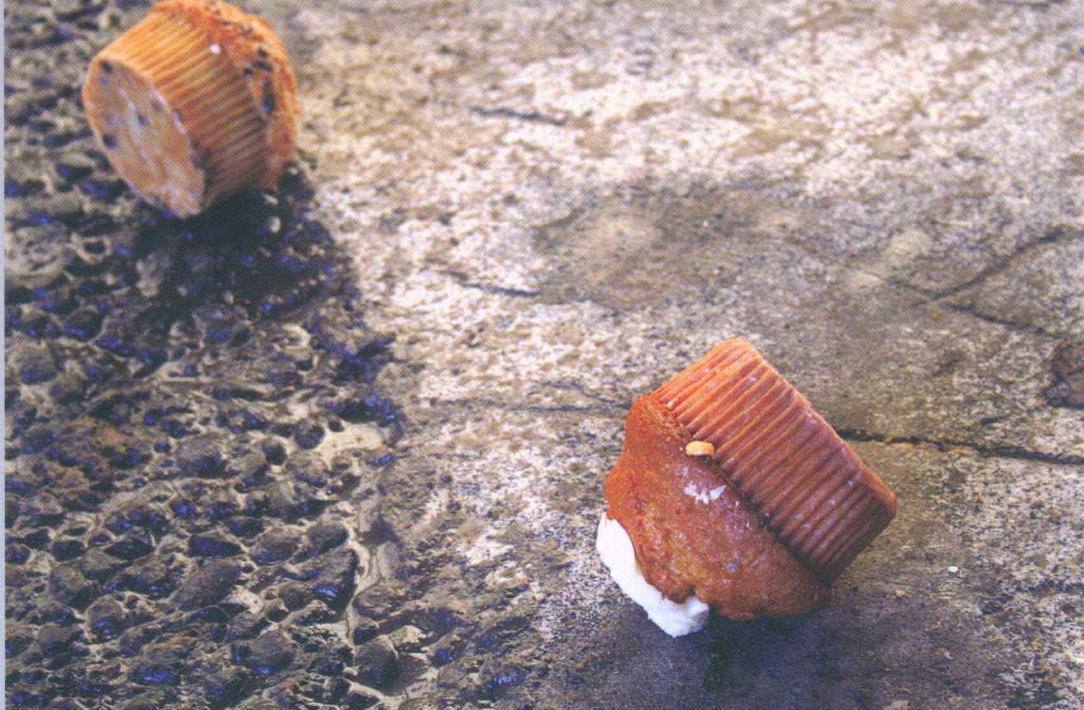




Study conducted for the International Congress

SAVE FOOD!

at Interpack2011
Düsseldorf, Germany



GLOBAL FOOD LOSSES AND FOOD WASTE



EXTENT,
CAUSES AND
PREVENTION



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International Congress

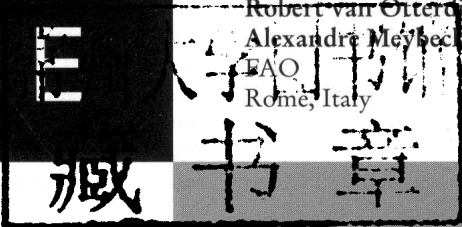
SAVE FOOD!

at Interpack2011
Düsseldorf, Germany

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FOOD
LOSSES
AND
FOOD
WASTE**

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**EXTENT,
CAUSES AND
PREVENTION**

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Preface

This publication is based on studies carried out from August 2010 to January 2011 by The Swedish Institute for Food and Biotechnology (SIK) on request from the Food and Agriculture Organization of the United Nations (FAO).

The two studies on global food losses (one for high/medium-income countries and one for low income countries) have been carried out to serve as a basis for the international congress Save Food!, 16-17 May 2011, at the international packaging industry fair Interpack2011 in Düsseldorf, Germany. Save Food! has been co-organized by Interpack2011 and FAO. Save Food! aims at awareness raising on global food losses and waste, and on the impact of these on poverty and hunger in the world, as well as on climate change and on the use of natural resources.

The authors would like to thank Lisa Kitinoja, Adel Kader, Felicitas Schneider, Vaclav Smil and Jesper Stage among other researchers who have contributed helpful inputs throughout the project.

Special thanks go to Jonathan Bloom, Harris Graber and Nick Saltmarsh for their photos, to Simone Morini for the cover design and the layout, and to Larissa D'Aquilio for the graphic project coordination.

Executive summary

The study highlights the losses occurring along the entire food chain, and makes assessments of their magnitude. Further, it identifies causes of food losses and possible ways of preventing them.

