The current issue and full text archive of this journal is available at
www.emeraldinsight.com/0007-070X.htm

BFJ
116,9

1460

Received 14 February 2014
Revised 9 April 2014
Accepted 15 May 2014

Surplus food recovery and donation in Italy: the upstream process

Paola Garrone, Marco Melacini and Alessandro Perego
Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Milano, Italy

Abstract

Purpose – This paper offers quantitative evidence on how surplus food, i.e. safe food that is not sold to the intended customers, is generated and recovered within Italian manufacturing and retail firms. The purpose of this paper is to enlighten the process through which the food supply chain firms come to donate surplus food-to-food banks.

Design/methodology/approach – Surplus food and recoverability were defined as the key terms of the problem. In total, 12 exploratory case studies were conducted to segment the manufacturing and retail sectors, to assess recoverability in each segment, and to establish the protocols for descriptive case studies. A multiple case-study approach was used and 83 firms were investigated.

Findings – The primary source of surplus food is shown to result from products reaching the internal sell-by date, i.e. the date by which manufacturers and warehouses must supply perishable products. Donation to food banks is found to be a relevant management practice in the ambient and chilled manufacturing segments and at retail distribution centres, while frozen food companies and retail stores are found to rely nearly exclusively on waste disposal.

Research limitations/implications – The degree to which our findings are specific to Italy is an issue to investigate. Future research should target surplus food management in farming and food services, and assess the cost effectiveness of alternative management channels.

Practical implications – The paper highlights the changes required to increase the amount of food recovered by food banks. It also summarises the steps for establishing a structured procedure for managing surplus food within firms.

Originality/value – The paper offers quantitative evidence on a relatively untapped yet socially relevant topic, i.e. the upstream process of food recovery and donation.

Keywords Food banks, Food recovery, Food supply chain, Surplus food

Paper type Research paper

1. Introduction and background

The issue of food supply chain sustainability has received much attention from stakeholders, policymakers, and scholars in last years. A large part of European debates over this topic have been framed almost exclusively in terms of resource efficiency and smaller environmental costs, with prevention of food waste disposal as the main goal (European Commission, 2011; WRAP, 2011). More recently, however, renewed consideration has been given to the question of surplus food redistribution as

The paper is based upon a research that was designed and conducted in cooperation with Fondazione per la Sussidiarietà. Miriam Pollo provided excellent research assistance. The research in part was financially supported by the food bank Fondazione Banco Alimentare, which also shared with us a unique knowledge of the characteristics of surplus food and the ways in which it may be recovered and distributed.

The usual disclaimer applies.

British Food Journal
Vol. 116 No. 9, 2014
pp. 1460-1477

0007-070X
DOI 10.1108/BFJ-02-2014-0076

an option both to relieve food poverty and to meet waste reduction targets (European Commission, 2012; WRAP, 2014).

This paper is aimed to contribute to this emerging debate by empirically examining surplus food management within companies. Surplus food and food waste are debated concepts, and definitions are not yet shared universally. Nevertheless, for the purpose of this paper, surplus food is defined as safe food that for various reasons, at any stage of supply chain, is not sold to or consumed by the intended customer, while food waste is defined as surplus food that is not used for feeding people (see Section 2.2 for more detailed definitions).

The objective of this research was twofold. This paper provides information about the reasons that surplus food is generated and how it is managed. It also identifies potential methods that companies and food banks could use to increase the quantities of food recovered and donated and to reduce the amount of food waste. Specifically, this paper focuses on two stages of the food supply chain: the manufacturing industry and retail trade. The research is based on 83 case studies of companies that operate in Italy.

Food poverty is an important issue even in developed countries. In 2011, 6 per cent of European Union (EU) inhabitants, i.e. almost 19 million people, were reached by the EU food aid programme through food banks and other charitable organisations (Gentilini, 2013). The UK food bank network estimates that in 2012-2013 food banks fed 346,992 people nationwide, while Fondazione Banco Alimentare, an Italian food bank, reports that Italian charitable organisations have assisted more than four million people in 2013.

The picture is at variance with the available data on food waste, which is acknowledged to be a huge problem worldwide, even though definitions, indicators and estimation methods are far from being harmonised. Gustavsson *et al.* (2011) estimated that food wastage is particularly severe in developed countries, with estimates as high as 280-300 kilograms per capita per year in Europe and North America. Countries in the EU are reported to generate 179 kilograms per capita of food waste every year, exclusive of agricultural waste (O'Connor, 2013). UK households are found to generate 260 kilograms per year per household of food and drink waste excluding packaging (WRAP, 2013a), whereas UK grocery retail, wholesale and manufacturing are shown to bear an additional stream of 4.3 million tonnes per year (WRAP, 2013b). The overall amount thus reaches 181 kilograms per year per capita, based on UK population data of the 2011 Census. The whole Italian food supply chain, from agriculture to households, is estimated to produce an overall amount of 5.5 million tonnes per year (Garrone *et al.*, 2013), or 94 kilograms per year per capita. Food losses from the whole Swiss supply chain amount to 299 kilograms per capita per year (Beretta *et al.*, 2013).

Even though a multifaceted and coherent global strategy is needed to address the food security challenge globally (Godfray and Charles, 2010), the incongruity between food waste and food security data is a strong indicator that an integrated approach to these two issues could be of significant value, at least in developed countries, where the management of food waste is increasingly acknowledged to be a lever for the mitigation of food insecurity (Kantor *et al.*, 1997), in addition to sustainable food consumption (Jones *et al.*, 2011). The waste hierarchy makes clear that food waste reduction at the source and food recovery for feeding humans are high priority options (Johnston and Green, 2004). In other words, surplus food should be reduced at the source for a more efficient use of input resources wherever possible (Cuéllar and Webber, 2010; Buzby *et al.*, 2011; Buzby and Hyman, 2012), or be recovered to help

those in need in other cases (Kantor *et al.*, 1997; Tarasuk and Eakin, 2003; Parfitt *et al.*, 2010; Gentilini, 2013; Garnett, 2013; WRAP, 2014). In this regard, it should be considered that not all surplus food is economically recoverable. Kantor *et al.* (1997) and Garrone *et al.* (2014) show that food recovery efforts are often limited by financial and logistical constraints that make it difficult to supply recovered food to potential recipients. These constraints are underscored by the need to maintain food safety.

