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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

REDUCTION OF FOOD LOSSES AND WASTE

IN EUROPE AND CENTRAL ASIA

FOR IMPROVED FOOD SECURITY AND AGRIFOOD CHAIN EFFICIENCY

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More information on the Agrarian Structures Initiative and its projects is available at <http://www.fao.org/europe/agrarian-structures-initiative/en/>

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Acronyms

ECA	Europe and Central Asia
EFTA	European Free Trade Association
ERC	Regional Conference for Europe
FAO	Food and Agricultural Organisation
FLW	Food losses and waste
IFC	International Finance Corporation
REU	Regional office for Europe and Central Asia
SIK	Swedish Institute for Food and Biotechnology
UN	United Nations

1. EXECUTIVE SUMMARY

This study represents one of a number of UN/FAO-supported research initiatives on the subject of food losses and waste. It builds on the ground breaking research and conclusions of the Global Food Losses Study commissioned in 2011 from the Swedish Institute for Food and Biotechnology, updating its data and consolidating its analysis of the impact of food losses and waste on the Europe and Central Asia region.

Drawing on research conducted into food losses and waste in the Europe and Central Asia region and more broadly, the sections below present the context and importance of addressing the issue of food losses and waste in the region, review the ongoing debate in this relation and current national and multi-national initiatives to reduce losses and waste.

Finally the study used recently conducted country studies commissioned by UN/FAO in two middle-income countries (Turkey and Ukraine) and one low-income country (Armenia) to provide an overall assessment of the levels of food loss and waste in the Europe and Central Asia region, as well as to analyse critical loss points and provide present policy options to reduce levels of loss and waste.

The study focuses on low and middle income countries of the region since high-income ECA states, primarily EU members have both already conducted extensive research and developed programs for loss and waste reduction and are also served directly by the major ongoing FUSIONS project in this sphere.

This study was informed by in-depth analysis of priority agri-food chains in the region, selected on the basis of their economic importance, employment generation, contribution to foreign exchange and contribution to food security. At least one agri-food chain was selected for analysis from each of the following commodity groupings: cereals, fruits and vegetables, meat and dairy. Critical loss point analysis was then conducted for each of five agri-food chain phases, i.e. agricultural production, post-harvest handling and storage, processing and packaging, distribution, and consumption.

Critical loss points

In the **cereals commodity grouping**, where the wheat and wheat products chain was analysed, for high income countries waste at the consumption phase is highest, with levels of nearly 25 percent waste of bread and other cereal products by consumers, followed by processing phase waste with a total of 10 percent losses and waste of grain and flour in the milling and baking industries, respectively. For middle income countries agricultural production stage losses dominate with 12 percent losses in the field and during the harvest, followed by consumption level losses of 8-9 percent. Low income countries show even higher levels of production phase losses, at which time over 15 percent of harvests are lost. Significantly lower level of consumption phase losses are reported, as might be expected, while processing and distribution phase losses are both between 7 percent and 9 percent.

For the **roots and tubers commodity grouping**, from which the potato agri-food chain was analysed, for high income countries waste at the production phase is highest, with just over 30 percent of crops lost or wasted during the harvesting process. Thereafter, processing and packaging results in

waste levels of over 17 percent as a result of high quality standards, offcuts and cancelled orders from retail chains. Middle and low income countries on the contrary see almost no processing and packaging loss or waste, primarily because potatoes are subject to little processing or packaging in such countries. Far higher are levels of loss during the agricultural production phase, at over 30 percent for low income and 10 percent for middle income countries and during the post-harvest handling and storage phase, which reaches nearly 40 percent in low income countries.

High income ECA countries also witness high levels of waste at the agricultural production and consumption ends of **fruit and vegetable supply chains**, at over 20 percent of the volumes of product entering each phase, as a result of high quality standards, overproduction and excessive purchase by consumers. Middle income countries also see high production and consumption phase losses, both over 10 percent, as well as 7 percent losses in post-harvest handling and storage as a result of cold chain logistics issues and poor storage capacity.

For **meat and meat products**, high income countries witness the highest levels of loss and waste during the consumption phase (nearly 12 percent), followed by the processing and distribution phases (at 5 percent and 4 percent respectively). Middle income countries experience far higher levels of losses during agricultural production (nearly 9 percent) and marginally higher levels during processing (5.5 percent). Interestingly, the low income country study reported loss and waste levels at below 1 percent at each phase of this agri-food chain, reflecting fewer discards of non-meat animal parts and higher levels of consumption of degraded produce as a result of relatively higher prices for such products.

In the **dairy sector** high income countries witness their highest levels of loss and waste during the consumption phase, with estimated losses and waste at 7 percent of produce purchased. 4 percent losses are seen in the agricultural production phase with minimal losses and waste between the farm and retail. Middle income countries, however, see the highest levels of losses during agricultural production (over 20 percent), primarily due to poor cattle management and milking practices. Processing, distribution and consumption losses are also 5 percent and higher, reflecting technological and cold chain deficiencies, leading to losses and shorter storage and shelf-lives of products. Low income countries reported their highest loss levels during processing, due to poor sanitation and primitive technologies.

Main causes

The bulk of losses in middle and low income countries of the region are evidenced at the agricultural production and post-harvest handling and storage stages of food supply chains. These result in large part from **insufficient modern harvest, post-harvest and storage machinery and equipment**. Exacerbating this absence of investment in technological upgrades are the overall investment climate and **difficulty of doing business** in many south-east European and former Soviet states, compounded by discouragingly **high rates of interest** (often over 20 percent per annum) charged by commercial lenders to value chain actors.

Management, marketing and product development were also emphasized as major causes of losses, with country studies pointing out poorly qualified management and labour as responsible for major losses. In addition, the **fragmented nature of agri-food production**, caused by the breakup of public vertically-integrated production systems during the 1990s and the slow pace of consolidation into

commercial farms have led to major challenges in value chain coordination as a result of the huge numbers of small producers.

