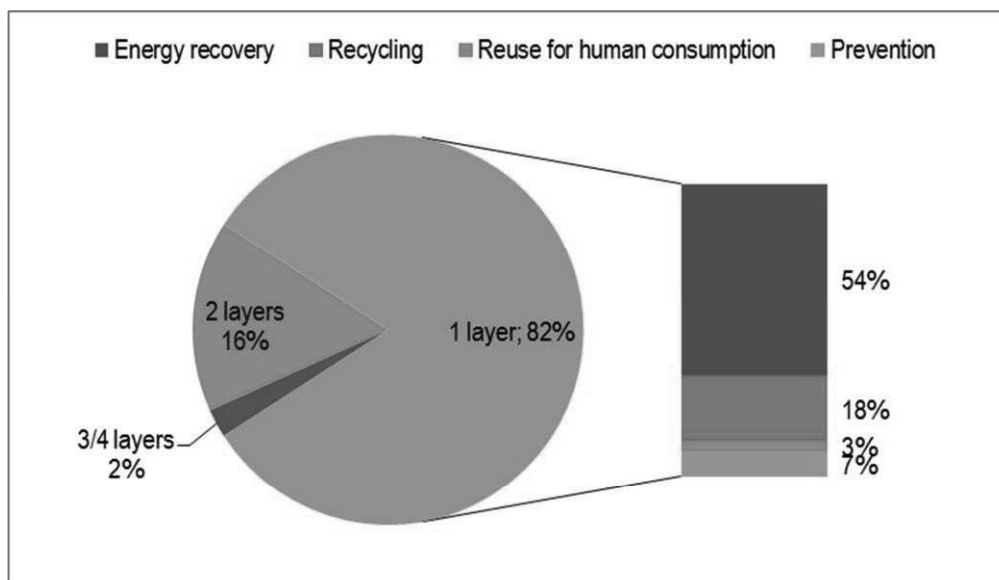
395 The search of the terms related to the layers of the food waste hierarchy was positive for
 396 1,752 documents dealing with the topic of food waste (60.2% of the total papers), showing at
 397 least one of the selected terms in the abstract. Figure 4 shows the distribution of these
 398 documents according to the occurrence in the abstract of terms related to one, two or more

399 layers of the food waste pyramid.

400 Figure 4 - Occurrence of keywords related to the food waste hierarchy (N=1,752)

⁴IP is the acronym for Implementing Provisions; SUA refers to suasive measures; REG stands for regulatory; MB means Market Based.

⁵For each measure, the number of the article of the French law 2016-138 and the corresponding number of the new articles inserted in the concerned codes are reported.



401

402

Source: authors' elaboration

403 Most of the documents showed in the abstract terms related to only one layer of the pyramid,
 404 most often related to energy recovery and, to a lesser extent, to recycling.

405 Terms related to energy recovery were detected in nearly 70% of the documents, and this
 406 topic was by far the most common in the literature on food waste. The occurrence of terms
 407 related to food waste recycling and composting was also rather common, being found in
 408 31.79% of the documents, while many less documents cited terms related to prevention and,
 409 especially, reuse of food waste for human consumption purposes (Table 3).

410

411 Table 3 - Number of journal articles with terms related to the food waste hierarchy (N=1,752)

Layer of the food waste hierarchy	Number of articles with related terms	% of articles with related terms (N=1,752)
Prevention	227	12,96%
Reuse for human consumption	108	6,16%
Recycling	557	31,79%
Energy recovery	1223	69,80%

412

Source: authors' elaboration

413

414 Table 4 shows the correlation matrix on the presence of the terms related to each layer of the
 415 food waste hierarchy. The presence in the abstract of terms related with energy recovery is
 416 negatively correlated with all the other variables, while the study of prevention strategies is
 417 positively correlated with the discussion on the possibility to reuse food waste for human
 418 consumption. The same is true, although to a lesser extent, for the correlation reuse-recycling.

