

# Food loss in a hungry world, a problem?

## Desperdiando comida en un mundo hambriento, ¿un problema?

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### ABSTRACT

Mainly in developing countries, food loss and waste is a problem that is difficult to measure. Investigations have been conducted in industrialized countries; however, consistent evidence of how much is really being depleted is limited. The accessible data give the illusion of evidence, but are supported by very restricted facts. In recent years, food waste and loss have gained importance because more than 35% of food is wasted. Nevertheless, with this percentage of food, most of the 800 million people that go hungry every day in the world could be fed. This reflection paper aims to describe the different approaches and meanings of food waste, food loss and food wastage. Similarly, this article identifies the phases of the food supply chain where food is being lost and wasted. Based on the available data, developed and developing countries are compared. It was concluded that, in developed countries, the most important losses are in the consumption phase; in developing countries, the losses take place in the growing and harvesting phase. Changing consumption habits as well as the improvement of cropping and harvesting processes could be an option for reducing this problem, especially in developing countries.

**Key words:** discarded food, food shortages, famine, consumption habits.

### RESUMEN

Principalmente en países en desarrollo la pérdida y desperdicio de comida es un problema difícil de medir. Investigaciones han sido llevadas a cabo en países industrializados; sin embargo, evidencia consistente de cuánta comida está siendo realmente desperdiciada es limitado. El acceso a datos da una posible evidencia, pero son soportados por pocos hechos. En los últimos años las pérdidas y desperdicio de comida han ganado importancia porque más del 35% de comida es desperdiciada. No obstante, con este porcentaje de comida, más de los 800 millones de personas que pasan hambre cada día en el mundo, podrían ser alimentadas. Este artículo de reflexión busca describir los diferentes enfoques y significado de residuos de comida, pérdida de comida y desperdicio de comida. De la misma manera, identifica las fases de la cadena de abastecimiento de alimentos donde la comida está siendo perdida y desperdiciada. Basado en los datos disponibles, se comparan los países industrializados y los países en desarrollo. Se concluye que las más importantes pérdidas son en la fase de consumo en países industrializados, y en la fase de cultivo y cosecha en los países en desarrollo. Por otra parte, nuevos hábitos de consumo, así como el mejoramiento de los procesos de cultivos y cosecha podrían ser una opción para reducir este problema, especialmente en los países en desarrollo.

**Palabras clave:** residuos de comida, descarte de comida, hambre, hábitos de consumo.

## Introduction

Global food loss and waste have become an enormous problem with social, environmental and economic implications. For that reason, governments, institutions and organizations in different countries have developed programs together with strategies in order to reduce the amount of food loss and waste in the different stages of the food supply chain.

According to Gustavsson (2011), approximately one-third of food produced for human consumption is lost or wasted globally, corresponding to about 1.3 billion tons per year. Therefore, the situation becomes difficult when, according

to the last FAO report (2013), 842 million people in the world are facing famine and 98% of them are living in developing countries. The distribution of hunger in the world shows that 553 million people are from Asia and the Pacific, 227 from Africa, 47 from Latin America and the Caribbean and 16 from developed countries.

Stuart (2009) stated that, with 40 million tons of food discarded each year in the United States by retailers, food service, and households, there is sufficient food for reducing the hunger of all the malnourished people around the world. Indeed, with a quarter of the food wasted in the US, UK and Europe, famine would disappear in the entire world.

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The objective of this reflection paper was to identify and discuss some of the causes of food loss and waste along the food supply chain in developed and developing countries. Consequently, the paper has three parts. The first part contains a discussion about the differences between food loss and waste and the second one describes the food losses and waste in each of the phases of the food supply chain considering the scenarios of developed and developing countries. Finally, the third part includes some statistics connected with losses and waste along the food supply chain.

## Different approaches

It is important to remark on the different concepts about similar matters, such as food loss, food waste and food wastage. According to the FAO (2013), food losses are "... a decrease in mass (dry matter) or nutritional value (quality) of food that was originally intended for human consumption." In other words, beyond the fact that the food can no longer be used, food losses are the characteristics or components of the food that are not available for feeding people.

Lipinsky *et al.* (2013) highlighted issues of food losses, such as the total lack or reduction of food quality due to spills and spoilage because of the inadequate food handling and transport. In fact, spoilage, such as bruising or wilting, reduces the time in which food is suitable for human consumption because of the acceleration of the physiological process of ripening and decomposition in perishable food.

Food losses are involved to the first part of the supply chain; whereas, food waste usually refers to the throwing away of food that is 'perfectly fit for consumption' and occurs in a later stage of the supply chain. Nevertheless, Buchner (2012) defined food losses as the losses that take place in the entire food supply chain, especially throughout growing, harvesting and treating, as a consequence of climatic, environmental and technological factors, including economic issues related to the market standards and policies.