The results of the study suggest that roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. This inevitably also means that huge amounts of the resources used in food production are used in vain, and that the greenhouse gas emissions caused by production of food that gets lost or wasted are also emissions in vain.

Food is lost or wasted throughout the supply chain, from initial agricultural production down to final household consumption. In medium- 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. 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.

Overall, on a per-capita basis, much more food is wasted in the industrialized world than in developing countries. We estimate that the per capita food waste by consumers in Europe and North-America is 95-115 kg/year, while this figure in Sub-Saharan Africa and South/Southeast Asia is only 6-11 kg/year.

The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems. Given that many smallholder farmers in developing countries live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their livelihoods.

The food supply chains in developing countries need to be strengthened by, *inter alia*, encouraging small farmers to organize and to diversify and upscale their production and marketing. Investments in infrastructure, transportation, food industries and packaging industries are also required. Both the public and private sectors have a role to play in achieving this.

The causes of food losses and waste in medium/high-income countries mainly relate to consumer behaviour as well as to a lack of coordination between different actors in the supply chain. Farmer-buyer sales agreements may contribute to quantities of farm crops being wasted. Food can be wasted due to quality standards, which reject food items not perfect in shape or appearance. 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 those consumers who can afford to waste food.

Food waste in industrialized countries can be reduced by raising awareness among food industries, retailers and consumers. There is a need to find good and beneficial use for safe food that is presently thrown away.

The study revealed that there are major data gaps in the knowledge of global food loss and waste. Further research in the area is urgent.

Food security is a major concern in large parts of the developing world. Food production must clearly increase significantly to meet the future demands of an increasing and more affluent world population. This study illustrates that one of the first means to fight imbalances and reduce tensions between the necessary increase in consumption and the challenging increase in production, is to also promote food loss reduction which alone has a considerable potential to increase the efficiency of the whole food chain. In a world with limited natural resources (land, water, energy, fertilizer), and where cost-effective solutions are to be found to produce enough safe and nutritious food for all, reducing food losses should not be a forgotten priority.

Cover photos:
Jonathan Bloom and Nick Saltmarsh

Cover design:
Simone Morini

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1. Introduction

The issue of food losses is of high importance in the efforts to combat hunger, raise income and improve food security in the world's poorest countries. Food losses have an impact on food security for poor people, on food quality and safety, on economic development and on the environment. The exact causes of food losses vary throughout the world and are very much dependent on the specific conditions and local situation in a given country. In broad terms, food losses will be influenced by crop production choices and patterns, internal infrastructure and capacity, marketing chains and channels for distribution, and consumer purchasing and food use practices. Irrespective of the level of economic development and maturity of systems in a country, food losses should be kept to a minimum.

Food losses represent a waste of resources used in production such as land, water, energy and inputs. Producing food that will not be consumed leads to unnecessary CO₂ emissions in addition to loss of economic value of the food produced.

Economically avoidable food losses have a direct and negative impact on the income of both farmers and consumers. Given that many smallholders live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their livelihoods. For poor consumers (food insecure or at-risk households), the priority is clearly to have access to food products that are nutritious, safe and affordable. It is important to note that food insecurity is often more a question of access (purchasing power and prices of food) than a supply problem. Improving the efficiency of the food supply chain could help to bring down the cost of food to the consumer and thus increase access. Given the magnitude of food losses, making profitable investments in reducing losses could be one way of reducing the cost of food. But that would, of course, require that financial gains from reduced losses are not outweighed by their costs.

How much food is lost and wasted in the world today and how can we prevent food losses? Those are questions impossible to give precise answers to, and there is not much ongoing research in the area. This is quite surprising as forecasts suggest that food production must increase significantly to meet future global demand. Insufficient attention appears to be paid to current global food supply chain losses, which are probably substantial.

For the international congress Save Food! at Interpack2011, FAO hired the services of the Swedish Institute for Food and Biotechnology (SIK) to carry out two studies on the extent and effects, as well as causes and prevention of food losses and food waste, one for high/medium-income countries, and one for low-income countries. The two studies highlighted the food losses occurring along food chains, and made assessments of the magnitude of these losses, focussing on quantitative weight losses. They compile, analyze and assemble data and reports produced on the topic of global food loss and waste during recent years. Where information was not available, assessments and assumptions have been made. Results of the two studies are combined in this paper.

2. Methodology

The Swedish Institute for Food and Biotechnology (SIK) has reconstructed mass flows of food aimed to human consumption, from production to consumption, using available data, in order to quantify food losses and wastes.

2.1 DEFINITION OF FOOD LOSSES AND FOOD WASTE

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, post-harvest and processing stages in the food supply chain (Parfitt *et al.*, 2010). Food losses occurring at the end of the food chain (retail and final consumption) are rather called “food waste”, which relates to retailers’ and consumers’ behavior. (Parfitt *et al.*, 2010).

