

Defining scenarios to food waste reduction: seeking for consensus among food supply stakeholders

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Defining scenarios to food waste reduction: seeking for consensus among food supply stakeholders

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Abstract

More than 40% of food produced for human consumption in Europe is lost or wasted every year from farm to fork; 95-115 kg of food per capita and year according to FAO's report in 2011. In order to achieve a sustainable feeding society, efforts to understand the reasons of food waste at the regional level are required. Therefore, the aim of the present project is to clear up the main causes and possible solutions of food waste in the metropolitan area of Barcelona tacking into consideration the whole food supply chain, from producers to consumers, including the policy institutions. The methodological framework followed in this study is based on a two-stage qualitative approach consisting of: 1) in-depth interviews; and 2) Delphi method to arrive at a consensus. The solutions proposed in the present study have been defined by stakeholders involved in the food supply chain that would help policy makers to implement the potential measures to reduce food waste.

Keywords: food waste, stakeholders, Delphi, interview

Introduction

In 2011 FAO reported that every year a third of the food produced worldwide is wasted or lost. Particularly in Europe, 280-300 kg of food per person per year are lost throughout the entire food supply chain (Gustavsson et al., 2011). Shockingly, at the same time, there are limitations in the access to food all around the world. In the process of finding a solution to this world-feeding conundrum food waste started to be considered as an environmental, economic, social and food security problem. The European Parliament in the Resolution 2011/2175(INI) called for practical measures to reduce food waste by 50% by 2025, later during the Rio+20 conference in 2012 it was recognized the need to significantly reduce post-harvest and other food losses and waste throughout the food supply chain. Therefore, there is a political agreement that, food security needs a sustainable food management system which must be developed at both societal and individual levels, paying special attention to resource consumption, food consumption and waste management. In order to achieve a sustainable feeding society, efforts to understand the reasons of food waste at the regional level are required.

A critical point to define a path toward the achievement of food supply chain efficiency is the current dissimilarity on quantifying food waste and losses. There is a lack of agreement in the conceptual definitions and calculation methodologies used to define the food fraction which is finally not consumed by humans. With the aim of reaching a major understanding of the problem, three outstanding institutions, named FAO, FUSIONS AND HLPE, have published their "self-definition" of food waste (FAO, 2013; HLPE, 2014; Östergren et al., 2014). FAO, (2013) and HLPE, (2014) are on the same wavelength, agreeing on differentiating amongst food waste and food loss in HLPE report or food wastage in FAO's. However, neither institution take into account inedible parts of food as it does FUSIONS. Nevertheless, for the purpose of our research, FUSIONS definition has been selected as reference due to its European context. "*Food waste: is any food, and inedible parts of food, removed from the food supply chain to be recovered or disposed (including composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or discarded to sea*" (Östergren et al., 2014)).

Different investigations tried to shed light to understand the factors that impact FW along different stages of the food supply chain. A compilation of the most relevant studies to date has been done (see Table 1) but it still need further investigation. As the Table 1 shown most of the studies are partial or use secondary data except from Göbel et al.,(2015) which gives a wider approach of the problem in a region of Germany. This study states that in order to achieve a sustainable feeding society, efforts to understand the reasons of food waste at the regional level are required. In doing so, it's important to contemplate the stakeholders' interest, responsibility, knowledge and influence. As a result potential scenarios and policy recommendations can be attained.

Table 1 Summary of references with causes of food waste

Reference	Data	Geographical scope	FSC	PRE-HARVEST	HARVEST	PROCESSING	WHOLESALE	RETAIL	CATERING	CONSUMER
(WRAP, 2007)	1	UK								X
(WRAP and Quested, 2009)	1	UK						X		
(WRAP, 2009)	2	UK								X
(Stuart, 2009)	2	World								X
(Parfitt et al., 2010)	2	World	X	X		X		X		X
(Bio Intelligence Service, 2010);	2	Europe				X		X	X	X
(Mena et al., 2011)	1	UK+Spain		X				X		
(HISPACOOP, 2012)	1	Spain								X
(ARC and UAB, 2011)	1+2	Catalonia, Spain						X	X	X
(Buzby and Hyman, 2012)	2	EEUU		X		X		X		X
(Beretta et al., 2013)	1	Switzerland		X				X		
(European Union, 2013)	2	Europe								X
(Stefan et al., 2013)	1	Romania								X
(FAO, 2013);	1+2	World		X		X		X		
(Garrone et al., 2014)	1	Italy		X		X				
(Magrama, 2014a)	1	Spain		X						
(Magrama, 2014b)	1	Spain						X	X	
(Magrama, 2014c)	1	Spain				X				
(Mena et al., 2014)	1	UK			X	X		X		
(HLPE, 2014)	2	World	X	X	X	X	X	X		X
(Canali et al., 2014)	2	World	X	X	X	X	X	X	X	X
(Montagut, Xavier; Gascón, 2014)	2	World	X	X						
(Parizeau et al., 2015)	1	Guelph, Ontario, Canada								X
(Göbel et al., 2015)	1	North Rhine-Westphalia, Germany	X	X	X	X	X	X		X

Data: Primary (1) Secondary (2)

Source: Own elaboration

This study aims at clearing up the main causes and possible solutions for food waste taking into consideration the whole food supply chain, from producers to consumers, including the policy institutions. As a case study we restrict our study to the Barcelona metropolitan area. To achieve the mentioned objective the following research steps have been followed: 1) identification of the food supply chain stakeholders; 2) differentiation of the stakeholders' role in the food waste generation process; 3) detection of the critical points and main causes of food waste along the food supply chain; and finally 4) consensus about solutions and definition of new policies and actions addressed to reduce food waste along the whole food supply chain.

