

Capítulo 1.

FOOD FOR THOUGHT: THE FOOD WASTE GLOBAL ISSUE

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ABSTRACT

Between 30 and 50 percent of the total amount of food produced around the world each year -4 billion tons- never makes it on to a plate. This means that roughly one-third of food produced for human consumption is lost or wasted globally, generating huge amounts of resources used in food production used in vain, like the energy, water or land. Moreover, food is lost and wasted to a varying extent across the globe, across all stages of the food value chain and comprising all types of food. This is a tragedy in its own, given that some 870 million people suffer from chronic malnourishment. Thus, the significance of the global food waste problem is extreme, while showing a direct impact on the two most pressing issues of our time - poverty and environment-.

What causes food waste?. Extreme weather conditions and pests can lead to losses prior to harvest; machinery, transport and storage produce food waste throughout food processing. Further downstream, waste occurs due to damaged packaging, *sell by* date regulations, over purchasing and especially due to regulations and overly selective quality and aesthetic standards. However, this global issue can be tackled. On one side, for poorer countries, simply building better food storage buildings could cut down massively on food waste, along with better harvesting technology; while on the other side, industrialized countries will need to increase awareness about throwing out so much perfectly good food. In this context, the purpose of this study is to identify the causes of food waste and suggest possible ways of preventing them.

RESUMEN

Entre el 30 y el 50 por ciento del total de los alimentos producidos en el mundo cada año -4 mil millones de toneladas- nunca llega al plato. Esto significa que aproximadamente un tercio de la comida producida para consumo humano se pierde o se desperdicia a nivel global, de modo que enormes cantidades de recursos empleados en la producción de alimentos son usados en vano, como la energía, el agua o la tierra. Además, los alimentos se pierden y desperdician en distinta medida a lo largo del planeta, en todas las etapas de la cadena de valor alimentaria y para todos los tipos de alimentos. Esto supone una tragedia, dado que alrededor de 870 millones de personas sufren desnutrición crónica. Por tanto, la importancia del desperdicio de alimentos a nivel global es extrema, a la vez que muestra un impacto directo en dos de los problemas más acuciantes de nuestro tiempo -la pobreza y el medio ambiente-.

Cuál es la causa del desperdicio de alimentos? Las condiciones climáticas extremas y las pestes pueden conllevar pérdidas de alimentos anteriores a la cosecha; la maquinaria, el transporte y el almacenamiento también crean desperdicio de alimentos a lo largo del proceso de elaboración de alimentos. En el otro extremo de la cadena alimentaria, el desperdicio de alimentos se produce debido al empaquetado en mal estado, a la regulación de las fechas de venta de los alimentos, la compra excesiva y especialmente debido a las normas y criterios de calidad selectivos, así como a los estándares estéticos. Sin embargo, se puede hacer frente a este problema global. Por un lado, en los países pobres, simplemente la construcción de mejores almacenes podría reducir de forma masiva el desperdicio de alimentos, así como una mejor tecnología aplicada a las cosechas; mientras que por otro lado, los países industrializados necesitarían incrementar la conciencia sobre cómo se desecha tanta comida en perfecto estado. En este contexto, el propósito de este estudio es identificar las causas del desperdicio de alimentos y sugerir posibles formas para prevenirlo.

MSC codes: 05-02

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1. THE FOOD WASTE GLOBAL ISSUE: WASTING FROM FARM TO FORK

An old traditional refrain when children did not finish the food on their plate often was “*think of all the starving children in the world*”. But, society has evolved from a culture where no food was wasted to a society where wasting food is accepted as a fact of life; highlighting that modern consumer culture includes that food produce is often wasted through retail and customer behavior (Kelleher and Robins, 2013).

In fact, the Food and Agriculture Organization of the United Nations (FAO) assumes that roughly one-third of the food produced globally for human consumption gets lost or wasted, which is about 1.3 billion tons per year; while at the same time, around 925 million people are suffering from hunger and malnutrition. Furthermore, food is wasted throughout the food supply chain, from initial agricultural production down to final household consumption, which also means a waste upon natural resources (Kranert et al., 2012).

There are numerous causes of losses and waste, being differentiated according to the different stages of the food supply chain. In developing countries, the most significant losses are concentrated at the first part of the food supply chain, primarily due to limits in the cultivation and harvesting, preserving techniques, or due to a lack of adequate transportation and storage infrastructures. However, in industrialized countries, the largest proportion of waste occurs at the final stages of the food supply chain, namely household consumption, restaurants and food services; despite there are significant losses due to aesthetic and quality standards, product regulations or production surpluses (Smil, 2010; Gustavsson et al., 2011). Consequently, the FAO estimates that food losses and food waste total about \$680 billion per year in industrialized countries and \$310 billion in developing countries (FAO 2013).

Food waste is a phenomenon that raises serious questions from a social point of view. In fact, given the problem of malnutrition that is afflicting around one billion people worldwide, the increase in food waste, appears extremely unacceptable. The lack of awareness of the scale of the food waste issue, along with its environmental, economic and social impact certainly do not assist with tackling this problem. This study highlights the food waste occurring along the entire food chain and makes an evaluation of the magnitude. Further, it identifies causes of food waste

and possible ways of preventing them, along with some marketing actions which could help tackling food waste.

2. THE CONCEPTUALIZATION OF FOOD WASTE

The term *food waste* most commonly means food that was purchased but not consumed and ends up in the garbage. A first conceptualization of food waste was given by the UN Food and Agriculture Organization (FAO) including any healthy or edible substance that instead of being destined for human consumption, is wasted, lost, degraded, or consumed at every stage of the food supply chain.

There is not any standardized definition of the waste food phenomenon. So, considering of all of the phases of the food supply chain, we propose to distinguish between *food loss* and *food waste*. Both food loss and food waste only refer to products intended for human consumption, therefore excluding animal feed and non-edible parts of plants and animal products. *Food losses* refer to the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Food losses take place at production, postharvest and processing stages in the food supply chain; that is, the losses that occur upstream of the food supply chain, mainly during the cultivation, harvesting, processing, preserving, and first agricultural transformation stages (Tarasuk and Eakin, 2005; Parfitt *et al.*, 2010). However food losses taking place at the end of the food chain -during industrial processing, distribution and final consumption are rather called *food waste*, which relates to retailers' and consumers' behavior. So, per definition, food waste are the masses of food lost or wasted in the part of food chains leading to edible products going to human consumption (Parfitt *et al.*, 2010).

Food waste typically occurs at the processing, storage, distribution and consumption stages of the food value chain, and is the unintended result of processes or technical limitations in storage, infrastructure, packaging or marketing; and often is the result of negligence or a conscious decision to throw food away. Consequently, any food substance, raw or cooked, which is discarded, or intended to be discarded is considered food waste, including the residues generated by the processing, handling, storage, sale, preparation, cooking and serving of foods (Griffin *et al.*, 2009; Segrè and Falasconi, 2011). On the other hand, as stated before, *food loss* refers to food that spills, spoils, incurs a reduction in quality, or otherwise gets lost before it reaches the consumer.

