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FEED THE HUNGRY

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Preface
by Corrado Passera*

I am very pleased to introduce this book, which describes the results of research on the topic of surplus food and food waste. The study, supported by the Fondazione per la sussidiarietà (Foundation for subsidiarity), was carried out by the Politecnico di Milano in collaboration with the Fondazione Banco Alimentare (Food Bank Foundation) and with Nielsen Italy. It represents an informed approach to a topical subject: the responsible utilisation of food produced in Italy, from the perspectives of both economic and social sustainability. The food supply chain is of significant strategic importance as it contributes approximately 10% to Italy’s GDP and it continues, even under difficult circumstances, to create jobs and achieve success in foreign markets.

The current economic crisis has brought problems and needs to the fore that were thought to be have been almost fully addressed in richer countries: however both new and traditional forms of poverty, including food poverty, are now growing at a worrying rate. Almost 6% of Italian families suffer from some level of food insecurity and protraction of the crisis could cause this extreme food uncertainty to grow even more, as data on reductions in food purchases appear to indicate.

In light of this alarming situation, institutions have a responsibility to provide concrete and convincing solutions, especially with respect to spurring growth and creating jobs. But they cannot do this alone: from an effective subsidiarity perspective, they also need appreciable support and cooperation from private enterprise, with an enthusiastic and engaged Third Sector. Today, more than ever, it is essential that citizens, institutions and companies, both

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for-profit and non-profit, work together to cope effectively with the pressing welfare needs of the “newly poor”, especially in terms of food poverty. This research, in addition to its more purely technical-scientific aspects, sheds some light on how these needs could be addressed with new endeavours by all parties involved.

It is important to underline that alongside desperate poverty, and a lack of necessary resources to meet the most basic of needs such as nutrition, there are also unacceptable levels of waste. The magnitude of this waste is so significant as to make one think: it is disheartening to realise that almost the entirety of Italy’s surplus food, or approximately 17% of total consumption, which in and of itself is clearly an asset to be valued and distributed, is not in fact reused in any way and ends up, literally, in the bin. This surplus needs to be put to better use, reclaiming and redistributing it in the spirit of the community: that which cannot be used by some and is therefore wasted can, and therefore must, be transformed into something useful for the benefit of those who need it. The very existence of this waste has reinvigorated the business of giving.

The laudable efforts made by associations that have worked in this arena for many years, like the Fondazione Banco Alimentare, are excellent examples of effective assistance strategies that demonstrate, among other things, that reducing food waste is not only imperative but is achievable.

However, we need to move beyond merely providing aid, and approach the issue of reducing food waste and helping the needy in a more organised and systematic manner, increasing the use of better surplus food management practices in companies within the food supply chain, from manufacturing companies to retailers, and while also educating families about more responsible shopping habits.

Helping the hungry should not be limited to charitable assistance arising from the “surplus” generosity and altruism of individual donors: much depends on how the agri-food industry is organised and capable of managing its surplus products.

The merit of this research, in addition to having provided a comprehensive analysis of food production in the food supply chain and presented new models for studying and managing surplus food, is that it has revealed to institutions, companies and citizens new
avenues for promoting more sustainable growth strategies that are less inefficient and more socially inclusive.

This is not limited only to “feeding the hungry”, but also involves steering investments in innovation toward production, distribution and consumption practices that further the recovery of as many food resources as possible, preventing this rich surplus from being transformed into food waste and sustained food poverty.

Only in this way, by pursuing the objective of balanced and sustainable development, will the benefit and solidarity that favours the few be transformed into solidarity and growth for society as a whole.
Some preliminary remarks: no food company wants to produce surplus food. It represents a waste three times over: it costs when it is created, it costs when it has to be destroyed and it costs because it can no longer do what it has been created for, that is to feed people. However, even the most careful planning cannot eliminate 100% of surplus food.

Therefore, when we realised the purpose of this project and its objectives, we immediately understood the value and the importance of this proposal and decided to offer our availability and a concrete contribution for its realisation.

In fact the research is perfectly in line with the development strategy of the Nestlé Group, that is Creating Shared Value: a philosophy with long-term objectives aimed at guaranteeing benefits not only for the company and its investors but also for the local communities where we operate.

As a Group, several years ago in Italy we started a close and fruitful partnership with the Fondazione Banco Alimentare ONLUS that allows us to recover our surplus food: our choice consists in supporting those that are committed, on a daily basis and in a concrete way, to recovering quality food that is no longer marketable and making it available to charitable organisations, contributing to improving the nutrition of needy people both in developing and in

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industrialised countries, where wealth and poverty coexist.

It could seem a paradox but unfortunately it is becoming a sad reality, worsened by the current international financial and economic crisis. In this situation the investigation “Feed the hungry: The potential of surplus food recovery” represents a very useful and important working tool because it provides trustworthy and concrete information to institutions and subjects involved in the recovery of surplus food in order to act immediately. Moreover it eliminates a convenient excuse for those who could act but decide not to act. Surplus food becomes a resource only if our organisations get involved in this direction.

Nestlé Group in Italy will follow this path, reinforcing its commitment to the creation of a shared and real value for society and representing an active and responsible participant.
Introduction

This book examines the issue of surplus food and food waste. The effective management of food resources and products is an integral part of sustainable development. Specifically, the management of surplus food plays a key role in the sustainability of the food supply chain by reducing food poverty and food waste.

This book addresses the multifaceted concept of food supply chain sustainability by presenting a model that describes surplus food generation and management, and encompasses the integrated food supply chain (i.e. business, environmental and social players). The main objectives are first to assess the relevance of surplus food and food waste in the Italian food supply chain, and secondly to identify the surplus food management strategies that can be used to reduce food poverty. The research was conducted by the Politecnico di Milano and the Fondazione per la Sussidiarietà, in collaboration with the Fondazione Banco Alimentare ONLUS and Nielsen Italia.

The research results presented in this book contribute to the broad debate that has been developing over the last ten years on problems related to food security, an issue that is extremely relevant in the current economic and social climate, which is characterised by increasing instability in the price of agricultural commodities, by unfolding problems of food poverty even in industrialized countries and by increasing environmental awareness. This combination of
factors suggests that the development of more effective surplus food management practices should be treated as a serious and urgent challenge by policy-makers, companies, non-governmental organisations involved in assisting the poor or protecting the environment, and by individual citizens.

As will be discussed in Chapters 1 and 2, our understanding of the factors that underlie the generation and management of surplus food is still very limited. In some respects, this is not very surprising. A coherent description of surplus food is complicated because surplus food can be seen either as a loss or as a potential opportunity. It is considered a loss, at least from a social perspective, when it is not recovered for its primary purpose, i.e. to satisfy the food needs of people. In this respect, valuable resources such as soil, water, labour and energy have been consumed in vain in the generation of surplus food. At the same time, the part of surplus food that cannot be reduced at the source attests to the availability of resources to satisfy the needs of those that, for whatever reason, are excluded from the market (i.e. the food poor) and in this respect the surplus food presents an opportunity. However, in addition to this “inherent” complexity, there are some shortcomings in the research on this subject: some ambiguities in the definition of key concepts (e.g. lack of clarity in distinguishing between surplus and waste, waste and scraps, waste from a social versus an environmental perspective); inadequate explanation of the methodologies used to assess the full magnitude of surplus food and food waste (e.g. inaccurate descriptions of the sample, data sources, or statistical techniques); the absence of a systematic analysis of the factors that lead to the generation of surplus food and the poor dissemination of good surplus food management practices throughout the supply chain, especially within the downstream stages (including household consumption). As a result of these problems, the results of academic and governmental research are not very helpful in the development of a strategy to reduce food waste, while the public debate is thwarted by a sensationalist approach to the topic.

Therefore it can be stated that the established knowledge of the issue of surplus food and food waste is, in many respects, inadequate. Notwithstanding this fact, many companies and non-governmental organisations have acquired considerable expertise in
the management of surplus food and in the reduction of food waste over the years, even in Italy. In conducting the research presented in this book, we therefore decided to abandon the “macro”, top-down approach that characterises most of the literature. In other words, we iterated empirical analysis and theory building, and formulated the research model only following a comprehensive review of the differences between the players and between the stages in the supply chain. We then used this model to obtain quantitative estimates of the amount of surplus food and food waste generated in Italy. This approach made it possible to determine the factors that lead to the generation of surplus food, to identify the management practices that enable food waste reduction and to identify some socially responsible practices, which can benefit all players in the system.

Objectives and research design

The objectives of this book are the following:

- To improve our understanding of the reasons for the generation of surplus food and to identify surplus food management options at individual stages in the food supply chain, from agriculture and fishing to household consumption;
- To develop a replicable methodology for the assessment of surplus food and food waste (from social, zoo-technical and environmental perspectives) at both microeconomic (companies and households) and macroeconomic (country) levels;
- To quantify surplus food and food waste in Italy, at individual stages in the supply chain and for the supply chain as a whole;
- To provide empirical evidence regarding the most critical challenges and advisable practices for those (companies, non-profit organisations and public authorities) that are committed to developing strategies and policies to reduce food poverty.

With these objectives in mind, the research was conducted in three phases:

1. A general conceptual model was developed to describe surplus food and food waste at the various different stages in the supply chain from social, zoo-technical and environmental perspectives,
based on a literature review, interviews with experts and exploratory case studies.

2. On the basis of 30 exploratory case studies, the nature of surplus food, the reasons it is generated, and how surplus food is managed at each stage in the food supply chain, were described.

3. The model was used to obtain empirical estimates of surplus food and food waste on a national level, for each stage in the supply chain, and for segments within the stages of the supply chain. This involved the use of various empirical methods and analyses: more than 100 in-depth case studies at the manufacturing, retail trade and food service stages; interviews with experts and collection and processing of data from public and secondary sources for the agriculture and fishing stage; and a survey of a representative sample of 6,000 households, designed and conducted in collaboration with Nielsen Italia.

Definitions: surplus food, food waste and recoverability

The main topics of the research are surplus food and food waste. In Chapter 3, surplus food is defined as edible food products that for various reasons are not purchased or consumed by customers or people for whom they were produced, processed, distributed, served or purchased. The various sources of surplus food are have been meticulously identified and described in this book (Chapters 5-9). For example, within the upstream stages, surplus food may be generated as a result of errors in demand forecasting or qualitative flaws that reduce the perceived value of the product (aesthetic imperfections, damaged packaging, etc.). Or, at the consumption stage, surplus food may be generated as a result of behaviours such as infrequent shopping, purchases of indivisible packages, or impulse purchases. The end result is a surplus of food product that must be managed outside of the usual commercial and household consumption channels.

In Chapter 3, once surplus food has been defined and examined, the different ways to manage it are described and “food waste” is defined as the part of surplus food that is not recovered for human consumption (social perspective), for feeding animals (zoo-technical perspective), or for the production of goods or energy (environmental perspective). However, food waste does not include
manufacturing and processing scraps or surplus food redirected to secondary markets.

A key role in the analysis of food waste is played by the concept of recoverability, which is defined as the potential to make use of the surplus food for human consumption with “minimal” additional effort by supply chain players. The degree of recoverability depends on both the “intrinsic recoverability” of the product (i.e. the degree to which it can be consumed by a beneficiary without further management and/or intermediation) and on the “management intensity” required (i.e. the level of effort made by companies and intermediaries to maximise the surplus food available to final beneficiaries).

Methodology

The research methodology is described in detail in Chapters 3 and 4. As mentioned above, a variety of different methods were used in the research:

- A review of the economic, policy, management, and industrial engineering literature;
- 30 exploratory case studies and interviews with experts;
- Development of an empirically-grounded conceptual model that describes surplus food and food waste;
- More than 100 case studies relating to the manufacturing, retail trade and food service stages;
- Collection, processing and interpretation of public data and information from secondary sources relating to the agriculture and fishing stage;
- A survey of 6,000 Italian households, which were considered to be representative in terms of geographical location, income, composition and other household characteristics; the focus on households was made possible through collaboration with Nielsen Company;
- Use of the research results and official public data on the volume of business in the different sectors to obtain quantitative estimates of surplus food and food waste both overall and at a sectorial level.
During the initial development of the conceptual model, called ASRW (Availability, Surplus, Recoverability, Waste), key concepts and relationships and the scope of the research were clearly defined. This model, which is described in Chapter 3, mainly focuses on the management of surplus food from a social perspective as a means to reduce food poverty, but it also considers the financial and environmental impact of surplus food and its management on supply chain players as well as its impact on a broader group of stakeholders.

The conceptual model was further developed and refined based on exploratory case studies, which were carried out in the early stages of the research. As described in Chapter 4, these case studies were used to identify the supply chain stages and segments within each stage, to clarify the configuration of their logistics and production systems, to identify the main reasons for the generation of surplus food, and to identify the ways in which it is either recovered or wasted. The exploratory case studies involved both sector experts and managers at companies in the supply chain.

The use of the model in the assessment of the Italian food supply chain, described in Chapters 5-9, involved over 100 in-depth case studies, including interviews with operational managers at companies in the manufacturing, retail trade and food service sectors. The studied sample represents about 10% (in terms of sales) of each stage in the supply chain. Quantitative data on the percentage of surplus food and food waste, as well as information on the sources of surplus food, and on the options available for managing surplus food were obtained from the case studies.

Finally, the results of the case studies, the Nielsen survey, and the results of the data analysis for the agriculture and fishing stage were used to assess surplus food and food waste at the country level, at individual stages in the supply chain and for individual segments within each stage.
Summary of main results

The empirical findings for each individual stage in the supply chain are presented in Chapters 5-9, together with information on data sources and methodology. A summary of the main research findings for the supply chain as a whole is provided in Chapter 10.

The research reveals that there are various reasons for the generation of surplus food that differ according to the stage in the supply chain. For example, at the manufacturing stage, where the recoverability is higher, five main reasons were identified: reaching internal product sell-by date, product non-compliance with aesthetic standards, damaged packaging, product refusals, and returns of unsold product. Overall, surplus food generated in the Italian food supply chain amounts to 6 million tonnes per year (17% of consumption; see Chapter 10) but there is significant variation between the individual supply chain stages. As shown in Chapters 5-9, the percentage of surplus food is highest in the food service industry and in households; it is moderate at the agriculture and fishing stage and in large-scale retail; it is lowest at the food manufacturing stage.

Today, most surplus food becomes waste from a social perspective (5.5 million tonnes/year, or 93% of surplus food and 16% of consumption; see Chapter 10). According to the definition provided previously, food waste from a social perspective means surplus food that is not recovered for human consumption. Only a small part of surplus food is donated to food banks and charitable organisations. The magnitude of food waste differs between individual stages in the supply chain and within different categories of products due to varying degrees of recoverability (Chapters 5-9): in the agriculture and fishing stage, in the food service industry and in households, as in retail trade, a significant proportion of the surplus food generated is wasted; the significance of food waste from a social perspective is much lower at the industrial manufacturing stage.

In addition to the assessment of surplus food and food waste, another objective of the research was to provide qualitative factual information to those who are interested in adopting and disseminating responsible surplus food management practices from a social, zoo-technical or environmental perspective. As the results
presented in Chapters 5-9 show, more systematic attempts to reduce food waste are found where the degree of recoverability is higher, i.e. at manufacturing companies. However it should be noted that a range of behaviours is observed even at this stage in the supply chain. While 35% of surplus food generated by manufacturing companies is donated to food banks or charitable organisations all over the country, 32% of surplus food products are still sent for disposal. The reasons behind company choices, given an equivalent degree of surplus food recoverability, are various: residual value of the surplus food; concerns about company image; how the surplus food is generated; management expertise; capabilities of available firms.

Observations and Recommendations

Chapter 11 discusses the implications of the research for companies, policy makers and citizens.

First, it was found that the implementation of good surplus food management practices is more widespread among manufacturing companies, the stage with a higher degree of recoverability, where there are already successful food waste reduction schemes and collaborations with experienced non-profit organisations. The priority within this stage is therefore to raise awareness of the features and benefits of responsible surplus food management practices and to increase their implementation through incremental innovations in the logistics-production process. Secondly, it is important to recognise that there is still a lot of work to be done in the other commercial sectors (agriculture and fishing, retail trade and food service). In these areas, where surplus food recoverability is lower, investment is needed at the system level. The supply chain players need to collaborate with each other and with non-profit intermediaries, such as the food banks, in order to identify the issues that are most critical at the system level and to look for new organisational and technological solutions that are also economically sustainable. Policy-makers, administrations and governments are called upon to promote policies that encourage such innovative efforts. In order to do so, the design and implementation of systematic monitoring and the ex-post evaluation of surplus food management practices is
needed; it should then be possible to evaluate, and then to implement on a broader scale, appropriate regulations that provide a range of incentives to companies that adopt responsible behaviour. Finally, the consumer represents a formidable challenge with respect to food waste reduction, although it should be noted that it is standard behaviour in many Italian families to limit the generation of surplus food by using food products before they expire and making use of leftovers. In this respect, additional efforts are needed to increase awareness among families about adopting more efficient shopping habits, and among companies in the manufacturing and retail trade sectors to come up with solutions that encourage these habits, for example in fields like packaging and commercial promotions.

From a policy and scholarly point of view, this research represents a valuable source of information for those who are interested in the sustainability of the food supply chain. We believe that this research presents the scientific and institutional community with a methodology that can be replicated on an international scale and over time, by describing the surplus-waste phenomenon in detail and distinguishing between surplus food and food waste that has a higher “social value”. Two other valuable products of this research are the quantitative assessment of surplus food and food waste both for Italy overall and at the sectorial levels, and the identification of socially responsible surplus food management practices. In conclusion, the empirical results demonstrate that, even in a developed economy like Italy, significant efforts are still needed to reduce food waste and to make use of surplus food to alleviate food poverty. The case studies provided valuable information regarding which strategies and actions are more likely to lead to the achievement of this goal. The result is a meaningful volume of knowledge and a significant amount of operational, business and institutional expertise that can be shared with all the stakeholders in the food supply chain.
Acknowledgements

This project would not have been possible without the collaboration of our two research partners. We would like to thank the non-profit food bank Fondazione Banco Alimentare ONLUS for having shared with us their unique knowledge of the characteristics of surplus food and the ways in which it can be managed to support those that have made a commitment to helping the poor on a daily basis and to help to combat food waste. We gratefully recognise Nielsen for taking part in this research effort, for sharing with us their wealth of knowledge about Italian household food consumption, and making it possible for us to acquire high quality information on this very important segment by conducting an ad hoc survey.

Moreover, we would like to acknowledge the contribution of the numerous companies and organisations in the food sector that agreed to participate in the case studies. In particular, we would like to thank the managers and directors who consented to long and repeated interviews with us, graciously sharing copious amounts of detailed information regarding production and logistics processes. For her diligence and her active role in the work of gathering and processing information and presenting the research results, we would like to express our sincere appreciation to Miriam Pollo. We are also truly grateful to Angela Frigo and Anna Mason for their dedicated efforts to produce a translation that conveys the concepts and research results very effectively in English.

Finally, a sincere thank you to those who financed the research and research-related activities, demonstrating their belief in the project and granting complete autonomy to the researchers involved. The contribution by Nestlé and Mediafriends Foundation made it possible for young scholars to participate in the research program, which made a significant contribution to the successful outcome of the research.
This book is part of the broad and complex debate on the issue of food poverty and on the benefits of recovering the surplus food produced at the various different stages in the food supply chain.

In general, issues related to food production and consumption are becoming more prevalent in the media, at scientific meetings, and in public and non-governmental agency reports. The origin of much of this interest is the recognition that, on a global level and especially in richer countries, food poverty represents a classic example of the “paradox of scarcity in abundance” (Campiglio and Rovati, 2009; see also Winne, 2008). In other words, a large part of the debate revolves around the challenge represented by the fact that entire countries and individual social groups are in a situation of hunger or “food insecurity”, with limited access to a sufficient amount of food for a healthy and active life, while the overall quantity of available food and food products should be sufficient to fulfil everybody’s needs. The issue of surplus food attracts the attention of many observers precisely because it represents a sign of abundance. However, there are other related aspects that are pertinent to the discussion of this topic. In rich countries, for example, the public debate deals with issues such as the environmental impact of the food supply chain, food quality, food safety and ways to reduce risks in the food supply chain (e.g. certification and labelling), changes in eating habits and the spread of food-related illnesses, and the
rediscovery of food-related traditions. But when taking a broader view of the situation, taking poor countries and the need to feed the growing world population into consideration, the most pressing issues are improving agricultural and zoo-technical productivity and new technologies, the effectiveness of international aid and the need to improve the efficiency of world markets for agricultural commodities.

A comprehensive review of the different perspectives that inspire the debate on food and the food supply chain is beyond the scope of this book. Nevertheless, a selective and critical review of the ideas put forward by the media and in the literature in this area was used to identify issues that, although interesting, will not be addressed in this book, thereby defining the scope of the research. This review helps to underscore why the objectives of the research – to assess surplus food and food waste in a developed country like Italy and to identify ways of managing surplus food that can reduce food poverty (see Introduction) – are important.

In conclusion, this chapter outlines the purpose of the study by providing some information on food poverty globally and in Italy and reviewing some of the more interesting points raised in both the scientific and media debates. Relevant information from the scientific literature that was used in the development of the conceptual model and to determine the study methods is presented in Chapter 2.

1.1. Food poverty: the global situation

The FAO – the United Nations’ Food and Agriculture Organization – estimates the number of undernourished people, meaning those whose food intake regularly provides less than the minimum dietary energy requirement, for different countries (FAO, 2011). For the three year period from 2006-2008, the FAO estimated that there were 850 million undernourished people, or 13% of the world population; more specifically, 33% of the population in the poorest countries and 12% of the population in developing countries were undernourished. The FAO also provides information on diet composition (presence of the major food groups: carbohydrates, proteins and fats) and on problems related to poor nutrition
The debate on food poverty and the recovery of surplus food

(underweight, overweight, obesity), with differing levels of detail and different revision dates for different countries. In general, low levels of protein in the diet and high percentages of underweight people are observed in countries in which there is a high probability for undernourishment in the population.

The issue of food poverty is not, however, an issue only in poor and developing countries. Again, the FAO statistics show that for the period from 2006-2008 three million people in the European Union were undernourished, although the number of undernourished people in higher-income European countries is “not statistically significant”. Nonetheless, many citizens in the richer countries are affected by food insecurity. In 2010, 6.9% of Italian citizens and 8.1% of European citizens experienced at least four of the nine living conditions that indicate a “severe material deprivation”, including the lack of a meal containing protein at least every two days (Eurostat, 2012). According to Nord et al. (2011), in 2010 14.5% of American households experienced at least a few days of food insecurity during the year, while 5.4% of households suffered serious food insecurity. The issue of food poverty in Italy will be discussed further in section 1.2., referring to research carried out by the Fondazione per la Sussidiarietà edited by Campiglio and Rovati (2009).

What are the underlying factors behind the hunger and food insecurity that affect a portion of the global population? This is the subject of extensive research in the areas of agriculture, food science, agricultural economics and development economics (for a recent overview, see the special issue on “food security” in Science magazine, Ash et al., 2010). Even a brief review of the results in this research area is beyond the scope of this book; given the purpose of this chapter, and for simplicity, information and analysis from a recent report in The Economist (2011) are presented. The report, which discusses the issue of “feeding the world” in an informative manner, and from different perspectives, includes some interesting ideas, which are presented below.

First, the Economist report identifies research and capitalising on the opportunities presented by new technologies as pivotal factors in satisfying the food demand of a population that is forecast to reach 9 billion in 2050, despite constraints on the availability of water and
land. As in the past, an increase in agricultural productivity is an essential part of the solution to the problem of feeding the world over the long term; in order to achieve this, and in the interest of world food security, concerns voiced in some quarters that innovative agricultural and zoo-technical production techniques pose a threat to the environment, food quality and food safety will need to be addressed and overcome.

Secondly, the report examines recent price increases in agricultural commodities markets, which obviously create a barrier to procuring food for the poorest. The crises that occurred in 2007-2008 and 2010-2011 are not a reflection of an underlying trend caused by increasing demand from industrialising countries; at the moment, China and India in particular import a relatively small quantity of food. The rising cost of agricultural goods is primarily a result of fluctuations contingent on supply, related to drought or floods in producer countries. A temporary contraction in supply can have disastrous effects in terms of price increases when added to the choice by some producer countries to freeze exports and, reciprocally, the choice by some importing countries to stockpile food products, both with the objective of safeguarding their own food supplies. Another set of political decisions also contributed to creating the crises. Environmental measures related to climate change, such as targets and subsidies for the production of energy from renewable sources, have led to a reduction in food production capacity. Specifically, measures that support the use of biofuels such as ethanol produced from maize in transportation or the production of electricity and heat from biomass, which have been adopted by several countries including the United States and the European Union countries, encourage the conversion of crops and land, to the detriment of agricultural production for the purposes of food consumption.

One final area studied is the mismanagement of surplus food, including food waste. The report states that 30-50% of the food produced globally does not get consumed. In poor countries most food waste occurs on or near the farm, where rats and other animals feed on crops in the fields or in storage, and milk and vegetables spoil in storage or in transit. About half of these losses could be avoided by building silos and providing more refrigeration,
potentially recovering 15-20% of production. Rich countries such as the United Kingdom and the United States waste roughly 100 kg of food per person per year; if half of this food could be distributed to poor countries, the problem of how to feed the 9 billion people in the world would be resolved.

Methodological issues are discussed later on in this chapter, and in more detail in Chapter 2, explaining why many measures of “food waste” reported in the media are unreliable. At this point, however, it is important to point out that The Economist report states that the distribution of unconsumed food from rich to poor countries is not feasible in practice, suggesting that the focus should instead be turned to developing markets, reducing “political interference”, and improving technology in order to tackle the global issue of food poverty.

1.2. Food poverty in Italy

As mentioned previously, the issue of food poverty in rich countries differs from that in emerging or developing countries.

The FAO states that the number of undernourished people in Italy is “not statistically significant” (FAO, 2011). However, as shown by Accolla and Rovati (2009) in research conducted by the Fondazione per la Sussidiarietà that was based on ISTAT data, in 2007, 4.4% of families living in Italy (1,050 million households, or approximately 3 million people) were unable to achieve a balanced diet or sufficient food intake. This finding was based on a comparison with the “food poverty line”, which the study determined for various socio-demographic groups; for example, nationally, the average threshold for a family of two was represented by an outlay of €222 per month on food and drink. The problem was found to be especially critical in the regions in Southern Italy, and in large families, single parent families, and elderly households. For the most part, these people do not suffer from hunger but their diet is of low nutritional quality, which can have serious consequences on physical and cognitive development, especially for children and young people.

Since the Italian food supply chain is the empirical setting of this book, the information reported is based on the Italian context. However, the situation that is described is typical of other advanced
economies, and shows that even in Italy, as in other rich countries, there are people who experience significant food insecurity issues. Some things that can be done to help these people to escape from this type of situation will be outlined later in this chapter.

1.3. Tonnes of food in the bin?

Even in rich countries like Italy, therefore, the issue of food insecurity is serious for a significant number of individuals and families. For this reason, newspaper articles and radio and television programmes frequently report on food waste.

In 2009, the headline in a major Italian newspaper proclaimed “Christmas: 40% of food will be wasted”, and the article continued by saying that “research … reveals that 40% of purchased food ends up in the rubbish bin. […] especially now as the Christmas holidays approach, a call for moderation is clearly needed. […] in Italy 6 million tonnes of food that is still edible is disposed every year … 5% of purchased bread, 18% of meat, and 12% of fruit and vegetables”. In 2012 another leading Italian newspaper reported that “Italian households waste an average of 17% of purchased fruit and vegetables, 15% of fish, 28% of pasta and bread, 29% of eggs, 30% of meat and 32% of dairy products”. Most recently, in April 2012, the findings of a study carried out by a prominent producers association were published. According to their press release, in Italy “food waste results in the annual loss of an estimated 37 billion euros, or enough food to feed 44 million people”.

The food poverty situation, regardless of the number of people involved, is serious. Therefore it is fitting that the media raise the issue of the failure to make use of surplus food for social purposes, at least in situations where the recovery of edible surplus food and its distribution to those in need is feasible. Although it is important to report on this issue, the repeated use of expressions such as “tonnes of food in the bin” appears to prevail over the reporting of articulate and justifiable data, despite the obvious need for clarity. Do Italian households really throw away 18% of purchased meat? Or even 30%? And do Italians, i.e. around 60 million people, waste enough food to feed 44 million people? If so, then who within the food supply chain is responsible for this behaviour? Is a country like
Italy, where memories of poverty still persist, where frugality and exemplary behaviour regarding the reuse of leftovers and voluntary commitment to helping the community’s poor were once habitual, today a country full of “profligates”? 

As will be shown in more detail in Chapter 2, there are various different definitions of “food waste” in the scientific literature and the indicators used to evaluate it were developed using a range of different methodologies, which are not without flaws and weaknesses. Barely a mention of this complexity is reported in the media, which, for the most part, report the more sensational data and neglect to explain clearly whether the waste referred to includes only edible food products or also scraps, and what sources and methods of analysis were used. Above all, the business, commercial and household processes that lead to the creation of food waste receive very little attention, making it difficult to appreciate the full extent of the problem, its causes and the potential solutions. 

The seriousness of the issue, and concerns about how it is presented in the media, mean that a rigorous quantification of surplus food, a comprehensive analysis of the factors that lead to its generation, and a detailed examination of the ways that it can be distributed to people suffering from food poverty are needed, both for Italy and for the individual stages of the food supply chain. These are the main objectives of this book. 

Before continuing, it is worth pointing out that a significant cultural and social movement, which presents itself as an alternative to the deterioration of modern food culture, has spread to many developed countries, starting with the United States, a country that traditionally and for various reasons has consistently experienced problems related to food waste. As described by Winne (2008, pp. 110-148), there is a growing awareness of the risks of consuming “junk food”. Farmers’ markets and community gardens are growing in popularity, together with the increasing consumption of locally produced and organic foods, in reaction to a rise in the prevalence of diseases such as obesity and diabetes, with the hope of reclaiming some of the intangible benefits obtained from a quality diet. This is a very interesting development, of which there are also signs in Italy. Aside from some élitist and “fad” aspects, it demonstrates that informed food education, which is also fundamental in the
reduction and management of surplus food within households, is making a comeback. While waiting for the broader impacts of this trend to become apparent, it is also important to understand current consumer behaviour regarding the use of surplus food in households, a topic that is discussed in Chapter 9.

1.4. The recovery of surplus food: myopia or opportunity?

Some factors that could contribute to reducing global food poverty were mentioned in the first part of this chapter. In this respect, it is clear that the means for using the surplus food produced by rich countries in a meaningful way in response to the tragedy of hunger and malnutrition in the poorest parts of the world are not available, at least in the short to medium term. However, the question about the relationship between the management of surplus food and the reduction of food insecurity within developed countries such as Italy remains unanswered.

To better understand whether, under certain conditions, the recovery of surplus food could be an essential component of the strategy to reduce food insecurity in more developed countries, it is important to address a common criticism of organisations, like food banks, whose function is to channel the surplus food from the manufacturing and sale of food products toward poor people. A book on the “food gap” in the United States presents the hypothesis that the recovery of surplus food for social purposes should be considered as a secondary strategy because other types of intervention would be more effective (Winne, 2008). This analysis is particularly interesting, not only because the author is an eminent exponent of the American food movement. The United States has a long tradition of public programmes and private social services aimed at reducing food poverty. In addition, many trends that originated there subsequently spread to other countries over time, including the development of the modern food industry and of large-scale retail, the sale of “zero kilometre” food products, the spread of community gardens, and the success of organic food products, all of which are described in the book.

Food banks in the United States expanded significantly at the
beginning of the 1980s in response to the failure of several federal food assistance programmes, and achieved a series of successes (Winne, 2008, pp. 21-36 and 72-74). However, their growth had two negative side-effects, according to Winne.

On the one hand, food banks promoted “co-dependency” between the demand by the poor for the distribution of food and the supply of surplus food by companies in the food supply chain. The former are content to receive free food, while the latter prefer to donate surplus food rather than eliminate profitable but socially inequitable practices such as the production of cheap food of low nutritional value, concentrating food retail outlets in wealthy areas, and so on (Winne, 2008, pp. 75-81). Moreover, companies then lobby for subsidies and financial benefits in return for donations. On the other hand, the food banks “diverted” the public and the policy-makers’ attention and commitment away from the need for public services to deal with food poverty, thereby redefining popular culture and policy on this issue. Due to the development of food banks, the number of policies whose fundamental purpose was to resolve the issue of food insecurity affecting a part of the population slowly decreased (Winne, 2008, p. 72).

In summary, Winne’s basic thesis (Winne, 2008, pp. 149-182) is that food banks are useful organisations for dealing with emergencies, but that in a rich country such as the United States the priorities are social policies to reduce poverty and promoting a new food culture. Food banks should embrace some of the goals of the broader food movement, such as overcoming the excessive industrialisation of food production or food education, and lend support to welfare measures such as the minimum wage or the creation of a national health system.

It is true that Winne’s arguments and findings relate to a specific context. Social policies in Italy and Europe have been subject to less dismantling in previous decades than those in the United States. Furthermore, there is generally a stronger informal support network which starts with the family, and the culture of “good nutrition” has deeper roots in most European countries. Nonetheless, consideration of the more general points raised by Winne and other critics of the recovery of surplus food for social purposes helps to illustrate the rationale behind, and the objectives of, this book.
First of all, it is impossible to avoid some degree of co-dependency between poverty and donations of surplus food, just as it is impossible to avoid the fact that the existence of food banks will have an influence on surplus food management processes. Nevertheless, if a certain level of surplus food proves to be intrinsic in some segments and, therefore, unavoidable, morally it would appear to be important to recover it and to prioritise its use toward the reduction of food insecurity. It should also be noted that the European Parliament and the Council of the European Union, with the Waste Framework Directive, and other agencies such as the United States Environmental Protection Agency, and the Department for Environment, Food and Rural Affairs in the United Kingdom, promote a balanced approach to the allocation of surplus food, the so-called “food waste hierarchy.” In descending order of priority, the following channels are available to companies in the food industry to make use of surplus food (Chapter 2 and Chapter 11): reduction of surplus food at the source, feeding humans, feeding animals, industrial uses, composting, and disposal.

In order to establish whether the recovery of surplus food and its use to assist the poor results in a net collective benefit, Chapters 5-9 carefully examine the factors that lead to the generation of surplus food and the components of the surplus that are less easily reduced at the source. These chapters also present a comprehensive analysis of the different ways in which surplus food is managed by the various supply chain players, from the agriculture and fishing sector through to household consumption.

Secondly, Winne maintains that more attention needs to be paid to welfare and food assistance policies in place of widespread reliance on charitable organisations and food banks to recover surplus food. These charitable organisations should only be involved when dealing with emergencies. While in no way minimising the importance of public policies for poverty relief, it should nonetheless be determined whether using surplus food for this purpose has some unique advantage.

In Italy, the system for recovering surplus food to support the poor is based on a network of non-profit organisations. This network includes intermediaries that specialise in the recovery of surplus food – food banks like the Banco Alimentare – and organisations
The debate on food poverty and the recovery of surplus food

that assist the poor directly – charitable organisations; the latter may be self-sufficient in the procurement of food supplies, but more and more frequently receive surplus food from food banks. This system is clearly subsidiary in nature, which differs from that in other countries. For example, in the United States, many food banks provide assistance to the poor first-hand (Winne, 2008, pp. 75-76). There are many advantages to a system like Italy’s. As shown by Lunghi (2009), Pesenti (2009), and Rovati (2009a) in the first comprehensive study on food poverty in Italy, the approximately 8,000 charitable organisations affiliated with the food bank network are able to reach a very diverse group of people in need. Their widespread presence throughout the country, their ability overcome cultural and psychological barriers through interaction with needy people and their ability to follow through over time, represent the basic elements needed to address this issue effectively over the long term.

In other words, the framework of charitable organisations is able to recognise, reach and serve the need very effectively, supported in this task by the food banks, which act as intermediaries. It therefore appears to be possible to refute Winne’s theory on the general superiority of public intervention in reducing food poverty, at least where Italy is concerned. Rather, the consideration given in this book to food banks and charitable organisations as surplus food “management channels” appears to be justified.

1.5. Contribution to knowledge

Some of the ideas presented recently in the media and by experts on food poverty and surplus food were discussed in this chapter, following the presentation of some information on global under-nutrition and food insecurity. The different perspectives on this debate were presented selectively, as the primary purpose was to explain the specific objectives of this book and its intended contribution to knowledge in this area.

First of all it should be underlined that this book is not intended to address the serious issue of global hunger and food insecurity, particularly in less developed countries. Nonetheless, some information is presented on the extent of the problem in poor and
developing countries as well as in richer countries such as Italy.

