Avoiding food waste in manufacturing operations

In a nutshell

Summary overview

Best practice is to reduce food waste generation at the production facility by identifying all avoidable waste with approaches such as:

- total productive maintenance: engaging staff at all levels and functions to maximise the overall effectiveness of production equipment,
- Kaizen: focusing on continuous improvement in reducing food waste identifying and realising the savings that are easy to achieve (i.e. easy wins, 'low-hanging fruit'),
- value stream mapping: improving visibility of value-adding and non-value-adding processes in order to highlight sources of waste.

Using these approaches, food waste can be reduced by implementing the following:

- awareness-raising/staff engagement campaigns,
- review of product ranges and consequently reduction of inventory losses,
- production-ready packaging in order to reduce raw ingredient losses,
- just-in-time procurement and delivery of raw material,
- increased visibility of wastage quantities generated through waste audits,
- optimise production yields,
- move from the traditional supplier 'push' approach to a customer 'pull' system to ensure that production reflects the demand,
- encourage tidier housekeeping and standards of cleanliness.

Moreover, it is best practice to publicly report on food waste generation and the waste prevention activities in place and planned for the future, as well as to identify targets in this field and plan appropriate activities to achieve them.

Target activities

All food and beverage manufacturing	Processing of coffee	Manufacturing of olive oil	Manufacture of soft drinks	Manufacture of beer
Production of meat products	Manufacture of fruit juice	Cheese making	Manufacture of bread, biscuits and cakes	Manufacture of wine

Applicability

This best practice is applicable to all food and beverage manufacturers.

Environmental performance indicators
• Overall equipment effectiveness (OEE)[1] (%) • Ratio between the amount of food waste generated (sent for recycling, recovery and disposal, including food waste used as a source of energy or fertilisers) and the quantity of finished products (tonnes of food waste/tonne of finished products)
Benchmarks of excellence
N/A

[1] Overall equipment effectiveness (OEE) is calculated by multiplying three elements: (i) availability (percentage of planned time the equipment is operating); (ii) performance (actual throughput versus target throughput, as a percentage); and (iii) product quality rate (percentage of overall products that are not defects or defective).

Description

In 2010, it was estimated that 89 million tonnes of food are wasted each year in the EU-27, a figure which could rise to approximately 126 million tonnes by 2020 if no action is taken (Bio Intelligence Service, 2010). Manufacturing or processing accounts for 34.8 million tonnes or nearly 39% of the waste generated. Figure 1 shows the break down by country with over 50% (18.6 million tonnes) of the total food waste from manufacturing being generated in three countries, namely, Poland, the Netherlands and Italy.

Figure 1: Annual food waste generation in food and drink manufacturing in EU-27 Member States (Bio Intelligence Service, 2010).

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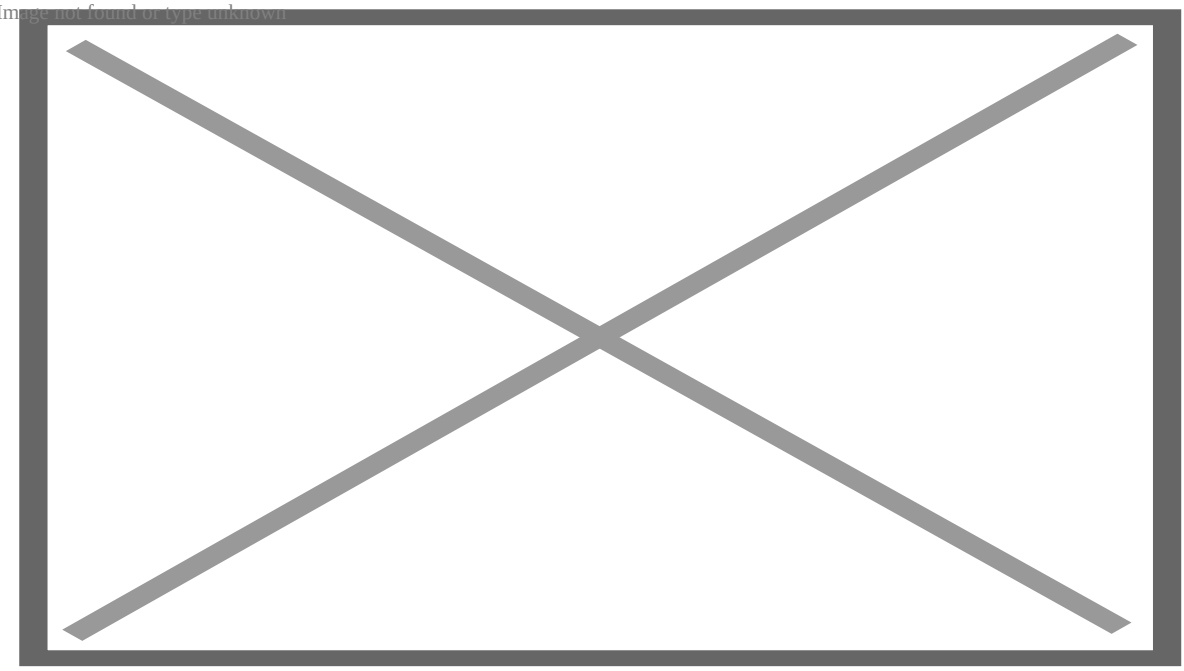

