

## **Magnitude of “food loss” in Belgian food processing industry: Results from multiple case studies**

**Manoj Dora, Dirk Van Goubergen, Hans De Steur, Xavier Gellynck**  
**Ghent University**  
**Ghent, Belgium**

### **Abstract**

The Food and Agriculture Organization estimated that one third of the world’s food is wasted each year and that the environment and the economy are hugely impacted. Food losses refer to the decrease in edible food mass throughout the food value chain: at production, postharvest and processing stages [1]. A food loss is quantified only for products that are intended for human consumption, excluding feed and parts of products that are non-edible. The cause of food loss is two-fold: technical and/or management errors. This study focuses on the food losses during the production process in an industrial setup. For example, losses may occur during washing, peeling, slicing and boiling or during process interruptions and accidental spillage. The main objective of this study is to gain access to reliable information related to food loss in the Belgian food-processing industry, by quantifying the food loss and exploring its causes within food processing companies through multiple case studies. A total of four company representatives participated in the study. The studies reveal the major data gaps on food loss, especially during the production process, and major causes of food loss within specific industries.

### **Keywords**

Food Processing, Food loss, Magnitude, Causes, Solutions

### **1. Introduction**

According to the United Nation’s Food and Agriculture Organization, there are over 870 million hungry people in the world. At the same time, a report entitled *Global Food: Waste not, want not* by the Institution of Mechanical Engineers in London shows that of the 4 billion metric tons of food we produce each year, between 1.2 and 2 billion tons is never consumed. On a local level, 200,000 people go hungry in Brussels, while this study estimates that Belgian households throw away 89kg of food per person per year[2]. This level of waste is unfortunate and needs immediate action in order to meet our future food demands. Moreover, studies show the extent of waste in the food sector is higher than elsewhere due to a general lack of willingness and/or inability to coordinate activities involved in the value chain [3, 4]. Hence, food loss is increasingly in the spotlight and of great concern.

FAO defined "food loss" as any change in the availability, edibility, wholesomeness or quality of the food that prevents it from being consumed by people. 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 [1, 5, 6]. In the processing of vegetable commodities and products, food losses are caused by spillage and degradation during industrial or domestic processing, e.g. juice production, canning and bread baking. Losses may occur when crops are sorted out if not suitable to process or during washing, peeling, slicing and boiling or during process interruptions and accidental spillage. In the processing of animal commodities and products such as bovine, pork and poultry meat, losses refer to trimming spillage during slaughtering and additional industrial processing, e.g. sausage production. For fish, losses refer to industrial processing such as canning or smoking. For milk, losses refer to spillage during industrial milk

treatment (e.g. pasteurization) and milk processing to, for example, cheese and yoghurt. Moreover, food losses occurring at the end of the food chain (retail and final consumption) are also a major source of waste.

Table 1: What is food loss?

WHAT IS FOOD LOSS?	WHAT IS NOT FOOD LOSS?
(Parts of) raw materials or products that are edible but somehow lost for human consumption e.g.. cutting waste, wrong shape Loss of water if this was added as an ingredient e.g. drinks produced, cooked pasta	(Parts of) commodities or products which are not edible for humans: secondary streams (waste and by-products) e.g. peelings, bones, beet pulp Products that are reworked e.g. dough residues Finished products that are given away e.g. to food banks Financial losses, giveaway e.g. bottle overfilling, lower quality at lower price Weight loss caused by water that is extracted during the process e.g. baking, dried products etc.

One of the most significant challenges is the unreliable data on food loss in the supply chain. It is very important to gain insight into this problem; to determine the true extent and to assess the causes and the consequent hotspots as well as possible measures to prevent food loss. This study focuses on the food losses in the Belgian food industry; it aims to identify its size and causes, the feasibility of measures and to assess the interaction between food and other links in the food chain. The specific objectives of the study are the following:

1. Determine the extent of food losses and waste
2. Assess the causes and prevention of food losses and waste
3. Determine a new strategy for food loss reduction