The book also provides some insights about the complexity of potential solutions and the possibility that a more efficient food supply chain, which incorporates appropriate management of surplus food, could contribute to the fight against food poverty. In this respect, it has been assumed, similarly to other studies, that the process of generating and managing surplus food in a rich country like Italy is unrelated to reducing hunger in less developed countries, at least for now.

This book is also intended to address the alarm raised by the media with respect to “food waste”. There appears to be an inclination toward sensationalism in the reporting of food waste indicators, which is not backed up with information on the methodological basis of the data, on the nature of the surplus food at different stages in the supply chain (specifically, on what portion can actually be used to feed humans), on the corporate and domestic practices that lead to the generation of surplus food, or on the ways of distributing it to those who suffer from food poverty. There is clearly an urgent need for a methodologically based assessment of surplus food in developed countries like Italy both overall and at the individual stages in the food supply chain, including an analysis of the reasons for its generation. At the same time, detailed research into the effectiveness of the various methods of managing surplus food is needed pertaining to the agriculture and fishing sector, food manufacturing companies, retail trade, the food service industry and households. This is the only way to thoroughly characterise and identify the full extent of “food waste” in Italy.

Finally, attention was focused on food banks and charitable organisations as the potential recipients of surplus food. This approach was confirmed following an appraisal of some of the possible objections to using the surplus food generated in the supply chain to support people in a condition of food poverty. In brief, some experts maintain that direct government intervention, through specific food assistance programmes and general social policies, would be more effective than reliance on food banks and charitable organisations. While recognising the important role of public intervention in relieving and reducing food poverty, in Italy there are arguments and data that demonstrate the effectiveness of the
network used to distribute surplus food to the needy, which includes food banks like the Banco Alimentare and charitable organisations all over the country.

The following chapters present the conceptual model that describes the processes that lead to the generation of surplus food and how it is managed at the individual stages in the food supply chain, the methodologies used to implement this model and the results obtained: a quantitative assessment of surplus food; identification of the various sources of surplus food; a review of surplus food management options, including recovery for social purposes; and finally, a quantitative assessment of “food waste”.
This chapter presents a summary of the findings published in the scientific literature that were the starting point for this research study. Articles and reports in various disciplines such as management, environmental studies, public policy analysis, industrial engineering, agricultural sciences, agricultural economics and development economics were reviewed; but all relate to the concepts of food security, i.e. the adequate availability of food for people, and sustainability of the food supply chain. Therefore, this chapter first presents the objectives of, and key issues in, these two areas of research. Secondly, it summarises the definitions of surplus food and food waste presented in the various studies. It then describes the methodologies used to assess surplus food in these studies, identifying both their strengths and their weaknesses. Finally, following a summary of the different ways of managing surplus food identified in the literature, the chapter presents and compares the available estimates of surplus food.

It is important to note that a number of different definitions of food security and food supply chain sustainability have been presented in the literature, not all of which are applicable to the characterisation of the phenomena of surplus food and food waste with respect to the fight against food poverty. For this reason, the definitions used in this book will be clearly outlined and defined in Chapter 3.
2.1. Food security

Since the 1970s the scientific literature has dealt with the issue of surplus food in relation to food security, which is defined as the availability of enough food, whether it be at the global, national, community, or household level (Pinstrup-Andersen, 2009).

Analysis of the issue at a global and national level often focuses on the upstream stages of the supply chain, that is, on food production. However, ensuring adequate food production does not guarantee the consumer’s food security for two reasons: downstream stages in the supply chain may not be sufficiently well-developed, or the nutritional content of the food itself may be insufficient. In light of these issues, in 1996 the FAO (United Nations’ Food and Agriculture Organization) determined that food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Research into food quality led to the development of a specific area of study dedicated to “food safety” (Trienekens and Zuurbier, 2008). A large volume of work dealing with tracking and control of food products falls into this area.

Addressing the issue of food security with respect to individuals often means examining welfare policies, in which the recovery of surplus food is seen as a way provide food to those who need it and to solve the problems related to distributing the available food (Parfitt et al., 2010). Studies of food recovery initiatives by governmental organisations and care facilities (Tarasuk and Eakin, 2003), and the comparison between the different forms of assistance, also fall within this ambit.

2.2. Sustainability of the food supply chain

A second area of research relates to the debate on sustainable development (Bates and Phillips, 1999). Since the 1980s, sustainable development has become an objective for governments and NGOs, which have produced numerous and varied definitions (Aiking and de Boer, 2004; Langhelle, 2000; Van Marrewijk, 2003). The World
Commission on Environment and Development defines sustainable development as follows: “to ensure that development meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987).

It should be noted that most scientific works emphasise the issue of inter-generational equity and consequently focus on the question of environmental protection. Even food issues are approached from an environmental perspective, for example by considering the environmental impact of waste (Levis et al., 2010). A Life Cycle Assessment (LCA) approach is often used, which means assessing the environmental effects of a product throughout its life cycle, including all the supply chain processes that impact on the environment in the analysis, from the use of raw materials to the disposal of finished products (Hagelaar and Van der Vorst, 2001). For example, Cuéllar and Webber (2010) estimated the energy required to cultivate, produce, transport, store, sell and prepare foods and the energy “stored” in wasted food.

The issue of intra-generational equity however seems to be overlooked to a certain extent (Steiner and Posch, 2006), although the importance of considering the relationships between economic, environmental and social issues, such as human rights, corruption and poverty is often mentioned (Lozano, 2008). At the moment, the social perspective enters the picture only indirectly, specifically in discussions about the implications of the different surplus food management options for individual companies. The social side of a company’s sustainability relates to its impact on the social context in which it operates and its relationships with various stakeholders (Labuschagne et al., 2005; Labuschagne and Brent, 2008). In keeping with this perspective, more effective management of food products can support a company’s “Corporate Responsibility Strategy” (CRS). For example, in a review of the CRS section on “health and safety” for companies in the food supply chain, Maloni and Brown (2006) emphasised that, although it is not their responsibility to find a solution, companies can potentially play an important role in resolving the problem of food insecurity.
2.3. What is surplus food?

There is no consistent definition of surplus food in the literature. Although this concept would appear to be intuitive, it is subject to differences in interpretation. For example, do all food products that are not harvested, sold or consumed qualify as surplus food? Or, within this group, should only edible and wholesome food be considered to be surplus food? Or, should that which is not initially used, but is later recovered in some way, be considered as surplus food? This uncertainty has repercussions on the effort to define the related concept of food waste. On the other hand, even official definitions need to be “operationalized” in order to analyse the phenomenon. These difficulties have been an issue since research first began on this specific topic (Singer, 1979).

Two expressions which are used in the literature in reference to surplus food in the main empirical studies are: food waste (Griffin et al., 2009) and food losses (Kantor et al., 1997). The first expression refers to food products that are “discarded” at the various stages in the supply chain with no distinction between edible and inedible products. The second expression appears to be more relevant for studying the issue of food security; it refers to edible products that get “lost” at different stages in the supply chain, i.e. they are not sold or consumed by those for whom they were produced. In reference to food waste, including edible and non-edible surplus, in their analysis of the food production process, Darlington and Rahimifard (2006) made a distinction between “waste” from finished products and production waste, which included process waste, but did not take into account its suitability for consumption. However, in some cases the term is used with a different meaning. Griffin et al. (2009) considered food lost at every stage in the supply chain, including crops damaged during harvesting, food damaged during transport and food discarded and mixed with other wastes, i.e. food losses that are not necessarily edible. Food waste is referred to in many studies but without explaining the meaning of the term, leaving it open to interpretation (e.g. Lundie and Peters, 2005).

Examples given by Kantor et al. (1997) to illustrate food losses, that is food products that are edible but are not suitable for the usual commercial and consumer channels, include products that cannot
be marketed for aesthetic reasons and food that was not served in the food service industry. The portion of products that is inedible and unsuitable for human consumption is excluded (Tarasuk and Eakin, 2005). Table 2.1 illustrates the difference between edible and inedible food products.

Table 2.1. Edible and inedible surplus food: some examples (adapted from Kantor et al., 1997)

<table>
<thead>
<tr>
<th>Edible surplus food</th>
<th>Inedible surplus food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unharvested edible fruits and vegetables</td>
<td>Diseased livestock not slaughtered</td>
</tr>
<tr>
<td>Products that are unmarketable for aesthetic reasons</td>
<td>Products that are unmarketable for health reasons</td>
</tr>
<tr>
<td>Unsold fresh fruit and vegetables from wholesalers and markets</td>
<td>Perishable products that have spoiled, such as meat and dairy products</td>
</tr>
<tr>
<td>Products that cannot be sold at retail stores due to packaging issues</td>
<td>Food processing wastes, such as meat bones</td>
</tr>
<tr>
<td>Cooked or perishable food in the food service sector that remains unsold</td>
<td>Leftover food on plates in the food service industry</td>
</tr>
</tbody>
</table>

2.4. Research methodologies

With the possible exception of agriculture (crop and livestock farming), for which detailed data are available for various countries, the assessment of surplus food is very difficult and has led to the development of different approaches, often using a combination of methods (Hall et al., 2009), depending on the scope of the study (food losses or food waste).

a. One methodology applies to the analysis of urban waste (Hall et al., 2009). A sample of waste is analysed, identifying the percentage of food products present and, from there, the percentage of edible products. These percentages are then applied to official waste collection statistics. Rathje (1991)
and Rathje and Murphy (1992) used this method to determine that every person produces approximately 140 g of edible and inedible surplus food (i.e. food waste) per day. This equates to a total quantity of approximately 50 kg per year, half of which is edible (i.e. food losses).

b. Another methodology used in the assessment of surplus food involves the use of the inferential method for individual stages in the supply chain (e.g. retail trade). Production volumes are obtained for each stage from national statistics and government reports (Griffin et al., 2009; Kantor et al., 1997). Annual production is expressed in terms of quantity; if the production volume is expressed in terms of monetary value then it must be converted into a quantity. A coefficient, which expresses the fractions of edible and inedible surplus food generated as a percentage, is applied to the annual production volume. In most cases coefficients developed by third parties are used. For example, based on studies by the Economic Research Service, Kantor et al. (1997) stated that 7% of products grown in fields in the United States are not harvested and can be considered as food loss. Griffin et al. (2009) used the same percentage to quantify the phenomenon of surplus food in agriculture in a specific county. The fact that the sample used by the reference source is not explicitly described is problematic, and means that applying the coefficient to a different population from the one analysed is questionable. Furthermore, many of the coefficients identified in these studies refer to periods in the past; for example, in an analysis of post-harvest food losses, Parfitt et al. (2010) used coefficients from a study conducted fifteen years previously (Blond, 1984). When these coefficients are not available in the literature or when a more exhaustive analysis is needed, interviews with experts or representative samples of the population are used. The sample used is not usually very large (Griffin et al., 2009). For example Mena et al. (2011) conducted 43 case studies in an analysis of the manufacturing and retail trade stages. In WRAP (2010) four case studies were conducted in a study of the retail trade stage.

c. A third methodology involves the calculation of production volumes at the various stages in the supply chain based on
agricultural production volumes. An example is the recent study by Gustavsson et al. (2011). The percentage of food losses at each stage is derived from third party sources, then used to estimate the quantity of unused food product at each stage (edible and inedible) and to estimate the production volume at the next stage.

It should be emphasised that, in order to avoid skewing the estimates, regardless of the methodology used, each stage in the supply chain is usually analysed independently (i.e. manufacturing, retail trade, and household consumption) and the stages are often further broken down into product categories. For example, WRAP (2010) studied the phase that involved the physical distribution of goods (including transportation and storage by distributors) independently of the in-store sales phase. In another study, Mena et al. (2011) divided the products into three categories: products stored at ambient temperatures, refrigerated products, and frozen products.

Finally, it should be noted that the role of the different reasons for the generation of surplus food is not assessed quantitatively in the available empirical studies. Mena et al. (2011), for example, described the main reasons for the generation of surplus food in the manufacturing and retail trade stages in a qualitative manner: a lack of shared information, forecasting difficulties (especially for promotions), errors in cold chain management or in product handling and a strong focus on quality.

2.5. Options for managing and reclaiming surplus food

Quantities of food waste are also a function of how surplus food is managed; appropriate management reduces the amount of surplus food that becomes waste. It should be noted that surplus food can be recovered in several ways.

One solution is to collect it from the fields, from manufacturing companies, from retailers and from food service providers for distribution to the needy. For example, some years ago Kraft Canada initiated the “National Product Return Program” which results in the automatic donation of products refused by retailers.
Specifically, products are redirected to the charitable organisation located closest to the delivery site (Cooper, 1997). Two important issues related to the collection and redistribution of food products that are discussed in the literature are those of liability for the safety of donated products, specifically with respect to perishable products and ready meals (Thang, 2009), and their nutritional value (Hosington et al., 2011). Along with these initiatives, it was found that attempts have been made to create secondary markets for the discounted sale of food products resulting from overstock or those with damaged packaging (Thang, 2009).

As proof of the value of using surplus food to assist the needy, Eikenberry and Smith (2005) reported that approximately 18.6% of a sample of American households affected by food insecurity had received assistance from charitable organisations, many of which are supported by food banks. Due to the variable quality of the surplus food donated, food banks usually perform an initial selection in addition to packaging, storing and distributing food products (Winne, 2005).

Surplus food that is not recovered for human consumption can be used for other purposes, including feeding animals, or in industrial processing or composting. More specifically, the surplus food can be used to produce other food products (e.g. overripe apples can be used to produce marmalade), animal feed, energy or biofuel (Kantor et al., 1997). It should be noted that some food scraps can be processed using industrial methods for the management of edible surplus; for example, apple peels can be used to produce vinegar (Hang, 2004).

Food products that are not recovered must be disposed of as waste either by incineration or in landfills. Disposal costs for incineration are higher than landfill disposal costs. In the United States, the ratio is about two to one: it costs $69.40 to incinerate a ton of waste, while it costs $35 to send a ton of food waste to landfill (Heller and Keoleian, 2003). In some countries food waste can be disposed at a household level using a Food Waste Processor (FWP), an appliance that combines waste and electricity to grind organic kitchen waste and dispose it in the waste water (Lundie and Peters, 2005).

It is not always economically or logistically feasible to recover food products because the level of effort needed to reclaim them
Surplus food in the scientific literature

may be too great. Singer (1979) and Kantor et al. (1997) pointed out that reducing wasted surplus is possible and desirable but that the cost effectiveness of potential solutions needs to be evaluated. The options are often evaluated from an environmental point of view. For example, Ohlsson (2004) compares the different ways of managing food waste through Life Cycle Assessment. Finally, it has been suggested that in some cases donation may be more affordable than disposal (Thang, 2009).

Despite these findings, there has been little research to-date on the cost impact of the different ways of managing surplus food for individual players in the supply chain.

In this respect Johnston and Green (2004) stress the need to create a hierarchy of methods for managing surplus food, that does not consider only the economic aspects but favours the donation of surplus food to the needy.

Although many studies identify different management options, few describe the level of adoption of the different alternatives in a quantitative manner (Heller and Keoleian, 2003). The exceptions to this are Kantor et al. (1997), Garvin et al. (2000) and Griffin et al. (2009), who have estimated that between 3% and 5% of food production is recovered for human consumption in the United States.

Finally, there are various projects at the government level whose purpose is to improve the management of food products in the food supply chain with a view to making it more sustainable, as shown by “food waste hierarchy” initiatives. Back in 1999, the Department of Agriculture proposed the Food Recovery & Gleaning initiative (U.S. Department of Agriculture, 1999). Similarly, the Department for Environment, Food and Rural Affairs in the United Kingdom developed the Food Industry Sustainability Strategy (DEFRA, 2006).

2.6. Main quantitative findings

As mentioned previously, it is difficult to compare the estimates of surplus food found in the literature due to differences in scope and the wide variety of methodologies used in the different studies. With respect to crop farming, Smil (2004) underlines the fact that
Food waste is not limited to the harvest – in which products are only partially harvested – but also involves losses in successive stages (e.g. during transportation and storage). A study by Liang (1993) supports this thesis, according to which 15% of grain is lost every year in China.

Kantor et al. (1997), found that 1.5% of available food is lost in the retail trade stage every year in the United States, while 25.5% is lost in the household consumption and food service stages. The total surplus food from these stages in the supply chain amounts to approximately 44 million tons. Dividing this amount by the population of the United States, it was calculated that approximately 9.4 kg of food products are lost in the retail trade stage and 157 kg in the household consumption stage per person every year. The proportion of edible food products in different product categories that are not consumed was determined as a percentage of the total available food for these stages taken as a whole (Table 2.2.). Although it is difficult to use these values because they combine very different stages in the supply chain, they do demonstrate the significance of the phenomenon. Mena et al. (2011) presented the incidence of food waste in Great Britain and in Spain as a percentage of the total products available in the manufacturing and retail trade stages, including the edible and inedible products that are not consumed, for different categories of product and storage temperatures (Table 2.3.).

Table 2.2. Percentage of edible surplus food lost through retail trade, food service and household consumption (adapted from Kantor et al., 1997)

<table>
<thead>
<tr>
<th>Food product category</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh fruits and vegetables</td>
<td>19.6%</td>
</tr>
<tr>
<td>Milk</td>
<td>18.1%</td>
</tr>
<tr>
<td>Cereals</td>
<td>15.2%</td>
</tr>
<tr>
<td>Sweeteners</td>
<td>12.4%</td>
</tr>
<tr>
<td>Processed fruits and vegetables</td>
<td>8.6%</td>
</tr>
<tr>
<td>Meat and fish</td>
<td>8.5%</td>
</tr>
<tr>
<td>Oils and fats</td>
<td>7.1%</td>
</tr>
<tr>
<td>Other</td>
<td>10.5%</td>
</tr>
</tbody>
</table>
Also referring to the United States, Griffin et al. (2009) evaluated the quantity of food waste produced within a single county and calculated an amount per person that is different from those previously reported. Based on the total quantity of food waste and the population, it was calculated that 21 kg of food waste was produced per person at the agricultural stage, 1 kg at the manufacturing stage, 20 kg at the retail trade stage and 63 kg at the household consumption stage.

In the United Kingdom, WRAP (2010) studied the phenomenon at the manufacturing, retail trade and household consumption stages. Based on the population in 2009, these results indicate that every year approximately 42 kg of food products are lost at the manufacturing stage per person, 6 kg at the retail trade stage and 134 kg at the household consumption stage. It is not clear whether the results refer to food waste or food losses.

A direct comparison cannot be made between these results due to the issues identified previously: differences in scope, methodology, or the sample considered. Nevertheless, it is useful to attempt to compare the data from the more comprehensive studies to obtain a benchmark. Figure 2.1. shows annual surplus food quantities,
expressed in kg/inhabitant provided by Griffin et al. (2009), Kantor et al. (1997), and WRAP (2010), divided into four supply chain stages: agriculture (crop and livestock farming), manufacturing, retail trade and final consumption. The information summarised in Figure 2.1. again illustrates the significant differences in the magnitude of the phenomenon amongst the individual stages of the supply chain and shows that surplus food generated at the final consumption stage predominates. However, it should be noted that only Griffin et al. (2009) looked at all of the stages of the supply chain, and both Kantor et al. (1997) and Griffin et al. (2009) included food service in the consumption stage, while WRAP (2010) did consider the food service industry and therefore consumption in that study is strictly domestic. Finally, it is important to reiterate that Kantor et al. (1997) considered only edible surplus food, Griffin et al. (2009) estimated surplus food but did not distinguish between edible and inedible products, and it was not explicitly stated in WRAP (2010) whether the estimates represent food waste or food losses.

Figure 2.1. Literature review: unrecovered surplus food in kg/person/year
The studies presented above referred primarily to Anglo-Saxon countries. A recent study by Segrè and Falasconi (2011) focuses on the situation in Italy. Based on statistical data (e.g. ISTAT data on food production), studies conducted by various Italian organisations (e.g. the Consumers’ Association), a survey of a sample of manufacturing companies of unknown size, and some quantitative data from the authors’ experiences in organisations that recover surplus food, it was estimated that nearly 20 million tonnes of food waste are generated within the Italian food supply chain every year. With respect to the Italy’s population in 2011, this corresponds to an annual quantity of approximately 330 kg per capita, an estimate that is higher than those for the United States and the United Kingdom presented in Figure 2.1.

2.7. Summary of the literature review

The significance of the issue of surplus food and food waste is confirmed by the review of the main studies in the literature, from both the point of view of food security and that of supply chain sustainability. However, the research also highlights some critical issues in terms of our understanding of the phenomenon of surplus food.

In order to develop a comprehensive picture of the issue and, most importantly, to identify decisive actions for reducing surplus food and finding ways to reclaim the component of food surplus in the supply chain that is unavoidable, the following issues need to be resolved:

• The term “food waste”, which is used in most international scientific articles on surplus food and food losses, is ambiguous, because few authors make a distinction between edible products that are disposed of and inedible food scraps or garbage. When the assessment includes both edible products and scraps generated during processing and preparation, it results in a very rough approximation of the issue.

• Although it is topical, few studies have examined the phenomenon in its entirety, including the whole food supply chain, from the agriculture and fishing stage through to household consumption. A number of studies focus on selected stages, while other studies
combine different points where surplus food is generated in a way that is unclear.

- The various studies are based on small samples, partly due to difficulties in obtaining information from supply chain players. As a result, food loss coefficients already reported in the literature are often used, though they may refer to very different contexts and periods. This practice is likely to produce misleading quantitative results, because the level of technological development, the organisation of business processes and consumer awareness – which are all determining factors in the generation and management of surplus food – can vary over time and between different countries.

- There are quite a few studies in the literature on Anglo-Saxon countries, but few studies relating to Italy and other continental European countries.

- Most studies focus on the concepts of surplus food and food waste, the environmental and social implications of these phenomena and, in some cases, the assessment of their relevance; little research has been conducted into the reasons for the generation of surplus food and, more generally, into potential courses of action. Similarly, few studies have investigated the phenomenon at individual stages or have considered individual players in the supply chain, and an examination of the phenomenon within companies appears to have been neglected.

The model described in Chapter 3 is based on the results of the literature discussed in this chapter and aims to address these critical issues.
Chapter 3

The conceptual model

The purpose of this chapter is to present a conceptual model that describes surplus food and food waste at individual stages in the food supply chain. The model identifies the main variables “surplus food” and “food waste” qualitatively, including their relationship with other variables such as “food availability” and “recoverability”. This model – called the “ASRW model” (Availability, Surplus, Recoverability, Waste) – represents the basis for the quantitative assessment of surplus food and food waste that is described in Chapter 4.

The aim of the development of the conceptual model is to clarify the scope of the study and to identify the variables that represent the key research concepts, in order to address the critical issues revealed in the literature review (Chapter 2). The research involves an in-depth examination of the ways of managing surplus food to help to reduce poverty and food insecurity and considers waste primarily from a social perspective. However, the conceptual model described below also clarifies some definitions that can be useful in the assessment of the economic value and the environmental impact of surplus food for various supply chain players and for a broader group of stakeholders.
3.1. ASRW model: variables and their relationships

The chapter presents the individual components of the ASRW model, that is the concepts of surplus food, surplus food management options, food waste and the recoverability of surplus food. It then describes the relationships between these components, an understanding of which is needed in order to conduct a quantitative assessment of surplus food and food waste (see Chapter 4).

3.1.1. Surplus food: definition

Food availability is defined as all food produced throughout the food supply chain. It includes food products at individual stages in the supply chain (e.g. fruit on trees, biscuits produced by a company, packaged pasta stored in a warehouse) which have undergone different levels of processing: raw materials (e.g. grains in the fields or coffee beans), semi-processed foods (e.g. cut fruit used in the production of yogurt or chocolate used in the production of ice-cream) and finished products (e.g. jams or cured meats).

As shown in Figure 3.1, there are three potential destinations for the overall food availability of the food supply chain.

Human consumption: this includes the edible food that is delivered through traditional market channels and is consumed by people to satisfy their food needs (e.g. packaged cheese purchased at the supermarket and then eaten, pizza eaten at a restaurant).

- Surplus food: this is the edible food that is produced, processed, distributed or served but for a variety of reasons is not purchased or consumed. It includes food produced at the agriculture and fishing stage, food processed at the manufacturing stage, food distributed at the retail trade stage, and food prepared or served at the food service stage, but not sold to the downstream client or to the final consumer. It also includes food purchased by the consumer that is not consumed.

- Food scraps: this is inedible food that is no longer suitable for human consumption. It includes food scraps from the manufacturing process (e.g. chocolate discards generated during
The concept of the cutting process, products that are damaged, broken or do not meet quality standards (e.g. sour yogurt) and the inedible components of edible food (e.g. fruit stones).

The boundary between these three components of food availability, especially between surplus food and food waste, is not fixed and may shift over time. Technological developments and process improvements in the supply chain can contribute to further decreasing the generation of food waste. Some examples include the use of milk fat from milk processing in the production of butter or the production of sausages using discards from the meat cutting process.

Figure 3.1. The components of food availability

3.1.2. Surplus food management options

Once created, surplus food can be managed in several different ways. Figure 3.2 presents the different options based on the intended use:

- Feeding humans: the use of surplus food to fulfil human needs, through sales to secondary markets or donations to charitable organisations or food banks.
- Feeding animals: the use of surplus food to fulfil the needs of animals. This may be achieved either by using the surplus food directly, by giving or selling it to kennels or zoos for example, or by conferring it to manufacturing companies that specialise in the production of animal feed.
- Waste recovery: the surplus food is conferred to companies (public or private) that specialise in the production of fertilisers (especially when food products are “wet”) or energy (especially for dry food products).
- Waste disposal: the surplus food is disposed in landfills.

Figure 3.2. Potential uses of surplus food

Two important details should be noted. First, food waste (Figure 3.1) may be used to fulfil the needs of animals or it may be managed as waste (to be recovered or disposed), but, unlike surplus food, food waste cannot be used for human consumption. For example, fish processing generates scraps, such as bones and skin, which can only be supplied to companies that produce animal feed. Secondly, it is important to note that even companies themselves are not always aware of how the waste they confer to waste disposal companies is subsequently managed. In fact it is often unknown whether the waste disposal companies hired reclaim waste or not.

It is important, when focusing on the recovery of surplus food by charitable organisations and food banks, to examine the different types of organisations that are involved. Some charitable organisations assist the needy directly; they are supported by other organisations called food banks. Relief organisations can include soup kitchens, parishes, associations that distribute food to the needy or, more generally, associations that provide assistance to particular categories of people such as the disabled. These organisations generally have limited logistics and management capabilities.
In order to overcome this deficiency, food banks were created in Western countries to act as dedicated intermediaries. They function as a link between the “donor” (e.g. manufacturing companies or retailers) and the organisations that deal directly with the needy, who are the final “consumer”.

Food banks first appeared in the mid-Sixties when the St. Mary’s Food Bank was established by John Van Hengel in Phoenix, Arizona. He grew up in Los Angeles and moved to Arizona in 1965 where he became a volunteer at a soup kitchen for poor people. The refectory had an annual budget of only $ 8,000. This induced Van Hengel to seek out sources of free food products. In the beginning he recovered vegetables left in the fields and fruit remaining on the trees. In so doing, however, he obtained more products than were needed in the soup kitchen where he worked. So he delivered the remaining products to other relief organisations, making it possible for them to offer additional meals. After a while, the need to give structure to this operation led to the creation of the first food network. An old bakery was used as a warehouse. Van Hengel and his colleagues soon began to recover surplus food from many supermarkets, which sometimes sent their vans directly to the warehouse. And so the first food bank was established; it recovered surplus food in a systematic way and then distributed it to charitable organisations who, in turn, distributed it to the needy.

The Fondazione Banco Alimentare ONLUS (a non-profit food bank foundation) and the charitable organisations affiliated with the Rete Banco Alimentare (food bank network) are described by Pesenti (2009) and Rovati (2009b) in their research on food insecurity conducted on behalf of the Fondazione per la Sussidiarietà (foundation for subsidiarity). The Fondazione Banco Alimentare ONLUS is an example of food bank in Italy. It has a network of collection and distribution warehouses throughout the country. In 2011 the Fondazione recovered nearly 80,000 tonnes of surplus food, which it distributed to 8,700 charitable organisations. It should be noted that charitable organisations and food banks have distinct and separate corporate identities. Non-profit organisations (Organizzazioni Non Lucrative di Utilità Sociale – ONLUS in Italy) may benefit from some tax breaks (see Chapter 11 for further information).
3.1.3. Food waste: definition

Food waste can be defined in various different ways depending on the surplus food management “hierarchy”, as shown in Figure 3.3.

The hierarchy that represents the uses of surplus food in this book is consistent with other studies in that it favours the social perspective, without negating the value of the other perspectives. For example, the United States Environmental Protection Agency developed a food recovery hierarchy that prioritises the options for managing surplus food (EPA, 2012; see also Chapter 11): feeding people, feeding animals, industrial uses, composting, and disposal by landfill or incineration. Accordingly, the research will focus on “social waste”, meaning surplus food that is not used toward the primary purpose of the food supply chain (i.e. for human consumption), because it represents a particularly significant example of the inefficient use of resources (land, water, energy, labour).

In accordance with the social perspective, food waste is defined as surplus food that is not recovered for human consumption (through sales to secondary markets or donations to food banks and charitable organisations). It should be noted that this definition of food waste does not include all food availability that does not reach the final consumer but includes only the “edible” component which is surplus food. For example, food scraps that are generated while preparing a meal at the household level do not fall within the definition of food waste. Similarly, scraps generated during the manufacturing process are not considered to be food waste (e.g. the outer leaves removed when cleaning and packaging lettuce).

Looking at food waste from a perspective that is both social and zoo-technical, food waste can be defined as surplus food that is not recovered to feed either humans or animals. In accordance with this definition, surplus food used to produce animal feed or to feed animals in general is not considered to be food waste.

Finally, taking a general system perspective that considers the beneficial use of surplus food in any form (human or animal consumption or the recovery of waste to produce energy or other products), the definition of food waste includes only disposed waste, that is, surplus food disposed of in landfills.
3.1.4. The recoverability of surplus food

From a social perspective (which favours the use of surplus food for human consumption), food waste is not all created equal. Take, for example, a company that disposes of part of a batch of snacks simply because the packaging does not reflect the latest advertising campaign: this is a perfectly intact product that is easily stored and has a long shelf-life. A second example is that of a canteen that discards portions of prepared pasta that were not served to the customer: this is an unpackaged cooked product and its management involves food safety considerations. The disposal of pasta portions is perceived as less wasteful than the disposal of the snacks in this example, even for an equivalent quantity and nutritional value.

The concept of “degree of recoverability” (DoR) was therefore introduced. Recoverability implies the relative ease of recovering surplus food for human consumption, and depends on the intrinsic recoverability (IR) of surplus food, and on the required management intensity (MI).

The intrinsic recoverability (IR) of a product represents the facility with which a potential beneficiary could make use of the surplus food for human consumption in the absence of additional management efforts and/or intermediation. The higher the intrinsic recoverability, as in the first example of a batch of snacks, the easier it is for the disadvantaged to access and consume the surplus food. The higher IR, the greater the DoR of the food product. The intrinsic
recoverability depends primarily on product characteristics (e.g. shelf-life, need for refrigeration) and then on the activities typically undertaken by the company (e.g. pre-cooking the food). Edible and healthy grain that is not harvested from the fields needs to be processed and cooked prior to being consumed. Conversely, a pre-cooked, packaged product that is not sold in a store due to a dent in the packaging has a high intrinsic recoverability because no further processing is required.

The management intensity (MI) represents the level of effort required by companies and intermediaries (e.g. charitable organisations) to maximise the usability of the surplus food by the final beneficiary. The higher the MI, the lower the DoR of the food product. The management intensity is itself a function of two components: the maintenance effort needed to maintain the product’s qualitative and nutritional properties; and the enhancement effort required to increase the opportunities for using the surplus food, efforts that would not otherwise be made. The greater the maintenance and enhancement effort required, the greater the surplus food management intensity and the lower its recoverability. For example, the enhancement effort is high for frozen products because organisations that recover this surplus food must collect and store the product in insulated containers or freezers. The maintenance effort required to manage surplus food is also high for retailers because they need to perform a daily check of products on the shelves in order to identify usable surplus food in time.

The application of the concept of recoverability to surplus food entails the creation of different categories of recoverability for each stage in the supply chain and, where necessary, for each individual segment within a stage. This measure of recoverability is, in turn, a function of the appraisal of the two components, intrinsic recoverability and management intensity.

3.1.5. Overview of the model

Figure 3.4 shows the ASRW model, which summarises the analysis of surplus food presented up to this point.

Food availability has been defined as all food produced throughout the food supply chain, and can be broken down into three
The conceptual model

components: human consumption, surplus food and food scraps.

Surplus food can be managed in different ways: for feeding humans, for feeding animals, for waste recovery, or the waste may be sent for disposal.

From a social perspective food waste is defined as the part of surplus food that is not used for human consumption. Surplus food has different levels of recoverability, that is the relative ease of recovering it for human consumption. Identifying the recoverability for each stage in the supply chain and, where needed, for each segment within a stage makes it possible to assess the generation of waste not only with respect to surplus food overall, but also as a function of recoverability level.

Figure 3.4. Depiction of the ASRW (Availability, Surplus, Waste, Recoverability) model used in the study of surplus food

The breakdown of surplus food as a function of recoverability reflects the authors’ preference not to limit the representation of the phenomenon to the abstract, but to incorporate critical surplus food management issues for individual supply chain players, including the consumer. Insights into the concept of recoverability and its determinants can lead to the identification of more feasible solutions, and the steps that need to be taken to transform surplus food into an opportunity.
3.2. ASRW model development

In order to use the ASRW model, all of the food supply chain stages and each of the segments within each stage need to be identified.

The food supply chain is first described as a whole, followed by the breakdown of each stage into segments. Subsequent chapters will provide more detail on the players involved in each of the stages and segments examined. The number of segments used to describe the food supply chain represents a compromise between the need to adequately describe the variability within the different stages and the difficulty of obtaining information to describe a multitude of disparate segments. At a later stage in the study, the analysis may be broken down into further segments from a consolidated empirical basis.

3.2.1. Stages in the food supply chain

The food supply chain can be divided into five stages, as shown in Figure 3.5. The first stage in the supply chain is the agriculture and fishing sector, which includes crop farmers, livestock farmers and fishermen. In addition to these producers, other players involved at this stage include consortia (e.g. producer organisations) and intermediaries (e.g. vegetable wholesalers). The agriculture and fishing sector produces raw food materials, which are then sold to manufacturing companies or directly to the final consumer (e.g. fresh fish or vegetables). In terms of crop production, only crops destined for human consumption were considered. Therefore, the portion of crop production destined for feeding animals (e.g. hay) or to produce fuels was not considered.

The second stage includes manufacturing companies that process raw materials to produce semi-processed products (e.g. companies that produce flour from wheat), and companies that produce finished products, that is products that can be used by the final consumer (e.g. pasta). The manufacturing stage also produces “sub-products”, which are secondary products that are a useful result of the production process, although not its main purpose, that can be used for other purposes or in other industries. For example, the whey from milk or cheese produced in the dairy industry is a
Figure 3.5. The food supply chain
raw material used in the pharmaceutical industry.

In the third stage of the supply chain, the products produced by the manufacturing companies are distributed through retail trade, including large-scale retailers, small-scale retailers and market stallholders.

Consumption of food products may take place at food service establishments (fourth stage of the supply chain) or in households (fifth stage).

3.2.2. Supply chain segments

The five stages of the supply chain were further subdivided into twelve segments, representing similar areas or product categories within the supply chain, as shown in Table 3.1. Two factors were taken into account when identifying the segments for each of the five stages in the supply chain:

• the configuration of logistics and production systems used by the companies in the supply chain stage under consideration;
• product characteristics.

For example, at the manufacturing stage, companies that produce frozen products plan in advance and produce large batches of products. In addition, products have a long shelf-life (i.e. the length of time the quality and safety of the product remain acceptable and therefore the period within which the product should be consumed). Conversely, companies that produce meat products prefer to manufacture on demand whenever possible and products have a shorter shelf-life.

In order to use the ASRW model, the degree of recoverability was determined for each of the twelve segments (Table 3.2.). The degree of recoverability was evaluated on a qualitative scale consisting of three levels (low, medium, high), as a function of intrinsic recoverability and management intensity. The evaluation of management intensity was, in turn, based on a function of the maintenance and enhancement effort required.