Additionally, the FAO (2013) said that food waste "...refers to food appropriate for human consumption being discarded, whether or not after it is kept beyond its expiration date or left to spoil. Often, this is because the food has spoiled, but it can be for other reasons, such as oversupply due to markets or individual consumer shopping/eating habits." Even though Lipinsky *et al.* (2013) and the FAO (2013) use the term spoilage in order to define different concepts; the first author considered the damage before consumers get the food, while the FAO would use this definition when the spoilage occurs in the consumers' hands.

In conclusion, food waste takes place when food arrives to the consumer in at least two different ways, especially connected with the type of food: misuse and/or ingestion practices. Certainly, misuse happens when consumers buy more products than they actually need and do not consume these products before they cease being edible food. Ingestion practices apply to habits or practices of cooking and eating, for example, some people remove the skin from fruits or vegetables and throw it away even though this part is edible.

Reinforcing the above statement, Lipinsky *et al.* (2013) asserted that food waste is "food that has good quality and is fit for human consumption but that does not get consumed because it is discarded – either before or after it spoils... typically, but not exclusively, this occurs in the retail and consumption stages in the food value chains and is the result of negligence or a conscious decision to throw food away". Besides losses in consumer hands and in transport, Buchner (2012) extended the possibilities to industrial processing.

However, Bond (2013) clearly distinguished the terms: he stressed the losses in the early stages of the food supply chain as food loss. For instance, this loss results from the pre-harvest, gathering, storage, transport and, transformation phases of the food supply chain, characterized by lower earnings. On the other hand, losses in phases with higher earnings, *e.g.* retail and final consumption, are identified as food waste.

## Food wastage toward the food supply chain

Food wastage happens in all levels of the food supply chain. Actually, before agricultural products arrive to the shelf and, consequently, to the consumers, most of them have traveled a long way; thus, agricultural products are transported, cooled, processed, turned, traded, treated and packaged. At the end, the products have changed not only their original form but a major part of them has been lost in the process (Hoering, 2012).

For a better understanding of the reasons why food eventually become waste, it is necessary to analyze the different stages of the food supply chain, taking into account two different scenarios: developed and developing countries. The differentiation is based on technical availability, economic capacities, level of education and opportunities to enter food supply chains.

Lipinsky *et al.* (2013) argued that developed countries and the industrialized Asian nations are responsible for about 56% of total food loss and waste, while developing

countries for 44%. Indeed, according to Pachón (2013), “the global food loss in 2011 was 36.17%, mainly in the consumption phase. In developed countries, the highest loss of cereals, roots and tubers, fish, seafood, fruit and vegetables is during the consumption phase. Meanwhile, in developing countries, such as in sub-Saharan Africa, higher losses are seen in the production stage.

The minimum loss in developing countries plainly occurs in the consumption phase. Food waste in postharvest handling and storage was 5.68%; 7.16% in processing together with packaging, and 6.39% in distribution”.

Figure 1 describes the different phases of the food supply chain in order to recognize the main causes of food loss and waste.