Product quality also plays a major role in losses and waste. Cereals, oilseeds and vegetables, primarily those produced in low and middle income countries, are relegated to animal feed on both local and international markets given their poor quality and large quantities of harvested produce is simply discarded as a result of blight and degradation. Processors, ranging from bakeries to meat processors, but most markedly dairies, cheese and fruit juice producers bemoan the lack of quality of raw materials, resulting in large part from the fragmented nature of production and the absence of standardized approaches to production, that allow the supply of commercial quantities of standardised produce.

Policy options

In review of existing literature and research on the subject, two major approaches are distinguishable and relate to whether losses and waste result from market or policy failure or are rather from economically rational behaviour of market actors. Policy responses to perceived market or policy failure need to be carefully analysed to ensure that proposed interventions are justified, through cost-benefit analysis, either of financial rates of return on private sector investment or socio-economic returns, including availability and access to food for public sector initiatives. Except where otherwise specified, the following policy options are of particular relevance to low and middle-income countries of the ECA region, although they remains applicable, particularly to more recent EU members.

In the sphere of **improving the investment climate**, the lead needs to be taken by national governments. Not only will this require concrete steps in terms of broader issues of rule of law, property rights and contract enforcement, but perhaps more immediately, direct threats to existing and potential investors can be addressed by individual and coordinated action by ministries and agencies on the procedures for business start-up and registration and particularly on permitting and inspection regimes.

In response to the **splintered nature of production** and the difficulty of ensuring an adequate supply of produce to enter the post-harvest phase of supply chains, producer organization development is key to consolidating supply, improving production and post-harvest processes. Further effort needs to be made to showcasing successful cooperative and marketing group models and support investment by them in production, quality control, post-harvest handling and marketing.

Responding to shortcomings identified in **workforce skills and motivation** is where the private sector, that has most to gain in reducing losses and waste, could be more active and learn from examples from across the region of successful engagement of agribusiness with technical secondary schools to establishing apprenticeship programs and scholarships for further qualification of those worth the investment. Additionally, inducements both in the form of performance-related pay and disciplinary procedures can be applied.

Consumer awareness campaigns should also be developed jointly by consumer organisations, relevant government authorities and industry associations to inform the public of expiry date labelling, public health issues and the benefits of improved buying, storage and cooking practises in relation to reducing waste, saving money and protecting family health.

Improved **monitoring and reporting** of losses and waste is possible by engaging national associations supporting private sector agri-food chain actors, who have expressed strong interest in the helping their members reduce losses. FAO could support such an initiative by coordinating loss and waste monitoring and reduction initiatives by interested low and middle income countries in the region, promoting a standard loss and waste definition and reporting methodology and coordinating exchange of best practises and lessons learned.

2. INTRODUCTION

This study represents one of a number of UN/FAO-supported research initiatives on the subject of food losses and waste. It builds on the ground breaking research and conclusions of the Global Food Losses Study commissioned in 2011 from the Swedish Institute for Food and Biotechnology, updating its data and consolidating its analysis of the impact of food losses and waste on the Europe and Central Asia region.

Drawing on research conducted into food losses and waste in the Europe and Central Asia region and more broadly, the sections below present the context and importance of addressing the issue of food losses and waste in the region, review the ongoing debate in this relation and current national and multi-national initiatives to reduce losses and waste.

Finally the study used recently conducted country studies commissioned by UN/FAO in two middle-income countries (Turkey and Ukraine) and one low-income country (Armenia) to provide an overall assessment of the levels of food loss and waste in the Europe and Central Asia region, as well as to analyse critical loss points and provide present policy options to reduce levels of loss and waste.

The study focuses on low and middle income countries of the region since high-income ECA states, primarily EU members have both already conducted extensive research and developed programs for loss and waste reduction and are also served directly by the major ongoing FUSIONS project in this sphere.

2.1 Background

In response to increased international focus on the issue of food losses and waste, in 2010-11 UN/FAO commissioned a landmark Global Food Losses and Food Waste study. The study aimed to provide broad responses to the questions of how much food is lost and wasted globally and whether and how such losses and waste can be avoided. The study underscored that the establishment of precise loss and waste levels was impossible, primarily due to a prevailing lack of monitoring and reporting of and research on food losses and waste.

The study, covering the extent and effects, causes and prevention of food losses and waste, was divided into two reports, one for high and medium-income regions (Europe, North America, Oceania, Japan, South Korea and China) and one for low income regions (South- and South-eastern Asia, South America, Africa, Western Asia and Central Asia). Despite considerable shortcomings in data availability and existing research and the need to make considerable assumptions in order to fill current gaps in information, the two studies succeeded in establishing board patterns of food loss and waste occurring along food chains, divided by commodity groupings, and assessed the magnitude of such losses and waste, with a focus on quantitative weight losses.

The results of the study showed that food losses and waste account for approximately one-third of all food produced for human consumption, the equivalent of some 1.3 billion tonnes of lost and wasted food each year, implying both major resource inefficiencies and unnecessary greenhouse gas emissions. The study further established that in medium to high income and industrialized countries,

overall food losses and waste are comprised primarily of *waste*, occurring during food distribution and consumption, which can result in substantial waste of energy resources and losses of economic value. In lower income countries, on the other hand, overall food losses and waste are comprised primarily of *losses*, occurring during the earlier production, post-harvest handling and processing phases of food chains.

While the study points out that per capita food waste by consumers in high income regions such as Europe and North-America is 95-115 kilograms per annum as against 6-11 kilograms per annum the low income Sub-Saharan Africa and South/Southeast Asia regions, overall industrialized and less industrialized countries dissipate roughly the same quantities of food, i.e. 670 and 630 million tonnes, respectively, meaning that lower income countries lose correspondingly more food during the early phases of agri-food chains.

Causes of food losses and waste in low-income countries were ascribed primarily to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, as well as in infrastructure, packaging and marketing systems. In medium- to high-income countries losses and waste were shown to result primarily from consumer behaviour, as well as insufficient supply chain coordination arising from farmers overproducing in order to ensure that contracted supply quantities are met; from food being rejected for failing to meet overly stringent quality standards.