The different stages of the food supply chain to take into account are: primary producers, food industry producers, wholesalers, retailers, hospitality service, social redistribution entities, institutional departments at different levels (regional, provincial and local), experts, social enterprise and social collectives.

The metropolitan area of Barcelona which is one of the most populated areas of Europe located along the Mediterranean coast, with a growing population accounting for more than 3.2 million of people for 2012 and occupies an area of approximately 636 km², whose 48% is urbanised (AMB, 2012). It is administered at the local level by the Barcelona Metropolitan Area - formed by 36 municipalities- which handle elements such as territory, environment, housing and transport. No food waste quantification studies are currently available at the metropolitan level. However, at the Catalan level, food waste was quantified from retailer to households during 2010 by the Catalan Waste Agency (ARC and UAB, 2011). Results show that about 262.471 tonnes of food are wasted every year in Catalonia, 35 kg per person/year.

1. Material and methods

The methodological framework followed in this study is based on a two-stage qualitative approach consisting of: 1) the implementation of in-depth interviews; and 2) the

employment of the Delphi method to reach a consensus. In the first stage a total of 25 semi-structured interviews were conducted from October 2014 to January 2015 to relevant stakeholders. Data have been analysed through the qualitative content analysis method. In the second stage, a two-round Delphi questionnaire has been distributed among 20 stakeholders. The field work was held from March to June in order to find a consensus about the most effective solutions to tackle food waste along the different food supply stages, including redistribution entities and institutions. The questionnaire was based on the results from the first stage in which stakeholders identified 47 alternative measures to reduce food waste along the food chain.

1.1. Panel of experts

Involving stakeholders in the decision process could lead to the development of understanding and trust between participants. Therefore, instrumental stakeholder research method has been employed to analyse the food system functioning in order to identify all the stakeholders that are directly or indirectly related with food waste generation. As proposed by Reed et al., (2009) the instrumental stakeholder research is devoted to understand and explain the behaviour of stakeholders whether they are individuals, organisations, policy-makers, etc. in addition, it is particularly addressed when consensus need to be reached as in our case.

Intentional sampling has been chosen to carry out the two-stage qualitative approach. Intentional sampling is a non-probabilistic procedure in which the selection of sampling units attends to subjective criteria related to the aim of the study. It is commonly used in qualitative studies where experts' judgments are necessary as in our case. As explained by Del-Val-Cid, (2009) there is a variety of strategies as: extreme case sampling, less common case sampling, maxim variability case sampling, homogeneous subgroups sampling, structural sampling or key informants sampling. The latter is the most appropriate for developing the Delphi method as it focuses on selecting stakeholders with the maximum information about a topic and it is performed using the snowball technique which individuals from initial interviews identify new informants.

1.2. In-depth interviews to stakeholders along the food supply chain

Semi-structured interviews are useful for in-depth insights in which the researcher asks to interviewee by means of “interview guide” which is not fixed. Thus the researcher could modify the order of the questions or add new ones depending on the conversation. The interviewee answers all questions without any limitation. This type of interview is appropriate, specially, in exploratory studies like in our case. One of the weaknesses is that it is time-consuming and hence costly (Viedma, 2009).

It has been implemented 25 interviews from October 2014 to January 2015 to different experts along the food supply chain and with different perspectives of the problematic (institutions, private sector and aware social stakeholders) as shown in Table 2. Interviews lasted from 45 to 100 minutes.

The sampling is intentional as explained above. The value of each respondent is related to their particular understanding of the phenomenon studied. Therefore, it is important that more than the number of interviews or heterogeneity, the sample represents all perspectives. The sampling is finished when interviewee are not offering alternative answers in explaining the phenomenon.

All interviews are recorded and verbatim transcript. Subsequently, the meaning of the texts have been determined through qualitative content analysis which is a systematic approach which follows different steps allowing us to identify the key concepts of discourse (Viedma, 2009). Concepts are coded and classified attending to discussion guide, tendencies and observed patterns. Then, all the categories are related with all previously identified, until obtaining a model with structure and dynamic. In order to validate the results obtained triangulation method has been employed by looking for outcomes that are agreed upon by all stakeholder groups (Guion et al., 2011).

1.3. Delphi method implementation to define solutions

The solution for food waste reduction is not a unique one centred in one stage of the food supply chain. Consequently, to define better policies to reduce food waste all the system in a macro perspective should be considered. The Delphi method has been implemented to reach a consensus among the different stakeholders in order to forecast the most effective measures. To do so a two-round questionnaire has been implemented. The questionnaire has been based on the results from the first stage in which stakeholders identify alternative measures to reduce food waste along the food chain. In the Delphi questionnaire, stakeholders had to assess the effectiveness of each of the alternatives using a Likert scale from 0 to 100. The panel of experts are shown in Table 1, part of them had participated in the previous interview and others have been invited to this stage.

The Delphi method is a technique of collecting information aimed at obtaining a consensus among experts on a complex issue. Traditionally, it has been applied to forecast, exploring ideas and trends and to reach consensus among experts on a complex issue. Likewise, it is also used to analyse the relative importance of a problem (Worrell et al., 2013). The process of obtaining results requires the participation of experts over 2 or 3 rounds of data collection through a more or less structured (depending on the phase of the study) questionnaire. The peculiarity of this method is that Delphi questionnaire responses of each round completed feed the next round, which will be applied in the same consulted sample. The three key elements to take into account are: a) communication between moderator and participants; b) continuous feedback of results; c) anonymity of participants, as the opinions expressed are presented only in aggregate form (Callejo Gallego, 2009).