This study only concentrates on the food losses during the industrial processing phase. At the manufacturing level, food waste is largely unavoidable (bones, carcasses and certain organs in meat products). In the remainder of the production chain, there are losses due to technical malfunctions such as overproduction, deformed products, and product and packaging damage. The food loss occurs in the processing stage due to poor housekeeping procedures, inherent process losses or poor conformity. Spillages, damages and contaminations of products may be caused by operator's negligence, poor handling procedures, forming equipment that result in improper seals on packaging. Studies have shown that a typical food product is handled an average of 33 times before it is ever touched by a consumer in a supermarket. Moreover, food loss as a result of poor conformity may occur at any time with respect to any ingredient or product by failing to adequately conform to specifications, quality, appearance, flavor, or aroma. With this backdrop, this study quantifies the food loss, investigates the most important causes of it and recommends possible solutions to prevent food loss according to the following structure: Firstly, we illustrate the literature on food loss and its impact. Next, the research methodology and results are explained. Finally, we analyze the findings of the data collected from food SMEs in Belgium.

## **2. Literature Review**

A recent study by Beretta et al, has quantified food losses in Switzerland at various stages of the food value chain (agricultural production, postharvest handling and trade, processing, food service industry, retail, and households). The study identified hotspots and analyzed the reasons for losses based on data from 31 companies within the food chain including public institutions and food associations [7]. The energy balance shows that 48% of the total calories produced are lost across the value chain. The study

suggested that half of these losses would be avoidable given appropriate mitigation measures. Similarly, Nahman et al quantified the household food waste stream in South Africa [8]. They estimated the economic (monetary) value of the wasted food as well as the costs associated with disposing putrescible food waste to landfills. Costs associated with the disposal of food waste to landfills are quantified based on estimates of the financial and external costs associated with landfilling. For household food waste alone, the costs to society are estimated at approximately US\$2.7 billion annually in South Africa.

Some studies also focused on the environmental consequences of the food loss such as Fehr et al, and determined the occurrence of fruit and vegetable waste at the wholesale and retail levels in Brazil [9]. They suggested that biodegradables may be collected separately from the remainder of the household waste. The study then proposed a formal policy framework for municipal administrations to follow in order to avoid the need of leaning biodegradable material. Similarly, Darlington et al, investigated various categories of waste and generated three analytical methods for the support of waste minimization activities by food manufacturers [10]. They found out that overproduction waste accounts for 20–40% of the material waste generated by convenience food manufacturers (such as ready-meals and sandwiches) and is attributed to the demands placed on the manufacturer to provide orders to supermarkets within a short timeframe. Their paper provided measures by which food industry waste can be identified and demonstrated the methodology through a practical example. Lebersorger and F. Schneider discussed a model for determining the proportion of food waste in household waste composition studies by analyzing specific problems and possible solutions [11]. The study suggests that in order to avoid a significant loss of information, waste should not be sieved before sorting and packed food waste should be classified into the relevant food waste category together with its packaging. Engström and Carlsson-Kanyama studied food losses in four food service institutions in Sweden [12]. The results show that about one-fifth of the food is lost. Plate waste is the single largest source of loss, at 11–13% of the amount of food served. Losses in food service institutions can be of significant economic value in Sweden. The results indicate that the economic and environmental consequences of current levels of food loss are considerable. Buzby and Hyman compiled estimates of the amount and value of food loss for more than 200 individual food companies in the United States using the US Department of Agriculture's Economic Research Service data and then aggregated these values to estimate the total value of food losses [13]. The results indicate that the estimated total value of food loss at the retail and consumer levels in the United States as purchased at retail prices was \$165.6 billion. The top three food groups in terms of food loss at these levels are: meat, poultry, and fish (41%); vegetables (17%) and dairy products (14%). Their estimates suggest that the annual value of food lost is almost 10% of the average amount spent on food per consumer in 2008 and over 1% of the average disposable income. Eriksson et al, analyzed the flows of fruit and vegetables at six Swedish retail stores, both by analyzing recorded data and by performing physical measurements [14]. They found that the total wasted fresh fruits and vegetables were 4.3% of the delivered quantity. The largest category was pre-store waste (goods rejected at delivery; 3.01%), followed by recorded in-store waste (0.99%) and unrecorded in-store waste (0.3%). A positive correlation between unrecorded in-store waste and total waste was found, indicating that a thorough recording of waste could be an effective way to reduce retail waste of fresh fruits and vegetables. The study also found that the practice of exhibiting large amounts of delivered goods was recognized as the main reason for the waste. With this background, this paper aims to measure the magnitude of food loss in the Belgian food processing industry and analyze the major hotspots of loss.