“Food” waste or loss is measured only for products that are directed to human consumption, excluding feed and parts of products which are not edible. Per definition, food losses or waste are the masses of food lost or wasted in *the part of* food chains *leading to* “edible products going to human consumption”. Therefore food that was originally meant to human consumption but which fortuitously gets out the human food chain is considered as food loss or waste even if it is then directed to a non-food use (feed, bioenergy...). This approach distinguishes “planned” non-food uses to “unplanned” non-food uses, which are hereby accounted under losses.

2.2 TYPES OF FOOD LOSSES/WASTE

Five system boundaries were distinguished in the food supply chains (FSC) of vegetable and animal commodities. Food loss/ waste were estimated for each of these segments of the FSC. The following aspects were considered:

Vegetable commodities and products:

Agricultural production: losses due to mechanical damage and/or spillage during harvest operation (e.g. threshing or fruit picking), crops sorted out post harvest, etc.

Postharvest handling and storage: including losses due to spillage and degradation during handling, storage and transportation between farm and distribution.

Processing: including losses due to 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.

Distribution: including losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets.

Consumption: including losses and waste during consumption at the household level.

Animal commodities and products:

Agricultural production: for bovine, pork and poultry meat, losses refer to animal death during breeding. For fish, losses refer to discards during fishing. For milk, losses refer to decreased milk production due to dairy cow sickness (mastitis).

Postharvest handling and storage: for bovine, pork and poultry meat, losses refer to death during transport to slaughter and condemnation at slaughterhouse. For fish, losses refer to spillage and degradation during icing, packaging, storage and transportation after landing. For milk, losses refer to spillage and degradation during transportation between farm and distribution.

Processing: for 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, e.g., cheese and yoghurt.

Distribution: includes losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets.

Consumption: includes losses and waste at the household level.

2.3 QUANTIFICATION OF FOOD LOSSES AND WASTE

Physical mass of food produced for human consumption and of food lost and wasted throughout the food supply chain have been quantified, using available data, results from the literature on global food waste and SIK's own assumptions. For each commodity group a mass flows model was used to account for food losses and waste in each step of the commodity's FSC. Model equations are provided in Annex 5.

The production volumes for all commodities (except for oil crops and pulses) were collected from the FAO Statistical Yearbook 2009 (FAOSTAT 2010a). The production volumes for oil crops and pulses were collected from FAO's Food Balance Sheets (FAOSTAT 2010d).

Allocation factors have been applied to determine the part of the produce oriented to human consumption (and not for animal feed). Conversion factors have been applied to determine the edible mass (Annex 2). At each stage of the Food Supply Chain, losses and waste were estimated using FAO's Food Balance Sheets from the year 2007 and results from a thorough literature search on the topic of global food waste. Where there are gaps of knowledge, SIK has made own assumptions and estimations, based on food waste levels in comparable regions, commodity groups and/or steps of the FSC. The figures used are presented in Annex 4. The sources and assumptions behind these estimations are described in detail in the study reports from SIK.

3. Extent of food losses and waste

3.1 FOOD VOLUMES PRODUCED

Figure 1 illustrates the 2007 production volumes of all commodity groups in their primary form, including animal feed products (which are then factored out using allocation factors), in the regions of the world studied. The production volumes were compiled from the FAO Statistical Yearbook 2009, except for the production volumes of oil crops and pulses which were collected from FAO's FBS, 2007.

Meat production in Industrialized Asia was dominated by large pig (around 46 million ton) and chicken (around 12 million ton) production. Meat production in Europe was dominated by pig (around 27 million ton) while it was more diversified in North America and Oceania, with chicken (18 million ton), cattle (16 million ton) and pig (12 million ton).

In developing regions, meat in Latin America was dominated by large cattle (around 15 million ton) and chicken (around 17 million ton) production. Meat produced in South and Southeast Asia mainly consisted of pig (7 million ton) and chicken (9 million ton). Animal production in sub-Saharan Africa mostly consisted of cattle (around 4 million ton) and in North Africa, West and Central Asia it was mostly chicken (around 4 million ton) production.

3.2 EXTENT OF FOOD LOSSES AND WASTE

Roughly one-third of the edible parts of food produced for human consumption, gets lost or wasted globally, which is about 1.3 billion ton per year. Food is wasted throughout the FSC, from initial agricultural production down to final household consumption. In medium- and high-income countries food is to a great extent wasted, meaning that it is thrown away even if it is still suitable for human consumption. Significant food loss and waste do, however, also occur early in the food supply chain. In low-income countries food is mainly lost during the early and middle stages of the food supply chain; much less food is wasted at the consumer level.