3. DEVELOPED AND DEVELOPING COUNTRIES: FACING DIFFERENT FOOD WASTE CAUSES

The FAO notes that food losses in developed countries are roughly the same as in developing countries – although there is a difference in *where* all of that waste occurs. Is in the most advanced and developed countries more than 40% of food losses take place at the retail and consumer levels, while largest quantities of food is harvested from the field but never reaches the marketplace. However, more than 40% of food losses in developing countries occur at post-harvest and processing levels, (Gustavsson *et al.* 2011).

More precisely, in developing countries, wastage tends to occur primarily at the farmer-producer stage of the supply chain. The inefficient harvesting, the inadequate local transportation and the lack of infrastructure mean that produce is frequently handled inappropriately and stored under unsuitable conditions.

As the development level of a country increases, the food waste issue generally moves further up the supply chain. Despite the availability of high efficient farming practices, better transport, storage and processing facilities ensure that a larger proportion of the food produced reaches markets and consumers, the consumerism and mass marketing lead to major food wastage (Finn, 2013).

In low-income countries food is lost mostly during the early and middle stages of the food supply chain; much less food is wasted at the consumer level. As the development level of a country increases, so the food loss problem generally moves further up the supply chain with deficiencies in regional and national infrastructure having the largest impact. In developed and high-income countries food is to a significant extent wasted at the consumption stage, meaning that it is discarded even if it is still suitable for human consumption. Significant losses also occur early in the food supply chains in the industrialized regions.

As an example, it was estimated that food wastage is particularly severe in developed countries, with estimates as high as 280 to 300 kg per capita annually in Europe and in North America (Gustavsson et al., 2011); meaning that food waste and losses at the retail and consumer levels amount to an overall value of 165.6 billion dollars (Buzby and Hyman, 2012; O'Connor, 2013); but this figure does not take into account of the losses during the production and harvesting stages (Smil, 2010).

3.1. Developed countries

In richer countries, around 30 percent or more of food is discarded in processing, transportation, retailing and in consumers' kitchens. The causes of food losses and waste in medium and high-income countries mainly relate to consumer behavior, as well as to a lack of coordination between different actors in the supply chain. Farmer to retailer or distributor agreements may contribute to overproduction of crops, thereafter being wasted. In addition, food can be wasted due to quality and aesthetic standards, rejecting food products not perfect in shape or appearance. Other major reason for food waste takes place when production exceeds demand. In order to ensure delivery of agreed quantities, farmers make harvesting and production plans but end-up producing larger quantities than needed. However, in developed countries, the major contribution to food waste comes from households (Parfitt et al., 2010). At the consumer level, insufficient purchase planning and expiring best *before dates* also cause large amounts of waste, in combination with the careless attitude of consumers who can afford to waste food. As a consequence, food waste in industrialized countries can be tackled by raising awareness among food industries, retailers and consumers.

As for example, the United States Department of Agriculture (USDA) estimates that every year the United States throw away 40% of the total food intended for human consumption. So, by one recent estimate, North Americans are squandering the equivalent of \$165 billion each year by wasting food, which mostly happens in restaurants and food services (Kantor et al. 1997). Europe does a better job of curtailing waste, since recent estimates indicate that the quantity of food wasted every year amounts to 98 million tons, or 180 kg per capita.

3.2. Developing countries

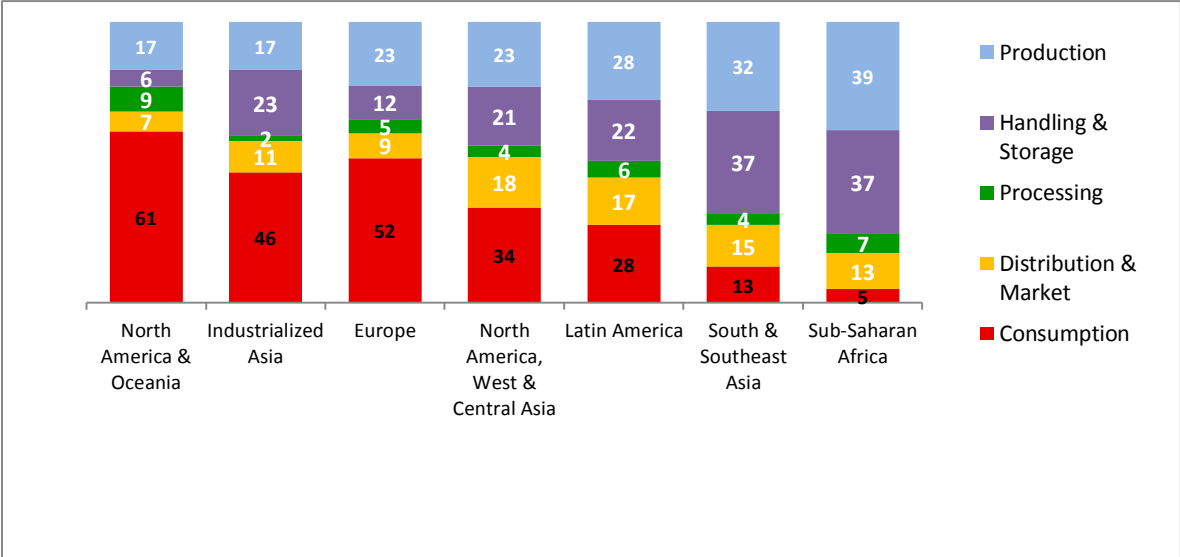
The causes of food losses and waste in low-income and developing countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities, along with difficult climatic conditions, a lack of infrastructures, poor

packaging and marketing systems. In poorer countries, much of the food waste occurs on the farm or soon thereafter. Depending on the crop, an estimated 20 to 35 percent of food may be lost in the farms because of poor agricultural techniques and factors such as droughts, flooding or pests; furthermore, another 10 to 15 percent is lost during processing, transport and storage given a lack of modern facilities and access to refrigeration.

Other major reason for food waste is *premature harvesting*. Poor farmers sometimes harvest crops too early due to food deficiency or the desperate need for cash. This way, the food incurs a loss in nutritional and economic value, and may get wasted if it is not suitable for consumption. However, given that many smallholder farmers in developing countries live on the margins of food, a reduction in food losses could have an immediate and significant impact on their livelihoods.

As for example, a survey in India showed that at least 40 percent of all its fruit and vegetables were lost between grower and consumer and about 21 million tons of wheat annually perishes, due to lack of refrigerated transport and post-harvest cooling, along with poor infrastructures and corruption. Other example is the former Soviet Republics where cold-storage warehouses and food processing facilities were engineered and constructed in the 1930s; thus being inefficient and unsafe. As a result, Ukraine shows on average 25 to 50 percent losses in grain production.