The rationale for this paper can be further illustrated by considering a common criticism of food donation and food banks. The organisation of and strategies used by food banks differ considerably between countries. Gentilini (2013) argues that food banks are intermediate agents that: raise in-kind and cash contributions from individuals, governments, and firms; handle and store them; deliver them to charitable organisations that distribute food to or prepare meals for the food poor. For instance, Italy has adopted this food banking model. By contrast, Tarasuk and Eakin (2003, 2005) and Winne (2008) suggest that North-American food banks include both larger intermediate agents and smaller front-line organisations that provide assistance to the poor. Whatever the model, those who express skepticism about the ultimate impact of food banks argue that food banks promote co-dependency between the food poor and food firms (Winne, 2008, pp. 75-81). Critics argue that, instead of "using" food banks to manage their surplus output, private firms should be making efforts to eliminate profitable but socially inequitable practices such as concentrating huge retail outlets in wealthy areas, producing cheap food of low nutritional value or lobbying for financial or fiscal benefits in return for donations. In some cases, the distribution practices were found to be excessively driven by donors' supply choices, and to be dissociated from client need (Tarasuk and Eakin, 2003). Furthermore, it is claimed that the existence of food banks serves to divert the public and policy makers' attention away from the need of social policies that target poverty (Winne, 2008, p. 72).

The authors acknowledge that the presence of food banks may influence the food firms' decisions about surplus food. Nevertheless the point is made in this paper that if a certain level of surplus food proves to be intrinsic in some segments of the supply chain, it is important to recover it and to prioritise its use towards the reduction of food insecurity.

A thorough understanding of what causes the generation of surplus food is necessary precisely to distinguish between unavoidable and "reducible" surplus food. This, in combination with an assessment of current management practices, could reveal those areas where recovery and donation can be intensified. Despite the numerous studies in which the various surplus food management policies are discussed, few provide a quantitative representation of them. Notable exceptions are Kantor *et al.* (1997) and Griffin *et al.* (2009), according to whom, in the USA, a percentage of between 3 and 5 per cent of surplus food is donated to charity organisations (e.g. food banks). This paper presents findings that contribute to fill this knowledge gap.

The remainder of the paper is organised as follows. The research methodology is presented in Section 2. Section 3 presents the main results about surplus food management. In Section 4, recommendations for firms and food banks are proposed, and some concluding remarks and suggestions for further research are proposed in Section 5.

2. Research methodology

The research involved three main steps:

- Step 1: definition of the terms of the problem (i.e. surplus food and recoverability);

- Step 2: realisation of the case studies; and
- Step 3: development of recommendations for food banks and firms.

The case studies conducted in Step 2 made it possible to:

- identify the reasons for the generation of surplus food; and
- understand the ways in which surplus food is managed by firms.

2.1 Literature survey

The introduction reported a few estimates of food waste, and recognised that there is an extensive debate about concepts and definitions. Before giving our own working definitions, it is worth summarising the state of the art. "Food losses" usually refers to food that is safe yet unmarketable for aesthetic or other reasons, and excludes those inedible parts that cannot be consumed (Tarasuk and Eakin, 2005; Beretta *et al.*, 2013; Buzby and Hyman, 2012; Kantor *et al.*, 1997; Mena *et al.*, 2011). "Food waste" is often defined as products neither sold nor used or consumed at any stage of the supply chain, and includes crops or food products discarded and mixed with garbage, materials, or leftovers that are not necessarily edible or safe (Griffin *et al.*, 2009; Kummu *et al.*, 2012; Parfitt *et al.*, 2010; Sonnino and McWilliam, 2011; WRAP, 2013b). The lack of harmonised definitions makes it difficult to compare the results of available studies. Moreover, studies that do not distinguish between safe and unsafe food waste are still relevant if resource efficiency and environment protection are the main goals, but they are useless if there is an issue of food recovery and donation.

Not only available studies do not lean on common definitions, they also use highly different methodologies for quantifying the phenomenon at hand. Many analyses use third-party sources (Buzby and Hyman, 2012; Griffin *et al.*, 2009; Kantor *et al.*, 1997; Kummu *et al.*, 2012). Statistics on municipal solid waste are a typical source of data in this area, but they may lead to consider mixed categories of waste and to over-assess food losses. Fewer studies use a sample of companies (Mena *et al.*, 2011), while other works mix sample and third-party data (e.g. Beretta *et al.*, 2013; Garrone *et al.*, 2013; WRAP, 2013b). Whenever a sample is used, sample results are projected to country and sector levels by the means of inferential methods. Estimates of waste factors are obtained from the sample, and are then projected to the whole sector or country by using available measures of the market size as a driver (e.g. Kantor *et al.*, 1997; Griffin *et al.*, 2009; Buzby and Hyman, 2012; Garrone *et al.*, 2013).

The research presented in this paper follows the most recent literature in two ways. It defines explicitly the scope of the analysis (Section 2.2). Additionally, it assumes a micro level, bottom-up perspective, i.e. it derives results on surplus food management by empirically analysing a sample of manufacturers and retailers (Section 2.3).

2.2 Terms of the problem

For the purpose of this work, we adopted definitions that are consistent with the concepts introduced by Garrone *et al.* (2014). The following definitions are very general, and are conceived to fit not only food manufacturing and retail, but production (i.e. agriculture and fishing), service (i.e. catering), and consumption at home as well. More specifically, "food availability" includes three different categories: "consumed food", "surplus food", and "food scrap":

- Consumed food is the safe food that is delivered through the traditional market and is consumed by humans.

- Surplus food is the safe food that is produced, manufactured, retailed or ready to be served but for various reasons is not sold to or consumed by the intended customer[1]. Surplus food can be reduced at the source, or can be recovered and used in a variety of ways: feeding humans (e.g. donations to food banks and charitable institutions, or sales through secondary markets), feeding animals, waste recovery (e.g. sale to firms that produce fertilizers or cosmetics or energy), waste disposal[2].
- Food scrap consists of non-edible food, i.e. food not suitable for human consumption. It includes production line leftovers at the manufacturing stage (e.g. chocolate leftovers generated during the cutting process), damaged/broken products that fail to meet quality standards (e.g. melted ice-cream) and the non-edible parts of otherwise edible food (e.g. vegetable peels or apple cores).