Acknowledging the importance of availability and access to food in low income countries and the potential impact of loss-reduction on the livelihoods of marginal groups, the study recommended encouraging the organization of small producers and their diversification and up-scaling of production and marketing, alongside increasing public and private sector investment in infrastructure, transportation, processing and packaging. For industrialized countries recommendations focused on raising awareness among food industries, retailers and consumers and the identification of alternative uses for the volumes of edible produce that is currently discarded.

2.2 Introduction

Given the potential impact identified by the Global Food Loss and Waste study on both increasing overall levels of food supply and on rationalizing the use of global resources, and in response to the study's call for urgent further research in order to address the absence of information and establish adequate monitoring and reporting of food losses and waste, at its 2012 session the FAO Regional Conference for Europe (ERC) called for a regional assessment of food losses and waste and identification of policy options for reduction in food losses and waste in the region.

In response, during 2013 the FAO Regional Office for Europe and Central Asia (REU) commissioned three countries studies from middle and low income countries of the region (Armenia, Turkey and Ukraine). Each study identified critical loss points and patterns of food losses and waste along at least five key agri-food chains, selected as having the greatest impact on food security and food supply in the country. This paper provides firstly a synthesis of the findings of the three country studies, including related research and debate; secondly an updated, refined and consolidated presentation of loss and waste levels by income grouping for countries of the Europe and Central Asia region; and

thirdly an analysis of the main causes of food losses and waste in the region and discusses policy options and approaches to reduce current levels of losses and waste.

The focus of this paper is the potential impact of food loss and waste reduction on global food security, through increasing availability and access to sustainably produced food. As many smallholder farmers in low income countries are considered food insecure, as reflected in nutrition indicators and international food aid responses, reductions in food losses in countries with significant low-income communities could therefore have an immediate and significant impact on the nutrition and livelihoods of vulnerable populations.

While the direct impact of waste-reduction in high income countries on food insecure populations is harder to establish and may ultimately lead more to a reduction in production and rationalisation of resource use in higher income countries, in broad terms the required 60 percent increase in levels of available food over the next 40 years could be achieved with only a 25 percent increase in volumes of food produced, if levels of food losses and waste could be reduced to 15 percent, i.e. halved from their current levels. Considering the nature and causes of food losses and waste, discussed in the Global Food Loss and Waste study and examined in more detail for the ECA region in this paper, the halving of food losses and waste globally is be considered a realistic target.

3. CONTEXT AND IMPORTANCE OF ADDRESSING THE FOOD LOSS AND WASTE ISSUES

Food security is a major concern given current and projected global demographic levels. Food production must clearly increase significantly to meet the future demands of an increasing and more affluent world population. Research to date has shown that a lever in reducing imbalances and tensions between increasing consumption and production is to promote the reduction of food losses and waste, which can considerably increase the efficiency of the whole food chain. As the Global Study underlines, in a world with limited natural resources and where cost-effective solutions are required to ensure sufficient safe and nutritious food for all, reducing food losses could be an important contributor to global food security.

As in other world regions, food losses and waste in middle and low income countries of Europe and Central Asia impact the availability of and access to food, particularly for poorer segments of society, as well as income levels and rates of economic development. High income countries, however, are more concerned with the impact of food losses and waste on resource efficiency and the environment, coupled with the belief that reducing particularly waste in their own economies can provide greater surplus for needier populations in other regions.

3.1 Context of Loss and Waste Discussion

As the Kiel study points out, food is often not viewed as a product like other ‘economic’ products whose value is expressed solely by their market prices. The histories of many peoples are marked by periods of food shortage and starvation, which add a symbolic importance to the value of food and a particular taboo to its wastage, which does not apply to other consumer goods. The study further questions the assumption that decreasing levels of waste, particularly in high income countries will miraculously result in higher levels of availability of and access to food in countries witnessing the highest levels of population growth and lowest levels of nutrition.

The European Union, OECD and United Nations are among the organizations leading research and policy development to reduce levels of food losses and waste among their member states. The Agriculture Committee of the European Parliament, for example, approved a resolution in November 2011 that called on the European Commission and member states to take radical measures to reduce losses and waste “from farm to fork” by 50 percent by 2025. Member countries have responded by designing policies encouraging small and medium agri-food producers to respond more closely to the demand of their local markets.

Additional examples of food loss and waste reduction initiatives launched by national governments and international organizations over the past five years include the following:

- The Vision for Agriculture established by the World Economic Forum in 2010, which is built on the premises that agriculture contributes 30 percent of global greenhouse gas emissions, provides 40 percent of employment worldwide (70 percent among the poorest billion people) and accounts for 70 percent of all water withdrawals;

- The report of the UK's Government Office for Science in 2011, which setting a target of halving levels of food waste, the equivalent of 25 percent of current production, by 2050;
- The Resource Efficiency Roadmap of the European Commission in 2011, which establishes a milestone of halving the disposal of edible food waste by 2020;
- The launch of an initiative by OECD since 2013 to build a preliminary data set covering food losses and waste in 34 OECD member countries and China;
- The launch of a global campaign aiming to reduce food losses and waste by UNEP, FAO and partners in January 2013, which provides a channel for information sharing on the multiple food loss and waste reduction initiatives worldwide, targeting in particular food wasted in the retail and consumption (domestic consumption and catering industry) phases of agri-food supply chains.

Public interest in the topic is also reflected by media coverage in recent years, which has seen articles in the daily press, weekly journals and magazines and on televised reports and talk shows. In addition, over 200 official publications have been produced covering primarily high-income country loss and waste and using a variety of definitions, methodologies and providing a number of policy recommendations, which have engendered lively debate at local, national and international levels. Overall the findings of studies conducted to date show that a significant proportion of food is either lost or wasted. Estimates available for some countries point out that up to 40 percent of food is lost or wasted.