A detailed explanation of the degree of recoverability assigned to each of the various supply chain segments is presented in subsequent chapters (subsections 5.1.3., 6.1.3., 7.1.3. and 8.1.3.).
Table 3.1. Breakdown of the food supply chain into segments

<table>
<thead>
<tr>
<th>Stage</th>
<th>Segment</th>
<th>Product Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and</td>
<td>Fruit and</td>
<td>Fruit (e.g. apples and pears) and vegetables (e.g. lettuce, courgettes and</td>
</tr>
<tr>
<td>fishing</td>
<td>vegetables</td>
<td>broccoli)</td>
</tr>
<tr>
<td>Cereals</td>
<td>Cereals</td>
<td>Cereals (e.g. rice and wheat)</td>
</tr>
<tr>
<td>Livestock</td>
<td>Meat</td>
<td>Meat (e.g. lamb, pork, poultry)</td>
</tr>
<tr>
<td>Fishing</td>
<td>Fish</td>
<td>Fish - wild-caught or farm-raised (e.g. tuna and shellfish)</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Ambient</td>
<td>Dry products (e.g. pasta, rice, canned goods, snacks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preserves (e.g. tomato sauce) and fruit juices</td>
</tr>
<tr>
<td></td>
<td>Chilled</td>
<td>Oil and vinegar</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alcoholic and non-alcoholic beverages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meat (e.g. packaged products, cured meats)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fish (e.g. packaged products, seafood)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dairy products (e.g. cheese, yogurt, desserts)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fresh, ready-to-eat (4th range) products (e.g. packaged salad, fruit salad)</td>
</tr>
<tr>
<td></td>
<td>Frozen</td>
<td>Frozen products (e.g. frozen ready-meals, frozen meat products, frozen fish</td>
</tr>
<tr>
<td></td>
<td></td>
<td>products, pizza, frozen vegetables)</td>
</tr>
<tr>
<td>Retail trade</td>
<td>Distribution</td>
<td>All product categories</td>
</tr>
<tr>
<td></td>
<td>centres</td>
<td>All product categories</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
<td>All product categories</td>
</tr>
<tr>
<td>Food service</td>
<td>Collective</td>
<td>All types of food</td>
</tr>
<tr>
<td></td>
<td>catering</td>
<td>All types of food</td>
</tr>
<tr>
<td></td>
<td>Commercial</td>
<td>All types of food</td>
</tr>
<tr>
<td></td>
<td>catering</td>
<td></td>
</tr>
<tr>
<td>Household consumption</td>
<td>Consumer</td>
<td>All product categories and all types of food</td>
</tr>
</tbody>
</table>
As an example, the reasoning behind the degree of recoverability assigned to the collective catering segment within the food service stage and that assigned to the household consumption stage is explained below. Surplus food in collective catering is 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 (it typically needs to be consumed within 24 hours of preparation). The management intensity is medium because a certain level of maintenance and enhancement effort is required in the collective catering segment. First, the company recovering the surplus food must package it, lower its temperature (using dedicated equipment to control potential bacterial growth) and store it in a refrigerated environment (both for daily and evening services). Then, food banks and charitable organisations must collect the surplus food daily from each canteen and transport it using insulated vehicles or containers.

At the household consumption stage, surplus food is characterised by a low degree of recoverability, resulting from the combination of a low intrinsic recoverability with a high management intensity. The intrinsic recoverability is low because surplus food in this segment includes products nearing their expiration date and food that has been cooked but not consumed (and would therefore need to be consumed within a few hours). The management intensity in this segment is high as significant maintenance and enhancement efforts would be required. To recover the surplus food, the consumer would have to act quickly to package the surplus food in an environment where adequate facilities are generally unavailable, that is, in the home. Charitable organisations or food banks would then have to collect the surplus food from each household daily and transport it in insulated vehicles or containers. In addition it should be noted that there would be no guaranteeing the quality of products cooked and stored at a household level. Improperly cooked or stored foods storage could potentially harm the health of the beneficiaries, but it would be difficult to assign responsibility to any individual donor.
The conceptual model

Table 3.2. Recoverability in supply chain segments

<table>
<thead>
<tr>
<th>Stage</th>
<th>Segment</th>
<th>Intrinsic recoverability (IR)</th>
<th>Management intensity (MI)</th>
<th>Recoverability (DoR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and Fishing</td>
<td>Fruit and Vegetables</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Cereals</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Farming</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Manufacture</td>
<td>Ambient</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Chilled</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Frozen</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Retail trade</td>
<td>Distribution centres</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Food service</td>
<td>Collective catering</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Commercial catering</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Household Consumption</td>
<td>Consumer</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>
The goal of this chapter is two-fold: first, to describe the assessment process for quantifying surplus food and food waste, based on the conceptual model described in Chapter 3; and second, to demonstrate how the method is applied to the Italian food supply chain.

This chapter first presents the information available from third-party sources on production in the Italian food supply chain. The analytical model used to obtain surplus food and food waste estimates for each segment of the supply chain, based on food production values and coefficients that describe the generation and management of surplus food, is then discussed. An exploratory empirical investigation, which enabled the development of the descriptive case studies that were essential for obtaining estimates of the value of these coefficients, is also presented. Finally, the protocol and sample set for the descriptive case studies are presented and the process used to obtain the coefficients needed to quantify surplus food and food waste in each segment of the food supply chain is described. The chapter concludes with a brief description of the empirical investigation conducted to assess the household consumption stage, which is presented in greater detail in Chapter 9.
It should be pointed out that the quantification of surplus food and food waste for the food supply chain as a whole was obtained using a bottom-up approach, by summing the quantities of surplus food and food waste estimated for each segment.

4.1. Available data sources

To-date, there is no structured process for tracking surplus food in Italy. Data on crop farming are published annually by ISTAT (the Italian National Institute of Statistics), but this covers only the production and harvest of fruit and vegetables, and cereals. Table 4.1 presents data on production and harvest volumes for 2008, excluding agricultural products destined for animal consumption. This information, which was obtained through a regional data collection process, provides an excellent starting point for exploring the topic of surplus food, but the data are not sufficient to fully describe the situation. Although not all of the unharvested product left in the fields is edible, other activities that take place downstream of the harvest may also generate surplus food, as identified in the literature review. ISTAT data are also available on livestock farming and fishing, with additional and more detailed information provided by ISMEA (the Institute for Agro-Food Market Services).

For the other stages in the food supply chain, ISTAT data or data from industry association studies (Federdistribuzione and Federalimentare) are available. While the data, expressed in

<table>
<thead>
<tr>
<th>Segment</th>
<th>Product Category</th>
<th>Production (million tonnes/year)</th>
<th>Harvest (million tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit and Vegetables</td>
<td>Fresh fruit, citrus fruit, vegetables, industrial crops, legumes, tubers, grapes, olives</td>
<td>41.7</td>
<td>40.1</td>
</tr>
<tr>
<td>Cereals</td>
<td>Wheat, rye, barley, oats, rice, maize, sorghum, other cereals</td>
<td>22.0</td>
<td>21.9</td>
</tr>
</tbody>
</table>
monetary units, refer only to Italian production (e.g. the data show that total sales for manufacturing companies in 2007 were just under 107 billion euros), other information is available regarding the number and size of the companies that operate in the various different stages of the supply chain.

In the other sectors, quantitative data on production volumes are unavailable.

For the retail trade stage, the monetary value of food availability in the distribution centres segment was calculated as a percentage of the availability at stores. This percentage expresses the portion of flows that transit through distribution centres before arriving at stores. An ad hoc procedure was used to study the consumer stage, which involved close collaboration between the research group and Nielsen - a global leader in marketing information and consumer survey data. Section 4.4 presents an overview of the procedure that was used. More detailed information is presented in Chapter 9. For the other segments, the process used was the following. The values for annual sales in each segment reported in Table 4.2 were used. These sales values exclude VAT and refer to the following ATECO (economic activity) codes: all class 10 codes (excluding sub-class 10.9, related to animal feed production companies) and all class 11 codes for manufacturing companies, all codes in sub-class 47.1 for retail trade companies and all codes in class 56 for food service companies.

<table>
<thead>
<tr>
<th>Table 4.2. Value of annual production at specified stages in the supply chain for companies operating in Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing companies</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Annual production (billion euro)</td>
</tr>
</tbody>
</table>

* The sales value reported refers to sales of food products and does not include small-scale retail stores and market stallholders (see section 7.1).
At the time the research was carried out, the data available for manufacturing companies referred to the year 2007. Therefore, the same time period was also used for the downstream stages (retail trade and food service).

With respect to surplus food management options, and thus the recovery of food products, very little data were available. There is some information available regarding market withdrawals of agricultural products. In Italy, according to the Directorate General for Agriculture of the Regione Emilia-Romagna, 1,167 tonnes of fruit and vegetable products were withdrawn from the market in 2009, 385 tonnes (or 33%) of which were distributed free of charge to accredited facilities.

In terms of food waste at the household level, a high-end estimate (which also takes food scraps into account) can be obtained by looking at urban waste generated in Italy (wet waste in particular). According to estimates from the Institute for Environmental Protection and Research (ISPRA), the total volume of urban waste produced in 2007 was 32.5 million tonnes, of which 9 million were disposed of through waste separation and recycling. In reference to separated waste, the wet waste category was comprised of 2.9 million tonnes (of which 67% was collected in Northern Italy). This information is not directly applicable, given the definitions of surplus food and food waste developed in Chapter 3. However, the data served to validate – as a higher end limit to surplus food and food waste in Italy - the estimates obtained as described in the rest of the chapter.

The information obtained from international studies on the incidence of surplus food is of limited use, as identified through the review of the scientific literature. The scope of the various studies was often different from that of the present research and the variability between proposed values was significant. In addition, company structure, the availability of services on a national level for recovering product, and differences in legislative framework between countries makes a direct comparison impossible. For these reasons, it was decided that coefficients describing the occurrence of surplus food presented in the international scientific literature would not be used.
4.2. Surplus food and food waste: an analytical model

The assessment of surplus food and food waste in the food supply chain was carried out using a bottom-up approach. The first phase consisted of estimating the quantities of surplus food and food waste generated in each of the individual segments of the food supply chain. The results were then summed to obtain an overall quantitative estimate of surplus food and food waste. In order to obtain this estimate, the conceptual model described in Chapter 3 had to be translated into an analytical format.

First, with reference to a generic segment within an individual stage in the Italian food supply chain, the starting point for the analysis was the annual production volume (Figure 4.1). As mentioned in the preceding section, this value was expressed in monetary terms for most of the segments studied. The quantity of food availability can be calculated from the production volume (in monetary units) and the value density. The value density for each segment represents the average product value per unit weight.

The amount of surplus food is then calculated as a percentage of the amount of food availability. Based on the assessment of recoverability for each segment, the surplus food can then be categorised as having a high, medium, or low recoverability.

Finally, given the percentage of product recovered for human consumption, the amount of surplus food that is not wasted from a social perspective (i.e. is used for human consumption) and the amount of surplus food that is wasted can be quantified.

4.3. Surplus food and food waste: data collection and assessment process

The model outlined in Figure 4.1 was used to assess all of the 12 segments considered, with some modifications to account for specific segment properties and variations in the quality of the available data. Some additional information and calculations were required for the estimation of surplus food and food waste; this information was collected and processed as described below. Detailed information
on the application of the method for the evaluation of household consumption is reported in section 4.4 and in Chapter 9. The results of the data collection and assessment process are presented in Chapters 4 through 10.

The progression from quantities of food availability to quantities of surplus food to food waste represents the core of the assessment process for each segment. It was first necessary to estimate food availability from the monetary value of food production (see Figure 4.1), by using value density coefficients (see Table 4.3). These values were obtained from the case studies conducted for the individual supply chain segments and through the interviews with sector experts described later in this section. In order to determine an average value density for each segment, a more detailed examination of the differences within a segment was needed (e.g. in the livestock farming segment, the value density of red meat is much greater than that of white meat) and a weighted average based on the flows within each segment was calculated.

Table 4.3. Value density coefficients in the manufacturing, retail trade and food service segments

<table>
<thead>
<tr>
<th>Stage</th>
<th>Segment</th>
<th>Average value density (€/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>Ambient</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Chilled</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>Frozen foods</td>
<td>2.5</td>
</tr>
<tr>
<td>Retail Trade</td>
<td>Distribution centres</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
<td>2.5</td>
</tr>
<tr>
<td>Food Service</td>
<td>Collective catering</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>Commercial catering</td>
<td>16.0</td>
</tr>
</tbody>
</table>
Figure 4.1. Outline of the model used to quantify surplus food and food waste

- **Segment sales [€/year]**
- **Value density [€/tonne]**
- **Food availability [tonnes/year]**
- **Percentage of surplus food**
- **Degree of recoverability**
- **Surplus food [tonnes/year]**
  - High recoverability
  - Medium recoverability
  - Low recoverability
- **Human consumption [tonnes/year]**
  - High recoverability
  - Medium recoverability
  - Low recoverability
- **Waste from a social perspective [tonnes/year]**
  - High recoverability
  - Medium recoverability
  - Low recoverability
- **Percentage of sales to secondary markets and donations**
The quantification of surplus food and food waste in each segment involved an in-depth assessment of the sources of surplus food, leading to estimates of the magnitude of surplus food (as a percentage of production) and of the proportion of surplus food recovered for human consumption.

For commercial enterprises in the food supply chain (i.e. all stages except the consumer), these values were obtained for each segment by following 4 steps:

- development of exploratory case studies;
- development of a protocol for conducting descriptive case studies;
- progression of the research, conducting more in-depth descriptive case studies;
- compilation and interpretation of case study results.

Details about each of these four steps will be presented in the subsections below. As can be seen from the proposed sequence, the chosen assessment methodology is not based on an extensive survey of a sample of companies in each segment. This choice is partly due to the essential difficulty of involving a large number of companies in the research and partly due to the desire to understand the factors underlying the results without being limited to simply producing quantitative findings about the phenomenon. In several cases, this understanding of the reported values led to the separate assessment of some specific cases and a convergence toward more accurate estimates of the phenomenon.

The decision to conduct case studies in this research context is in line with standard practice in management research; in fact it is deemed to be especially appropriate during the initial evaluation of a phenomenon (Eisenhardt, 1989; Yin, 1994) and is one of the better methodologies for developing new theories (Van De Ven, 1989; Voss et al., 2002).
4.3.1. Development of the exploratory case studies

Ten sector experts and twenty companies operating in the different stages of the food supply chain were involved in the exploratory case studies.

The panel of sector experts included academics (3), trade associations (4) and institutions involved in the collection of surplus food (3).

The objective of the exploratory case studies was threefold:

- to strengthen the definition of the concept of surplus food (and thus the ASRW model development);
- to ascertain the best way to conduct the subsequent descriptive case studies (questions proposed, collection of information and approach to the interviews in general);
- to obtain preliminary quantitative results.

Tables 4.4., 4.5., 4.6. and 4.7. provide information about the panel of companies involved in the exploratory case studies for the agriculture and fishing, manufacturing, retail trade, and food service sectors, respectively. It can be seen that the panel includes both national and international companies in various different segments of the food supply chain. The company representatives who were interviewed in the exploratory case studies were not chosen randomly.

Where possible, individuals who had already worked with the research group on other projects and who showed a willingness to collaborate were selected so as to avoid receiving inaccurate or unverified responses. Moreover, preference was given to individuals with experience at more than one company in the food industry and, more generally, experts on the food supply chain. The names of the companies and the individuals involved in the interviews have not been reported for confidentiality reasons.
Table 4.4. Sample of companies and entities in the agriculture and fishing sector involved in the exploratory case studies

<table>
<thead>
<tr>
<th>Case number</th>
<th>Respondent's role</th>
<th>Company type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CEO</td>
<td>Apple producer, national</td>
</tr>
<tr>
<td></td>
<td>Quality assurance manager</td>
<td>Fruit and vegetables organisation, national</td>
</tr>
<tr>
<td></td>
<td>Company owner</td>
<td>Purchasing and distribution of fish, national</td>
</tr>
<tr>
<td></td>
<td>Quality assurance manager</td>
<td>Livestock farming company, national</td>
</tr>
</tbody>
</table>

Table 4.5. Sample of companies and entities in the food manufacturing sector involved in exploratory case studies

<table>
<thead>
<tr>
<th>Case number</th>
<th>Respondent's role</th>
<th>Company type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Director of general accounting</td>
<td>Producer of preserves, sauces and ambient prepared products, national</td>
</tr>
<tr>
<td></td>
<td>and suppliers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Director of logistics</td>
<td>Producer of chocolate products, multinational</td>
</tr>
<tr>
<td></td>
<td>Director of logistics and</td>
<td>Producer of cured meats and meat-based snacks, multinational</td>
</tr>
<tr>
<td></td>
<td>procurement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Director of logistics</td>
<td>Producer of cured meats and meat-based products, national</td>
</tr>
<tr>
<td></td>
<td>Supply chain director</td>
<td>Yogurt producer, multinational</td>
</tr>
<tr>
<td></td>
<td>General manager of fresh products</td>
<td>Producer of vegetables and vegetable-based prepared products, multinational</td>
</tr>
<tr>
<td></td>
<td>Director of operations</td>
<td>Frozen fish products producer, multinational</td>
</tr>
<tr>
<td></td>
<td>Director of logistics</td>
<td>Producer of frozen bread and pastry products, multinational</td>
</tr>
</tbody>
</table>
Table 4.6. Sample of companies and entities in the retail trade sector involved in the exploratory case studies

<table>
<thead>
<tr>
<th>Case number</th>
<th>Respondent's role</th>
<th>Company type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Director of logistics</td>
<td>Retailer with 3 distribution centres and over 100 stores, multinational</td>
</tr>
<tr>
<td>2</td>
<td>Director of logistics</td>
<td>Retailer with 4 distribution centres and over 300 stores, national</td>
</tr>
<tr>
<td>3</td>
<td>Director of logistics</td>
<td>Retailer with 20 distribution centres and over 1,000 stores, multinational</td>
</tr>
<tr>
<td>4</td>
<td>Store manager</td>
<td>Store belonging to a multinational company, over 2,500 m2 in size with sales of more than 70 million euros</td>
</tr>
</tbody>
</table>

Table 4.7. Sample of companies and entities in the food service industry involved in the exploratory case studies

<table>
<thead>
<tr>
<th>Case number</th>
<th>Respondent's role</th>
<th>Company type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Director of planning</td>
<td>Company that prepares over 70 million meals annually, national</td>
</tr>
<tr>
<td>2</td>
<td>Quality assurance manager</td>
<td>Company that prepares over 20 million meals annually, multinational</td>
</tr>
<tr>
<td>3</td>
<td>Director quality assurance and the environment</td>
<td>Commercial catering company with over 500 restaurants, international</td>
</tr>
<tr>
<td>4</td>
<td>Restaurant manager</td>
<td>Commercial catering company that serves over 130,000 meals annually, national</td>
</tr>
</tbody>
</table>
4.3.2. Development of a protocol for conducting the descriptive case studies

Following the exploratory case studies, descriptive and explanatory case studies were conducted in order to obtain a comprehensive description of the studied phenomenon. As suggested by Yin (2002), the specified case study protocol was subdivided into 4 parts:

- determination of the specific objectives of the case studies;
- identification of the information collection method;
- definition of the interview outline;
- definition of the report structure for each case study.

The clear protocol made it possible involve teams including post-graduates and graduate students in the implementation of the case studies.

Specific objectives
The first objective of each case study was to determine the percentage of surplus food generated by the company being interviewed. The second objective was to determine the reasons surplus food is generated and the relative weight of each of these sources of surplus food and to gather additional information about the different ways surplus food is managed. During the case study interviews it was necessary to make sure the interviewee understood the purpose of the research, and the importance of avoiding subjective interpretations of quantitative research results (e.g. high or low estimates of surplus food or food waste) was stressed.

Information collection method
To be able to gather the necessary information effectively, it was important to select the appropriate person to interview. When gathering information, interaction with a “key informant” is fundamental. This person should not be limited to providing information alone (i.e. being a mere respondent), but needs to be someone who may be able to offer insights on the phenomenon being investigated. The roles of the selected participants represent a variety of different business functions: logistics or operations
directors, store managers, sales directors and quality assurance managers. The choice was determined by the supply chain segment being considered. It was held to be sufficient to interview one person per company, aside from the retail trade stage where it was deemed necessary to involve different people to represent the distribution centres and stores segments.

A letter was sent to potential interviewees to explain the research project and outline the interview process, so that each respondent could prepare ahead of time. In some cases in fact, the interviewees had to obtain permission to provide the information, gather the necessary documents and, if necessary, hold prior discussions with colleagues. For these reasons, the interviews were generally conducted about 10 days later at the company’s site.

Prior to the interview, information was collected about the company (sales, products, and problems) and on the surplus food phenomenon in particular. Internet sites, sector journals, sustainability reports (social and environmental) and previous studies carried out by the companies themselves proved useful in this regard. Given the level of detail involved, each interview lasted about 2 or 3 hours.

**Interview outline**

Granted that case study questionnaires represent a guide to the conversation rather than a structured set of closed-ended questions, an interview outline was developed for each segment in the study. The questions were grouped into three sections (A, B and C).

Section A covers general company information: the segment to which the company belongs, its sales in Italy, sales volumes (expressed in tonnes of product), configuration of logistics and production systems, planning process for the procurement of raw materials, and production and distribution planning processes.

The purpose of Section B is to examine surplus food both quantitatively and qualitatively. More specifically, it entails describing the concept of surplus food to the interviewee and asking that they quantify surplus food as a percentage of sales volume. Moreover, it involves obtaining detailed information from the interviewee about the source of company data as well as any company policies geared toward reducing surplus food.
The purpose of Section C is to examine the reasons for the generation of surplus food and how it is managed. More specifically, this means suggesting possible sources of surplus food to the interviewee and finding out how the amounts identified in Section B are allocated and, if necessary, identifying additional sources. Each source of surplus food is subsequently discussed in further detail. For example, for the reason “internal product sell-by date reached”, it was advisable to find out up to what point the company considers the product to be saleable through traditional channels. The interviewee was also asked to provide as much detail as possible about the “underlying causes” (e.g. it was found that at times the internal sell-by date is reached because of large production lots or due to reduced forecasting accuracy during promotional periods). During the exploratory case studies it was found that identifying the relative impact of the underlying causes on a company-wide level was difficult, therefore it was decided that only a rough indication of their significance would be requested during the descriptive case studies rather than a percentage impact. The final purpose of Section C in the interview outline is to investigate the options for managing surplus food. As before, the interview outline is designed to suggest various options available for using the surplus food and to ask the interviewee about relative percentages. The interviewee was asked to evaluate surplus food management options, without considering any product reprocessing by the company (e.g. when a box breaks in the warehouse, simply re-packaging the product may be all that is required to get the product back into the commercial process). Once this quantitative information was obtained, the interviewee was asked to provide reasons for choosing between the different options and the implications of their choice (business and process-related).

As the description of the interview outline shows, the interviewee was asked to provide quantitative information and useful facts to aid in their interpretation, limiting the opportunities to express a subjective opinion as much as possible.
Case study report
Following each case study two types of reports were prepared:

- The “full-length” case, which reproduces the entire interview.
- The case “summary”, where the main quantitative information is reported along with some explanatory notes.

4.3.3. Determination of the extensive sample for descriptive case studies

In order to expand the research, companies had to be identified for each segment of the food supply chain that could potentially be involved in the extended study. To this end, sector directories which list the main market players were consulted (e.g. the magazine for large-scale retailers, Largo Consumo, publishes an annual list of the main manufacturing companies) and information about companies belonging to ISTAT’s ATECO codes for the agro-food industry were consulted using the AIDA database (a database containing financial information, company details and commercial data for over 700,000 corporations operating in Italy).

A list of companies to be contacted was created from the list of potential candidates. Contact information (names, telephone numbers and email addresses) was obtained for company officials in parallel with the company identification task. This activity was accomplished both through previous contacts with the selected companies and through participation at industry events (i.e. conferences or trade shows).

Once the internal contact person was identified, an invitation to participate in the research was sent out, as laid out in the preceding subsection. In many cases the invitation to participate was declined. In other cases, it was necessary for those involved to obtain formal authorisation from the company in order to participate. It was agreed to maintain the anonymity of the companies involved in the descriptive case studies as well.

The problem of getting companies involved, as the smaller sample size used in many studies reported in the literature also demonstrates, is partly a reflection of corporate concerns about image and reputation; that is, they do not want to be perceived as
“a wasteful company” (even when the phenomenon is marginal percentage-wise). However, this difficulty imposes consequent limitations on the sample size and the method used (case studies rather than large-scale survey).

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 for the properties examined 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.

A second factor that influenced the determination of the sample size was the quality of the official data available. In the agriculture and fishing sector, where more detailed national statistics are available, fewer case studies were conducted in comparison with the other stages (see Table 4.8.), although several types of operators were involved: 4 case studies involved Producer Organisations (POs) specialising in a range of products (vegetables, peaches, apples, melons, kiwi and strawberries), 10 case studies involved farmers, 2 case studies looked at wholesale produce markets and the CSO – Centro Servizi Ortofrutticoli (a fruit and vegetables cooperative in Emilia-Romagna) was also involved. Next, one case study was conducted with a company involved in raising livestock, another case study involved a slaughterhouse, and three involved the purchasing managers at food manufacturing companies (producers of both meat-based and milk-based foods) that have firm relationships with livestock farmers and butchers. In addition, six case studies were conducted with wholesale fish markets (production and/or distribution) and two case studies with the purchasing managers at companies that produce fish-based foods.
Table 4.8. Information on the sample set used to study the agriculture and fishing sector segments

<table>
<thead>
<tr>
<th>Segment</th>
<th>Number of case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit and Vegetables</td>
<td>13</td>
</tr>
<tr>
<td>Cereals</td>
<td>4</td>
</tr>
<tr>
<td>Livestock</td>
<td>5</td>
</tr>
<tr>
<td>Fishing</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 4.9. presents the number of case studies conducted for the other commercial stages in the food supply chain, and reports the percentage of sector sales represented by the companies involved in the case studies. These 94 case studies were added to the 30 from the agriculture and fishing sector for a total of 124 case studies. Though statistically-based generalisations cannot be made with respect to case studies (Yin, 2002), the sample set of companies studied is significant, even in terms of the share of sales involved: in most segments, the group of participating companies represents more than 10% of sector sales. The more concentrated an individual segment (e.g. collective catering), the greater the percentage of sector sales it represents. Where possible, an effort was made to include both medium-large (i.e. with more than 250 employees) as well as small-medium companies in the study.

Table 4.9. Information on the sample set used to study the segments in the food manufacturing, retail trade and food service sectors

<table>
<thead>
<tr>
<th>Stage</th>
<th>Segment</th>
<th>Number of case studies</th>
<th>Percentage of sector sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>Ambient</td>
<td>22</td>
<td>8.7%</td>
</tr>
<tr>
<td></td>
<td>Chilled</td>
<td>24</td>
<td>13.8%</td>
</tr>
<tr>
<td></td>
<td>Frozen foods</td>
<td>3</td>
<td>11.2%</td>
</tr>
<tr>
<td>Retail trade</td>
<td>Distribution</td>
<td>5</td>
<td>19.6%</td>
</tr>
<tr>
<td></td>
<td>Centres Stores</td>
<td>29</td>
<td>19.6%</td>
</tr>
<tr>
<td>Food Service</td>
<td>Collective catering</td>
<td>7</td>
<td>43%</td>
</tr>
<tr>
<td></td>
<td>Commercial catering</td>
<td>4</td>
<td>4%</td>
</tr>
</tbody>
</table>
4.3.4. **Compilation and interpretation of descriptive case study results**

Once each case study was completed, the results were entered into a database in Microsoft Excel. The database contains the information presented in the summary report for each case (numeric results and related notes) and is broken down by food supply chain segment. More specifically, the following information was entered for each case study:

- value of sales (euros/year);
- flow volume (tonnes/year);
- value density (data obtained from preceding sales value and flow volume);
- percentage of surplus food before reprocessing;
- percentage of surplus food excluding food sent for reprocessing;
- percent occurrence of the different sources of surplus food;
- percent occurrence of the different options for managing surplus food;
- relevant notes.

Once the database was complete the data obtained for each segment were analysed. Average values were calculated (as a weighted average of case study flows) as well as the distribution of the data around the mean. This initial analysis revealed variations around the mean, and made it possible to eliminate outliers (i.e. data points resulting from exceptional circumstances that were not applicable to the segment as a whole) from the analysis. A “pattern-matching” analysis (Trochim, 1989) was then carried out, which involved comparing these results to those obtained from the exploratory case studies. The final judgement about the coefficients (percentages) to be used in the estimation of surplus food and food waste was based on this comparison, along with the insights gained about the process and underlying causes, and further discussions with sector experts.

Finally, the coefficients were compared, where possible, with those available in the literature (taking the main differences in the estimates and studied sample into account). The overall results were further validated by looking at “multiple sources of evidence”
The quantitative assessment process was compared to the amount of wet waste collected in Italy. This value, as previously explained, represents an upper limit to the amount of surplus food and food waste in Italy.

4.4. Assessment of surplus food in households: study approach

The study of the generation of surplus food at the consumer level involved the active collaboration of Nielsen, as mentioned previously and as discussed in more detail in Chapter 9. The scope of the study and the best way to collect the information were determined jointly.

The general framework presented in Figure 4.1 was followed. A measure of food availability was calculated from food expenditures by Italian households and the value density of those purchases. In this regard, it is important to note that the cost of household purchases includes VAT, while the value of sales for each segment of the food supply chain is exclusive of VAT.

At this stage of the food supply chain, food waste consists of both expired products and foods that have been prepared but not consumed. At the household level in fact, even those foods nearing their expiration date may be consumed, or foods may be consumed at a meal subsequent to the one for which they were prepared. Surplus food, and thus food waste, is generated when this does not occur, as the food cannot be destined for other uses (both for reasons of food safety and due to the absence of structured processes). At this stage the consumer can take action to reduce surplus food, but has little ability to reduce the resulting waste.

A large scale survey was undertaken to estimate the frequency of occurrence of these two categories of surplus food and food waste (expired products and unconsumed prepared foods) in percentage terms. The method used was different that that used for the other segments of the food supply chain due to the heterogeneity of the population. In contrast to companies operating in a specific segment, each individual consumer follows certain rules and has habits and needs that are very specific. The results could not have been generalised if a lesser number of consumers had been
examined. Chapter 9 presents a detailed description of the survey (questionnaire structure, when and how sampling was conducted, and data analysis method). Since the survey was conducted in 2011, the data related to purchases refers to that same year and not to previous years (as for other data sources mentioned above). It was decided that it was preferable to obtain more reliable information (due to consistency between flow data and percentages) than to maintain a consistent time period throughout the study.
Chapter 5

Agriculture and fishing

This chapter describes the agriculture and fishing sector in the Italian food supply chain in terms of size, flows, configuration of logistics and production systems and degree of recoverability. The sector is subdivided into four segments: crop farming - fruit and vegetables, crop farming - cereals, livestock farming, and fishing. It also describes the assessment of surplus food in the sector, which was obtained using the method described in Chapters 3 and 4, exploring the reasons surplus food is generated. Finally, following an analysis of the different ways in which surplus food may be managed, the quantification of food waste is presented.

5.1. Organisation of the agriculture and fishing sector

The agriculture and fishing sector represents the first stage in the food supply chain. It provides raw materials to manufacturing companies (e.g. cereals and milk) as well as products that can be brought to market without undergoing any prior processing (e.g. fruit and vegetables and fresh fish). In Italy, the turnover generated by crop and livestock farms and fishing companies is approximately 42 billion euros (source ISMEA, 2008 data).
5.1.1. Classification into segments

Operational practices, the complexity of the supply chain and the degree of recoverability vary according to the type of product. In light of these differences, it was decided that the study should differentiate between livestock farming (hereinafter called “livestock segment”), fishing (hereinafter called “fishing segment”) and crop farming, which was further subdivided into the “fruit and vegetables segment” and the “cereals segment”.

The fruit and vegetables segment includes fresh fruit, citrus fruit, vegetables, legumes, tubers, grapes and olives for a total annual production of 41.7 million tonnes (Table 5.1.). Wine and olive oil production is not included in this segment (though these products are considered in the manufacturing sector in Chapter 6). The cereals segment is exclusive to cereal grains used for food (for a total production of 22 million tonnes). The fruit and vegetables segment represents approximately two-thirds of crop production volumes, which amount to 63.7 million tonnes per year.

Fruit and vegetable products may be displayed at room temperature (protected from the sun) for a limited period of time (e.g. while on sale). However, they should generally be stored at a controlled temperature (about 4°C, although the specific temperature depends on the type of product). Above this temperature products may spoil, while below this temperature products may freeze. Some products in particular (e.g. apples) may be stored in maturation chambers maintained at a temperature of approximately 4°C until closer to the date of sale. The temperature is later raised to 10°C in order to allow the fruit to ripen at the appropriate time.

Cereals, on the other hand, may be stored at room temperature. Most of the time, cereals are not ready for “immediate” consumption but need to undergo processing (e.g. wheat must undergo decortication and barley must undergo pearling).
Agriculture and fishing

Table 5.1. Main product categories and quantities produced in the fruit and vegetables and cereals segments (based on ISTAT data for 2008)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Product Category</th>
<th>Production (million tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit and Vegetables</td>
<td>Fresh fruit</td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>Citrus fruit</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td>Vegetables</td>
<td>13.7</td>
</tr>
<tr>
<td></td>
<td>Industrial crops*</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>Legumes</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Tubers</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Grapes</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>Olives</td>
<td>3.6</td>
</tr>
<tr>
<td>Cereals</td>
<td>Wheat</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>Rye</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Barley</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>Oats</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>Maize</td>
<td>9.8</td>
</tr>
<tr>
<td></td>
<td>Sorghum</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>Other cereals</td>
<td>0.05</td>
</tr>
</tbody>
</table>

The livestock farming segment includes butcher meats and milk for a total production of 15 million tonnes per year (Table 5.2.).

Table 5.2. Main product categories and quantities produced in the livestock segment (source: ISMEA, 2008 data)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Product Category</th>
<th>Production (1,000 tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livestock</td>
<td>Cattle</td>
<td>1,057</td>
</tr>
<tr>
<td></td>
<td>Pigs</td>
<td>1,457</td>
</tr>
<tr>
<td></td>
<td>Sheep and goats</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Equines</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Poultry</td>
<td>1,109</td>
</tr>
<tr>
<td></td>
<td>Rabbits and game</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Milk</td>
<td>11,228</td>
</tr>
</tbody>
</table>

* Including, for example, rapeseed, sugar beet, sunflower and soy
Table 5.3. Main product categories and quantities produced in the fishing segment (source: ISMEA, 2009 data)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Product Category</th>
<th>Production (1,000 tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing</td>
<td>Fishing - anchovies</td>
<td>54.4</td>
</tr>
<tr>
<td></td>
<td>Fishing - clams</td>
<td>17.3</td>
</tr>
<tr>
<td></td>
<td>Fishing - hake</td>
<td>15.6</td>
</tr>
<tr>
<td></td>
<td>Fishing - cuttlefish</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Fishing - pink shrimp</td>
<td>9.7</td>
</tr>
<tr>
<td></td>
<td>Fishing - mantis prawn</td>
<td>9.6</td>
</tr>
<tr>
<td></td>
<td>Fishing - red mullet</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>Fishing - swordfish</td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>Fishing - other</td>
<td>110.8</td>
</tr>
<tr>
<td></td>
<td>Aquaculture - fish</td>
<td>74.1</td>
</tr>
<tr>
<td></td>
<td>Aquaculture - molluscs</td>
<td>158.0</td>
</tr>
</tbody>
</table>

5.1.2. The configuration of logistics and production systems

This subsection discusses first the crop farming segments followed by the livestock farming and fishing segments.

Many different players are involved in the fruit and vegetables segment and the cereals segment, including farmers, Producer Organisations (POs), markets and the Agenzia per le Erogazioni in Agricoltura (AGEA), which is the government agency that manages the delivery of EU funds to agricultural producers.

Farmers cultivate and harvest the crops to be marketed. During or following the harvest, they sort and categorise the product based on size and appearance for distribution to the most suitable customers. Finally, they store and distribute the product (mainly at a local level).

Farmers may operate autonomously or they may be associated with a PO. In turn, a PO may be associated with an Association of Producer Organisations (APO). POs, of which there are approximately 280 located throughout Italy, market their members’ products with strong incentives from the European Union as they aim to:
• ensure that production is planned and adapted to demand, in terms of both quality and quantity;
• promote the aggregation of supply and introduction to the market of products produced by their members;
• reduce production costs and stabilise producer prices;
• encourage environmentally sound cultivation, production and waste management practices, particularly with respect to the protection of water quality, soil quality and landscapes, and to preserve and/or encourage biodiversity.