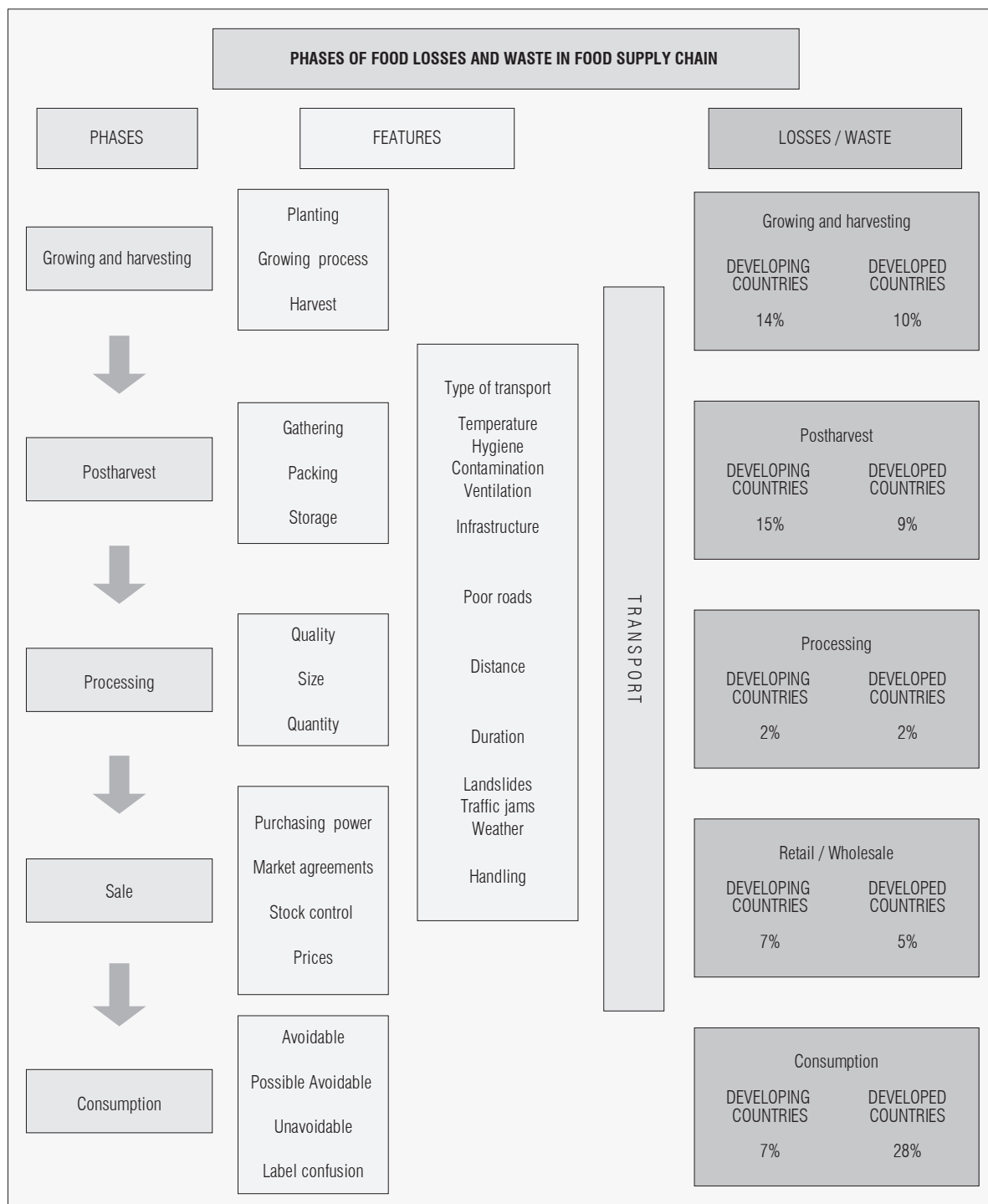


FIGURE 1. Phases of food losses and waste in the food supply chain.

## Growing and harvesting

This stage includes the time from planting until crop collection. The fundamental causes of losses in this phase are determined by adverse environmental conditions that can generate pest and diseases affecting the quality of the crops and access to the markets. In many cases, the use of adequate technology as well as integrated crop management might decrease these losses.

Regarding the growing process, the Institution of mechanical Engineers (2013) remarked that, in developing countries, these operations are carried out by hand. In a scenario of insufficient labor availability, the process becomes slow and exposed to adverse weather conditions and the crops are susceptible to attack from pests that reduce the quality and quantity of the harvested crop; as a result, they are sometimes destroyed or left in the field. Likewise, Gunders (2012) argued that, in many cases, besides damage from pest, diseases and weather, growers prefer to not collect or harvest the crops, in order to avoid incurring more expenses. Certainly, in comparison with other continents, Latin America lost the highest level of food per capita in the pre-consumption phase due to administrative, financial and technical constraints that directly affect the process of planting and harvesting together with the storage and freezing infrastructure (Schuldt, 2011).

In animal production, bovine, pork and poultry meat losses principally occur because of death during breeding, discarding during fishing in the case of fish, and milk losses due to an incidence of sickness such as mastitis (Gustavsson, 2011).

In other cases, farmers grow many more crops than they need, as a measure to protect themselves against unfavorable weather due to market arrangements. In developed countries, "...the purchasing policies for fresh products operated by the major supermarkets actively encourage waste in the field. In this regard, rather than entering into supply contracts with farmers, these large-scale purchasers procure produce through 'supply agreements' where the benefits are weighted in the favor of the buyer." (Institution of mechanical Engineers, 2013); the consequence of this procedure is that around 10% of crops are lost in the field in developed countries (Lipinsky *et al.*, 2013).

On the other hand, for the purpose of satisfying quality market requirements, workers in the field and farmers have been trained to discern some special characteristics during the harvest. These characteristics mainly include four: the

shape, the size, the color and the time to ripeness. Products that do not meet the requirements are not suitable for transport pallets and are categorized as "not sellable" and are left to rot in the fields (Hoering, 2012). As previously mentioned, throughout the harvest procedure, some losses are carried out due to machine-driven damage and/or spillage. Indeed, a large part of the harvest gets lost through pollution during drying, threshing and separation of chaff and grains. In other cases, as a result of higher production costs, poor farmers pick crops before the vegetables or fruits reach the necessary nutritional characteristics and economic value, which might get wasted if they are not appropriate for eating (Gustavsson, 2011).

## Postharvest

This phase involves all the procedures for gathering or processes related to the collection of all the products in a single place: packing or activities concerned with putting the products into bags, cases, boxes or containers, aiming to send them somewhere, with storage until processing or commercialization.

The gathering process is not highly remarked on by researchers as an important stage in which food could be lost. However, accurate gathering is crucial in order to increase the product's durability. For instance, if uncontaminated milk has been gathered with milk from cows that hold mastitis, the milk will be contaminated.