The transition from surplus food-to-food waste is also a function of the "degree of recoverability" (DoR). Surplus food recoverability for human consumption is inherently different at different stages in the food supply chain and for different kinds of products. For instance, edible and healthy grains not collected from the fields are only somewhat recoverable because they must undergo a physical transformation in order to be consumed by people; conversely, an edible, healthy packaged product not sold in a store due to dented packaging has a higher intrinsic recoverability, as it is ready to eat. Recoverability implies the relative ease of recovering surplus food for human consumption, and depends on the intrinsic recoverability of surplus food, and on the required management intensity. Section A1 in Appendix presents a thorough discussion of the DoR for the supply chain segments considered in this paper:

- Food waste from a social perspective is defined as surplus food that is not used for feeding people, while food waste from an environmental perspective is defined as surplus food that is not re-used or recovered in any form and is disposed of.

2.3 Multiple case-study analysis

The research focused on two stages of the food supply chain: the manufacturing industry, and retail trade. As part of a larger research project on surplus food and food waste in Italy, 12 exploratory case studies in these two stages were first conducted, in order to determine how these two stages of the supply chain could be subdivided into segments representing similar areas or product categories within the supply chain, to assess the DoR of the segments, and to establish the protocols for the large-scale analysis. Based on the protocols, 83 descriptive in-depth case studies were conducted, in order to obtain empirical data on the sources, significance, and management of surplus food (Table I). Section A2 of Appendix describes the methodology in greater detail.

Table I.
Information on the sample used to study the segments of food manufacturing and retail trade

Stage	Segment	Number of case studies	Percentage of segment sales
Manufacturing industry	Ambient	22	8.7
	Chilled	24	13.8
	Frozen foods	3	11.2
Retail trade	Distribution centres	5	19.6
	Stores	29	19.6

The manufacturing stage was divided into three segments: ambient, chilled, and frozen. In fact, as shown in the literature (e.g. Mena *et al.*, 2011), even within a stage, significant differences exist in the production structure, in the logistics network, in the product characteristics (e.g. perishability, storage temperature, usability by the final consumer) and in the surplus food sources. Examples of product categories for each segment are shown in Table AI in Appendix.

The retail stage was divided into two segments: distribution centres and stores. In fact, from an organisational point of view, stores and distribution centres are very different from each other. The focus of the former is on selling products while the latter specialise in running the logistical operations needed to ensure products are available at the stores (e.g. order preparation). In addition, distribution centres stock sufficient quantities of product to meet demand for an average of two weeks, while much lower levels of stock are kept at stores, which regularly receive new supplies from the distribution centres. For these reasons it was decided that stores should be studied separately from distribution centres. Conceptually, it would also be possible to further break down the analysis of recoverability by product type within the retail stage. However, given the strong commonality of the processes studied in the retail trade sector, it was decided against further segmentation.

As shown in Appendix, each segment is characterised by a DoR that depends on technological and organisational aspects. The ambient and distribution centres segments are characterised by a high DoR, while that of the other three segments is medium.

For each segment a number of case studies were conducted. The sample is composed of firms operating in Italy, for a total of 83 case studies. The manufacturing industry case studies include 24 small companies (less than 250 employees) and 25 larger companies. Many of the companies are based in northern Italy but have plants and warehouses throughout the country. The retail trade stage is analysed through 34 case studies. The companies interviewed are located throughout the country. 29 out of 34 cases concern the stores segment, i.e. supermarkets, hypermarkets, convenience stores, and cash-and-carrys.

Table I reports the sample size and the percentage of segment sales represented by the companies involved in the case studies. The percentage of segment sales is computed as the ratio between the sales of sample cases belonging to a given segment and the total sales of the same segment. As regards manufacturing, data on the total sales of each segment (i.e. product class) at the country level were taken from the National Institute of Statistics (manufacturing industry). Table AI of Appendix list the product classes of manufacturing segments. As regards retail trade, country-level data on the total sales of stores related to food products were taken from statistics published by the association of Italian retailers, Federdistribuzione. Since the distribution centres are within-company warehouses, only nominal sales can be calculated for this segment. The stores turnover is weighted by the share of good flows that enter stores after transiting through the distribution centres.

The sample size and the method used (case studies rather than a large-scale survey), are a consequence of the problem of getting companies involved. In light of this consideration, an approach similar to that used to simulate industrial processes was used to determine the requisite number of case studies to conduct. For each segment, the average values of surplus food and food waste percentages were recalculated following each new case study. Once the values started to stabilise and the explanations of the underlying causes became consistent, the search for new companies was halted.

For example, in the retail trade segment, the data relating to distribution centres proved to be much more stable than the data obtained in relation to stores. For this reason, a smaller number of case studies was conducted for the distribution centres segment than for the stores segment. Further details on the quantitative assessment method can be found in Garrone *et al.* (2013, pp. 70-88).

Finally, on the basis of volume of activity in each segment obtained from the Italian National Institute of Statistics and the percentages determined from the case studies, the phenomenon (e.g. surplus food, reasons for surplus food generation) was also studied in quantitative terms.

2.4 Identification of recommendations for firms and food banks

The results of Step 2 were shared with some of the companies involved in the case studies and with Fondazione Banco Alimentare, a non-governmental organisation that collects around 15,500 tonnes per year of surplus food from manufacturing and retail trade firms in Italy and distributes it to charitable organisations that assist the food poor. Additional supplies come from the EU aid programmes, agriculture and food service sectors, and the public[3].

More in detail, a few meetings to present our research were organised and useful observations and comments from Fondazione Banco Alimentare and some of the companies involved were collected.

The outcome of this final step was to highlight some potential directions to pursue to increase donations. In this final step, the main supply channel for food banks/charitable organisations in Italy, namely surplus food recovery and donation by firms, was considered. In fact, other supply channels, such as the purchase of goods at affordable prices, are not commonly used in Italy.

3. Surplus food, recovery, and causes: main results

This section presents the results of the research, i.e. it illustrates the sources and uses of surplus food within Italian manufacturing and retail trade companies as emerging from our case studies. The empirical methodology is illustrated in Section 2.3, and more in detail by Garrone *et al.* (2013). It is worth recalling that the paper does not deal with possible "external" causes for the creation of surplus food, such as excess production in agricultural markets, packaging practices or households' shopping habits, nor it touches upon the food waste issue as such. An overall summary of the results is provided in Section 3.3.