In general, POs are better structured and have a greater industrial capacity than individual farmers. They are involved in the selection, storage, and marketing of products (see Box 5.1.). The products delivered to POs have already undergone an initial selection because member farmers are subject to the “harvest rules” (a set of rules signed when farmers join the PO that lays out the product quality standards required by the organisation). Although POs are mostly located in North-Central Italy, they represent farmers throughout the country. To-date, only some farmers are associated with a PO and therefore only a portion of national production is managed by these organisations.

In the cereals segment, cereals are usually first conferred to the manufacturing industry for processing to transform them into products that are suitable for human consumption.

Some of the fruit and vegetable products marketed by POs or by individual farmers are sold at wholesale produce markets (ortomercati in Italy), where demand meets supply, and some are sold directly to large-scale retail companies (Box 5.1). The wholesale produce markets are open on weekdays and receive supplies daily (during the night). Prices for the various products are determined daily and are published in a daily report called the “mercuriale”, which discloses the minimum, maximum and prevailing prices. Markets are usually open in the morning but there are also some that are open in the afternoon. At the wholesale produce markets, wholesalers may sell products that they own or products that are managed on a sale and return basis. It is not possible to store large quantities of products at a wholesale produce market, therefore wholesalers have only enough refrigeration capacity to meet demand for a limited
period of time. In the past few years, wholesale produce markets have lost market share (it is estimated that they currently handle 40% of flows), creating an opportunity for direct contact between POs and large-scale retailers (Figure 5.1). A number of players are involved downstream of farmers, POs and wholesale produce markets, including the food manufacturing industry, large-scale retail, small-scale retail (including stallholders), the food service industry and the final consumer. The contribution of these players to the generation and management of surplus food will be discussed in subsequent chapters (Chapters 6, 7, 8 and 9, respectively).

Figure 5.1. Sales channels for fruit and vegetable products

Finally, it is important to consider the role of AGEA, and European agricultural policy in general, in studying the phenomenon of surplus food. Despite its fundamental role in the supply chain, crop farming is not often a very profitable activity for a number of reasons. This sector has historically been subsidised in the various EU member states through the European Commission’s CAP (Common Agricultural Policy). The Commission establishes one or more “paying agencies” in each member state, that is, departments or entities that distribute Community aid to farmers and regulate the management of market withdrawals. When there is more than one accredited paying agency, the member state must appoint a coordinating body. In Italy, AGEA performs this role. It is
recognised as a paying agency for the management of Community aid and as the coordinating body for the paying agencies established in autonomous provinces and regions. Emilia-Romagna, Veneto, Basilicata, Piedmont, Lombardy and Trentino-Alto Adige have paying agencies that are accredited at a regional level. In the regions where there is no paying agency, AGEA is the responsible agency.

Prefectures supplement the role played by AGEA. They accredit the institutions that may receive surplus food from POs and certify the donations so that POs can receive financial aid in relation to donated products.

**Box 5.1. An example: apples, from tree to table**

A number of activities take place in order to put apples on the tables of Italians. First, apples are harvested from the trees at intervals to allow the fruit to ripen (the harvest usually takes place in September-October).

The apples are then transported, using suitable insulated vehicles, to collection centres or to POs (e.g. Melavì and Melinda). Product classification then takes place, which establishes the destination (direct to market, to industry, to disposal) based on size, colour and irregularities. Next, the apples are washed, packaged and labelled. The apples are then stored in a refrigerated environment until they are distributed to clients (large-scale retailers and wholesale produce markets), which usually takes place within a year. Finally, prior to distribution, the fruit is once again checked and selected in order to ensure the qualitative standards required by each client are met.

An analysis of the livestock farming and fishing segments was also conducted.

The livestock farming segment involves farmers and slaughterhouses (which are not usually the same firms that breed the animals). Farmers raise the animals using either extensive or intensive farming techniques (in the former the animals are free to move and graze in a medium to large area; in the latter the animals
are confined in stables). Slaughterhouses deal with the butchering of animals once they have attained the required age and height parameters. Downstream of the slaughterhouse, the cut meat may be sent to manufacturing companies that produce sausages, processed meat, or packaged meat in general, foods for fresh consumption (i.e. to large and small-scale retailers), or to manufacturing companies that produce animal feed. In Italy, both Italian and foreign meat are sold because domestic production of certain meats is insufficient to satisfy demand. It is important to note that when meat is not sold immediately following butchering, it may be stored at very low temperatures.

The fishing segment involves various players, including fishermen, Producer Organisations (POs), and wholesale markets located near either production or distribution centres. Fishermen may belong to a PO that sets out an annual operational programme which is binding for all its members. As in the crop farming segment, the European Commission also regulates the fishing segment. There are strong incentives from the European Union for POs. The Common Fisheries Policy (CFP) sets fishing quotas for each species for each member state, imposing a maximum fish quota and setting limits on the types of fish caught and allocating production in such a way as to prevent surpluses or shortages. In addition to quantity limits there are limits on the size of fish caught. Therefore the POs, of which there are just over thirty, are made up of fishermen who associate of their own accord to implement the Community rules, to ensure that their operations run smoothly, and to create optimal conditions for marketing their products. Downstream of the fisherman, there are wholesale “production” markets, which are usually located in harbour cities, where auctioning of the daily catch for the main markets takes place. Wholesale “distribution” markets, which are located in the major Italian cities, work in a similar way to wholesale produce markets, selling products to small and large-scale retailers, and companies in the food service industry. There are also mixed markets which function as wholesale markets for both producers and distributors. Downstream of the production and distribution wholesale markets, fish may be sent to manufacturing companies that produce processed and frozen products, foods for fresh consumption (i.e. for large and small-scale retailers), or to
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manufacturing companies that produce animal feed.

As is evident from the description of the logistics and production configuration, today the flow of fish production and distribution is mainly a “pull flow”, as fish must reach the consumer within a few days of being caught. With respect to aquaculture, however, the process is much more industrialised and fish is caught according to market demand.

5.1.3. The recoverability of surplus food

The specific characteristics of each of the four segments give rise to different degrees of surplus food recoverability, which is a function of intrinsic recoverability and management intensity (see Chapter 3, subsection 3.1.4 for more details).

The fruit and vegetables segment is characterised by a medium degree of recoverability, determined by an appraisal of its intrinsic recoverability (high) and management intensity (medium). The intrinsic recoverability is high because fruit and vegetables are easy to store and ready to use (e.g. apples or oranges). The management intensity is medium because some effort is needed to reclaim and recover surplus food in the fruit and vegetables segment. For farmers, the management of surplus food means that produce cannot be left in the fields but must be harvested, packaged and stored. Similarly, as demand is often concentrated in big cities while production takes place all over the country, food banks and charitable organisations must be able to transport the surplus food quickly, often over long distances, otherwise it spoils.

The cereals segment is characterised by a low degree of recoverability, which is obtained from the combination of its intrinsic recoverability (medium) and management intensity (high). Cereal products are less perishable than fruit and vegetable products, but they need to be processed and cooked prior to consumption.

The livestock farming segment is characterised by a low degree of recoverability, as it has a low intrinsic recoverability and a high management intensity. The intrinsic recoverability is low because the meat needs to be stored at a controlled temperature and is not easily consumed following slaughter as the cuts of meat are too large to be managed at home. Moreover, drinking raw milk is not
recommended. The management intensity in the livestock farming segment is high because a medium level of effort is required to reclaim and recover surplus food and a high level of effort is needed to maintain it. Smaller cuts of meat need to be obtained and insulated vehicles must be used to distribute the products. For fruit and vegetables, furthermore, demand is often concentrated in the big cities while production takes place in the countryside.

Similar characteristics are present in the fishing segment. However, unlike the livestock farming segment, the intrinsic recoverability of the product is higher because small fish are ready for consumption once they have been cleaned and cooked, and these operations can also be performed easily at a household level.

5.2. Study sample

ISTAT and ISMEA statistics were the primary source of the data on food production used to study the Italian agriculture and fishing sector. With respect to crop farming, these statistics focus on production and the harvest, and are based on a data collection process at a regional level. Table 5.4. lists the amounts produced and harvested, excluding agricultural products destined for animal consumption. Official statistics on the difference between usable product and what is actually used are not available for the livestock farming and fishing segments; the only data available are the annual production volumes presented in Tables 5.2. and 5.3.

Table 5.4. Volumes produced and harvested in the two crop farming segments (based on ISTAT data for 2008)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Product Category</th>
<th>Production (million tonnes/year)</th>
<th>Harvest (million tonnes/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit and</td>
<td>Fresh fruit, citrus fruit, vegetables, industrial crops, legumes, tubers,</td>
<td>41.7</td>
<td>40.1</td>
</tr>
<tr>
<td>Vegetables</td>
<td>grapes, olives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cereals</td>
<td>Wheat, rye, barley, oats, rice, maize, sorghum, other cereals</td>
<td>22.0</td>
<td>21.9</td>
</tr>
</tbody>
</table>
As identified by some experts in the agricultural sector and as explained in the following paragraphs, official statistics are a good starting point from which to examine the issue of surplus food, but they do not show the full picture. Only a portion of unharvested products are in fact edible; and activities that take place downstream of the harvest may also produce surplus food.

In order to assess these aspects, the following people and organisations were interviewed:

- experts in the agriculture and fishing sector, including both academics and members of government agencies that deal with the issue of managing surplus food;
- four POs specialising in different products (vegetables, peaches, apples, melons, kiwis and strawberries), ten farmers, a fruit and vegetables cooperative in the Emilia-Romagna region, and two wholesale produce markets;
- two companies – one that raises livestock and one slaughtering company – and the purchasing managers at three food manufacturing companies (that produce food made from both meat and milk), which have established relationships with livestock farmers and slaughterhouses;
- six markets (including production and distribution wholesale markets), and the purchasing managers at two companies that produce food products made from fish.

It should be underlined that less “quantitative” information was available about this sector in comparison with the case study data obtained for other stages in the food supply chain, especially with regard to the different reasons that surplus food is generated and in what percentages. Therefore, in the discussion of the results that follows, the level of detail is determined by the quality of the initial data. Nonetheless, the case studies and the interviews were enough to develop an understanding of the dynamics involved in the generation and management of surplus food and

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1 Emilia-Romagna is the region with the most farmers involved in POs. It is also very active in the prevention, management and monitoring of the phenomenon of surplus food.
to provide an empirical basis for the quantitative assessment of surplus food and food waste on an annual basis (for more details see Chapter 4).

5.3. The generation of surplus food

There are four main reasons for the generation of surplus food in the agriculture and fishing sector: product non-conformance with commercial standards, over-production, product deterioration in storage, and damaged product.

5.3.1. The main sources of surplus food

Product non-conformance with commercial standards is the main reason for the generation of surplus food. Although technical progress has improved the cultivation process over the past few decades, through the use of fertilisers and preventing contamination by pesticides for example, it is not possible to control a product’s appearance to any significant degree. Products that do not meet aesthetic standards (e.g. the colours required by the market) are not harvested, thereby generating surplus food in the fields, or they may be excluded from the sales network during the selection process, generating surplus food for farmers and POs (Box 5.2.). The case studies revealed that during the sorting phase, products are categorised based on their appearance. The best products, from an aesthetic perspective, are sent directly to the market (perhaps with different price ranges). Products that are less compliant with aesthetic requirements are earmarked for the food industry. And finally, some products are designated as scraps. It was found that, the stricter the standards imposed by a PO in their “harvest rules”, the greater the impact of this source of surplus food. When products do not meet these standards, the farmer retains them and they remain unsold.

An evaluation of the environmental benefits of these practices is beyond the scope of this study.
This source (i.e. non-conformance) is largely irrelevant in the livestock farming segment. In the fishing segment, however, fish may be caught that do not conform to specific standards (e.g. fish that are too small). If they are thrown back into the sea when caught, they do not come within the scope of the analysis of surplus food. If they are discarded in port, however, they are considered to contribute to the generation of surplus food. This source of surplus food is not often seen in the wholesale production and distribution markets because the selection is made at a previous stage.

Another source of surplus food is over-production, that is where production exceeds demand.

In crop farming this can be the result of an exceptional harvest or it may be caused by competition with products from foreign markets which are sold at lower prices than products produced domestically. It is important to recall that production planning is critical in crop farming due to the unpredictability of production volumes, which are highly dependent on favourable or unfavourable
weather conditions. The result of over-production is product left in the fields or product that is stored, usually by POs. It is important to note that it is common policy not to release over-production onto the market in order to maintain fair product pricing, with some portion being retained by farmers and POs, thus generating surplus food. Farmers may not even benefit from harvesting surplus product because market prices may be extremely low in comparison with the costs of harvesting and handling. Alternatively, product may be fully harvested through the use of mechanical equipment only to remain at the farm unsold.

In the livestock farming segment, over-production may result in the generation of surplus food at slaughterhouses, although in most cases any slaughtered meat that exceeds market demand may be stored for later use.

With respect to the fishing segment, however, the quantity of fish caught may exceed predetermined quantities. Although in this case if the fish is thrown back in the sea at the time it is caught it is not included in the assessment of surplus food.

Another source of surplus food results from the deterioration products in storage. In the fruit and vegetables segment and in the livestock farming and fishing segments, ineffective product management (e.g. unsuitable storage temperatures) or unsound management policies (e.g. storing larger quantities than required) may lead to product deterioration during transfer to the warehouse or in storage, such that some product may no longer be marketable. This is typically the case with wholesalers that operate in the wholesale produce markets. If a product remains unsold for several days, it is increasingly likely to deteriorate. Moreover, the case studies showed that this situation is more significant amongst wholesalers that work on a consignment basis, where the perceived risk associated with unsold product is lower. Similarly, this can be a significant issue at fish production and distribution markets because unsold fish may remain when the market closes.

Another source of surplus food results from mishandling of the goods. During this phase, a product may in fact get damaged and lose the aesthetic quality required by the customer. This can happen during handling operations carried out by farmers, POs, slaughterhouses, or fishermen, or within the markets,
or during transportation of the product. As mentioned in section 5.2., official data on the relative impact of these different sources are not available. It is often difficult to quantify some of the sources of surplus food (e.g. non-conforming fish that is caught and then thrown back into the sea). The interviewees indicated that the first two sources tend to predominate – product non-conformance with commercial standards and over-production – in all of the segments studied.

5.4. The quantification of surplus food

The agriculture and fishing sector generates approximately 2.3 million tonnes of surplus food annually (Table 5.5.), representing 2.93% of production. This is a significant amount, both in absolute terms and as a percentage of the total. The percentages of surplus food generated in each of the segments considered are: 5.2% in the fruit and vegetables segment (which is also the most significant in terms of production volume), 0.3% in the cereals segment, 0.4% in the livestock segment and 2.2% in the fishing segment.

These values include only edible products and exclude products that remain unharvested due to deterioration or, in general, products discarded because they are not suitable for consumption from a qualitative point of view (e.g. meat with a higher than acceptable degree of acidity). Furthermore, this value does not include products sold to manufacturing companies (e.g. plums for jams or processed meat) or unsold products that are frozen and later sold.

Surplus food in the crop farming segments represents 3.5% of production. Most of the surplus food in this sector consists of fruit and vegetable products as they are the most perishable. More specifically, 20% of the surplus food is generated in the fields as a result of unharvested products, while the rest is generated downstream of the harvest at farms, POs and wholesale produce markets. Cereals, however, are less perishable and more easily stored. If demand falls, products can be stored and later sold without manifesting any signs of organoleptic decay. Finally, it is important to remember that domestic supply is insufficient to meet demand (making it necessary to import cereals from foreign markets). This minimises the occurrence of surplus food.
A very low percentage of surplus food is generated in the livestock segment (0.35%) and a higher percentage is generated in the fishing segment (2.2%). The difference between these two segments is a result of differences in the configuration of the logistics and production systems and differences in product characteristics, as discussed in section 5.1.

Table 5.5. Summary of surplus food generated in the agriculture and fishing sector

<table>
<thead>
<tr>
<th></th>
<th>Fruit and Vegetables</th>
<th>Cereals</th>
<th>Livestock</th>
<th>Fishing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Volume</td>
<td>41,728</td>
<td>22,031</td>
<td>14,989$^4$</td>
<td>475</td>
<td>79,223</td>
</tr>
<tr>
<td>Surplus Food Volume</td>
<td>2,187</td>
<td>68</td>
<td>52.5</td>
<td>10.5</td>
<td>2,318</td>
</tr>
<tr>
<td>Percentage of production (%)</td>
<td>5.24</td>
<td>0.31</td>
<td>0.35</td>
<td>2.20</td>
<td>2.93</td>
</tr>
</tbody>
</table>

5.5. Managing surplus food

Surplus food in the agriculture and fishing sector may be managed in four different ways:

- donation to charitable organisations or food banks;
- use for feeding animals on the farm (e.g. feeding pigs);
- use as fertiliser or biomass on the farm or by suitable processing companies (hereinafter this option is referred to as waste recovery);
- conferral to waste management companies.

It should be emphasised that recourse to secondary markets was not mentioned because, as mentioned in section 5.4, the quantification of surplus food excludes transfers to processing companies that in turn reuse products destined for human consumption.

$^4$ Value includes milk
The findings with respect to surplus food management options in the fruit and vegetables segment reveal that waste recovery dominates (54.7%, Figure 5.2), namely fertilisation of the soil and energy production. This is followed by the use of surplus for feeding animals (28.5%).

Figure 5.2. How surplus food is managed in the fruit and vegetables segment

Waste recovery is used for both agricultural products that remain unharvested and surplus food is generated downstream of the harvest. This option was used in most of the cases studied for farms in particular. At POs, this management option is used in conjunction with donation to food banks or charitable organisations. POs donate a large proportion of the surplus food, especially in times of market crisis (see Box 5.6). When there is no market crisis, donations tend to be less sizeable in quantitative terms. At wholesale produce markets, the waste management options are chosen by the individual wholesalers and are influenced by existing agreements between the wholesale market and the waste management company. Donation of surplus food and its conferral to waste management companies are used (see Box 5.3). Agreements about collection frequency by the company may vary, although collection typically takes place at the
close of the daily market or at the end of the work week.

Donations are infrequent in the cereals, livestock farming and fishing segments; the management of surplus food as waste and its use for feeding animals (mainly through conferral to processing companies; see Boxes 5.4 and 5.5) prevail. With respect to milk, however, over 90% of surplus production is recovered for human consumption (through the production of cheese and UHT milk).

5.6. The quantification of food waste

As described in section 3.1.3., food waste can be analysed from different perspectives. From a social perspective, all edible surplus food products that are not used for human consumption are considered to be food waste. Therefore surplus food generated at this stage in the supply chain that is not donated to food banks or charitable organisations is “wasted”. From this point of view, food waste was calculated to be approximately two million tonnes/year, or 88.2% of the surplus food generated (see Table 5.6.).

Table 5.6. Summary of food waste in the agriculture and fishing sector

<table>
<thead>
<tr>
<th>Surplus Food</th>
<th>Fruit and Vegetables</th>
<th>Cereals</th>
<th>Livestock</th>
<th>Fishing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (1,000 tonnes)</td>
<td>2,187</td>
<td>68.1</td>
<td>52.5</td>
<td>10.5</td>
<td>2,318</td>
</tr>
<tr>
<td>Social waste</td>
<td>Volume (1,000 tonnes)</td>
<td>1,948</td>
<td>67.4</td>
<td>20.3</td>
<td>9.4</td>
</tr>
<tr>
<td>Percentage of surplus (%)</td>
<td>89.08</td>
<td>98.92</td>
<td>38.66</td>
<td>90.00</td>
<td>88.23</td>
</tr>
<tr>
<td>Recoverability</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

Although the differences between the segments are not very significant in percentage terms (excluding the livestock farming segment where the use of milk in secondary markets reduces the percentage of food waste), it should be noted that food waste is greater when the degree of recoverability is lower, as observed for the cereals and fishing segments.
Box 5.3. – Wholesale produce markets: managing surplus food

Amongst the wholesale produce markets studied, a typical example conducts a volume of business equal to 100,000 tonnes sold annually. Trading takes place in two periods during the day: morning and afternoon. The wholesale produce market is open every day of the week except Sunday.

Wholesalers operate at the produce market, receiving supplies daily from local producers (supplies arrive early in the morning). The local producers would have a hard time selling their products directly to customers as they would be unable to provide a constant supply of predetermined quantities. Customers at the wholesale produce market include small-scale retailers and market stallholders that do not use intermediaries, as well as players involved in the food service industry and in large-scale retail. For the most part these are small companies that need daily supplies (80% of customers make daily purchases).

At the market, only small cold rooms with the capacity to contain a daily quantity are available to the wholesalers, making it difficult for them to stock enough goods to satisfy demand for several days. If product remains unsold at the end of the day, each wholesaler will store that amount to sell the following day. In addition, by receiving supplies daily, the generation of surplus food is reduced to a minimum as wholesalers are only able to restock sufficient quantities to meet the daily demand, net of any stock.

However, if unsold product remains on Saturday, the day before the weekly closure, it is unlikely the product can be sold on the Monday. Statistics on the wholesale produce market show that 500 tonnes of surplus food is generated annually (0.5% of flows), of which approximately 80% is recovered for human consumption. Approximately 20% is disposed of as waste. Wholesalers can choose whether to confer surplus products to a waste management company that operates at the wholesale produce market or whether to donate products to charitable organisations that collaborate with the market, with whom there is a signed agreement. Specifically, these organisations will come to the market on Saturday to collect any surplus food and deliver it to those in need.
Box 5.4. – Fish products: the use of surplus food to produce animal feed

Fish products may be used by manufacturing companies to produce animal feed. Both surplus fish products and process scraps (such as the offal obtained from cleaning the fish) may be used in the manufacture of these products. Therefore, there are players in the fishing segment (e.g. fishermen and wholesalers) that have medium-long term agreements with manufacturing companies, to whom they regularly provide process scraps (think of the quantity of food scraps generated by cleaning large fish) and any surplus food. In some cases the manufacturing company will leave a large bin with the fishermen or at the markets for the collection of food scraps and surplus food, with a commitment to collect it at predetermined times.

5.7. Summary of results

Surplus food in the agriculture and fishing sector is significant both in absolute terms (2.3 million tonnes/year, Table 5.7.) and in percentage terms (2.9% of sector production).

Table 5.7. Summary of surplus food and food waste in the agriculture and fishing sector

<table>
<thead>
<tr>
<th></th>
<th>Fruit and Vegetables</th>
<th>Cereals</th>
<th>Livestock</th>
<th>Fishing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Volume (1,000 tonnes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>41,728</td>
<td>22,031</td>
<td>14,989</td>
<td>475</td>
<td>79,223</td>
</tr>
<tr>
<td>Surplus food</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,187</td>
<td>68.1</td>
<td>52.5</td>
<td>10.5</td>
<td>2,318</td>
</tr>
<tr>
<td></td>
<td>Percentage of production (%)</td>
<td>5.24</td>
<td>0.31</td>
<td>0.35</td>
<td>2.20</td>
</tr>
<tr>
<td>Social waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,948</td>
<td>67.4</td>
<td>20.3</td>
<td>9.4</td>
<td>2,045</td>
</tr>
<tr>
<td></td>
<td>Percentage of surplus (%)</td>
<td></td>
<td>89.08</td>
<td>98.92</td>
<td>38.66</td>
</tr>
</tbody>
</table>

Recoverability       | Medium               | Low     | Low       | Low     |       |

5 Value includes milk and eggs
Agriculture and fishing

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There is a long way to go in order to attain the objective of reducing food waste: approximately 90% of surplus food is wasted in the fruit and vegetables, cereals and fishing segments. This value is partly a result of the difficulties involved in managing the product, which are due primarily to the distances between where the surplus food is generated and where there is a “need” for it, and is partly a result of product characteristics. The amount of food waste is lower in the livestock farming segment due to production practices that make the most of a longer product shelf-life.

Box 5.5. The integrated meat supply chain

Using a classic example from among those studied, the generation and management of surplus food in the meat supply chain can be examined. The firm involved is a leader in the production of fresh meat products (including chicken, rabbit and turkey products). It has direct contact with:
• companies that manufacture animal feed;
• livestock farmers;
• slaughterhouses;
• companies that produce energy.
The company stocks the necessary animal feed and provides livestock farmers with both the animals to be raised and the animal feed needed to raise them. It collects the adult animals and arranges their slaughter. It then produces meat-based food products at its plants and sells those products throughout the country.
In periods when there are large quantities of primary material, these are processed and frozen in the form of either semi-finished or finished products (in compliance with regulations), thereby creating a sort of product inventory in preparation for any potential product shortages. Food scraps generated through processing (e.g. offal) and any surplus food are used to produce food for domestic animals (another business in which the company is involved) or are conferred to animal feed manufacturing companies or energy production companies. The food scraps are suitable for the production of animal feed in particular. Animal fat obtained during production is also suitable for use in energy production.

There is a long way to go in order to attain the objective of reducing food waste: approximately 90% of surplus food is wasted in the fruit and vegetables, cereals and fishing segments. This value is partly a result of the difficulties involved in managing the product, which are due primarily to the distances between where the surplus food is generated and where there is a “need” for it, and is partly a result of product characteristics. The amount of food waste is lower in the livestock farming segment due to production practices that make the most of a longer product shelf-life.
There are two ways for improvement. First, a reduction in the volume of unharvested product in the fruit and vegetables segment is needed. And secondly, the management of surplus food needs to be improved, especially at hubs where the logistics capacity is greater (primarily at POs and markets), by encouraging collaboration with food banks and charitable organisations throughout the country.

In the crop farming and fishing segments policy-makers are endeavouring to promote the recovery of surplus food with a medium-low degree of recoverability, with reimbursements that recognise the effort involved by crop farmers and fishermen. Further work along these lines could encourage the processing of the product. Processed product would, in fact, be more easily stored and its use could be more spread out over time.
This chapter describes the food manufacturing sector in Italy, in terms of size, flows, configuration of logistics and production systems and degree of recoverability. This stage in the supply chain is subdivided into three segments: ambient, chilled and frozen products. It also describes the assessment of surplus food in the sector, which was obtained using the method described in Chapters 3 and 4, exploring the reasons surplus food is generated. Finally, following an analysis of the different ways in which surplus food is managed, the quantification of food waste is presented.

6.1. Organisation of the manufacturing sector

Food manufacturing companies, with an annual turnover of 106.8 billion euros (ISTAT, 2007), are the second most important sector in Italy. The sector is made up of more than 70,000 companies (ISTAT, 2007), which belong to several different product categories. This product variety is often accompanied by significant differences in companies’ logistics and production systems and in the recoverability of surplus food.
6.1.1. Classification into segments

In order to account for the differences between companies, in this study companies operating in Italy were categorised according to the storage temperature of the food products they produce because temperature influences the generation of surplus food and its degree of recoverability. Manufacturing companies were grouped into three different product segments: food products stored at room temperature ("ambient" segment), food products kept at a controlled temperature between 0 and 4°C ("chilled" segment) and food products stored temperatures below 0°C ("frozen" segment). Table 6.1 shows the different segments and identifies the main product categories within each segment.

The analysis and processing of ISTAT data on the basis of food storage temperature reveals that the ambient segment accounts for the highest percentage of the total turnover (61.1% of 106.8 billion euros, Figure 6.1), followed by the chilled (35.1%) and frozen (3.8%) segments.

These three segments not only have different logistics and production requirements, but the product “value density”, which is expressed in terms of €/kg, also varies between the segments.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Product Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient</td>
<td>Non-perishable products (e.g. pasta, rice, canned goods, snacks)</td>
</tr>
<tr>
<td></td>
<td>Preserves (e.g. tomato sauce) and fruit juices</td>
</tr>
<tr>
<td></td>
<td>Oil and vinegar</td>
</tr>
<tr>
<td></td>
<td>Alcoholic and non-alcoholic beverages</td>
</tr>
<tr>
<td>Chilled</td>
<td>Meat (e.g. packaged products, cured meats)</td>
</tr>
<tr>
<td></td>
<td>Fish (e.g. packaged products, seafood)</td>
</tr>
<tr>
<td></td>
<td>Dairy products (e.g. cheese, yogurt, desserts)</td>
</tr>
<tr>
<td></td>
<td>Fresh, ready-to-eat (4th range) products</td>
</tr>
<tr>
<td></td>
<td>(e.g. packaged salad, fruit salad)</td>
</tr>
<tr>
<td>Frozen</td>
<td>Frozen ready-meals, frozen meat products, frozen fish products, pizza, frozen vegetables</td>
</tr>
</tbody>
</table>
The product category with the highest value density is the chilled segment (with an average value of 4.4 €/kg), followed by the frozen (2.5 €/kg) and ambient (1.9 €/kg) segments. In volumetric terms, the ambient segment is the most significant (34.6 million tonnes, 77.3% of volume sold) due to its lower density value, followed by the chilled (8.6 million tonnes, 19.1% of volume sold) and the frozen (1.6 million tonnes, 3.6% of volume sold) segments.

6.1.2. The configuration of logistics and production systems

Different systems for managing the flow of materials are used in the different product segments. In the ambient and frozen segments, the preferred approach is MTS (Make to Stock), where production for warehousing is based on demand forecasts. In the frozen segment, demand-based production forecasting is also a function of the seasonality of available materials (e.g. tomatoes) and sales (e.g. ice-cream). Conversely, in the chilled segment, production (especially packaging) usually only takes place following the placement of an order by a customer. This limits the creation of overstock and, therefore, of surplus food and food waste.
Although some companies in this sector, the multinationals in particular, do not have manufacturing facilities in Italy, they all have at least one “central warehouse” where production flows are consolidated and stock for the Italian market is handled. The distribution of products to customers (e.g. large-scale retail) takes place both from the central warehouse and from peripheral warehouses located throughout the country which generally maintain very low levels of stock.

6.1.3. The recoverability of surplus food

The distinctive characteristics of each of the three segments give rise to different degrees of surplus food recoverability, which is a function of intrinsic recoverability, that is the potential for “immediate” reuse for human consumption, and the level of effort required by companies to reclaim and maintain the surplus food (see Chapter 3, subsection 3.1.4. for more details).

The ambient segment is characterised by a high degree of recoverability, resulting from the combination of a high intrinsic recoverability with a low management intensity. The intrinsic recoverability is high because products are easily stored (as they are usually packaged), ready to use, and their residual shelf-life (following the generation of surplus food) usually exceeds one week. The management intensity is low because the level of effort needed to reclaim and maintain the surplus food is limited. For companies, the management of the surplus food usually entails temporarily storing the goods and preparing the appropriate documentation. Furthermore, “normal” vehicles can be used to transport the surplus food and it can be stored in traditional warehouses.

The chilled segment is characterised by a medium degree of recoverability. The intrinsic recoverability is medium because, although the product is ready to be consumed (e.g. mozzarella cheese or yogurt), its shelf-life is short and it must be stored at a controlled temperature. The management intensity is medium because controlled temperature facilities are needed and manufacturers, food banks and/or charitable organisations must comply with cold chain standards during storage and transport. The frozen segment also has a medium degree of recoverability. As in the ambient segment, the
The food manufacturing industry

intrinsic recoverability is high, for the same reasons; however, the management intensity is higher even than in the chilled segment due to the need for specific and expensive equipment to maintain even lower temperatures during storage and transport in compliance with cold chain standards.

6.2. Study sample

In order to study the surplus food phenomenon in detail, 49 case studies were conducted (Table 6.2.) pertaining to the three different product segments. More specifically, 22 case studies were conducted within the ambient segment, 24 in the chilled segment and 3 in the frozen segment. The case studies primarily involved operations and logistics managers; where possible, interviews took place at company headquarters.

An analysis of the sample shows that the companies involved in the study represent 8.7% of the market in the ambient segment, 13.8% in the chilled segment and 11.2% in the frozen segment. Both medium-large size companies\(^1\) (25 case studies) and medium-small size companies (24 case studies) were involved. Many of the companies are based in Northern Italy but have factories and warehouses throughout the country.

The study sample was used to both understand the dynamics of creating and managing surplus food and to provide an empirical basis for the assessment of surplus food and food waste on an annual basis (see Chapter 4 for more details).

Table 6.2. Information on the sample set used to study the food manufacturing sector

<table>
<thead>
<tr>
<th></th>
<th>Ambient</th>
<th>Chilled</th>
<th>Frozen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of case studies</td>
<td>22</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>Percentage of sector sales represented by the case studies</td>
<td>8.7%</td>
<td>13.8%</td>
<td>11.2%</td>
</tr>
</tbody>
</table>

\(^1\) Companies with more than 250 employees were considered as medium-large. Conversely, companies with less than 250 employees were considered as medium-small.
6.3. The generation of surplus food

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.

6.3.1. The main sources of surplus food

One 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.

If “shelf-life” is defined as the length of time between the date the product was produced and date by which it must be consumed, the manufacturing company’s internal sell-by date is on the order of 30% of the product’s shelf-life. 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, and surplus food is generated (see Box 6.1).

**Box 6.1. An example of internal sell-by date: a producer of preserves and ready-meals**

A manufacturer of ready-to-eat foods that can be stored at room temperature produces products with a shelf-life of 18 months. In accordance with its contractual agreements with large-scale retailers, the company must guarantee a minimum 12 month shelf-life at the time of sale. The company also has less stringent agreements in place whereby it can sell its products through direct distribution channels even if the remaining shelf-life is 10 months. Therefore, the company’s internal sell-by date is 6-8 months, depending on the distribution channel. This means that, once the internal sell-by date has been reached, the company generates surplus food that has a residual shelf-life of up to 10 months.
The main reasons for reaching the internal sell-by date are production planning or demand forecasting errors. These errors are only partially avoidable (see subsection 6.3.6.).

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 means 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 (see Box 6.2.).

Box 6.2. An example of non-compliance with commercial standards: an ice-cream manufacturer

Last year, an entire batch of product was impacted by an aesthetic imperfection at an ice-cream manufacturer. Specifically, the manufacturer’s trademark, placed on the product using a dark coloured cream, was not identifiable. The company therefore decided not to sell the product, thereby generating surplus food consisting of an entire production batch.

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. It was found, in fact, that line malfunctions during the packaging process can lead to an imperfectly packaged product or to branding inaccuracies on the package. Those products that do meet quality control requirements may later be damaged during normal warehouse activities or during transport. Some food products, such as snacks, are particularly light and fragile and therefore even a small overlay by a heavier product can lead to damage. Another example of packaging non-compliance involves the storage of products that have been specially packaged for a particular promotion. Special packaging or the insertion of free items within a product’s packaging are often used in product promotions. When the promotion ends, any product that remains in the warehouse cannot be sold through traditional market channels (see Box 6.3.).
At manufacturing companies, surplus food is also generated as a result of product returns by customers. First of all, there are “product refusals”, a term that refers to the refusal of the goods by the customer at the time of delivery. Product returns may occur as a result of issues related to order composition or issues related to delivery time (which is a common issue in dealing with large-scale retailers). Once the product has been refused by a customer, unless it can be redirected to another customer, the product refusal generates surplus food. Product redirection has become even more difficult due to the increasingly common practice in the large-scale retail sector of refusing to accept delivery if the product expiration date precedes that of a load received previously. Therefore, if the load is not redirected quickly, surplus food consisting of perfectly edible products with a long remaining shelf-life is generated. However, this need for a quick turnaround conflicts with the need to conduct quality control on the returned products (either on the entire load, or on a sample).

Another form of product return by customers is the return of unsold goods, which may be part of the agreement between a food manufacturing company and its customers. The opportunity to return unsold food products is associated with promotions, typical holiday products (e.g. chocolate Easter eggs or Christmas panettoni), or products more likely to expire (e.g. milk).
In most cases, the products returned by customers are unsuitable for subsequent sale on the market. This practice is a result of the business necessity for retailers to maintain fully stocked shelves.

6.3.2. The impact of surplus food sources

The results of the analysis of the relative impact of the different sources of surplus food (Figure 6.2.) reveal that most surplus food is generated because the product’s internal sell-by date has been reached (66.9% of surplus food by volume). The second most frequent source of surplus food is products that are unmarketable due to non-compliance with either manufacturing or commercial standards (12.2%). A slightly lower percentage of surplus food is caused by products refusals (9.1%). And finally, 6.1% of surplus food is generated by the return of unsold products and 5.7% as a result of product packaging that does not comply with required standards.

Figure 6.2. Reasons for the generation of surplus food in the food manufacturing sector
Box 6.4. Surplus food caused by demand forecasting errors: the example of a yogurt manufacturer

A yogurt manufacturer showed that small errors in demand forecasting and in production planning are an unavoidable part of the production process. In fact, clients usually place orders with little advance notice, making it necessary for the company to operate in Make To Stock mode. The resulting surplus is not large and is easily managed (e.g. by offering client discounts). More significant issues arise when surplus is generated as a result of inaccurate sales forecasts in relation to promotions or upon the release of new products. The surplus generated in these cases can, in fact, be huge and very difficult to manage. More than 35% of the surplus food generated annually by the company can, in fact, be related to a single promotion. The fact that these are fresh products makes it even harder to redistribute them through other channels (secondary markets or charitable organisations).