Figure 2 reports the food waste hierarchy and, in order to address food waste, avoiding or preventing its generation is the preferred option. This best practice explores the of frontrunner food and beverage manufacturers to avoid or prevent the generation of food waste.

The food waste estimates shown in Figure 1 do not distinguish between avoidable and unavoidable waste. The actions detailed in this best practice are focussed on those wastes that can be avoided or prevented. Food and Drink Europe describes these preventable wastes using the term ‘food wastage’ to refer to the decrease in edible food mass that was originally intended for human consumption (FoodDrinkEurope 2014a). The food waste generated at the production facility (unavoidable waste and avoidable waste) can be reduced by optimisation measures which include redistributing to people (e.g. charities, food banks) the food which cannot be sold but is still edible, extracting valuable by-products for human consumption (e.g. essential oils, pectines, fibres from citrus and apple juice processing) while the remaining suitable part can be used as animal feed (Figure 1).

Figure 2: The food and drink material hierarchy (UNEP 2014)

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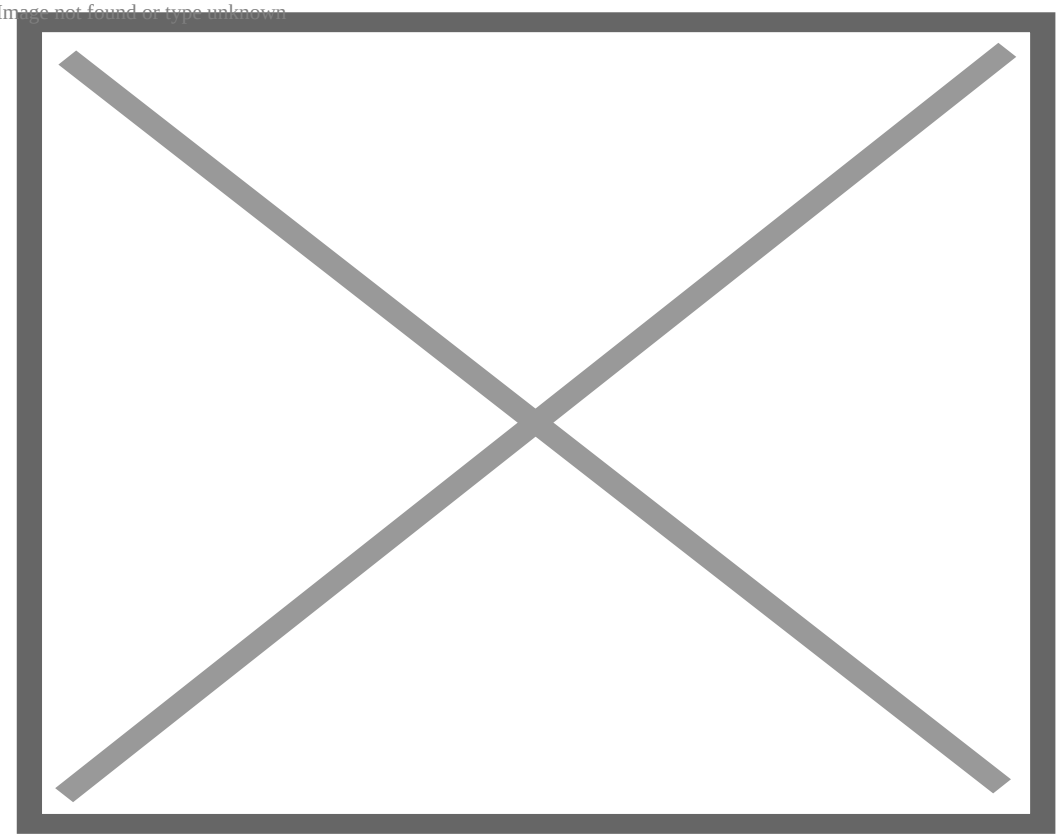

Table 1 shows an estimated breakdown of avoidable food waste in the Italian food industry. The total quantity wasted (1.89 million tonnes) is significantly lower than the 5.6 million tonnes shown for Italy in Figure 1. (Please note that the year of publication differs for the two datasets and hence no comparative calculations should be made).