However, the causes of food losses and waste and the critical loss points in agri-food supply chains vary significantly both between countries and between different categories of producers and processors within a single country. Causes of food waste at the retail and household level for example, vary widely, depending on cultural practice, climate, diet and socio-economic factors, such as average household size, household income (including availability of adequate refrigeration and storage) and frequency of eating out. Causes of food losses and waste during the production, processing and distribution phases of agri-food supply chains also vary widely, depending on availability of technology and management and worker practises, as well as specialised equipment for transportation, processing, cooling and storage.

As a result, governments aiming to institute policy measures to reduce food losses and waste need to conduct in-depth analysis of how much food is lost and wasted at which stage in agri-food chains and to identify the specific causes for such losses and waste, given the idiosyncrasies of the value chains in their countries for the food products in question.

The generally accepted point of departure for loss and waste reduction policy initiatives is that reduction of losses and waste not only increase food availability at national and global levels, but also reduce the resources needed to produce food actually consumed and thus increase overall welfare. Moreover, it is argued that less food losses and waste would contribute to positive climate effects. In support of this EU research conducted in 2010 states that "in order to assess all the environmental benefits of food waste reduction initiatives, one must consider not only the fact that food waste treatment is reduced but that the food processing and other upstream steps of the life cycle are avoided too. For that reason, the environmental impacts of the life cycle of food waste were quantified, not only those linked to the treatment of food waste but also those generated during the other steps of the life cycle before they become waste".

The Kiel study, however, questions these seemingly strong economic, environmental and moral arguments for the need to reduce food losses and waste, particularly by higher income societies, pointing out that while some food losses and waste are avoidable, others are not and some are indeed economically rational. An example of an economically rational level of losses would be compound losses that cost a business less than the cost of an investment in a new harvester, processing line or refrigeration capacity over the working life of such a new investment. Likewise at the consumer level, the cost to a household of over-shopping once a week (and resultant waste through non-consumed produce) may be less than the cost shopping daily in order to ensure only as much as can be consumed is purchased.

The study goes on to raise a number of issues with current approaches to analysis of food losses and waste and to discussion of policy interventions aimed at their reduction, as follows:

- Determination of the level of food losses and waste. Most research to date has focused on determining food loss and waste levels according to their volume, measured by weight. It is argued that more sophisticated measurement should be utilised to reflect not only compound losses up the value chain (i.e. the loss of one kilogram of cheese should be calculated based on the number of litres of milk equivalent plus milk losses prior to the production of a kilogram of cheese), but also to reflect monetary and calorific values of losses and waste.
- Determination of the goal of food loss and waste reduction. While research has focused on the triple goals of food availability and access, resource use efficiency and moral propriety, it is argued that different units of quantification of food losses and waste will depend on which specific goal a particular policy intervention is seeking to address. For example food security goals may elect to quantify losses in calorific value, while interventions aiming to increase agri-food chain efficiency may quantify losses in monetary terms, while both would need to aggregate losses along food supply chains.
- Cost of reducing food losses and waste. Research also tends to assume that food losses and waste can be reduced primarily through a change in practises, with relatively little cost to those responsible for food losses and waste. As this study underlines, significant investment in new technologies and skills will be required to reduce losses, particularly in middle and low income countries of the ECA region and it will fall primarily to the private sector to determine whether such investments are justifiable in terms of increased profits.
- Relationship between loss and waste reduction and stated goals of such interventions. It is not always clearly established how, for example, a reduction of consumer waste in a high-income EU country will increase access to food in a low income country of the region or in other regions of the world. A distinction therefore perhaps should be drawn between resource efficiency goals for higher income countries and access to food and food chain efficiency goals in medium and low income countries.

3.2 Dimensions of Loss and Waste Analysis

Taking into consideration the aforementioned caveats relating to the ongoing debate over the impact of reducing food losses and waste on the range of possible goals, the following dimensions of reducing food losses and waste are considered of particular relevance for the Europe and Central

Asia region both in quantifying and analysing loss and waste levels and in leading discussion of loss and waste reduction interventions for the region.

- Impact on food security (availability and access). The reduction of food losses is relevant to both the poor smallholder food producer and the poor food insecure consumer. Given that many smallholder producers live on the margins of food insecurity, a reduction in food losses could have an immediate and significant impact on their livelihoods. This is particularly relevant for smallholder women farmers who experience limited access to relevant agricultural inputs and technologies, extension services and information, infrastructure, storage facilities and markets. In terms of the impact on poor consumers (food insecure or at risk households), the priority is clearly to have access to food products that are nutritious, safe and affordable. At the household level, a reduction in food losses would have a significant impact on women, who are normally responsible for household food distribution and consumption and maintaining household food security.
- Impact on nutrition, food quality and safety. Food losses are also manifested by a loss in quality. Qualitative losses may cause reduced nutritional value; low quality products may also be unsafe with adverse effects on the health, wellbeing and productivity of the consumer, and may affect men and women differently, pregnant and lactating women are particularly vulnerable to a poor quality diet, as are children.
- Impact on the environment. Food production and consumption, and thus losses and waste, entail negative environmental impacts. These are very often external to producers and consumers; i.e. producers and consumers generate negative “externalities”. These include the overuse of natural resources in production, processing and distribution processes, such as, land salinization and erosion, overuse of ground and river water; externalities from the use of pesticides and chemical fertilizers, such as water and air pollution, health problems for workers and consumers. These impacts can be expressed as the "Food Loss and Waste Footprint" on the environment. Each year, food that is produced but not eaten amounts to the use of a volume of water equivalent to the annual flow of Russia's Volga River and is responsible for adding 3.3 billion tonnes of greenhouse gases to the planet's atmosphere. Reducing food losses and waste has also been identified as an important way of reducing GHG emissions from the food and agriculture sector without compromising food security.
- Economic and income-distributional aspects. At the production and distribution levels, losses occur as a consequence of technological choices and market-driven expectation of producers, based on the expected profitability of various options. Selected technically feasible options to reduce food losses are discarded because they are not expected to be profitable, given the opportunity cost of labour, capital and other inputs. Other options are out of reach of single agents in terms of investment requirements, know-how, organizational capacities etc. At consumer level, wasting food; i.e. discarding edible or formerly edible food items, given the current state of consumer preferences, has to be seen not as a loss of income but as an expenditure that generates welfare per se, or as a direct consequence of choices which are sources of welfare. For instance, to avoid the risk of falling short of food at home, the consumer over-purchases. In addition, the consumer enjoys “capabilities”; i.e. freedom of choice between several options.
- Impacts at varying stages of supply chains. The distribution of economic benefits from reductions in food losses and waste depends critically on market circumstances and where in the supply