Good packaging can prolong the edible lifecycle of several products. However, inadequate materials and ways to pack instead of extending longevity could accelerate the natural process of decomposition. "The lifetime of products with high water content, cucumbers for example, can be extended fivefold through plastic film wrapping, as it reduces water loss. Packaging also performs a protective function for fragile goods." (Monier, 2010).

Regarding storage, it is worth remarking that the objective of good storage is to maintain basic conditions such as temperature, light, moisture, oxygen level, and sanitation, which promote the conservation of all the food's characteristics. Insufficient storage conditions could produce food loss through different ways. To illustrate, in the case of perishable goods such as vegetables, fruits, milk, and meat, the temperature must be reached according to the characteristics of the products and, at the same time, remain the same, in order to avoid dehydration, rot, mould, decomposition, and lack of organoleptic characteristics of food.

## Processing

The processing phase could be described as the series of activities of food transformation, adding chemicals or other substances, with the purpose of keeping it fresh for a long time and offering new products. In order to be processed, food must satisfy high exigencies of quality, size, and quantity according to the characteristics of the machinery used and market demands.

Losses throughout processing, -industrial or domestic-, include spillage and degradation; which can occur when products are not appropriate for processing or during cleaning, peeling, chopping and boiling or even during procedure disruption and spills.

With regard to animal processing, "...bovine, pork and poultry meat losses refer to trimming spillage during slaughtering and additional industrial processing, *e.g.* sausage production. For fish, losses allude to industrial processing such as canning or smoking. For milk, losses relate to spillage during industrial milk treatment -*e.g.* pasteurization and milk processing for cheese and yogurt" (Gustavsson, 2011).

In developing countries, a lack of processing facilities triggers high food losses. Based on the high offering of seasonal products, the processing industry does not always have the ability to process and store all of its production. On the other hand, the industry does not have the economic capacity for high investments in new and efficient machinery.

On the contrary, in developed countries, "at the processing level, much waste is generated as a result of legislative restrictions on outsized produce. The phasing out of regulations on the size and shape of fruit and vegetables approved by the European Commission (Commission Regulation (EC) No. 1221/2008) should significantly reduce the quantity of fresh produce needlessly discarded before reaching retail outlets" (Monier, 2010).

A clear example of losses during processing is the case of potatoes that are frequently offered to consumers as packaged fried potatoes. The process starts with an initial selection that rejects all the potatoes that do not achieve the size and consistency demanded by the industry -a first loss-. In the next step, the potatoes are peeled and hence the skin is discarded, a second loss quantified by Putz (1991) as from 15 to 40%, depending on the procedure applied. In some cases, the skin has some extracted phenolic acids (Schieber, 2001). After that, the parts not apt for further treatment are removed, a third loss. Final losses before consumption

are the rejects due to over fried or unexpected changes in characteristics, such as color, form or breaking.

## Transport

The transport phase or the process of moving food from one place to another transverses all the stages in the food supply chain. Transport implicates issues such as type of transport, infrastructure, distance between pickup and delivery and duration of moving and handling.

Regarding the type of transport and in order to avoid food losses, it is necessary to use adequate conveyance conditions, for example temperature controlled ships or aircrafts, which move fruits and vegetables between continents. For milk products, trucks collect milk, linking farms with pasteurization plants. A truck's carriage must be hygienic and easy to clean in order to avoid food contamination with materials that could transfer colors, flavors, or toxic substances, as well as systems for draining fluids in the case of fresh chicken, meat or fish.

Mainly in developing countries, some food damage, such as bumps and bruises, are related to poorly maintained roads (Institution of mechanical Engineers, 2013). In fact, rainy seasons decline the likelihood for using rural road infrastructure because of landslides or road blockage. On the other hand, during dry seasons, dust can contaminate food transport.

Concerning distance and duration of moving, when both are enlarged, a process of ripening is triggered in food, therefore decreasing the likelihood of commercialization and some of this food is rejected. This is mainly difficult in developing countries because of the congestion, bad weather or failures in transport.

## Sale

The sale phase refers to a set of operations in the retail and wholesale sector that attempts to make food available for consumers. These operations are based on the offer and the demand of products and are responsible for assigning correct prices according to consumer purchasing and habits, market agreements with producers and food availability.

Most of the losses occur in a market atmosphere, as shown by Buchner (2012), and are due to food that is discarded after it has remained unsold for a long time and has exceeded the permissible legal standards of safe food, although their real characteristics are still safe for consumption. However, in the food sale procedure, the "quality and esthetical standards, marketing strategies, and logistical aspects" are

also important. The first one, since most of the consumers prefer to buy products with a range of size, color and form, rejects products with some malformations or low intensity colors. The second one implicates tactics developed by sellers in order to highlight the characteristics of the products themselves, such as nutritional components and physical appearance, to make them more attractive for the consumer. Finally, logistic aspects refer to organization of transport and delivery, ensuring minimum damage and spoilage.