Figure 6.3. Reasons for the generation of surplus food in the three food manufacturing segments
Each source of surplus food is, in turn, associated with other factors, which are more difficult to quantify. For example, reaching the internal product sell-by date is related to production planning errors, to the minimum production line batch size and to forecasting errors. In turn, forecasting errors are tied to demand variability and the impact of promotions (see Box 6.4.). For example, in the frozen segment, some examples were found where slow-moving products had reached the internal sell-by date because they were produced in large quantities as a result of a large batch production policy.

Table 6.3. Reasons for the generation of surplus food in the three food manufacturing product segments

<table>
<thead>
<tr>
<th>Reason</th>
<th>Ambient</th>
<th>Chilled</th>
<th>Frozen</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal sell-by date reached</td>
<td>63.9%</td>
<td>68.8%</td>
<td>87.1%</td>
<td>66.9%</td>
</tr>
<tr>
<td>Product non-compliance</td>
<td>16.2%</td>
<td>5.4%</td>
<td>1.4%</td>
<td>12.2%</td>
</tr>
<tr>
<td>Packaging non-compliance</td>
<td>6.8%</td>
<td>4.0%</td>
<td>2.1%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Product refusals</td>
<td>7.5%</td>
<td>13.1%</td>
<td>8.3%</td>
<td>9.1%</td>
</tr>
<tr>
<td>Returns of unsold product</td>
<td>5.6%</td>
<td>8.7%</td>
<td>1.1%</td>
<td>6.1%</td>
</tr>
</tbody>
</table>

Box 6.5. Product refusals: the example of a manufacturer of cured meats

A cured meats manufacturer explained that it is often difficult to manage products refused upon delivery for two reasons. If the shipment was opened at the destination, the company requires the implementation of appropriate quality control measures. In addition to taking time, this also means that the shipment must be returned to the plant prior to subsequent redistribution. Therefore, it is not always possible to achieve this alternative due to the internal product sell-by date.

Secondly, in the event that a shipment was not opened at the destination, there may not be any other potential customers nearby to whom the shipment could be redirected.

These two circumstances are rare in relation to the total number of deliveries rejected but, when they do occur, they result in the generation of an enormous quantity of surplus food (equivalent to a full shipment of product).
The relative impact of the various different sources of surplus food varies depending on which of the three product segments is considered (Figure 6.3. and Table 6.3.). Although the primary reason is always that the internal sell-by date has been reached, it was found that the impact of “product non-compliance” and “packaging non-compliance” is significant in the ambient segment (16.2% and 6.8%, respectively) where there are frequent promotions (both price promotions with no packaging modifications and those involving the use of dedicated packaging). Conversely, the impact of “product refusals” is significant in the chilled segment (13.1%), mainly due to insufficient turnaround time for the redirection of these products to the market (see Boxes 6.5. and 6.6.).

**Box 6.6. Product refusals: the example of a cheese manufacturer**

A cheese manufacturer explained that it is often difficult to redirect products refused upon delivery for contractual reasons. Specifically, many clients will not accept the delivery of a product with an expiration date that is earlier than the expiration date of products received previously. For example, if a supermarket receives a product today that expires in 10 days, it will not accept delivery tomorrow of a product with an earlier expiration date. However the redirection of the shipment involves a portion of the product’s shelf-life (sometimes even several days).

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.

6.3.3. *Food scraps and reutilisation*

It should be noted that the sources listed above do not always result in the generation of surplus food. In fact, in some cases products may still be distributed through commercial channels provided
specified measures have been taken. For example, if the secondary product packaging has been damaged, a company might replace the packaging (bearing the cost of labour and material) and then sell the product. Similarly, if certain products have reached their internal sell-by date, companies may be able to release them on the market following quality control procedures and/or additional processing.

In the context of this study, products that are managed in this way are not included in the quantification of surplus food. The tonnages and percentages of surplus food presented in this chapter are exclusive of such practices. In other words, the percentages presented for each of the sources of surplus food described above were based on the volume of surplus food generated by companies, and do not include foods that underwent repackaging/reprocessing.

Finally, issues related to quality (e.g. dairy products with high acidity) were not considered among the sources of surplus food or in its quantification. In the latter case the product would in fact no longer be considered to be edible and would therefore be categorised as food waste (which also includes manufacturing scraps, such as the leftover raw materials from chocolate production).

6.4. The quantification of surplus food

Surplus food was found to amount to a total of 181,000 tonnes per year (Table 6.4.), or 0.4% of sales. In absolute terms it is a significant quantity that would, for example, fill 6,600 articulated lorries.

| Table 6.4. Summary of surplus food generated in the food manufacturing sector |
|-----------------------------------------------|-----------------|-----------------|-----------------|------------------|
| Production                                   | Ambient (€)     | Chilled (€)     | Frozen (€)      | Total (€)        |
| Sales (billion €)                            | 65.3            | 37.5            | 4.0             | 106.8            |
| Volume (1,000 t)                             | 34,642          | 8,552           | 1,592           | 44,786           |
| Surplus Food                                 | Volume (1,000 t) | Percentage of production (%) | Total (t)      |
|                                              | 118.2           | 0.34            | 11.7            | 181.4            |
|                                              | 51.5            | 0.60            | 0.73            | 0.41             |
Overall, the percentage of surplus food is the weighted average of the contributions from each of the three product segments: 0.3% for the ambient segment (the most significant in terms of volume of sales), 0.6% in the frozen segment and 0.7% in the chilled segment.

The percentage of surplus food in relation to sales volumes is greater in the chilled segment than in the other segments. This is due to the fact that these products are more perishable and the time period available in which to sell them prior to the internal sell-by date is shorter (which, as mentioned above, may also have a bearing on the generation of surplus food if the product is refused upon delivery).

6.5. Managing surplus food

Once it has been generated, surplus food can be managed by manufacturing companies in four ways:

- sales through secondary markets (e.g. factory outlets or stockists);
- donation to charitable organisations, either directly to associations (e.g. Banco delle Opere di Carità, Caritas, Society of St Vincent de Paul, Banchi di Solidarietà) or indirectly through food banks (Fondazione Banco Alimentare ONLUS, Associazione Banco Alimentare Roma);
- conferral, or possibly sale, to manufacturing companies, usually those that produce animal feed;
- conferral to waste management companies, which manage the surplus food as waste, possibly recovering it using available methods (e.g. a source of energy).

The findings with respect to surplus food management options (Figure 6.4.) reveal a polarization on two alternatives: donation to charitable organisations (35.3%) and conferral to waste management companies (32.2%).

Companies have also demonstrated a reasonable capacity for sales through secondary markets (20.0%), as these markets are usually more flexible with respect to sell-by dates compared to the main sales channels. It should also be noted that conferral to manufacturing companies (12.5%) is important in that the surplus food is often not provided free of charge, but is in fact sold.
The impact of each of the alternatives for managing surplus food is very different in each of the three segments examined (Figure 6.5., Table 6.5.).

The sale of surplus food through secondary markets is most common amongst companies in the ambient segment (27.4% compared to approximately 7% 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%), it is also frequently used in the chilled segment (27.6%), while it is infrequent in the frozen segment (1.5%). 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%) because these products can
be reused to produce animal feed. Milk and “fourth range” products, meaning fresh packaged fruit and vegetables that are ready to eat, are two examples.

The conferral of surplus food to waste management companies dominates in the frozen segment (97.2%) because of the challenges involved in finding other solutions. In the other two segments the percentage of surplus food managed by waste management companies is between 25 and 33%.

Figure 6.5. How surplus food is managed in the three food manufacturing segments

<table>
<thead>
<tr>
<th></th>
<th>Ambient</th>
<th>Chilled</th>
<th>Frozen</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste management companies</td>
<td>25.1%</td>
<td>33.5%</td>
<td>97.2%</td>
<td>32.2%</td>
</tr>
<tr>
<td>Secondary markets</td>
<td>27.4%</td>
<td>7.3%</td>
<td>0.8%</td>
<td>20.0%</td>
</tr>
<tr>
<td>Food banks/charitable organisations</td>
<td>42.1%</td>
<td>27.6%</td>
<td>1.5%</td>
<td>35.3%</td>
</tr>
<tr>
<td>Manufacturing companies</td>
<td>5.4%</td>
<td>31.6%</td>
<td>0.5%</td>
<td>12.5%</td>
</tr>
</tbody>
</table>
It is difficult to make generalisations about the reasons for the choices companies make with respect to managing surplus food. Six factors that influence these decisions were identified through the research:

- the residual value of the surplus food;
- concerns about company image;
- how the surplus food was generated;
- management expertise;
- capabilities of available firms;
- recoverability.

If the product is still marketable, sales to secondary markets or to manufacturing companies are an option that makes it possible, at least in part, to recover production costs.

The case studies revealed that product donation is sometimes avoided because of concerns about potential mismanagement of the donated product by charitable organisations, and products are therefore managed through other channels. Specifically, companies want guarantees that the donated product will not be delivered to the beneficiary (soup kitchens, needy families, etc.) “too late”, in order to prevent any adverse impact to the health of the final recipient that could potentially damage the company’s brand image. This is a common concern among companies that donate surplus food to charitable organisations that may not be in a position to provide any guarantees of the effectiveness of food management practices. In most cases, this concern does not prevent donation, but it leads companies to donate only products whose remaining shelf-life is long to charitable organisations, effectively selecting which surplus food to donate. This means that food that is closer to its expiration date is disposed of by other means.

A third factor that influences decisions about surplus food management options is related to the frequency with which surplus food is generated and in what quantities. If surplus food is generated sporadically (e.g. following a promotion that was less successful than anticipated), a substantial management effort is required by the charitable organisation that receives it. In fact, the organisation may be unable to collect and redistribute it within the available time frame. At the other extreme, if surplus food is generated frequently
but in small quantities, the charitable organisation that receives the donation has to make an effort on a daily basis to regularly collect small quantities of product.

A fourth factor that can limit the practice of donation is the lack of a structured process for managing surplus food within a company. Decisions about the management of surplus food are very often left up to the goodwill of individuals. The authors firmly believe that a more structured surplus food management process could increase the amount of surplus food donated. In fact, companies may be unaware of the potential alternatives to the disposal of surplus food or may not have assessed their feasibility.

The factor “capabilities of available firms” refers to the availability of non-profit organisations throughout the country that are able not only to help the needy but also to support companies that want to donate their products. This factor is particularly relevant in sectors that have a high management intensity, such as frozen food products.

Finally, the analysis confirmed the importance of the degree of recoverability in corporate decision-making (the ambient segment was ascribed a high degree of recoverability, while recoverability in the other two segments is medium). Donation to food banks or other charitable organisations is the primary surplus food management method in the high recoverability (ambient) segment (42.1% vs 22.7%, Figure 6.6), along with sales through secondary markets (27.4% vs 6.1%). As the recoverability diminishes, more food products are conferred to waste management companies (45.4% in the segments with a medium recoverability and 25.1% in the segment with a high recoverability).

Box 6.7. An example of an obstacle to donation

A dry foods manufacturer donates surplus food to developing countries outside of the European Union. The company does not donate to food banks or national charitable organisations because of points promotions on the packaging. By collecting points, the consumer may be eligible to receive free products such as sweatshirts or knapsacks. Donations within the country could be overly costly if the company had to sustain the cost of giveaways in addition to lost production costs.
Box 6.8. An example of structured management

A dry foods manufacturer donates its surplus food to both food banks and charitable organisations in the surrounding area. By turning to multiple organisations, the company is able to donate the surplus food even if the quantities are concentrated in only a few events over the course of a year. However, when donation is not a viable option, the surplus food is conferred to companies for the production of animal feed (receiving payment for the products provided). This company’s method of managing surplus food serves as an excellent example, as the surplus food is used for human consumption whenever possible and the alternative of using it for animal feed is available as needed. The fees paid by the purchasing company in the second alternative can be used to cover, at least in part, the cost of producing the surplus food, in addition to preventing its disposal as waste.

Figure 6.6. Surplus food management as a function of degree of recoverability in the food manufacturing sector (high: Ambient; medium: Chilled and Frozen)
6.6. The quantification of food waste

As described in subsection 3.1.3., food waste can be analysed from different perspectives. From a social perspective, all edible surplus food products that are not used for human consumption are considered to be food waste. Therefore surplus food that is not donated to food banks or charitable organisations or sold through secondary markets is “wasted”. From this point of view, food waste was calculated to be approximately 81,000 tonnes/year, or 44.7% of the surplus food generated.

Food waste expressed as a percentage of surplus food in each of the three product segments is presented in Table 6.6. It amounted to 30.5% in companies in the ambient segment, 65.1% in companies belonging to the chilled segment and 97.7% in companies in the frozen segment. Differences in the percentages of surplus food wasted can be explained by the different choices made regarding surplus food management options, as described in section 6.5.

Table 6.6. Summary of food waste in the food manufacturing sector

<table>
<thead>
<tr>
<th></th>
<th>Ambient</th>
<th>Chilled</th>
<th>Frozen</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surplus Food Volume (1,000 t)</td>
<td>118.2</td>
<td>51.5</td>
<td>11.7</td>
<td>181.4</td>
</tr>
<tr>
<td>Social waste Volume (1,000 t)</td>
<td>36.1</td>
<td>33.5</td>
<td>11.4</td>
<td>81.0</td>
</tr>
<tr>
<td>Percentage of surplus (%)</td>
<td>30.5</td>
<td>65.1</td>
<td>97.7</td>
<td>44.7</td>
</tr>
<tr>
<td>Recoverability</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>

Considering both the total amount of surplus food and the percentage of waste generated in each segment, the contribution of each segment to the total amount of food waste in the food manufacturing industry was calculated (Table 6.7. and Figure 6.7.): the ambient segment generates 65.2% of surplus food and accounts for 44.5% of food waste; the chilled segment generates 28.4% of surplus food and accounts for 41.4% of food waste; the frozen segment generates only 6.4% of surplus food and accounts for 14.1% of the total food waste.
The food manufacturing industry

Table 6.7. Percentage of surplus food and food waste for segments in the food manufacturing sector

<table>
<thead>
<tr>
<th></th>
<th>Ambient</th>
<th>Chilled</th>
<th>Frozen</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surplus Food</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume (1,000 t)</td>
<td>118.2</td>
<td>51.5</td>
<td>11.7</td>
<td>181.4</td>
</tr>
<tr>
<td>Percentage by segment (%)</td>
<td>65.2</td>
<td>28.4</td>
<td>6.4</td>
<td>100</td>
</tr>
<tr>
<td>Social waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume (1,000 t)</td>
<td>36.1</td>
<td>33.5</td>
<td>11.4</td>
<td>81.0</td>
</tr>
<tr>
<td>Percentage of segment (%)</td>
<td>44.5</td>
<td>41.4</td>
<td>14.1</td>
<td>100</td>
</tr>
</tbody>
</table>

Recoverability   High   Medium   Medium

Figure 6.7. Percentages of surplus food and food waste for product segments in the food manufacturing sector

Finally, looking at the three segments in terms of degree of recoverability, the segment with a high recoverability (the ambient segment) accounts for 44.5% of the total food waste, while the segments with a medium recoverability account for 55.5% of food waste. A higher percentage of food waste was found to be associated with a lower degree of recoverability.
6.7. Summary of results

Although the generation of surplus food in the manufacturing sector does not appear to be significant in percentage terms (0.4% of sales, Table 6.8), the total amount of surplus food generated is considerable (181,400 tonnes). Approximately 118,200 tonnes of this surplus food consists of products that can be stored at room temperature and for which no special infrastructure is required in terms of storage. Chilled products represent approximately 51,500 tonnes, most of which are packaged. And finally, 11,700 tonnes consist of frozen products, which include both pre-cooked food products and those that require cooking.

It was found that companies are paying increasing attention to the phenomenon of surplus food and are making continuing efforts to try to reduce it. In fact, surplus food incurs costs that affect the customer and the company’s competitiveness: costs are incurred to produce a product that then is not sold (or is sold through secondary markets), and to manage and dispose of the product.

Not all surplus food becomes waste: 55.3% of surplus food at this stage in the food supply chain is recovered for human consumption. There are in fact companies that sell surplus food products on secondary markets or donate them to food banks and charitable organisations.

<table>
<thead>
<tr>
<th></th>
<th>Ambient</th>
<th>Chilled</th>
<th>Frozen</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sales (billion €)</td>
<td>65.3</td>
<td>37.5</td>
<td>4.0</td>
<td>106.8</td>
</tr>
<tr>
<td>Volume (1,000 t)</td>
<td>34,641</td>
<td>8,553</td>
<td>1,592</td>
<td>44,786</td>
</tr>
<tr>
<td>Surplus Food</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume (1,000 t)</td>
<td>118.2</td>
<td>51.5</td>
<td>11.7</td>
<td>181.4</td>
</tr>
<tr>
<td>Percentage of production (%)</td>
<td>0.34</td>
<td>0.60</td>
<td>0.73</td>
<td>0.41</td>
</tr>
<tr>
<td>Social waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume (1,000 t)</td>
<td>36.1</td>
<td>33.5</td>
<td>11.4</td>
<td>81.0</td>
</tr>
<tr>
<td>Percentage of surplus (%)</td>
<td>30.5</td>
<td>65.1</td>
<td>97.7</td>
<td>44.7</td>
</tr>
<tr>
<td>Recoverability</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>
The food manufacturing industry

The case study analysis showed that, although there is a strong emphasis on limiting the generation of surplus food, companies pay less attention to its management. Approximately 44.7% of surplus food becomes food waste even if its recoverability is good.

This figure represents a starting point for improving the management of surplus food. To this end, internal corporate factors and other circumstances that lead to the “deterioration” of surplus food into food waste need to be considered. A greater understanding of these factors is needed to reduce food waste. Responsible surplus food management practices already in use by manufacturing companies and non-profit organisations can be helpful in this respect.

The establishment of a structured surplus food management process at a corporate level is a good solution for determining the best uses of surplus food products in the shortest possible time. First, each company would evaluate the different alternatives and create an action plan for dealing with the generation of surplus food. The plan would need to take into account how surplus food is generated (consistent low volumes, or large quantities generated infrequently) and include a hierarchy of preferred options for managing surplus food that prioritises financial returns, corporate image or ethical and social aspects.

From a broader perspective, policy-makers could encourage the use of responsible surplus food management practices and assist in the development of non-profit organisations that manage surplus food even in segments where it is more difficult, such as the chilled and frozen food products segments.
The company is a multinational that operates in the chilled segment, specifically in the dairy products sector. It has annual sales in Italy of over 50 million euros. It sells approximately 100 products, which are produced in European manufacturing plants. The sales channel is primarily made up of large-scale retail companies, while the logistics channel consists of two central warehouses. The products have a short shelf-life (approximately 30 days) and demand is seasonal. According to supply contracts with its clients, the company must guarantee approximately 20 days of shelf-life upon delivery: the internal product sell-by date is, therefore, approximately 10 days. Of this, about a day is spent at the manufacturing plant for preparation of the shipment, a day (sometimes two days) is needed to transport the products through the Italian logistics network, while the remaining days are spent in inventory at the Italian warehouses (inventory coverage lasts an average of 7 days). The quantity of surplus food generated annually by the company is equal to 0.6% of products sold. The primary reason for the generation of surplus food is that the food reached its internal sell-by date as a result of errors in demand forecasting and, therefore, production planning. One factor that affects the accuracy of demand forecasting significantly is the high number of promotions and the short notice provided by large-scale retailers when ordering (i.e. next-day orders), which makes it necessary to maintain high inventory levels. Surplus food is also generated as a result of packaging damage (packaging may become damaged at the European plant or during shipment to the client, due to pallet overlap during transport). The company has a long-standing relationship with a charitable organisation that distributes the surplus food to the needy (this decision was based primarily on ethical considerations). However a large quantity of surplus food can be generated in a few periods of the year, making it difficult for the charitable organisation to collect it all. When the organisation is unable to collect and redistribute the surplus food, it is conferred to companies that specialise in the production of animal feed.
Box 6.10. An example in the “ambient segment”

The company is a multinational food manufacturer that operates in the ambient segment. It has annual sales in Italy of over 50 million euros. The products it sells are made in European manufacturing plants. Its sales channel is primarily made up of large-scale retail companies, but also includes small-scale retailers. The logistics channel consists of one central warehouse and several local warehouses. The products have a long shelf-life (approximately 9-12 months), are of average fragility, and seasonal variations in demand are low. According to supply contracts with its clients, the company must guarantee two thirds of the product’s shelf-life upon delivery: the internal product sell-by date is, therefore, approximately 6-8 months. The quantity of surplus food generated annually by the company is equal to 0.5% of products sold, which is consistent with studies of the sector. The primary reason for the generation of surplus food is that the food reached its internal sell-by date as a result of errors in demand forecasting mainly related to promotions. Promotions at this company are, in fact, very frequent and include both discounted product prices and ad hoc packaging. In the latter case in particular, if a product with promotional packaging is not sold prior to the end of the promotion, it becomes surplus food. The client will, of course, not accept delivery of product that displays information about an old promotion. Another reason for the generation of surplus food is packaging damage (packaging may become damaged at the European plant or during shipment to the client). Finally, there are two other causes, related to returns upon delivery (when the product cannot be reintroduced into the sales channel) or returns of unsold product (related to special promotions or recurring events). The company has relationships with several food banks and charitable organisations that allow it to redirect some of the surplus food to the needy. Specifically, surplus food with a long shelf-life is donated to these groups. Surplus food nearing its expiration date is sold to an animal feed manufacturer with which the company has a well-established relationship. The products sold by the company are, in fact, well suited for this use. This second surplus food management option allows the company to recover at least some of its production costs.
Chapter 7

Retail trade

This chapter describes the retail trade sector in Italy, in terms of size, flows, configuration of logistics and production systems and degree of recoverability, subdivided into two segments (distribution centres and stores). It also describes the assessment of surplus food in the sector, which was obtained using the method described in Chapters 3 and 4, exploring the reasons surplus food is generated.

Finally, following an analysis of surplus food management options, the quantification of food waste is presented.

7.1. Organisation of the retail trade sector

Food retailers, with an annual turnover of 109.7 billion euros (Federdistribuzione, 2007), represent the intermediate stage between manufacturing companies and customers (both companies that offer food service and final consumers). The sector is composed of large-scale retail companies, small-scale retailers and market stallholders. There are 19,500 large-scale retail stores, approximately 175,000 small-scale retail stores and 29,000 market stallholders in Italy (Federdistribuzione, 2007). Although there are fewer large-scale retail stores, large-scale retail accounts for 70% of the market (77 billion euros), while small-scale retailers account for 20% and market stallholders the remaining 10%.
The analysis focused on large-scale retailers. Since small-scale retailers and market stallholders do not belong to retail chains, it is difficult to make generalisations or quantify their role as each individual store may have distinct management methods.

7.1.1. Classification into segments

The network of large-scale retail companies is characterised by:

- a network of stores;
- a network of warehouses, otherwise known as distribution centres.

Most of the time (80% of volumes handled), suppliers (e.g. manufacturing companies) deliver products to the distribution centres, which then deliver them to the stores. The rest of the time suppliers deliver products directly to the stores, especially when dealing with chilled products (e.g. milk) and small shops.

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 (hereinafter called “stores segment”) should be studied separately from distribution centres (hereinafter called “distribution centres segment”).

7.1.2. The configuration of logistics and production systems

Different systems for managing the flow of products are used in the two segments studied (stores and distribution centres).

In the distribution centres segment procurement is based on aggregated sales forecasts (i.e. for all stores served), which is facilitated by the use of software for managing replenishment. It is also common practice in the sector to make speculative purchases, where large quantities of product are purchased at a discount from
suppliers. Products are usually handled as full unit loads, on pallets containing multiple cartons of the same item. In order to ensure stores receive a high level of service, managing products from stock is preferred in this segment, although some flows are also managed by cross-docking (mainly perishable products, such as fruit and vegetables). With this method, product deliveries from multiple suppliers are received and checked, and a multi-product shipment is immediately prepared for delivery to retail stores.

At stores, procurement is based on the individual retailer’s sales forecasts. A minimal amount of product is kept in stock (storage facilities are not always available at stores). In the event of a stock-out, the desired products will be replenished in the next delivery from the distribution centre. The management unit - for orders and restocking the shelves - may be a single article up to a carton containing multiple packages of the same article. Larger stores also have departments where certain products are processed (e.g. the fresh meat department), where products are prepared to meet the specific needs of the business. In the stores segment generally, various different departments can be identified on the basis of the products and how they are managed (Table 7.1).

In recent years, some companies in the retail trade sector have set up their own processing/manufacturing centres in order to market products under their own brand (private label). This flow, which is still marginal, was included in the analysis of food manufacturing companies.

<table>
<thead>
<tr>
<th>Department</th>
<th>Examples of Product Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-perishable food products</td>
<td>Pasta, rice, preserves, oil, beverages</td>
</tr>
<tr>
<td>Bakery</td>
<td>Fresh bread</td>
</tr>
<tr>
<td>Dairy and other chilled products</td>
<td>Milk, pre-packaged cheese and cured meats</td>
</tr>
<tr>
<td>Deli counter</td>
<td>Cheese and cured meats packaged to order, freshly prepared deli foods</td>
</tr>
<tr>
<td>Fresh meat</td>
<td>Freshly packaged meat</td>
</tr>
<tr>
<td>Fish</td>
<td>Freshly packaged fish</td>
</tr>
<tr>
<td>Produce</td>
<td>Fruit and vegetables</td>
</tr>
<tr>
<td>Frozen foods</td>
<td>Ice cream, pre-cooked foods, frozen vegetables</td>
</tr>
</tbody>
</table>
7.1.3. The recoverability of surplus food

The distinctive characteristics of the two segments give rise to different degrees of surplus food recoverability, which is a function of intrinsic recoverability and the level of effort required by companies to reclaim and maintain the surplus food (see Chapter 3, subsection 3.1.4. for more details).

In terms of recoverability, the distribution centres segment is comparable to food manufacturing companies. It is characterised by a high degree of recoverability resulting from the combination of its intrinsic recoverability (high) and management intensity (low). The intrinsic recoverability is high because products are easily stored (as they are usually packaged), ready to use, and their residual shelf-life (following the generation of surplus) usually exceeds one week. The management intensity is low because the level of effort required to reclaim (in most cases this involves the temporary storage of products and compiling the necessary documentation) and maintain (regular vans and conventional storage can be used to transport and store the product) products is generally minimal.

However, the stores segment is characterised by a medium degree of recoverability. The intrinsic recoverability is medium because products are packaged and ready to use, however the remaining shelf-life is usually only a few days. The management intensity is medium because stores do not often have enough space to temporarily store surplus food products so charitable organisations or food banks must frequently collect small quantities of surplus food from each store, with consequent logistical issues.

Conceptually, it would also be possible to further break down the analysis of recoverability by product type at this stage in the food supply chain. However, given the strong commonality of the processes studied in the retail trade sector, it was decided against further segmentation of the analysis.

7.2. Study sample

In order to study the surplus food phenomenon in detail, 34 case studies were conducted (Table 7.1.) within the two segments of the retail trade sector. More specifically, 5 case studies were conducted
within the distribution centres segment and 29 case studies within the stores segment (involving supermarkets, hypermarkets, convenience stores, and cash-and-carrys). The case studies primarily involved logistics directors in the first segment and sales managers in the second segment. The interviews were carried out on-site, whenever possible.

An analysis of the composition of the study sample shows that the companies interviewed are located throughout the country and represent a 19.6% share of the retail trade market¹.

Table 7.2. Information on the sample set used to study the food retail sector

<table>
<thead>
<tr>
<th>Department</th>
<th>Distribution centres</th>
<th>Stores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of case studies</td>
<td>5</td>
<td>29</td>
</tr>
<tr>
<td>Percentage of sector sales represented by the case studies</td>
<td>19.6%</td>
<td>19.6%</td>
</tr>
</tbody>
</table>

The study sample was used to both understand the dynamics of creating and managing surplus food and to provide an empirical basis for the quantitative assessment of surplus food and food waste on an annual basis (see Chapter 4 for more details).

The data available for this stage in the supply chain were based on the monetary value of sales. It was therefore necessary to introduce some assumptions regarding product value density (2.5 €/kg). This value, which was derived from the case studies, takes into account both the sales mix and the density of various different product categories.

There was a difference in the quality of the quantitative data available on the generation of surplus food between the distribution centres segment and the stores segment. Sources of surplus food are often recorded in information systems in the distribution centres segment. In the stores segment, stock levels are monitored and the difference between sales and the quantities received from distribution centres is documented, while the reasons for this difference are evaluated qualitatively.

¹ This percentage includes only the portion of the business’ sales related to food products.
7.3. The generation of surplus food

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.

7.3.1. The main sources of surplus food

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, the date by which a product must be delivered to a store so that the retailer has time to sell it to the consumer may be reached (see Box 7.1.).

<table>
<thead>
<tr>
<th>Products</th>
<th>Internal sell-by date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-perishable food products with a shelf-life of 451 to 999 days</td>
<td>47 days</td>
</tr>
<tr>
<td>Non-perishable food products with a shelf-life of 91 to 150 days</td>
<td>30 days</td>
</tr>
<tr>
<td>Eggs</td>
<td>25 days</td>
</tr>
<tr>
<td>Sausage</td>
<td>60 days</td>
</tr>
<tr>
<td>Fresh cheese</td>
<td>20 days</td>
</tr>
<tr>
<td>Packaged cured meats</td>
<td>30 days</td>
</tr>
<tr>
<td>Frozen foods</td>
<td>120 days</td>
</tr>
</tbody>
</table>

Box 7.1. An example of “internal sell-by date”

A large-scale retail company enters the internal sell-by date for various foods into its database in order to ensure that stores receive products that have sufficient time remaining before they reach their sell-by date. Some examples are shown in the following table.

In the stores segment, once the product reaches its sell-by date it can no longer be sold to the consumer. This trend has been on the increase as consumers often choose products that have further to go...
before reaching their expiration date, while products that need to be consumed sooner are left on the shelves. In addition, consumers sometimes move products within a store. For example, the consumer may pick a product up and then decide not to buy it, leaving it near the checkout. If products such as these are not found by staff and promptly returned to the appropriate section they may not be purchased.

Another source of surplus food in the retail trade sector is caused by non-compliance.

One form of non-compliance is that related to the deterioration of product packaging, which includes both packaging damage and packaging for promotions that have ended.

A second form of non-compliance involves product damage. In the distribution centres segment incorrect handling may take place either at the distribution centre or during transport. Some product packaging, packaged salad for example, is especially fragile so even a small area of overlap by a heavier product can cause damage. In the stores segment, however, packaging damage is often caused by customers (for example products may get dropped on the ground or knocked by supermarket trolleys). At cash-and-carrys it was also found that the consumer will often open multi-product packages (e.g. packages containing multiple packs of crisps) but take only one item. The opened packages, or the individual products they contain, may not always be subsequently purchased.

In addition, the product itself rather than its packaging may not be in compliance with required commercial standards (e.g. appearance or information provided on the label).

For example, as was observed in the previous stages, fruit and vegetables and other fresh products may be selected based on their appearance even within distribution centres. Or the product label or carton label may contain partial or incorrect information (e.g. weight or date of packaging). This generates surplus food at the distribution centre both when the error is identified there and when it is identified at the store, which results in the return of the product to the distribution centre.

At stores, however, a qualitative loss in terms of product appearance may be caused by carelessness on the part of the consumer when examining food products, especially fruit and vegetables.

In the stores segment, non-compliance related to labelling is a significant issue. Non-compliance related to labelling may involve
both products packaged in-store, where weighing and pricing errors may occur, and pre-packaged products that are labelled in-store.

A further reason for the generation of surplus food is product returns. The stores that were studied belong to a retail chain that has centralised the distribution of goods. Nonetheless, a store may refuse to accept a delivery from the distribution centre if the contents of a shipment are incorrect. This situation occurs even more frequently at stores that are franchises. This causes surplus food to be generated at the distribution centre unless the returned products can be redirected to other stores within a reasonable time frame.

Products that are not sold by a store will also be returned to the distribution centre, generating surplus food at that location. This practice comes from the commercial imperative to ensure that specific products, or those related to special promotions or holidays, are available on the shelves. It may be preferable to have the distribution centre manage these products if they are not purchased by the consumer. The distribution centre may be able to reallocate the product to other stores; if not, it may be able to return the unsold product to the manufacturer or dispose of it centrally.

7.3.2. The impact of surplus food sources

The relative impact of the various different sources of surplus food varies depending on which of the two segments is considered.

In the distribution centres segment, surplus food is generated primarily because the product’s internal sell-by date has been reached (48.7%, as shown in Figure 7.1). The second most common source of surplus food is product returns (28.1%). 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%). A slightly lower percentage of surplus food is a result of packaging non-compliance (10.4%).

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. This is followed by packaging and product non-compliance (mainly fruit and vegetables).
7.3.3. Food scraps and reutilisation

The sources listed above do not always lead to the generation of surplus food. In fact, in some cases products may still be distributed through commercial channels provided specified measures have been taken. For example, if the secondary product packaging were to be damaged at the distribution centre, it could be replaced (incurring the costs of labour and materials). In order to reduce the generation of surplus food at stores, special discounts may be applied to products that are approaching their expiration date (see Box 7.2.).

In the context of this study, products that are managed in these ways are not included in the quantification of surplus food (see Chapters 3 and 4). Therefore, the percentages presented for the sources described above and the tonnages presented in the following paragraphs were calculated based on the volume of surplus food generated, exclusive of these practices.
Box 7.2. Avoiding surplus through discounts

At many stores, products that are approaching their expiration date are often offered to customers at a reduced price. The most common situation involves non-perishable food products, for which a store will lower the price several weeks prior to the product expiration date to move the product more quickly and make room for “new” products to be displayed on the shelves. Discounts on chilled products are more interesting. The case studies showed that the stores belonging to one retail chain put nearly expired dairy products in a special display, discounting them first by 30% and then by 50%. This reduces the risk that the product will not be sold before it reaches its expiration date.

Another large-scale retail chain uses a different sales approach to reduce surplus food in the fish department. Stores belonging to this retail chain discount unsold fish products by 50%. The sale takes place at a predetermined time on Sundays, although the consumer is unaware of this. The idea is to benefit customers that happen to be in the store during that time period while minimising the creation of deal-seeking behaviour amongst consumers.

Finally, the following situations were not considered to generate surplus food and were therefore not considered in its quantification:

- food safety issues such as opened products that are taken off the market, as when advised to do so by health authorities; the quality of these products is no longer assured and the product therefore becomes food waste;
- products returned to suppliers, which were included in the previous chapter in relation to food manufacturing companies;
- thefts and product shrinkage; for example, when there is a decrease in the unit weight of a product following its arrival at a store due to dehydration, either during storage or while on display, this weight reduction does not enter into the surplus food calculation;
- processing scraps, such as ham parts discarded by counter staff at the deli counter.
7.4. The quantification of surplus food

The retail trade sector generates approximately 777,600 tonnes of surplus food (Table 7.3.), or 1.4% of total sales. The stores segment generates a more substantial proportion of surplus food (2.3% of sales) than the distribution centres segment (0.3% of volumes handled).

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 sections in stores that generate the most surplus food as a proportion of sales (see Table 7.4.) are the bakery (9.0%), the fish department (5.0%), the produce department (5.0%) and the fresh meat department (4.0%). These are followed by the deli counter (3.5%) and the dairy and other chilled perishable products section (1.5%). The departments that generate the lowest percentages of surplus food are the non-perishable food products section where products are stored at room temperature (0.5%) and the frozen foods section (0.25%).

7.5. Managing surplus food

The options for managing surplus food are well-defined in both segments, due in part to specific tax laws. Once it has been generated, retail chains can manage surplus food in three different ways:
• donation to charitable organisations or food banks (e.g. Fondazione Banco Alimentare and Last Minute Market);
• conferral, or possibly sale, to manufacturing companies, typically those that produce animal feed;
• conferral to waste management companies.