The expert panel has to be formed in relation to the participant's ability to assess the issue in question and to be able to forecast the different options to reduce food waste. In our case the prior in-depth interviews and stakeholder analyses will serve to select the panel. The panel should be either experts, scholars, interested or directly affected by the subject matter (Pill, 1971). The number of experts can vary between 10 and 30 depending on the complexity of the topic.

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Our expert panel was formed by 20 experts along the food supply chain, see Table 2. The survey has been designed based on the first-stage results. It includes a battery of 48 measures to reduce the amount of food waste generated in the metropolitan area of Barcelona in a near future. The experts have evaluated each measure using a 100 point scale (0 no efficient, 100 more efficient). The statements have been grouped considering the different stages of the supply chain, and all sets of questions could potentially suggest a new one. Therefore, the final questionnaire has proposed 53 potential statements.

The Delphi questionnaire was implemented in two rounds during March and June of 2015 (the first round from March to May, and the second from May to June). Including in the second-round questionnaire the information gathered during the first round. In order to facilitate experts' comprehension, the mean, the coefficient of variation and a boxplot figure were provided during the second round exposing in a comparative way their own previous answers.

Table 2 Panel of experts

Participant	Stage					Stakeholder type					Food supply stage				
	1st Stage: Interview	2nd stage:	Private	Institutional	Social-Awared	Food supply	Primary production	Processing	Wholesale	Retail	Redistribution	Catering	Consumer	Education	
#1	x	x			x	x									
#2	x	x		x		x									
#3	x	x		x		x									
#4	x	x		x		x									
#5	x			x		x									
#6	x	x		x			x								
#7	x	x		x			x								
#8	x			x			x								
#9	x		x				x								
#10		x		x			x								
#11	x		x					x							
#12	x		x					x							
#13		x	x					x							
#14		x	x					x							
#15	x	x	x						x						
#16	x		x						x						
#17	x		x							x					
#18	x	x	x							x					
#19	x	x	x							x					
#20	x	x		x						x					
#21		x	x							x					
#22	x	x			x						x				
#23	x	x			x						x				
#24	x		x									x			
#25	x	x			x								x		
#26	x	x			x								x		
#27	x			x									x		
#28	x	x			x									x	
#29	x	x			x									x	

By analysing both round of Delphi questionnaire it is possible to define on one hand the effectiveness of the measures and the level of agreement among experts. The effectiveness of every statement has been evaluated by mean of a 0-100 continuous scale. Adapting the importance scale of Clibbens et al., (2012) to effectiveness scale: very high effective : 90-100; high: 80-89; moderate: 65-79; low effective; 50-64; very low: below 50.

And on the other hand, to determine the consensus by certain level of agreement Interquartile range (IQR) is used. Consensus is reached when IQR is no large than 20 in a scale of 100 (Gary and von der Gracht, 2015; von der Gracht, 2012). We are also interested in highlighting the divergence, so the statement with IQR equal or higher than 40 have been classified as dissensus statements.

From the results it is possible to analyse also the stability and convergence among rounds. Stability is achieved when IQR among rounds changes less or equal to 7.0 points. Convergence is observed when IQR changed between rounds towards zero more than 7.0 points (Clibbens et al., 2012).

2. Results

In this section of the papers we will present the obtained results in the following way:

- 1) An explanation of the information collected from the in-depth questionnaires is presented and structures by conceptions.
- 2) The main results of the Delphi questionnaire are discussed.

2.1. Results from in-depth interviews to stakeholders

Interest

Stakeholders have shown interest in the problem of food waste despite not being one of the most priority issues in their daily activities. This interest has increased in recent years, with the economic crisis as one of the main reasons.

Food waste definitional framework

It is important to note the definition of waste considered by stakeholders. Many different words have been used referring to food waste and food loss, including concepts such as surplus, wastage, by-products, etc. Despite the heterogeneity of concepts, the mind-set of the experts can be structured considering four definitional frameworks as follows: a) FUSIONS, b) Added value, c) No valorisation, and d) Circular vision.

- FUSIONS: accepts the definition proposed by FUSIONS excluding inedible food.
- Added value: accepts the definition proposed by FUSIONS but propose to expand the destinations considered to valorisation (composting, anaerobic digestion and co-energy).
- No valorisation: does not consider the distinction between valorisation and food waste. All are considered as food waste.
- Circular vision: broader view of the problem, which includes carbon footprint, food intake of nutrients or types of food.

Responsibilities

When considering responsibilities a shared approach was identified. Participants recognized that no solely responsible exists regarding to the volumes that are generated along the food supply chain but distributed among stakeholders. Answers picture the key stakeholders of each stage as the main responsible for the volumes generated in that stage of the chain except at the agricultural level, where responsibilities have been divided among the great distribution, farmers and industry stakeholders. Furthermore, considering the entire food value chain, farmers have been considered as the less responsible of the food waste volumes generated. Although institutions are not an active member of the food value chain they have been identified with some influence at all stages of the chain.

Influence

It is not only the responsibility of the amount of waste generated but also who are the stakeholders with higher degree on power to reduce the volumes generated nowadays. The experts have pointed out the governmental institutions and consumers those with a greater degree of influence.

Stakeholders' connection

Different interviews have allowed the relationships identification among the agents involved in the food waste generation in the metropolitan area of Barcelona. It has been observed high interconnected stakeholders. The Food Bank and municipal entities have shown to be the most connected with different actors in the territory.

Level Knowledge

We observed a lack of knowledge of the volumes generated from food waste throughout the food chain by agents involved in this. Even tough, they do not want or do not know the volume produced in the own stage. During the interviews, the food waste volumes have not been mentioned. And at the end, the interviewees had the possibility to fulfil a diagram with mass (kg) or percentage of food waste among different stages but all of them have decline the question due to their lack of knowledge.