### **3. Methodology**

The case study method is considered to be the most suitable methodology with regard to the exploratory nature that combines both qualitative and quantitative data [15]. To achieve the desired information from the food companies, it is important that the questions are targeted, relevant and clear. The questionnaire contains: a proper definition of the concept of food loss so that the respondents have a good understanding of the flows that are meant, figures that the magnitude of the food loss within the company and show both absolute (tonnage) and percentage (relative to incoming raw materials, compared to

finished product), composition of the food losses, processing and conveyance of food losses, sources / causes of the losses. It targets a sample of four companies from different subsectors. The subsequent audits of which were carried out by experienced researchers. During the audit, the entire production was screened on the basis of the audit schedule. The estimations and measurements were based on data from four food processing companies engaged in the fields of vegetable and fruit processing, pasta and sugar manufacturing, and baking and dairy processing. The firms were assumed to be representative of the Belgian market. During the study, besides walking through the production process, a total of 21 interviews with operators, operation managers and general managers were carried out. This study includes interviews, applicable documents and on-site observations in order to get an overall insight into the process and food loss [16]. This combination of data types can be highly synergistic and is therefore referred to as a triangulation method [17]. Table 2 provides an overview of the four food processing companies that participated in the study.

Table 2: Description of the Food Processing SMEs

Company	Product	No. of employees	Turnover (€)	Quality Assurance
A	Ready meals	45	9 million	EFS
B	Bakery	25	3 million	ISO 2200
C	Fresh vegetable	150	65 million	IFS, BRC
D	Frozen vegetable	400	95 million	IFS, BRC

## 4. Result and Discussion

### Company A

The magnitude of food loss in this ready meal company is very high. A walk through the production process and interviews with the operation manager and operator revealed a number of food loss hotspots and respective quantities. Important food loss hotspots were: expiration date, loss due to spillage and bad handling, and cleaning. Table 3 illustrates the food losses.

Table 3 Hotspots and quantity of food loss in company A

Hotspot	Amount	Estimated cost
<b>Total</b>	<b>59,677 kg</b>	<b>1,62,925 Euro</b>

Further significant food losses resulted from the following:

1. Insufficient planning & demand forecasting is an endemic concern within the company. As a policy, the company forecasts its production two weeks in advance, while the shelf life of products is typically three days. Resultant fluctuation in demand due to weather variations and the very short shelf-life of the products lead to a huge food loss.
2. Bad handling of food by the employees is another reason; employee training and level of awareness with respect to food loss is very low. Moreover, we observed a generally low involvement of employees within the company with respect to such practices.
3. The company instructs the employees to follow FIFO principles, but it was observed that they are not followed, resulting in food waste.
4. Lack of space is a major constraint for the company that leads to poor product organization and results in food loss.

### Company B

The magnitude of food loss in this bakery company is comparatively higher than other . A walk through the production process and interviews with the operation manager and operator revealed food loss

hotspots and their quantity. Important hotspots for food loss are as follows. Discarding of leftover bread, incorrect mixing of dough that dries due to operator negligence. Table 4 illustrates these results.

Table 4 Hotspots and quantity of food loss in company B

Hotspot	Amount	Estimated cost
<b>Total</b>	<b>110,400 kg</b>	<b>80,000 Euro</b>

Further significant food losses resulted from the following:

1. Planning error is prevalent, resulting in food loss due to the low product shelf-life.
2. Bad handling of food by the employees is another reason; employee training and level of awareness with respect to food loss is very low. Moreover, we observed a generally low involvement of employees within the company with respect to such practices.
3. The company instructs the employees to follow FIFO principles, but it was observed that they are not followed, resulting in food waste.
4. Some of the largest customers are hospitals which have strict specifications that often lead to product rejections and resultant food loss.