chain losses are reduced. Losses during and following harvest reduce marketable quantities. Reducing losses will be of greater benefit to farmers if it is coupled with improving the efficiency of supply chains. This benefits both producers and consumers by narrowing the mark-up between producers and final consumers. Lower food prices increase the real incomes of poor net food purchasers in both urban and rural areas. On the other hand, reductions in waste result in lower aggregate demand and potentially lead to lower commodity prices for producers. Households that are net sellers of food may suffer negative consequences in terms of income, which may lead to increased poverty. These negative potential impacts, however, may be reversed with time as soon as resources freed by the increased efficiency in food production find alternative more remunerative uses.

- Societal perspective. Addressing food losses is expected to improve social conditions of both poor producers and poor consumers. Food availability would increase for both producers (own-consumption) and the society. In addition, access to food would increase for producers through increased income, and for poor consumers through reduced food prices. Furthermore, as food losses, pretty much as all food production, cause pressure on natural resources, including the climate, it is expected that reducing food losses would reduce the pressure on natural resources. However, for cultural reasons, regulatory norms, habits, lack of information or knowledge, the consumer may over-purchase and over-prepare foods and/or discard good quality edible food because it is reputedly unsafe, unhealthy or no longer tastes good.
- Food systems perspective. The approach to reducing food losses and waste is embedded in the broader concept of promoting sustainable food systems, which also encompasses sustainable food production on the one hand, and sustainable diets and consumption (such as through the reduction of food waste), on the other. A gender analysis of food systems is pivotal to ensure the social sustainability of the approach. Women and men play different roles and thus have different capacity needs in food production, processing, preparation and consumption. New strategies for interventions should take into consideration the socio-economic dynamics of different actors and their respective capacities and potential to prevent food losses and waste.

4. THE STATE OF PUBLIC DEBATE ON FOOD LOSSES AND WASTE

Recent reviews of publications, by Parfitt in 2010 and the Fusions project in 2013, list over 220 papers on the subject of food losses and waste, most commissioned by international or national organizations and conducted by researchers from universities or collaborations of several project partners. The vast majority of these studies are generated in and focused on countries not suffering from food insecurity.

In order to provide a structured overview of the debate, the literature review provided below is grouped by key issues, ranging from the aims of the studies commissioned to the definition of food losses and waste, methodologies for data collection and aggregation, and analysis of the causes of losses and waste, reduction initiatives and how such savings can be transferred to food insecure groups and regions.

4.1 Aims of Studies Conducted

There are major differences in the aims of studies that analyse and document food losses and waste. Several studies, especially those originating from developed countries, have social and ethical motivations and although they argue that it is unethical for food to be wasted in some parts of the world while people suffer hunger in other areas, few such studies discuss how reducing waste in high income countries and regions can be transferred to needy populations in lower income countries and regions.

Other studies aim at improving availability and access to food. This aspect is of particular importance for developing countries or countries in transition, as their food production is less secure and stable compared to fully industrialized countries. While it is more apparent that reducing particularly losses in low income countries is likely to have a positive impact on food availability and access in such countries, questions still remain as to how particularly retail and consumer waste reduction in high income regions can positively impact access to food in regions with food shortcomings.

A further aim of reducing food losses and waste is to increase resource efficiency, based on the premise that resources used to produce food that is wasted could be better used for something else. Related aims include a focus on environmental factors, such as reducing emissions of carbon dioxide or eutrophication by producing less food that ultimately goes to waste.

4.2 Definitions of Food Losses and Waste

Definitions of food losses and waste vary widely between research papers produced to date with over 100 different definitions of “food loss” and “food waste” having been collected by the FUSIONS project. For the most part, however, “food loss” is taken to relate to decreases in food quantity or quality rendering it no longer available for human consumption, while “food waste” is used to refer to losses due to behavioural issues and often connected to a conscious decision to discard food. The EU waste directive 2008/98/EC, for example, defines waste as “any substance or object which the

holder discards or intends or is required to discard". The following are the main issues under discussion in current definitions of food loss and food waste:

- Distinguishing what is edible from what is inedible. Until recently there was little consensus on whether inedible parts of foodstuffs should be considered as losses or waste. This issue is particularly relevant when assessing potentially edible parts of animals that are currently in many societies used, but for non-food purposes, such as soap production. The issue also has a cultural aspect, in that what is considered inedible in one society may be eaten in another.
- Food grade products used as animal feed. While the majority of studies consider food grade products and commodities, which have the potential of being eaten by humans but that are used for animal feed, as waste. Other studies do not. In such discussions, the intended purpose of standing crops and animal parts come under scrutiny and it can be argued that if crops and animal parts are intended for use as feed, they should not be considered as losses to human consumption.
- Storage and natural weight loss. Weight loss takes place in non-animal food commodities during storage and is also part of the drying process required for further use of grains and some fruits. Such losses, as well as natural weight losses in the transportation of livestock to slaughter and subsequent butchery and hanging processes, should arguably not be considered as food losses.
- Excessive human consumption. Particularly in high-income countries, people increasingly consume more calories than is actually considered healthy. The question is whether the excess calorie consumption should also be labelled as waste or merely as inefficiency in its use.
- Start point for measuring food losses. As discussed below, the Global Food Losses and Waste Study included decreased milk production by dairy cows as losses and similarly birthing mortality by livestock reared for meat as losses, while measuring non-animal product losses only from the moment that crops are ripe and ready to harvest in the field. The point of departure for calculating food losses and whether potential harvests and therefore potential food should be included will clearly have a major impact on the volume of losses calculated.