3.1 Manufacturing industry

There are five main reasons for the generation of surplus food in the food manufacturing industry: products that have reached the internal sell-by date, product non-compliance with commercial standards, non-compliance of product packaging with required standards, product refusals, and returns of unsold product.

As shown in Table II, the different reasons have a different impact in each of the three segments. The main reason for the generation of surplus food is related to the "internal sell-by date", the date by which a perishable product must be sold by the manufacturing company to a distributor, so that the latter has time to sell it to the consumer. The manufacturing company's internal sell-by date is on the order of 30 per cent of the product's shelf-life, i.e. the length of time between the date the product was produced and date by which it must be consumed ("use-by" or final sell-by date). In fact, at least two-thirds of the overall shelf life of the product is required by customers (primarily distribution companies). Once the manufacturer's internal sell-by

date has been reached, the food product can no longer be sold to customers (e.g. retailers), and surplus food is generated. The main reasons for reaching the internal sell-by date are production planning or demand forecasting errors. These errors are only partially avoidable. The time issue is particularly severe for some ambient products and all chilled products raise a time issue insofar as they are perishable (see also Appendix on DoR and product classification). The overall percentage of surplus food is 0.3 per cent for the ambient segment (the most significant in terms of volume of sales), 0.6 per cent in the frozen segment, and 0.7 per cent in the chilled segment. On the basis of these percentages and considering the annual sales volume in each segment (expressed in tonnes), the amount of surplus food in Italy is estimated to be equal to a total of around 181,400 tonnes per year, or 0.4 per cent of sales.

Surplus food generated as a result of "non-compliance with commercial standards" includes products that do not meet the requirements of either the manufacturing process or of the market, such as aesthetic characteristics. This form of product non-compliance leads to the exclusion of products from the usual market channels despite the fact that they are perfectly edible from a nutritional point of view. Non-compliance of product packaging, yet another factor in the creation of surplus food, can occur during the packaging process, through handling at the warehouse, or during transportation. The impact of "product non-compliance" and "packaging non-compliance" is significant in the ambient segment (16.2 per cent and 6.8 per cent, respectively) where there are frequent promotions.

The impact of "product refusals" is significant in the chilled segment (13.1 per cent), mainly due to insufficient turnaround time for the redirection of these products to the market. Finally the proportion of products returned unsold is higher in the ambient segment, where there are frequent promotions, and in the chilled segment where sales may occur upon delivery, and unsold product is taken back.

The results with respect to surplus food management options (Table III) reveal a polarisation on two alternatives: donation to charitable organisations (35.3 per cent) and conferral to waste management companies (32.2 per cent).

	Ambient	Chilled	Frozen	Total
Internal sell-by date reached (%)	63.9	68.8	87.1	66.9
Product non-compliance (%)	16.2	5.4	1.4	12.2
Product refusals (%)	7.5	13.1	8.3	9.1
Packaging non-compliance (%)	6.8	4.0	2.1	5.7
Returns of unsold product (%)	5.6	8.7	1.1	6.1
Surplus food – Italy (1,000 tonnes per year)	118.2	51.5	11.7	181.4
	100.0%	100.0%	100.0%	100.0%

Table II. Reasons for the generation of surplus food in the manufacturing stage

	Ambient	Chilled	Frozen	Total
Donation to food banks/charitable organisations (%)	42.1	27.6	1.5	35.3
Conferral to waste management companies (%)	25.1	33.5	97.2	32.2
Sales to secondary markets (%)	27.4	7.3	0.8	20.0
Conferral to manufacturing companies (%)	5.4	31.6	0.5	12.5
Surplus food – Italy (1,000 tonnes per year)	118.2	51.5	11.7	181.4
	100.0%	100.0%	100.0%	100.0%

Table III. How surplus food is managed in the manufacturing stage

The impact of each of the alternatives for managing surplus food is very different in each of the three segments examined. The sale of surplus food through secondary markets is most common amongst companies in the ambient segment (27.4 per cent compared to percentages lower than 8 per cent for the other two segments). One possible explanation is that the useful life of a product in the ambient segment is longer than in the other segments and therefore there is more time available prior to reaching the product's sell-by date.

Donation by companies to food banks or charitable organisations is most prevalent in the ambient segment (42.1 per cent), it is also frequently used in the chilled segment (27.6 per cent), while it is infrequent in the frozen segment (1.5 per cent). Donations in the frozen segment are limited, primarily due to the intensive management required by charitable organisations to deal with the product, in terms of both transportation and storage of large quantities of product.

The conferral of surplus food to manufacturing companies occurs mainly in the chilled segment (31.6 per cent) because these products can be reused to produce animal feed.

3.2 Retail trade

There are four main reasons for the generation of surplus food in the food retail sector: the sell-by date has been reached, product packaging does not comply with required standards, the product itself does not comply with required standards, and product returns. As was found with food manufacturing companies, one of the main reasons for the generation of surplus food is that the product has reached its "internal sell-by date". In the distribution centres segment in particular (i.e. in large warehouses), this means the date by which a product must be delivered to a store so that the retailer has time to sell it to the consumer before the product approaches its final sell-by date, also because products that need to be consumed sooner tend to be left on the shelves.

In the distribution centres segment, surplus food is generated primarily because the product's internal sell-by date has been reached (48.7 per cent, as shown in Table IV). The second most common source of surplus food is product returns (28.1 per cent). Product non-compliance, due to a failure to meet either production or commercial standards, also contributes considerably to the generation of surplus food (12.8 per cent). A slightly lower percentage of surplus food is a result of packaging non-compliance (10.4 per cent). Reliable quantitative data were not available for the stores segment but, according to the interviewees, the main reason for the generation of surplus food in this segment is also that the sell-by date has been reached.