Figure 1. Differences among developing and developed countries in food waste (WRAP, 2009). **Percentage of food wasted**



4. THE ORIGIN OF FOOD WASTE

During the 20th century, progress in agriculture, cultivation, and the food industry allowed most developed countries to overcome the condition of food scarcity which had been prevalent before that time. Additionally, the increase in average income has given ever-larger segments of the population access to greater quantities and higher quality of food. As a result, the increasing availability and variety of food, its decreasing price, and a lower percentage of income spent on food has progressively led to greater tolerance to food waste. Furthermore, it should be remarked some global trends that had important consequences on the amount of food wasted. Firstly, the most remarkable influence is *urbanization*, which has resulted in the lengthening of the agribusiness supply chain, in order to satisfy the food requirements of the population residing in cities. The greater

distance between the place of production and that of final consumption, requires the improvement of transportation, storage, and sale infrastructure in order to avoid and reduce food losses (Parfitt et al., 2010). Secondly, the change the *composition* of the human *diet*, which is associated with the increase in the available income; meaning that instead of starchy diets, consumers are increasingly demanding meat, fish and fresh products such as fruits and vegetables. This phenomenon is particularly relevant in the so-called emerging economies such as Brazil, Russia, India and China, (Lundqvist et al., 2008; Parfitt et al., 2010). Third, the increasing *globalization of commerce* and the rapid expansion and generalization of large-scale mass distribution in many developing countries; in fact, many food retailers have become the main intermediaries between food producers and consumers in Africa, Asia, and South America, thus enabling a greater diversification of diet. Finally, the demand for higher quality food products, the higher safety standards and the increase in the volume of food products marketed, clearly influence the level of food waste generated.

Table 1. Description of food waste along the value chain (Lipinski et al., 2013)

Production	Handling and storage	Processing and packaging	Distribution and marketing	Consumption
During or immediately after harvesting	After produce leaves the farm for handling, storage and transport	Industrial or domestic processing and packaging	Distribution to markets (losses at wholesale and retail markets)	Losses in the home of consumer of business (restaurants, catering...)
Stages of the value chain generating food waste				
Crops left behind in fields due to poor mechanical harvesting or drops in prices	Edible food ruined by pests	Inappropriate packaging that damages produce	Edible products spilled or damaged in market	Poor storage and stock management in houses
Fruits bruised during picking or threshing	Edible produce degraded by disease or fungus	Livestock trimming during slaughtering or industrial processing	Edible produce sorted out due to poor quality	Products sorted out due to quality
Crops damaged because of poor harvesting	Contamination and natural drying of food	Fruit or grains sorted out as not suitable for processing	Edible produce sorted out due to aesthetical standards	Food purchased but not eaten
Fish discarded during fishing operations	Fish that are spilled or degraded after landing	Fish spilled or damaged during canning or processing	Edible products expired before being purchased	Food cooked but not eaten
Crops sorted out in post-harvest for not meeting quality standards	Livestock death during transport to slaughter or not accepted for slaughter	Milk spilled during pasteurization and processing	Product discarded in supply chain	Food discarded in packaging because confusion on best before and use-by dates
			Losses caused by lack of cooling	Food waste inconsistently

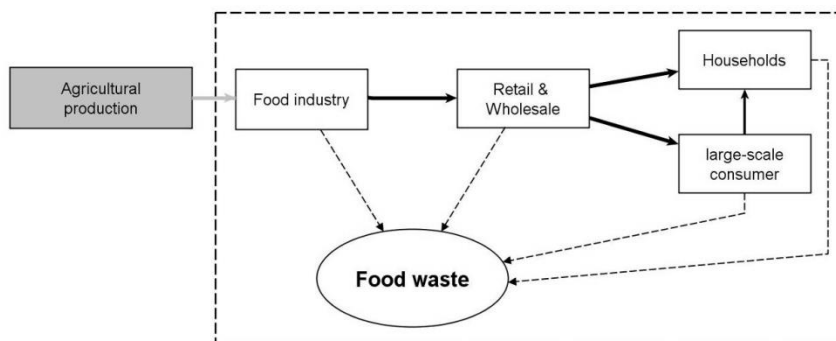
			and cold appropriate storage	treated
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4.1. Production and Harvest

During the stage of the agricultural produce and farming, the main causes of waste are technical malfunctions and inefficiencies in the production processes, due to mechanical damage or spillage during harvest operation, such as threshing or fruit picking. However, the production of a sufficient amount of food is an important issue for human being, resulting in specific national and international plans to ensure the food supply, at least for developed countries. Thus, more food is produced than needed, because potentially losses due to weather incidences, diseases or pests should have consequences on food supply. This behavior is comprehensible, but implies several perspectives which may lead to food wastage (Schneider, 2008). In order to prevent food wastage in agriculture -where the weather dependency is high, forecasts have to be done to estimate the expected production; and often high amounts of edible food are wasted due to surpluses, over production, unprofitable prices as well as not marketable dimensions or weight of food products (Kranert et al., 2012).

As for example, in the United States roughly 7 percent of the produce that is grown simply gets stranded on fields each year: while some produce goes unpicked because it does not meet shape or weight standards, at times, perfectly fine crops go unpicked due to fluctuating immigration laws, which create shortages of farmworkers.

Figure 2. Areas of food waste (Source: Kranert et al., 2012)



4.2. Processing and industry

Plenty of food gets trimmed in the manufacturing and processing stage. This stage in the food chain, losses may occur when crops are sorted out if not suitable to process or during washing, peeling, slicing and boiling or during process interruptions, spillage and degradation during industrial or domestic processing. Thus, technical malfunctions in processing and refrigeration are one big factor, along with the fact that many retailers often reject produce after crops have been gathered due to quality and aesthetic standards of size, color or weight.

In first place, errors in the *production process* lead to defective or damaged food products, which can no longer be sold, while another source of waste is the spillage of products, which often occurs during the filling of liquid food (Gustavsson, et al., 2011). Additionally, production technical problems may also constitute the cause for food waste,

along with damaged packaging and technical problems in labelling (Parfitt, et al., 2010; Monier, et al., 2010). Secondly, poor *storage facilities* and the lack of *infrastructure* cause postharvest food losses, mainly in developing countries. Specially, fresh produce like fruits, vegetables, meat or fish can be spoilt in hot climates, due to lack of adequate infrastructure for transportation, storage, cooling or market (Rolle, 2006; Stuart, 2009).

Third, food products that do not comply with certain *quality* and *aesthetic characteristics* are sorted out, including for example, irregularly shaped or sized products that are not suitable for certain processes (Monier, et al., 2010). The percentage of food losses due to this reason varies depending on the type of crop and the quality standards set by regulations or requested by retailers, meaning that it is not always economically viable to collect and market certain food products. Food waste also arises during *quality assurance operations*, when food processing companies must take samples and keep them in order to check and to prove the perfect quality of their products throughout the whole shelf life; which are then disposed of (Schneider, 2009; Escaler, et al., 2011). Finally, the food loss results from *overproduction* or *poor planning* by food retailers; causes that include the *irregular demand* (Gustavsson et al., 2011; Kranert et al., 2012). Thus, it seems that it is nearly impossible to avoid food waste at this stage of the value-added chain.