Figure 1. Production volumes of each commodity group, per region (million tonnes)

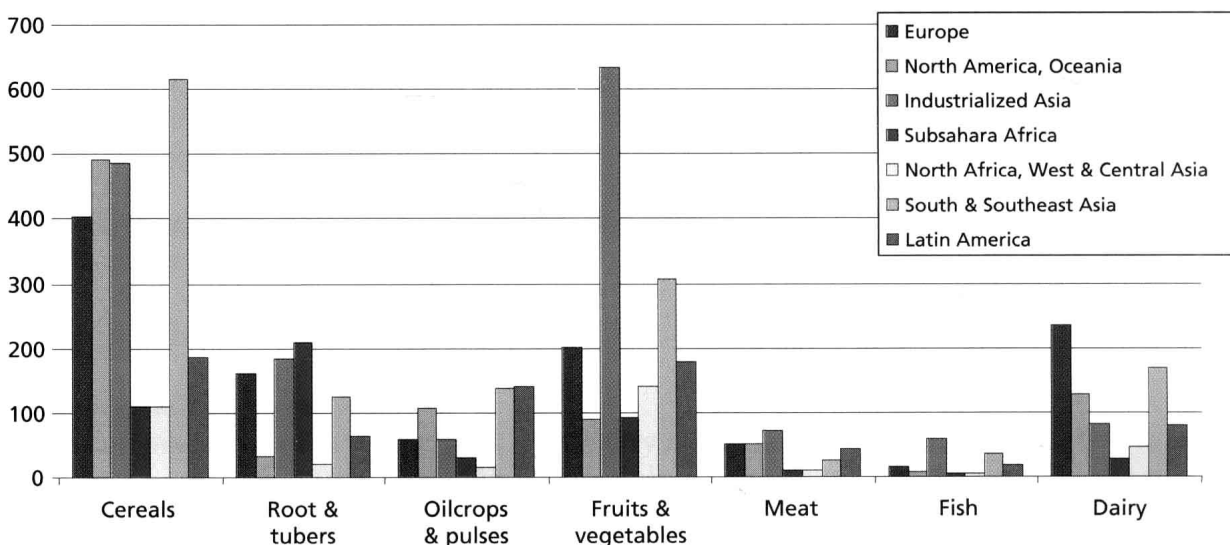


Figure 2. Per capita food losses and waste, at consumption and pre-consumptions stages, in different regions

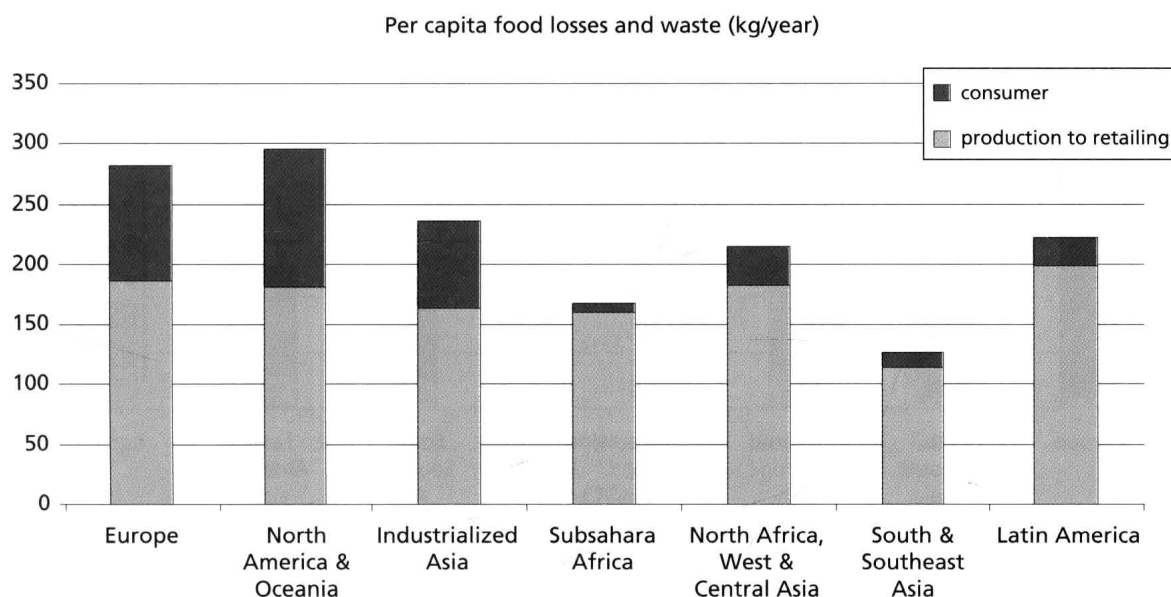


Figure 2 shows that the per capita food loss in Europe and North-America is 280-300 kg/year. In Sub-Saharan Africa and South/Southeast Asia it is 120-170 kg/year. The total per capita production of edible parts of food for human consumption is, in Europe and North-America, about 900 kg/year and, in sub-Saharan Africa and South/Southeast Asia, 460 kg/year.