Causes

Food waste causes are diverse and they occur in different stages of the food supply. Interviewed experts have valued what are the reasons and practices which entails food waste in the metropolitan area of Barcelona. In general, the causes are related to the type of produce, stakeholders' knowledge, commercial operation or business internal processes or within different stages and causes related to specific regulations, standards and laws.

At the farm level interviewees have pointed out the type of produce, as the fresh and perishable fruits and vegetables leads to more problems that the rest. It has been identified a lack of agricultural forecast, an imbalance of supply and demand due to a glut or low prices; it has been mentioned also that certain agricultural or sales models of agriculture (industrial, ecological, etc.) could affect the volumes generated; the lack of cooperatives in the area; and certain standards and regulations about sizes and quality.

In the wholesale distribution, the causes are mainly divided into commercial dynamics al and causes related to incidents during the operation of the business, such as handling defects, storage accidents during transport or mistakes buying the product.

In the food industry the reasons can be grouped into reasons due to type of product or industry, fresh foods entail more problems; the production process: whether the standards of the company or distribution companies; causes related to inefficiencies in the operation as it could be poor planning; and lack of awareness about the problem.

At retail distribution, it should be distinguished between large retailers such as big supermarkets and small local businesses or municipal markets. In supermarkets the causes can be grouped by product type, certain business strategies, packaging and labelling, incorrect handling, certain quality standards and regulations, and the difficulties that exist in channelling food unfit for sales to social charities. In the small local business other causes have been identified regarding to operational inefficiencies, supply and demand, or the lack of surplus management knowledge.

In households the causes could be grouped into lack of knowledge, certain behaviours, people's values, lifestyle and certain aesthetic standards. As could be the consumer knowledge about food safety issues, the myths and legends and the lack of confidence in the explanations given on food safety; the lack of awareness of the volume of waste generated, difficulties in spreading anti-food waste message, convenience or improper household food management (purchasing and cooking).

Along the stages of the food value different problems arises and leads to products that are not able for sales any more but for human consumption without being redistributed to social organisations. Redistribution of food to charities is a complex phenomenon that requires a lot of resources, logistic capacity and agility from the redistribution organizations. Problems have been identified in four dimensions: regulations, operational inefficiencies, regarding to produce type and related to stakeholders knowledge.

Solutions

A list of proposed solutions to reduce food waste in the near future in the metropolitan area was generated with the in-depth questionnaires with the aim of designing the Delphi

questionnaire to analyse consensus on those. More detail on this issue is can be found in the following section of the results.

2.2. Results from Delphi method implementation to define solutions

Experts have evaluated 53 statements to reduce waste. From those, 14 encourage increasing the awareness and knowledge, 21 are measures proposing a better redistribution system to increase food donation and 8 set out a change on certain regulations and laws. All the statements could be implemented from public sector (43), private sector (34) or both – working together private and public sectors (23).

To define conjoint solutions to reduce food waste different perspectives of the problem have to be taken into account. Among our experts' panel we have three dimensions that grouped them into three categories. There is a group of experts form the public sector, institutional group. Another group from the private sector and the third one which groups all the experts belonging to social initiatives that are aware of the problem. Due to sample size, ANOVA analysis is not robust enough and we have done qualitative comparison by means of graphic representation (Figure 3 and Figure 4) and differences in means (Table 6).

For the purpose of this paper two sets of statements are discussed among 53, those that have shown consensus and dissensus. Moreover, there is a battery of 33 statements that are not examined here because neither agreement nor disagreement has been found.

Consensus

Within the 53 statements there are 15 that appeared to have consensus amongst experts along the food supply chain, 2 at the farm level, 1 at the wholesale central market level, 2 in the supermarkets, 3 at the local retail stores, 1 in the redistribution sector and 6 at the consumer level. The main issue arising from the experts' valuation is the need to increase awareness of consumers as well as from private operators, improving the redistribution of food to be donated and working together with other food supply stages with the aim of reducing food waste (see Table 3 and Figure1).

The mean of the proposals is from 68 to 89 points expressing a high to moderate efficiency of the statements according to (Clibbens et al., 2012). And the interquartile range IQR= 5.5 - 20.

Statements 39 and 38 have the highest efficiency and more consensus: *S39: "Awareness campaigns to introduce the issue and to increase consumer awareness"* and *S38: "To educate in values and to value food"*. These are centered on rising consumer awareness.