4.3. Distribution and retailing

Retailing and distribution are another huge source of wasted food, since it has been estimated that food retailers loss about \$15 billion worth of unsold fruits and vegetables each year. This stage of the chain creates food waste due to spillage and degradation during handling, storage and transportation between farm and consumer, along with other causes analyzed below.

Wholesale and retail distribution waste is generally a consequence of *inappropriate ordering* and *incorrect planning of demand* for food products, resulting in large quantities of merchandise which are not sold before the expiration date or before their natural deterioration (Gustavsson, et al., 2011). Estimating demand for food products, in fact, is very complex and is influenced by multiple factors, such as climate, season, specific marketing campaigns, new product launches, promotions and even customers' attitude. Consequently, it is very difficult to predict consumers' demand; thus, leading to excess stocks (Monier, et al., 2010). According to Stenmarck (2011), the order process is one of the main problems, along with difficulties regarding the merchandise information system or in demand-based stock planning.

Other major reason leading to food waste in wholesale are the *excess stocks*. These excess stocks often result from agreements related to un-marketed food products with retailers or from orders that are cancelled at short notice (Monier et al., 2010). Food retailers focus on minimizing *stock holding*, whereas fulfilling the consumer demand, which has led to the late confirmation of order volumes as a commonplace. In fact, this confirmation of the required volumes shortly before the food products must be shipped, presents planning complexities for manufacturers and results in the creation of large amounts of food overproduction. Consequently, retailers often use different marketing strategies for food with a short shelf life in order to *reduce excess stocks* (Monier, et al., 2010). For example, in many countries, it is perfectly legal to sell food past its expiration date.

Other relevant reason for food waste at this stage is the *overproduction* and *oversupply* of food (Gustavsson, et al., 2011). That is, a huge variety of food products and shelves that are always completely filled, being in part responsible for wastage. Consumers expect the shelves to be filled and a wide range of food products available in stores; thus, consequently retailers are

forced to order more food products than they actually sell, causing *overproduction*, with more foods produced than the expected to be sold during the day in order to meet the customers' demand (Stenmarck, 2011). The large quantities on display and a wide range of food products in *supply* lead also to food waste, since retailers need to order a variety of food types from the same manufacturer to get beneficial prices; despite increasing the likelihood of some products reaching their *sell by* date before being sold, and thereby wasted. However, many stores and retailers would rather overstock their shelves and throw out the remainder than look empty; thus, food waste is seen as the cost of doing business.

Hence, *overproduction* constitutes significant cost to food companies as materials, energy and production capacity in manufacturing are wasted, given that the product no longer reaches the end customer. The underlying causes for food overproduction are mainly attributed to inefficiencies in the supply chain and to the *limited shelf life* of food products. In fact, food is mainly disposed of by retailing because it is or becomes *unsalable* or *unmarketable*, due to food products with an expired best before or use by date, along with perishable food that is often not labelled with a date, such as bread, fruits and vegetables. Therefore, a significant proportion of food waste is attributed to the *short shelf-life* of both the ingredients and products, often generated as a result of overproduction to meet retailer demands (Darlington and Rahimifar, 2006). Consequently, it may be possible to reduce the overproduction by the authorized extension of the product's *shelf life*.

Of particular significance is, however, the improper *handling* of food products, which constitutes another major reason for food losses. Quite often food products are damaged due to improper handling, and therefore can no longer be sold (Stenmarck, et al., 2011). Inadequate or improper food handling represents plenty of reasons that food is disposed of despite being undamaged: storage under insufficient temperature or lighting conditions, improper positioning of the foods products or even damaged *packaging* (Stenmarck, et al., 2011). Finally, reducing *in-store food losses* would also help in reducing food waste, which could be accomplished through better ordering and in-store inventory management.

It should be remarked that in developing countries this stage of the supply chain is characterized by a total absence or a tremendous inefficiency of wholesale distribution. The waste is attributable to the *lack of processing facilities* along with the inadequate *market systems* causing high food losses. In many situations the food processing industry does not have the capacity to process and preserve fresh produce in order to meet the demand, there are only few distributors and retail facilities providing suitable storage and sales conditions for food products, and markets are often small, overcrowded, unsanitary and lacking cooling equipment (Kader, 2005; Stuart, 2009).

4.3.1. Food waste caused by aesthetic standards

Major retailers, in meeting consumer expectations, will often reject entire crops of perfectly edible fruit and vegetables at the farm due to rigorous quality and aesthetic standards; that is, because they do not meet marketing standards concerning their physical appearance and characteristics, such as size, shape, color or weight. Although some rejected crops are used as animal feed, the high quality standards might divert food originally aimed for human consumption to other uses (Stuart, 2009). Globally, the high

appearance standards required by retailers to fresh produce, leads to generate 1.6 million tons of food waste annually in this way. One example would be the carrots quality standards required by the retailer Asda in U.K. One British farm –Poskitt Carrots- is the major supplier of carrots for this retailer. Among its production, large quantities of out-graded carrots, even having a slight bend, are sent off as animal feed. Then, all carrots pass through sensor machines in search for aesthetic defects; and thus, carrots that are not bright orange, had a bend or blemish or are broken, are swept off; since Asda requires that all carrots should be straight, so customers can peel the full length in one easy stroke (Stuart, 2009). So, finally 25 to 30% of all carrots handled by Poskitt Carrots were out-graded.

Food retailers seem convinced that consumers will not buy food which has the *wrong shape*, size, weight or appearance. However, previous research shows that consumers are willing to buy heterogeneous food produce as long as the taste is not affected, which could be done by offering consumers a broader quality range of products in the retail stores (Stuart, 2009). Consequently, consumers have the power to influence and change the *aesthetic standards*.

4.3.2. Large-scale consumers (restaurants, catering, schools, hospitals)

The main source of surplus food is overproduction due to errors in demand forecasting. Surplus food in large-scale consumers or collective catering mainly includes cooked products not yet served to customers, which is managed mainly through waste disposal, similarly to what occurs at food retailing (Garrone et al., 2014). Since food is generally regarded as the least costly resource in restaurants and catering, it is often viewed as disposable; consequently, in general terms the catering industry throws away a third of its food, as restaurants deliberately order too much produce in order to avoid running out.

Regarding the large-scale consumers, the reasons for food waste are quite similar to those of food retailing, since many reasons arise from internal organization and services for customers. In first place, in the kitchen, an *inadequate storage* and *different degrees of processing* of food products are the main causes of waste, as well as a *lack of planning* regarding the number of menus and meals to be prepared is another reason for food wastage. Since, only few kitchen chefs have recourse to data on pre-confirmed dishes, they have to rely on their experience. Secondly, much food waste arises when restaurants and caterings *do not reuse* prepared, but not yet served food. Third, and with respect to customers, waste factors include *menu selection*, *serving size* and *type* of the portions offered, given that the excessive size of food portions served will be left on the plate. However, the more customers are addressed, the more likely will be they finish their meal. This is further complicated in the case of buffet service, since buffets usually involve preparation of a larger amount of food than is necessary. Further reasons for food waste are *hygiene* and *food safety regulations* concerning the passing on and reutilization of food, as well as *lack of information* -for example, vegetarian customers want to know whether or not the meal contains meat-. In most cases, the awareness about the amount of waste generated on a daily basis in large-scale kitchens results in the decrease of food waste (Leanpath, 2006).