Table 2: Estimates of waste in the Italian food industry, 2011 (Barilla 2012).

Industrial sector	Quantity produced (thousand t)	Quantity wasted (thousand t)	Quantity wasted (%)
Production, processing, and preservation of meat and meat products	6011	150	2.5
Production and preservation of fish and fish products	232	8	3.5
Production and preserving of fruits and vegetables	6215	279	4.5
Manufacture of vegetable and animal oils and fats	4894	73	1.5
Dairy products and ice cream industry	13484	404	3
Production of grain and starch products	16390	245	1.5
Manufacture of other food products	11977	239	2
Drinks industry	24641	492	2
Total	83844	1890	2.6

Barilla (2012) reports that the main causes of production waste are technical malfunctions and inefficiencies in the production processes and cites the estimated value of the impact this has in Italy is EUR 1178 million per year.

In 2009, Informance International produced a benchmarking report that found that food and beverage manufacturers struggle most with equipment failures, but the best performing manufacturers can minimize those losses: Equipment failures represent 6% of capacity for the best performers versus 16% for the lowest quartile (Noria Corporation, 2009).

BEMP is to reduce food waste generation at the production facility by identifying all avoidable waste with approaches such as:

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- Kaizen: focusing on continuous improvement in reducing food waste identifying and realising the savings that are easy to achieve (i.e. easy wins, ‘low-hanging fruit’),
- value stream mapping: improving visibility of value-adding and non-value-adding processes in order to highlight sources of waste.

Moreover, it is best practice to publicly report on food waste generation and the waste prevention activities in place and planned for the future, as well as to identify targets in this field and plan appropriate activities to achieve them.

Total Productive Maintenance (TPM)

This involves engaging staff at all levels and functions to maximise the overall effectiveness of production equipment. Table 3 shows the six types of losses targeted by TPM. Overall Equipment Effectiveness (OEE) is typically used to

measure and monitor the on-going performance of the system OEE is calculated by multiplying the following three elements:

- availability (percentage of planned time the equipment is operating),
- performance (actual throughput versus target throughput, as a percentage) and
- product quality rate (percentage of overall products that are not defects or defective).

Table 3: The six major losses that can result from poor maintenance, faulty equipment or inefficient operation.

Type of loss	**Costs to organisation**
Unexpected breakdown losses	Results in equipment downtime for repairs. Costs can include downtime (and lost production opportunity or yields), labour, and spare parts.
Set-up and adjustment losses	Results in lost production opportunity (yields) that occurs during product changeovers, shift change or other changes in operating conditions.
Stoppage losses	Results in frequent production downtime from zero to 10 minutes in length and which are difficult to record manually. As a result, these losses are usually hidden from efficiency reports and are built into machine capabilities but can cause substantial equipment downtime and lost production opportunity.
Speed losses	Results in productivity losses when equipment must be slowed down to prevent quality defects or minor stoppages. In most cases, this loss is not recorded because the equipment continues to operate.
Quality defect losses	Results in off-spec production and defects due to equipment malfunction or poor performance, leading to output which must be reworked or scrapped as waste.
Equipment and capital investment losses	Results in wear and tear on equipment that reduces its durability and productive life span, leading to more frequent capital investment in replacement equipment.

Source: USEPA 2014

Kaizen

Kaizen is the Japanese word for ‘improvement’, and a ‘kaizen event’ (also known as a ‘kaizen burst’ or ‘blitz’) is a focussed improvement project to cut waste from a specific part of the process. Given the short time-frame, the emphasis is on taking action rather than in-depth analysis of problems. Consequently, Kaizen is best suited to identifying and realising the savings that are typically classified as ‘easy wins’ or ‘low hanging fruit’. The Kaizen philosophy focuses on continuous improvement through incremental change.

Value Stream Mapping (VSM)

Value Stream Mapping (VSM) forms a cornerstone of the lean philosophy where the focus is on the delivery of value to the customer. A definition of lean is (Defra 2012):

‘Lean is a way of focusing on what the customer values and is willing to pay for; any activity that does not add to value, as perceived by the end customer, is waste. This waste includes any use of resources – cost, time, movement, material, energy, water, and labour’.