Per capita food wasted by consumers in Europe and North-America is 95-115 kg/year, while this figure in sub-Saharan Africa and South/Southeast Asia is only 6-11 kg/year.

Food losses in industrialized countries are as high as in developing countries, but in developing countries more than 40% of the food losses occur at post harvest and processing levels, while in industrialized countries, more than 40% of the food losses occur at retail and consumer levels. Food waste at consumer level in industrialized countries (222 million ton) is almost as high as the total net food production in sub-Saharan Africa (230 million ton).

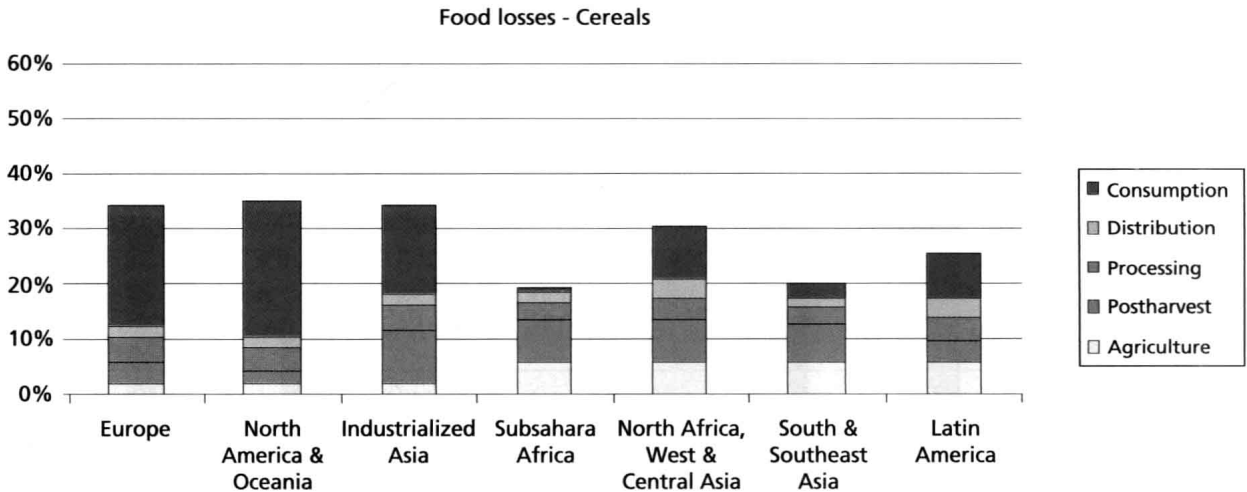
The graphs of the seven commodity groups below show the percentage food losses and waste of the edible parts of food products that were produced for human consumption.

In the case of *cereals* (Figure 3), wheat is the dominant crop supply in medium- and high-income countries, and the consumer phase is the stage with largest losses, between 40-50% of total cereal food waste.

In low-income regions rice is the dominant crop, especially in the highly populated region of South and Southeast Asia. For these regions, agricultural production and postharvest handling and storage are stages in the FSC with relatively high food losses, as opposed to the distribution and consumption levels.

In the *roots and tubers* group (Figure 4), potato (sweet potato in China) is the dominating crop supply in medium- and high-income countries. Results indicate that all three medium- and high-income regions lose the largest volumes during agricultural production. This mainly depends on postharvest crop grading, due to quality standards set by retailers. Food waste at the consumer level is, however, also high.

Figure 3. Part of the initial production lost or wasted, at different FSC stages, for cereals in different regions



Cassava is the dominant supply crop in SSA and LA and potato the dominant crop in North America, West Asia and Central Asia, and South and Southeast Asia. For these regions, agricultural production and postharvest handling and storage are stages in the FSC with relatively high food losses, as opposed to the distribution and consumption levels. One reason for this is that fresh roots and tubers are perishable, which make these products easily damaged during harvest and postharvest activities, especially in the warm and humid climates of many developing countries.

In the *oil crops and pulses* commodity group (Figure 5), sunflower seed and rape seed are the dominating crop supplies in Europe, while soybeans are the dominating crop supply in North America and Oceania and Industrialized Asia. Losses in all medium- and high-income regions are relatively large during agricultural production, contributing waste percentages between 6 and 12% during harvest.