4.4. Household consumption

Previous studies note that overall between 30 and 50 percent of food that has been bought in developed countries is thrown away by consumers (Quester et al., 2013). Furthermore, of the food waste discarded into the garbage, approximately the 64 percent could be classified as avoidable. It seems that the culture of *abundance* and *consumer attitudes* lead to high food waste in industrialized countries, and may be one of the most important reasons for food waste in rich

countries is that consumers simply can afford to waste food, while spending proportionally less income on food and less time on food preparation than previous generations (Quested et al., 2011).

Considering the food system, it should be remarked that most food decisions are made by consumers as family units, causing food waste during consumption at the household level. Surplus food at home includes both products that are bought but not consumed before the end of their shelf life, and products that are cooked but not consumed (Garrone et al., 2014). Thus, household food waste has two main causes. First is that too much food is cooked, prepared and served; thus producing the so-called *leftovers*; and second, the food that is not consumed in time, that is, food and beverages are *thrown away* because they exceeded the expiration date stated on the package, are deteriorated or no longer seem to be edible. However, household food waste reasons cannot be generalized as they depend on the product, as well as on the way of the style life of the households.

According to Glanz (2008), there is a broad range of reasons for household food waste. Consumers most often referred to the purchase of special ingredients –food products used rarely or only for certain meals-, the inadequate storage, a lack of knowledge of food stocks, food that was already spoiled before it was bought, freshness and taste -preference of freshly bought products-, products for any eventuality and trial purchases made to test new food products. Additionally, home waste arises due to the difficulties consumers face with correctly interpreting food labelling, the mistakes in the preparation or the preparation of over generous serving portions, incorrect shopping and planning and foods not being preserved appropriately.

According to Quester et al. (2013), there are two main ways of reducing the amount of food wasted in homes: by influencing consumers' behavior and attitudes, or by making changes to the food products sold and the way they are packaged. More specifically, consumers can reduce food waste at home by for example keeping fresh food produce in conditions that maximize their shelf life, planning meals in advance, checking levels of food in storage or fridge prior to shopping, making a shopping list, using the freezer to extend the shelf-life of food, portioning food like rice and pasta, using up leftovers and learning and understanding date labels on food (Quester et al., 2013).

Food wasted at consumer level is minimal in *developing countries*, since poverty and limited household income make it unacceptable to waste food. Thus, once the food gets to market, little goes to waste because food is simply considered too valuable (Finn, 2013). A contributing factor is that consumers in developing countries generally buy smaller amounts of food products at the time, often just enough for meals on the day of purchase (Stuart, 2009).

5. THE ENVIRONMENTAL, ECONOMIC AND SOCIAL IMPACT

Since roughly one third of food produced for human consumption is wasted globally -which amounts to 1.3 billion tons per year-, this fact inevitably means that huge amounts of the resources used in food production are used in vain, and that greenhouse gas emissions, caused by production of wasted food are also emissions in vain. The largest environmental benefit comes from preventing food from being wasted in the first place – consequently reducing the energy, water and resources used to grow, harvest,

transport, process and sell the food-, as well as emissions associated with storage and cooking (Quested et al., 2013). Therefore, wasting food means losing not only life-supporting nourishment but also precious resources, including land, water and energy that are used in the production, processing and distribution of wasted food. So, reducing food waste can have a substantial positive environmental effect.

5.1. The environmental impact

The production of food that will not be consumed needlessly uses up natural resources and generates greenhouse gas emissions, due to the growing, processing, packaging and transporting the food to the consumer, which finally gets wasted. In fact, it should be stressed that food and drink production requires substantial inputs of water, energy and pesticides. As an example, the U.S. food waste represents the energy equivalent of 350 million of barrels of oil, enough to power the whole country for a week. More specifically, three indicators can be taken considered, namely *carbon* and *water footprint*.

On one hand, the *carbon footprint* represents greenhouse gas emissions generated during food production, comprised primarily of CO₂ generated through the use of fossil fuels, from methane derived from livestock fermentation and the emissions of nitrous oxide caused by the use of nitrogen-based fertilizers. Consequently, food waste has a large environmental impact, since avoidable food waste was estimated to contribute the equivalent of 17 million tons of CO₂ in greenhouse gas emissions annually. On the other hand, the *water footprint* is a specific indicator of the use of fresh water and is devised to convey both the actual quantities of water resources used and the way the water is used. In the case of food production, the water used in the industrial production stage is taken into account, as well as the evapotranspiration of irrigated agriculture. So, wasted food is also wasted water; since water losses accumulate as food is wasted before and after it reaches the consumer. Calculations estimate that food waste accounts for more than a quarter of total freshwater consumption globally; and the WRAP found that the water footprint of food waste was 5,400 million cubic meters, while 550 billion m³ of water is wasted globally in growing crops that never reach the consumer.

5.2. The economic and social impact

There are two main ways in which the economic impact of food waste could be assessed, referring to the production cost and the market price of food products. In first place, according to the *classic school* of economic theory, the value of a product is proportional to the resources which were necessary to produce it. Hence, the economic impact could be evaluated as the value that was lost with waste. In second place, according to the *neoclassical school* of economic theory, the value of a product does not depend on the production cost, but on its utility, represented by the market price. So, the economic impact of food waste could be estimated using the price of the individual food products. Finally, it should be included an evaluation based on the theory of the *economics of well-being*, which estimates food waste as the impact on the usefulness of the entire society. Consequently, the economic impact should be evaluated calculating the opportunity cost of the agricultural surface used to produce the wasted goods.

The *social impact* of waste food can be tackled using the concepts of *food security* and *access to food*. Access to food is conceptualized today as a situation where “all people, at all times, have physical, social, and economic access to sufficient and nutritious food, in order to meet their dietary needs and food preferences for a healthy active life”. However, the concept of food security refers to the “availability of food nationally, in such quantities that will satisfy the

energy requirements of the reference population”, meaning that along with the energy requirements, a diet should also guarantee an adequate nutrient content. Although the data concerning food supply shows an availability of food that should be sufficient to fulfill the global population’s energy requirements, there continues to be malnutrition.

6. HOW CAN FOOD WASTE BE TACKLED?

Given the scale of the problem, there are significant opportunities and solutions to be considered in order to tackle and reduce food waste, which could developed by policy makers, by farmers, food companies and consumers. In low income countries, measures should foremost have a producer perspective, by improving harvest techniques, farmer education, storage facilities and cooling chains; whereas in industrialized countries, solutions should include producer, industrial and household levels. In order to reduce food waste, the FAO (Food and Agriculture Organization), along with the UNEP (United Nations Environment Program) began a campaign targeting the aim to change the culture of food wasted by consumers and food retailers worldwide. Moreover, the European Parliament adopted a resolution in year 2012 regarding food waste, with the target of reducing food waste in EU member states by 50 percent by 2020.