For the purposes of this study, food losses are understood to refer to food that between the moment of its readiness for harvest and the moment it becomes a final product ready for consumption it is spilled, spoiled or otherwise lost. Losses are considered as unintended results primarily of poor practise and a lack of technology. Food Waste, on the other hand, is understood to refer to food that has reached the stage of a final product ready for consumption but that is discarded and not consumed. Such waste results from a deliberate act or omission, generally by retailers and consumers.

While discussion is still ongoing, FAO and FUSIONS have reached a general consensus on the definition of quantitative food loss and waste as including any food that is finally not eaten. For this definition, following the Codex Alimentarius, food is defined as 'any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparation or treatment of 'food', but does not include cosmetics or tobacco or substances used only as drugs. FAO will publish the definition of quantitative and qualitative food losses and waste at the session of Committee on Agriculture in May 2014.

4.3 Data Collection Methods and Data Quality

As the data collection methods are for the most part not standardized, a large number of different approaches have evolved, which are often not validated. Further, even though most studies argue that the data presented is representative for a larger region; this is also open to debate. Thus, the quality of the data varies significantly and rating the quality of the data provided in many publications is highly challenging.

The methods for assessing volumes of food losses and waste can be grouped into quantitative and qualitative approaches. Quantitative methods attempt to measure the volume of losses and waste directly while qualitative methods rely predominantly on the information from interviewees. The selection of methods for data collection depends both on the stage of the supply chain targeted for analysis and the specifics of the country or region under analysis.

Quantitative methods generally aim at actually collecting samples of the wasted foods. For example, the UK's WRAP initiative sampled the food losses and waste of several English households in 2008. The advantage of quantitative methods is that they provide very detailed estimates of the level of food losses and waste. The disadvantage of this approach is that it is both expensive and time-consuming. The advantage of qualitative methods such as interviews is that they are easier to implement, but the information is also more subjective and less reliable.

To facilitate comparison across studies, the Save Food Initiative has issued a guideline for data collection relating to losses in small-scale agriculture and fisheries subsectors. Under the guideline, secondary data should be screened and on the basis of the results of the screening, surveys to collect information from different stakeholders using questionnaire and own observations should be conducted. In addition, the specific amount of food losses should be sampled before conducting a synthesis in order to develop a prediction of the total amount of food losses and waste and to estimate models for certain locations.

There clearly, therefore, a pressing need to have more reliable and valid data available to assess the extent of food losses and waste and to compare diverse practices and systems. This requires both harmonized monitoring methodologies, preferably from a global perspective, but also the commitment of stakeholder groups to be transparent on reporting losses and waste in food supply chain practice.

Developing global protocols for the measurement of food losses and waste, however, is highly complex, having to account for a large number of variables, often different from country to country. While most of the data on post-harvest losses in food supply chains in developing countries is not available or recorded, there is no recorded data on food waste at the consumer end in the developed countries. Therefore, it is felt that there is an urgent need for harmonized methodologies and protocols to describe and measure FLW.

4.4 Aggregation

Aggregation is also a further point of discussion in the current debate on food losses and waste since no standard protocol for measuring losses and waste has been developed to date and different methods of aggregation emerged. While most studies have aggregated losses and waste on the basis of weight or value and only a few have used caloric equivalents, some even convert losses and waste into greenhouse gas emissions or water use.

While adding the number of kilograms of lost and wasted foods is relatively a straightforward method, it also has its drawbacks. For example, producing one kilogram of meat uses more resources than producing one kilogram of potatoes. Thus, the weight of losses and waste does not necessarily allow conclusions to be drawn regarding how many people could have been fed, if such losses and waste were eliminated.

Drawbacks relating to aggregation of losses and waste through determining retail prices of the products in question include the fact that only a small share of retail price actually reflects the value of the product itself. Cereals, for example that cost one dollar at the farm gate may cost seven times that much at retail as a result of the value added through processing, trading, storing and marketing.

Aggregating data by greenhouse gas emissions or water use allows the issue to be analysed in terms of environmental impact and resource efficiency, but such conversions require additional data that is not available for all countries and application is therefore limited. Very few studies aggregate caloric equivalents as data collection for such aggregation is more complex, although this approach allows a more direct correlation between the reduction of losses and waste and the increase in capacity to feed people.

4.5 Causes of Food Losses and Waste and Responses to them

On the question of causes of food losses and waste, two major approaches are distinguishable and relate to whether losses and waste result from either market or policy failure. According to OECD, in research conducted in 2011, food losses and waste can be ascribed to the rational behaviour of producers, traders and consumers, since given current consumer preferences, prices and available amounts of food, it is often optimal for individuals and companies to discard food.

Other studies suggest, however, that losses and waste arise from market failure, for example the failure to provide access to finance, allowing value chain actors to invest in improved technologies and practises; or from policy failure, for example the absence of legal and regulatory environments encouraging such investments. Such failures are most noted in research relating to low and middle income country.

Responses to perceived market and policy failure also need to be carefully analysed to ensure that proposed interventions are justified, through cost-benefit analysis, either of financial rates of return on private sector investment or socio-economic returns, including availability and access to food for public sector initiatives.

5. INITIATIVES TO REDUCE FOOD LOSSES AND WASTE

To raise awareness, initiatives to reduce food losses and waste have been implemented by several international, supra-national and national organizations, as illustrated in the list of indicative national level initiatives included in Annex 1. This reflects the fact that food losses and waste have evolved into a high-profile public issue. Public interest in the issue has also been reflected in the public media over the last two years. There are articles in the daily press, weekly journals and magazines, on TV in reports and talk shows.