The stores segment generates a more substantial proportion of surplus food (2.3 per cent of sales) than the distribution centres segment (0.3 per cent of volumes handled). On the basis of these percentages and considering the sales for all the segment (expressed in tonnes), we can estimate an amount of surplus food that for Italy is equal

Table IV.
Reasons for the generation of surplus food in the distribution centres segment

	Retail distribution centres
Internal sell-by date reached (%)	48.7
Returns of unsold product (%)	28.1
Product non-compliance (%)	12.8
Packaging non-compliance (%)	10.4
Surplus food – Italy (1,000 tonnes per year)	73.6

to a total of around 777,600 tonnes, or 1.4 per cent of total sales. To provide a sense of the scale of the problem and considering the number of large-scale retail stores, by assuming that the surplus food is equally distributed among the stores, the amount of surplus food generated annually at each store would be 36 tonnes, or 0.7 tonnes per week.

The results regarding surplus food management methods reveal that a considerable amount of product is disposed of as waste (91.5 per cent, see Table V). Nonetheless, donation to food banks and charitable organisations is not negligible (7.5 per cent). A small amount of surplus food is conferred to manufacturing companies (1.0 per cent).

The relative impact of the different surplus food management methods is different in each of the two segments considered. Specifically, more than half of the surplus food in the distribution centres segment is conferred to waste management companies (55 per cent), although a good proportion (35 per cent) is also donated to food banks and charitable organisations. The remainder (10 per cent) is conferred to manufacturing companies. It can be seen that in the stores segment almost all of the surplus food (95.4 per cent) is disposed of as waste.

3.3 Synthesis of results

The total quantity of surplus food generated in Italy in the two stages examined is equal to almost one million tonnes per year (Table VI). By relating this quantity to the number of people living in Italy, it is calculated that 16 kilograms of surplus food per capita is generated in these two stages of the food supply chain every year.

Not all of the surplus food generated in these stages is equally recoverable (see Section 2.1 and the Appendix).

Of the one million tonnes of surplus food generated annually, it can be seen that only 194,800 tonnes has a high DoR. In other words, only 19.5 per cent of surplus food can be recovered for the purpose of feeding humans with a limited level of effort by players in the food supply chain. To date, only a small part of surplus food is managed through donation (12.3 per cent).

	Distribution centres	Stores	Total
Conferral to waste management companies (%)	55.0	95.4	91.5
Donation to food banks/charitable organizations (%)	35.0	4.6	7.5
Conferral to manufacturing companies	10.0	–	1.0
Surplus food – Italy (1,000 tonnes per year)	73.6	704.0	777.6
	100.0%	100.0%	100.0%

Table V. How surplus food is managed in the retail trade stage

Stage	Segment	Surplus food (tonnes per year)	Recoverability	Donation (%)
Manufacturing	Ambient	118.2	High	42.1
	Chilled	51.5	Medium	27.6
	Frozen	11.7	Medium	1.5
Retail trade	Distribution centres	73.6	High	35
	Stores	704	Medium	4.6
Total		959		12.3

Table VI. Surplus food amount and incidence of donation to food banks/charitable organisations in the studied segments

It is interesting to examine the percentage of donation at each stage as a function of DoR. The segments that generate the lower percentage of donation are the stages that are characterised by a medium DoR, with the possible exception of chilled products. To date, in fact, surplus food with a high recoverability is in an important part already recovered for human consumption.

More generally, the relevance of donation option depends not only on the DoR for the segment but on opportunity costs as well. For instance, case studies have offered hints that low tariffs for waste collection and treatment drive firms to confer surplus food to waste utilities, and discourage alternative uses of surplus food, e.g. donation to charities and food banks, sale to animal feed companies, recycling as energy or fertilizers. Italian retail stores are likely to donate so little, not only because recoverability of surplus food in the segment is inherently low, but also because waste collection and treatment costs are almost fixed with respect to the waste amount (i.e. tariffs are related to the store size, and do not reflect the amount of generated waste).

4. Recommendations for firms and food banks

In order to increase the amount of surplus food recovered for human consumption, surplus food management processes need to be improved, both from the point of view of companies in the food supply chain, and beneficiary organisations such as food banks. Based on the research findings, together with a critical analysis of these results in consultation with some of the companies involved, a number of recommendations were developed.

The research has been conducted in Italy, and may reflect specific characteristics of Italian firms and charitable organisations. Nevertheless, it is to underline that some of the following evolution lines seem to be similar to those proposed by some recent international studies (e.g. WRAP, 2014).

The case study research revealed that donations often occur as a result of the initiative or goodwill of individuals who turn to charitable organisations and food banks when surplus food is generated (e.g. following an unsuccessful promotion or when a significant quantity of product is returned that cannot be redirected). Often, this philanthropic practice ceases simply because the person directly involved in the donation process changes jobs or responsibilities. In other words, donation does often not ensue from a structured and systematic process. This seems to be confirmed by a recent WRAP study, according to which the introduction of a process with structured arrangements boosted the amount of surplus food redistributed by 40 per cent (WRAP, 2014).

The establishment of a clear, predefined, structured procedure for managing surplus food could make it easier to recover larger quantities of surplus food more predictably and using fewer resources (time and dedicated personnel). This process should take into account the recoverability of the surplus food generated and the needs of the organisations involved in managing the surplus food. At a large company, this procedure could be included within a broader Corporate Social Responsibility programme, because food disposal is recognised to be an industry issue (Maloni and Brown, 2006). In order to set up a structured process for recovering and donating surplus food it is necessary to understand the phenomenon, to establish a management hierarchy, to decide the number and type of organisations that will be involved and, finally, to establish the details of the collaborative relationship.

The capabilities – both quantitative and qualitative – of food banks and other non-profit organisations that collect and distribute surplus food play a key role in the

recovery of surplus food. The maturity of the non-profit sector companies involved in reclaiming surplus food can be broken down into several categories: logistics excellence, transparency, and capillarity.

Logistics excellence is important for at least two reasons. First, the technical feasibility and economic sustainability of recovering a huge amount of surplus food with a medium DoR, i.e. chilled and frozen food products from manufacturers and products from stores of large-scale retailers, calls for recipients with well-developed logistics capabilities. Second, cost-effectiveness – or at least cost containment – for potential donor companies depends strongly on the beneficiary's logistics capabilities, in terms of the tasks that it can handle and how the various processes, such as transportation, administration, and quality control, are managed. Not only is adequate infrastructure – such as refrigerators and insulated vehicles, and equipment for picking and sorting individual packages – necessary, but structured and reliable processes – for cold chain management, tracking, and organising frequent collection and distribution trips – are also needed. For example, the "Feeding America" food bank, one of the largest charitable organisations in USA, has a dense network of warehouses through the country (Warshawsky, 2010). Gentilini (2013) underlines the role of food banks as intermediate agents that connect donors and beneficiaries, and help charitable organisations by handling, storing, and delivering food commodities and products. Involving third parties with logistics capabilities, as FareShare and FoodCycle, has allowed the UK players of food redistribution to overcome issues such as agreements on collection timings or concerns about food handling and safety (WRAP, 2014).