Table 2. Initiatives for reducing food waste (Own elaboration from Lipinski et al., 2013)

Production	Handling and Storage	Processing and Packaging	Distribution and Marketing	Consumption
Facilitate donation of unmarketable crops	Access to low-cost handling and storage technologies	Re-think manufacturing processes	Facilitate donation of unsold foods	Facilitate donation of unsold foods from restaurants and caterers
Improve availability of agricultural extension services	Develop ethylene and microbial management of food in storage	Improve supply chain management	Change food date labeling practices	Consumer education campaigns
Improve harvesting techniques	Improve infrastructure	Develop packaging to keep food last longer	Change in-store promotions	Consumer awareness campaigns
Improve market access	Introduce refrigeration		Provide guidance on food storage and preparation	Reduce food portion sizes

6.1. Food redistribution

There are numerous initiatives worldwide aimed at the reduction and recuperation of food products that can no longer be sold but are still edible. Some of the most popular actions are known as *food redistribution* or *donation* programs, useful methods for reducing food loss and waste which allow food and retail companies to partner with charitable groups to redistribute food that would otherwise go uneaten. Following

Lipinski et al. (2013) *food redistribution* means voluntarily giving away food that otherwise would be wasted to recipients -such as food banks-, which then redistribute the food to those who need it (Lipinski et al., 2013).

Thus, food redistribution applies at the production stage with crops that otherwise would go un-harvested, at the manufacturing stage with overproduced products, and at the distribution and market stage with food left unsold at stores. At the manufacturing stage, a food company might produce a surplus amount of food to meet a purchase order, but then the order is subsequently reduced by the retailer that placed it. At the market stage, surplus food might be generated when a store purchases too much of a certain food product that approaches or goes past the *sell by* date or *display until* date, printed by the manufacturer. Food is still safe to eat after these dates, as it is only an approximate measure of when a food product has reached its peak quality. However, stores are unable to sell such products in most markets due to local regulations and consumer concerns. Additionally, fresh-cooked meals at food retailers that are unsold at the end of the day are often thrown away (Lipinski et al., 2013). The major obstacles to food redistribution are related to transportation factors; since farmers and food stores with surplus food might not be physically close to food banks or charity organizations to deliver unused food.

Many organizations provide food aid through food redistribution and food donations from industry or restaurants, collecting food that would be destroyed or thrown away, and distributing it to charity. One of these organizations are the *Food Banks*. The goal of their activity is to provide surplus food from agriculture, industry -especially the food industry-, large-scale retailers and franchise restaurants; to collect food at large-scale retail centers and redistribute them to organizations dealing with aid and assistance programs. So, Food Banks collect food from a variety of sources all over the food chain, save the food in a warehouse and distribute it to poor families and individuals through local social welfare organizations, including community centers, shelters, childcare centers and senior programs. The Food Banks are able to handle surplus fruits and vegetables, which by nature have a very short life cycle requiring cold storage, and thus need a particularly rapid reception and redistribution system. More specifically, from the food industry there are thousands of companies that donate tons of products of their surplus food to the Food Banks, showing a long-standing collaboration.

Other non-profit organization dealing with food redistribution is the *Fare Share* charity association which provides quality food -collected from the food industry- to organizations that assist disadvantaged people. In some cases, the organizations recover and prepare food in community kitchens and then serve it in cafeterias, such as charity dinners, or during collective events (Segré and Gaiani, 2012). One example are the *Food Cycle* charity dinners, which organizes groups of volunteers who collect surplus food produced locally and prepares meals from it in the unused spaces of food service and restaurant kitchens, along with the development of community kitchens where meals are served at affordable prices for lunch. Other programs, such as the North American *Rock and Wrap It Up!* recovers food that is still intact at the end of public, private or during collective events -like concerts, sporting events or business meetings- and redistributes them to Food Banks and charity organizations (Segré an Gaiani, 2012).

Other interesting initiative is the well-known *Last Minute Market*, which favors a direct relationship between supply and demand, aiming at the recovery of unsold or un-marketable food for charitable organizations. However, the *Last Minute Market* does not directly handle unsold food products, nor does it have stores, since the organization promotes the direct encounter of demand and supply, ensuring safety for all stages. The logistical and organizational

system developed by *Last Minute Market* allows the completely safe recovery of all types of products, including those that fall into the category of fresh, creating a network that progressively activates the donations and pick-up system, checking nutritional, sanitation and logistical aspects. Finally, other initiatives include the use of Internet websites to market food products at discounted prices close to the recommended expiration date, such as the *Quel che c'è* initiative in Italy.

6.2. Awareness campaigns

Nowadays, the decrease in food prices coupled with an apparent abundant availability of food have led to negligence towards food and an increase in wasteful behavior (Stuart, 2009). Specifically in industrialized nations with a culture of abundance, food is relatively cheap and that plentiful nature is reinforced with every trip to attractive, fully-stocked supermarkets (Finn, 2013). Thus, there is a need to change this culture of abundance in industrialized nations, creating recognition and awareness of the *value of food*, along with the value of resources used to produce it. In fact, it is widely reported in research studies that consumers are largely unaware of the levels of food waste generated, being the lack of awareness the reason for the slow progress on reducing food waste. Hand in hand with increased awareness is the need for education in order to change food waste behavior.

Consumer attitudes and behavior play a large role in determining the amount of food that is wasted in households. Food waste at the household level occurs for a number of reasons: food leftovers on one's plate that gets thrown into the garbage or leftovers that are saved for later may be eventually thrown out, confusion over date labels such as *sell by*, *display until* and *use by*, causing some consumers to throw out food that is nutritious and safe (Lipinski et al., 2013). Moreover, some consumers do not realize the amount of waste that is actually taking place in their homes; and consequently when made aware of the staggering amounts of waste, most consumers are eager to make changes in their individual behavior.

Although changing the consumption and the food waste behavior could be difficult, communication campaigns can help influence consumer behavior at the household level. Raising awareness about food waste should be done via media campaigns in order to reach as much of the population as possible. Additional consumer information and advice to avoid waste should be communicated through internet based platforms. Since it is necessary to deal with the diverse causes of food waste one instrument could be a cooking tool to calculate proper portion serving sizes and other tool may be information on the adequate food storage (Glanz, 2008). Thus, raising food waste awareness can be effectively achieved through communication media channels such as press exposure and advertising, in order to teach consumers how to purchase, preserve, prepare, and dispose food on a more sustainable basis (Quested et al., 2013).

On one hand, food retailing can play an important role in reducing food waste at the consumption stage, because of the retailer's direct interaction with consumers. So, for example, Sainsbury's and Morrison's -the third and fourth largest grocery retailers in UK, respectively- each have created waste reduction campaigns, highlighting the food waste issue among consumers who might otherwise be uninformed, while providing them with advice for reducing waste. These two food retailers reach customers through in store

displays, brochures and websites that contain recipes and information on storage and shelf lives of food products.