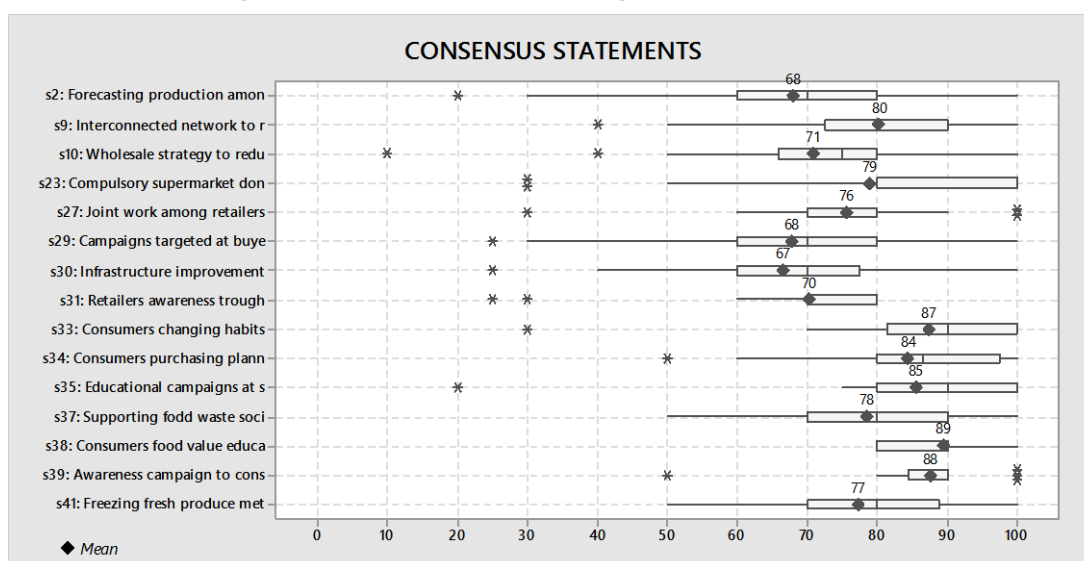
Analysing the differences between groups of experts (see Figure 3 and Table 6) it is observed that the interquartile range of the Private group is higher than others, showing more divergence in this group. The social group tend to value all the statements with higher efficiency than others.

There are four statements in which differences among groups are higher. First, *S9: "Create and promote an interconnected system to distribute and use the farm's food surplus."*, for this statement the group institutional do not consider the measure efficient to reduce food waste as they have valued it with a mean_I=42.9. Next, the private group has shown a huge heterogeneity in *S10: "Create a plan to include the reduction of food waste in the management of Mercabarna both direct and induced."* IQR_P= 77.5. The only statement that proposes the launch of a new protocol is valued with less efficiency by the group private and with divergence among the group *S23: "Developing compulsory supermarket donation protocols"* mean_P= 66 and IQR_P=55. Finally *S35: "Educating on food waste in schools and school canteens."* is less valued by the provat group mean_P= 74 and IQR_P=31.

Table 3 Consensus statements indicators summary

#	Statements	IQR	Mean	SD
s2	Planning farming concerning to cooperative linked to the commercialization of the product.	20.0	67.9	21.2
s9	Create and promote an interconnected system to distribute and use the farm's food surplus.	17.5	80.3	16.1
s10	Create a plan to include the reduction of food waste in the management of Mercabarna both direct and induced.	14.0	70.8	21.8
s23	Developing compulsory supermarket donation protocols	20.0	78.9	22.1
s27	Working together different suppliers and competitors. to find ways of minimizing wastage	10.0	75.7	15.7
s29	Campaigns targeted at buyers with local administrations and environment departments to use recipes. planning menus that allow you to make a wise purchase	20.0	67.9	18.3
s30	Infrastructure improvement at municipal markets that help food perseveration and logistics	17.5	66.6	16.2
s31	Working on retailers awareness trough stock management and cold storage	10.0	70.3	16.5
s33	Encouraging behaviour change to reduce the volume of food waste.	18.5	87.3	15.8
s34	Encouraging food planning purchasing.	17.5	84.4	13.7
s35	Educating on food waste in schools and school canteens.	20.0	85.5	17.8
s37	Supporting social movements that testify the problems and they could nudge authorities and companies.	20.0	78.4	15.4
s38	To educate in values and to value food. Encourage healthy eating because it would increase the people's value of food.	10.0	89.4	7.1
s39	Awareness campaigns to introduce the issue and to increase consumer awareness	5.5	87.6	11.1
s41	To establish procedures for freezing fresh produce such as meat to facilitate donations to social organizations.	18.8	77.3	15.0

Figure 1 Consensus statements graphic representation



Dissensus

Eight statements have shown a clear divergence among experts. Half of the measures propose laws and regulations and the other half make suggestions to improve the donation process. The efficiency of the measures is between moderate and low, means are from 58 to 73 points.

Interestingly, there is a clear rejection of any kind of new legislation or regulation. Two promoting compulsory food donations s49: "Having laws that establish the boundaries among food price drops and food donation within different stakeholders along the food value chain" and s52: "To incorporate laws and regulation that do not leave donations to business voluntary actions."; and other two about waste management, s16: "Increase the taxes and procedures of industrial waste disposal" and s45: "Adopting a legislation that coerce food operator to donate food to human consumption instead of animal food production." which promotes the waste hierarchy.

Comparing by groups (see Figure 4 and Table 6) statement s16: "*Increase the taxes and procedures of industrial waste disposal*" the group Private do not consider the solution efficient $\text{mean}_P=30$. The group Institutional consider the measures more efficient and with higher consensus among themselves.

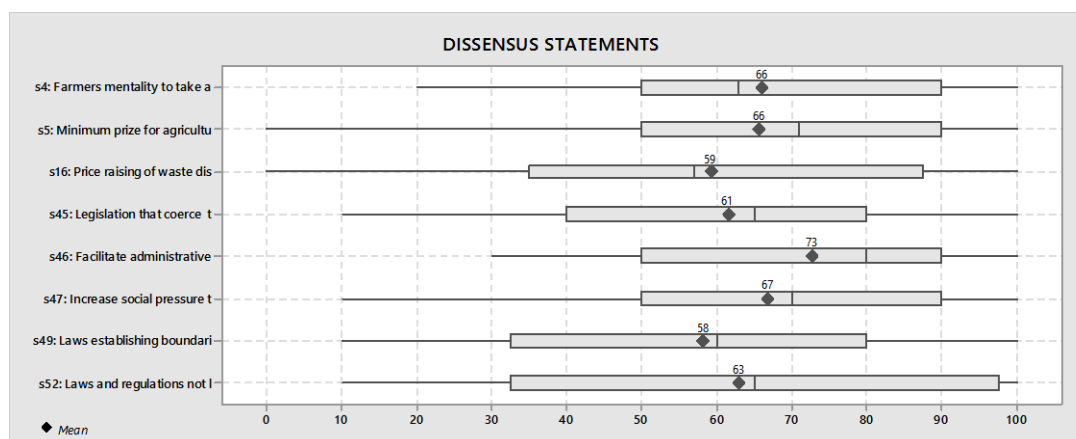
The statement s45: "*Adopting a legislation that coerce food operator to donate food to human consumption instead of animal food production*" shows a divergence among all three groups. However, the means are diverse, $\text{mean}_P= 47$, $\text{mean}_I= 56$ and $\text{mean}_S= 78$.