### **Company C**

The magnitude of food loss in this fresh vegetable company is very high. A walk through the production process and interviews with the operation manager and operator revealed the food loss hotspots and quantity. Important food loss hotspots were due to food expiration, spillage, improper handling and cleaning. Table 5 illustrates food loss quantity.

Table 5 Hotspots and quantity of food loss in company C

Hotspot	Amount	Estimated cost
<b>Total</b>	<b>7773 tones</b>	<b>280,000 Euro</b>

Further significant food losses resulted from the following:

1. Planning inefficiency, improper food handling procedures by the employees, their food loss training and awareness level, as well as low involvement within the company.
2. The company instructs the employees to follow FIFO principles, but it was observed that they are not followed, resulting in food waste.
3. Spillage is a major reason of food loss in companies that handle fresh vegetables, especially during preparation and cleaning.
4. Residue of the vegetable is generally unavoidable and not cost effective for the company to take measures to prevent food loss.

### **Company D**

The magnitude of food loss in this frozen vegetable company is comparatively lower than other case companies. A walk through the production process and interviews with the operation manager and operator revealed the food loss hotspots and quantity. Important food loss hotspots were due to food expiration, spillage, scanning error, transportation and improper handling and cleaning. Table 6 illustrates the food loss quantity.

Table 6 Hotspots and quantity of food loss in company D

Hotspot	Amount	Estimated cost
<b>Total</b>	<b>5124 tones</b>	<b>130,000 Euro</b>

Further significant food losses resulted from the following:

1. Planning inefficiency, improper food handling procedures by the employees, their food loss training and awareness level, as well as low involvement within the company.
2. The company instructs the employees to follow FIFO principles, but it was observed that they are not followed, resulting in food waste.
3. Spillage is a major reason of food loss in companies that handle fresh vegetables, especially during preparation and cleaning.  
Scanning error: This was a unique situation. The company installed a scanner in an effort to remove defective vegetables prior to packing, but the scanner rejected good vegetables along with the bad and lead to significant losses for the company.
4. Demand from retailers required both quality and quantity, which frequently changed and resulted in losses.
5. Residue of the vegetable is generally unavoidable and not cost effective for the company to take measures to prevent food loss.

All the above reasons of food loss found in different steps of production process can be classified and aligned with eight waste of lean manufacturing principles propagated by [18]. Table 7 describes this reasoning and classification.

Table 7 waste generators

<b>Waste generators</b>	<b>Result</b>
Defect	Bad quality, communication errors, short shelf-life, long delivery time
Overproduction	Excess production, poor product flow, resulting in giveaway and discarding
Waiting	Long inactivity results in poor materials or information flow, long lead times and increased spoilage
Non-value added processing	Incorrect and unnecessary procedures or systems lead to waste
Transportation	Excessive movements of products or information
Inventory	Creates excessive delay, poor customer service, long cycle times, excessive spoilage
Motion	Poor design of workplace leads to lost or damaged items
Employees	Lack of employees involvement and unused knowledge of employees to prevent food loss

Food loss can be prevented by using lean manufacturing tools and techniques such as value stream mapping, error proofing, kaizen, 5S, total preventive maintenance etc.

## 5. Conclusion

This study compiled and analyzed a magnitude of food losses in four food-processing companies in Belgium. Waste levels and waste volumes in each step of the production process were estimated. Causes of and possible ways to prevent food losses in each step of the process were reported. Food loss is a big challenge for society and needs to be addressed. Several studies show that there are no simple methods to eliminate food loss. There is a pressing need to use innovative management systems such lean manufacturing, six sigma and other techniques to prevent food loss.

This study highlighted the magnitude and causes of food loss in Belgium using the case study approach. However, there are a few limitations of the study that need to be mentioned. Due to a lack of a proper

measurement system, many assumptions on food loss had to be made. Therefore, the results in this study must be interpreted with great caution. Another limitation is the food loss quantities, based principally on inconsistent definitions of food loss and methodologies for calculation, presented a major difficulty in the accurate identification of trends, in addition to the unavailability of time-series data.

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