419

420 Table 4- Correlation matrix of the occurrences (N=2,908)

Variables	Prevention	Reuse for human consumption	Recycling	Energy recovery
Prevention	1	0,051	0,005	-0,064
Reuse for human consumption	0,051	1	0,043	-0,009
Recycling	0,005	0,043	1	-0,052
Energy recovery	-0,064	-0,009	-0,052	1

421 *Source: authors' elaboration*

422

423 6. Discussion

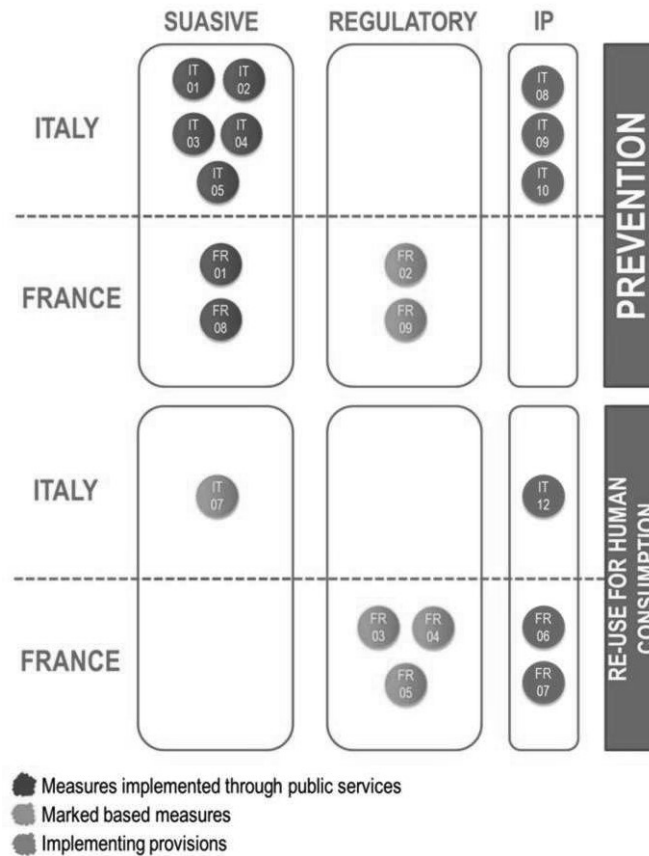
424 6.1 Comparing the Italian and French laws

425 Solutions against food waste, as identified in the Italian and French laws, belong to the first
 426 two levels of the food waste pyramid - prevention and re-use for human consumption. No
 427 direct mention is made to other levels of intervention in the law, suggesting that solutions at
 428 different levels may compete with one another and can therefore be hardly addressed together
 429 in the same legal framework (Mourad, 2016).

430 The classification of the measures from the Italian and French laws against food waste was
 431 transferred in a graphical representation (Figure 5), with the aim to highlight the similarities
 432 and differences among the two.

433

434 Figure 5 - Graphical representation of the measures in the Italian and French law



435

436 *Source: authors' elaboration*

437 The Italian law's general provisions (Clauses 1, 2, 3, 4 of art. 3) clearly state the willing to
 438 follow the waste prevention pyramid proposed by the European Commission, just as the
 439 French regulation does in article 1. However, the two laws show many discrepancies in
 440 applying this framework. As pointed out by the synthesis in Figure 6, a huge difference
 441 concerns the policy approach adopted by the regulations: indeed, while the Italian law is
 442 mainly based on a suasive approach, the French one is much more focused on regulatory
 443 measures. It is also evident that the Italian law put more efforts in trying to enhance
 444 prevention by awareness raising campaigns, whilst the French law mostly call food chain
 445 actors - especially supermarkets - in taking action against food waste.