Figure 4. Part of the initial production lost or wasted at different stages of the FSC for root and tuber crops in different region

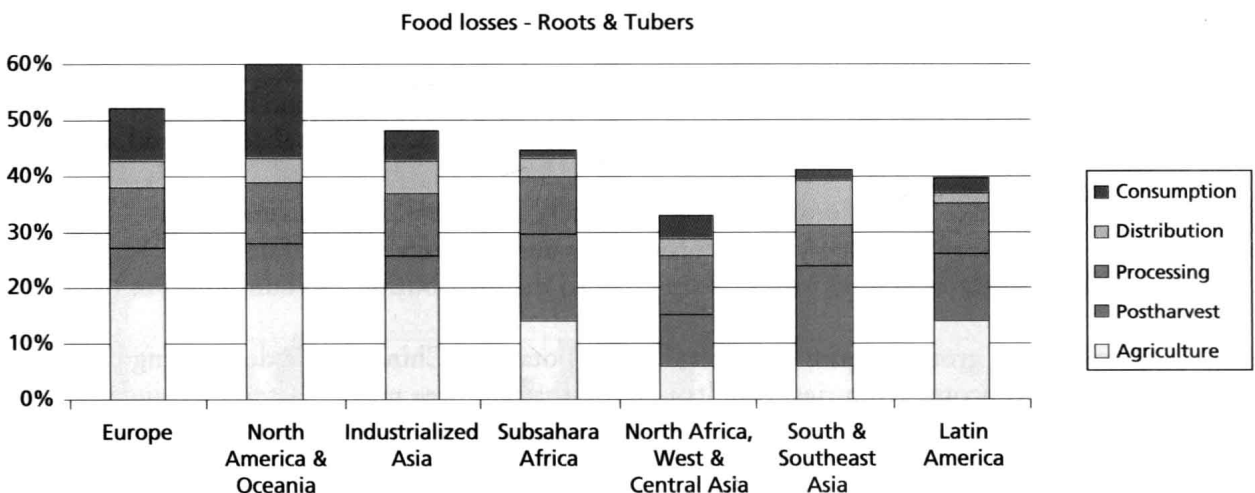
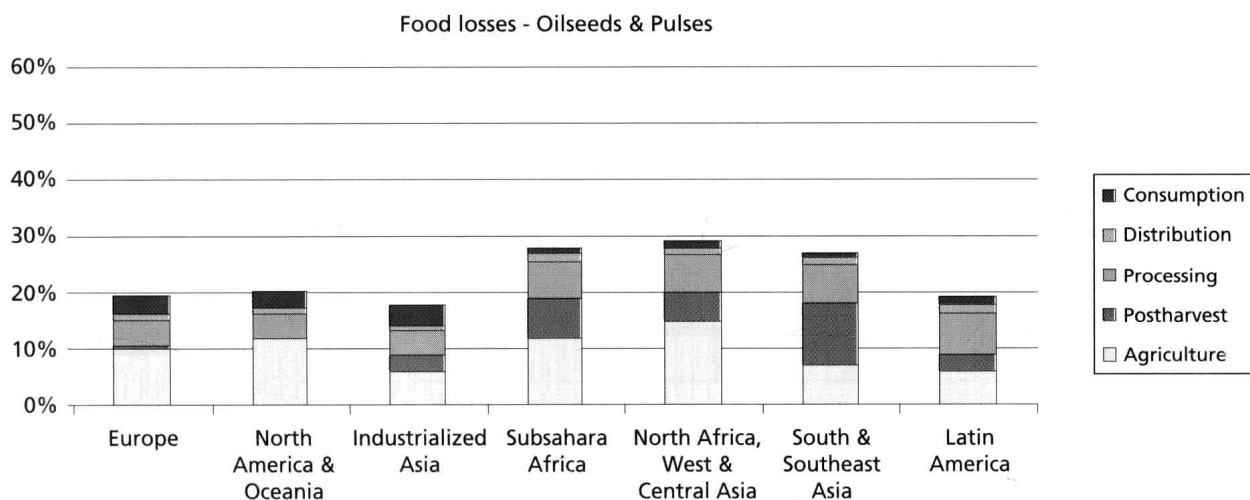


Figure 5. Part of the initial production lost or wasted at different stages in the FSC for oilseeds and pulses in different regions



Groundnut is a dominant oil crop in SSA; soybean and olives in North America, West and Central Asia; soybean and coconut in South and Southeast Asia and soybean in Latin America. Losses in these regions are largest in agricultural production and during postharvest handling and storage. This is, however, also due to the fact that oil crops in the distribution and consumption stages are mainly consumed as vegetable oils, products which are wasted relatively little compared to fresh products.