5.1 Global Initiatives

In May 2011, FAO and trade fair organizer Messe Düsseldorf GmbH organized the international conference "Save Food" at Interpack2011 in Düsseldorf, the world's biggest trade fair for the packaging industry. After this successful event, FAO and Messe Düsseldorf launched the Global Initiative on Food Loss and Waste Reduction. This global initiative rests on four main pillars, as follows:

- Awareness raising on the impact of, and solutions for food loss and waste;
- Collaboration and coordination of world-wide initiatives on food loss and waste reduction;
- Policy, strategy and programme development for food loss and waste reduction; and
- Support to investment programmes and projects, implemented by private and public sectors.

The Global Initiative is directly involved in the EU project "Food Use for Social Innovation by Optimising waste prevention Strategies" (FUSIONS), and in addition will collaborate with a number of public and private partners in Europe to address the problem of food waste in all segments of the food supply chains.

Food losses and waste are increasingly considered by the Committee on World Food Security (CFS), informed by the reports of its High Level Panel of Experts on food security and nutrition (HLPE). The need to reduce food losses and waste was again emphasized by the HLPE in 2012 in its report on climate change and food security as a way to reduce GHG emissions from the food and agriculture sector. The CFS endorsed this advice and recommended the reduction of post-harvest losses and food waste in a sustainable manner. At the same session, CFS requested that the HLPE prepare a report on "food losses and waste in the context of sustainable food systems" for its 41st session in 2014.

In 2011, FAO and UNEP launched a joint Sustainable Food Systems Programme (SFSP) to improve resource use efficiency and reduce the pollution intensity of food systems from production to consumption, while at the same time addressing issues of food and nutrition security. The programme brings together a broad coalition of concerned stakeholders, including governments, food and fish producers, agro-industry actors, retailers and consumers. UNEP and FAO are founding partners of the Think Eat Save - Reduce Your Foodprint campaign, whose aim is to assist in coordinating worldwide efforts for reducing waste.

In June 2012 the lead UN agriculture and food agencies jointly pledged to minimize food losses and food waste by supporting the fifth objective of the "Zero Hunger Challenge" (zero loss or waste of

food) from a social, economic and environmental perspective. Additionally, for Rio+20 (United Nations Conference on Sustainable Development) FAO issued the policy paper Towards the future we want - End hunger and make the transition to sustainable agricultural and food systems.

5.2 Europe and Central Asia Regional Initiatives

The European Parliament is also at the forefront of initiatives to reduce food losses and waste. The Parliament's agriculture committee approved a resolution on 23 November 2011 that calls for the European Commission and member states to take "radical measures" to reduce waste – "from farm to fork" – by 50 percent before 2025 (EU Parliament, 2011). The members of the European Parliament (MEP) want to cut food waste in the EU through measures such as encouraging small- and medium-scale farming and crop production that is geared towards local market demand.

Furthermore, several institutions initiated programmes and/or declared their intent and targets to reduce food losses and waste. These include the UK Government Office of Science; the European Commission, which set a milestone of halving the disposal of edible food waste by 2020; the World Economic Forum; and OECD, which has started to build a preliminary data set on food waste, which includes 34 OECD member countries and China.

FAO has traditionally been at the forefront of initiatives and technical support programmes dealing with the reduction of post-harvest food losses. With the market integration and development of global value chains it become necessary to address the issue of food supply chain efficiency all the way from production to consumption, thus developing a holistic approach, which would address food waste as an integral part of food losses and waste along food supply chains.

In the 2014-15 biennium the Global Initiative will be implemented under Strategic Objective 4: "Enable more inclusive and efficient food and agricultural systems at local, national and international levels". SO4 includes private sector capacity and engagement, as well as creating the required enabling environment, for more productive and efficient food supply systems, following a holistic and integrated value chain approach, based on viable business cases and taking into account social and environmental appropriateness. This approach is essential for and conducive to reducing food losses and waste.

In Europe and Central Asia the Global Initiative on Food Loss and Waste Reduction will address the issues of dietary transition through a strong programme of awareness raising on food waste, including consumer behaviour and dietary habits in economically developed areas. This campaign aims at reducing food waste by promoting a more sensible and healthier consumption pattern among households, in line with the guidance of the 'sustainable consumption and production' programme of FAO and UNEP.

In response to the request of the FAO Regional Conference for Europe (ERC) 2012, within the framework of the FAO flagship programme Agrarian Structures Initiative in ECA, REU has initiated work on regional assessment of food losses and waste and the identification of policy options for the reduction of food losses and waste in ECA.

The project intends to improve the understanding of the underlying causes of food losses and waste along selected food supply chains in developing countries in the region, and contribute to global assessment and initiatives to address the issues of food losses and waste. The project approach was to update and upgrade the assessment of food losses and waste in the ECA region using a methodology applied in the global FLW study, and to identify and analyse critical points of FLW along selected food supply chains in developing countries in the region.

6. CONCEPT, METHODOLOGY AND IMPACT ASSESSMENT OF FOOD LOSSES AND WASTE

The FAO Regional Conference for Europe (ERC) 2012 requested that the Regional Office produce three studies for the ERC 2014. One of these papers was to focus on food losses and waste (FLW) in Europe and Central Asia (ECA). In response to that REU, within the framework of the FAO flagship programme on agrarian structures in ECA, conducted this regional assessment of FLW and identification of policy options for reduction of FLW in the region.

6.1 Concept

The approach was to update and refine the Global Food Losses and Waste assessment for the ECA region using the methodology applied in the global study, and to identify and analyse the critical points of FLW along selected food supply chains in low and middle-income countries of the region. For that purpose REU commissioned three country studies during 2013, focusing on two middle income (Turkey and Ukraine) and one low income (Armenia) countries in the region. The country studies provided an overall assessment of FLW and their impact on food security and food supply and identified the main technical, economic and policy related causes for FLW along selected agri-food chains.

Results and findings of the country studies as well as an analysis of them conducted by the Department of Agricultural Economics, Kiel University, were presented, discussed and validated at a regional expert consultation on 22 November 2013. Based on the information and findings obtained by these analyses and discussions, this paper was developed as the final synthesis study in order to present the FAO assessment of food losses and waste in Europe and Central Asia and the key causes of food waste and losses in the region as well as to discuss the policy options for reduction of food losses and waste, particularly in low and middle income countries of the region.