An important and determinant factor of selling products is the purchasing power of consumers, which determines the amount of selling products. In developing countries, where most of the population does not have enough income, the likelihood of acquiring a large quantity of products is low, and hence the probability to waste a huge amount of food in supermarkets or small shops is higher. On the other hand, Tran-Thanh (2013) exposed the cultural aspect of food loss and emphasized that, in developing countries, poverty and limited household incomes make food waste inadmissible.

Remarkably, consumer habits similarly play an important role in the market. Gustavsson (2011) underlined that consumers look for a wide range of products, which increases the opportunities of selection; a situation that entails raising the chance of some products to achieve “sell-by” dates before being sold. Indeed, consumers always prefer products that are not close to the due date.

According to Monier (2010), systems such as “the take-back” and last minute order cancellation are responsible of huge losses of edible food because agreements between retailers and suppliers force the receipt of products which have already completed 75% of shelf life in order to remove them from the shelves. The above statement visualizes the disadvantages that some stakeholders may suffer in the food supply chain when they must carry back their products with a minimum shelf life, which can lead to its loss.

Gunders (2012) affirmed that “...most retail stores operate under the assumption that customers buy more from brimming, fully stocked displays, preferring to choose their apples from a towering pile rather than from a scantily filled bin. This leads to overstocking and over-handling by both staff and customers and damage to items on the bottom from the accumulated weight.” This declaration shows that part of the marketing strategies to attract customers can trigger a huge amount of food waste; moreover, consumer behavior shows a tendency to buy products with good quality and price.

## Consumption

The last phase in the food supply chain is consumption, which takes place in food service locations and in private homes. Quested and Johnson (2009) classified food in different levels according to the likelihood of avoiding waste: avoidable, possibly avoidable or unavoidable. Other issues to consider include consumer habits, storage at home, and the amount of products bought. As a matter of fact, the food scale of how much a person can waste varies extremely, being contingent on what he or she earns and how he or she eats and lives.

Avoidable food and drinks are defined as products that were thrown away; however, at one time, they were edible. They have split the avoidable food and drinks according to the reason for discarding them. The first reason is food and drinks that have been cooked or served excessively at homes or restaurants and discarded. Moreover, the food and drink are not ingested; this category also covers damage during the process, such as burning, spilling or unexpected consistency. The second one is food and drinks that are not used on time and are wasted because they become rotten or moldy after the expiration date has passed. Another reason that must be considered is the fact that products are bought and wasted because they were not tasty enough.

Possibly avoidable is defined as food and drink that people used to eat or not according to cooked manner. An example of it is the skin of apples or potatoes. Finally, the unavoidable category is food that was never edible, for instance egg shells, banana and kiwi skins or corncobs.

Consumption particularly highlights the difference between developed and developing countries and across the regions. In developed countries, people can afford food that they will not fully use, called an “embarrassment of riches” (The World Bank Group, 2014). Stuart (2009), as cited by Gustavsson (2011), argued that “...the amount of available food per person in retail stores and restaurants has increased during the last decades in both the USA and the EU. Moreover, as regards the FAO, as cited by The World Bank Group (2014), per capita food losses in the developed sphere represents an amount of 250-300 kg per year and, of them, 75-115 kg are the sum of consumer waste. It is a fact that a lot of restaurants serve buffets at fixed prices, which encourages people to fill their plates with more food than they can actually eat.” On the contrary, in developing countries, people buy smaller amounts of food, sometimes just for one meal a day.

Another important cause of waste in consumption at the household level is the misinterpretation or confusion over date labels employed, such as “best before”, “use by”, “sell by”, “display until” or just the date. In these cases, the consumers tend to treat all terms in the same way; as a consequence, in some situations leave a safety margin before the stamped date. “Applying ‘best before’ dates to products that show visible signs of decay may be unnecessary, causing consumers to discard something that does not pose a safety risk. Consumers might be better left to judge the quality and safety of such products autonomously, bread or potatoes for example. The use of “best before” dates, by contrast, on products that are liable to pose microbiological risks after a certain date, is also a concern, eggs or yogurt for example. In this scenario, consumers may consider the date as a quality indicator, when in fact the product may have become dangerous.” (Monier, 2010).

### Estimation of food loss and waste

Below some data about food waste and loss is analyzed. Moreover, it is important to notice that data in international literature are not widely available. The majority is based on studies conducted by Tristram Stuart (2009) and the FAO, and especially on research conducted by Gustavsson for the FAO.

Based on the phases of the food supply chain, 24% of global food loss and waste occurs at the production stage, 24% during postharvest, and 35% at consumption. Together, these stages account for more than 80% of global food loss and waste (Lipinsky *et al.*, 2013).