Table 7.4. Percentages of surplus food generated in various store departments

<table>
<thead>
<tr>
<th>Department</th>
<th>% Surplus Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-perishable food products</td>
<td>0.5</td>
</tr>
<tr>
<td>Bakery</td>
<td>9.0</td>
</tr>
<tr>
<td>Dairy and other chilled products</td>
<td>1.5</td>
</tr>
<tr>
<td>Deli counter</td>
<td>3.5</td>
</tr>
<tr>
<td>Fresh meat</td>
<td>4.0</td>
</tr>
<tr>
<td>Fish</td>
<td>5.0</td>
</tr>
<tr>
<td>Produce</td>
<td>5.0</td>
</tr>
<tr>
<td>Frozen foods</td>
<td>0.25</td>
</tr>
</tbody>
</table>

It is important to note that it is impossible to sell a product thorough secondary channels at this stage in the supply chain as there is no alternative to in-store sales.

Conferral to waste management companies in the stores segment refers to the local municipal waste management company. The cost incurred by stores for waste collection is a function of store size (rather than waste volume) and, unlike the distribution centres segment, waste collection in the stores segment is paid by means of a waste tax or fee. It follows that donations to food banks or charitable organisations do not lead to any direct savings with respect to this cost item.

The findings regarding surplus food management methods reveal that a considerable amount of product is disposed of as waste (91.5%, Figure 7.2.). Nonetheless, donation to food banks and charitable organisations is not negligible (7.5%). A small amount of surplus food is conferred to manufacturing companies (1.0%).

The relative impact of the different surplus food management methods is different in each of the two segments considered (Figure 7.3. and Table 7.5.). Specifically, more than half of the surplus food
Figure 7.2. How surplus food is managed in the retail trade sector

Figure 7.3. How surplus food is managed in the two food retail segments
in the distribution centres segment is conferred to waste management companies (55%), although a good proportion (35%) is also donated to food banks and charitable organisations. The remainder (10%) is conferred to manufacturing companies. It can be seen that in the stores segment almost all of the surplus food (95.4%) is disposed of as waste, for the reasons mentioned above. Despite recent initiatives to reclaim surplus food generated by stores (see Box 7.3), to-date only a small proportion of surplus food (4.6%) is recovered for human consumption.

**Box 7.3. An example of structured surplus food management at retail stores**

A retail chain with operations throughout the country started collaborating with various associations for the collection of surplus food, establishing internal procedures for product selection by personnel and collection by the associations. Over 180,000 euros worth of surplus food was donated in 2010. This amount was collected from the six hypermarkets involved in the initiative to-date and is limited to packaged products stored either at room temperature or refrigerated. Other product categories, such as non-packaged chilled products, meat and fish are not currently included in the initiative. Stores, in fact, prefer to donate products that are safe from a health and safety perspective and products that are pre-labelled with a clear expiration date. In fact, the agreements require that store personnel and association volunteers carefully check product labels prior to their collection. The collection of surplus food from the hypermarkets is scheduled for specific times and days of the week, as it is identified during nightly product checks in the store departments. The possible expansion of the initiative to other stores is currently being considered.

**Table 7.5. How surplus food is managed in the two food retail segments**

<table>
<thead>
<tr>
<th></th>
<th>Distribution centres</th>
<th>Stores</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste management companies</td>
<td>55.0%</td>
<td>95.4%</td>
<td>91.5%</td>
</tr>
<tr>
<td>Food banks/charitable organisations</td>
<td>35.0%</td>
<td>4.6%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Manufacturing companies</td>
<td>10.0%</td>
<td>-</td>
<td>1.0%</td>
</tr>
</tbody>
</table>
It is interesting to note that the store department that donates the highest proportion of its surplus food is the non-perishable food products section, where products are stored at room temperature and where approximately 30% of the surplus food generated is donated (Table 7.6). This is followed by the bakery department and the dairy and other chilled perishable products department, where donation accounts for approximately 10% of the surplus food generated in each department.

Table 7.6. Percentage of donations from different departments in the stores segment

<table>
<thead>
<tr>
<th>Department</th>
<th>% Surplus Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-perishable food products</td>
<td>30.0</td>
</tr>
<tr>
<td>Bakery</td>
<td>10.0</td>
</tr>
<tr>
<td>Dairy and other chilled products</td>
<td>10.0</td>
</tr>
<tr>
<td>Deli counter</td>
<td>0.5</td>
</tr>
<tr>
<td>Fresh meat</td>
<td>0.0</td>
</tr>
<tr>
<td>Fish</td>
<td>0.0</td>
</tr>
<tr>
<td>Produce</td>
<td>0.5</td>
</tr>
<tr>
<td>Frozen foods</td>
<td>1.0</td>
</tr>
</tbody>
</table>

The reasons for the choices companies make with respect to managing surplus food are similar to those identified at manufacturing companies. The following factors were found to influence company choices:

- residual value of the surplus food;
- recoverability;
- agreements with manufacturers and logistics operators
- management expertise;
- capabilities of available firms;
- health and safety regulations

In some cases, products with a short shelf-life are not donated, both because there is a lack of awareness of the fact that food banks and charitable organisations will collect products nearing their
expiration date, and to avoid product being delivered to the needy “too late” (potentially to the detriment of the recipient’s health or to the company’s image). This means that food that is closer to its expiration date is disposed of by other means.

A second factor that influences decisions about surplus food management is related to recoverability and the difficulties involved in collecting surplus food from stores, and the collection of chilled and frozen products generally. In fact, this involves the frequent collection (several times a week) of small quantities of product nearing the expiration date.

Another factor that should be highlighted involves agreements between food manufacturing companies and retail companies. Food manufacturing companies may not authorise the donation of brand name products by retailers, fearing that inappropriate management of the donated product could have a negative impact on company image. In this situation, the surplus food generated at distribution centres becomes waste. Similarly, agreements between retailers and the logistics providers that manage the distribution centres may impose limitations on the choice of surplus food management options. In particular, contractual agreements may stipulate reimbursement for products damaged during normal handling operations at the warehouse and the disposal of such products by the logistics provider. In this situation, the management of surplus food caused by packaging damage is therefore delegated to a third party and the retailer is not involved in its management.

A fourth factor that can impede the practice of donation is the lack of a structured surplus food management process within a company. At some retail chains, it was found that store managers could make independent choices about donating food, following rules and practices that had been established at a local level. In other cases, it was found that individual store managers were required to wait for corporate guidance prior to initiating any collaborative projects with food banks or charitable organisations. The capabilities of the organisations involved in handling donations play an important role. It appears to be critical to have organisations available across the country that can collect surplus food generated by a number of different stores on a very
frequent basis. Small towns may have a number of small stores that each generate small quantities of surplus food on a daily basis. It cannot be taken for granted that associations will be available to collect small amounts and have the means to move them, especially for surplus food from the chilled or frozen food departments.

Finally, it is important to highlight that some surplus food products do not lend themselves well to donation due to health and safety regulations. These include unpackaged products that are sold at the deli counter, and in the fish and fresh meat departments. These products cannot be conferred without first being suitably packaged and labelled to indicate the product preparation and expiration dates.

The study confirmed that the degree of recoverability is an important factor in corporate decision-making at this stage in the supply chain as well. It may be recalled that recoverability in the distribution centres segment was determined to be high, while in the stores segment it was identified as medium. Figure 7.3 shows that it is primarily distribution centres, the segment with a high recoverability, that donate surplus food to food banks and charitable organisations (35% vs. 4.6%), and that confer surplus food to manufacturing companies (10% compared to not used). The disposal of surplus food as waste predominates in the stores segment (95.4% vs. 55%), which is the segment with a lower recoverability.

7.6. The quantification of food waste

As described in subsection 3.1.3., food waste can be analysed from different perspectives. From a social perspective, all edible products that are not used for human consumption are considered to be food waste. Therefore surplus food that is not donated to food banks or charitable organisations is “wasted”. From this point of view, as shown in Table 7.7., food waste was calculated to be approximately 719,100 tonnes/year, or 92.5% of the surplus food generated.

Food waste expressed as a percentage of surplus food is different in each of the two segments. It amounts to 65% in the distribution centres segment and to 95.4% in the stores segment. The reason for the different percentages of food waste is the different level of donation in each of the two segments.
Considering the total amount of surplus food generated by each segment and the total amount of food waste generated by each segment, it can be seen that: the distribution centres segment, which generates 9.5% of surplus food, contributes 6.7% of food waste (Table 7.8. and Figure 7.4.); the stores segment, which generates 90.5% of surplus food, contributes 93.3% of all food waste generated at this stage in the supply chain.

It should be noted that, overall, the percentage of food waste in the distribution centres segment (6.7%), which has a high degree of recoverability, is lower than the percentage of food waste in the stores segment (93.3%), which has a medium degree of recoverability.

Table 7.7. Summary of food waste in the two food retail sector segments

<table>
<thead>
<tr>
<th>Surplus Food</th>
<th>Distribution centres</th>
<th>Stores</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (1,000 tonnes)</td>
<td>73.6</td>
<td>704.0</td>
<td>777.6</td>
</tr>
<tr>
<td>Social waste</td>
<td>Volume (1,000 tonnes)</td>
<td>47.8</td>
<td>671.3</td>
</tr>
<tr>
<td>Percentage of surplus (%)</td>
<td>65.0%</td>
<td>95.4</td>
<td>92.5</td>
</tr>
<tr>
<td>Recoverability</td>
<td>High</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>

Table 7.8. Percentages of surplus food and food waste in the retail trade sector

<table>
<thead>
<tr>
<th>Surplus Food</th>
<th>Distribution centres</th>
<th>Stores</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (1,000 tonnes)</td>
<td>73.6</td>
<td>704.0</td>
<td>777.6</td>
</tr>
<tr>
<td>Percentage by segment (%)</td>
<td>9.5</td>
<td>90.5</td>
<td>100</td>
</tr>
<tr>
<td>Social waste</td>
<td>Volume (1,000 tonnes)</td>
<td>47.8</td>
<td>671.3</td>
</tr>
<tr>
<td>Percentage by segment (%)</td>
<td>6.7</td>
<td>93.3</td>
<td>100</td>
</tr>
<tr>
<td>Recoverability</td>
<td>High</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>
On the other hand, a closer look at the distribution centres segment reveals that the percentage of surplus food wasted within this segment (65%) is much higher than an amount that would be considered to be “unavoidable”. Therefore, much work still remains to be done in terms of waste reduction. This is even more true in the stores segment, despite the fact that surplus food recoverability in this segment is lower.

7.7 Summary of results

The generation of surplus food in the retail trade sector is significant both in absolute terms (777,600 tonnes, as shown in Table 7.9.) and in percentage terms (2.3% of store sales and 1.4% of the total volume channelled through the network of distribution centres and stores).

Approximately 73,600 tonnes are generated by distribution centres, while 704,000 tonnes are generated by stores. This phenomenon is particularly relevant from a food security perspective, given the wide variety of food products involved (dry foods, beverages, bread, dairy products, cured meats, fresh meat, fish, and frozen products, all for the most part packaged).

Figure 7.4. Percentages of surplus food and food waste in the retail trade sector
Reducing food waste at this level in the food supply chain would be beneficial not only because of the quantity of surplus food involved, but also because of its nutritional value.

Although the percentage of surplus food that is wasted is considerable, the situation is improving. It was found that some large-scale retail chains are developing pilot projects and have started collaborating with food banks and charitable organisations to improve the recovery of surplus food. This strategy requires an on-going commitment by those involved in the collaboration. On one side, the retail chains (i.e. stores) must employ resources to identify surplus food on the shelves and to store it until it is picked up. On the other side, food banks and charitable organisations must make regular trips to the various stores (even for small quantities) and quickly redistribute the collected products, as in the situation described in Box 7.4.
Box 7.4. A structured organisation for recovering surplus food from stores

Siticibo is a Fondazione Banco Alimentare association that was founded in 2003 for the collection of surplus food from retail stores and food service establishments in the food service industry (see Chapter 8). There are several critical aspects to the collection of surplus food from these businesses, the most important of which is the need to rapidly redistribute the food before it goes bad. The Siticibo GDO project (Grande Distribuzione Organizzata, or Fast Moving Consumer Goods), which focuses on collecting surplus food from stores, was started in 2009 in the province of Florence and has now spread to various other locations in Northern Italy, including the Milan area. Operationally, following the drafting of a preliminary agreement with the interested store that identifies the products to be collected, collection times, and the responsibilities of the parties involved, a trial period is initiated. If both the store and the association feel that the trial was successful, they will continue the collaboration. More specifically, once the product has been selected by store personnel, the association goes to collect the surplus product. Association volunteers check both the product and storage conditions when it is collected. Concurrently with pickups at various stores, Siticibo redistributes the surplus food to beneficiary organisations. This is a “just-in-time” flow, which ensures that the product will be consumed before it reaches its expiration date.

Today, the association collects over 1,500 tonnes of surplus food per year, using its insulated vehicles and a team of volunteers.
It is clear that there are plenty of opportunities in the retail trade sector to improve the recovery of surplus food for social purposes. First, the recovery of surplus food generated by the distribution centres segment, which is characterised by a high degree of recoverability, can be increased. In this regard, it may be useful to learn from the experiences of manufacturing companies. Or it might be more convenient to send the surplus food generated by stores back to the distribution centres so that associations can collect larger quantities from a single location. Distribution centres could, in fact, collect surplus food when they deliver products without incurring additional costs. Secondly, it could be worthwhile, when a distribution centre is unable to collect the surplus food, to involve aid organisations in collecting surplus food directly from stores. Some useful information can be gained from the experiences of several retail chains. In addition, structuring the management process at the corporate level could make it easier to recover products in the shortest possible time frame.

It is also useful to consider the role of policies. Policy-makers could identify ways in which to promote the dissemination of responsible donation practices. In particular, it should be noted that a significant quantity of surplus food from stores is conferred to waste management companies as “garbage”, in part because the waste disposal fee is related strictly to store size, regardless of the actual quantity of waste disposed. This means that, for now, there is no financial incentive for stores to take a more responsible approach to food waste. It would seem appropriate that reductions in the volume of waste disposed (through the recovery of surplus food for the purpose of human consumption, which involves effort by the store) should be reflected in lower waste disposal costs.
This chapter describes the food service sector, in terms of size, flows, configuration of logistics and production systems and degree of recoverability. It also describes the assessment of surplus food in the sector, exploring the reasons surplus food is generated. Finally, the different ways in which surplus food is managed are presented, followed by the quantification of food waste.

8.1. Organisation of the food service industry

The food service sector is becoming increasingly important in Italy, given the growing number of meals eaten outside home. The total annual turnover for the 230,000 food service establishments in Italy, including bars, restaurants and canteens, is approximately 45 billion euros (ISTAT, 2007).

8.1.1. Classification into segments

Operational practices, the organisation of the supply chain and the degree of recoverability vary according to the type of food service provided. In order to account for the differences between these services, food service establishments were categorised as either collective food service (hereinafter referred to as the “collective
The total annual turnover of the approximately 3,000 companies in the collective catering segment, which provide food services at company, school, hospital and military canteens, is approximately 4 billion euros. The sector is highly concentrated, and the market is dominated by a few more structured companies. There are 227,000 companies in the commercial catering segment, including bars, fast food outlets, restaurants and pizzerias, with a total annual turnover of over 39 billion euros.

The main differences between the two food service segments are the organisational structure, how meals are delivered, and the type of meals served.

In terms of organisational structure, most business in the collective catering segment is outsourced by large corporations by means of a competitive tender process. Once a company has won the tender, the contractual terms that specify the details relating to the services to be provided (e.g. hours during which the service is provided and the type of meals to be served) are established. The contractor must strictly comply with the provisions of the contract. The commercial catering segment, on the other hand, is made up primarily of small independent companies and large restaurant chains.

In terms of meal delivery, food is served on a large scale (e.g. canteen service for the military) and according to a set schedule (in most cases at lunchtime) in the collective catering segment. In addition, depending on the establishment, meal delivery may be self-service, table service or even home delivery (e.g. assisted living services for the elderly). In the collective catering segment, meals are typically prepared in advance because the number and type of meals required is either known in advance or may be estimated (e.g. menus for schools or hospitals). In the commercial catering segment, however, the volume of meals served may be smaller and the time at which they are served is not fixed. There are cafés known as “tavole fredde” in Italian (a sort of cafeteria that serves pre-prepared meals, typically reheated but not cooked on-site) where meals are served throughout the day, restaurants that are only open in the evening, and fast food restaurants that stay open all night. In addition, the
meal is usually prepared after the customer has placed their order. In terms of the type of food served, in the collective catering segment the menus, types of dishes to be served for each course (e.g. how many first and second courses), portion sizes, time and manner of preparation, and limitations on repeating the same dishes are all established at the time the contract is signed. In the commercial catering segment there is much more flexibility in terms of the dishes offered, which may be decided daily by restaurant managers or chosen by customers from a menu.

8.1.2. The configuration of logistics and production systems

An understanding of how the logistics and production systems are configured at both collective and commercial catering companies is needed in order to study the generation of surplus food in the food service sector. Four different configurations were identified (as shown in Figure 8.1.1.).

Figure 8.1. Logistics and production configurations in the food service industry
In privately managed businesses, managers procure supplies directly and store products on-site when required (i.e. a structure similar to configuration A). When a company manages multiple food service establishments, the procurement of raw materials is usually centralised (configurations B, C and D). More specifically, information systems are used to support product ordering, taking into account the quantities identified in the contract and estimates of customer turnout or number of reservations (a list of ingredients and quantities is available for each type of meal). This makes it possible to obtain the discounts and services typically available when large volumes of product are purchased. Centralised warehouses are also commonly used, from which deliveries to the company’s kitchens will be made (configurations C and D), with the exception of deliveries of fresh products such as bread, dairy products, and fruit and vegetables. The process of procuring supplies for food service establishments takes into account the types of products and the storage facilities available. Usually, products that can be stored at room temperature are procured on a weekly basis, while fresh products are procured more frequently, two or three times a week.

Some food service establishments have a kitchen on site (configurations A and C), so that food products can be prepared and cooked at the location where the meal will be consumed. Others need to outsource food preparation and cooking to central kitchens.

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**Box 8.1. An example of a centralised warehouse in the collective catering segment**

One of the biggest companies in the Italian collective catering segment has a storage facility of over 23,000 m² in central Italy, two-thirds of which is used to store products at ambient temperatures and one-third of which is used to store refrigerated products. The warehouse receives products from over 300 accredited suppliers, stores them temporarily, and then distributes them to meal-preparation facilities. Over 60,000 tonnes of product is handled at the warehouse annually, using the same management processes identified at food manufacturing company warehouses (Chapter 6) and large-scale retail distribution centres (Chapter 7).
The food service industry

( configurations B and D, this is common for school canteens for example). In this second case, meals that are ready to be served leave the central kitchen facility shortly before the meal service is scheduled to start, and are delivered to canteens using suitable means of transport. No additional preparation, aside from portioning, is needed. In the collective catering segment, the kitchens and equipment at canteen locations are usually owned by the client. Conversely, large central kitchens are owned by the contractor, and are located in a central position with respect to the canteens that they serve. Variants on this arrangement may also be found, such as central kitchens that provide both centralised service and the opportunity to consume a meal on site.

8.1.3. The recoverability of surplus food

The specific characteristics of the two different segments give rise to different degrees of surplus food recoverability, which is a function of intrinsic recoverability and management intensity (see Chapter 3, subsection 3.1.4. for more details).

Surplus food in the collective catering segment consists primarily of prepared or cooked foods that did not get served to the consumer. Surplus food in this segment is characterised by a medium degree of recoverability, 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 has a short shelf-life (it typically needs to be consumed within 24 hours of being prepared). The management intensity is medium because a significant level of effort is needed by both the collective catering service providers and by the recipients (e.g. food banks) to reclaim and maintain surplus food products. Food service companies need to lower the temperature of the food (using special equipment such as a blast chiller, as illustrated in Box 8.2) in order to recover it, then they must package it and refrigerate it (this must be done for both daytime and evening meals). Food banks and charitable organisations must collect the surplus food from each canteen on a daily basis.
Surplus food in the commercial catering segment also consists primarily of prepared or cooked food products not served to the consumer. The commercial catering segment however is characterised by a low degree of recoverability. The activities involved in managing surplus food are the same as in the collective food service segment, but more effort is needed for three reasons. The first reason is that, on average, each restaurant generates a smaller volume of surplus food (as fewer meals are served). Secondly, restaurants in the commercial catering segment have less storage capacity in which to maintain the surplus food prior to its collection by food banks or charitable organisations. And finally, restaurants generate surplus food throughout the day (as mealtimes are not fixed). This means that more frequent collection by food banks or charitable organisations is needed.

The dynamics of generating and managing surplus food also vary according to the type of dish prepared. For example, the following considerations affect the potential use of various dishes in the collective catering segment:

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**Box 8.2. Equipment needed to manage surplus food in the food service sector**

The equipment needed to recover/reutilise foods are: blast chillers, heat-sealing machines and separate refrigerators. The blast chiller uses high speed cold air circulation to rapidly extract heat from food in a controlled manner, cooling it rapidly. This preserves the product’s qualitative and organoleptic properties. This equipment is quite expensive, takes up a lot of room and uses a lot of energy. As a result, not all facilities will have access to this equipment. The heat-sealing machine safely and securely seals the chilled food in packages. Each package must then be labelled with the following information: type of product, number of portions, ingredients, and date. Separate refrigerators are needed because chilled foods and blast chilled foods should be stored in separate environments for food safety reasons.

It should be underlined that in the collective catering segment, this equipment often belongs to the client, who may decline to invest in these solutions. Not having access to a blast chiller in fact means that all meals must be freshly prepared and are not reheated.
• First and second courses: first courses are produced in large quantities as production costs are low and consumers always request them. Second courses are prepared on a smaller scale as the raw materials are more expensive. Companies will often prepare or cook them upon request and provide alternatives that can be prepared to order (e.g. they prefer to offer grilled meat over breaded cutlet). The blast chilling process is simple to implement for both first and second courses and it facilitates the donation of these dishes.

• Side dishes: are produced in large quantities because they are often requested by the consumer. Cooked side dishes may be recovered using a blast chiller. It is difficult to donate uncooked “dressed” side dishes as they are highly perishable (however uncooked products that have not been dressed may be stored for later use).

• Fruit and bread: these foods are always available on the menu and are easily recovered for human consumption, although they need to be recovered and used without delay. At some facilities (e.g. schools) bread and fruit are part of the standard menu, but once served and handled by the children they cannot be recovered for human consumption, even if unconsumed. Some steps have been taken to reduce this issue at the source by sizing portions more accurately or providing bread and fruit upon request.

8.2. Study sample

In order to study the surplus food phenomenon in detail, 11 case studies were conducted, 7 in the collective catering segment and 4 in the commercial catering segment (Table 8.1.). The case studies involved operations or logistics directors and quality assurance managers. An analysis of the sample shows that the companies involved in the study represent 43% of the market in the collective catering segment (it should be recalled that this sector is highly concentrated, as discussed in section 8.1) and 4% in the commercial catering segment. Both medium-large companies (9 case studies) and medium-small companies (2 case studies) were involved. Many of the companies are based in Northern Italy, a number of which have various food service establishments throughout the country.

1 Companies with more than 250 employees were considered as medium-large. Conversely, companies with less than 250 employees were considered as medium-small.
The study sample was used to both understand the dynamics of creating and managing surplus food and to provide an empirical basis for the assessment of surplus food and food waste on an annual basis (see Chapter 4 for more details). The data available for this stage in the supply chain were based on the monetary value of sales. Annual production was estimated using the density of a meal (€/kg), which itself was calculated as a function of meal composition (a mixture of first and second courses, side dishes and fruit) for each of the two segments.

It should be noted that there was less information available about surplus food at a company level in comparison with other stages in the supply chain. Therefore, the level of detail of the study was constrained by the availability of data.

The study was only able to provide a glimpse into the generation of surplus food at the many family-run restaurants and bars in Italy (over 200,000). This contribution cannot, to-date, be extracted from the ISTAT data on commercial catering. It was therefore decided to extrapolate the findings from the case studies on restaurant chains to the commercial catering segment as a whole. It is believed that, although surplus food generated by small businesses may often be “reutilised” internally, fewer organisational opportunities likely lead to the generation of larger amounts of surplus food, with the overall result being a percentage of surplus food that is comparable to that of larger businesses.

8.3. The generation of surplus food

There are three main reasons for the generation of surplus in the food service industry: unconsumed food, meal preparation errors and delays in meal delivery.

| Table 8.1. Information on the sample set used to study the food service industry |
|---------------------------------|----------------|----------------|
|                                  | Collective      | Commercial     |
| Number of case studies           | 7              | 4              |
| Percentage of sector sales       | 43%            | 4%             |
8.3.1. The main sources of surplus food

Unconsumed food is primarily a result of inaccurate estimation of the number of meals required or changes in the number of reservations. Order forecasting is especially problematic in two respects. First, it is difficult to predict the influx of customers, with respect to both numbers and time of day (especially in the commercial catering segment). Secondly, it is difficult to predict which dishes customers will choose (this factor has a minimal influence only when there is a set menu for all customers). Another factor that complicates forecasting is that food service is often provided outside of usual mealtimes (e.g., at fast food outlets) and meals are not served only at breakfast, lunch and dinnertime.

Inaccurate order forecasting and changes to the number of reservations can result in a surplus of both finished products (i.e., prepared and cooked food that is ready to be consumed), when food preparation and cooking is based on a forecast, and semi-prepared products (i.e., prepared products that are ready to be used or cooked), when meal preparation is based on a forecast but cooking only takes place to order. For example, some pizzerias that provide takeaway service prepare the pizza in advance and display it in the shop window, ready for consumption by customers. Other pizzerias that provide table service prepare the necessary ingredients in advance (e.g., the cheese and other toppings are pre-cut) but they are put together and cooked only following a customer’s order.

The generation of surplus food is especially significant when food is prepared and served buffet-style based on an estimated customer turnout, due to the unpredictability of the total number of customers. Food that has not been consumed when the buffet closes becomes surplus food. This issue is especially critical at canteens where reservations are not taken and meals are prepared in advance, as personnel have only historical data and past experience to rely on when planning meals. This problem is even more acute when a wide variety of dishes is served. Under these circumstances, it is extremely difficult to keep the generation of surplus ingredients in check.

Errors in meal preparation are another source of surplus food. For example, if the wrong dish is served to the customer, it is difficult to serve it to another customer. Although this may be possible if the
product is easily preserved (e.g. a salad), it is almost impossible for a product that needs to be consumed shortly (e.g. a freshly baked pizza).

Finally, when meals are prepared at central kitchens and subsequently delivered to canteens, surplus food may be generated as a result of transportation delays. More specifically, if meals are received at the canteen after the main influx of consumers (e.g. as a result of traffic or delays in food preparation), these meals may not be consumed. It should be noted that these situations occur quite rarely, especially in the more proficient organisations.

As mentioned in section 8.2., official data on the relative impact of each of these different sources are not available (they are difficult to measure). However the interviewees indicated that the impact of the first reason (unconsumed food) far outweighs the impact of the other sources of surplus food.

8.3.2. Food scraps and reutilisation

The sources listed above do not always result in the generation of surplus food. In fact, if there are no contractual constraints and/or health or qualitative issues, unconsumed food can be stored and cooked for consumption at the next sitting. Alternatively, it may be used in the preparation and cooking of other dishes if the appropriate equipment is available at the central kitchen (see Box 8.2.).

Products that are managed in this way are not included in the quantification of surplus food. In other words, the tonnages and percentages of surplus food presented in this chapter are exclusive of such practices.

It should be noted that some contracts may include constraints on the reutilisation of surplus food: using it the following day or using it as a raw material in the preparation of other dishes may not be permitted.

Finally, food scraps generated during meal preparation and plate waste (food remaining on the consumer’s plate) were not considered to be sources of surplus food and were not included in its quantification.

For example, in schools it was found that children and teenagers will often not eat the foods that their schoolmates are not eating.
If some children do not eat their vegetables, others may not eat them either (sometimes the contractual terms may impose constraints on menu composition, dictating that the company must provide a full menu even if the environment or circumstances are not right for encouraging the children to try all of the available foods). These foods are considered to be scraps rather than surplus food because they are in effect unavoidable – according to health and safety policies - and it is almost impossible to recover them.

In addition, when the consumer does not physically pay for their meal, if the cost is deducted from the employee’s payslip or the meal is paid for by the company, the quantity of unconsumed food is greater. This is a result of both the consumer’s tendency to choose more food than needed (due to a diminished perception of the actual value of what gets wasted) and because consumer behaviour becomes even more unpredictable. In both of these examples the excess food is considered to be scraps rather than surplus food, as spoiled foods cannot be reutilised.

In some cases, left over meals at the self-service counter (buffet) may also be considered as food scraps, due to food safety concerns. If self-serve food is handled only by food service personnel until it has been portioned (e.g. food is displayed behind glass), it is suitable for human consumption and therefore meets the definition of surplus food. However, if self-serve food is also handled by the customer (e.g. at a self-service salad bar), it is considered to be scraps for food safety reasons. So the dividing line between food scraps and surplus food is closely related to health and safety aspects at this stage in the supply chain.

8.4. The quantification of surplus food

Surplus food was found to amount to a total of 209,000 tonnes per year (Table 8.2.), or approximately 6% of volumes handled. The percentages of surplus food were different in the two segments considered. In the collective catering segment, approximately 10% of volumes handled result in surplus food. A lower value (5%) is seen in the commercial catering segment, where most meals are prepared or cooked to order.
8.5. Managing surplus food

Surplus food in the food service industry is managed in three ways:

- donation to food banks and charitable organisations;
- conferral to manufacturing companies;
- conferral to waste management companies.

Table 8.2. Summary of surplus food generated in the food service industry

<table>
<thead>
<tr>
<th></th>
<th>Collective catering</th>
<th>Commercial catering</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Volume (1,000 tonnes)</td>
<td>869</td>
<td>2,443</td>
</tr>
<tr>
<td>Surplus Food</td>
<td>Volume (1,000 tonnes)</td>
<td>86.9</td>
<td>122.2</td>
</tr>
<tr>
<td></td>
<td>Percentage of production (%)</td>
<td>10.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Figure 8.2. How surplus food is managed in the food service industry
The findings with respect to surplus food management methods (Figure 8.2.) reveal the predominance of conferral to waste management companies (87.4%), although some companies have chosen to donate surplus food to food banks or charitable organisations (9.2%, see Boxes 8.3 and 8.4). In addition, surplus food is sometimes conferred to manufacturing companies (3.4%), including kennels and animal parks.

The conferral of surplus food to waste management companies is the most widely chosen alternative both in the commercial catering segment (92%, Table 8.3.) and in the collective catering segment (81%). Donation to food banks or charitable organisations occurs more frequently in the collective catering segment (15%) than in the commercial catering segment (5%). It should be noted that many companies in the food service industry have made an effort to arrange for the recovery of surplus fruit and bread. Donation is more difficult in the commercial catering segment because the individual restaurants generate much smaller amounts of surplus food in comparison with canteens in the collective catering segment, making its recovery more onerous. The practice of displaying surplus food in shop windows may constrain its later donation, as product quality may be compromised. In addition, most businesses in the commercial catering segment will not have access to the equipment needed to properly lower the temperature of the product and store it appropriately.

The conferral of surplus food to third parties, such as kennels, is not used very frequently in either the collective catering segment (4%) or the commercial catering segment (3%), mainly due to concerns that the food could be resold or mishandled, potentially harming people, animals or corporate image.

Table 8.3. How surplus food is managed in the two food service segments

<table>
<thead>
<tr>
<th></th>
<th>Collective catering</th>
<th>Commercial catering</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste management companies</td>
<td>81%</td>
<td>92%</td>
<td>87.4%</td>
</tr>
<tr>
<td>Food banks/charitable organisations</td>
<td>15%</td>
<td>5%</td>
<td>9.2%</td>
</tr>
<tr>
<td>Manufacturing companies</td>
<td>4%</td>
<td>3%</td>
<td>3.4%</td>
</tr>
</tbody>
</table>
8.6. The quantification of food waste

As described in section 3.1.3., food waste can be analysed from different perspectives. From a social perspective, all edible surplus food products that are not used for human consumption are considered to be food waste. Therefore surplus food that is not donated to food banks or charitable organisations is “wasted”. From this point of view, food waste was calculated to be approximately 190,000 tonnes/year (Table 8.4.), or 90.8% of the surplus food generated.

Food waste expressed as a percentage of surplus food is different in the two segments studied. It amounts to 85% at companies in the collective catering segment and to 95% at companies in the commercial catering segment. Differences in the percentages of surplus food wasted can be explained by the different methods used to manage surplus food, as described in section 8.5.

Table 8.4. Summary of food waste in the food service industry

<table>
<thead>
<tr>
<th></th>
<th>Collective catering</th>
<th>Commercial catering</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surplus Food</td>
<td>Volume (1,000 tonnes)</td>
<td>86.9</td>
<td>122.2</td>
</tr>
<tr>
<td>Social waste</td>
<td>Volume (1,000 tonnes)</td>
<td>73.8</td>
<td>116.1</td>
</tr>
<tr>
<td></td>
<td>Percentage of surplus (%)</td>
<td>85.0</td>
<td>95.0</td>
</tr>
<tr>
<td>Recoverability</td>
<td>Medium</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

8.7. Summary of results

Surplus food in the food service industry is significant both in absolute terms (209,000 tonnes) and in percentage terms (6.3%). Approximately 87,000 tonnes of surplus food are generated by the collective catering segment, and approximately 122,000 tonnes are generated by the commercial catering segment.

It was found that companies even at this stage in the supply chain are paying increasing attention to the phenomenon of surplus food and are making continuing efforts to try to reduce it.
In fact, surplus food involves costs - often the preparation costs for meals that will not be sold - that have an impact on the competitiveness of commercial businesses and catering companies. Waste disposal costs are not perceived to be a meaningful factor since these costs are a function of the size of the facility (and not of the waste quantities actually disposed) and this payment is borne by the owner of the facility (usually the client).

The majority of the surplus food generated at this stage in the supply chain becomes waste: only 9.2% is recovered for human consumption. The reasons for this are the level of effort needed to properly handle the surplus food so that it can be donated and the difficulties involved in its collection by food banks and charitable organisations. To be able to donate surplus food, canteens need to have properly equipped facilities, and must incur the cost of disposable containers in which to store the product as well as the cost of resources used to package the surplus food. In order to implement an efficient collection system and to obtain sufficient quantities of food to justify the costs, food banks and charitable organisations tend to deal only with large canteens located in urban areas.

Table 8.5. Summary of surplus food and food waste in the food service industry

<table>
<thead>
<tr>
<th></th>
<th>Collective catering</th>
<th>Commercial catering</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>869</td>
<td>2,443</td>
<td>3,312</td>
</tr>
<tr>
<td>Surplus Food</td>
<td>86.9</td>
<td>122.2</td>
<td>209.1</td>
</tr>
<tr>
<td>Percentage of production (%)</td>
<td>10.0</td>
<td>5.0</td>
<td>6.31</td>
</tr>
<tr>
<td>Social waste</td>
<td>73.8</td>
<td>116.1</td>
<td>189.9</td>
</tr>
<tr>
<td>Percentage of surplus (%)</td>
<td>85.0</td>
<td>95.0</td>
<td>90.8</td>
</tr>
<tr>
<td>Recoverability</td>
<td>Medium</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

It should be pointed out that in the collective catering segment, which is better suited to the recovery of surplus food, the client companies should be the ones to endorse the practice of donation. However, they are often quite unaware of the surplus food generated at their facilities. It is in fact difficult for the contractor to identify these wasted quantities because in doing so they risk creating the perception that the service they provide is inefficient.
Finally, several of the case studies revealed that there is a lack of awareness about the possibility of donating surplus food and a lack of information about the organisations that undertake to recover surplus food in the local area.

Box 8.3. An example of waste reduction at a catering service

A small restaurant organises catering services for company events (both breakfasts and lunches). The foods provided include croissants, baked biscuits, pre-cooked pasta dishes, sandwiches, desserts and beverages. In order to ensure that the food is fresh and tastes good, it is prepared the same day based on the number of attendees anticipated by the client. The staff noticed that there were often fewer attendees than predicted by the client, but the estimated number of meals had to be prepared and available all the same. Unconsumed foods left over at a buffet table cannot be recovered for human consumption for health and safety reasons as they have been handled by customers. In order to be able to recover food for human consumption, food service personnel often do not put all of the food out on the buffet table but restock the buffet regularly in order to maintain the food’s integrity. Food products that were not displayed can then be conserved properly in refrigerated vehicles or temporary storage areas. This prevents the unconsumed food from becoming waste. It should be noted that these products are not reused by the company at subsequent events, but are conferred, where possible, to the nearby parish. The quality and taste of the unconsumed food would in fact be compromised if it were to be served at a subsequent event. However there is no reason that the food should not be consumed the same day.