In the *fruits and vegetables* commodity group (Figure 6), losses in agricultural production dominate for all three industrialized regions, mostly due to postharvest fruit and vegetable grading caused by quality standards set by retailers. Waste at the end of the FSC is also substantial in all three regions, with 15-30% of purchases by mass discarded by consumers.

In developing regions losses in agricultural production dominate total losses throughout the FSC. Losses during postharvest and distribution stages are also severe, which can be explained by deterioration of

Figure 6. Part of the initial production lost or wasted at different stages of the FSC for fruits and vegetables in different regions

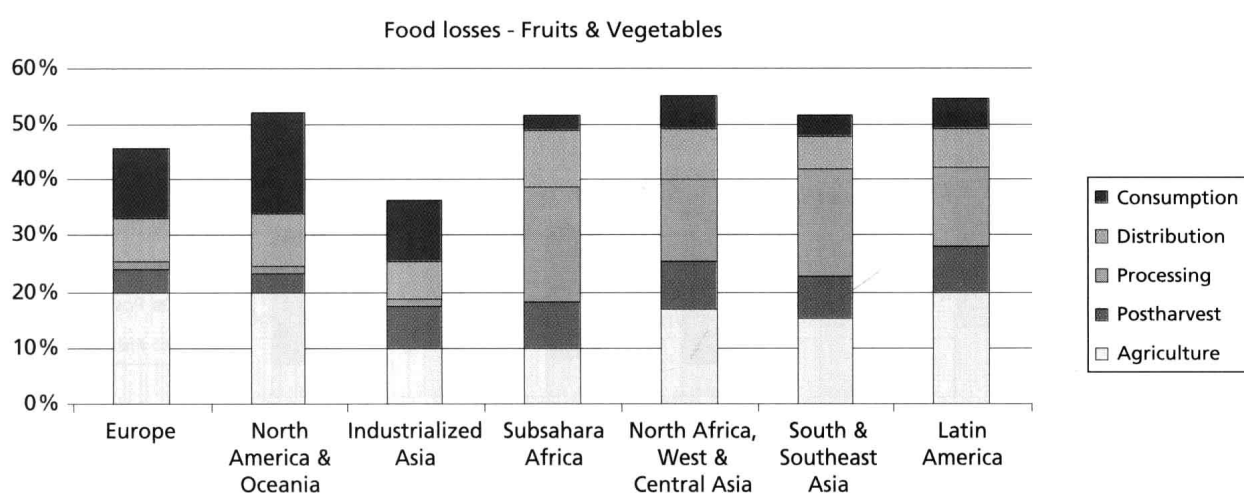
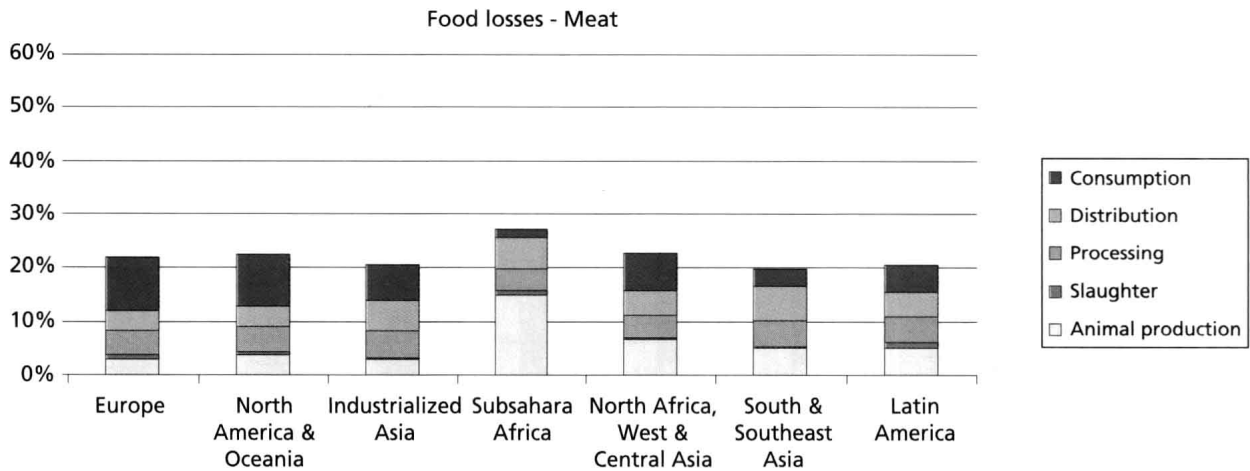