VSM provides a view of an entire process, helping those involved to recognise what is actually happening, to highlight sources of waste, and to plan future improvements. A value stream map is a high-level visual depiction of all the activities involved in delivering goods or services to the customer. Identifying the value stream will reveal those activities which are not adding value adding (i.e. wasteful), and which can therefore be eliminated. VSM is often considered the most important first step towards the implementation of lean philosophy (Womack and Jones 2003), and can be extended beyond the boundaries of a specific company to entire supply chains. By understanding the relationships which exist within their supply chain, organisations can identify where effort should be focused to encourage further process improvements.

Using these three approaches, food waste can be reduced by implementing the following:

- Increased visibility of generated wastage quantities through waste audits.
- Moving from the traditional supplier ‘push’ to a customer ‘pull’ system to ensure that what is being produced is what the customer wants.
- encourage tidier housekeeping and standards of cleanliness.
- Improved information flows across the whole supply chain. This is particular important in sales/demand forecasting for products with high demand or supply volatility and for promotions. Improved information flow across the supply chain can lead to food waste reduction e.g. through customer/supplier contractual arrangements aimed at matching supply/demand needs.
- Lower inventory storage time. This is key for short shelf life products or raw ingredients.
- Optimised production yields (i.e. through better training and communication of best practice, performance monitoring or process improvements).

Environmental benefits

The prevention of food waste at the point of manufacture can generate significant environmental benefits throughout the supply chain. From a raw material perspective, less energy, water, etc. is required to produce products that are destined to become waste at the point of manufacture. In a similar way, transportation efficiencies can be improved by reducing the quantity of raw materials being transported that are destined to become waste. Likewise, the processing plant efficiencies will increase and there will be reductions in the quantity of waste that requires managing.

Table 4 provides an estimate of the additional environmental benefits that can be achieved by preventing food or drink waste at source rather than managing the waste through recovery, composting or landfill. For example, this shows that an average saving of 4,040 $kgCO_2eq$ per tonne is achieved when moving from the landfilling of waste food to waste prevention.

Table 4: Net $kgCO_2eq$ emitted per tonne of waste treated / disposed of (including avoided impacts) by method. (WRAP 2012a)

Waste type	Prevention	Recovery (Combustion)	Recovery (anaerobic digestion)	Composting	Landfill
Food and drink	-3590	-89	-162	-39	450

Staff engagement

The food and drink industry is the largest employer in Europe accounting for 15.5% of total employment with 4.2 million staff (FoodDrinkEurope 2014b). Employee engagement and behaviour change are therefore key opportunities in terms of waste prevention initiatives. Some examples can be found below.

In 2007, **United Biscuits** developed a programme of employee engagement in waste reduction at all of its manufacturing sites resulting in an 18% reduction in food waste in the first eight months of 2008 (FDF 2008).

Similarly, **Greencore** worked in partnership with WRAP at one of their manufacturing sites in the UK and through an employee engagement programme delivered a reduction in annual food waste arisings of 950 tonnes or 12.6% (SA Partners 2013). Measures implemented included:

- Implementing a new process whereby tomato ends were used as diced tomatoes, reducing waste by 97.9 tonnes every year.
- Sending ham ends back for re-usage by suppliers, saving 13.1 tonnes every year.
- Developing methods to re-use sausage ends in stuffing saving 7.8 tonnes per year.

PepsiCo has reduced food losses at its UK sites by over 20% since 2009 (FoodDrinkEurope 2014b). This has been achieved through effective measurement systems, development of solutions to eliminate waste and strong engagement from employees.

Operations consultants Suiko undertook a Kaizen-like approach at **Fox's Biscuits**, where, through employee training, an increase from 74% to 85% in operation equipment effectiveness (OEE) was realised and factory waste was reduced by 26% (Defra 2012). This represents frontrunner performance since Gerresheimer, a German packaging company, measured OEE values on food and beverage production line of 30% - 63% (average 44%) (Gerresheimer, 2012).

Reporting on waste prevention

Businesses that report waste prevention activities in their annual accounts include **Greencore, Mondel?z** and **Unilever**. Table 5 shows that **Greencore** has reduced the overall tonnes of waste generated per tonne of product at its manufacturing sites by 3.4% between 2011/12 and 2012/13 (Greencore 2013). **Mondel?z** report that it has reduced net waste by 46% per tonne from 2010 to 2013 (Mondel?z 2013) and **Unilever** use a similar measure and report a reduction in total waste of 66% per tonne of production between 2008 and 2013 (Unilever 2013).