Transparency, that is the existence of a clear and open process for managing and distributing the surplus food received, is an essential factor for strengthening donor confidence in the organisation. This topic is related to the more general concept of visibility within supply chain (Caridi *et al.*, 2014). The donation of surplus food to a recipient that manages it well has a high social value. Donating surplus food to an organisation that does not provide visibility regarding its use represents a risk to company image that most companies cannot afford (WRAP, 2014). Transparency is achieved through investments in processes and technologies to track flows and assure quality.

Capillarity has at least three possible meanings. At a local level it means being able to respond to donors as and when required, given the characteristics of the donated food products and the donor organisation. It also means being able to communicate with charitable organisations or other needy beneficiaries as and when needed, subject to the constraints imposed by the type of food handled and the recipients themselves. For instance, some food banks in Canada act as clearing houses that coordinate food collection and distribution, and provide food to emergency deeding programmes, soup kitchens or community kitchens (Riches, 2002). In the broadest sense, it means being able to set up effective donor-intermediary-beneficiary communication processes that are universally valid. For a commercial firm that has a broad operations base – nationwide for example – this means the establishment of operational procedures that can be applied consistently throughout the business, with economies of scale and scope.

In earlier research on the issue of food recovery and donation in Italy, Campiglio and Rovati (2009) found that several non-profit organisations recover and distribute surplus food in Italy including well-structured food banks that function as intermediaries between commercial enterprises and charitable organisations, and small charitable organisations that work at a local level (e.g. a parish). This heterogeneity

is clearly an asset, as it shows that there is a high level of awareness in Italian society about food insecurity issues as well as demonstrating strong local capillarity (in accordance with the first two meanings of this term presented above). However, it should be recognised that economies of scale and scope and the development of the requisite competences are essential if excellence in logistics, transparency, and capillarity are to be ensured, especially with respect to relationships with donors. In the authors' opinion, therefore, the best way to fully utilise the capabilities of all of these players would be to encourage the growth of organisations that can act proficiently – while upholding their social and non-profit motivation – as intermediaries between businesses and the thousands of charitable organisations whose capillarity and close relationship with the needy is indispensable asset, while at the same time acquainting these players with the advantages of using intermediaries.

5. Concluding remarks

This paper presents the findings from an empirical analysis of surplus food management in two stages of food supply chain, i.e. manufacturing and retail trade. More particularly, 83 case studies yielded empirical evidence on the sources of surplus food and surplus food management practices in five segments, i.e. ambient, chilled and frozen food products, retail distribution centres, and retail stores.

In all of the food manufacturing segments and at distribution centres, the majority of surplus food is generated primarily because the product's internal sell-by date has been reached. The main reasons this occurs are production planning or demand forecasting errors, which are only partially avoidable and thus represent a logical opportunity to promote recovery and donation as a management strategy. In contrast, the development of marketing strategies and operating practices to reduce surplus food at the source is the most appropriate approach for dealing with another frequent cause of surplus food generation, i.e. non-compliance of products with commercial requirements.

Surplus food recovery for human consumption is already a reality in segments that have a high DoR (i.e. distribution centres, and manufacturing of ambient products). Companies that currently have low surplus food donation rates can emulate the best practices already in place in the supply chain. However, segments with a medium DoR (i.e. manufacturing of chilled and frozen products, and stores) have still only minimally touched on recovery and donation practices. In particular, an excessively large amount of surplus food is generated by retail stores, a segment where management efforts to recover surplus food can be significant. In order for food banks to target this segment, the innovation path described in Section 4, i.e. logistics excellence, capillarity, and transparency, is recommended.

An assessment of the costs of various surplus food management policies was beyond the scope of this study, however, cost effectiveness is just as relevant as improved food security and food waste reduction if the goal of food supply chain sustainability is to be achieved. One of the next steps in the continuing research on this topic should be to find a way to introduce cost factors in the analysis. If recovery and donation are found to be cost effective, fiscal incentives should be considered. Additionally, our results about surplus food sources and uses are based upon a sample study. The sample size is comparable to or even better than most existing analyses, and we have halted its expansion only when results converged (Section 2.3). Nevertheless, we are aware that caution should be exercised when considering the country-level projection of results. We also wonder whether our results can be generalised to the food

supply chains of other countries. We are thus open to further checks of our approach and results, following emerging studies that use alternative methods and samples. Finally, the thorough investigation of surplus food sources and management practices that was developed for the manufacturing and retail stages should be conducted for the food production (i.e. agriculture and fishing) and food service (i.e. collective and commercial catering) stages.

Notes

1. Surplus food from the food service stage, e.g. restaurants, canteens, or bars, is food that was prepared but not served. Hygiene concerns impede any recovery of served and not consumed food, which instead must be treated as food waste.
2. Donations from agriculture typically come from intermediate organizations, i.e. large producers' consortia and cooperatives that collect, select, store, and distribute farmed food.
3. The EU adopted in 1987 the "Food Distribution programme for the Most Deprived Persons of the Community", and modified it over the years. The most recent scheme is currently being phased-out, and being replaced by new rules and criteria (see http://ec.europa.eu/agriculture/most-deprived-persons/).

References

Beretta, C., Stoessel, F., Baier, U. and Hellweg, S. (2013), "Quantifying food losses and the potential for reduction in Switzerland", *Waste Manag*, Vol. 33 No. 3, pp. 764-773.

Buzby, J.C. and Hyman, J. (2012), "Total and per capita value of food loss in the United States", *Food Policy*, Vol. 37 No. 5, pp. 561-570.

Buzby, J.C., Hyman, J., Stewart, H. and Wells, H.F. (2011), "The value of retail-and costumer-level fruit and vegetable losses in the United States", *Journal of Consumer Affairs*, Vol. 45 No. 3, pp. 492-515.