Figure 2 shows a comparison of food loss and waste between developed and developing countries. It is evident that the most important losses in developed countries are in the consumption phase. As discussed above, this issue is related

to purchasing power. On the other hand, in developing countries, the losses are mainly in the growing, harvesting and post harvesting phases. A possible explanation is related to technological issues. However, it is remarkable that losses in developed countries, in general, are higher than in developing ones, and the major contribution to these losses, is the consumption stage. Looking again at the view of the research of The World Bank Group (2014), the socioeconomic status plays an important role in the food waste-loss issue, given that lower-income groups waste less food than higher earnings groups; consequently, higher-income families generate more solid waste, among others, than poorer ones.

Institution of mechanical Engineers (2013) highlights an example about wheat loss in India. There, 21 million tons of wheat are wasted each year due to inadequate storage and distribution systems. Consequently, according to Pachón (2013), during 2012, more than 230 million people went hungry daily in that country.

According to the FAO statistics (2013), 557 million people in Asia are suffering from hunger each year. Furthermore, in South-East Asian countries, losses of rice range from 37 to 80% of the entire production, depending on the development stage and total about 180 million tons annually. The same statistics cited by Hoering (2012) reveal that of the 1.3 billion tons of food that are lost per year around 30% of the most important staple food, such as rice, wheat and other cereals are being wasted. Dramatically, vegetables and fruits are from 40 to 50%; hence, oilseeds, meat and milk products are only 20%.

Figure 3 shows a comparison between different regions of the world. In developed countries from areas such as North America and Oceania, Europe or Industrialized Asia, the losses are mainly in the sale and consumption phases.

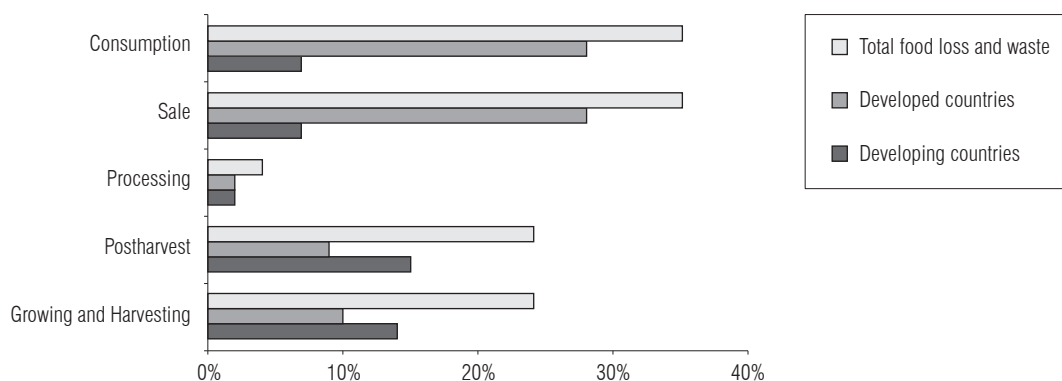


FIGURE 2. Food loss and waste. Comparison between Developed and Developing countries. Source: Adapted from Gustavsson (2011).

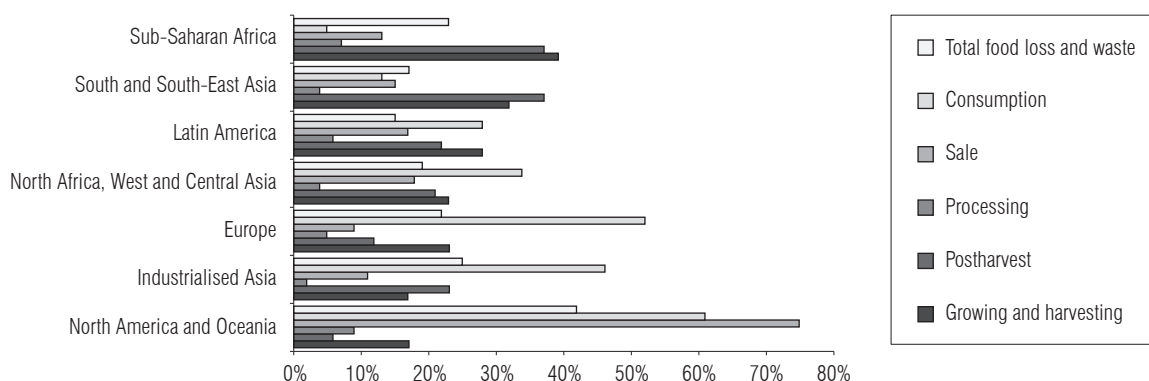


FIGURE 3. Comparison of food loss and waste between world regions. Source: Adapted from Gustavsson (2011).

On the other hand, in developing countries from Africa, South and Southeast Asia and Latin America, the losses are located in the growing, harvesting and post-harvesting phases. Certainly, significant losses of staple food take place on the way from the field to the processing stage. Hoering (2012) clarified that a lot of these problems, which may be in other more developed regions, would be resolved using simple means, reflecting a long-term governmental neglect of rural agriculture.

According to Stuart (2009), the UK, US and Europe have approximately double as much food as is essential for the dietary requirements of their residents. Up to half of all food is wasted during the food supply chain. If inefficient livestock production is incorporated, European countries have more than three times food than they need, while the US has around four times more.