446 Another difference concerns funding to the measures settled in the two laws. In the Italian
 447 law, only few measures are supported with financial instruments. The many actions foreseen

448 on communication and awareness raising are not specifically financed, although they are
449 supposed to be addressed to many actors, ranging from schools to general public. Only
450 measure IT01 - awareness raising campaign broadcasted through TV and radio - has been
451 specifically financed. Similarly, interventions aimed at increasing pupils' education are
452 neither mandatory for school, nor financed. In the Italian law, improving the shelf-life of food
453 products (measure IT04) seems to be at the top of priorities, being mentioned in more than
454 one article and financed (300.000 out of 1.000.000 euros granted COMIECO, the consortium
455 for recycling in Italy). In the French law, no specific funding is foreseen for measures against
456 food waste; however, the regulatory measures included in the law provide market-based
457 instruments - namely, fines to actors who do not fulfil the provisions stated by the law - to
458 assure that the measures are correctly applied by the concerned actors.

459 Regarding food donations, many differences arise between the two laws. First, most of the
460 effort of the French law is on donation by supermarkets, while actions aimed to prevention
461 have much less importance. This appears to be in contrast with the priorities set by the
462 European Commission - and by the French law itself - concerning the food waste prevention
463 hierarchy, where avoiding the production of surplus food should be regarded as a primary
464 objective, and donations should be used only in case this is not possible. Another essential
465 difference is that food donation is mandatory in the French law, while only encouraged and
466 supported in the Italian regulation. To this respect, it seems that in Italy much effort has been
467 put on harmonizing and simplifying existing normative on food donation at retail's level, thus
468 making donation easier and more feasible for businesses, whilst in France all the
469 responsibility is charged to retailers, who are forced to set agreements with charities if they
470 want to avoid fines. The Italian law also shows a potentially wider application, as the
471 donation process is supported in different stages of the supply chain (restaurants) and includes

472 non-food products. The definition of the potential beneficiaries has been accurately detailed in
473 the Italian law, thus limiting in the practice the number of people who can benefit from the
474 donations process (Vaque, 2017).

475 Market based instruments have been found in several measures of the French law, while they
476 are used to a lesser extent in the Italian regulation. The fines foreseen in the French law for
477 retailers that do not fulfil the prescriptions about the setting of agreements with charities, as
478 well as the publication of the names of these retailers so as consumers can get to know who
479 fails to comply, are probably set with the aim of encouraging retailers to start donations
480 (Vaque, 2017). Instead, in the Italian law, market based instruments are much weaker, and
481 only concern the possibility for municipalities to propose reduction of the waste tax to
482 supermarkets that donate food (measure IT07).

483 The results of the policy analysis suggest that neither the Italian nor the French laws tackle the
484 issue of food waste with a “*strong prevention*” approach (Mourad, 2016: 469), i.e. no
485 structural changes have been foreseen in the food system to avoid the generation of food
486 waste but communication to consumers have been privileged. Rather, the Italian law provides
487 examples of “*weak prevention*” initiatives, (Mourad, 2016: 468), but evidently both
488 regulations focus their attention on recovery strategies to re-use food waste for human
489 consumption. In both cases, most of interventions have not been foreseen in the
490 manufacturing and distribution phases but at retail/consumption. This is consistent with the
491 tendency of “blaming the consumer” (Evans, 2011) for the generation of food waste. Post-
492 consumption actions may then be seen as the main tool to manage food waste, instead of
493 targeting the production system as a whole to find where and how the generation of food
494 waste can be avoided.

495

496 6.2 Comparing the trajectories of the research with the policy actions

497 The systematization of the scientific articles dealing with initiatives against food waste shows
498 very clearly that the frequency of the topics analysed in the research does not reflect the
499 priorities of the food waste hierarchy settled by the European directive. Indeed, most
500 scientific research is focused on the energy recovery of food waste, which is the least
501 desirable option before disposal (Papargyropoulou et al., 2014). The possibility to recover
502 part of the energy of the food wasted at the end of the chain captures much more attention
503 than other possible ways to prevent or reduce the generation of food waste (see Xiong et L.,
504 2019). This result is consistent with Mourad (2016), who remarked that the relative
505 importance of the fields of research tackled by the literature is the opposite with respect to the
506 priorities set in the food waste hierarchy. However, it should be noted that energy recovery
507 has been very often studied in relation to the management of municipal organic waste, i.e. at
508 the last steps of the food chain (household consumption and private/public food service).
509 Given that consumption is the phase of the food chain where most of the food waste is
510 produced, this might show a good awareness of how this phase of the chain is crucial in the
511 generation of food waste.