Finally Institution do not agree ($\text{mean}_I=47$) that s4: "*Farmers should have the mentality to take advantage of everything that gives the cultivation conserve transforming part of the harvest that has no market sales and look for alternative sales channels.*"

Table 4 Dissensus statements indicators summary

#	Statements	IQR	Mean	SD
S4	Farmers should have the mentality to take advantage of everything that gives the cultivation conserve transforming part of the harvest that has no market sales and look for alternative sales channels.	40.0	65.9	24.5
S5	Guaranteeing a minimum price exciting and profitable for farmers.	40.0	65.6	30.2
S16	Increase the taxes and procedures of industrial waste disposal	52.5	59.2	28.2
S45	Adopting a legislation that coerce food operator to donate food to human consumption instead of animal food production	40.0	61.5	27.1
S46	Facilitate administratively supermarkets donations since they sometimes find it difficult bureaucratically.	40.0	72.8	22.1
S47	Increasing social pressure in order to increase food donations	40.0	66.8	25.8
S49	Having laws that establish the boundaries among food price drops and food donation within different stakeholders along the food value chain.	47.5	58.2	27.8
S52	To incorporate laws and regulations that do not leave donations to business voluntary actions.	65.0	63.0	31.8

Figure 2 Dissensus statements graphic representation



Overall all the statements except four converged towards consensus (see Table 6, Δ IQR difference between rounds, according to (Clibbens et al., 2012). Three statements, s16, s34 and s33 were stable across rounds. Only one statement s52 has arises divergence among rounds. Analysing the convergence among groups (Table 5) we can state that Institutional group has been stable on their answers, the Private has converged overall but has been stable in dissensus statements. And the aware Social group has converged on both kind of statements.

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Table 5 Means of interquartile differences by group

	Mean Δ IQR	Mean Δ IQR CONSENSUS	Mean Δ IQR DISSENSUS
<i>Institutional</i>	-1.9	-2.3	-1.2
<i>Private</i>	-13.8	-11.0	-1.2
<i>Social</i>	-10.3	-7.6	-15.3

Figure 3 Comparisson consensus by groups

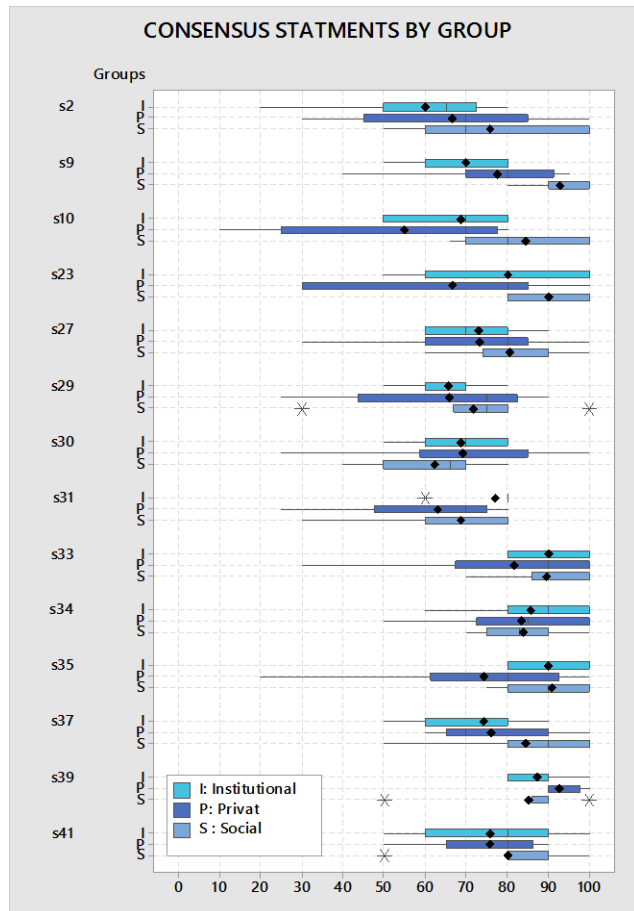
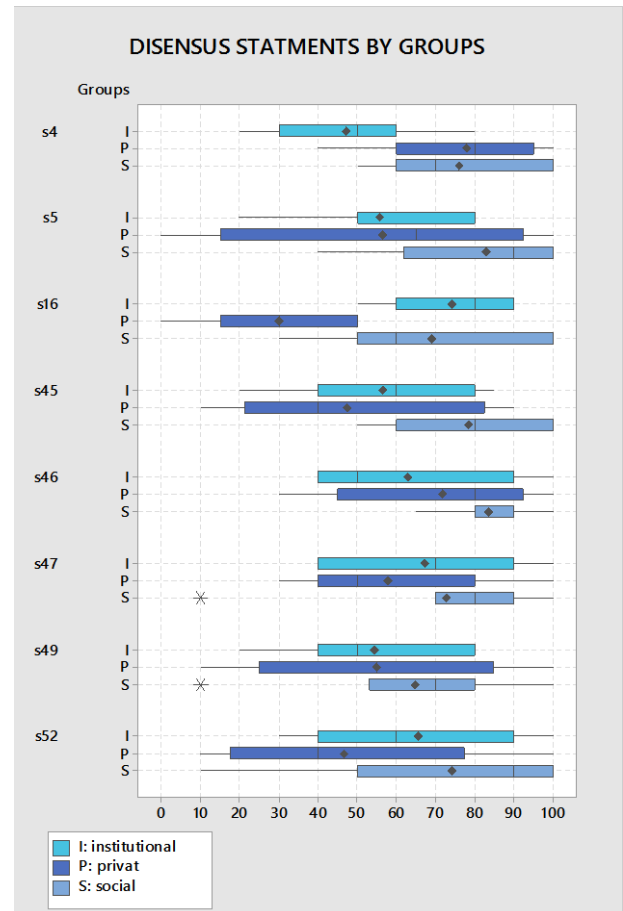