In developed nations, the processing phase shows a minimum loss. However, in North America and Oceania, it is higher than in the others. A possible explanation is that the standards of consumption or consumer habits are dominated by the “throw-away mentality”. For instance, Stuart (2009) showed how about 2.3 million tons of fish are discarded in the North Atlantic and the North Sea each year, as well as 40 to 60% of all fish caught in Europe, either because they are the wrong size or species, or because of the European quota system. An estimated 20 to 40% of UK fruit and vegetables are rejected even before they reach the shops, mostly because they do not match the supermarkets’ cosmetic standards.

Latin America is the region that holds the least food waste, but at the same time shows the main percentage of losses in the growing and harvesting phase. Actually, environmental and technical matters could be related to this loss. Concerning to the FAO (2013), in the growing and consumption phases, food waste is nearly 28%. Losses in postharvest

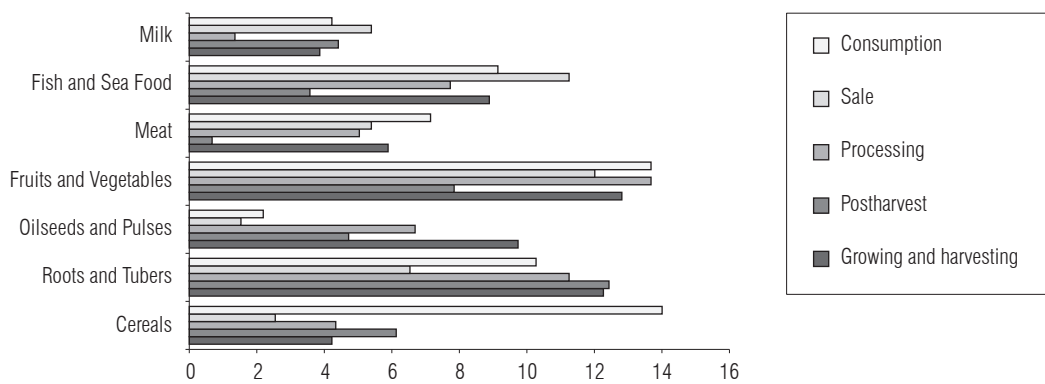
are characterized by 22%, sale 16%, and processing 6%; in Colombia, 1.4 million tons of fruits and vegetables were wasted in 2012.

In the European Union, 89 million tons are lost each year, or 180 kg per capita. For instance, more than 50% of total food waste is generated in consumption; 14% by the food service and catering sector and 5% by the retail/wholesale sector (Monier, 2010). By contrast, in sub-Saharan Africa, consumption is just responsible for around 8% of overall food waste (Gustavsson, 2011). Consumers in Europe and North America waste around 95 and 115 kg of food per person/year, respectively; while consumers in sub-Saharan Africa waste only 6 kg of food per person/year (Gustavsson, 2011).

“Per capita food loss in Europe and North-America is 280-300 kg year<sup>-1</sup>. In Sub-Saharan Africa and South/Southeast Asia it is 120-170 kg year<sup>-1</sup>. The total per capita production of edible parts of food for human consumption is, in Europe and North-America, about 900 kg year<sup>-1</sup> and, in Sub-Saharan Africa and South/Southeast Asia, 460 kg year<sup>-1</sup>. Per capita food wasted by consumers in Europe and North-America is 95-115 kg year<sup>-1</sup>, while this figure in sub-Saharan Africa and South/Southeast Asia is only 6-11 kg year<sup>-1</sup>. Food losses in industrialized countries are as high in developing countries, but in developing countries more than 40% of the food losses occur at the post-harvest and processing stages, while in industrialized countries, more than 40% of the food losses occur at the retail and consumer levels. Food waste at the consumer level in industrialized countries (222 million ton) is close to the total net food loss production in Sub-Saharan Africa (230 million) (Gustavsson, 2011).

A study on food wasted in the United Kingdom shows that consumers throw away 31% of the food that they buy (Ventour, 2008). A 46% of cultivated potatoes are





**FIGURE 4.** Comparison between losses of selected products in different phases. Source: Adapted from Gustavsson (2011).

not distributed into the retail market. 6% were lost in the countryside, 12% were discarded in the primary sorting, 5% were lost in stores, 1% were lost in the post-storage assessment, and 22% were lost due to rejection after washing (Institution of mechanical Engineers, 2013). Tran-Thanh (2013) explained that, in developed regions, the task of preparing family meals, and maintaining a level of foodstuffs, fresh and conserved, has been seized by the industrialized food chain. Consequently, a representative number of the population is now mere food consumers at the end of the supply chain; part of whom have been removed from the food supply system and unfortunately have no real awareness of it. Not surprisingly, a culture of loss and wastage has been growing; a culture which designates little value to food, making people trough it without much thought; in few words, food is a cheap and abundant item.