512 The policy analysis shows a great attention of regulations to re-use as a main way to reduce
513 food waste. However, similarly to the tendency observed in scientific articles, this is not
514 consistent with the priorities set by the food waste hierarchy. Moreover, especially in the
515 French regulation, the focus of measures against food waste is on retail, disregarding the fact
516 that this phase of the food chain is responsible for the generation of only about 5% of the total
517 food waste (Stenmarck et al., 2016). An argument to explain the choice of this trajectory in
518 the design of policies against food waste may be that donation, besides saving the
519 environmental resources used to produce the food, is also an example of socially and

520 economically sustainable solution (Schneider, 2013b). On the contrary, it is also possible to
521 speculate that privileging food donations, while not questioning the strong unbalance in the
522 current food production system and its negative externalities (included food waste), lies under
523 a sort of “philatroc capitalist” (Bishop and Green, 2009) approach that shifts a problem of
524 unbalanced distribution of resources and waste production to a philanthropic solution. Indeed,
525 donating food is somehow easier than taking measures against over-production/supply and it
526 can have direct, positive implications for the society, intervening in the market failure that
527 produces unequal food access. What should be further questioned is the role of national states
528 in committing public resources to encourage private subjects in food waste donation and
529 preventing them to pay for the externalities of their economic activities, as in the case of Italy.
530 Indeed, it is important to point out that a consistent analysis of the impact of food donation to
531 reduce food poverty is missing in the existing scientific literature. So far, the extent to which
532 food donation alleviates food poverty is unknown, as well as how it may be effective (if
533 donated food is always nutritious, for instance, or effectively consumed or just thrown away
534 elsewhere). At a pure theoretical level, an analysis of such an approach in terms of food and
535 environmental justice would be recommended. Borrowing the words of Arcuri (2019) and
536 applying them to both the laws examined in this article “[...] it is difficult not to agree with
537 the principle that, in the face of excess food and hungry people, the right thing to be done is to
538 give them that food rather than wasting it. This rationale appeals to the moral obligation of
539 feeding the poor and translates into a deeply rooted ethic, shared by many churches and
540 secular institutions (Bane et al. 2000). The strength of Gadda law lies in the capacity to refer
541 to such principle, reconcile different positions and bring actors together a round a short term
542 objective”.

543 However, the results of this study confirm that both research and policies are far from a full
544 implementation of the food waste hierarchy, suggesting that the EU will struggle to meet the
545 objective of reducing by 30% the quantity of food waste by 2025.

546

547 **7. Conclusions**

548 After the recognition of food waste as a main environmental problem at the global level, in
549 2014 the EU set a clear objective against food waste and called countries to adopt regulations
550 on this topic. The hierarchy provided by the waste regulation in force should guide actions
551 and research in tackling the issue of food waste, therefore maximum priority should be given
552 to prevention measures. Here, the trajectories of research and policies on this issue are
553 analysed.

554 The two laws examined only partially reflect the priorities suggested by the hierarchy. The
555 distance between the principles stated by the Directive, the intent of the two national laws and
556 the types of regulated measures suggest that, in the transition from the general guidelines to
557 the actions, the hierarchical structure of the priorities and the logic of the principles
558 underlying the European legislation have partially been lost. Moreover, the focus on the
559 distribution phase of the food chain (especially in the French regulation) is somewhat in
560 contrast with the evidence that only a little part of the total food waste is produced at
561 supermarkets, although its recoverability is higher than in any other step of the food chain.