Table 5: Reduction of food waste generated per tonne of product at Greencore

Environmental indicator	2011/12	2012/2013	Year on year change
Tonnes of waste per tonne of product	0.153	0.148	-3.4%

Side effects

Moving to a just-in-time (JIT) process for procurement and delivery of raw materials to drive down inventory can result in a reduction in the delivery efficiencies to the production facilities and hence can have a significant impact on fuel consumption. This can be particularly significant for products that are not sourced locally.

The CO_2 emissions associated with different freight transport modes vary significantly. For example, a freight aircraft for intercontinental transport of goods emits 8509.68gCO_2/kg whereas, for a bulk sea vessel the impact is 599.82gCO_2/kg (ITC 2007). Consequently, there can be a trade-off between reducing procurement lead times to minimise wastage and the environmental impact of the transport.

Applicability

This best practice is applicable to all food and beverage manufacturers.

Economics

Many businesses simply focus on the purchase cost of the raw materials and the waste management costs as the two key savings opportunities in any food waste prevention initiative. However, the undertaking of a robust cost-benefit analysis exercise is key for fully understanding the business case and for maximising the savings potential from any food waste prevention intervention. The costs should include the resources (labour costs) for delivering the work and the hidden benefits should include the labour cost for producing the product to the point of rejection and handling of the waste, the embedded energy and water costs, etc. Quantifying the benefits in this way will ensure that the budget to develop the solution matches the savings opportunity.

For example, in the WRAP waste prevention reviews (WRAP 2012b) a study in a bakery found that the continuous improvement team focused only on the previous weeks major incidents of bread losses. Typical incidents involved major equipment failures that required engineering fixes. A detailed review of the data capturing system found that, in total, major incidents accounted for only 20% of total product losses. A review of total losses over a one-year period found that one issue (fallen stacks of bread) accounted for 20% of total losses, equating to a six-figure financial loss. Knowing the full value of the savings opportunity provided the budget guide for the development of the solution. A solution was developed with a payback of less than three months.

WRAP estimates that the savings that can be made through the prevention of food waste at the manufacture stage is GBP 950 (EUR 1215) per tonne (WRAP 2013a). Typically free or low-cost interventions will be available, i.e. the ‘low-hanging fruit’ and hence these benefits can be realised at very little cost.

Conversely, many of the lean-type interventions are undertaken by external consultants and Table 7 presents costs quoted by Enterprise Ireland (2011) for implementing different levels of lean philosophy.

Table 7: Scope and scale of Lean implementation at various levels (Enterprise Ireland 2011)

	Project summary	**Key outcomes**	**Duration**	**Project cost (EUR)**
Lean: Start	Short, cost-reduction project delivered by external Lean provider. Introduction of basic Lean principles and techniques.	Cost reduction targets achieved. Lean approach successfully piloted; Foundation for further Lean or productivity project.	Typically 8-12 weeks	6,300
Lean: Plus	Medium-scale business improvement project(s) delivered by external Lean provider. Significant learning and use by company of Lean techniques, and/or other proven business process improvement methodology which can deliver cost reduction	Significant productivity improvement targets achieved; Embedding of business improvement culture and lean techniques; Support of trained staff; Programme to pursue company-wide improvement.	Typically 30 day assignment days over 6-9 month period	Up to 75000

	Project summary	Key outcomes	Duration	Project cost (EUR)
Lean: Transform	Holistic company transformation programme by external consultancy team.	Company-wide transformation in culture and performance; Business improvement and productivity targets achieved; Sustainable continuous improvement programme established across the business and its supply chain.	1-2 years	Over 100000

Driving forces for implementation

The drivers for this best practice include:

- Cost savings. As stressed previously, Barilla (2012) reports that the main causes of production waste are technical malfunctions and inefficiencies in the production processes and cites the estimated value of the impact this has in Italy at EUR 1178 million per year. Additionally, in the UK WRAP estimates the savings from the prevention of one tonne of food waste at EUR 1215.
- Supply chain pressure especially from consumers and retailers. CSR reports produced by food manufacturers now include the company's performance on waste prevention. For example, the aforementioned environmental performance indicators introduced by Greencore, Unilever and Mondel?z.
- Voluntary agreements – e.g. the **Courtauld Commitment** in the UK. This is a means of putting peer pressure on companies to commit to waste prevention.
- Anticipation of stricter waste legislation

Reference organisations

The reference organisations fall under two main categories: those that have implemented a food waste prevention initiative involving employee engagement and those that have introduced relevant environmental performance indicators associated with waste prevention.

Employee engagement initiatives:

- Fox's Biscuits
- Greencore
- PepsiCo
- United Biscuits

Introduced environmental indicators:

- Greencore
- Unilever

- Mondel?z

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