Box 8.4. A company canteen’s experience

Somewhat more than a year ago, a surplus food donation project was started at the canteen of a large company near Milan. The initiative began following the realisation that significant quantities of unconsumed food were being disposed daily, at a high cost to both the company and the community, in the face of increasing demand by the needy. Both the company and the food service provider were involved in getting the donation project off the ground.
Following a preliminary phase during which the details were worked out, an agreement was made with Siticibo, a Fondazione Banco Alimentare association established in 2003 with operations near the main industrial centres of 9 cities.

At a company canteen, the usual process for preparing foods for donation is the following:

- container preparation: the day before collection, the unserved surplus food is placed in the appropriate single-use containers in quantities of at least 7 servings per container;
- blast chilling: the containers are chilled using dedicated equipment and following prescribed procedures;
- compilation of documentation;
- sealing of containers: the packages are sealed;
- labelling: a label, which provides the following information, is compiled and put on the container: producer, type of product, number of portions, weight, ingredients, preparation date and method of conservation;
- conservation: products are stored at a temperature of between 0 and 4°C until they are collected the following day.
- Siticibo personnel conduct the following activities when they collect the surplus product:
  - verify the integrity of the food: several fundamental aspects are checked, including the absence of holes in the containers, the integrity and consistency of the food, and that the label is consistent with the packaged product;
  - check the temperature: the food storage temperature is verified;
  - pack the products in insulated containers: the food is placed in insulated containers and vehicles.
  - deliver products to the beneficiary: the surplus food collected from the canteen is delivered to charitable organisations the same day it was collected.

The organisation has established food safety procedures to ensure the collected products are safe and to ensure their integrity and palatability. These procedures are followed by all players in the supply chain, donors, volunteers and beneficiary organisations.

Those that receive the product undertake to properly store the food until it can be served to those in need, and to serve the food within 12 hours of its delivery. The final result is the creation of a just-in-time flow which, within 24 hours, prevents surplus food from canteens from becoming waste.
Chapter 9

Household consumption

The purpose of this chapter is to describe the methodology used to study and quantify consumer-generated surplus food. First, the means (Nielsen consumer panel) and the methodology used (survey of panel households and tracking of household purchases made by those same families) are presented. The results of the survey are then described, with some discussion about the more relevant socio-demographic differences. Finally, an estimate of the amount of food waste created by Italian household for the year 2011 is provided.

9.1. The Nielsen Consumer Panel and the Italian household population

The theme of consumer-generated surplus food was examined through a study that involved the Nielsen Consumer Panel. The purpose of the panel, which is made up of 9,000 households, is to measure the main quantitative indicators of consumer behaviour within the large-scale retail environment.

This panel represents the 23.5 million households in Italy, from a total population of approximately 59.8 million individuals. A household is intended to mean a group of people living together in a stable arrangement and sharing goods (singles are included). Non-household consumption (hospitals, military barracks, tourists,
foreigners, etc.), consumption outside of the home and consumption at a second home are not considered. The socio-demographic data are updated annually and come from official ISTAT sources as well as other primary sources (e.g. Bank of Italy). The panel includes households located throughout Italy (approximately 2,000 municipalities) which means that households located in small towns are also represented.

The panel is stratified according to the following variables:

1) Nielsen Area (4 Areas)
   - Area 1: Piedmont, Liguria, Valle D’Aosta, Lombardy
   - Area 2: Triveneto, Emilia Romagna
   - Area 3: Tuscany, Marche, Umbria, Lazio, Sardinia
   - Area 4: Campania, Abruzzo, Molise, Puglia, Basilicata, Calabria, Sicily

2) Cluster (Classification based on demographic and distribution variables related to the organisation of trade, known as Retail-Centric Design).

The stratified sampling design, compared to simple random sampling, has the advantage of increasing the efficiency of the statistical estimates. The stratification is based on parameters by which the measured variables (in this case, household purchases) are discriminated. The sample is allocated in proportion to the stratification variables.

The sample was also post-stratified according to the following variables:
- Number of components (1-2-3-4-5 and more)
- Type of municipality (self-representing municipalities – non-self-representing municipalities; the independent municipalities are the 12 largest Italian municipalities)
- Affluence: Four groups of households were identified from a concentration curve of net income per capita.
  - Low Affluence (20%)
  - Below-average Affluence (30%)
  - Above-average Affluence (30%)
  - High Affluence (20%)
Affluence represents the concept of income per capita over time, which is calculated as:

\[
\text{Household net income} = 1 + 0.7(\text{No. of household members} - \text{No. of children} - 1) + 0.5 \times \text{children}
\]

- Age of head of household (0-34, 35-44, 45-54, 55-64, 65 and older)
- Age of primary purchaser (0-34, 35-44, 45-54, 55-64, 65 and older)
- Presence of children (0-6 years)
- Life-stages
  - Pre-Families: singles under 35 years old, or couples with primary purchaser under 35 with no children.
  - New Families: families with young children (<= 6 years).
  - Maturing Families: families with children under 17 years, not all young (<=6 years), or all older (between 11 and 17 years)
  - Established Families: families with older children (between 11 and 17 years).
  - Post-Families: singles aged 35 to 54 or families with primary purchaser between the ages of 35 and 54 with no children under the age of 18.
  - Older Couples: families with primary purchaser older than 55 and no children under 18.
  - Older Singles: singles over the age of 55.
- Geographical area

The post-stratification ensures that the major segments are represented and the weightings out of the total are correct.

The households that make up the panel actively take part in the process for tracking retail purchases using “home scanning” technology: the family’s product purchases reveal, through a mini computer with an optical reader, information related to their purchasing behaviour which is transmitted electronically to Nielsen on a weekly basis.

The households on the panel receive questionnaires periodically (either individual or addressed to the primary purchaser). The questionnaires are delivered by mail, the individuals respond using
the optical reader that is used for tracking purchases and the answers are automatically sent via modem to Nielsen.

The device therefore makes it possible to correlate value or attitude-based judgements (drawn from questionnaires) with the consumer behaviour measured objectively using the home scanner, given that both types of information are based on the same sample (the families and individuals on the Consumer Panel).

9.2. Survey: questionnaire structure and sample

The first step in the study involved sending a questionnaire to a subset of the panel, the purpose of which was to quantify the occurrence of household behaviours that limit food waste, and to obtain an estimate of food waste as a percentage of food purchases.

The reference sample consists of 6,000 households on the Nielsen Consumer Panel.

The characteristics of the sampling are as follows:

- random and representative of the universe being measured (Italian households)
- stratified by number of family members, age, income, geographical location, size of municipality.

The person interviewed was the primary person responsible for household purchases.

The survey method used was a hard copy questionnaire, sent through the regular mail, and completed independently by the respondent using a handheld scanner (i.e. with no help from an interviewer). The questionnaire, prepared by Nielsen researchers and agreed upon with the Politecnico di Milano team, contained closed questions only.

The fieldwork took place in July 2011. The response rate was approximately 70%.

The questionnaire followed two lines of enquiry: leftover food cleared from the table and food thrown out because the expiration date was reached or the food was spoiled. Two types of information were gathered for both fields of enquiry: the occurrence of responsible behaviours geared at limiting surplus food was ascertained, and an estimate of the
percentage of food wasted by the household was requested.

Finally, two other pieces of information were gathered regarding how the household approaches food expiration dates: it was asked when a product was deemed to have expired or spoiled; it was also asked in what way the “best-before” date (phrased on Italian food packaging as “preferably to be consumed by”) influences household behaviour with respect to throwing food products out.

9.3. Survey findings

9.3.1. Leftover food

This section examines Italian household behaviour toward leftover food, that is that part of food brought to the table for a meal that is not consumed despite being edible.

More specifically, the following research questions were posed: What behaviours do Italian households typically use to avoid creating and “wasting” leftovers? What percentage of leftovers are estimated to have been thrown out by Italian households in relation to the total amount of food served? The time period referred to was the month preceding the survey (June 2011).

Figure 9.1. Behaviours used to avoid creating leftovers (frequency of selected behaviours)
Household approach to leftovers

To gain an understanding of consumer behaviour towards leftover food, survey respondents were asked the following question: *What approaches are used regularly by your family to avoid creating and wasting leftovers?* There were several possible answers to the question and the questions were not mutually exclusive.

As shown in Figure 9.1., 75% of respondents stated that they save leftovers (in the refrigerator, in the freezer, or by other means) to be eaten another time. Next, 52% responded that they are careful about bringing only the necessary amount of food to the table. The reuse of leftovers to in the preparation of other dishes (e.g. meatballs, sauces, etc.) is less common (34%). And finally, 21% of Italian respondents stated that they collect leftovers for alternative uses (e.g. to feed pets, for composting, etc.).

The first response “We save leftovers to be eaten another time” (75% of respondents) is more prevalent in big cities (where the percentage rises to 81%), in the Northeast (80%), in new families (85%) and in established families (81%). This number drops significantly in pre-families (63%) and for those with a lower level of education (69%).

The response “We are careful to prepare/serve only the amount of food we truly need” (52% of respondents) is more common in younger households (the percentage increases to 63% when the primary purchaser is under 34 years old) and drops with increasing age (44% for those over 65). In the lifecycle of a household, younger families are more conscientious (pre-families 60%, new families 60%).

The third behaviour “We reuse leftovers in the preparation of other dishes” (34% of respondents) is more common in Northern Italy (38% in the Northeast, 37% in the Northwest) than in the South (28%). The percentage is higher amongst those living in cities (40%) and when the primary purchaser has a high level of education (38% for university graduates). Although older couples have demonstrated some commitment to this behaviour (38%), it is less common among older singles (27%).

The final response “We collect leftovers for alternative uses” (21% of respondents) is above average amongst younger primary purchasers (25%) and those living in the Northeast (25%). The percentage of respondents that adopt this behaviour decreases with increasing levels of education and as the city size increases.
Estimated percentage of leftovers

Having explored the approaches/behaviours used regularly by Italian households to avoid creating or wasting leftovers, the respondents were then asked to try to estimate the percentage of leftovers disposed. The question posed was the following: *Try to provide an estimate of the percentage of leftovers that your family has thrown out in relation to the total amount of food served in the past month*. Only one response was permitted.

More than two-thirds of Italians claim to have thrown out a modest amount of that which was served at the table: 70% of households responded that they throw out less than 5% of food served: approximately one household in five stated that they throw out 5-10% of food; 6% of households throw out 10-15% and the remaining 3% of households throw out more than 15% of food served.

From a socio-demographic standpoint, there is a correlation between age and quantities of food thrown out: the elderly are more conscientious than the young. In 83% of households where the primary purchaser is over 65 years of age, the percentage of served food that gets thrown out was less than 5%, while younger

Figure 9.2. Estimated percentage of leftover food thrown out in relation to the total amount of food served (percentage of households)
households stated that they throw out 5-10% of food (30% of primary purchasers under 34 years of age). Naturally this is also reflected in the lifecycle of the household: 84% of older couples stated that less than 5% of food is disposed, while 32% of pre-families threw out 5-10%. Fully 8% of pre-families disposed of more than 15%.

In Northern Italy there is a tendency to claim less food is wasted (75% in area 1 and area 2 for the response “less than 5%”), while in Central Italy, and even more markedly in the South, the percentage of food wasted is greater.

Those with a lower level of education produce lesser quantities of leftovers. It is worth noting that 79% of those who completed only a primary education selected the response “less than 5%”.

9.3.2. Food that has expired or spoiled

This section examines the behaviour of Italian households towards foods that have expired or spoiled. A certain food may not be cooked or served because the expiration date located on the package has passed or because it has become spoiled (fruit, cheese or meat have a bad smell or taste, or an unpleasant appearance). Thus food that is purchased and thrown out without being served or cooked is considered in the category of expired and spoiled foods.

The following product categories were considered separately.

Table 9.1. Food product categories and product descriptions

<table>
<thead>
<tr>
<th>Food product category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-perishable food products (with a long shelf-life)</td>
<td>products typically kept in the pantry or kitchen cupboard (e.g. pasta, rice, tomato sauce, snacks, canned and boxed goods, shelf-stable (UHT) dairy products)</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>excluding frozen</td>
</tr>
<tr>
<td>Meat and fish</td>
<td>excluding frozen</td>
</tr>
<tr>
<td>Chilled</td>
<td>Products kept in the refrigerator (e.g. cheese, deli meat, ready-to-eat foods, fresh pasta, eggs, milk, yogurt)</td>
</tr>
<tr>
<td>Frozen</td>
<td>Products typically kept in the freezer (e.g. ready-to-eat pizza, pasta and other ready-meals, ice cream, meat/fish)</td>
</tr>
<tr>
<td>Beverages</td>
<td>Liquor, wine, beer, carbonated and non-carbonated non-alcoholic drinks, juices, excluding milk</td>
</tr>
<tr>
<td>Fresh bread</td>
<td>-</td>
</tr>
</tbody>
</table>
Specifically, the following research questions were posed: what behaviours are used by Italian households to avoid having purchased foods expire or spoil? What is the estimated percentage of food products that are thrown out because they have expired or spoiled? The time period referred to was the month preceding the survey (June 2011).

**Household approach to expired or spoiled food**

As in the case of leftovers, the following question was asked: *What approaches are used regularly by your family to avoid having purchased foods “expire” or “spoil”?* There were several possible answers to the question.

To avoid food spoilage, Italians tend first of all to shop frequently so as not have too much more food than is needed (50% of respondents). The foods that tend to be purchased more frequently are fruit and vegetables (73%), chilled products (68%) and fresh bread (63%), as these products are perishable.

Purchasing behaviour is different for non-perishable food products. Checking the expiration date prior to purchasing a product is a common behaviour (71%), as is making an effort to use products before they expire or spoil (63%). Many households also plan food purchases carefully by, for example, checking quantities of stored food and preparing a shopping list, thereby avoiding impulse purchases or the purchase of large quantities of food that is on sale. A higher than average number of households freeze many of the meat and fish products, and to a lesser extent fresh bread, that they purchase (51% and 30% respectively). For frozen foods, the most common household behaviour is to check the product expiration date prior to purchasing (46%). Finally, most of the behaviours described above to prevent purchased products from expiring or spoiling are observed less frequently in the beverages category. In this category, the only result that was slightly above the average was checking the expiration date prior to purchasing a product (39%).

Overall, it was found that the elderly tend to be more conscientious in their approach to avoiding the purchase of more food than they are able to consume. Among the more mature age groups, frequent shopping is more common, as is the purchase of smaller packages and unpackaged products that are then frozen to preserve their
Table 9.2. Behaviours used to limit food expiration or spoilage (by food product category)

<table>
<thead>
<tr>
<th>Household approach</th>
<th>Total</th>
<th>Non-perishable food products</th>
<th>Fruit and vegetables</th>
<th>Meat and fish</th>
<th>Chilled</th>
<th>Frozen</th>
<th>Beverages</th>
<th>Fresh bread</th>
</tr>
</thead>
<tbody>
<tr>
<td>We shop often and do not store many extra food products</td>
<td>50%</td>
<td>42%</td>
<td>73%</td>
<td>49%</td>
<td>68%</td>
<td>20%</td>
<td>32%</td>
<td>63%</td>
</tr>
<tr>
<td>We use food products before they expire or spoil</td>
<td>36%</td>
<td>63%</td>
<td>39%</td>
<td>31%</td>
<td>40%</td>
<td>36%</td>
<td>31%</td>
<td>14%</td>
</tr>
<tr>
<td>We check the expiration date prior to purchasing a product</td>
<td>34%</td>
<td>71%</td>
<td>14%</td>
<td>24%</td>
<td>37%</td>
<td>46%</td>
<td>39%</td>
<td>5%</td>
</tr>
<tr>
<td>We plan our food purchases carefully</td>
<td>33%</td>
<td>45%</td>
<td>33%</td>
<td>35%</td>
<td>37%</td>
<td>33%</td>
<td>31%</td>
<td>15%</td>
</tr>
<tr>
<td>We purchase food products in small and/or divisible packages</td>
<td>22%</td>
<td>32%</td>
<td>17%</td>
<td>26%</td>
<td>27%</td>
<td>25%</td>
<td>12%</td>
<td>12%</td>
</tr>
<tr>
<td>We freeze many of the food products we purchase</td>
<td>21%</td>
<td>24%</td>
<td>7%</td>
<td>51%</td>
<td>11%</td>
<td>18%</td>
<td>3%</td>
<td>30%</td>
</tr>
<tr>
<td>We buy unpackaged food products</td>
<td>17%</td>
<td>11%</td>
<td>41%</td>
<td>22%</td>
<td>22%</td>
<td>4%</td>
<td>4%</td>
<td>17%</td>
</tr>
<tr>
<td>We do not consume/purchase products in this category</td>
<td>8%</td>
<td>5%</td>
<td>4%</td>
<td>4%</td>
<td>4%</td>
<td>11%</td>
<td>16%</td>
<td>10%</td>
</tr>
</tbody>
</table>
Household consumption

freshness. The younger respondents are more conscientious than the average about consuming food before it expires or spoils.

Estimated percentage of leftovers

Having explored the approaches/behaviours generally used by households to avoid having food expire or spoil, the respondents were then asked to try to estimate the percentage of food thrown out as it was no longer considered to be edible. The question posed was the following: *What percentage of food did your family throw out in the past month because the product had expired or spoiled?* Only one response was permitted.

For expired/spoiled foods, even more so than for leftovers, the responses were concentrated in the lowest range: 85% of households stated that they disposed of less than 5% of purchased food products; 9% claimed that they threw out 5-10% of foods purchased; 3% disposed of 10-15%, and 2% disposed of more than 15%.

Fruit and vegetables, fresh bread and chilled products are the categories in which the highest percentages of waste were registered (in these three categories, respectively, 29%, 23%, and 19% of households responded that they had thrown out more than 5% of food purchased, as compared to the average of 9%).

Table 9.3. Percentages of expired and spoiled food disposed. Percentage of households per product category

<table>
<thead>
<tr>
<th>Type of food product</th>
<th>% of purchased food thrown out</th>
<th>Total</th>
<th>Non-perishable food products</th>
<th>Fruit and vegetables</th>
<th>Meat and fish</th>
<th>Chilled</th>
<th>Frozen</th>
<th>Beverages</th>
<th>Fresh bread</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5%</td>
<td>50%</td>
<td>42%</td>
<td>73%</td>
<td>49%</td>
<td>68%</td>
<td>20%</td>
<td>32%</td>
<td>63%</td>
<td></td>
</tr>
<tr>
<td>5-10 %</td>
<td>36%</td>
<td>63%</td>
<td>39%</td>
<td>31%</td>
<td>40%</td>
<td>36%</td>
<td>31%</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>10-15 %</td>
<td>34%</td>
<td>71%</td>
<td>14%</td>
<td>24%</td>
<td>37%</td>
<td>46%</td>
<td>39%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>More than 15%</td>
<td>33%</td>
<td>45%</td>
<td>33%</td>
<td>35%</td>
<td>37%</td>
<td>33%</td>
<td>31%</td>
<td>15%</td>
<td></td>
</tr>
</tbody>
</table>
The expiration date
Finally additional information was gathered in relation to two further aspects of food expiration dates. First, the primary purchasers were asked how they determine whether a food product has expired or spoiled. Secondly, they were asked how the phrase “best-before”, which does not represent a definite “use-by” date, influences household behaviour with respect to the disposal of food products.

Figure 9.3. Approach to product expiration dates. Percentage of households

Approximately three out of five households use the expiration date only as an indicator and base their assessment of product condition on appearance/odour. One in three households adheres strictly to the expiration date. Only 5% of the population ignores the expiration date and judges whether a product is edible based solely on appearance/odour.

The respondent’s age influences the importance attributed to the product expiration date. Older respondents adhere more strictly to product expiration dates (the percentage increases to 44% when the primary purchaser is over 65 years of age). Younger respondents are more likely to use the expiration date only as an indicator of edibility (69% when the primary purchaser is under 44 years of age).

Residents in the South of Italy pay close attention to product expiration dates (41%), as do those with lower levels of education
(53%), older singles (42%) and older couples (40%). Conversely, residents in the Northeast (67%), university graduates (68%), maturing families (73%) and new families (71%) tend to use the expiration date only as an indicator of product edibility.

Figure 9.4. The importance given to the phrase “best-before” when deciding whether to throw out a food product. Percentage of households

More than half of households (55%) stated that they are influenced (very+fairly) by the phrase “best-before” before throwing out a product. On a scale of 1 to 5, the average result was 3.5 (a moderate influence).

Even without a rigorous use-by date, households where the primary purchaser is over 65 years of age are more influenced by the phrase “best-before” (60% selected the top two boxes, i.e. very+fairly). This confirms the previous findings that the expiration date is closely adhered to, even if it is only a “preferred” date: it influences those with lower levels of education (63% chose very or fairly and the average was 3.7), residents of southern Italy (61% chose very or fairly) and older couples (60% chose very or fairly) the most.
9.4. Estimate of household food waste

The final step in this study consisted of tying together the information presented above, obtained through the survey, with the information on purchases made by those same households. The amount of food availability expressed in tonnes was calculated based on the value of food purchases made by Italian households. The percentages of food waste obtained from households were then applied.

The amount of food waste was estimated in the same way as in the survey: foods prepared but not consumed, and expired and spoiled products, were quantified.

Overall, Italian households are estimated to waste 2.6 million tonnes, or 8.2% of food purchases, at their principal residence.

The breakdown of consumer-generated food waste by product category, not entirely exclusive of each other (e.g. orange juice belongs both to beverages and chilled products), is shown on Figure 9.5.

Figure 9.5. Breakdown of total household food waste in Italy by product category (percentage of total amount in tonnes).
Beverages is the product category where the highest percentage of waste (40%) occurs, based on the total amount of food waste by Italian households, in tonnes. The product category with the second-highest amount wasted is chilled products (25%), the third is non-perishable food products (17%). Following these, in order, are fruit and vegetables (14%), meat and fish (6%), fresh bread (4%) and, finally, frozen foods (2%).

Figure 9.6. shows overall consumer-generated food waste broken down into the categories of leftovers compared to the amount of food served and food products thrown out because they expired or spoiled.

Figure 9.6. Breakdown of household waste into leftovers and expired/spoiled products

Leftover food that is served but not eaten represents more than half of household food waste (58%). The total amount of leftovers represents 4.79% of overall household purchases (expressed in tonnes).

Expired or spoiled foods represent 3.41% of all food purchases made by Italian households (see Table 9.4.). There is a marked variability between the different product categories.
The product categories where the most food is thrown out because it has expired or spoiled are fresh bread (4.52%) and fruit and vegetables (4.43%). As expected, frozen foods (2.91%) and non-perishable food products (2.86%), which typically last longer than other foods, are the product categories with the lowest percentages of waste.

<table>
<thead>
<tr>
<th>% expired or spoiled food by product category</th>
<th>Percentage of food purchases expired or spoiled</th>
<th>Allocation index with respect to total expired or spoiled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3.41</td>
<td>100</td>
</tr>
<tr>
<td>Fresh bread</td>
<td>4.52</td>
<td>132</td>
</tr>
<tr>
<td>Fruit and vegetables</td>
<td>4.43</td>
<td>130</td>
</tr>
<tr>
<td>Chilled</td>
<td>3.84</td>
<td>113</td>
</tr>
<tr>
<td>Beverages</td>
<td>3.06</td>
<td>90</td>
</tr>
<tr>
<td>Meat and fish</td>
<td>3.04</td>
<td>89</td>
</tr>
<tr>
<td>Frozen</td>
<td>2.91</td>
<td>85</td>
</tr>
<tr>
<td>Non-perishable food products (with a long shelf-life)</td>
<td>2.86</td>
<td>84</td>
</tr>
</tbody>
</table>

Table 9.4. Estimated percentage of expired or spoiled products and allocation index out of total food purchases
Chapter 10

The food supply chain: the overall picture

The previous sections discussed surplus food at the various individual stages in the Italian food supply chain in some depth. This chapter presents the results of the research for the supply chain as a whole, providing a comprehensive summary of the phenomenon.

10.1. Surplus food in the food supply chain

The food supply chain consists of five stages: agriculture and fishing (which includes crop and livestock farming, and fishing), food manufacturing, retail trade, food service, and household consumption. At each stage of the supply chain, segments with similar product characteristics and logistics and production configurations were identified for individual analysis, for a total of twelve study segments.

In order to make it easier to read this chapter, the annual flows handled in each of the 12 segments are presented in Table 10.1.; it should be reiterated that flow volumes for each individual segment were obtained by analysing the available data from a variety of sources, such as ISTAT, ISMEA, Federdistribuzione, and Nielsen, not all of which refer to the same calendar year.
Table 10.1. Summary of flows in the study segments

<table>
<thead>
<tr>
<th>Stage</th>
<th>Segment</th>
<th>Flows handled annually (1,000 tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and fishing</td>
<td>Fruit and vegetables</td>
<td>41,728</td>
</tr>
<tr>
<td></td>
<td>Cereals</td>
<td>22,031</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>14,989</td>
</tr>
<tr>
<td></td>
<td>Fishing</td>
<td>475</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Ambient</td>
<td>34,641</td>
</tr>
<tr>
<td></td>
<td>Chilled</td>
<td>8,553</td>
</tr>
<tr>
<td></td>
<td>Frozen</td>
<td>1,592</td>
</tr>
<tr>
<td>Retail trade</td>
<td>Distribution centres</td>
<td>24,524</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
<td>30,655</td>
</tr>
<tr>
<td>Food service</td>
<td>Collective catering</td>
<td>869</td>
</tr>
<tr>
<td></td>
<td>Commercial catering</td>
<td>2,443</td>
</tr>
<tr>
<td>Household consumption</td>
<td>Consumer</td>
<td>31,268</td>
</tr>
</tbody>
</table>

Table 10.2. Summary of surplus food generated annually in the segments studied

<table>
<thead>
<tr>
<th>Stage</th>
<th>Segment</th>
<th>Surplus food (1,000 tonnes)</th>
<th>Recoverability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and fishing</td>
<td>Fruit and vegetables</td>
<td>2,187.1</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Cereals</td>
<td>68.1</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>52.5</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Fishing</td>
<td>10.5</td>
<td>Low</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Ambient</td>
<td>118.2</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Chilled</td>
<td>51.5</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Frozen</td>
<td>11.7</td>
<td>Medium</td>
</tr>
<tr>
<td>Retail trade</td>
<td>Distribution Centres</td>
<td>73.6</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
<td>704.0</td>
<td>Medium</td>
</tr>
<tr>
<td>Food service</td>
<td>Collective catering</td>
<td>86.9</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Commercial catering</td>
<td>122.2</td>
<td>Low</td>
</tr>
<tr>
<td>Household consumption</td>
<td>Consumer</td>
<td>2,513.5</td>
<td>Low</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5,999.8</td>
<td></td>
</tr>
</tbody>
</table>
The total quantity of surplus food generated in Italy, determined by summing the contributions from each of the individual segments, is equal to almost six million tonnes per year (Table 10.2.). This quantity is equivalent to 17.4% of annual food consumption (at food service establishments and in households). By relating this quantity to the number of people living in Italy, it is calculated that 101 kg of surplus food per capita is generated in the food supply chain every year. A detailed examination of surplus food quantities shows that each segment contributes to the generation of surplus food to differing degrees. More specifically, most of the surplus food (58.1%) is generated by commercial enterprises, but final consumers also make a notable contribution to the phenomenon (41.9%) (Figure 10.1.).

Looking at the surplus food generated by businesses (Figure 10.2.), it can be seen that 66.5% of all surplus food is generated in the agriculture and fishing sector, 5.2% in food manufacturing, 22.3% at the retail trade stage, and 6.0% in the food service industry.
Figure 10.2. Breakdown of surplus food generated at various stages in the food supply chain, excluding household consumption.

The contribution of each stage to the total amount of surplus food depends on both the magnitude of the flows handled (expressed in tonnes in this study) and on the relative percentage of surplus food generated at each stage (in its turn a function of the specific logistics and production systems). For example, the percentage of food production that becomes surplus food is greater in the food service industry (6.3%) than in retail trade (2.5%), but the total amount contributed (209,100 tonnes/year) is lower than that of the retail trade stage (777,600 tonnes/year), as the magnitude of flows handled is lower.

Figure 10.3. summarises each stage’s contribution to the total amount of surplus food generated in Italy. It can be seen that the stage that generates the greatest volume of surplus food is household consumption (2.513 million tonnes/year), followed by agriculture and fishing, and retail trade. The percentages shown on the figure represent the amount of surplus food generated as a percentage of the total volume of food handled at each individual stage: from 0.4% in food manufacturing, to 8% for household consumption.
Figure 10.3. Surplus food generated at each individual stage in the food supply chain

(*) Surplus food as a percentage of flows for each individual stage in the supply chain
10.2. The recoverability of surplus food

Not all of the surplus food generated in the food supply chain is equally recoverable. Of the six million tonnes of surplus food generated annually, it can be seen (Figure 10.4.) that only 191,835 tonnes has a high degree of recoverability (on a scale of low, medium and high values). In other words, only 3.2% 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. As shown in Figure 10.4., just over half of surplus food has a medium degree of recoverability (50.7%) and just over 45% has a low degree of recoverability (46.1%).

Figure 10.4. Recoverability of surplus food (1,000 tonnes/year)

The conclusions reached regarding the contribution of each stage to the generation of surplus food differ when the degree of recoverability is considered in addition to the total volume of the surplus (Figure 10.5.). For instance, only 3.0% of the total amount of surplus food is generated by the manufacturing sector, however this represents fully 61.6% of all surplus food with a high degree of recoverability (related to products in the ambient segment). Similarly, retail trade generates 13.0% of all surplus food, but this represents 38.4% of surplus food with a high degree of recoverability.
The food supply chain: the overall picture

(surplus food from distribution centres). The stages that generate the most surplus food with a medium degree of recoverability are agriculture and fishing (71.9%, products in the fruit and vegetables segment) and retail trade (23.1%, surplus food generated by stores). Almost all surplus food with a low recoverability is associated with household consumption and food service.

Figure 10.5. Breakdown of surplus food by supply chain stage and degree of recoverability

10.3. The economic value of surplus food

The value of surplus food can be examined not only in quantitative terms (i.e. in tonnes/year), but also in economic terms.

First, if the value density (i.e. value per unit weight) is used to calculate the economic value of surplus food in the twelve segments analysed, the total value of surplus food is estimated to be approximately 13 billion euros (Figure 10.6.), or 15% of household consumption. Based on this value and the number of people living in Italy, it is calculated that 220 euros worth of surplus food is generated per capita in the food supply chain each year. As shown in Figure 10.6., the downstream stages in the food supply chain have the greatest impact in monetary terms as the value density of food products increases as they progress through the food supply chain.

The value of surplus food generated confirms that the
The analysis also provides information that is relevant to evaluating how recovering surplus food can benefit the Italian economic system. As identified in the previous chapters, both food supply chain players and surplus food recipients (primarily food banks) need to make a concerted effort if surplus food is not to become waste. Additional costs are often incurred as a result of this commitment. If the investment is considered to be beneficial to the country's economy, these costs could be partially shared through, for example, tax incentives. The sustainability of an investment in surplus food management processes can be evaluated by comparing the value of the surplus food recovered to the cost of recovering it. For example, if an investment of several million euros would make it possible to recover food products valued at hundreds of millions of euros, the community benefit would rightly be considered to be significant. The growing need for food security would be addressed.
by a welfare measure that would have a limited economic impact compared to other forms of social assistance. Since the example given (a cost of several million euros to recover several hundred million euros of surplus food) is representative of the scale of the potential savings involved, it follows that it is imperative for the country’s leaders to support players in identifying the most appropriate models for effectively managing surplus food and to implement measures to support them (see Chapter 11).

From the point of view of recovering surplus food, it is important to consider not only the value of the surplus food but also its degree of recoverability. Figure 10.7. shows that a portion of the surplus food that has a high economic value (e.g. in the fishing segment or in commercial catering) has a low degree of recoverability. However there are some segments of average value (e.g. the retail trade segments) that have a good degree of recoverability. These segments clearly represent an important target area.

Finally, in the literature review related to food security, it was identified that food products can also be differentiated according

![Figure 10.7. Surplus food (in 1,000 tonnes/year) generated in the 12 supply chain segments as a function of degree of recoverability and value density](image-url)
to their nutritional value. This aspect is relevant not only for those who can well afford groceries, but more importantly for the poor. In order to examine this aspect, it would be helpful to also differentiate surplus food according to its nutritional value, which is in turn a function of nutritional content (e.g. the nutritional value of a soft drink is lower than that of fresh fruit) and nutritional variety (e.g. a tonne of surplus dry pasta is less varied than a tonne of surplus products of different types collected from a store). It would in fact make the most sense to focus surplus food management efforts on the segments that have medium-high levels of recoverability, economic value and nutritional quality.

10.4. Managing surplus food

Once generated, surplus food can be managed in four different ways. 
• sale through secondary markets (e.g. factory outlets or stockists);
• donation to charitable organisations, either directly or through food banks;
• conferral, or possibly sale, to manufacturing companies, typically those that produce animal feed;
• conferral to waste management companies, which manage the surplus food as waste, possibly recovering it using available methods (e.g. energy production at waste to energy plants).

To-date, most surplus food (81.0%, Figure 10.8) is conferred to waste management companies, where it may be used as fertiliser or in energy production. A smaller proportion of surplus food (11.5%) is conferred or sold to manufacturing companies that use it to feed animals or to produce animal feed. A limited proportion of surplus food (less than 10%) is recovered for purposes of human consumption through donations to food banks and charitable organisations (6.4%) or through secondary market sales (1.1%).

There are several factors that influence the decision about which of the different surplus food management options to choose, including:

• the residual value of the surplus food;
• the shelf-life remaining until the product expiration date;
• the recoverability of the surplus food, that is the level of effort
required by various players to recover the product for human consumption;

- how the surplus food is generated (surplus food that is generated regularly and in predictable amounts is more easily recovered for human consumption than large quantities of surplus food that are generated unexpectedly);
- awareness of the potential alternatives to waste disposal;
- the existence of a structured surplus food management process;
- concerns that mismanagement of surplus food by third parties (either stockists, charitable organisations or manufacturing companies) could potentially damage the corporate image.

Figure 10.8. How surplus food is managed

10.5. Food waste from a social perspective

As described in section 3.1.3., food waste can be analysed from different perspectives. From a social perspective, all edible surplus food products that are not used for human consumption are considered to be food waste. Therefore surplus food that is not donated to food banks or charitable organisations or sold through
secondary markets is “wasted”. From this point of view, 5.5 million tonnes of food are wasted in the Italian food supply chain each year, which represents 92.5% of surplus food, and is equivalent to 16.0% of annual food consumption (at a household level and in commercial establishments). By relating this quantity to the number of people living in Italy, it was calculated that 94 kg of food products are wasted per capita along the food supply chain every year.

Annual quantities of food waste are presented in Table 10.3 for each segment of the food supply chain.

Food waste is generated in almost equal proportions by commercial enterprises (54.7%) and by final consumers (45.3%) (Figure 10.9.).

Looking at the surplus food generated by businesses (Figure 10.10), it can be seen that that 67.3% of the waste is generated in the agriculture and fishing sector, only 2.7% in the manufacturing sector, 23.7% at the retail trade stage, and 6.3% in the food service industry.

Figure 10.9. Breakdown of food waste generated in the food supply chain
The food supply chain: the overall picture

Table 10.3. Summary of annual quantities of food waste in the segments studied

<table>
<thead>
<tr>
<th>Stage</th>
<th>Segment</th>
<th>Waste (1,000 tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and fishing</td>
<td>Fruit and vegetables</td>
<td>1,948.2</td>
</tr>
<tr>
<td></td>
<td>Cereals</td>
<td>67.4</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>20.3</td>
</tr>
<tr>
<td></td>
<td>Fishing</td>
<td>9.4</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Ambient</td>
<td>36.1</td>
</tr>
<tr>
<td></td>
<td>Chilled</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td>Frozen</td>
<td>11.4</td>
</tr>
<tr>
<td>Retail trade</td>
<td>Distribution Centres</td>
<td>47.8</td>
</tr>
<tr>
<td></td>
<td>Stores</td>
<td>671.3</td>
</tr>
<tr>
<td>Food service</td>
<td>Collective catering</td>
<td>73.8</td>
</tr>
<tr>
<td></td>
<td>Commercial catering</td>
<td>116.1</td>
</tr>
<tr>
<td>Household consumption</td>
<td>Consumer</td>
<td>2,513.5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5,548.8</td>
</tr>
</tbody>
</table>

Figure 10.10. Breakdown of food waste generated by commercial enterprises
The contribution each stage makes to the total amount of food waste is a function of both the quantity of surplus food generated (expressed in tonnes in this study), and on the level of recourse to less responsible surplus management practices (Figure 10.11.). Focusing on this latter aspect, it can be seen that 88.2% of surplus food in the agriculture and fishing sector becomes food waste. At manufacturing companies this value decreases to 44.7%. The retail trade and food service sectors are characterised by extremely high percentages of food waste (92.5% and 90.8%, respectively).

As with surplus food, it can be seen that the stage that contributes the most to the generation of food waste is household consumption (100% of surplus food is wasted, or approximately 2.513 million tonnes/year). The manufacturing stage, however, contributes less to the generation of food waste both in terms of waste volumes and in terms of the percentage of surplus food wasted (44% of surplus food is wasted, or 81,000 tonnes/year).

10.6. The recoverability of food waste

Food waste generated in the food supply chain can be analysed as a function of its degree of recoverability, as was done for surplus food. By evaluating the 5.5 million tonnes of food waste as a function of degree of recoverability (low, medium, or high), it can be seen that only 83,900 tonnes (1.5% of all food waste) has a high degree of recoverability, but well over 2.7 million tonnes (almost 50% of food waste) has a medium degree of recoverability, and can therefore be recovered if an appreciable level of management effort is made (Figure 10.12.).

It is interesting to examine the amount of food waste generated at each stage as a function of its degree of recoverability (Figure 10.13.). The stages and the segments that generate the most food waste are the stages that are characterised by a medium or a low degree of recoverability. To-date, in fact, surplus food with a high recoverability is in large part already recovered for human consumption. Although it is still important to work towards recovering the remainder of the food waste in the segments with a high recoverability (manufacturing and retail stores), the medium-long term objective is to target food waste with a medium
Figure 10.11. Food waste generated by each individual stage in the supply chain

<table>
<thead>
<tr>
<th>Stage</th>
<th>Waste (m tonnes/yr)</th>
<th>Waste as Percentage of Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture and fishing</td>
<td>2.045</td>
<td>88.2% (*)</td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retail trade</td>
<td>0.719</td>
<td>92.5% (*)</td>
</tr>
<tr>
<td>Food service</td>
<td>0.081</td>
<td>44.7% (*)</td>
</tr>
<tr>
<td>Household consumption</td>
<td>0.190</td>
<td>90.8% (*)</td>
</tr>
<tr>
<td>Overall</td>
<td>2.513</td>
<td>100% (*)</td>
</tr>
</tbody>
</table>

(*): Food waste as a percentage of surplus food for each individual stage in the supply chain.
recoverability in the agriculture and fishing, retail trade (stores), and food service sectors. Fortunately, there are a number of examples where socially responsible companies are implementing projects to recover surplus food for social purposes.

10.7. Summary of the research results

The amount of surplus food generated annually in the Italian food supply chain is significant both in absolute terms (six million tonnes) and in percentage terms (17.4% of annual food consumption). The amount of surplus food generated per capita (101 kg), which is lower than the quantities determined through similar studies in Anglo-Saxon countries (although differences in scope and methods make the results difficult to compare – see Chapter 2), appears to suggest that companies in the Italian food supply chain - including final consumers - are more efficient than in other western economies.

The reasons surplus food is generated differ depending on the supply chain stage considered. In the food manufacturing sector, for example, there are five main reasons for the generation of surplus food: internal product sell-by date has been reached (66.9%),
product non-compliance with “aesthetic” standards (12.2%), packaging non-compliance with required standards (5.7%), product refusals (9.1%), and returns of unsold product (6.1%). The most basic underlying reason for surplus food generation - in all of the stages examined - can be traced back to discrepancies between quantities produced or bought and quantities sold or consumed. For the manufacturing and retail trade segments, this results when the internal sell-by-date has been reached, for agriculture and fishing it is caused by over-production, for food service and household consumption it means that more meals are prepared than consumed. The second major reason surplus food is generated, especially on the commercial side of the food supply chain, is product non-compliance with commercial standards. It should be recalled that these standards relate only to aesthetic aspects and not to the edibility of the product.

Looking at the quantities of surplus food generated at individual stages in the supply chain, the most critical stages, where the most attention should be focused, were identified as agriculture (i.e. crop and livestock farming) and household consumption. However, the perspective changes when surplus food is examined in light of its degree of recoverability. Surplus food with the highest degree of recoverability is in fact generated by food manufacturing companies and retailers.

Figure 10.13. Breakdown of food waste by supply chain stage and degree of recoverability

![Figure 10.13. Breakdown of food waste by supply chain stage and degree of recoverability](image)
To-date, a significant proportion of surplus food has become food waste from a social perspective. In fact, only a small portion is recovered for human consumption (through donations to food banks or charitable organisations). Food waste in Italy adds up to 5.5 million tonnes per year. This amount represents 92.5% of surplus food and 16.0% of food consumption.

If food waste is examined from the point of view of recoverability, it can be seen that, as expected, a higher degree of recoverability is correlated with a lower percentage of food waste. In the segments with a low recoverability (livestock farming, fishing, crop farming - cereals, commercial catering, and household consumption), 98.6% of surplus food is wasted. In the segments with a medium recoverability (crop farming - fruit and vegetables, manufacturing - chilled, manufacturing - frozen, retail trade - stores and collective catering), 90% of surplus food is wasted. And finally, in the segments with a high recoverability (manufacturing - ambient and retail trade - distribution centres) the amount of surplus food wasted is lower at 43.8%.

During the investigation into surplus food management options, it was found that there are structured attempts to reduce food waste in the segments where recoverability is the highest, and at manufacturing companies in particular. It should be noted, however, that even at this stage in the supply chain a wide range of behaviours was observed. Although 35% of surplus food in the manufacturing sector is donated to food banks or charitable organisations located throughout the country, 32% is disposed of as waste. The reasons that companies make different choices, for managing surplus food with a given degree of recoverability, are several: residual value of the surplus food, concerns about company image, how the surplus food is generated, management expertise, and capabilities of available firms. The relative weight of each of these factors varies significantly between the different stages in the food supply chain.
The total amounts of surplus food and food waste in Italy have been quantified in the preceding sections for both the individual stages in the food supply chain and for the supply chain as a whole. This chapter discusses the phenomenon of surplus food from the perspective of firms operating within the food supply chain, with a particular focus on commercial enterprises. The cost impacts of the various surplus food management options and strategies for encouraging its more effective management are discussed (sections 11.1., 11.2. and 11.3.). Specifically, the importance of establishing “structured” surplus food management processes is emphasised, from defining a hierarchy of preferred management channels to the definition of responsibilities. Then, given that other stakeholders, such as charitable organisations and sector policy-makers, play a key role in reducing food poverty, some ideas related to their roles are discussed (section 11.4.).
11.1. How surplus food is managed: financial implications

The management of surplus food has strong social, environmental and financial implications for businesses in the food supply chain (whether they operate in the agriculture and fishing, manufacturing, retail trade or food service sectors). The social and environmental aspects have been discussed in sufficient detail in the preceding chapters. The financial implications of the alternatives for managing surplus food will now be assessed in order to gain a better understanding of the main benefits and the most critical issues related to the sustainable management of surplus food. Currently, most business decisions are based on an evaluation of financial returns (short or long term). The cost of the activities defined previously as “management intensity” need to be evaluated in greater detail in order to analyse financial impacts.

Each surplus food management option involves several activities, including: processing or preparation of the product; storage and handling; transportation; and the fulfilment of administrative requirements. From the business’ point of view, each category of activity has a financial impact that varies depending on which management option is chosen.

The processing or product preparation needed to make the surplus food suitable for conferral to a third party entails associated labour costs (e.g. to sort and select surplus food products) or the use of special packaging (e.g. disposable containers used in the recovery of surplus food in the food service industry).

Storage and handling, which are necessary to maintain the product prior to its conferral to a third party, entail costs that are proportional to the length of time the goods are stored (this may be a few days at retail stores or several weeks at farms) and to the magnitude of the flows of surplus food generated. This cost category includes both storage costs (which can be significant if the surplus food needs to be refrigerated) and the cost of handling the goods.

Transportation, which is needed to transfer the product from the point of generation to a third party recipient, entails costs that are a function of the volumes involved and the distance between the point
of generation and the destination. This expense may be incurred by the companies that generate the surplus food or by the organisations that receive it.

The administrative costs related to the supporting documentation necessary for the conferral of surplus products are mainly related to labour costs to complete both tax and transportation documents.

Some disposal options involve the payment of fees. For example, if the surplus food is conferred to a waste management company, the cost is proportional to the volume of waste disposed (usually inclusive of transportation costs). There may be a significant cost differential depending on the type of business (private or public) and on the geographical area. The case studies revealed that these values range from €100 to €200 per tonne. The conferral of surplus food to manufacturing companies that produce animal feed may sometimes involve a cost, while in other cases payment may be received for the surplus product. Manufacturing companies may provide compensation for surplus products that have a high manufacturing value (e.g. some companies are willing to pay for dry cereal-based food products, which are particularly suited to the production of animal feed). In other cases, they charge a fee based on the weight of the products accepted (e.g. fish products), although this cost is less than the cost of disposal. In general, the financial return from the assignment of surplus food to manufacturing companies does not cover production costs.

When surplus food is donated to non-profit organisations (known as ONLUS in Italy), there are tax incentives that depend on the volume of product and the sector to which the company belongs.

Finally, an initial investment is needed for some of the surplus food management options. For donations to non-profit organisations for example, companies incur some start-up costs (usually small) for setting up the procedures for managing the surplus food (sometimes information systems may need to be updated) and to train and educate their staff. In addition, if the company does not have the equipment needed to recover the surplus food, it must incur the relative purchase costs (e.g. for blast chillers in the food service industry).
Surplus food management costs are a function of the quantities of surplus food generated and handling frequency. Costs also depend on the supply chain stage and how the surplus food is managed. The results of the financial impact analysis for several segments in the supply chain are presented below. These segments were chosen to represent different stages in the supply chain and different degrees of product recoverability. More specifically, the “ambient” segment was chosen from the manufacturing stage (high recoverability), the “stores” segment for the retail trade stage (medium recoverability) and the “collective catering” segment for the food service stage (medium recoverability).

Prior to proceeding, it should be noted that the financial analysis was based on a cost comparison of the different options for managing surplus food. The potential benefits a company might achieve by managing surplus food for social purposes within a Corporate Social Responsibility programme were not considered, although

Figure 11.1. Financial impact of surplus food management options for a manufacturing company in the “ambient” segment
these benefits, which may not be achieved by other means, could be significant (e.g. by attracting “socially-oriented” customers).

In other words the analysis considered only the immediate and tangible financial impacts. The less tangible impacts or those that are related to specific business strategies could be the subject of another study.

11.1.1. Manufacturing companies - ambient segment

In theory, any of the different surplus food management options presented previously could be selected in the “ambient” segment of the food manufacturing stage (see section 6.5. for more details). Figure 11.1. shows the impact of the different management options in relation to the main cost items. The magnitude of the impact was estimated based on the findings of the case studies.

Some general observations can be made from an examination of the different management options. Sales through secondary markets often generate sufficient returns to cover the cost of managing the surplus food and to partially recoup production costs (not shown on the chart). In some cases, conferral to other manufacturing companies may also generate some revenue (though less than that generated by secondary market sales) that may be sufficient to cover management costs. In this second situation, the manufacturing companies that receive the surplus food often pay the transportation costs as well. However, an investment in containers in which to store the surplus food may be required.

Looking at the donation of surplus food to charitable organisations and food banks, it can be seen that no returns are generated and management costs are higher. It fact, careful product selection and diligent maintenance are necessary to maintain quality and ensure that the product remains suitable for human consumption (storage costs are more significant in the chilled and frozen product segments). In addition, specific administrative steps must be taken for each donation including: contacting the charitable organisation or food bank, preparing the necessary documentation (including the transport document and registered mail to the Revenue Agency with return receipt, if needed), and storing documents received from the charitable organisation or food bank following the receipt of goods. If the
charitable organisation or food bank is a non-profit organisation, there is a tax break on the VAT for purchases of raw materials, the amount of which depends on the type of goods donated and where they were produced. Finally, this option – in order to be effective – requires an investment to implement a structured process for the identification and distribution of surplus food (e.g. information systems could provide alerts about the possible generation of surplus food, as described in section 11.3.). This cost varies depending on the business context but will be lower if the company already has a structured process for managing surplus food, even if donating the surplus food was not considered previously.

The “external” costs of conferring surplus food to waste management companies are high, and are a function of disposal costs and volumes generated. However, the preparation, storage and administrative costs are lower. It should be noted that when surplus food is conferred to manufacturing companies for a fee, the costs are similar to this last alternative, although the cost of disposal is typically lower.

Figure 11.1. shows that conferral of surplus food to waste management companies is usually the most expensive management option. Therefore, it makes sense from a financial perspective, as well as from a social and environmental perspective, to resort to this alternative only when the other options are infeasible. However, there is a potential conflict between social and financial interests when deciding whether to confer surplus food to charitable organisations and food banks or to manufacturing companies that can recover it (and therefore pay for it).

These results, and the fact that surplus food in this segment has a high degree of recoverability, explain why surplus food is seldom disposed of as waste in this industry segment: only 25.1% (32.2% for the manufacturing stage overall) compared to more than 70% for the food supply chain as a whole.

11.1.2. Retail companies - stores segment

There are only two options for the management of surplus food in the retail stores segment: it may be donated to charitable organisations or food banks or it may be conferred to waste management companies
for disposal (see section 7.5. for further details). Figure 11.2. shows the level of financial impact for various cost items that would be incurred by a generic store for each of these two management options. The financial impacts were estimated based on the findings of the case studies.

Figure 11.2. Financial impact of surplus food management options for a company in the retail trade sector, stores segment

<table>
<thead>
<tr>
<th>Impact area</th>
<th>Processing / preparation</th>
<th>Storage / handling</th>
<th>Transportation</th>
<th>Administration</th>
<th>Additional investment</th>
<th>Additional external returns/costs</th>
<th>Tax benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donation</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>🟢</td>
<td>/</td>
<td>🟢</td>
</tr>
<tr>
<td>Confer to waste management companies</td>
<td>🟢 (*)</td>
<td>🟢</td>
<td>🟢</td>
<td>/</td>
<td>🟢</td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

(*) Cost is independent of the volume disposed

Donating surplus food to charitable organisations or food banks is generally more onerous than its conferral to waste management companies. There are no potential returns and the management costs involved are significant. Surplus food on the shelves must be identified and products carefully selected, at a time sufficiently in advance of the product expiration date. With fresh products especially, these activities need to take place on a daily basis. If products that are not pre-packaged (e.g. cheese from the deli counter) are to be donated, they first need to be properly packaged and labelled. Once selected and prepared, surplus food needs to be properly stored in order to ensure that it remains suitable for human consumption. Storage costs are significant because storage areas within stores are small and expensive and because of the
need for refrigeration if chilled and perishable products are to be donated. Furthermore, from an administrative perspective, it is necessary to fill in forms every time surplus food is donated and store the documents received from the charitable organisation or food bank following receipt of the goods. This cost is high due to the large number of products that can be donated (and must be listed in the documentation) and the high donation frequency (regular pickups are needed because products at stores are approaching their expiration date). The tax break relating to goods donated to non-profit organisations is significant as companies are entitled to rebates on the VAT paid in relation to the donated product. Finally, as was noted for manufacturing companies, resources need to be invested to implement an efficient process for the identification and distribution of surplus food that can be donated (e.g. this could involve training staff and developing agreements with the recipient organisations).

Local municipal facilities are usually used for the disposal of food waste, where disposal costs are based on store size rather than the volume of waste disposed (with some exceptions). However, the preparation, storage and administrative costs are minimal.

The cost comparison shows that in this segment there is a potential conflict between social and financial interests when deciding between donating surplus food to charitable organisations or food banks - which is generally more costly - and disposal.

These findings, together with the fact that the intrinsic recoverability is good but not really high, partly explain why donation in not common (below 5%) in this segment of the supply chain.

11.1.3. Food service companies - collective catering segment

In the collective catering segment surplus food may be conferred to organisations that tend to animals, such as kennels (generically designated as manufacturing companies in Figure 11.3.), donated to charitable organisations or food banks, or conferred to waste management companies (see section 8.5.). Figure 11.3. shows the financial impact of these surplus food management options for various cost items from the perspective of a generic company in the collective catering segment.
The conferral of surplus food to manufacturing companies (in this example, organisations that look after animals) does not involve costs, aside from the minimal preparation and storage costs associated with selecting and maintaining the surplus food. Transportation costs are usually incurred by the recipient of the surplus food.

The choice of donating surplus food to charitable organisations or food banks is usually more costly. The surplus food must be selected, packaged in suitable single-use containers, blast chilled (i.e. to control temperature), labelled and stored in refrigerators until it is picked up by the recipient. Specific equipment is therefore required, including at least one blast-chiller, one heat-sealing machine, and separate refrigerators than those used to store fresh products. As shown in Chapter 8, it is often the client company that owns this equipment in the collective catering segment. However, the client may be reluctant to make this type of investment because not providing this equipment guarantees that all meals will be prepared daily (i.e. reheated food will not be served). In short, the contractor might have to purchase this equipment itself in order to
be able to donate surplus food.

The disposal of surplus food as waste is not usually expensive and is a function of facility size rather than volumes of waste disposed. Furthermore, this cost is in most cases incurred by the owner of the building in which the canteen is located (i.e. the company that contracts out the food service).

The cost comparison shows that there is a potential conflict between social and economic interests in this segment when deciding between donating surplus food to charitable organisations or food banks – which is generally more costly – and conferring it to waste management companies or for use as animal feed. These findings, together with the fact that prepared meals have a medium intrinsic recoverability, explain why donation is infrequent in this segment of the supply chain, as discussed previously in Chapter 8.

11.2. Setting up a structured surplus food management process

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 companies.

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.

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 CSR (Corporate Social Responsibility) programme.

In order to set up a structured process for managing 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.

11.2.1. Understanding the surplus food phenomenon

First of all it is important that each company - whether they operate in the agriculture and fishing, food manufacturing, retail trade or food service sector - determine the amount of surplus food generated, the reasons it is generated (e.g. the sell-by date is reached, packaging is damaged), the frequency of surplus food generation (i.e. whether it takes place throughout the year or is a result of unsuccessful promotional campaigns) and the product shelf-life (i.e. the period within which the product can be sold or conferred to other players in the supply chain). It is essential that these elements be understood in order to design the surplus food management process.

11.2.2 Establishing the surplus food management hierarchy

As mentioned in the literature review, a hierarchy of preferred management options must be established in order to create a more effective process for managing surplus food (i.e. to reduce food waste and to alleviate food poverty).

Figure 11.4 shows an example of a surplus food management hierarchy that is based on the approach proposed by the United States Environmental Protection Agency (EPA, 2012). This hierarchy meets both social and environmental sustainability objectives. The recovery of surplus food for human consumption is prioritised. If this is not possible, then surplus food can be used for animal feed, for industrial purposes, or for composting. Disposal of surplus food as waste in landfills or incinerators is to be considered only as a last resort.
Once the previous two steps have been completed, the company needs to identify the beneficiary organisations with which to collaborate (type and number of organisations). Organisations that recover surplus food for human consumption can be grouped according to the type of service that they offer. First, there are commercial enterprises that deal with selling products through secondary markets (e.g. stockists or food outlets), which are different from charitable enterprises that collect surplus food for social purposes. Charitable enterprises can also be subdivided into charitable organisations, which recover surplus food and distribute it to the needy, and food banks, which recover surplus food and distribute it to charitable organisations (see section 3.1.2.). Secondly, organisations can be differentiated on the basis of the area they serve (i.e. based on the food needs they fulfil) and the geographical area in which they operate. When selecting beneficiary organisations, the company must take the service capabilities of the organisation into consideration (in terms of product categories, volumes, time frames, collection areas).
If the company (e.g. a food manufacturing company) generates large volumes of surplus food with a long shelf-life a few times a year, it may choose to collaborate with a food bank that has a considerable ability to manage and redistribute the product. If the company regularly generates a small amount of surplus food or generates surplus food that has a short shelf-life, it may choose to collaborate with local charitable organisations, so that the surplus food can be collected daily and delivery to the final recipients can take place almost simultaneously. Other qualitative aspects may be considered important, such as a preference to work with a specific organisation, with an organisation that provides special guarantees, or with an organisation that is familiar to the company’s customers (e.g. to benefit from brand association). It may in fact make sense to collaborate both with a large organisation, which operates throughout Italy, and with a local organisation that is more visible in the area where the company operates.

Organisations that manage surplus food by methods other than donation can also be grouped according to the final destination (production of animal feed, energy or fertiliser, or destruction as waste) and service capabilities. Preference may be given to the socially responsible use of the product (a preference for the production of animal feed over disposal as waste) or to cost-effectiveness when selecting between the alternative recipient organisations. As mentioned above, the company’s priorities form the basis of the hierarchy of surplus food alternative uses.

With regard to choosing the organisations with which to collaborate, the case studies showed that some companies prefer to collaborate with only one partner while others prefer to maintain collaborative relationships with more than one organisation. There is no right or wrong choice in this regard. A single structured partner organisation can generally be relied up on to collect significant quantities of surplus food, even in different geographical areas. More partner organisations, located in different places, can provide greater flexibility and more control over how the surplus food is used.
11.2.4. Setting up a collaborative agreement

The rules of the collaborative relationship need to be agreed with each recipient organisation, in terms of:

• acceptable products (e.g. only dry products with damaged packaging);
• the roles and responsibilities of each party (e.g. channels of communication, when collection takes place, and what documentation is required);
• fees and division of costs (e.g. who pays the transportation costs).

The procedure for managing surplus food needs to be explicitly defined and clearly outlined in relation to the possible sources of generation.

11.3. A structured surplus food management process: the example of a food manufacturing company

An example of a structured process for managing surplus food at a manufacturing company is presented in this section.

First, the shelf-life of each of the different products or product families and their associated critical deadlines need to be identified (Figure 11.5.):

• deadline (X) - also known as the internal sell-by date - the date by which the product must be sold to companies in the retail trade and food service industries (they usually require two-thirds of the product’s shelf-life);
• deadline (Y) - also known as the sell-by date - the date by which the product must be sold via secondary channels, where there are fewer restrictions than the traditional commercial channels; after this date the product is no longer marketable;
• deadline (Z) - the date by which the product must be donated to charitable organisations or food banks to enable them to distribute the product before its expiration date; this date, which would be specified in the related agreement, is usually later than deadline Y because the process used by charitable organisations
to manage food products is faster than distribution channels;
• deadline (H) - the date by which the product must be delivered to manufacturing companies;
• the product expiration date (K); sometimes the product expiration date is later than deadline H; in other cases it coincides with deadline H; deadline H can also be later than K as some manufacturing companies will also accept expired products.

It is important for a company to establish appropriate procedures for managing products according to remaining product shelf-life. Thus, by monitoring the remaining shelf-life of stored products, identifying the time remaining before the various deadlines and implementing defined procedures, the generation of surplus food can be avoided. The remaining shelf-life of stored products can be checked using modern ERP (Enterprise Resource Planning) systems, where a unique identifier is used for individual packages. For example, it makes sense to implement a procedure that, when deadline X (internal sell-by date) is approaching, stimulates sales in traditional markets through discounts in order to avoid the generation of surplus food. Secondly, it is important for a company
to establish appropriate management procedures for dealing with surplus food - once it is generated - according to the remaining shelf-life and the reason it was generated. Two examples are presented in the following pages: a model for managing surplus food generated because the internal sell-by date was reached and a model for managing surplus food generated as a result of packaging non-compliance.

11.3.1 Structured management of surplus food that has reached its internal sell-by date

The case studies revealed that, at the manufacturing stage, 66.9% of surplus food is generated because the internal product sell-by date has been reached. One potential scenario that is consistent with the hierarchy of social and environmental priorities (Figure 11.6.), is to direct these products toward secondary markets as soon as the internal sell-by date (i.e. deadline X) has been reached. If any surplus product has not been sold through these markets when the sell-by date (i.e. deadline Y) has been reached, donations should be made to charitable organisations or food banks. Once deadline Z has been reached, surplus food that has not been donated to charitable organisations can be conferred to manufacturing companies. Once the date by which the product must be received by these companies has been reached (i.e. deadline H; either before or after the product expiration date), the only option remaining is conferral of the product to waste management companies.

It is important to note that this management process was developed in accordance with social and environmental priorities. The cost-effectiveness of one management channel compared to another also depends on the responsibilities assumed by the beneficiary (e.g. transportation costs and collection frequency) and whether any payment will be made for the goods received. The sequence of priorities may differ when cost considerations are taken into account.

Each company can make its own decision about when to initiate the different management options. Specifically, the deadlines for initiating the different management options may be
Figure 11.6. Structured management of surplus food that has reached the internal product sell-by date

![Structured Management Diagram]

Legend:
- X: deadline for sale to main markets
- Y: deadline for sale to secondary markets
- Z: deadline for conferment to charitable organisations/food banks
- H: Deadline for conferment to manufacturing companies
- K: Product expiration date

Included in the company’s information system. The information system can therefore proactively suggest the initiation of selected procedures. Clearly, the closer to the related deadline it is when a particular solution is set in motion, the lower the chances of managing the surplus food effectively.

Surplus food generated by the return of unsold products or products refused upon delivery that are not reintroduced through commercial channels (15.2% of surplus food generated at the
manufacturing stage) can also be managed in accordance with the procedure described above. Special attention must be paid to products refused upon delivery (e.g. loads not accepted by the customer due to inconsistencies with the order placed), where it is important that quality control of the returned products is completed rapidly so that deadlines X and Z are not missed.

11.3.2. Structured management of surplus food caused by non-compliance of product packaging

The case studies revealed that 5.7% of surplus food generated at the manufacturing stage is a result of non-compliance of product packaging. Non-compliance of product packaging may

Figure 11.7. Structured management of surplus food caused by non-compliance of product packaging
refer to the secondary packaging (i.e. the carton that contains the packaged products) or the primary packaging (i.e. an individual saleable package). If the non-compliance is identified prior to deadline X (internal sell-by date) and if repackaging of the product is both possible and economically feasible (typically for secondary packaging), repackaging and sale of the product is recommended in order to reduce the amount of surplus food generated (Figure 11.7.).

If repackaging is not possible or if the product could not be sold, the product could still be donated to charitable organisations. In this event, it is important to ascertain whether deadline Z has been reached.

This process, like the previous one, was developed in accordance with social and environmental priorities. When the company’s priorities are financial, the same considerations apply as were mentioned above with regard to the structured management of surplus food that has reached the internal product sell-by date. It is important to note that surplus food generated as a result of product non-compliance can also be managed in accordance with this procedure (although the prospects for product reprocessing are fewer).

11.4. The role of non-profit organisations, State and bridging institutions

In the preceding section, the surplus food phenomenon was examined from the perspective of “commercial” players in the food supply chain (i.e. businesses). This section assumes the perspective of non-profit organisations and policy-makers.

11.4.1. Food banks and other non-profit organisations

Key aspects of surplus food management can also be reviewed through the eyes of food banks and, more generally, of the non-profit organisations that are the potential recipients of the surplus food (information about beneficiaries in Italy is provided by Pesenti (2009) and Rovati (2009b):
there is an enormous quantity of surplus food that is not currently donated to food banks or other charitable organisations; it amounts to approximately 90% of all surplus food generated in Italy;

- approximately 50% of this surplus food has a low recoverability – these products are extremely difficult to recover for human consumption – but nearly 50% consists of products with a medium recoverability that can be recovered if they are managed carefully and competently;

- donation may or may not be financially viable for businesses, depending on how the business-beneficiary agreement is set up and managed (see section 11.1.1.).

As a consequence, the capabilities – both quantitative and qualitative – of the non-profit organisations that collect and distribute surplus food play a key role in the recovery of surplus food for social purposes.

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 degree of recoverability – from large-scale retailers, the food service industry, and some agricultural segments – calls for recipients with well-developed logistics capabilities. Secondly, 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.

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. 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. 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. 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 surplus food, the Fondazione per la Sussidiarietà carried out a study on food poverty in Italy (Campiglio and Rovati, 2009), which 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.

11.4.2. State and bridging institutions

The donation of surplus food and its subsequent distribution to
people suffering from food insecurity is of public value, that is, it
represents a benefit to the community. Therefore, it follows that
policies and other system-wide changes that support and enable
strategies promoted by businesses in the food supply chain and the
endeavours of food banks and charitable organisations in this field
should be considered. This effort is even more essential in light of
the current economic and social crisis, which raises the associated
risk of a food emergency.

Before presenting possible strategic actions, a notable
pioneering policy, which did not create additional costs for
the State, and yet removed some of the barriers that prevented
the growth of donations, should be recalled. This is Italian law
number 155/2003 (known as the “Good Samaritan” law), whose
sole article states that: “Organisations that are recognised as
non-profit in accordance with Article 10 of Legislative Decree
No. 460, 4 December 1997, and subsequent modifications, that
distribute food products free of charge to the needy for charitable
purposes, are considered, within the limits of the service provided,
as equivalent to final consumers with respect to the appropriate
conservation, transportation, storage and use of food.” This law
absolves the donors of surplus food from liability with respect
to the storage and use of food products recovered by food
banks and other non-profit organisations, allowing these social
enterprises to fulfil their mission at their discretion. To further
the elimination of barriers that obstruct businesses and non-profit
organisations, policy-makers, administrations, governments
and other institutions that work in the public interest – such
as Chambers of Commerce and producers’ associations – can
play an important role in several ways: raising awareness of
the phenomenon; collecting and disseminating scientific data
on surplus food and food waste; supporting efforts to develop new models for managing surplus food in the more complex segments of the food supply chain; endorsing, perhaps using economic regulation, responsible management practices that benefit society as a whole, even if they are not cost-effective for individual supply chain players.

First of all, surplus food management needs to be better understood within the food supply chain. As has already been made clear, the superficial and sensationalist approach to the phenomenon makes it difficult to clearly understand it in sufficient detail to be able to make rational decisions (Chapter 1). At least two aspects need to be investigated in greater detail to broaden the existing knowledge base. First, work is needed in the cultural arena to develop knowledge amongst the players: dissemination of the “hierarchy of surplus food uses” to businesses in the supply chain, compilation and communication of responsible surplus food management success stories, and training on technical and legislative issues. Secondly, it would be valuable to obtain rigorous estimates of the phenomenon on a regular basis, rather than just one-time estimates, through a sort of permanent monitoring body, which would use the model to assess surplus food and food waste periodically (the ASRW model, similar models, or model updates). Key roles can be played by the ministries in charge of environment, industry and social policy, and by sector and supply chain associations, with the recognition that reducing surplus food at the source, and putting it to good use once it has been generated, can be important to the competitiveness the national food supply chain as a whole.

A second strategic action involves the promotion of pilot projects in “promising” and “difficult” segments of the supply chain, i.e. segments in which the surplus food has a high value and nutritional content but is more difficult to recover for social purposes. It is essential that any pilot project include an in-depth analysis of the needs of the social and commercial enterprises involved, such as the constraints to which they are subject, fostering the exchange of knowledge. This phase should also include an initial assessment of surplus food and food waste.
Then, best management practices in the relevant segment need to be identified and evaluated, both in terms of technologies used (e.g. to preserve cooked food) and of processes for managing surplus food. Following the completion of the pilot project, quantities of surplus food and food waste must again be estimated, together with the costs incurred by each participant. These findings should form the basis for recommendations to be presented, via trade associations or Chambers of Commerce, to other companies in the segment to encourage the wider implementation of effective surplus food management practices.

To move beyond a general discussion, two suggestions for pilot projects are presented that could be trialled in two particularly “promising” segments of the supply chain: commercial catering and retail stores.

The pilot project in the commercial catering segment could be conducted at a shopping mall. Indeed, there is clearly a large concentration of flows at a shopping mall, where there are usually multiple food service outlets. The implementation of a pilot project at a shopping mall near a large town would satisfy two conditions: the requisite volumes of surplus food needed to minimise logistics costs could be attained, and a variety of charitable organisations should be present within the local area. Similar trials have been carried out in the United States, where some organisations recover surplus food generated during large sporting events.

For the retail trade sector, a group of experts could be assembled to assist a retail chain willing to conduct a trial. Their task would be to assess the technical and health and safety implications of widening the range of products recovered (e.g. not only dry packaged products, but also fresh products) and, together, to track the results of monitoring to verify product compliance with quality and health and safety standards. In addition, with the aim of achieving economies of scale, the possibility of organising the recovery of surplus food by bringing together nearby stores that belong to different retail chains (e.g. stores in the same neighbourhood) should be evaluated, as retailers that belong to the same chain are not usually located in close proximity.
A third strategy involves promoting the adoption of socially responsible practices for recovering surplus food through tax incentives and, more generally, through economic regulations. In the first part of this chapter it was shown that, in some segments, the recovery of surplus food for social purposes involves additional activities that create added costs for those who undertake them. However, it is conceivable that these costs are, in many cases, still lower than the public benefit of reducing the scale of food insecurity suffered by a portion of the population. In this case, there is a sound basis for tax measures to enable the recovery of these costs in the form of tax reductions or deductions, subject to the appropriate certification. The introduction of tax incentives in favour of donation should be preceded by a general cost-benefit analysis that takes into consideration the environmental benefits of using surplus food for social purposes in addition to the direct social benefits.

Tax incentives could benefit not only the companies that generate surplus food, but also those who can contribute to reducing the level of effort involved in managing it. For example, trucking or logistics firms that make their partially under-utilised resources – trucks or warehouse space – available to non-profit organisations could qualify for such benefits. For example, a truck that has just delivered a shipment of goods to a retailer’s distribution centre could load the available surplus food and deliver it to a food bank’s warehouse, with a slight increase in terms of time and costs, which could be at least partially recovered through the tax benefit.

As tax incentives may be difficult to implement during a period of government spending cuts, an alternative strategy would be to address the pricing structure for waste collection and disposal. It was found that sometimes, at retail stores for example, waste disposal costs are based on store size rather than the volume of surplus food conferred to waste management companies. As a result, limited consideration is given to reducing waste volumes by implementing more responsible surplus food management practices. Therefore the introduction of tariffs based on waste volume could be experimented at the municipal level for some supply chain segments, primarily retail trade but also collective catering.
11.5. Summary of the research results

Management intensity, that is, the level of commitment and expense needed to effectively manage surplus food, is a factor that explains the range of behaviours observed within the supply chain in terms of deciding how best to manage surplus food. This component of recoverability – a counterpart to the intrinsic recoverability of the surplus food – was the focus of this chapter, in which the financial implications of the alternatives for managing surplus food for businesses in the supply chain were examined.

Some significant differences in the way the players in different sectors choose to balance cost-effectiveness and social and environmental concerns were identified. It is usually worthwhile for manufacturing companies to avoid disposing of surplus food as waste from all three perspectives. The cost-effectiveness of making donations to charitable organisations or food banks rather than conferring surplus food to other manufacturing companies depends on conveyance changes. However, at the other stages in the supply chain there is less alignment between the economic perspective and the social and environmental perspectives. This difference is partly due to disposal costs, which are not currently tied to the volume of surplus food disposed (but are instead a function of the size of the store or food service establishment), and partly due to the considerable level of management effort needed to donate the surplus food.

The study also showed that the individual players in the supply chain need to change their processes if food waste is to be reduced, beginning with the development of a clear hierarchy for the different surplus food management options at individual companies. A structured process for managing surplus food at manufacturing companies was proposed, based on a social perspective. The key activity in the proposed process is the formal definition of product condition (most importantly sell-by dates), which forms the basis for activating the various management procedures. The model presented for the manufacturing stage may obviously be adapted for other stages of the supply chain as well.

The analysis confirms that for some stages or segments of the supply chain, where the management effort required is not high,
reducing food waste depends mainly on the willingness of supply chain players. Companies that currently have low surplus food donation rates should emulate the best practices already in place in the supply chain. For most of the supply chain segments – retail trade and food service for example – the management intensity can be significant so it is imperative that new models or incentive systems be identified if greater quantities of surplus food are to be recovered and food waste reduced.

Finally, it was found that policy and system-wide changes are required in order achieve more widespread recovery of surplus food. This is an area that requires careful consideration by policymakers, governments, legislators and even private entities that work in the public interest, such as trade associations and Chambers of Commerce. There are several possible strategic actions that could complement the initiatives of commercial enterprises and social organisations. The first strategy involves developing measures to promote awareness about socially responsible surplus food management practices and to monitor surplus food and food waste at the individual stages and in the supply chain as a whole. A second strategy involves experimenting with new and innovative models for managing surplus food in the segments where donation is currently infrequent. Finally, the idea of introducing tax incentives to enable at least partial recovery of the costs involved in certain specific management activities should be seriously considered; changes to the waste disposal rate structure also represent a promising area for social innovation.
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**Websites**


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