562 The systematization of the literature showed that in the scientific debate there is a clear
563 overturning of the priorities of the food waste hierarchy, with most of the research focused on
564 energy recovery of municipal organic waste. This reflects the tendency of focusing on post-
565 consumption actions to manage food waste, instead of targeting the whole production system
566 to find where and how the generation of food waste can be avoided.

567 Results shall however be intended as a first attempt to study the path undertaken by national
568 governments and research institutions. The present study did not consider all the measures
569 included in the waste laws or other normative frameworks existing in the EU countries out of
570 Italy and France- and the latest review of all policy actions undertaken in Europe is dated
571 2015, even before the two laws were adopted. Moreover, while underlying the weakness of a
572 prevention approach in the two laws, the present article does not suggest possible prevention
573 actions to be privileged instead of recovery measures. Further studies are recommended to
574 show the prevention approach undertaken by other laws. Last, the attention of the present
575 article was focused on European Union, yet other experiences of food waste prevention ruled
576 by national laws exist and should be taken in consideration in future analyses. An implication
577 of the present study should be the need to verify the impact, in terms of food poverty
578 reduction and avoided waste, of food donation as well as of the communication campaigns.
579 To pursue this stream of research, further studies are envisaged, tackling the assessment of the
580 impact of policy measures against food waste on the actual quantity of food discarded at the
581 different steps of the chain. This would be very useful to set informed policies in the many
582 EU countries that still do not have taken action against food waste.

583

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Tables

Table 1 - Table of measure of the Italian law against food waste¹

Cod e	Article	Comma	Policy approach	Type of measure	Food waste pyramid	Actor in charge	Actor addressed	Funding
IT01	9	1	SUA	PS	Prevention	National Tv Channel	General public	Yes
IT02	9	2	SUA	PS	Prevention	Ministries of Env, Agr and Work	General public	No
IT03	9	3	SUA	PS	Prevention	Ministries of ENV, AGR and HEALTH	General public	No
IT04	9	4	SUA	PS	Prevention	Regional authorities and Municipalities, packaging producers	Restaurants	Yes
IT05	9	5	SUA	PS	Prevention	Ministries of education, environment, health, agriculture	Primary and secondary schools	No
IT06	10	1	SUA	PS	Re-use	Ministry of health	Canteens	No
IT07	17	1	SUA	MB	Re-use	Municipalities	Retailers, canteens	No
IT08	8	1-3		IP	Prevention	Ministry of agriculture	Selected food-chain stakeholders	No
IT09	11	2		IP	Prevention	Ministry of Environment	-	Yes
IT10	12	1-2		IP	Prevention	Ministry of Environment	-	Yes
IT11	11	1		IP	-	Government	-	Yes
IT12	16	1-7		IP	Re-use	Retail sector	Recipients (NGO, charities)	No

Source: authors' elaboration

¹ IP is the acronym for Implementing Provisions; SUA refers to suasive measure; REG stands for regulatory; MB means Market Based.

Table 2 - Table of measure of the French law against food waste²

Code	Article	Insertion³	Policy approach	Type of measure	Food waste pyramid	Actor in charge	Actor addressed	Funding
FR01	1	Code Environnement 541-15-4	SUA	PS	Prevention	Ministry of Environment	Producers, food industry, retailers, consumers, charities	No
FR02	1	Code Environnement 541-15-5	REG	MB	Prevention	Retailers	Retailers	No
FR03	1	Code Environnement 541-15-5	REG	MB	Re-use	Retailers	Retailers, charities	No
FR04	1	Code Environnement 541-15-5	REG	MB	Re-use	Retailers	Retailers, charities	No
FR05	1	Code Environnement 541-15-6	REG	MB	Re-use	Retailers	Retailers, charities	No
FR06	1	Code Environnement 543-306/7	IP		Re-use	Retailers, charities	Retailers, charities	No
FR07	2	Code Civil 1386-6	IP		Re-use	Retailers	Retailers	No
FR08	3	Code Education 312-17-3	SUA	PS	Prevention	Ministry of Education, Schools	Pupils	No
FR09	4	Code Commerce 225-102-1	SUA	MB	Prevention	Businesses in general	Businesses in general	No

Source: authors' elaboration

² IP is the acronym for Implementing Provisions; SUA refers to suasive measures; REG stands for regulatory; MB means Market Based.