Figure 4 Comparisson dissensus by groups



3. Conclusions

It is important to highlight that the solutions proposed in the present study have been defined by stakeholders involved in the food supply chain. Moreover, through the two-stage qualitative approach we have not only defined the future scenarios to reduce food waste but

also a stakeholder network analysis (responsibility. influence. interest. etc.) which would help policy makers to implement the potential measures.

Food waste is an important topic and new strategies are currently being defined by policy bodies. Analysing food waste behaviours entails a broad view of the food supply chain. It is needed an integrated perspective considering each stage a part of a whole. Engage stakeholders in the deflections of new action to reduce food waste is crucial as it will guarantee the acceptance of the information shared and would increase the participation.

The results obtained in this study are relevant to the definition of waste reduction policies. The more relevant aspects are:

- Interest: there is an interest on the topic although it is not the core problem of food supply chain stakeholders. There is an opportunity to keep growing their interest on it.
- Lack of knowledge about the volumes: there are few studies reporting the volumes of food waste along the food supply chain. Besides stakeholders do not know how much food waste is generated in their region or even so in the stages in which they operate. Qualitative studies should be complemented with detailed quantifications along Europe.
- Shared responsibilities: although worldwide reports highlight primary production and households as the stages with higher volumes of food waste generated it is important to point out that “it is important not to confuse “where” a specific loss or waste is occurring, with its “cause” (HLPE, 2014). In that sense, the experts agree with the HLPE’s statement. The food supply is compressed by all the elements that interact, people, infrastructures, institutions, etc. and all of them are partly responsibly about the amount of food waste generated.
- Administration role: administrations are seen with the higher power to change the food waste dynamic in spite they are not active agents of the food value chain. They

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have an important role of gathering together different sensitivities of the topic and encourage all of them to work together. As it is explained above, new laws and regulations are not considered as effective as rising awareness, improving food redistribution or working different stages with the same agreed objective.

- Food redistribution: improving food donation has emerged as an important topic both in the analysis of the causes and in the proposal of solutions. In the metropolitan area of Barcelona the donation network is improving but experts urge to keep working on it.
- Definitional frameworks: having a common food waste definition is very important in order to be able to compare regionally and temporally data. But, it is important not to impose a definition otherwise to be able to move from the different views to an overall European framework.
- In general, it has been convergence among stakeholders on the measures proposed to reduce food waste. Meaning that there is predisposition of different stakeholders to reach intermediate steps between what they initially think and what the others suggest. It is very positive since the stakeholders are willing to work together.