Figure 7. Part of the initial production lost or wasted for meat products at different stages in the FSC in different regions

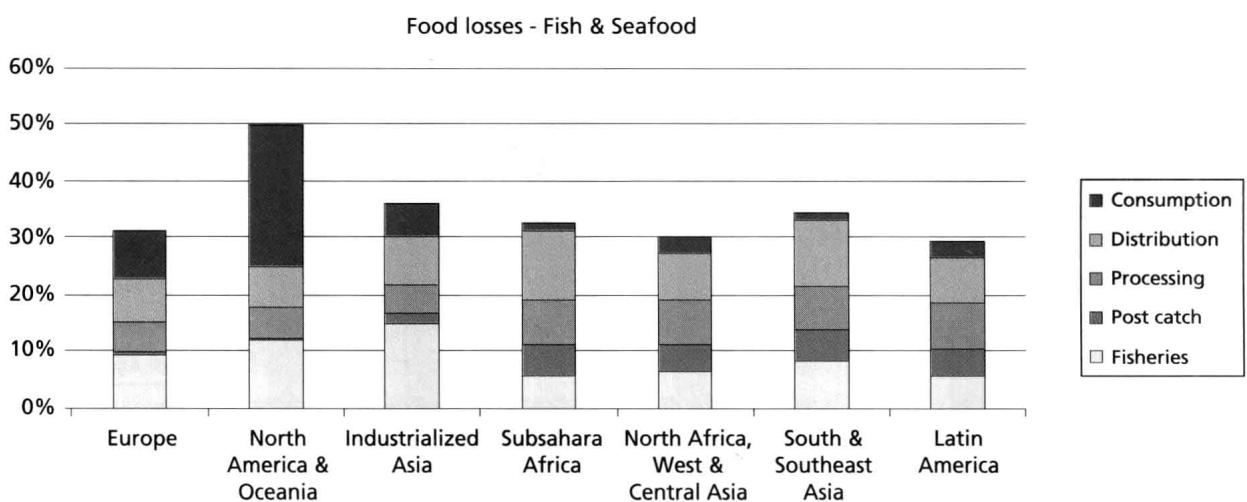


perishable crops in the warm and humid climate of many developing countries as well as by seasonality that leads to unsaleable gluts.

In the case of *meat and meat products* (Figure 7): losses and waste in industrialized regions are most severe at the end of the FSC, explained by a high per capita meat consumption combined with large waste proportions by retailers and consumers, especially in Europe and the U.S. Waste at the consumption level makes up approximately half of total meat losses and waste. The relatively low levels of waste during agricultural production and postharvest handling and storage can be explained by relatively low losses due to animal mortality during breeding and transportation to slaughter.

Losses in all developing regions are distributed quite equally throughout the FSC, but notable is the relatively high losses in agricultural production in SSA. This is explained by high animal mortality, caused by frequent diseases (e.g. pneumonia, digestive diseases and parasites) in livestock breeding.

Figure 8. Part of the initial catchings (fish and seafood harvested) discarded, lost and wasted in different regions and at different stages in the FSC



Box 1. Snapshot case: fish discards

Fish discards as potential human consumption

Discards, the proportion of total catch that is returned to the sea (in most case dead, dying or badly damaged), represent a significant part of the world's marine catches and is generally considered a wasteful misuse of marine resources. The first global assessment was published in 1994 and it identified a total discard of 27 million ton (Alverson *et al.*, 1994). The latest global study conducted by FAO in 2005 suggests that discard have dropped to 7.3 million but the figures are not totally comparable. Even if the first was overestimated and the latter underestimated, reductions seem to have been significant. The latest assessment corresponds to a weighted global discard ratio of 8%. However, large variations among fishing methods and regions exist (Kelleher, 2005).

For all three industrialized regions, losses in primary *fish and seafood* (Figure 8) production are significant due to discard rates of between 9-15% of marine catches. A large proportion of purchased fish and seafood is also wasted by consumer households.

In developing countries, losses in primary production mostly depend on discard rates between 6-8% of marine catches. High losses at the distribution level can be explained by high levels of deterioration occurring during fresh fish and seafood distribution.

For *milk* (Figure 9): waste at the consumption level makes up approximately 40-65% of total food waste in all three industrialized regions. Losses in agricultural production are significant since dairy cow illness (mostly mastitis infections) causes an approximate 3-4% decrease in milk yield.

For all developing regions, waste of milk during postharvest handling and storage, as well as at the distribution level, is relatively high.

Figure 9. Part of the initial milk and dairy production lost or wasted for each region at different stages in the FSC