³ For each measure, the number of the article of the French law 2016-138 and the corresponding number of the new

articles inserted in the concerned codes are reported.

Table 3 - Number of journal articles with terms related to the food waste hierarchy (N=1,752)

Layer of the food waste hierarchy	Number of articles with related terms	% of articles with related terms (N=1,752)
Prevention	227	12,96%
Reuse for human consumption	108	6,16%
Recycling	557	31,79%
Energy recovery	1223	69,80%

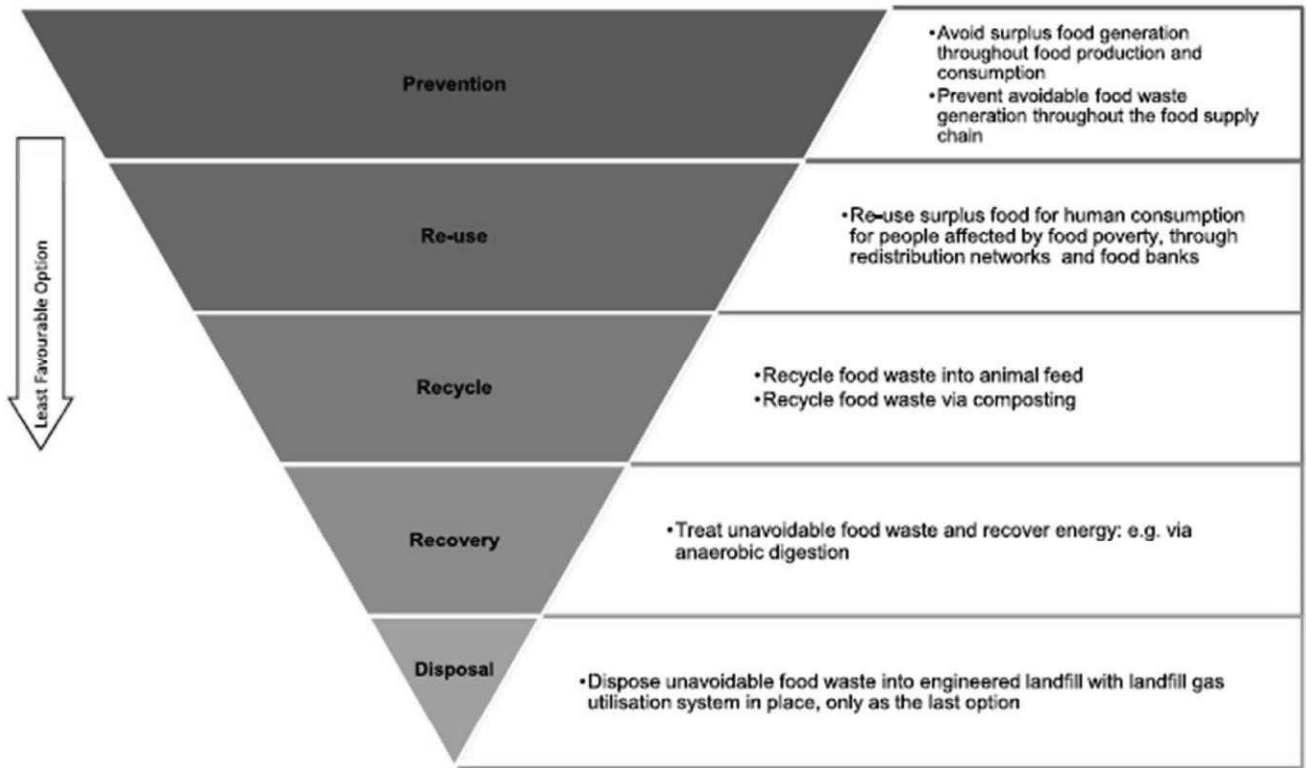
Source: authors' elaboration

	consumption			
Prevention	1	0,051	0,005	-0,064
Reuse for human	0,051	1	0,043	-0,009
Recycling	0,005	0,043	1	-0,052
Energy recovery	-0,064	-0,009	-0,052	1