On the other hand, consumer education campaigns outside of retailing can also be effective in reducing food waste. One example is the *Love Food Hate Waste* campaign, started by the Waste and Resources Action Program (WRAP). This campaign deals with food manufacturers and retailers focused in store waste reduction initiatives, as well as with local authorities and local groups, developing activities such as interactive events, cooking demonstrations and recipe sharing gatherings, that help reduce food waste stemming from the improvement of home economics skills to unused leftovers. This initiative also comprises leaflets and newspaper advertisements providing information about how to reduce food waste and raising awareness of the environmental impact of food waste issue

Image 1. Campaign Love Food, Hate Waste directed at consumers.



However, raising awareness and provision of information alone are unlikely to change behavior across the whole population, so other methods of engagement have also been used (Quested et al., 2013). Thus, to prevent food waste, governments, municipal agencies and organizations such as the United Nations must create initiatives to help change the way people view their food, to appreciate the waste that takes place, and discourage wasteful practices. In this way, some interesting initiatives were the food waste awareness campaigns *Hate Waste* and the *This is Rubbish* developed in Great Britain or the campaign *Stop Wasting Food* in Denmark.

6.3. Re-thinking labeling

Dates provided on the packaging of food, such as *use-by*, *sell-by* and *best before*, are intended to provide consumers with information regarding the freshness and safety of foods. However, these seemingly simple dates can actually confuse consumers about how long it is safe to store food and when they should dispose uneaten food products.

Part of the confusion surrounding product labeling is that there are a number of different terms related to dates that might appear on food packages, such as, *use-by*, *sell-by* and *best before*. One date relates to the expiration of the period during which the merchandise can be displayed and sold –*sell by*-; other indicates the period during which it should be consumed –*use by*-; and still another indicates the period during which the product would be optimal –*best before*-. However, consumers often view all of these dates as being a measure of food safety - that is, a measure of whether the food could potentially cause illness when eaten-, these dates all refer to food quality or food flavor, instead of food safety. So, food that has passed its *sell by*, might be less desirable than newly-purchased food, while it is still entirely safe to eat. This

misperception may lead consumers to throw away edible food they believe is no longer safe to eat. This suggests that while some of food waste may be due to safety concerns, there may be room to reduce unnecessary household food waste by clarifying the meaning of these dates and changing the way in which they are used and interpreted by consumers.

The Waste Resource Action Programme (WRAP), states that on-pack date labels and storage guidance creates consumer confusion and is a major contributing factor of food waste; thus, WRAP guidance is that customers prefer single date codes, and that *best before* is best understood. Additionally, governments could reduce food date confusion by implementing policies or providing guidance on what dates manufacturers and retailers should print on their packaging. In this way, some countries such as the UK abolish the *sell by* date which appeared on packages for all types of food products, with the goal of avoiding the waste of food products that have passed their sale dates, but were still perfectly edible.

Moreover, dates are important only to the manufacturer and the retailer could be hidden; while dates relevant to consumers could be renamed for greater clarity. More specifically, manufacturers and retailers could move to a closed date system, which would replace a *sell-by* date with a code that can be scanned by the manufacturer and retailer, but not by the consumer. Any of these actions would require a small shift in packaging, since packages would need to be slightly redesigned and would prevent consumers from misinterpreting a date on a package and throwing the food product away prematurely. Finally, retailers can reduce date-related food waste by implementing consumer education efforts, such as including in-store displays, leaflets, online guidance, or printed messages on grocery bags that define the food date labels and explain the differences between them.

6.4. Reduced portion sizes

Restaurants use larger portion sizes as a selling proposition to suggest consumers that they are receiving a bargain for the food they purchase; and consequently food portion sizes have mostly been increasing since the 70s. However, for restaurants, caterings and other food service providers, portion sizes can determine the amount of food waste that occurs within their business, since larger portions increase the likelihood that a consumer will not eat all of the food purchased (Quested et al., 2013). Thus, reducing food portion sizes in both direct –retailing- and indirect ways –restaurants and catering- can both tackle food waste and save money for food providers.

One straightforward approach for reducing this food waste would be for the restaurant to reduce portion sizes or to offer smaller portion sizes at a lower price. However, this might lead customers to feel like they are receiving less *value for money* if applied uniformly across an entire menu. This action would allow customers with smaller appetites to order a smaller meal and presumably leave less of it behind, while also lowering preparation costs for the restaurant. Other initiative in order to reduce food waste is to remove *all-you-can-eat* restaurants and caterings, and replace them with *pay-by-weight* restaurants where the weight of the food plate determines the cost of the meal. This action might reduce food waste by giving consumers a clear economic incentive not to take more food than necessary (Lipinski et al., 2013).

7. CAN MARKETING HELP IN TACKLING FOOD WASTE?

7. 1. Food products' labelling

The way in which food is packaged, delivered, and marketed has a huge impact on disposal. Changes to packaging, labelling and merchandising can reinforce and complement the reduction of food waste (Quested et al., 2013). Research has shown that food products' *date labelling* is a determinant key factor in food disposal decisions, and that labeling of many food products can actually encourage waste. More specifically, one major cause of food waste is the strict *sell by* dates on food products, since many consumers have a poor understanding of these dates, being particularly difficult to grasp the difference between the *best by* -which relates to food quality- and *use by* -which refers to food safety-. Thus, the interpretation of the wording and the date on the food label clearly influences purchasing decisions and food disposal (Segré and Gaiani, 2012). Moreover, consumers have a tendency to select and purchase food products with a longer remaining shelf life, contributing to an increase in unsold food; and thus, to food waste (Segré and Gaiani, 2012). Consequently, some developed countries have been exploring and rethinking their use of food labels, which often encourage food retailers to toss out food long before it actually goes bad.

Similarly, many food retailers began helping consumers to use the food they buy by extending shelf life of products, providing clear and consistent date labels, improving storage and freezing guidance and also providing recipe ideas for using up leftover foods. As for example, the retailer *Morrison's* launched the campaign *Great Taste Less Waste* to help its customers waste less food, including *best kept* labelling to inform consumers how best to store food products, and promotion of effective meal planning through recipe suggestions. Other examples are the food retailers *Warburtons* and *Hovis*, which both improved on-pack labelling to make it easier for customers to know how to store their bread and when to eat it by.

7. 2. Packaging

Packaging can have a positive role in preventing food waste by extending the shelf life of food and protecting the product from damage, since damaged packaging is another reason that food is disposed of. As for example, the use of inadequate wrapping and use of wrong materials may affect healthy preservation of food and reduce the consumption period. However, a high proportion of consumers are unaware of the key role of food packaging to the preservation of food; therefore, retailers have a responsibility to communicate the benefits of packaging and inform about how food should be stored to avoid unnecessary food waste. Moreover, retailing industry might be expected to assess the magnitude of food waste related to specific packaging and processing systems and the cost-benefit relationship of alternative food products.