Figure 4 shows losses for different products. It is remarkable that cereals, fruits and vegetables are lost in the consumption phase. These products show the most important loss, as compared with the others, perhaps due to their perishability. Similarly, fish and seafood share an important percentage of losses because of their higher perishability.

Finally, some data about developing countries estimate that “The total cost of food waste across the food value chain in South Africa was estimated at US\$7.7 billion per annum; equivalent to 2.1% of South Africa’s annual gross domestic product” (Nahman and de Lange, 2013). In Buenos Aires (Argentina), around 41.55% of all the solid residues produced in the metropolitan area correspond to food. In other Argentinean towns, such as Avellaneda, Lanús and Quilmes, the residues that correspond to food are 45.61; 43.08 and 40.75%, respectively (Pérez, 2013). In Mexico, around 30,000 tons of food are discarded per day. A great part of this food remains usable for human consumption. According to Pascoe (2011), 15% of this wasted food could

feed malnourished people in Mexico; in Brazil, 64% of food is discarded throughout the food supply chain; 20% during the harvest, 8% in transportation and storage, 15% during processing, and 20% in consumption.

In Bogota, just in Corabastos, the main food market of the city, 4500 tons are wasted per day. According to Unidad Administrativa Especial de Servicios Públicos-UAESP (2014), 58.8% of fruits and vegetables are wasted per day. This means that 1381 tons of food end up in the rubbish. Ironically, households located in poor neighborhoods waste more than 60% of food, where precisely 234,000 children under 5-years-old are suffering from malnutrition.

## Alternatives

The dramatic amount of food waste and loss in developing and developed economies was approached and the initiatives of institutions, NGOs, and charity groups, among others, confront food waste and generate a better distribution of food (Schneider, 2013). The main aim of such groups is to look for economic, social and environmental benefits when food waste continues to have an alternative of utilization (EPA, 2009). The first step is concerned with improving the problem-solving capacity regarding the amount of food wastage reduction. Second, they promote the reuse of food with properties still suitable for consumption. Examples include the UK-FareShare and the Colombian-ABACO programs, which redistribute surplus food to a network of community organizations that assist vulnerable people (Tran-Thanh, 2013). The third step attempts the use of “food wastage” to feed animals. The next stage strives to use food for industrial purposes. Finally, the disposal of food waste has to follow sustainable parameters, such as composting, disposal in sanitary fill, or incineration if it represents some risk (EPA, 2009). In Mexico, at least 61 food banks are working, where mainly

supermarkets are donating food that does not have the best characteristics for commercialization but that is suitable for human consumption. The initiative is currently feeding more than one million people around the city.

Even though technological alternatives for improving losses during the growing, harvesting and post harvesting processes would be applied, consumer habits have to change in order to consistently reduce food waste. For instance, the education for women, who in general are responsible for making decisions about buying and using food, is a key issue because, as they have more access to education, resources, major incomes and infrastructure, they are able to prevent food losses. Similarly, schools and public initiatives are a powerful way to make people aware of sustainable food production and food waste.

At the household level, the improvement of consumption habits is related to several topics. For example, buying just the necessary items, even though sometimes supermarkets offer special sales, which almost always are near the expiration date. However, if people agree buy from special sales, they have to be aware that this food must be consumed as soon as possible or adequately stored. Satisfactory storage at home, such as freezing or conservation processing, becomes a good loss avoidance strategy. In fact, cold storage is nothing but location, exist fridge-packing plans to keep the food fresh and reachable. On the other hand, consumer perception has to change and he or she has to learn to not idealize fruits and vegetables. Consumers have to understand that even if an apple, peach, strawberry, tomato, carrot, or potato, and so on, does not have an adequate shape, the size is not commercial desirable or there are some spots on the skin, it is still perfectly nutritious and tasty.

## Conclusions

This work identified some possible causes of food wastage in the food supply chain, finding clear differences in each step according to the degree of development of the countries. The data of each phase, especially in developing countries, are difficult to find, demonstrating once more the gap between both economies.

The discussion connected to food loss and waste refers to the big amount of losses in developing countries that occurs in the first phases, with a close relationship with deficient conditions in the following aspects: infrastructure, technology and economy facilities. On the other hand, in developed countries, waste is concentrated on the consumption step

where the relation is directly influenced by consumer behavior and awareness.

Food wastage entails not just economic losses for stakeholders in the food supply chain but also includes environmental consequences according to the amount of methane emissions in the decomposition phase of wastage. Moreover, not only is food eventually discarded but also a wealth of natural resources and energy is wasted.

Real change in the food supply chain depends on the consumers. When consumer habits change, the other stages of the food supply value chain will change in order to fulfill consumer requirements. For instance, if people get used to consuming 'ugly food', supermarkets will sell this kind of product; hence, farmers would not discard them. That is why governments must start education campaigns in order to make consumers aware of the characteristics, benefits and production processes of food.

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