Campiglio, L. and Rovati, G. (2009), "La povertà alimentare in Italia", Guerini e Associati, Milano.

Caridi, M., Moretto, A., Perego, A. and Tumino, A. (2014), "The benefits of supply chain visibility: a value assessment model", *International Journal of Production Economics*, Vol. 151, pp. 1-19.

Cuéllar, A. and Webber, M. (2010), "Wasted food, wasted energy: the embedded energy in food waste in the United States", *Env. Sci. Technol*, Vol. 44 No. 16, pp. 6464-6469.

Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Manag. Review*, Vol. 14 No. 4, pp. 532-550.

European Commission (2011), "Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions", Roadmap to a Resource Efficient Europe, COM (2011) 571 final, Brussels, available at: http://eur-lex.europa.eu/ (accessed 28 August 2014).

European Commission (2012), "Report of the meeting of the working group on food losses/food waste of the Advisory Group on the Food Chain, Animal and Plant Health," Health and Consumers Directorate-General, Brussels, available at: http://eur-lex.europa.eu/ (accessed 28 August 2014).

Garnett, T. (2013), "Food sustainability: problems, perspectives and solutions", *The Proceedings of the Nutrition Society*, Vol. 72 No. 1, pp. 29-39.

Garrone, P., Melacini, M. and Perego, A. (2013), *Feed the Hungry: The Potential of Surplus Food Recovery*, Fondazione per la Sussidiarietà, Milano.

Garrone, P., Melacini, M. and Perego, A. (2014), "Opening the black box of food waste reduction", *Food Policy*, Vol. 46, pp. 129-139.

Gentilini, U. (2013), "Banking on food. Examining the scale, features and implications of food banks in high-income countries", Draft, Institute of Development Studies, Brighton.

Godfray, H. and Charles, J. (2010), "Food security: the challenge of feeding 9 billion people", *Science*, Vol. 327 No. 5967, pp. 812-818.

Green, A. and Johnston, N. (2004), "Food surplus; reduction, recovery and recycle", *Total Foods*, Vol. 25 No. 4, p. 4.

Griffin, M., Sobal, J. and Lyson, T. (2009), "An analysis of a community food waste stream", *Agriculture and Human Values*, Vol. 26 Nos 1/2, pp. 67-81.

Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R. and Meybeck, A. (2011), *Global Food Losses and Food Waste: Extent, Causes and Prevention*, Rome, FAO, available at: www.fao.org/docrep/014/mb060e/mb060e.pdf (accessed 28 August 2014).

Johnston, N. and Green, A. (2004), "Food surplus; reduction, recovery and recycling", in Waldron, K., Faulds, C. and Smith, A. (Eds), *Total Food*, IFR, Norwich, pp. 35-40, available at: www.ifr.ac.uk/totalfood2009/Total%20Food%202009/ProceedingsTotalFo od2004.pdf

Jones, P., Hillier, D. and Comfort, D. (2011), "Shopping for tomorrow: promoting sustainable consumption within food stores", *British Food Journal*, Vol. 113 No. 7, pp. 935-948.

Kantor, L., Lipton, K., Manchester, A. and Oliveira, V. (1997), "Estimating and addressing America's food losses", *Food Review*, Vol. 20 No. 1, pp. 2-12.

Kummu, M., De Moel, H., Porkka, M., Siebert, S., Varis, O. and Ward, P.J. (2012), "Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use", *Sc. Tot. Envir*, Vol. 438, pp. 477-489.

Maloni, M.J. and Brown, M.E. (2006), "Corporate social responsibility in the supply chain: an application in the food industry", *Journal of Business Ethics*, Vol. 68 No. 1, pp. 35-52.

Mena, C., Adenso-Diaz, B. and Yurt, O. (2011), "The causes of food waste in the supplier-retailer interface: evidences from UK and Spain", *Resource, Conservation and Recycling*, Vol. 55 No. 6, pp. 648-658.

O'Connor, C. (2013), "Quantification of food waste in the EU", *4th OECD Food Chain Network Analysis Meeting*, OECD, available at: www.oecd.org/site/agrfcn/Session%201_Clementine OConnor.pdf (accessed 8 October 2013).

Parfitt, J., Barthel, M. and Macnaughton, S. (2010), "Food waste within food supply chains: quantification and potential for change to 2050", *Philos. Trans. Roy. Soc. B*, Vol. 365 No. 1554, pp. 3065-3081.

Pettigrew, A. (1988), *The Management of Strategic Change*, Blackwell, Oxford.

Riches, G. (2002), "Food banks and food security: welfare reform, human rights and social policy. Lessons from Canada?", *Social Policy & Administration*, Vol. 36 No. 6, pp. 648-663.

Sonnino, R. and McWilliam, S. (2011), "Food waste, catering practices and public procurement: a case study of hospital food systems in Wales", *Food Policy*, Vol. 36 No. 6, pp. 823-829.

Tarasuk, V. and Eakin, M. (2003), "Charitable food assistance as symbolic gesture: an ethnographic study of food banks in Ontario", *Soc. Sci. Med*, Vol. 56 No. 7, pp. 1505-1515.

Tarasuk, V. and Eakin, M. (2005), "Food assistance through 'surplus' food: insights from an ethnographic study of food bank work", *Agric. Hum. Values*, Vol. 22 No. 2, pp. 177-186.

Van De Ven, A.H. (1989), "Nothing is quite as practical as a good theory", *Academy of Manag. Review*, Vol. 14 No. 4, pp. 486-489.

Voss, C., Tsikriktsis, N. and Frohlich, M. (2002), "Case research in operations management", *Int. J. Oper. Prod. Manag*, Vol. 22 No. 2, pp. 195-219.

Warshawsky, D.N. (2010), "New power relations served here: the growth of food banking in Chicago", *Geoforum*, Vol. 41 No. 5, pp. 763-775.

Winne, M. (2008), *Closing the Food Gap. Resetting the Table in the Land of Plenty*, Beacon Press, Boston, MA.

WRAP (2013a), "Household food and drink waste in the United Kingdom 2012", final report, WRAP, Banbury, available at: www.wrap.org.uk/sites/files/wrap/hhfdw-2012-main.pdf.pdf (accessed 28 August 2014).