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Annex

Table 6 Detailed information about rounds and groups

Statement	Delphi rounds										Stakeholder groups																	
	Round1			Round2			Dif. R2 – R1			Institutional			Private			Social			Dif. Ints-Private			Dif. Private-Social			Dif. Inst-Social			
	IQR1	Mean1	SD1	IQR2	Mean2	SD2	ΔMean (2-1)	ΔSD (2-1)	ΔIQR (2-1)	Mean (I)	SD (I)	IQR(I)	Mean (P)	SD (P)	IQR (P)	Mean (S)	SD (S)	IQR (S)	Δ Mean (I-P)	Δ SD (I-P)	Δ IQR (I-P)	Δ Mean (P-S)	Δ SD (P-S)	Δ IQR (P-S)	Δ Mean (I-S)	Δ SD (I-S)	Δ IQR (I-S)	
CONSENSUS	s2	50.0	69.5	24.8	20.0	67.9	21.2	-1.6	-3.6	-30.0	60.0	21.0	22.5	66.7	24.2	40.0	75.7	19.0	40.0	-6.7	-3.2	-17.5	-9.0	5.2	0.0	-15.7	2.0	-17.5
	s9	26.3	80.8	20.0	17.5	80.3	16.1	-0.5	-3.9	-8.8	70.0	11.5	20.0	77.5	19.4	21.3	92.9	7.6	10.0	-7.5	-7.9	-1.3	-15.4	11.9	11.3	-22.9	4.0	10.0
	s10	30.0	66.8	27.0	14.0	70.8	21.8	4.0	-5.2	-16.0	68.6	13.5	30.0	55.0	29.6	52.5	84.4	15.2	30.0	13.6	-16.1	-22.5	-29.4	14.4	22.5	-15.9	-1.7	0.0
	s23	30.0	78.9	22.8	20.0	78.9	22.1	0.0	-0.7	-10.0	80.0	19.1	40.0	66.7	29.4	55.0	90.0	11.0	20.0	13.3	-10.3	-15.0	-23.3	18.5	35.0	-10.0	8.2	20.0
	s27	27.5	74.0	19.3	10.0	75.7	15.7	1.7	-3.6	-17.5	72.9	11.1	20.0	73.3	23.4	25.0	80.6	12.5	16.0	-0.5	-12.3	-5.0	-7.2	10.9	9.0	-7.7	-1.3	4.0
	s29	27.5	67.0	24.1	20.0	67.9	18.3	0.8	-5.8	-7.5	65.7	9.8	10.0	65.8	24.2	38.8	71.7	21.3	13.0	-0.1	-14.4	-28.8	-5.9	2.9	25.8	-6.0	-11.5	-3.0
	s30	30.0	66.8	24.3	17.5	66.6	16.2	-0.2	-8.1	-12.5	68.6	10.7	20.0	69.2	24.6	26.3	62.3	13.5	20.0	-0.6	-13.9	-6.3	6.9	11.0	6.3	6.3	-2.8	0.0
	s31	20.0	71.3	21.4	10.0	70.3	16.5	-0.9	-4.9	-10.0	77.1	7.6	0.0	63.0	21.7	27.5	68.7	18.7	20.0	14.1	-14.1	-27.5	-5.7	3.0	7.5	8.4	-11.1	-20.0
	s33	20.0	86.0	22.1	18.5	87.3	15.8	1.3	-6.3	-1.5	90.0	8.2	20.0	81.7	26.4	32.5	89.4	10.1	14.0	8.3	-18.2	-12.5	-7.8	16.3	18.5	0.6	-1.9	6.0
	s34	23.8	83.3	17.3	17.5	84.4	13.7	1.2	-3.7	-6.3	85.7	14.0	20.0	83.3	18.6	27.5	84.0	10.2	15.0	2.4	-4.6	-7.5	-0.7	8.4	12.5	1.7	3.8	5.0
	s35	20.0	88.2	9.9	20.0	85.5	17.8	-2.7	7.9	0.0	90.0	8.2	20.0	74.2	28.0	31.3	90.7	10.2	20.0	15.8	-19.8	-11.3	-16.5	17.8	11.3	-0.7	-2.0	0.0
	s37	30.0	77.9	17.2	20.0	78.4	15.4	0.5	-1.8	-10.0	74.3	14.0	20.0	76.0	15.2	25.0	84.3	17.2	20.0	-1.7	-1.2	-5.0	-8.3	-2.0	5.0	-10.0	-3.2	0.0
	s38	20.0	88.9	8.8	10.0	89.4	7.1	0.4	-1.7	-10.0	87.1	7.6	10.0	92.0	8.4	15.0	89.7	5.8	2.0	-4.9	-0.8	-5.0	2.3	2.5	13.0	-2.6	1.7	8.0
	s39	20.0	86.8	12.5	5.5	87.6	11.1	0.7	-1.4	-14.5	87.1	7.6	10.0	92.5	5.0	7.5	85.1	16.1	4.0	-5.4	2.6	2.5	7.4	-11.1	3.5	2.0	-8.5	6.0
s41	35.0	78.0	17.7	18.8	77.3	15.0	-0.8	-2.7	-16.3	75.7	17.2	30.0	75.8	14.3	21.3	80.0	15.3	10.0	-0.1	2.9	8.8	-4.2	-1.0	11.3	-4.3	1.9	20.0	
DISSENSUS	s4	50.0	63.7	28.1	40.0	65.9	24.5	2.3	-3.6	-10.0	47.1	19.8	30.0	78.0	22.8	35.0	76.1	20.4	40.0	-30.9	-3.0	-5.0	1.9	2.5	-5.0	-29.0	-0.6	-10.0
	s5	57.5	62.3	35.8	40.0	65.6	30.2	3.3	-5.6	-17.5	55.7	20.7	30.0	56.7	40.3	77.5	83.1	23.3	38.0	-1.0	-19.6	-47.5	-26.5	17.0	39.5	-27.4	-2.6	-8.0
	s16	57.5	54.0	33.9	52.5	59.2	28.2	5.2	-5.7	-5.0	74.3	15.1	30.0	30.0	19.0	35.0	69.1	27.5	50.0	44.3	-3.9	-5.0	-39.1	-8.6	-15.0	5.1	-12.4	-20.0
	s45	40.0	60.5	30.1	40.0	61.5	27.1	1.0	-3.0	0.0	56.4	23.9	40.0	47.5	31.9	61.3	78.6	18.6	40.0	8.9	-8.0	-21.3	-31.1	13.3	21.3	-22.1	5.3	0.0
	s46	47.5	65.5	30.7	40.0	72.8	22.1	7.3	-8.6	-7.5	62.9	24.3	50.0	71.7	26.4	47.5	83.6	11.1	10.0	-8.8	-2.1	2.5	-11.9	15.3	37.5	-20.7	13.2	40.0
	s47	50.0	64.0	33.8	40.0	66.8	25.8	2.8	-7.9	-10.0	67.1	24.3	50.0	58.0	25.9	40.0	72.9	29.3	20.0	9.1	-1.6	10.0	-14.9	-3.4	20.0	-5.7	-5.0	30.0
	s49	60.0	53.2	30.7	47.5	58.2	27.8	5.0	-2.9	-12.5	54.3	21.5	40.0	55.0	36.2	60.0	64.7	28.6	27.0	-0.7	-14.7	-20.0	-9.7	7.6	33.0	-10.4	-7.1	13.0
	s52	57.5	60.8	34.8	65.0	63.0	31.8	2.3	-3.0	7.5	65.7	25.7	50.0	46.7	33.9	60.0	74.3	34.1	50.0	19.0	-8.1	-10.0	-27.6	-0.2	10.0	-8.6	-8.4	0.0

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