Source: authors' elaboration

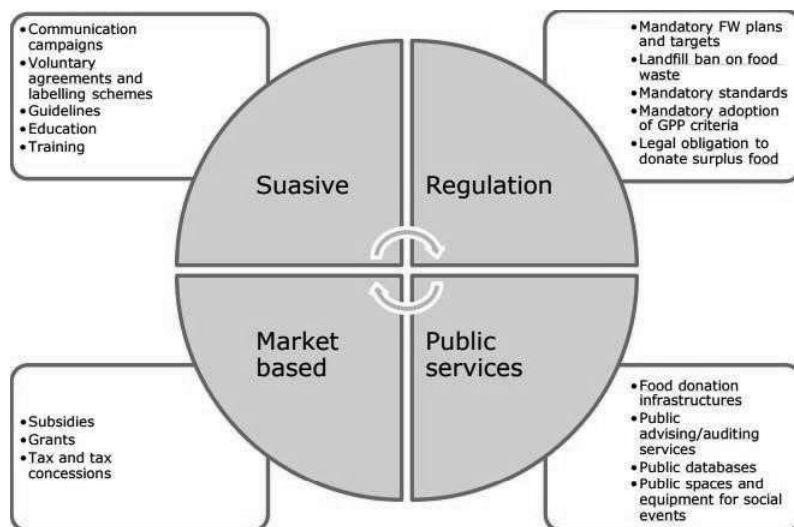
Figures

Figure 1 - Food waste prevention pyramid



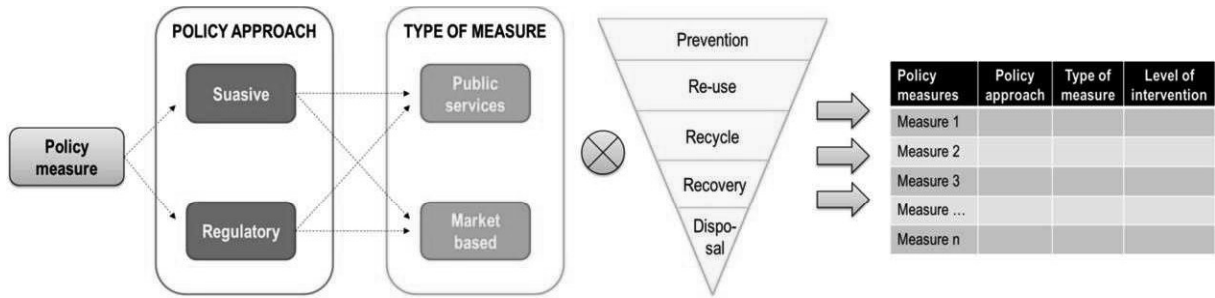
Source: Papargyropoulou et al., 2014, adapted from European Parliament Council 2008

Figure 2- FUSIONS' classification approach for the policy measures.