However, packaging will at some point go to waste, either in the supply chain or at the point of consumption, so excessive packaging is to be avoided. (Mena et al., 2011). In this way, one initiative in developed by food retailers in order to meet customers' needs is the strategy of selling food products *without any packaging*. Many food retailers realized that part of their product range could be offered and sold unpackaged; and this strategy would encourage customers to buy food in accordance with their actual needs, purchasing single products instead of large packs (Kranert et al., 2012). Other interesting initiative is to develop *better packaging* in order to reduce these damages. In fact, new *packaging technologies* have provided significant advances in reducing spoilage and food contamination, thereby extending shelf-life and reducing waste. Furthermore, there exists significant potential in utilizing new materials and processes to further extend food products' integrity, such as the *polypropylene trays* for the preservation of

fruits and vegetables sold as self-service, which reduces packaging and maintains the characteristics of the food product.

Some large retailers developed actions in their packaging in order to reduce food waste, considering that packaging can be crucial for the durability of food. The British retailer *Morrisons* developed the *Great Taste Less Waste* campaign, which consisted in the introduction of *best kept* stickers on fresh food to show customers the best way of preserving fresh products at home and also include practical advice in their stores. They even introduced a new packaging system for fresh and cooked products, allowing customers who need smaller food quantities to purchase a single product at a time. Moreover, the retailer *Marks & Spencer* redesigned and improved their food packaging to use less plastic and to maintain the product fresh for as long as possible; while *Warburtons* introduced a new bread loaf format designed for single consumers. Finally, the food manufacturer *Heinz* launched an innovative *fridge pack*, which could be kept in the fridge for up to five days after opening, giving consumers longer to eat the product. Hence, from a waste point of view, the decisions about what kind of packaging and how much packaging to use are critical.

7.3. Product sizes

Food manufacturers produce oversized ready to eat meals and oversized food product packages (Stuart, 2009). Consequently, household food waste often reflects *excessive pack sizes* of food products especially for smaller households; thus, some particular households are at risk of producing larger quantities of waste, such as households which are single person. The reason is that while smaller pack sizes are available at a premium price, food products' price is the prevailing driver in purchasing decisions. Thus, consideration should be given to ensure that *smaller sizes* of food products are offered consistently cheaper than larger-volume food products (Defra, 2008). So, one interesting initiative to reduce food waste would consist on *buying the right amount*, which could be achieved by manufacturers and retailers offering the *right size* of pack and using promotional mechanics in order to reduce the risk of food waste. For example, the use of price reductions –25% off – as opposed to volume offers –such as 4 units for 3 euros, or buy 2 for the price of 3-. Portion size is, therefore, a significant challenge for the industry; and some manufacturers have introduced different product sizes in order to tackle this problem, like Warburtons and Kingsmill which introduced different bread loaf sizes.

Finally, restaurants should also encourage consumers to take surplus food home for later consumption -a practice which is culturally acceptable in the U.S.- The reason is that consumers who waste food away from home do not feel a sense of ownership or responsibility about the food they leave, and the amount of food they are given is considered to be out of their control.

7.4. Food promotion offers

Food retailers' commonly used sales promotions frequently encourage consumers to purchase excessive quantities which, in the case of perishable food products inevitably generates wastage in the home. Large retailers often use different *marketing strategies* for food with a short shelf life to reduce excess stocks, which could lead the food to be shifted from retail waste to household waste (Monier, et al., 2010). Particular mention should be given in this regard to the *Buy One Get One Free* promotions, since are one of

the major causes of food waste. That is, while some retail promotions offer good value for money with little impact in food waste, other promotions -like the *Buy One Get One Free* on perishable foods- can lead to an increasing food waste, by incorrect planning of food purchase, which often leads to the purchase of excessive quantities of food to take advantage of promotional offers. Moreover, the high-pressure advertising campaigns, including *bulk discounts*, also encourages consumers to buy large quantities in excess of their actual needs, which leads to substantial food wastage in the home.

In this sense, the British government also reported that *2x1 sales promotions* were among the major reasons customers purchase more food than they really need. So, some food retailers decided changing their sales promotion activities in order to reduce food waste. For example, *Sainsbury's* and *Tesco* introduced the promotion *Buy One, Get One Later*, in order to stagger purchases over time. That is, customers can buy one food item and then pick up a second one, at a later time for free, rather than having to purchase both food products at the same time. This strategy was a new spin on traditional *Buy One, Get One Free* promotions that often result in food spoiling.

Other key aspect of food waste generation also lies within retail provision, where the most compelling retail driver and competitive advantage is to maintain *stock availability* and *provision* of food commodities throughout the year. This type of supply-chain generates food waste through demand forecasting inaccuracies, product-gradings and over-production (Defra, 2008). As a consequence, the challenge for food retail management is forecasting demand and inventory management to ensure appropriate levels of stock rotation to maximize sales whilst minimizing waste. However, food demand forecasting still proves highly problematic for retailers, due to the seasonality of goods, weather patterns or even consumer trends (Defra, 2008). Finally, some retailing management practices are often culturally embedded which focuses on maintaining food products' *replenished shelves* to increase consumer satisfaction and long-term loyalty. Thus, consumers should be educated to be more tolerant of shelves that aren't stocked to full capacity right up until closing time with excessive varieties of food products.

7.5. New products and retailing concepts

The concept of *day-before bakeries* that only offer bakers' wares of the previous day can be an important way in reducing avoidable bakery food waste; along with retailers' *happy hour* concept, when products are offered at sharply reduced price levels shortly before closing time (Kranert et al., 2012). Moreover, *highlighting bargains* for food products that are nearing their *best before* date is an adequate way to reduce avoidable food waste. In this way, some food retailers give away products that have reached their *best before* date to their customers or donate them to welfare services. Finally, the inclusion of *local products* in the range of goods offered by food retailers shortens transport routes, reducing the use of resources (Kranert et al., 2012).

Regarding the development of new food products, it should be remarked the initiative carried out in Denmark, by which restaurants created a partnership to produce fish snacks rich in Omega-3 from fish that was no longer saleable. Considering than more than 50% of the fish in Denmark is considered as non-edible, this experience can be an interesting solution for a product that would otherwise be discarded.

8. FOOD FOR THOUGHT

Avoidable food waste is the largest and most economical source of additional food available in our society. Consumers need to value food to a much greater degree, and there is a

need to address the shortcomings of the food system in order to minimize food losses from farm to fork. Food is wasted throughout the supply chain, from initial agricultural production down to final household consumption; consequently, the involvement of all stakeholders in the food chain is needed in order to halve avoidable food waste.

While in low-income countries food is wasted mostly during the early and middle stages of the food supply chain, being the causes mainly connected to financial, managerial and technical limitations in harvesting, storage, infrastructure, packaging and marketing systems; on the other hand, in medium and high-income countries food is to a significant extent wasted at the consumption stage; being the causes of food waste mainly related to consumer behavior. Therefore, food waste in industrialized countries can be reduced by raising awareness of the scale of the global food waste issue. Moreover, some other initiatives are proposed in order to tackle food waste such as reducing pack sizes, considering the impact of in-store promotions –buy one, get one free- and clarifying date labelling.

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