WRAP (2013b), "Estimates of waste in the food and drink supply chain", final report, WRAP, Banbury, available at: www.wrap.org.uk/sites/files/wrap/Estimates%20of%20waste%20in%20the%20food%20and%20drink%20supply%20chain_0.pdf (accessed 28 August 2014).

WRAP (2014), "Food connection programme", final report, WRAP, Banbury, available at: www.wrap.org.uk/sites/files/wrap/Food%20Connection%20Programme%20Final%20Published%20Report.pdf (accessed 28 August 2014).

Yin, R.K. (1994), *Case Study Research*, Sage Publications, Thousand Oaks, CA.

Further reading

Coleman-Jensen, A., Nord, M., Andrews, M. and Carlson, S. (2012), *Household Food Security in the United States in 2011*, ERR-141, US Department of Agriculture, Economic Research Service, Washington.

Appendix

A1: DoR

The DoR is a key component of the analysis. First of all, DoR depends on the intrinsic recoverability of surplus food, i.e. the degree to which a potential beneficiary could use the surplus food "as-is" for human consumption, i.e. even in the absence of additional management efforts by manufacturers or retailers and intermediaries (e.g. food banks). Intrinsic recoverability varies with the type of product (e.g. shelf life) and the activities that normally take place in the supply chain (e.g. certification, scrap elimination). Second, DoR depends on the commitment required by manufacturers or retailers and intermediaries to make surplus food usable to the greatest degree by the final beneficiary, i.e. maintenance and other activities to preserve or expand the potential uses of the surplus food (e.g. transportation, refrigeration, warehousing, hygienic certification).

Both intrinsic recoverability and management intensity were assessed for each of the five product segments by the means of exploratory case studies (Garrone *et al.*, 2014), and were evaluated on a qualitative scale consisting of three levels (low, medium, high). The resulting DoR qualitatively combines the assessment of intrinsic recoverability and management intensity, as is shown in Table AI.

As an example, the reasoning behind the DoR assigned to the chilled food segment within the manufacturing stage is explained below. Products such as milk, yogurt, packaged meat, or packaged salad are characterised by a medium recoverability degree, which is obtained by combining the appraised value of the intrinsic recoverability (medium) and the management intensity (medium). The intrinsic recoverability was judged to be medium because surplus food in this segment is ready to be consumed but it has a short shelf life. The management intensity is also medium because a certain level of maintenance and enhancement effort is required when surplus food is to be donated. First, the company must store it in a refrigerated environment. Then, food banks and charitable organisations must collect the surplus food promptly and transport it using insulated vehicles or containers.

In fact, the exploratory case studies confirmed that intrinsic recoverability was high for ambient and frozen food products (on a scale of low, medium, and high values), and for food products that are stored in retail distribution centres, while it is medium for chilled food products and in stores. At the same time, interviewed managers acknowledged that intrinsic

Stage	Segment	Product category	Intrinsic recoverability	Management intensity	Recoverability
Manufacturing	Ambient	Dry products (e.g. pasta, rice, tinned food, snacks), preserves (e.g. tomato sauce) and fruit juices, oil and vinegar, alcoholic and non-alcoholic beverages	High	Low	High
	Chilled	Meat (e.g. packaged products, cured meats), fish (e.g. packaged products, seafood), dairy products (e.g. cheese, yoghurt, desserts), fresh, ready-to-eat (4th range) products (e.g. packaged salad, fruit salad)	Medium	Medium	Medium
	Frozen	Frozen products (e.g. frozen ready-meals, frozen meat products, frozen fish products, pizza, frozen vegetables)	High	High	Medium
Retail trade	Distribution centres	All product categories	High	Medium	High
	Points of sale	All product categories	Medium	Medium	Medium

Table AI.
Recoverability in product segments

recoverability should be considered in combination with the required management intensity, which turned out to be low for ambient products, medium for chilled products and in stores, high for frozen products and in retail distribution centres. The final DoR for each of the five segments is reported in Table AI.

A2: Case studies

The case study methodology was adopted because it is particularly appropriate at the early stages of the investigation of a phenomenon (Eisenhardt, 1989; Yin, 1994), and when the goal is the development of a new theory (Van De Ven, 1989; Voss *et al.*, 2002).

The exploratory case studies included 12 case studies at firms involved in two stages of the food supply chain: manufacturing and retail trade (Table AII). The interviewees were managers with significant sector and supply chain structure expertise. For reasons of confidentiality, the names of companies and interviewees are not provided. Regarding the selection of exploratory case studies, as Pettigrew (1988) noted, it is advisable to choose such cases as "extreme situations and polar types in which the process of interest is transparently observable", due to the limited number of companies which can usually be studied.

Protocols for a large-scale empirical survey were developed, consisting of three sections (Yin, 1994). In Section A, following an overview of the research project, the interviewer requests general information about the company: annual turnover, annual sales volume (expressed in tonnes), structure of the production and logistics network, and sales and operational planning process descriptions. In Section B, the interviewer delves further into the topic of surplus food and requests an initial estimate of surplus food. It is important at this stage to share sources of data and information on actions taken by the firm to reduce surplus food. In Section C, the interviewer requests even more detailed information on sources and management modalities for surplus food, obtaining numerical data to use in the analysis. The protocols were used to conduct 83 in-depth descriptive case studies (Table I). The case studies involved multiple face-to-face interviews (3-4 h conversations) with managers representing various departments in the company (e.g. operations, administration, social responsibility).

Stage	Job title of interviewee	Main characteristics of companies
Manufacturing	General and suppliers accounting manager	National company that produces conserves, sauce and dry prepared products
	Logistics manager	International company that produces chocolate products
	Logistics and purchasing manager	International company that produces jam and snacks
	Logistics manager	National company that produces ham and ham-based products
	Supply chain manager	International company that produces yogurt
	General manager	International company that produces vegetable and vegetable-based prepared products
	Operations manager	International company that produces frozen fish products
	Logistics manager	International company that produces bakery products and frozen bread
Retail trade	Logistics manager	International retail company with three DCs and more than 100 stores in Italy
	Logistics manager	National retail company with four DCs and more than 300 stores
	Logistics manager	National retail company with more than 20 DCs and more and 1,000 stores
	Store manager	International POS over 2,500 m^2 and €70 million of food turnover

Table AII.
Exploratory case studies

Corresponding author
Professor Paola Garrone can be contacted at: paola.garrone@polimi.it