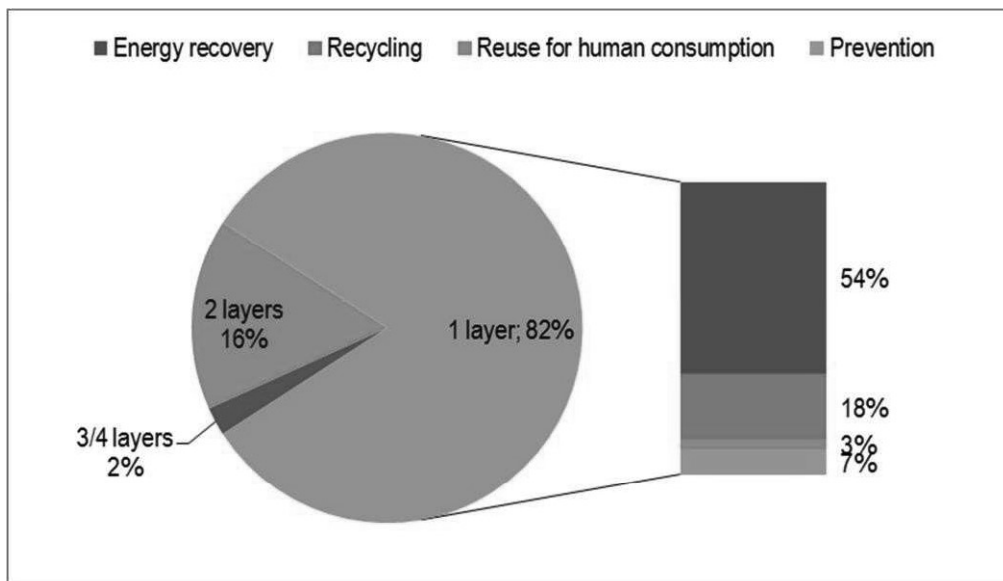
Source: FUSIONS, 2016, p.22

Figure 3- Classification framework adopted for policy measures' analysis.



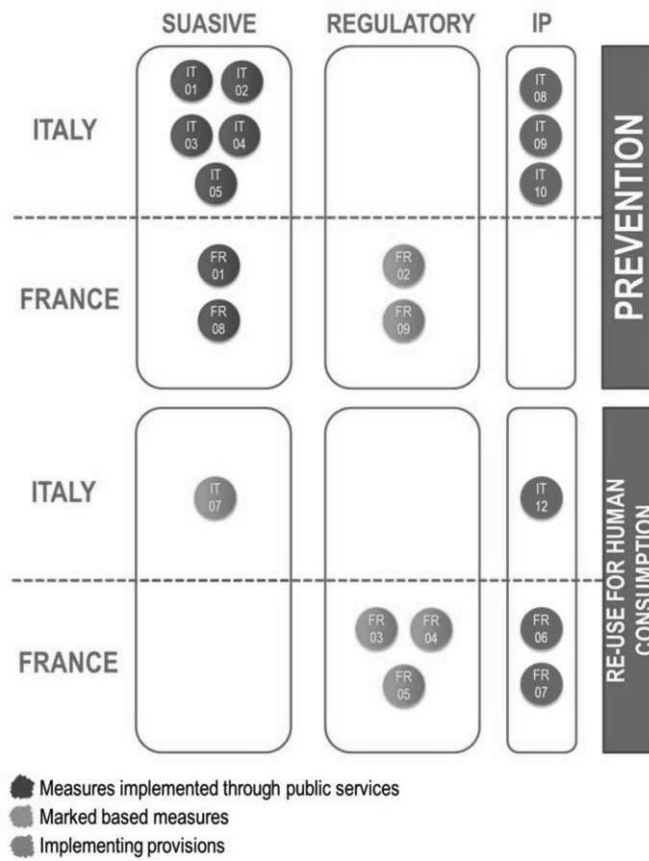
Source: authors' elaboration

Figure 4 - Occurrence of keywords related to the food waste hierarchy (N=1,752)



Source: authors' elaboration

Figure 5 - Graphical representation of the measures in the Italian and French law



Source: authors' elaboration

Highlights

Priorities expressed by the food waste hierarchy are only partially addressed

The French law adopts a regulatory approach while the Italian law is primarily suasive

The Italian and French laws against food waste mostly target food donation

The prevention is mainly practiced through the awareness raising campaign

Academic research focus attention on energy recovery and household's stage

Declaration of interests

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

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: