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Preventing Food Waste

CASE STUDIES OF JAPAN AND THE UNITED KINGDOM

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Abstract

PREVENTING FOOD WASTE: CASE STUDIES OF JAPAN AND THE UNITED KINGDOM

by

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This report contains case studies of food loss and waste policy practices in Japan and the United Kingdom. The Japanese case study examines the goals, measurements, achievements and future challenges of the country's food loss and waste policies. The Japanese government has implemented policies to suppress and recycle food loss and waste since 2000 under its Food Recycling Law. The control of food waste generation is based on a specific target for each industry group, in order to address differences in the scope for loss and waste reduction across sectors. While food waste in the food industry has been reduced, the waste at consumer stage has shown no change in recent years, highlighting outstanding challenges at the consumer stage.

Preventing food waste has been a priority for Governments in the United Kingdom for over a decade, and a range of mechanisms have been put in place to deliver this within households, hospitality and food service, food manufacture, retail and wholesale sectors. The UK case study outlines the policy context within which food waste prevention sits, explains how food waste is defined in the United Kingdom, provides detail on the level and types of food waste across different sectors, and describes the interventions adopted and their impacts. Between 2007 and 2012 household food waste reduced by 15%, despite a 4% increase in household numbers, and food waste at manufacture and retail fell by 10% between 2009 and 2012. There is significant potential to reduce food waste further, however it is likely that this will become increasingly challenging

Keywords: Food waste, Japan, United Kingdom, Love Food Hate Waste, Courtauld Commitment.

JEL classification: Q13, Q10, Q18

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Abbreviations

AD	Anaerobic Digestion
CC	Courtauld Commitment
Defra	Department for Environment, Food and Rural Affairs, United Kingdom
FAO	Food and Agriculture Organization of the United Nations
FUSIONS	Food Use for Social Innovation by Optimising Waste Prevention Strategies
GBP	British Pound Sterling
GHG	Greenhouse Gas
GVA	Gross Value Added
HaFS	Hospitality and Food Service
HaFSA	Hospitality and Food Service Agreement
JPY	Japanese Yen
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LFHW	Love Food Hate Waste
MAFF	Ministry of Agriculture, Forestry and Fisheries (Japan)
MOE	Ministry of Environment (Japan)
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
QSR	Quick Service Restaurant
UK	United Kingdom
UNEP	United Nations Environment Programme
W.A.S.T.E	Waste definition, Analyse and identify root causes, Solution generation, Trial, evaluate and measure and Execute sustainable change and reduce waste
WRAP	Waste and Resources Action Programme, United Kingdom

Executive Summary

- Two case studies are presented as examples of food loss and waste policy practices in Japan and the United Kingdom. They have been prepared by the Government of Japan and DEFRA and WRAP in the United Kingdom as a contribution to the OECD's ongoing work on market and trade impacts of food loss and waste reduction.
- Japan is a major food importing country with trade accounting for about 60% of its food intake. However, food loss and waste at each stage of the food chain is a serious concern. The government has implemented policies to control and recycle food loss and waste since 2000 under the Food Recycling Law. Section 1 summarises Japan's goals, measurements, achievements and future challenges of its food loss and waste policies.
- In order to monitor these policies, data on food waste in Japan is collected from the food manufacturing, wholesaling, retail and catering industries. It is a requirement that all business operators with more than 100 tonnes of annual food waste generation report annually the status of the generation and recycling of their food wastes. The estimates for the entire country are calculated on the basis of those complying with the law, together with a sample survey of business operators who generate 100 tonnes or less of waste. Data on food waste in the food service industry and households is also collected through other statistics. An interesting feature of Japanese statistics is that they estimate the amount that is recycled for feed or fertiliser use.
- The government plans to target the amount of food waste that is to be reduced, and this is a priority over reuse and recycling. Following a technical investigation, target value for the control of food waste generation were established to cover 26 industry groups for a period of five years from April 2014. The indicator "reference generation unit" is applied as the target value for the control of food waste generation.
- Food waste resulting from returned goods and excess inventory is difficult for individual companies to resolve and should be tackled by the entire food chain. In this regard, the food industry in Japan has formed a working group to examine business customs in order to reduce food waste and to review delivery deadlines, best before date use standards, and labelling methods. These reviews are drawing attention particularly as the extension of product expiration dates is expected to improve domestic stockpiles in case of disasters.
- The measures in Japan summarised in this paper seem effective but concern only the control of waste generation and recycling of food waste in the food industry and do not cover food loss occurring at the farm level. It should be noted that food waste at the consumer level has shown no change in recent years. Looking over the entire food chain, future challenges for food loss and waste at each stage of the food value chain are outlined.
- Preventing food waste has been a priority for Governments in the United Kingdom for over a decade, and a range of mechanisms have been put in place to deliver this. Section 2 outlines the policy context within which food waste prevention sits, explains how food waste is defined in the United Kingdom, provides detail on the level and types of food waste across different sectors, and describes the interventions adopted and their impacts.

- Three major WRAP (The Waste and Resources Action Programme) studies carried out in 2013 estimated annual food waste arising within households, hospitality and food service, food manufacture, retail and wholesale sectors at around 12 Mt, 75% of which could have been avoided. Around 90% (by weight) of the avoidable food waste arises in households and food manufacture.
- The primary mechanisms in the United Kingdom for facilitating the reduction in food waste are the Courtauld Commitment (CC) and Hospitality and Food Service Agreement (HaFSA), both voluntary agreements managed by WRAP, and funded by Westminster, Scottish, Welsh and Northern Ireland governments, and the consumer facing Love Food Hate Waste (LFHW) campaign. Based on the experience in the United Kingdom, the following factors are highlighted as important for successfully reducing food waste:
  - **An evidence based strategy**, to identify priorities, build a persuasive case for action, develop clear and robust recommendations and inform the development of effective messages and materials for engaging with consumers, industry and other stakeholders.
  - **An integrated approach**, looking across the whole supply chain (recognising the influence those at any given stage in the supply chain can have on others in the supply chain), and also in terms of householders incorporating three key elements (national / large scale awareness raising campaigns, local/community engagement to influence behaviours and changes to products, packaging and labelling to make it easier to buy the right amounts of food and use what is bought), which if implemented together deliver much more than any element in isolation.
  - **A framework for action**, such as the CC and HaFSA, with collective targets which provides a mechanism for sharing best practice and facilitating the uptake of recommendations for change.
  - **Monitoring and reporting**, to assess progress against targets, allow changes in action to be made in response to this and to recognise (publically) achievements (show what can be done) and benefits of taking action.
- The chapter concludes by exploring the challenges ahead and implications of reduced food waste levels. While the United Kingdom has made positive progress in reducing food waste, it is likely that further reduction will become increasingly challenging (for example as the "quick wins" will have been achieved). Population growth and other economic factors will also limit the reduction of food waste.

FOOD LOSS AND WASTE REDUCTION ACTIVITIES IN JAPAN

1.1. Background

Japan is a major food importing country, importing 60% of its food supply. The food self-sufficiency rate on a calorie basis is among the lowest of OECD countries. However, Japan's culinary culture highly values fresh food, such as sashimi and foods that are in season, and this results an excessively freshness-conscious consumer base which, in turn, is thought to result in considerable food loss and waste at each stage of the food chain. Since the Food Recycling Law was enacted in 2000 under the joint jurisdiction of the Ministry of Environment (MOE) and the Ministry of Agriculture, Forestry and Fisheries (MAFF), the government has introduced policies on the control and recycling of food loss and waste. The motivation to fight food loss and waste in Japan is related to lower costs for both consumers and producers, but also concerns for the global environment and solidarity with underdeveloped nations (Marra, 2013). The present study summarises Japan's goal setting, measurements and achievements as well as the future challenges of its food loss and waste policies.

This section provides an overview of the policies targeting waste in general. Since the Law for the Promotion of Effective Utilities of Resources (Recycling Law) and the Basic Environmental Law were enacted in 1991 and 1993, respectively, other environmental issues have been dealt with separately; for example, by the revision of the Waste Disposal and Public Cleansing Law. Nevertheless, a large amount of waste is still generated every year which makes it difficult to ensure the waste disposal site, and complicates the waste management with problems such as illegal dumping. In order to address such waste and recycling problems, by moving away from an economy of "mass production, mass consumption and mass disposal" and achieving a "recycling society" with low environmental impacts, the Basic Law for Establishing the Recycling-Based Society was enacted. This law provides the framework to promote the formation of a recycling-oriented society and was enacted in June 2000 and fully enforced as of January 2001.

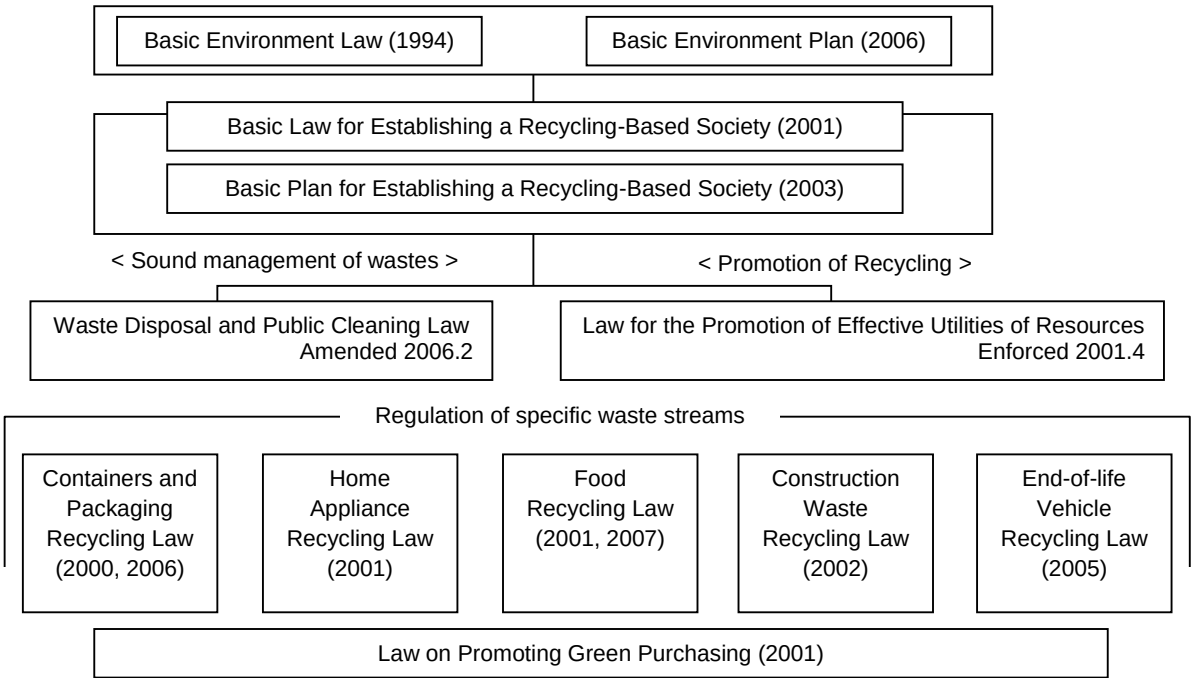
Comparison of international policy frameworks (Sakai et al., 2011) indicates that the major focus of waste management policies changed during the late 20th and early 21st centuries, driven by global environmental problems and concerns about the depletion of natural resource. Formerly, the focus was on promoting environmentally-sound waste treatment to avoid local environmental pollution, but today policies have shifted to pursue the concept of sustainability by introducing and promoting 3R (Reduce, Reuse, Recycle) policies.

The Basic Law for Establishing the Recycling-Based Society, which is positioned under the Basic Environmental Law, has become a central law over and above other individual laws on waste and recycling. This legislation defines a recycling-oriented society in which the generation of waste from products is controlled, the proper cyclical use of wasted products is promoted, the proper disposal of cyclical resources is ensured, and consumption of natural resources and environmental stresses are reduced via appropriate measures. It states the priority of the process in the order of "waste reduction", "re-use", "material recycling",

"thermal recovery" and "proper disposal." The concept of extended producer responsibility is adopted in the law in the way that a producer assumes certain responsibilities for the disposal and recycling of its products, as well as the state measures that define the implementation of receipt of products after use, their recycling and the pre-evaluation of products.

Various recycling laws were enacted together with the Basic Law, and revisions of the Recycling Law and Waste Disposal and Public Cleansing Law were also undertaken (Figure 1). Newly enacted laws were the Food Recycling Law, Construction Waste Recycling Law, Containers and Packaging Recycling Law, Home Appliance Recycling Law, End-of-life Vehicle Recycling Law, and the Law on Promoting Green Purchasing. In 2012, a Small Electronic Appliance Recycling Law that covers mobile phones and game machines was also enacted.

Figure 1. Waste Management framework in Japan



Source: Sakai et al. (2011).

The Food Recycling Law addresses both the reduction of waste, such as processing residues from food production, unsold or uneaten foods in the distribution and consumption process, and recycling of waste materials to feed and fertiliser uses, etc. These laws are aimed at creating a recycling-oriented society with low environmental impact as well as reducing the amount of food waste. Food-related businesses in the manufacture, distribution and catering sectors are obliged to recycle waste materials, and if their activities are deemed insufficient, the government can issue instructions and recommendations, or even publish the name of the company. Penalties can be imposed in case government instructions are not obeyed.

The Food Recycling Law defines food waste as follows:

- Food materials which are disposed after being served or without being served as food

- Materials which are not able to be provided as food and can be obtained as a by-product in the process of manufacturing processing and cooking

The scope of Japanese definition of food waste is different from FAO's and limited to manufacturer, wholesaler, retailer, caterer and consumer stage. It is assumed that non-edible portions of food and by-products are included in Japanese definition of food waste.

The Food Recycling Law provides a registration system of recycling operators and a certification system for business plans on recycling in order to promote recycling by food-related businesses. This is the system where operators producing specific feeds and fertilisers from recycled food materials can be registered by the Ministry; 180 operators were registered nationwide as of March 2014. The registration identifies business operators who undertake their recycling business according to government norms, with the goal of cultivating good recycling companies. The registration requirements are that the production of feeds and fertilisers do not hinder the conservation of the living environment, that the scale and type of facilities are appropriate to efficiently implement the business (processing of food resources of 5 tonnes or more per day), and that there is a sufficient financial basis for project implementation. The advantages of registration are expanded business opportunities owing to the publication of their company on a government website, special treatment under the Feed Safety Law and Fertiliser Control Act that does not require repetitive notification of sales and production of feed and fertiliser, and a special treatment under the Waste Disposal and Public Cleansing Law that does not require a work permit for the transportation of municipal solid waste in the unloading area (a work permit is required, however, from the municipality in the loading area).

The certification system of a business plan on recycling, called "recycling loop", that uses specific feed and fertiliser from recycled food materials can be formulated jointly by manufacturers and operators on agriculture, forestry and fishery industries, etc., as a specific user, and receive recognition from the respective Ministries. Once the plan is approved, the business plan will receive special treatment under the Feed Safety Law, Fertiliser Control Act, and the Waste Disposal and Public Cleansing Law. Under this system, food-related businesses can expect stable supplies of primary products from agriculture, livestock and fisheries, and recycling businesses, and the primary sector may secure customers within the recycling loop. In March 2014, there were 52 certified business plans on recycling, consisting of 20 livestock feed businesses and 32 fertiliser businesses. For example, vegetables and pork are produced using a fertiliser or feed that has been recycled from food. The Food Recycling Law must be reviewed for its enforcement status five years after implementation, and take necessary measures recommended by the review. In response to this, a committee composed of representatives from the MOE and MAFF met in 2006, and the law was amended in 2007.

In order to monitor this policy, data on food waste is collected by the food manufacturing, wholesaling, retail and catering industries. In response to the legislative changes in 2007, it is necessary for the operators with more than 100 tonnes of annual food waste generation to report annually the status of generation and recycling of their food wastes. The estimates of food waste for the entire country are made from the responses together with a sample survey for the operators of 100 tonnes or less. Data on food waste in the food service industry and households is collected through other statistics, and the MOE also has other estimates of household waste. An interesting feature in Japanese statistics is that it contains the amount that is recycled for feed or fertilisers. Recent policies are monitored by these detailed statistics, but in the past, the rough estimates of food waste were calculated by taking the difference between the intake and the supply amount per capita per day on a calorie basis (Box 1). Stuart (2009) proposed to compare the required intake amount per capita for each country and the supply amount obtained from FAO's food balance sheets. This enables simple international comparison of excessive food intake and food waste. Such a method with the

data readily accessible would be helpful in countries that do not collect data specific to food waste.

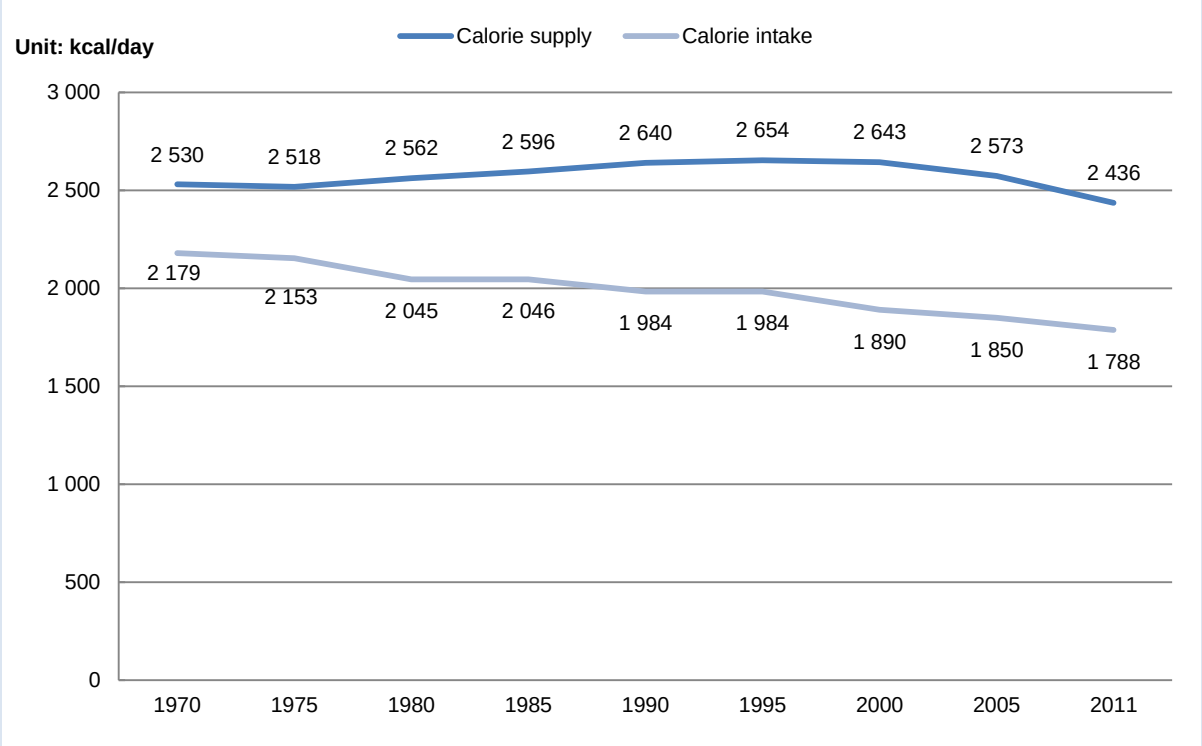
At the time of the revision of the Food Recycling Law in 2007, the following items were revised in addition to the introduction of mandatory reporting of food waste generation:

- Additional recycling method.
- Additional treatment of food resources: heat recovery.
- Setting targets of recycling rate for each industry and reference targets for each operators.
- Handling a franchise chain as a single integrated operator.
- Review of the certification system of business plans on recycling to facilitate efforts by food-related businesses.

Box 1. One meal's worth of calories are lost between the supply and intake amounts in Japan

The calories supply per capita initially shows an increasing trend from 2 530 kcal in 1970 to 2 670 kcal in 1996, and then a decline to 2 436 kcal in 2011 (Figure 2). On the other hand, calorie intake per capita has decreased steadily since 1970 and was 1 788 kcal in 2011. It is considered that the difference between the two figures provides a rough indication of inevitable residues during the processing stage of the food industry and leftover foods at the household level, etc., and equates to around 600 to 700 kcal, which is equivalent to one meal of a day.

Figure 2. Trends in calorie supply and intake per capita in Japan



1. The intake and supply amounts are surveyed and calculated differently, and the difference is indicative only.
2. The supply amount is on a fiscal year basis (April – March).
3. The data does not include alcohol drinks.

Source: MAFF (2013), "FY2012 Annual Report on Food, Agriculture and Rural Areas", "Food Balance Sheet", MHLW "National Health and Nutrition Examination Survey."

The remainder of this section notes a few key points about the situation of food waste recycling. Although a reduction in generation of food waste has priority, other activities after generation are also important. Food materials should be recycled as feed and fertiliser where feasible, and only if recycling is difficult should heat recovery be carried out. In the case where recycling and heat recovery are both impossible, the amount of waste should be reduced by dewatering and drying. Such priority setting in Japan is in line with recommendations such as those embodied in the "toolkit" by the FAO (2013).

In the practice of recycling, the amount, composition and potential demand of food waste should be clearly understood in order to select the appropriate method of recycling. Discharge of waste is properly separated from containers, packaging, tableware, and any other foreign matter, e.g. toothpick and food waste that are not suitable for recycling. The livestock feed use of waste is a means capable of recycling effectively calorie and ingredients, which contributes to the improvement of feed self-sufficiency. It is important to select it preferentially when performing recycling, while ensuring the safety of the feed. Fertiliser should be produced on the premise to ensure its utilisation, by taking into account the quality needs of farmers and the supply and demand situation of organic fertiliser in regional markets. The revision of the law in 2007 added ethanol and hydrocarbon products to be used as fuel and a reducing agent as recycling methods, in addition to feed, fertilisers, oils and fats, and methane.

- The revision has also added heat recovery as a treatment of food resources. However, it is restricted to situations where recycling is difficult. There are two conditions where heat recovery should be chosen.
- There is no manufacturing facility of specific feed and fertiliser in a range of 75 km, and the nature and type of food waste is extremely difficult to recycle.
- Even if there is a manufacturing facility of specific feed and fertiliser within 75 km, it is possible to recover energy equally or more efficiently than that of methane.

The certification system of the business plan on recycling has been reviewed to include additional requirements for certification where food-related operators are sure to accept specific products of agriculture, livestock and fisheries which have been produced with recycled feeds and fertilisers, to the amount stipulated by the ordinance of the Ministry. In short, there is a need to complete the recycling loop that circulates food resources among the three parties (Box 2).

More than a decade has passed since the Food Recycling Law was enacted and the majority of food waste associated with business activities is now recycled in Japan. With regard to the quantitative analysis in the OECD study of food waste and loss reduction impacts on markets and trade, it should be noted that the materials that have been recycled as a by-product will be counted as waste, and only the amount of reduction will be dealt with in the study.

Box 2. Assessment of environmental impact of the food waste recycling in Japan

The Food Recycling Law in Japan promotes the "recycling loop" that requires food industries to purchase farm products that are grown using food waste-derived compost/animal feed. One question is whether these recycling loops are environmentally and economically effective.

Takata et al, (2012) applied the Life Cycle Assessment (LCA) and Life Cycle Cost (LCC) approach to evaluate global warming potential and running cost of five looped facilities for machine integrated compost, windrow compost, liquid feed, dry feed, and bio-gasification. The LCA results showed low total GHG (greenhouse gas) emissions of − 126 and − 49 kg-CO2/t-waste, respectively, for dry feed and bio-gasification facilities, due to a high substitution effect. The LCC study showed a low running cost for composting facilities of – 15 648 and – 18 955 JPY/t-waste, respectively, due to high revenue from the food waste collection.

It was found that mandatory reporting of food waste emitters to the government increased collection fees; however, the collection fee from animal feed facilities was relatively low because food waste was collected at a low price or nutritious food waste was purchased to produce quality feed. In the characterisation survey of various treatment methods, the composting facilities showed a relatively low environmental impact and a high economic efficiency.

Animal feed facilities had a wide distribution of the total GHG emissions, depending on both the energy usage during the drying process and the substitution effect, which were related to the water content of the food waste and the number of recycled products. In comparison with incineration, the majority of the food recycling facilities showed low GHG emissions and economic effectiveness. The study also reported on the effects of recycling loops by comparing looped and non-looped animal feed facilities, and confirmed that the looped facilities were economically effective due to an increased amount of food waste collection.

1.2. Target for the control of food waste generation

An issue after the revision of the legislation in 2007 is the effort of controlling the generation of food waste. In the summary of the review meeting held in December 2006, proposals were made as follows for the promotional measures to reduce food waste generation (Box 3).

Box 3. Excerpt from the summary of the Food Recycling Law review in Japan

Control of the generation of food waste is defined as the top priority. However, it is difficult to point out any clear results indicating the progress of generation control, and current efforts seem to be insufficient. One reason is that the promotion mechanism and the assessment of generation control do not reflect the characteristics of food-related businesses in order to effectively encourage their activities.

Therefore, to further promote the control of waste generation within the current framework, the goal to achieve this generation control should be established separately from the target of recycling, based on the characteristics of the business category and industry.

On the other hand, at the time the goals were set it was intended not to put excessive constraints on industrial activities so as to avoid the situation where the domestic food industry would unnecessarily seek overseas procurement of semi-finished or finished products. From this point of view, the basic unit of generation control should be established with reference to the progressive approaches by some operators and in order to provide goals for other individual food-related businesses. Characteristics of the industry and business category should be taken into account, for example, by strengthening the efforts of operators whose basic unit is less than the average.

As noted, the revision of the Food Recycling Law requires periodical reporting of waste generation and recycling by each operator creating more than 100 tonnes of food waste. It is planned that the government establishes the target value for the control of food waste generation based on the data gained from the mandatory reporting. In this connection, the MAFF and MOE jointly created a working group to carry out a technical investigation. Targets for the control of food waste generation have been set (Table 1). They first covered

16 industry groups that dispose of edible parts of food due to over-production, over-storage and product returns; the target levels have been tentatively set for a two year period starting from April 2012. Since April 2014, these targets have been fully operational by widening the coverage to 26 industry groups. They apply the "reference generation unit" indicator as the target amount of food waste reduction. This indicator is the amount of food waste generated divided by the indicator that closely relates to the amount of food waste, such as sales, and production volumes and varies according to the type of business.

$$Reference\ generation\ unit = \frac{Amount\ of\ food\ waste\ generated}{e.g. Sales,\ Production\ volumes}$$

Table 1. Target value for the control of food waste generation in Japan

Industry	Industry group for target setting	Indicator	Target value	Unit
Manufacturing	Meat processing	Sales	113	kg/million JPY
	Dairy product	Sales	108	kg/million JPY
	Soya source	Sales	895	kg/million JPY
	Soya paste	Sales	191	kg/million JPY
	Source	Production	59.8	kg/t
	Bread	Sales	194	kg/million JPY
	Noodle	Sales	270	kg/million JPY
	Soya bean curd	Sales	2560	kg/million JPY
	Frozen food	Sales	363	kg/million JPY
	Delicatessen	Sales	403	kg/million JPY
	Sushi, bento, and bread products	Sales	224	kg/million JPY
	Canned and bottled fishery products	Sales	480	kg/million JPY
	Vegetable pickles	Sales	668	kg/million JPY
Wholesales	Drinks	Sales	14.8	kg/million JPY
Retailing	Various food products	Sales	65.6	kg/million JPY
	Bread and confectionery	Sales	106	kg/million JPY
	Convenience stores	Sales	44.1	kg/million JPY
Catering	Noodle restaurant	Sales	175	kg/million JPY
	Restaurants not specialized in noodles	Sales	152	kg/million JPY
	Taverns	Sales	152	kg/million JPY
	Cafe	Sales	108	kg/million JPY
	Fast foods	Sales	108	kg/million JPY
	Other restaurants	Sales	108	kg/million JPY
	Takeaway and delivery	Sales	184	kg/million JPY
	Wedding hall	Customer	0.826	kg/person
	Inns	Customer	0.777	kg/person

Source: MAFF.

Tentative targets were developed first with operators that have high reference generation units with less control of waste generation so as to contribute to a control of waste generation throughout the entire industry, rather than to set up targets based on good track records of the more progressive companies with low reference generation units. Specifically, the target values were obtained by adding the standard deviation (set as 0.5 sigma) to a two-year average of the reference generation unit of each industry. As a result, about 70% of all

operators will have already achieved the desired reference generation unit. However, it is necessary for the operators below the target value to strive to maintain or reduce the reference generation unit. At present, it is desired that target setting will be accomplished with as many industries as possible with a view to promoting efforts throughout the food chain, and there is an emphasis on increasing this momentum by civil society.

Before the full implementation from April 2014, target setting was reviewed in light of data from the latest mandatory reporting, for both of 16 industry groups with tentative targets and 21 groups without target setting. 15 groups among preceding 16 groups were considered for full implementation, but many operators have not achieved their tentative targets, and these tentative targets of 15 groups have been set as the targets for full implementation. The period of full implementation has been set as five years from April 2014, in view of targets for food recycling which are also set for five years.

The sub-sections below are based on the report that the expert group submitted in January 2012. This report describes how targets are established using the data from mandatory reporting and provides interesting observations on target setting and their prospects according to the stage of the food supply chain, such as food manufacturing and wholesale industries.

(1) Base data and considerations on target setting

Accurate data on the occurrence of food waste became available because of the mandatory reporting required for operators with food waste of more than 100 tonnes since the fiscal year 2008 after the revision of the Food Recycling Law. For this reason, the target value for the control of food waste generation was established based on the data from regular reports. The target value needs to be determined in each industry, using the particular indicator that closely relates to the amount of food waste such as sales and production volume. In order to identify the indicator, correlation analysis of the potential indicators and the amount of food waste was performed. For some industries, the correlation analysis was done in subdivided industry groups to set the target value, thus better reflecting their actual situations.

It was decided that industries which lack necessary data to carry out the correlation analysis were to be exempted from the first exercise. According to the recommendations in the summary review of the Food Recycling Law in 2007, the exercise should not place excessive burdens on any industrial activity. For this reason, interviews with industry representatives and surveys via questionnaires, in addition to the mandatory reporting, were conducted in order to develop the target setting in light of the characteristics of the industry. Where there seemed to be an excessive burden placed on an industry, the target setting was foregone.

(2) Considerations on target setting for food manufacturing industry

The rate of recycling implemented by the food manufacturing industry as a whole reached 95% in 2011, achieving the target value set for 2012. Recycling was the primary activity carried out, and the volume of waste disposal was relatively small. The food waste generated from food manufacturing industry occurs either as a result of transactions with food distribution industry or due naturally to the production of food. Of these, inedible parts of food such as bone and certain meat parts from livestock and marine products and pomace of fruit juice that inevitably occurs during food production is difficult to be re-used as food, and the control of its occurrence requires development of new technologies and new products, which is a difficult effort within a short period of time. For this reason, for those industries for which food waste is composed of inedible parts of food should not be subjected to target setting at this stage and to efforts to reduce food waste.

The parts of food which are edible but which are removed during the food manufacturing process, e.g. breadcrumbs and poultry livers, can be reused as food by the development of new products. However, it is time consuming and not easy to develop new products, and the balance between the part of food used for manufacturing and other edible parts from manufacturing does not necessarily meet demand. Thus the generation control of these parts is difficult in the short timeframe. The method of setting the target value for the reduction amount of food which is edible but inevitably removed during food manufacturing should be treated with caution so that it does not put excessive constraints on industrial activities. Since it is nevertheless desirable to control the occurrence of food waste which occurs during food manufacturing, it is necessary to first quantify amounts of edible and inedible parts in order to assess the possibility and methods to control these amounts.

On the other hand, food waste that occurs as a result of transactions within the food distribution industry, e.g. overproduction, excessive stocks, returned goods, can be reused directly as food. Such food waste has scope for control through the review of business customs, the improvement of more accurate orders, and the use of food banks. The methods can be determined through discussion and various approaches are possible depending on the scheme.

(3) Considerations on target setting for food distribution (wholesale and retail) industry

The recycling rates implemented by food wholesaling and food retailing reached 57% and 41%, respectively, in 2011; both are below the target level established for 2012. The absolute amount of food waste from food retailing is larger than that of food wholesaling (Figure 3). Food waste from the retailing industry derive mainly from excessive stocks, damaged goods, cooking wastes, and unsold goods which occur in the course of distribution, cooking and sales. It is important to control these amounts as they are mostly edible; this will also contribute to achieving the target recycling rate. A variety of control measures are possible; for example, greater accuracy when ordering amounts of food products, the use of food banks, consumer education. In addition, while food waste generated by returned goods and excess inventory occurs throughout the food chain, the distribution industry should take the lead in efforts to control such waste and spread the efforts to other participants in the food chain.

When setting the target value, downstream industries such as retailing should go ahead of others. In this case, it is necessary to avoid easy solutions that are restrained to just returning the good to the upstream food manufacturing industry. The food waste generated from wholesale agriculture, livestock and fisheries and fresh fish retailers, excluding the meat wholesale industry, is characterised by a small amount of unsold or returned goods but a not so negligible amount of internal organs of fish, preparation residue of vegetables and rice bran, which is confronted with the same problem of food waste that inevitably occurs during food manufacturing. Thus, it is necessary in the future to consider the possibility and methods to control food waste by properly understanding the generation of food waste.

(4) Considerations on target setting for catering industry

The recycling rates implemented by the catering industry reached 23% in 2011, which is below the target level set for 2012, and it indicates a large amount of food waste disposal (Figure 3). Food waste from the catering industry is mainly composed of cooking waste and uneaten foods which occur in the course of cooking, eating, drinking and sales. It is important to control these amounts as they are mostly edible, and their recycling seems difficult to progress because of contamination with foreign ingredients, salts and oils. Thus reducing waste will be achieved by reducing the base amount. A variety of control measures are possible, for example supply better reflecting sales volume, optimisation of cooking volume, use of doggy bags for leftovers. Whatever the approach used, a basic understanding by consumers is a prerequisite.

In the review of 2014, business categories within the catering industry are diverse but in order to reflect the manner of food waste generation well, target value setting has been done by dividing the restaurant to smaller subgroups. Targets of other categories in catering industry are in line with the current industry classification used in the mandatory reporting.

(5) Industry groups for which target values cannot be established

Following are the 14 industry groups, which will strive to control food waste generation and to promote recycling in the meantime by voluntary efforts, with a view to setting their target values in future. Their food waste is mostly inedible part that inevitably occurs during food production, but quantification of edible and inedible parts of the food is insufficient, and it will still be required to assess the possibility and methods to control these amounts.

- Meat parts and frozen meat manufacturing industry
- Seaweed processing industry
- Manufacturing of salted goods and dried salted products
- Frozen marine products manufacturing
- Frozen aquatic food manufacturing industry
- Cane sugar manufacturing
- Miscellaneous grain-milling
- Tea industry
- Coffee manufacturing
- Fruit wine manufacturing industry
- Rice, barley and millet wholesaling
- Vegetables and fruit wholesaling
- Fresh seafood wholesaling
- Fresh fish retail

These industry groups manufacture or produce meat and fish products, grain-milling and wholesaling of vegetables, and fresh fish. These commodities and the stages of the food supply chains seem to correspond with the categories that show low figures in the food loss and waste estimates to be used in the scenario analysis using the Aglink-Cosimo model. For example, in the food loss and waste estimates, the processing and packaging, and distribution stages of cereals in Europe and North America shows low figures of 0.5%-10% and 2% respectively, and primary processing and storage stages of meat and seafood are lower than 1%. These figures suggest it is more difficult to control food waste for these commodities and industries in particular.

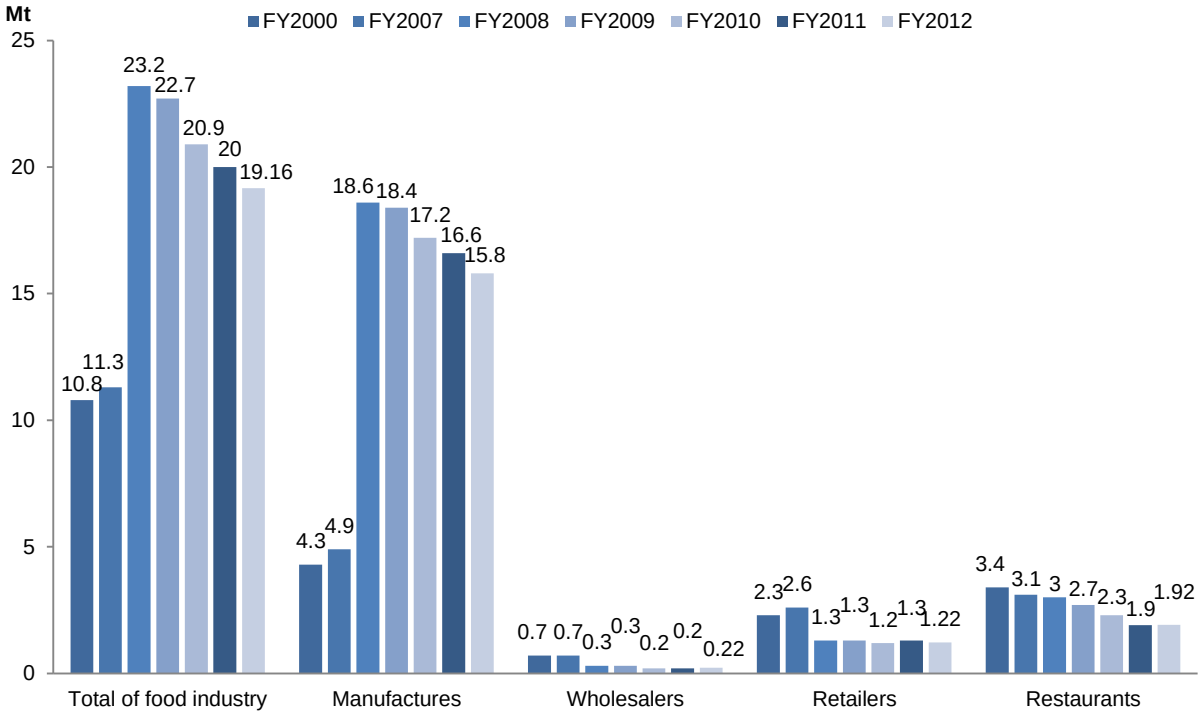
It has been assumed that considerable discussion and technical assessments for each industry groups were made by experts to establish the target value of waste reduction that can be accepted by industries, academics and the government. The current target values do not refer to the level of food waste that should be possible as the starting point. The concept is to evaluate the current level of food waste as fairly as possible, and to start with a target that is easy to tackle in view of the reality faced by industries.

(6) Recent situation about the control of food waste

This sub-section summarises how the control of food wastes has been progressing. Currently, the data on the amount of food waste and the recycling rate are estimated using statistical surveys and mandatory reporting under the Food Recycling Law. Figure 3 shows the change in the amount of food waste generated by the food industry. There is a gap in the data series between 2007 and 2008, and we will focus on the data since 2008. The food industry has been regularly reducing food waste generation, especially in the food manufacturing industry which accounts for most of food waste generation. The amount of food waste declined from 20.9 Mt in 2010 to 19.96 Mt in 2011, which is about 4%, where the share of food manufacturing industry is 83%. The food manufacturing industry and catering (restaurants) show declines in the recent year, but the data on wholesalers do not change, and the retailers show an increase of 7%.

Considerations on target setting summarised in the last section reflect the data in Figure 3. Food manufacturers, which show the largest amount of food waste generation and also most of its reduction, have already achieved high rates of recycling and low rates of waste disposal. Part of such efficiency may be due to the fact that most wastes from food manufacturers are categorised as inedible or edible part of food loss that inevitably occurs during food production, which are easier to control and less difficult to reduce the amount than other kinds of food loss and waste.

Figure 3. Change in the amount of food waste generation in food industry in Japan



The gap in the data series between 2007 and 2008 is due to the introduction of mandatory reporting for operators with more than 100 tonnes of food waste per year. In 2008, the amounts reported by operators with more than 100 tonnes of food waste totalled more than the amount calculated for 2008 based on the estimation methodology used up to 2007. There were several reasons for this. For example, up to 2007, statistics were collected from the samples hierarchically divided according to the number of employees without knowing the relative

distribution of food waste generation among the hierarchies. In addition, in the food manufacturing industry which involves relatively large waste generations, the data of the operators that generate a large amount of waste were not sufficiently obtained in the statistical survey before 2008. This provided a general lesson in conducting sample surveys, but since then, estimates are made only for operators with less than 100 tonnes of food waste, these are then combined with the results of periodic reporting introduced by revised Food Recycling Law, which improved the estimation methods and has produced figures closer to reality.

(7) Statistics for consumers and catering industries

In addition to policy measures and statistics for the food industry, MAFF (2013a) conducts statistical surveys on the food waste occurring in household consumption and catering (restaurants). This amount of waste represents discarded food, including outdated foodstuff and ready-to-eat food, edible portion removed by the decay during preparation and table leftovers. Since the scope food loss concerned in the household survey is intended to be the inner number of net food supply and demand of the Food Balance Sheet, the following components are not included.

- The amount that has been directed to feed, etc.
- Depletion during storage, transport, warehouse, and point-of-sale.
- Inedible parts of food such as fish bones and vegetable waste.

One question may be how the survey distinguishes the inedible parts from that which is discarded as food waste. The survey uses the discard rate prescribed by the Ministry of Education in the "Standard Tables of Food Composition in Japan." For example, if radish skins are peeled too thick and the amount exceeds the discard rate for radishes as set forth by the Standard Table, the difference will be counted as food waste and the amount corresponding to the discard rate will be considered as inedible.

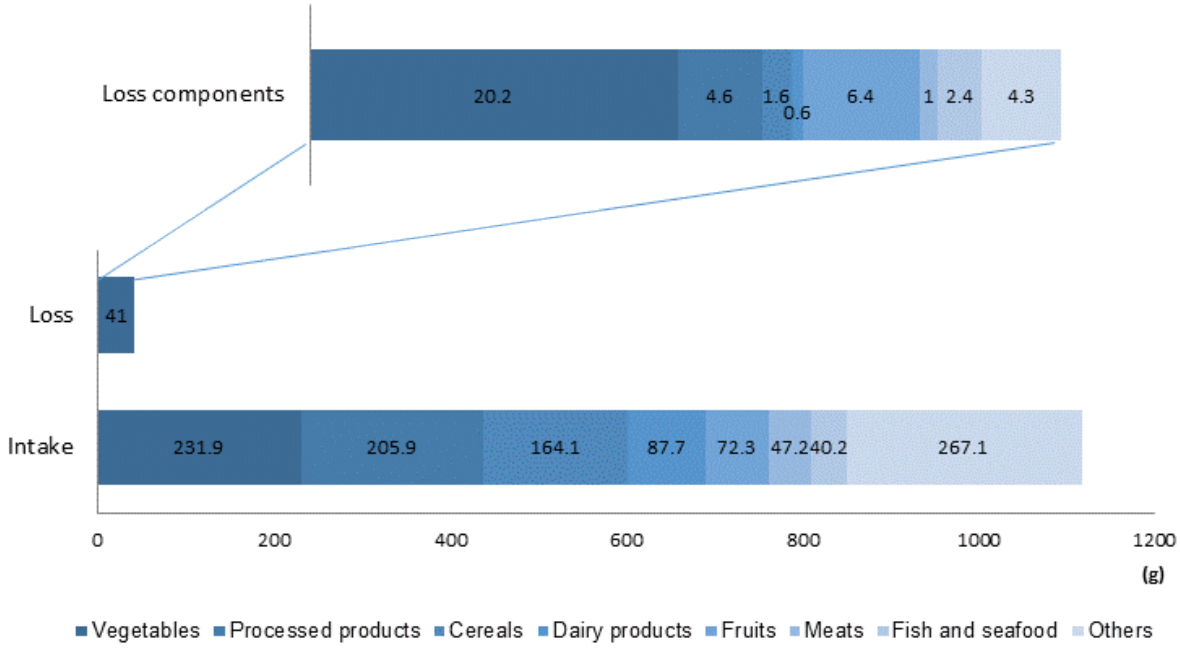
Figure 4 shows the amount of food usage and food waste per person per day. Fruits (8.9%), vegetables (8.7%), and seafood (6.0%) account for higher rates of waste than other commodity groups. The overall rate of food loss is 3.7% in 2009. A comparison with other industrialised regions for the food waste at the consumption stage (Table 2) shows the low rates that appear in the Japanese survey. Large differences in staple foods may relate not only to the data collection methodology, but also to the fact that food supply per person in Japan is one of the lowest among industrialized countries and eating portions are generally small, as observed by Stuart (2009). Childhood education on food consumption where leftover is considered wasteful (Mottainai) may partly explain these effects.

Table 2. Regional food loss and waste estimated by FAO and the survey in Japan

Commodity groups	Europe including Russia	North America and Oceania	Industrialised Asia	Survey in Japan
		%		
Cereals	25	27	20	1
Roots and tubers	17	30	10	–
Oilseeds and pulses	4	4	4	–
Fruits and vegetables	19	28	15	9
Fish and seafood	11	33	8	6
Dairy products	7	15	5	1

Source: FAO (2011), MAFF.

Figure 4. The amount of food usage and food waste per person per day in Japan in 2009

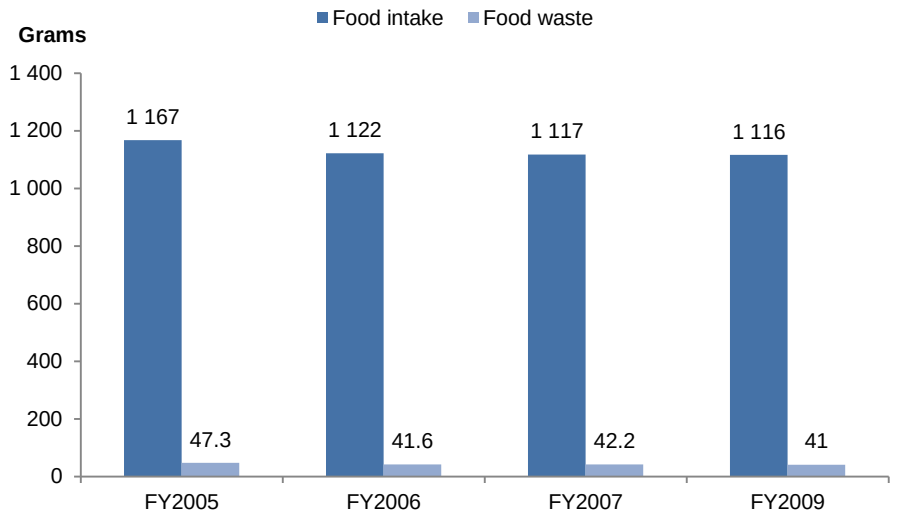


Source: MAFF.

This statistical survey also shows the rate of food waste classified by the structure of household members and the age of the dietary manager of the household. In terms of household member structure, two-person households (4.2%) and single-person households (4.8%) are beginning to show higher food waste than the households of three or more people (3.4%). The households with an elderly dietary manager show more food waste than those with a younger dietary manager, and the rate increases when the age classification goes from over 50 to over 60 years old. Changes in the aging Japanese society, such as the increase in single-person households, seem to impact the issue of food waste negatively.

In this survey, the degree of food freshness has been cited the most frequently as the reason for direct disposal of food and foodstuff. Other reasons, such as the expiration of use by date and best before date, come after that concerning freshness. These survey results may be due to insufficient understanding of date labelling method, as we can see that the best before date is taken as a reason to discard foods as well as the use by date. Since the time series data on food waste by the survey shows no major change in the trend at the household level (Figure 5), it seems that existing policies are more effective in impacting the food industry.

Figure 5. The trend of amount of food usage and food waste per person per day in Japan



Source: MAFF.

1.3. Reasons and countermeasures against food loss and waste

In order to promote the control of the generation of food waste, it is necessary to propose feasible and effective measures by understanding the cause and occurrence of food waste. For example, whereas in the upstream side and food manufacturing industry foods have been discarded without being shipped as a result of excessive production to avoid shortage, the industries in direct contact with consumers, such as retailing, tend to focus on freshness of products, constant replenishment, and enhancing the store shelves in order to avoid a bad reputation due to shortages and service degradation. Such business behaviour on the presumption of consumer needs is considered to be a major factor of food loss and waste in the food industry.

Japan's Organics Recycling Association reported in detail the causes of food loss and waste in 2011 as a result of interview surveys on the occurrence of food loss and waste. The report summarises the causes by types of food industry, such as manufacturing, wholesaling and retailing, and by types of foods such as ready-made, daily delivered goods, frozen, canned and retort food. It also analysed the causes of food waste associated to particular business customs and which are useful to refer to when examining individual measures against food loss and waste. Table 3 summarises different causes of food loss and waste among the food manufacturing, wholesale and retail industries.

Table 3. Causes of food loss and waste in Japan

Sector	Causes	Content and examples
Manufacturing		
	Manufacturing (processing) residues	Inedible part of food that occurs during food manufacturing and processing
	Loss during manufacturing (processing)	Loss during the change of products, falls from manufacturing line, non-standard goods, residues in tanks and manufacturing line
	Loss related to equipment	Loss due to troubles of manufacturing machines
	Irregular products	Products failing to pass inspections
	Excess amount against shortages	Loss of products and materials due to excessive manufacturing to avoid miss-out
	Sample for inspection	Loss of products kept for inspection for a certain period
	Returned goods	Products drawn out from distribution due to accidents and marking irregularity
	Trial products	Products made on trial basis during the development of new products and launch of new production facility, but not eaten
	Expired raw materials	Loss of raw materials that passed their use by date or best before date
Wholesaling and retailing		
	Returned goods because of expiry date of delivery	Discarded or returned goods that failed to meet the date of delivery (1/3 or 1/4 from the date of manufacturing)
	Difference between placement and reception of order	Excessive order to avoid miss-out, but not to be delivered
	Goods failing inspection	Goods considered to be irregular at customs and component analysis during imports
	Damaged goods	Scratches, dents, and damage of packaging during transport
	Processing residues	Residues during cooking and processing at retailers and restaurants
	Unsold goods	Good unsold within sell-by date
	Change of display	Seasonal products and expired products taken out from distribution due to the introduction of new products

Source: Japan Organics Recycling Association

(1) Working team to examine business customs to reduce food waste

Food waste resulting from returned goods and excess inventory that involves business counterparts is difficult for individual companies to resolve, and this should be tackled by the entire food chain. In this regard, the food industry in Japan has installed a "working team to examine business customs to reduce food waste" as a means for discussion among manufacturing, wholesale and retail industries. The government is supporting the secretariat to promote the initiative. The team of 18 people announced their interim report for the food waste reduction in March 2013. Their results of survey on returned goods and disposal of processed food revealed the followings. Causes of returned goods are soiled and damaged products, expiration of delivery or sales dates and replacements for new products, etc.

- The rate of disposal without shipment is high in beverages and confectionery.
- Causes of disposal without shipment are low prediction accuracy of shipment and expiration of delivery date, etc.
- Expiratory date of delivery is often set as the one-third of the period set as best before date.

The working team is expected to deal with a pilot project to review expiratory dates of delivery and extension and labelling method of best before date in particular.

(2) Pilot project to review expiratory date of deliver

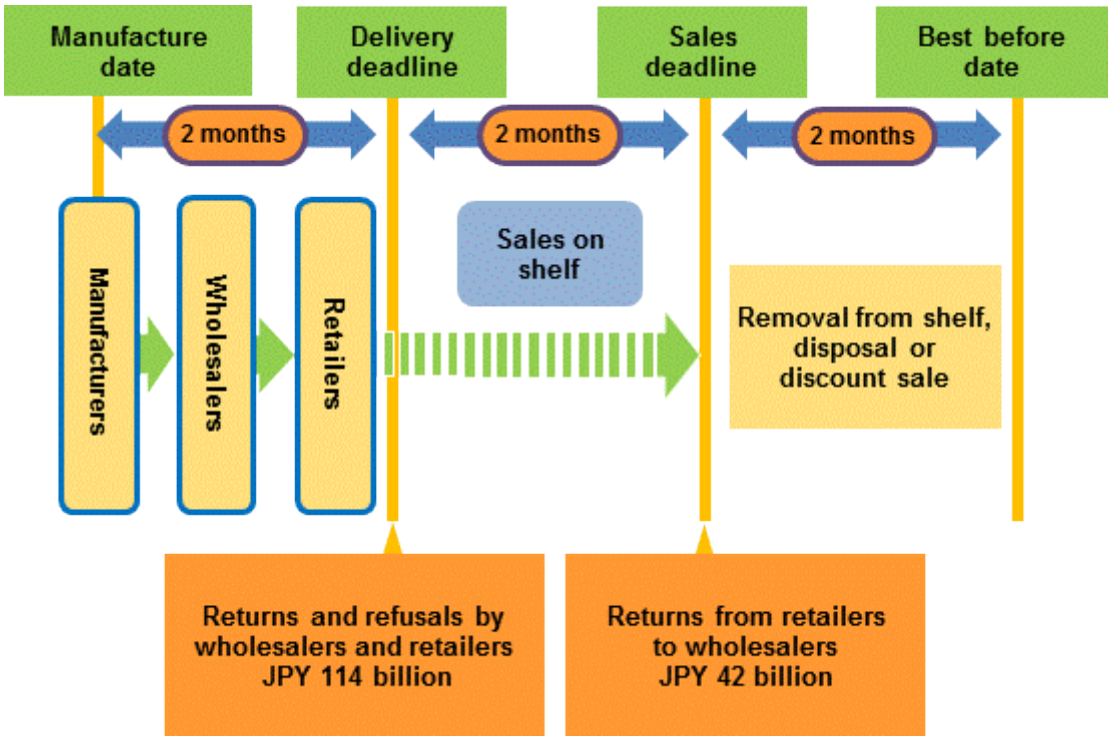
One of the business customs between food manufacturers, wholesalers and retailers is called the "one-third rule." According to this rule, retailers divide the period from the date of manufacture to the best before date into roughly three equal parts, and apply them as the period for the products to be delivered from manufacturers or wholesalers and as the period for the products to be sold to consumers. For example in Figure 6, for a product with a best before date of six months, retailers will reject or return the products which have passed two months since the date of manufacture to their manufacturers or wholesalers. For the products which have passed four months since the date of manufacture and with less than one-third of their best before dates remaining, retailers will remove them from the shop front, discard them or sell them at a discounted price.

With the one-third rule retailers can secure more than one-third of the best before dates for any goods to be sold at the store. This business custom in Japan applies stricter standards of freshness compared with other countries. For example, the deadline for product delivery in the United States is set as half of the best before dates, and in the case of European countries it is two-thirds of the best before dates. Naturally, this business custom will be a cause of food waste with returned or rejected products.

A cooperation council consisting of 43 companies of food manufacturing, wholesaling and retailers estimated the amount of returned processed foods from wholesalers to food manufacturers to be JPY 113.9 billion a year based on the value of manufacturer shipment in the fiscal year 2010. The expiration of delivery date accounts for more than one-third of the reasons for returned goods. The removal of products from the shelf due to the launch of new products also accounts for more than one-third of reasons for returned goods. On the other hand, returned products from retailers to wholesalers amount to JPY 41.7 billion, for reasons such as the expiration of sell-by date prescribed by the one-third rule. Another study by the working team to examine business customs to reduce food waste with 16 companies participating, 74% of the products returned to the manufacturer are discarded, and the amount of resale through other channels such as discount stores was a mere 16%.

The causes for returned good and unshipped disposal are complex as they include damage, spoilage, product replacement and inaccuracy of prediction for delivery amount, but one important cause is considered to be the delivery deadline established through negotiations between companies and set as the custom. A pilot project has been implemented in cooperation with industry associations to relieve the delivery deadline, beginning from the items which may be easier to obtain the consensus among participants. In cooperation with the MAFF and the Ministry of Economy, Trade and Industry, participants from food and beverage manufacturers, wholesalers and retailers will extend the delivery deadline to retailers from one-third period to the half of the best before dates. The project will then examine how this affects the goods at the retail level, product inventory of delivery expiration, returned and discarded goods at dedicated logistic centres, simulation of unshipped discards at manufacturers, and undertake surveys on consumer purchasing intentions. The pilot project began in August 2013 and published the final results in March 2014, which includes the estimated potential to reduce waste from drink and confectionary with more than 180 days of best before dates by 40 000 tonnes per year.

Figure 6. Conceptual chart of one-third rule in Japan



Source: Distribution Economics Institute of Japan (DEIJ).

(3) Review of extension and labelling method of best before date

In recent years, technology developments have been made to maintain the quality of the product longer through improvements in productivity and sanitation during the food manufacturing process and the development of packaging materials to allow for longer shelf life. However, it is believed that revising the expiration date was not necessarily performed alongside such technological development, and existing expiratory dates may not reflect the current situation correctly. For this reason, the food manufacturing industry is verifying best before dates of existing products based on scientific knowledge from the viewpoint of food waste reduction. It will include the review of guidelines, manuals and safety indicators by industry groups on setting the best before dates. Based on the results obtained, the industry is supposed to address the extension of best before dates, while gaining the understanding by consumers.

As for the review of labelling methods, the items with a long shelf-life have a lower speed of quality degradation and it is less meaningful to manage them by date rather than month at the consumption stage; the delivery of these by date order at the distribution stage may lead to the occurrence of food waste. Since items of more than three months of shelf-life are already allowed to display the best before date with month and year only, companies are expected to devise existing labelling methods for the items with long shelf-life, including the change to month/year labelling, to be understood by consumers without difficulty.

For example, the cooperative organisation of small and medium-sized supermarkets called CGC Japan has been asking industry groups and manufacturers to review and extend the shelf-life, but it is very time consuming and burdensome to realise in practice. Thus CGC Japan has started to review the expiration dates of its own private-brand products, and they assumed that the shelf-life of canned products can be as long as ten years without problem,

whereas it is usually set as three years after manufacture. In cooperation with a leading food manufacturer, some of their private-brand products such as boiled mackerel were proved to have no problem by sensory tests, and their expiration dates have been extended from three to four years. The extension of best before date from two to three years was done for bottled water, and the extension from one and half year to two years for packed rice cakes. These reviews were thought to be urgent especially after the Great East Japan Earthquake in 2011, as water, canned products and rice cakes are identified to make it more possible to spend the interim refuge. They are focused on the extension of best before dates of product that can be used as stored meal in order to increase the domestic stockpile against disasters. CGC Japan also argues that the extension of the best before dates based on scientific evidence is directly linked to the cost reduction of food manufacturers. In another example in 2014, the best before dates of instant noodles in cups and sachets have been extended according to the guideline set by an industry organization for instant foods.

Unshipped disposal that occurs even after these reviews of business customs should be addressed by the food bank or the society-wide efforts to reduce food waste. In Japan, active recycling activities are targeting food wastes that are still generated despite these initiatives to reduce them.

1.4. Future prospects

In October 2014, in response to the discussions between experts in the Joint Committee, MAFF and MOE produced the future orientation of the food recycling system. In view of the review and inspection of the implementation of the Food Recycling Law every five years, they have been continuing the debate since then. In addition to voluntary efforts such as the extension of best before dates by food industries and the full-scale implementation of target setting on the control of food waste generation described above, strengthening cooperation amongst local governments, food industries and recycling businesses has also been explored as a future focus.

On the other hand, the measures in Japan summarised in this paper seem effective but concerned only generation control and the recycling of food waste in the food industry. It does not cover food loss occurring at the farm level. It is noted that the amount of food waste at the consumer stage has not shown any change in recent years. The government has started to reinforce the campaign targeting consumers in 2013 to reduce food waste, called "NO-FOODLOSS PROJECT", and statistical surveys on food waste occurring at the household consumption and catering (restaurants) levels will be implemented for the first time since 2009. Looking over the entire food chain, the future challenges against food loss and waste at consumer stage of food chain are clearly evident.

2. Preventing food waste in the United Kingdom: A UK case study

2.1. Policy context

In 2000, households, commerce and industry in England and Wales generated 106 Mt of waste a year, 83% of which went to landfill; the average municipal composting and recycling rate was just 9%. That year, the Governments of England and Wales published *Waste Strategy 2000 for England and Wales*, calling for a tripling of municipal composting and recycling rates, and an 85% reduction in the amount of commercial and industrial waste sent to landfill, both by 2015. At the time, household waste was growing at 3% a year. As a result, the United Kingdom has adopted a range of approaches to tackle food waste and between 2007 and 2012 household food waste decreased by 15% which equates to an estimated 1.3 Mt reduction in food waste over a five year period. New data on historical changes and a scenario analysis of what may be achievable in the future suggests that between 2015 and 2025 around 20 Mt of food waste could be prevented in the United Kingdom (WRAP, 2014d).

While there is an economic, social and environmental rationale to tackle food waste, there are barriers that have prevented businesses and households taking action to tackle this, such as lack of awareness and information, and lack of fora for businesses to safely share best practice. For this reason there has been a requirement for government intervention, which has primarily been delivered through WRAP (The Waste and Resources Action Programme[1]). Although good progress has been made in the United Kingdom, approximately 15 Mt of food and drink are still wasted each year, a loss to the economy and a cost to the environment. Around half of this is from households (7 Mt), of which 60% is avoidable (i.e. could have been consumed, rather than being inedible such as bones, tea bags, etc.). UK householders spend GBP 12.5 billion every year on food that could have been eaten but ends up being thrown away. Food and packaging waste also costs business money. Food waste and packaging waste in the UK food supply chain is estimated at GBP 6.9 billion a year (WRAP, 2013a), which is equivalent to more than 10% of GVA (which was GBP 52 billion for 2012). There are wider environmental implications when food is wasted, such as around 20 Mt of CO_2e a year and many billions of tonnes of water, the majority of which is associated with the production, transport and packaging of food rather than its disposal. Accordingly, food waste was one of the priority waste streams under the Waste Prevention Programme for England (Defra, 2011a; updated in Defra, 2013a).

Tackling food waste provides economic benefits for both business and households. Households can save the money previously spent on wasted food or use it to purchase other goods. For businesses reducing waste helps to support a sustainable, competitive sector, where improved profitability can come from reducing costs associated with waste.

There will always be some unavoidable food waste, such as meat bones or peelings, and this waste should be directed into the appropriate treatment, such as anaerobic digestion (AD)

1 http://www.wrap.org.uk/.

or composting. Waste treated by AD can produce biomethane, a renewable energy source, which in turn can be used to generate electricity, heat, be injected directly into the gas grid or used as a transport fuel.

Growth in this part of the Waste Management sector is being stimulated in the United Kingdom by the Government's Anaerobic Digestion Strategy and Action Plan (Defra, 2011b). There has been significant growth in the AD sector over the last two years, with the number of plants rising from 54 when the AD Strategy was published to 115 currently. Much of this growth has been in plants treating food waste. There continues to be good progress in implementing the AD Action Plan (Defra, 2013b).

2.2. Definition of food waste

The most commonly adopted specific definition of food[2] waste is that of the FAO (FAO, 2011), which distinguishes between food losses, which occur as the result of 'unintentional' events and food waste, which occurs more through conscious action or 'negligence'. This definition only applies to the edible portions of food. There is currently much discussion about how best to define food waste, for example the EC-funded FUSIONS project has an objective to review available evidence and propose a standard approach on system boundaries and the definition of food waste[3] (and see Östergren et al. (2014) and a recent UK House of Lords Inquiry into food waste received evidence from a wide variety of sources on this topic (UK House of Lords European Union Committee (2014). The World Resources Institute (WRI), in collaboration with UNEP, FAO, WRAP and FUSIONS, will be designing a global standard for measuring food waste (the "Food Loss and Waste Protocol"), which will also aim to define the possible components of food loss and waste[4].

In order to facilitate its work on food waste prevention and management WRAP has proposed a simple definition of food waste[5], which is:

> *Food waste is any food that had the potential to be eaten, together with any unavoidable waste, which is lost from the human food supply chain, at any point along that chain.*

This definition covers:

- Only food produced for human consumption;
- All food and drink types, all disposal routes, and all sectors of the supply chain; and
- Both avoidable (edible) and unavoidable (inedible) food waste.

This definition does not include:

- Food/food surplus used as animal feed because this is not viewed as 'leaving the human food supply chain', and therefore is not considered to be waste, but rather prevents material from becoming waste.

2. In this paper, "food waste" is used as shorthand for "food and drink waste."

3. See http://eu-fusions.org/news/making-progress-towards-defining-food-waste.

4. http://www.wri.org/our-work/project/global-food-loss-and-waste-measurement-protocol.

5. The European Commission has proposed a definition of food waste, consistent with both the WRAP and FUSIONS definitions, see http://eur-lex.europa.eu/legal-content/EN/TXT/DOC/?uri=CELEX:52014PC0397&from=EN.

Understanding all fractions of food waste is important when considering both prevention and optimal treatment of waste. The classification of avoidable (edible) vs. unavoidable (inedible) may vary with culture, and steps can be taken to influence both avoidable and unavoidable waste, through changes in the types of food bought (for example households purchasing more prepared foods, better trimmed fresh produce, chicken breasts vs whole chickens – ensuring that greater benefit is gained from the unavoidable fractions in the supply chain [soups, stocks, etc.).

Unavoidable waste is however much more likely to be affected (and increase) as a result of an increasing population (the UK population is forecast to grow by 6 million by 2025, a 10% increase (UK ONS, 2014).

There is broad agreement that the following are the most important factors to quantify, in terms of the amounts arising and their fate, from which clear comparisons can be made between the factors on which those interrogating the data wish to focus, and to have strategies in place to minimise the economic and environmental impact of:

- Total food waste (food made to be consumed by humans but which ends up not being so).
- Both avoidable and unavoidable fractions (the classification of which may vary).
- Food and related materials (including by-products) used as animal feed.
- Other by-products arising from the food supply chain.

A focus on practical and robust approaches to quantify the above is as, if not more important than gaining agreement on the definition of food waste.

2.3. Food waste arising in the United Kingdom

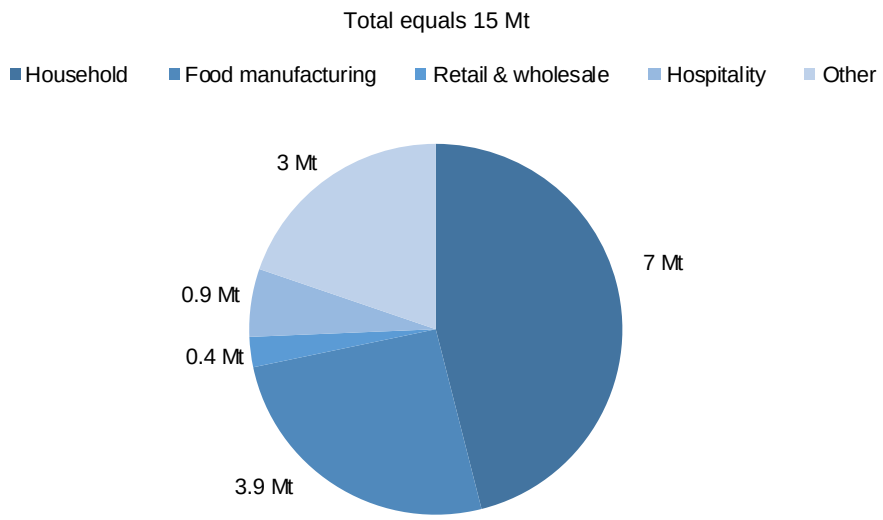
Three major WRAP studies carried out in 2013 estimated annual food waste arising within households, hospitality and food service, food manufacture, retail and wholesale sectors at around 12 Mt (WRAP 2013a, 2013b, 2013c), 75% of which could have been avoided. This had a value of over GBP 19 billion a year, and was associated with at least 20 Mt of greenhouse gas emissions (CO_2 equivalents). Around 90% (by weight) of the avoidable food waste arises in households and food manufacture, although waste arising in one part of the supply chain is certainly influenced by other parts of the chain.

The focus of work has been on households, hospitality and food service, food manufacture, retail and wholesale sectors. It has also been estimated that 3.0 Mt of food waste arises from other sectors (WRAP, 2014a). This includes estimates for other food thrown away by consumers out of home (e.g. from home-made lunches at work, as litter, in litter bins) and the pre-factory gate stages of the food supply chain. Existing estimates of agricultural food wastage are indicative, and based on a synthesis of evidence available at that time (Environment Agency, 2004), and may include food losses as a result of weather, for example. Food waste and losses arising in agriculture has not been an area of focus for WRAP. However, going forward, it will be looking at ways to improve resource efficiency and deliver financial savings throughout the whole supply chain, which would include understanding more about food waste on farm.

The breakdown of this 15 Mt of food waste is illustrated in Figure 7 and Annex 2.A. In comparison around 43 Mt of food are purchased in the United Kingdom (Defra 2013c; WRAP, 2013d) (the majority for in home use), meaning that the amount of food wasted throughout the supply chain is equivalent to around a third of that purchased. In addition to food waste there are also 2.2 Mt of food or food by-products from food manufacturing used as animal feed, and another 2 Mt of animal by-products sent to rendering plants. Annexes 2.B and 2C illustrate the 'food loop' in the United Kingdom, and the initiatives directed at

reducing food waste around the loop. This updated, detailed evidence base will allow Governments, WRAP and its partners to make strategic decisions regarding the prevention, collection and treatment of food waste. It will enable the approaches and materials aimed at delivering this to be refreshed and targeted, bringing benefits to individuals, communities, businesses and the United Kingdom as a whole.

Figure 7. Amount of food waste arising in the United Kingdom, by sector



Source: WRAP.

(1) Household food waste (see WRAP 2013b for more detail)

The 7.0 Mt of food and drink waste thrown away from households in 2012 is enough to fill Wembley Stadium in the United Kingdom nine times over, and represents 19%, by weight, of food and drink brought into the home. Of this total:

- 4.2 Mt (or 60% of the total) is avoidable, worth GBP 12.5 billion. This avoidable waste is food and drink that would have been edible at some point prior to being thrown away, for example slices of bread, apples, yoghurts, etc. This is equivalent to the average household throwing away six meals per week, and is equivalent to 12% of the weight of edible food and drink brought into the home.
- 1.2 Mt (17% of the total) was considered 'possibly avoidable'. This includes bread crusts and potato peelings that some people eat but others do not.
- 1.6 Mt (23% of the total) was unavoidable waste. Five types of waste made up 60% of this (tea waste, banana skins, poultry bones, onion skins and orange peel).

Two-thirds (4.7 Mt) of household food and drink waste was collected by local authorities. Of this, most was collected in kerbside 'residual' or general waste, although more than half a Mt (around 11% of that collected) was in targeted collections of food waste, meaning it could be treated to generate energy and useful digestate or compost. Around a fifth was disposed of via the sewer (1.6 Mt; the kitchen sink and other drains), with drinks and dairy products making up more than half of this. The remainder was either composted at home (0.51 Mt) or fed to animals (0.28 Mt).

For the average household, the price of the avoidable food and drink waste was around GBP 470 per year, and therefore, avoidable food and drink waste accounted for approximately 14% of the shopping budget.

The higher the number of people in a household, the greater the amount of food waste generated, although the increase was not proportional, i.e. an average four-person household wastes less than four times the average single-occupancy household. One-person households threw away, on average, over 40% more avoidable food and drink waste than the overall amount per person in the United Kingdom, worth GBP 290 a year compared to the UK average of GBP 200 per person.

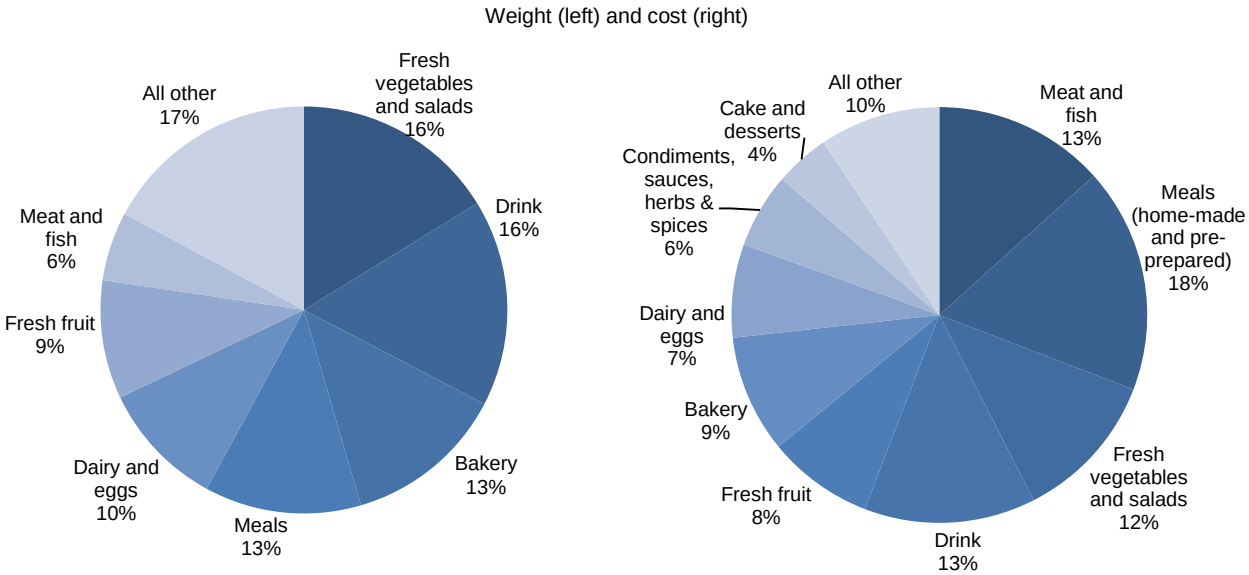
By weight (Figure 8), the largest contributions to avoidable food waste were from:

- Fresh vegetables and salads (19%; 810,000 tonnes).
- Drink (17%; 710,000 tonnes).
- Bakery (11%; 450,000 tonnes).
- Home-made and pre-prepared meals (10%; 440,000 tonnes).
- Dairy and eggs (10%; 420,000 tonnes).

By cost, the largest food groups wasted were:

- Meat and fish (17%; GBP 2.1 billion).
- Home-made and pre-prepared meals (17%; GBP 2.1 billion).
- Fresh vegetables and salad (14%; GBP 1.7 billion).
- Drink (10%; GBP 1.3 billion).
- Fresh fruit (7%; GBP 900 million).

Figure 8. Proportions of avoidable food and drink waste by food group in the United Kingdom



Source: WRAP (adapted from WRAP, 2013b).

Fresh fruit, vegetable and salads combined, amounted to 1.2 Mt, worth GBP 2.6 billion, and more than 13 billion "5 a day" portions of fruit and vegetables were thrown away in 2012,[6] enough to provide more than 7 million people with their "5 a day" for a year.

The greenhouse gas emissions associated with avoidable food and drink waste from UK homes accounted for approximately 17 Mt of CO_2 equivalent (including contributions from growing, manufacturing, packaging, transporting and disposing of the waste).. The carbon saving of preventing all avoidable food waste in 2012 is equivalent to taking one in four cars off UK roads.

Land is required to produce food and drink that is subsequently thrown away by UK households. For the first time, an estimate has been made of these land requirements: 19 000 square kilometres or an area about 91% the size of Wales.

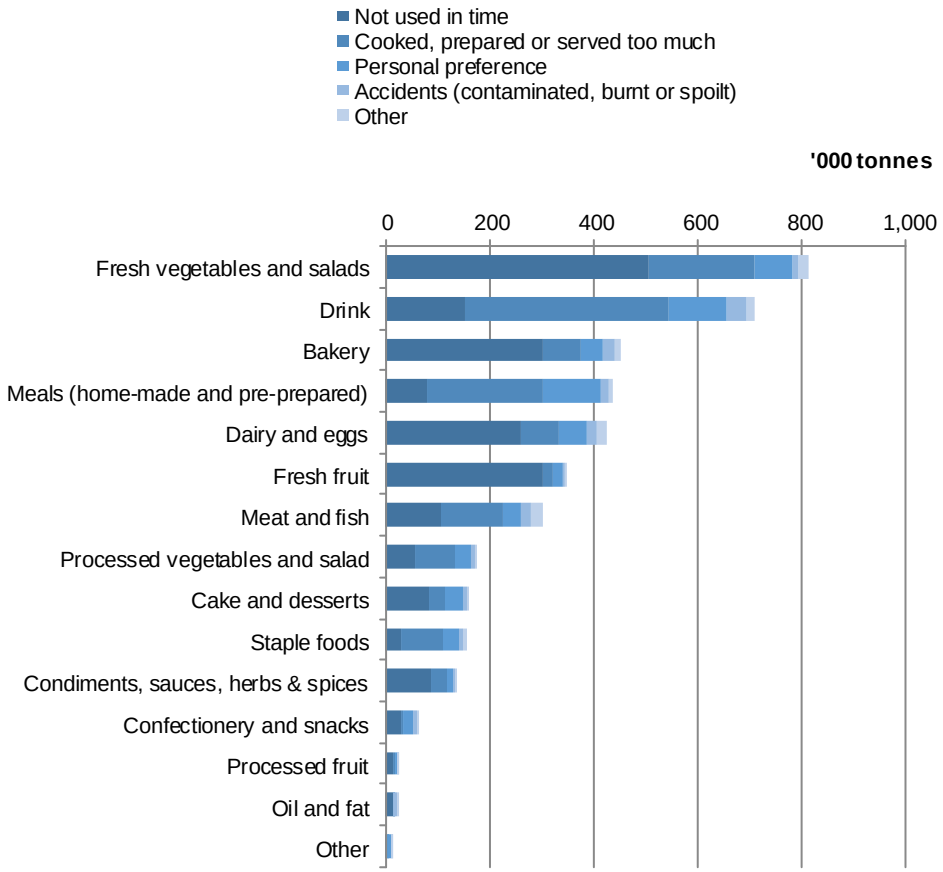
Just under half of avoidable food and drink waste (worth GBP 5.6 billion) was classified as "not used in time:" thrown away because it had either gone off or passed the date on the packaging (Figure 9). This included large amounts of bread, milk and fresh potatoes. A further 31% (worth GBP 4.1 billion) was classified as "cooked, prepared or served too much:" this included food and drink that had been left over after preparation or serving, such as carbonated soft drinks, home-made and pre-prepared meals, and cooked potatoes. Approximately 80% of food and drink is wasted because it either wasn't used in time, or too much was cooked, prepared or served, so addressing these issues will deliver the greatest benefits.

The remaining reasons are linked to personal preferences including health reasons and not liking certain foods (GBP 1.9 billion), and accidents, including "food dropped on the floor" and "failure of a freezer" (GBP 560 million). A new report (WRAP, 2014e) further explores the relationship between the level of avoidable food and drink waste from households, factors including socio-demographics, and behaviours relating to food, such as healthy eating and time available for food-related activities.

The reasons for disposal vary considerably by food group. For the following categories, most was wasted because it was not used in time: fresh vegetables and salads, bakery, dairy and eggs, and fruit. For example, avoidable fresh vegetable and salad wasted because it was not used in time cost GBP 1.1 billion, approximately two-thirds of the total cost of fresh vegetables and salads thrown away. In contrast, drinks and meal waste had high levels of waste from leftovers: too much was prepared, cooked or served.

6. As per the accepted definition of what contributes to "5 a day," fresh fruit and vegetables are included (except for potatoes) alongside processed fruit, vegetables fruit juices and smoothies.

Figure 9. Weight of avoidable food and drink waste by food group in the United Kingdom, split by reason for disposal



Note: Staple foods include breakfast cereals, pasta, rice, couscous, etc.
Source: WRAP (adapted from WRAP, 2013b).

The percentage of food bought subsequently thrown away varies by food type, as illustrated in Table 4.[7]

7. WRAP analysis of 2012, Defra Family Food Survey purchase data (Defra, 2013c) and WRAP food waste data (WRAP, 2014b). Adjustments have been made to account for changes in weight resulting from cooking (dehydration or absorption of water). For some categories the percent wasted will be an underestimate, due to the use of individual foods in meal preparation (e.g. fresh vegetables thrown away as part of a lasagne will be counted as meal waste rather than vegetable waste).

Table 4. Food waste by type and per cent of that bought in the United Kingdom

Food type	Purchased (tonnes per year in UK)	Total waste (tonnes per year in UK)	Proportion wasted	Avoidable wasted (tonnes per year in UK)	Proportion wasted
Food & drink (total)	35 800 000	7 000 000	18.5%	4 200 000	11.7%
Fresh fruit	2 500 000	910 000	37%	350 000	14%
Fresh vegetables	3 900 000	1 600 000	42%	810 000	21%
Bakery	2 000 000	570 000	28%	460 000	23%
Meat and fish	2 700 000	570 000	21%	300 000	11%
Dairy and eggs	6 900 000	550 000	8%	490 000	7%
Drinks	8 400 000	770 000	9%	620 000	7%

Source: WRAP (adapted from WRAP, 2013b).

(2) Hospitality and food service food waste (see WRAP, 2013c for more detail)

The Hospitality and Food Service (HaFS) sector can be defined as outlets that sell food and drinks for immediate consumption outside of the home. There are nine major HaFS subsectors as defined by Horizons[8]: staff catering, healthcare, education, services, restaurants, QSRs, pubs, hotels and leisure.

The cost of food being wasted in the UK from the UK HaFS sector is estimated at GBP 2.5 billion per year in 2011, rising to GBP 3.0 billion per year by 2016. 920,000 tonnes of food is wasted at outlets each year, 75% of which is avoidable and could have been eaten. Preventing avoidable food waste has the potential to reduce greenhouse gas emissions by 2.7 Mt (CO_2 equivalent). Overall 17.8% of total food purchased by the HaFS industry by weight is wasted, of which 13.2% is avoidable and the remaining 4.6% is unavoidable. The amount of food that is wasted is influenced by a number of factors, such as: the amount of on-site food preparation, over-production of meals, menu choice and the extent to which consumers leave food uneaten.

Table 5 highlights the scope of savings associated with food waste, ranked in descending order of tonnes arising, with the restaurant, pub and education the top three subsectors. The total costs associated with all food being wasted are greatest within restaurant, pub and hotel subsectors.

Overall, the weight of food waste across the HaFS sector is equivalent to 1.3 billion meals, or throwing away one in every six of the 8 billion meals served each year. This takes account of differences in the average weight of a typical meal served across the nine different UK HaFS subsectors. In restaurants, pubs, services and leisure the proportion of food waste is over 20% of the weight of food purchased, equivalent to around one in five meals being wasted. Lower wastage rates are associated with Quick Service Restaurants (QSRs) and staff catering, where lighter meals are served and/or where snacks and 'grab and go'[9] catering is more prevalent

8. Horizons FS Limited, a supplier of market data and analysis for the UK HaFS sector

9. Note: a 'grab and go' provision could have resulted in less of the food waste being captured by the waste reviews conducted as part of this research as food waste may be disposed of away from the main catering outlet.

Differences in levels of waste also relate to the use of ready-to-serve meals and pre-prepared ingredients, in which case more of the waste is generated further up the supply chain (an estimated 130 000 tonnes of food is wasted from the preparation of ready to serve food items and meals at HaFS manufacturing sites. Ready-to-serve includes sandwiches, soups, sauces and pre-prepared meals). For instance, the supply chain waste associated with QSR is estimated to be equivalent to approximately a third of food waste discarded at QSR outlets.

Table 5. The quantity and cost of food being wasted by the UK HaFS by subsector

Subsector	Number of outlets with food service	Total food waste (thousand tonnes)	Cost total food waste* (GBP/tonne)	Total cost* (GBP millions)
Restaurants	40 958	199	3 500	682
Pubs	45 087	173	2 100	357
Education	34 744	123	2 100	250
Healthcare	19 257	121	1 900	230
Hotels	45 763	79	4 000	318
Quick Service Restaurants (QSRs)	31 450	76	3 500	277
Services	2 029	68	1 700	112
Leisure	9 255	60	4 000	241
Staff catering	7 172	21	2 200	44
UK HaFS total	235 715	920	N/A	2 511

*Costs estimated for 2011.

Source: Caterlyst 2012 estimates (adapted from WRAP, 2013b).

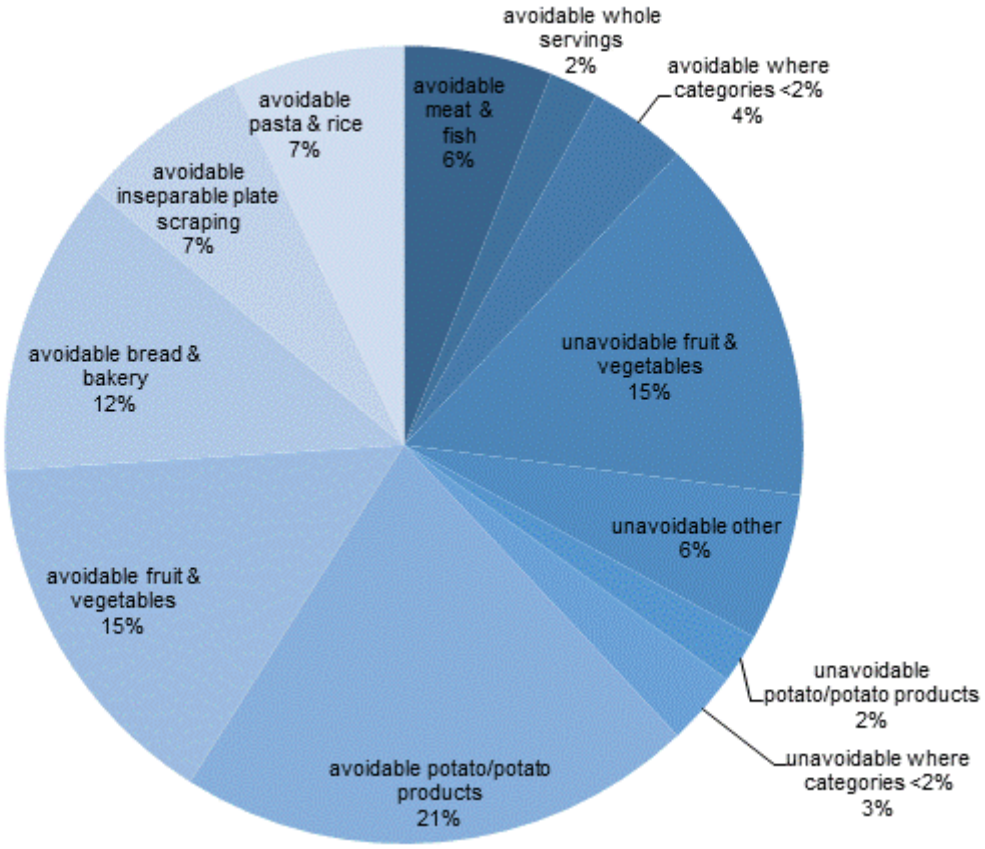
The composition of food that is wasted by the HaFS sector was compiled from research conducted between 2009 and 2012, and the average composition of food waste is summarised for HaFS as a whole in Figure 10.

Key findings on the composition of food being wasted include:

- 40% of all food waste is associated with 'carbohydrate foods', including the following avoidable categories:
  - potato and potato products (21%);
  - bread and bakery (12%); and
  - pasta/rice (7%).
- The higher value food types account for a lower proportion of avoidable food waste, for example:
  - fruit and vegetable food waste (15%); and
  - meat/fish (6%).
- The quarter of all food waste that is unavoidable mainly consists of fruit and vegetable peelings.

Carbohydrates are a high priority across all subsectors, with wasted potatoes and potato products a significant component of food being wasted. Action to reduce these food types being wasted could have a significant impact in reducing the total amount of food being wasted. Higher value food types are also wasted across the HaFS (Table 6).

Figure 10. Average composition of food being wasted in the UK HaFS sector



Source: WRAP (adapted from WRAP, 2013b).

WRAP also carried out research to understand the point at which food is being wasted from spoilage, food preparation and from customer plates in different types of commercial kitchens, and identify the actions that would most significantly reduce food being wasted. This research shows that, on average:

- 21% of food waste arises from spoilage;
- 45% of food waste arises from food preparation; and
- 34% of food waste is generated from customer plates.

Table 7 shows where food waste arises in different kitchen types. The ratios of food waste arising are consistent across three of the commercial kitchen types, namely, contract catering, casual and fine dining. In the basic dining category, however, food waste from customer plates (46%) is higher than waste from preparation (32%); this may be due to a number of reasons including less food preparation on site.

Table 6. Summary of priority food types to target in waste prevention in the United Kingdom

Subsector	Carbohydrates			Fruit and vegetables	Meat and fish	Whole servings/ sandwiches	Unavoidable/ prep. waste
	Potatoes / potato products	Pasta/ rice	Bread / bakery				
Restaurants	*			*	*		*
QSRs	*		*		*		
Pubs	*			*	*		*
Hotels	*			*			*
Leisure	*		*				*
Staff catering			*			*	
Healthcare	*						
Education	*	*		*		*	
Services	*	*			*		

Source: WRAP (adapted from WRAP, 2013b).

Table 7. Food waste arises by kitchen type (average) in the United Kingdom

Food waste arising point	Basic dining	Casual dining	Fine dining	Contract catering	Mean across kitchen types
Spoilage waste (%)	22%	21%	16%	26%	21%
Preparation waste (%)	32%	50%	61%	38%	45%
Plate waste (%)	46%	29%	23%	36%	34%
Waste per cover (kg)	0.17	0.38	0.31	0.15	0.22

Source: WRAP (adapted from WRAP, 2013b).

(3) Manufacturing and retail supply chain food waste (see WRAP, 2013a for more detail)

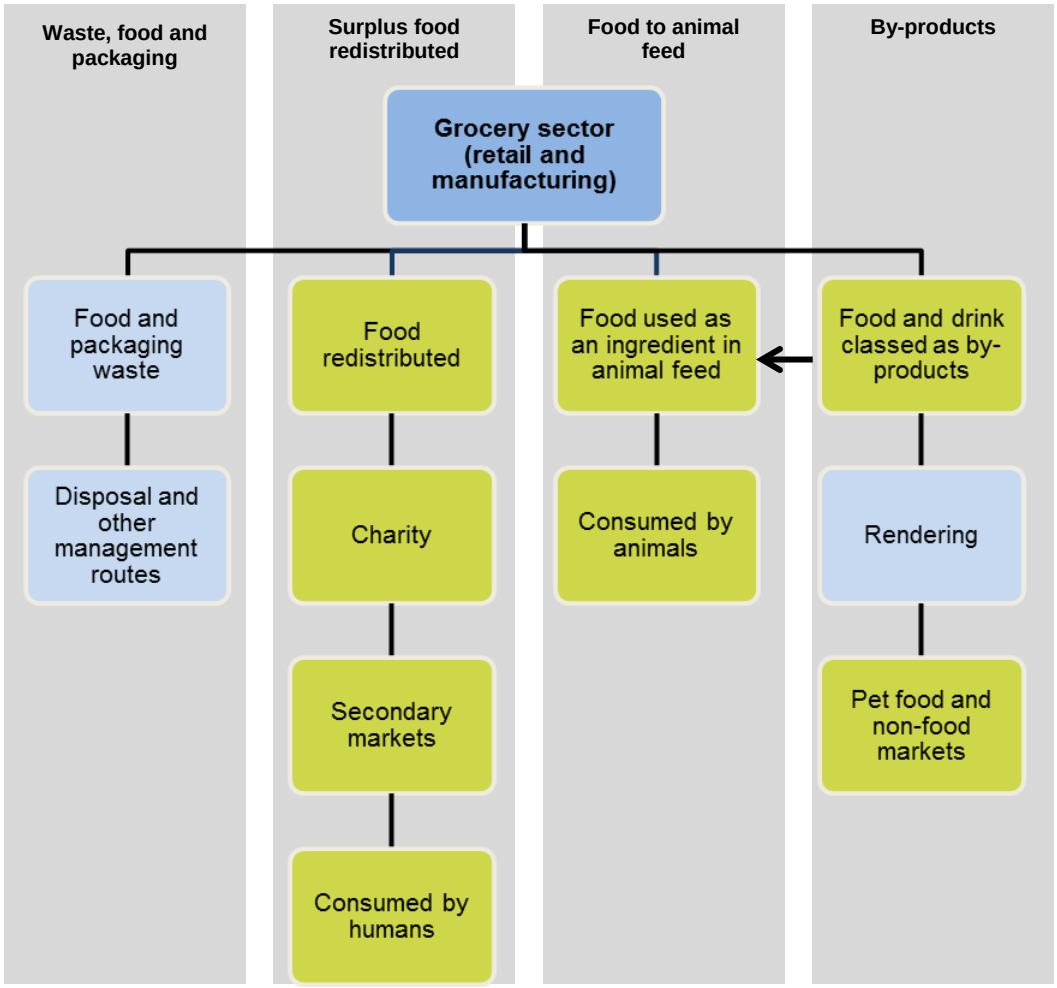
In 2012 WRAP undertook work to provide robust estimates for the grocery supply chain (agriculture/fishing and households were excluded from this supply chain research). Waste disposed to sewer is also excluded (though WRAP has published estimates from signatories to its Courtauld Commitment; WRAP 2011a). All food and drink waste arising in manufacturing is attributed to the grocery retail market[10].

In total, some 10.7 Mt of food, drink and packaging is managed through the routes shown in Figure 11. Not all of this material is legally classed as waste and not all is lost to human consumption (though the majority is). Some material is legally classified as by-product and

10. Industrial classifications based on the dominant business activity at a site do not differentiate between grocery retail and foodservice markets. Similarly, waste audit data and Courtauld Commitment returns do not split out waste arising at a manufacturing site with respect to these different markets.

may then be treated as a waste, in line with waste regulations. It has not proved possible to fully quantify all these flows in this

Figure 11. Grocery waste and non-waste material flows in the United Kingdom



Source: WRAP.

The principal material output is waste (Column 1, waste food and packaging, Figure 11), as legally defined, and the work undertaken provides estimates, for 2011, of total waste from the grocery retail grocery sector disaggregated into food, packaging and mixed waste streams. These data are further disaggregated into, for example, the management routes for this waste. All the food and drink within this material is lost to human consumption.

WRAP estimates that there are 6.5 Mt of grocery waste.[11] This total comprises 1.6 Mt from grocery retail and wholesale and 4.9 Mt from manufacturing.

Grocery retailers and manufacturers segregate some food for waste and other management but there is also a significant quantity (0.8 Mt) of mixed waste that has not been segregated

11. Excludes all material that is disposed to sewer. Courtauld signatories reported some 0.2 Mt of waste was disposed to sewer in 2010.This suggests there are significant additional quantities of waste disposed this way and not included in the above total.

and comprises both food and packaging (there is also 0.5 Mt of 'Other' waste that is neither food/drink nor packaging).

Total food waste from the grocery sector, therefore, includes food waste that is segregated and an estimate of food that is part of mixed waste (that is, not segregated). Total food waste in 2011 is 4.3 Mt. This includes 3.8 Mt of segregated food waste and 0.5 Mt of food included in the mixed, non-segregated waste stream (of which 0.4 Mt is from grocery retail and 0.1 Mt from manufacturing).

Food waste in manufacturing amounts to 3.9 Mt and in grocery retail (and wholesale) 0.4 Mt.

Surplus food and drink that is redistributed (Column 2, surplus food redistributed, Figure 11) amounts to some 5 800 tonnes which goes to charities such as FareShare who use the surplus food to feed people. In addition, a minimum of 11 000 tonnes of food and drink is sold to organisations like 'The Company Shop' who buy food for sale onto secondary markets.[12] Both these routes for managing food are termed 'redistribution' because the food is still being consumed by humans, albeit probably involving an economic loss.

Food used as an ingredient in animal feed (Column 3, food to animal feed in Figure 11) is more difficult to estimate. Some food material can also fall into Column 4, by-products, Figure 11 because they are legally defined as by-products (for example, spent grain from distilleries). It has been estimated that around 450 000 tonnes of food is used as an ingredient in animal feed and that further quantities of mostly unavoidable material like peelings and skins are also sent for animal feed together with material legally classed as animal by-products.

Wholly within Column 4, of Figure 11, are by-products from manufacturing operations and animal by-products and co-products that arise from slaughtering cows, pigs, sheep, chickens and fish. A total of 2.2 Mt of food is used as an ingredient in animal feed. About 1.7 Mt is by-product and the remainder is food (Column 3 - food to animal feed, Figure 11). In addition, the carcase and other material from slaughtered animals are regarded as animal by-products (and co-products) under European legislation and primarily sent for rendering which in turn produces pet food and a range of non-food products. There are about 2.0 Mt of such material in the United Kingdom.[13]

WRAP estimates that food and packaging waste is valued at GBP 6.9 billion. This includes the costs of producing food and packaging, disposal costs and lost profit. For food waste specifically the value is GBP 3.7 billion for manufacture and GBP 0.5 billion for retail.

This money is being wasted and value is being lost to the economy. The total represents around 7% of consumer expenditure on food and drink and 8.6% of the sectors GVA. These percentages are likely to be a higher proportion than many grocery retailer and manufacturer profit margins (in comparison with sales). Whilst waste cannot be reduced to zero, there are

12. In this context the term refers largely to wholesalers and street markets.

13. FABRA estimate that 2.25 Mt of animal by-products are handled by the United Kingdom rendering industry. This includes material including fallen stock out of scope in this work. Animal by-products and co-products sent for rendering are classed as waste, but wastes sent to rendering are currently excluded from Waste controls under the revised Animal by Products Regulations. Readers should refer to the waste regulations and to guidance from the regulators, e.g. in England and Wales, the Environment Agency provides sector guidance. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/296981/LIT_7666_8d1271.pdf

significant opportunities to reduce it and achieve the associated economic benefits of doing so.

Across WRAP's work, the GHG impact of agriculture, manufacturing, grocery retail and distribution is allocated to the food which is purchased by households. This means that no impacts are allocated to the creation of waste produced at each of these stages. For consistency, it is therefore appropriate only to attribute disposal emissions to the food waste when considering the footprint of supply chain food waste. Waste emissions from manufacture to grocery retail are estimated at 250 000 tonnes CO_2e.

However, there is also an opportunity cost associated with the wasted food. The opportunity cost is the value of the best alternative forgone. Depending on whether the food was suitable for animal feed or human consumption, the opportunity cost is between 1 and 13 Mt CO_2e respectively.

At present it is not possible to break down food waste arising in manufacturing and retail by food type, although WRAP has produced detailed 'resource maps' for key food categories, such as fresh fruit and vegetables, meat and fish, which document waste and economic losses through the supply chain (WRAP, 2011b).

2.4. Interventions and impact

The primary mechanisms in the UK for facilitating the reduction in food waste are the Courtauld Commitment (CC)[14] and Hospitality and Food Service Agreement (HaFSA)[15], both voluntary agreements managed by WRAP, and funded by Westminster, Scottish, Welsh and Northern Ireland governments, and the consumer facing Love Food Hate Waste (LFHW) campaign.[16]

(1) Household food waste

Over the last six years WRAP has built up a comprehensive evidence base which has raised awareness, developed a strong case for change and given focus to the areas where consumers need the most help, where business and local authorities can benefit, and where the biggest impacts can be made.

Influencing decisions around food product design, production processes, purchase and use is challenging. WRAP has worked with a wide range of partners to develop a credible, integrated and consistent approach, increasingly supporting people and organisations to develop their own action plans. WRAP provides a suite of tools and guidelines making it easier for those consumers who want to change to buy the right amounts of food and make the most of what they buy.

WRAP launched LFHW in 2007 to help deliver practical ways to reduce food waste, and expanded an agreement with the food industry (the CC) to help consumers make more of the food and drink they buy, and throw less away.

Since that work in 2007, tackling food and drink waste has received much attention in the UK and indeed around the world: Governments, international agencies, businesses, local authorities, community groups and many others have worked with consumers to change the way we buy and use food. Major retailers, food brands and other manufacturers have helped through innovations in products, packaging and labelling.

14. http://www.wrap.org.uk/node/14507

15. http://www.wrap.org.uk/content/hospitality-and-food-service-agreement-3

16. http://www.lovefoodhatewaste.com/

WRAP recently announced that there was 1.3 Mt less household food waste in 2012 compared to 2007, a 15% reduction, despite an increase of 4% in the number of households in the UK (WRAP, 2013b). Almost all, 85% (1.1 Mt; or enough to completely fill Wembley Stadium) of this reduction was in food that could have been eaten (avoidable). Avoidable household food waste reduced by 21%, which would have cost GBP 3.3 billion to purchase. This means on average every household in the United Kingdom not having to spend GBP 130 a year on food bought but thrown away, helping to mitigate the impact of rising food prices. In addition this will have prevented 4.4 Mt of carbon dioxide emissions a year, and saved a billion tonnes of water. External factors have also influenced levels of household food waste in this period, with an economic downturn and rising food prices. Untangling the contributions of such factors is an ongoing focus of further research.

The contributions to the large reduction in avoidable food and drink waste were primarily concentrated in five categories, each with reductions of more than 100 000 tonnes: home-made and pre-prepared meals, bakery, drink, fresh fruit and dairy and eggs. A range of behaviours (buying appropriate amounts, storing food under the optimal conditions, portion control, using the freezer more effectively etc.) and technical innovations (range of pack sizes available, improved storage and freezing guidance, clearer date labelling, increased shelf-life, packaging innovations etc.) will have contributed to these reductions, supported by LFHW and its partners through a wide range of national and local initiatives.

Now in its third phase, the CC, with more than 50 of the largest food retailers, brands and manufacturers as signatories, has a target to further reduce household food and drink waste by another 5% by 2015.

(2) Manufacturing and retail supply chain food waste

The second phase of the CC introduced a target to reduce food and packaging waste in the supply chain by 5% (2012 vs 2009).

WRAP has developed the W.A.S.T.E. process (**W**aste definition, **A**nalyse and identify root causes, **S**olution generation, **T**rial, evaluate and measure and **E**xecute sustainable change and reduce waste) to help businesses identify waste and reduce it within their operations and across supply chains. The W.A.S.T.E. process is based on a problem-solving discipline rooted in continuous improvement and LEAN manufacturing strategies and builds on established techniques. Resources are also available to assist during the various stages of the W.A.S.T.E. process. Good Practice Guidance for reducing waste has been produced, underpinned by WRAP's activity and research through waste prevention reviews undertaken at 26 UK sites in the food and drink manufacturing sector. In addition, waste prevention case studies highlight WRAP's work with Courtauld signatories and other companies to prevent waste at UK manufacturing sites. The studies identified the amount of waste created and determined root causes of generation. Sustainable solutions were then developed and implemented by the organisations to reduce their waste.

There are opportunities to prevent waste within an individual site or business and across supply chains. Working collaboratively across a supply chain can lead to higher levels of waste prevention.

Under the CC (phase 2) traditional food and packaging waste in the grocery supply chain was reduced by 7.4%, exceeding the 5% target. Supply chain waste decreased by 217,000 tonnes per year over the period (WRAP, 2013e).

Specific examples of success include a major manufacturer of pre-prepared foods identifying how to cut food waste by 25% after a 3 month project, and a retailer and supplier working together to optimise how bananas were supplied to store, and identifying how to

reduce waste by 90%. A similar exercise with bagged salad suggested waste could be reduced by between a third and 80%.

More recently WRAP founded The Product Sustainability Forum (PSF)[17], a collaboration of organisations made up of grocery and home improvement retailers and suppliers, academics, NGOs and UK Government representatives, which provides a platform for these organisations to work together to measure, improve and communicate the environmental performance of the grocery and home improvement products (which includes the reduction in waste).

In 2013 a major report was published, 'An initial assessment of the environmental impact of grocery products', and a range of practical materials to help implement changes to reduce impact. A range of 'pathfinder' projects have been initiated aimed at preventing waste and improving resource efficiency by identifying and implementing specific solutions to waste/resource hotspots and root causes across the supply chain. The projects will also inform the development of transferable learnings and a replicable approach for implementing whole chain resource efficiency. As an example, The Co-operative Group is engaging internal stakeholders across its entire fresh potato value chain, from farm to fork, to identify and implement opportunities to prevent waste and improve wider resource efficiency (energy consumption, water consumption and GHG emissions). The intention is that the learnings from this exercise will be replicated across other fresh produce in the future.

(3) Hospitality and food service food waste

The Hospitality and Food Service Agreement (HaFSA), launched in June 2012, is a voluntary agreement to support the sector in reducing waste and recycling more, and has targets to reduce food and associated packaging waste by 5% and increase recycling rate to 70% or more by the end of 2015. The Agreement now has 175 signatories and supporters, covering 24% of the sector by turnover, and is flexible to allow any size of organisation to sign up, from multi-national companies to smaller businesses, from sector wholesalers/distributors to trade bodies. Signatories and supporters work towards delivering collective goals, and also influence their peers and supply chains, therefore accelerating change across the sector. Working groups encourage collaborative action delivering accelerated change, and the development of innovative approaches to address existing gaps in sector knowledge, which currently act as barriers to change.

Interim results are not yet available, but there are a range of published case studies detailing successful approaches to reduce waste, for example a meal supplier to the public sector cut waste by 60% through small changes to the size of cooking batches.[18]

17. http://www.wrap.org.uk/content/product-sustainability-forum.

18. See http://www.wrap.org.uk/content/good-practice-case-studies.

2.5. The voluntary approach

Based on the experience in the United Kingdom, we would highlight the following factors as important for successfully reducing food waste:

- **An evidence-based strategy**, to identify priorities, build a persuasive case for action, develop clear and robust recommendations and inform the development of effective messages and materials for engaging with consumers, industry and other stakeholders.
- **An integrated approach**, looking across the whole supply chain (recognising the influence those at any given stage in the supply chain can have on others in the supply chain), and also in terms of householders incorporating three key elements (national / large scale awareness raising campaigns, local / community engagement to influence behaviours and changes to products, packaging and labelling to make it easier to buy the right amounts of food and use what is bought), which if implemented together deliver much more than any element in isolation.
- **A framework for action**, such as the CC and HaFSA, with collective targets which provides a mechanism for sharing best practice and facilitating the uptake of recommendations for change.
- **Monitoring and reporting**, to assess progress against targets, allow changes in action to be made in response to this and to recognise (publically) achievements (show what can be done) and benefits of taking action.

The United Kingdom has worked successfully with industry to reduce supply chain food and packaging waste by nearly 10% (2009 to 2012), while household food waste is down by even more -15% between 2007 and 2012. The latest results from the CC show that the voluntary approach can deliver real reductions in waste, while allowing businesses to reduce waste and be more efficient and competitive. Business continues to value the voluntary agreement form as one where they can receive impartial information and tools, and work together with their supply chains for a common aim. As well as the continuation of the CC to reduce food and packaging waste in the retail and manufacturing sector, the United Kingdom has launched a further voluntary agreement which takes the same approach with the hospitality and food service sector.

The impact of CC3 is predicted to be a cumulative reduction of 1.1 Mt of waste, 2.9 Mt of CO_2e and a cost benefit of GBP 1.6 billion to consumers, the food and drink sector and local authorities. During the three phases of the CC, a 20% reduction in household food waste is expected to be achieved.

The new HaFSA is a voluntary agreement with the hospitality and food service sector, which includes restaurants, hotels, caterers and pubs. This agreement supports the sector in preventing and recycling food and packaging waste. There is now about 24% coverage of the sector by food and drink sales (with over 170 signatories and supporters). The target is 25%.

Voluntary agreements can be effective in achieving policy aims in certain circumstances. Some voluntary schemes in the United Kingdom, such as the CC have proven effective in reducing waste production.

This approach does not just allow improvements to be made as a result of specialist advice from WRAP as it also provides a safe forum for signatories to share knowledge and best practice. The targets are for signatories to reach as a whole so it's important to promulgate best practice horizontally and vertically through the supply chain. The advantage of a voluntary approach is that it allows businesses to make informed decisions, which should generally result in efficiency savings for the business. Partners are engaged as they have made a specific commitment to make improvement to processes to reduce waste.

WRAP's LFHW campaign helps consumers to make informed choices on reducing food waste. LFHW has established a respected, credible and effective brand, materials and messages, working in partnership with a broad range of organisations (e.g. local councils, retailers and the food supply chain). Through LFHW, consumers have been helped to save money and waste less food by a combination of helpful advice, tools (meal planning; portioning) and simple but inspiring recipe ideas.

LFHW messages have been used by CC signatories as a key tool to meet the household food waste target. This demonstrates the joined up approach whereby retailers have targets for both supply chain and for households, so extending the reach beyond merely reducing their own waste but also in influencing and considering the potential indirect effects of the actions of signatories.

While CC is a UK based agreement it provides opportunities beyond that. The operations of many signatories extend beyond UK borders, and so opportunities exist for these partners to apply such knowledge beyond their UK operations.

While the primary focus is waste prevention, a resilient supply chain will always have some surplus. WRAP has worked with industry to assess how much good quality surplus food that would otherwise have gone to waste can be made available for redistribution. An industry working group led by WRAP has agreed a set of guiding principles that the wider industry can sign up to. These principles will help industry to communicate how they prioritise redistribution for human consumption internally and externally. CC3 encourages action in line with the waste hierarchy. If surplus food cannot be prevented, the next best option is to ensure it is redistributed for human consumption.

As the voluntary approach allows for information sharing between businesses, this allows better interventions across the waste hierarchy. Companies should apply the waste hierarchy but as this collaborative approach provides a forum, by sharing best practice this provides opportunities to correctly manage waste, when it arises, so surplus food can be redistributed to people, or for animal feed if it is not suitable for human consumption, otherwise Anaerobic Digestion or composting are preferable alternatives to landfilling. To attempt the same gains from regulation would not necessary bring such collaboration as shared voluntary targets which signatories need to work together to meet.

2.6. Challenges and opportunities for the future

While the United Kingdom has made positive progress in reducing food waste, it is likely that further reduction will become increasingly challenging (for example as the 'quick wins' will have been achieved). There will be a point at which the benefit from further reductions may be outweighed by the resource used to achieve that reduction, but we do not believe we have yet reached that point. However, the rate of reduction is likely to reduce as that point is approached.

The European Commission's recent Circular Economy package (2014) includes a proposal for an aspirational objective of a 30% reduction in food waste by 2025. A reduction of 30% by 2025, from 2007 levels (when the United Kingdom ramped up efforts to decrease food waste), could be achieved but would be extremely challenging. The new report by WRAP (2014d) provides an analysis of potential future reductions in food waste in the United Kingdom, and the associated costs and benefits.

Population growth will limit the absolute reductions possible as demand for food increases. This is likely to have two effects a) to increase unavoidable food waste as this is primarily influenced by population size and overall amounts of food purchased, and b) make percentage reduction in overall food waste more challenging as the increased demand will act to counterbalance any reducing effect on avoidable waste (for example between 2007 and

2012 avoidable food waste at a household level reduced by 24% in the United Kingdom, but 21% at a national level as the population increased by around 4% over that period).

External economic factors such as economic growth and any potential fall in food prices could result in some behavioural reversion as economic factors become less significant drivers to encourage households to reduce waste.

WRAP has been having discussions with governments and industry stakeholders about a new framework for collaborative action in the United Kingdom to follow the third phase of CC, which is proposed to be a ten-year framework (2016-2025) for collaborative action across the food and drink life-cycle, helping businesses to become more resilient to future changes in supply and demand. Targets have not yet been agreed but one area of focus is likely to be a continued reduction in food waste (WRAP, 2014f).

2.7. Implications of reductions in food waste

An analysis of the amounts (tonnage) of food and drink bought in the UK does show a significant reduction, at a household level, of around 4% between 2007 and 2012. This reduction is consistent with consumers having to buy less (as they waste less), but will of course also have been influenced by other initiatives such as those aimed at promoting healthy eating. However, population growth has meant there was only a reduction of ca 0.5% at a UK level, suggesting that an increase in population (of 4.4%) has off-set most of the reduction due to less food being wasted.[19] The UK population is forecast to grow by 6.1 million people by 2025, a 10% increase, and would (with current consumption patterns) require need an extra 4.1 Mt of food; much more than the further reduction in food waste thought possible by that time (1.7 Mt).

In addition econometric modelling (WRAP, 2014c) suggests that as consumers find ways to avoid waste, many change their purchasing behaviour and buy smaller quantities of more expensive food, which is a form of "trading up." It would be useful to develop further understanding of such behaviours to quantify the economic effect of reducing food waste.

Reducing waste in manufacture or the grocery retail and hospitality and food service supply chains will deliver financial savings, and the potential for increases in productivity and competitiveness. The UK currently has a food trade deficit of around GBP 19 billion (the same value as that for food wasted across the supply chain), and therefore there should also be opportunities to reduce dependency on food imports (for some food types) and increase exports.

19. WRAP analysis of Defra Family Food Survey data (Defra, 2013c).

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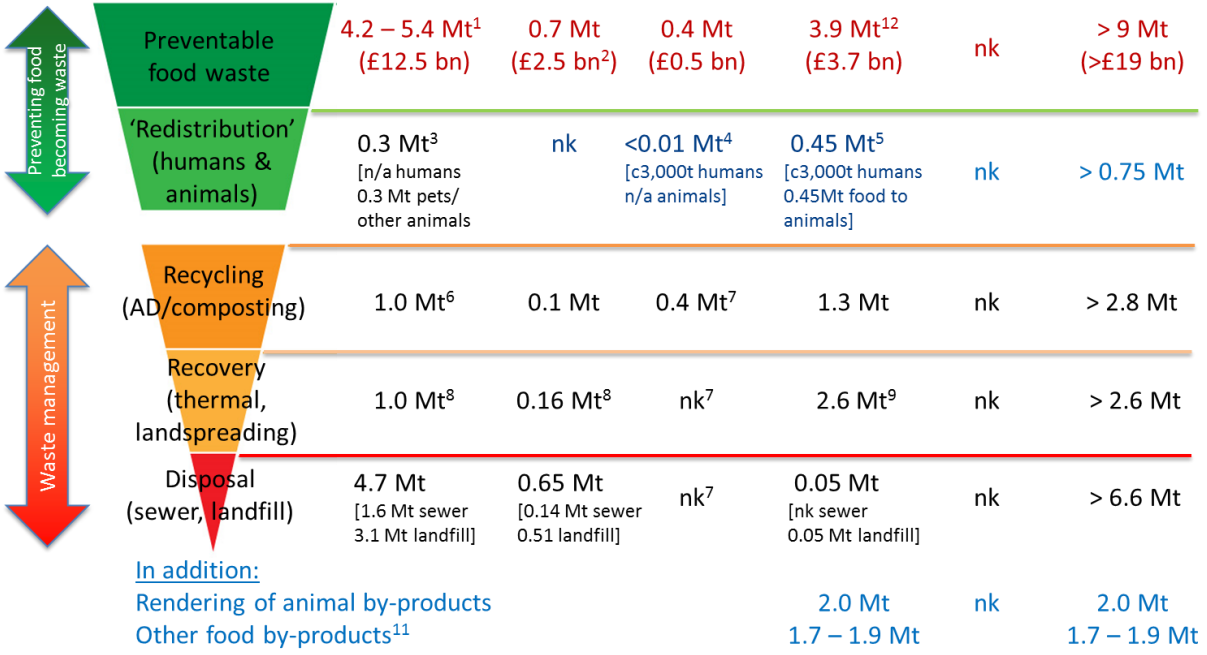
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Annex 2A. Details of UK food waste and related materials, by supply chain stage (horizontal) and utilisation or disposal route (vertical)



	Household	HaFS*	Retail**	Manufac-turing	Farm	Total[10]
Total food waste	**7.0 Mt**	**0.9 Mt**	**0.4 Mt**	**3.9 Mt**	**ca 3.0 Mt**	**ca. 15 Mt**
Preventable food waste	4.2 – 5.4 Mt[1] (£12.5 bn)	0.7 Mt (£2.5 bn[2])	0.4 Mt (£0.5 bn)	3.9 Mt[12] (£3.7 bn)	nk	> 9 Mt (>£19 bn)
'Redistribution' (humans & animals)	0.3 Mt[3] [n/a humans 0.3 Mt pets/ other animals	nk	<0.01 Mt[4] [c3,000t humans n/a animals]	0.45 Mt[5] [c3,000t humans 0.45Mt food to animals]	nk	> 0.75 Mt
Recycling (AD/composting)	1.0 Mt[6]	0.1 Mt	0.4 Mt[7]	1.3 Mt	nk	> 2.8 Mt
Recovery (thermal, landspreading)	1.0 Mt[8]	0.16 Mt[8]	nk[7]	2.6 Mt[9]	nk	> 2.6 Mt
Disposal (sewer, landfill)	4.7 Mt [1.6 Mt sewer 3.1 Mt landfill]	0.65 Mt [0.14 Mt sewer 0.51 landfill]	nk[7]	0.05 Mt [nk sewer 0.05 Mt landfill]	nk	> 6.6 Mt
In addition:						
Rendering of animal by-products				2.0 Mt	nk	2.0 Mt
Other food by-products[11]				1.7 – 1.9 Mt		1.7 – 1.9 Mt

* HaFS = hospitality and food service; ** Retail includes wholesale; nk = not known; n/a = not applicable

Notes to Annex 2A Table

Figures in black are the breakdown of the total food waste (figures in black and bold).

The fractions of the total food waste that could be prevented are shown in red, and are a fraction of the total food waste (and should not be added to the figures in black or blue).

Figures in blue are materials arising from food manufacture but not classed as food waste, and are therefore not included in the total food waste figures in black.

1. Includes both avoidable (4.2 Mt) and possibly avoidable (1.2 Mt) food waste (items which some people may eat, some of the time, including potato peelings, bread crusts), but the financial value is based on the avoidable fraction only.
2. The value of food waste in the HaFS sector is based on both avoidable and unavoidable food waste (as this sector probably has the greatest scope to reduce unavoidable food waste through altered procurement, or to make use of this fraction of food waste).
3. This covers food waste fed to pets and other animals, most of which is likely to leave the 'food chain' and should therefore be considered as waste diversion.
4. This covers food redistributed for human consumption, which was estimated to be around 3,000 tonnes in 2011, but this will now be an underestimate.
5. This consists of 0.45 Mt of food used as animal feed (this is therefore not classed as food waste, but could be added to the 3.9 Mt of food waste to give a total indication of food lost to the human food chain; and food redistributed for human consumption, which was estimated to be around 3,000 tonnes in 2011, but this will now be an underestimate).
6. This includes 0.5 Mt of food waste collected separately by local authorities and 0.5 Mt of food waste home composted.
7. In WRAP's research it was not possible to identify the disposal route for much of the food waste from retail, but information from Courtauld signatories suggests that most is recycled (via AD or composting) although some may be disposed of via thermal treatment or to landfill.
8. Based on 2010 UK data as submitted to Eurostat, which shows 24% of household mixed waste being incinerated and 76% going to landfill
9. In WRAP's published research it was not possible to identify the disposal route for around 0.2 Mt of food waste from the manufacturing sector, but information from Courtauld signatories suggests this is unlikely to be disposed of to landfill, and so this has been included within the estimate for food recovery.
10. Estimates under the total column are indicated as minima, due to the absence of detailed data from on farm.
11. Examples include spent grain from brewing and dried sugar beet pulp
12. For food waste arising in manufacturing it is assumed that all is avoidable, as the vast majority of what would be unavoidable is not classed as a waste but a by-product of some sort. It is possible that a small proportion of manufacturing waste is unavoidable though it appears that the majority of this material is disposed to animal feed.

    Note – For households, food waste fed to pets and other animals has been included in the overall estimate for waste; whilst commercial food and related by-products used as animal feed are not classed as waste (as this is defined as a waste prevention activity). Estimates have been rounded and may not therefore add up to the total estimate for any given sector.

Source material

Households ('Household Food and Drink Waste in the UK 2012'; WRAP, 2013b).

Hospitality and Food Service ('Overview of Waste in the UK Hospitality and Food Service Sector'; WRAP, 2013c; data for 2011).

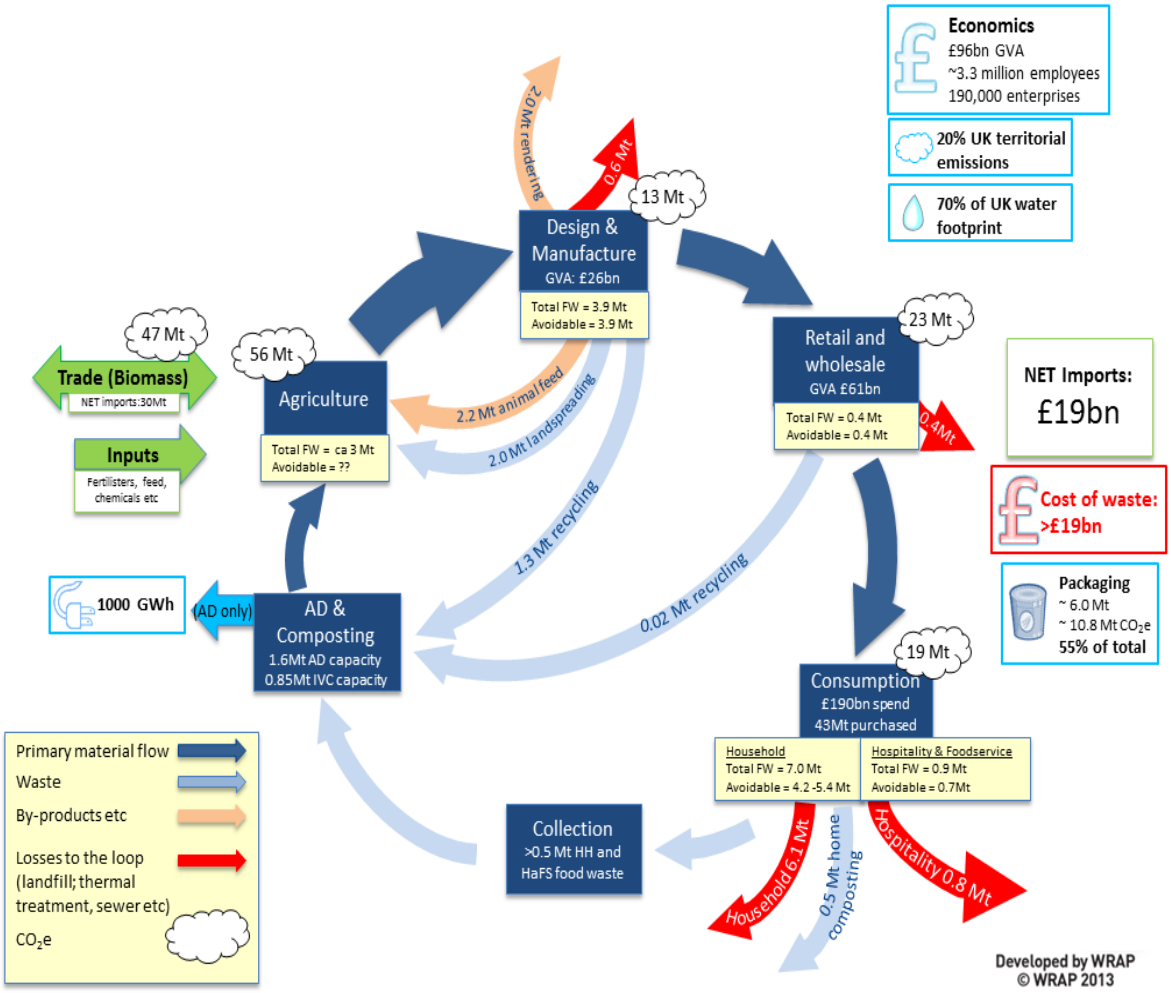
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Farm (Food waste arising in agriculture has not been an area of focus for WRAP). Existing estimates of agricultural food waste are indicative, and based on a 2004 synthesis of evidence available at that time ('Review of agricultural waste research and development projects'; Environment Agency, 2004).

Annex 2B.

The "Food Loop" in the United Kingdom



Annex 2C.

What is being done to reduce food waste around the food loop in the United Kingdom