The decision to focus on low and middle income countries was taken on the grounds that high income countries, comprised primarily of EU states, have already conducted extensive research and developed advanced programs for monitoring and reducing losses and waste both at the national and EU levels as well as through bodies such as OECD. Further, the FUSIONS (EU FP7) project, in which FAO and the Swedish Institute for Food and Biotechnology (SIK) are implementing partners, is leading and coordinating research and policy initiatives in the sphere of food losses and waste.

6.2 Objective and Methodology

The objective of the study is to identify critical points and patterns of food losses and waste along selected food supply chains in low and middle income countries in the region, which have the largest impact on food security and food supply in the country. For that purpose the study provides an overall assessment of food losses and waste and its impact on food security and food supply, as well as identifying and analysing critical points for food losses and waste along selected agri-food chains.

The study follows the methodology established by FAO and the Swedish Institute for Food and Biotechnology in dividing agri-food products into commodity groupings, i.e. cereals, roots and tubers, oilseeds and pulses, fruits and vegetables, meat, fish and seafood, milk and eggs for preliminary analysis.

While the methodology excluded crops not destined for human consumption, such as feed maize, feed wheat and potatoes destined for use as animal feed, from analysis, as crops initially intended for human consumption tend to be redirected to animal feed uses when degraded, it was considered that if product quality could be improved, significant amounts of produce currently used for animal feed could be consumed by humans.

Priority agri-food chains for each of the three countries were identified in the 2013 country studies through analysis of their economic importance, employment generation, contribution to foreign exchange and contribution to food security and the prioritisation was validated through key informant interviews on the magnitude of food losses and waste in the respective chains. The priority agri-food chains identified by country study were as follows:

Priority agri-food chains (products) identified by country studies

Commodity Group	Armenia	Turkey	Ukraine
Cereals	Wheat	Wheat	Wheat
Roots and Tubers	Potato	Potato	Potato
Fruit and Vegetables	Tomato Apple	Tomato Olive oil	Apple
Meat	Beef	Red meat	Pork
Fish and Seafood	Fish	not selected	not selected
Milk and Dairy	Milk and dairy (excl. butter)	Milk and dairy	Milk and dairy
Eggs	Eggs	not selected	not selected

Country studies then analysed priority agri-food chains to identify critical loss (and waste) points at five steps of each agri-food chain, i.e. (1) agricultural production, (2) post-harvest handling and storage, (3) processing and packaging, (4) distribution and (5) consumption. At each step loss and waste were quantified as percentages of the overall volume of produce entering the step. For vegetable (non-animal products) the analysis was initiated from the moment of a crops ripening (although in some cases earlier blights were also examined). For animal products, production losses such as animal mortality and disease were considered. The following tables provide the framework for this critical loss point identification and quantification analysis.

Vegetable (non-animal) product agri-food chains

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	<ul style="list-style-type: none"> - Mechanical damage/spillage during harvest - Crops left in field - Animal/disease attacks after finished growth
2. Post-harvest handling and storage	Storage facilities	<ul style="list-style-type: none"> - Insects, rodents, birds, pests, disease - Natural drying - Mechanical and handling damage - Transport to storage/processing
3. Processing and packaging	Farm industry	<ul style="list-style-type: none"> - Damage from packaging - Losses during processing - Mechanical damage during processing - Rodents (etc.)
4. Distribution	Wholesale Supermarkets Retailers Markets	<ul style="list-style-type: none"> - Transport to distribution - Lack of cooling - Outdated food - Unsold food
5. Consumption	Households Food services	<ul style="list-style-type: none"> - Outdated food - Poor storage - Plate waste - Passed 'use by' dates - Other waste

Animal product agri-food chains

Supply chain step	Location	Causes of food loss/waste
1. Agricultural Production	Field	<ul style="list-style-type: none"> - Animal mortality - Animal disease/medical treatments
2. Post-harvest handling and storage	Farm / Slaughterhouse facilities	<ul style="list-style-type: none"> - Insects, rodents, birds, pests, disease - Mechanical damage - Transport to slaughterhouse/processing
3. Processing and packaging	Slaughterhouse industry	<ul style="list-style-type: none"> - Damage from packaging - Losses during processing - Mechanical damage during processing
4. Distribution	Wholesale Supermarkets Retailers Markets	<ul style="list-style-type: none"> - Transport to distribution - Lack of cooling - Outdated food - Unsold food
5. Consumption	Households Food services	<ul style="list-style-type: none"> - Outdated food - Poor storage - Plate waste - Passed 'use by' dates - Other waste

Given extreme variations in the technology and processes used at each stage of agri-food chains, the Ukrainian study broke down its analysis was broken down into three sub-chains for each product, i.e. produce originating on modern commercial farms, produce originating on outdated Soviet-era farms and produce originating on smallholder (household) farms. Additional sub-chains for processed fruit and vegetable and dairy produce and for processed meat were also analysed.

6.3 Sources and Types of Information

The main sources of information used in developing this study, are outlined in the table below, grouped by type of information.

Sources and Types of Information

Information	Armenia	Turkey	Ukraine
Statistical Data	FAO Food Balance Sheets State Statistics Industry Statistics	FAO Food Balance Sheets State Statistics Association Statistics	FAO Food Balance Sheets State Statistics Industry Statistics
Existing Research	International Organization reports Ministries of Agriculture, Economy and Trade reports Customs service reports Previous ICARE studies	National Reports Research Papers Academic Theses International Project Results Association Reports Boards of Trade Papers	Academic Research State Agency Reports Private Sector Research International Organizations Agribusiness Associations Chambers of Commerce
Focus Groups		Focus Groups held for wheat, milk, meat, fish and seafood value chains	Validation workshop with national representatives for each value chain
Key Informant Interviews	Interviews with business support organizations, official bodies and value chain actors representing each phase	Interviews conducted for olive oil, tomato products, egg, sugar and potato value chain	Interviews with value chain actors representing each stage of five value chains, including support actors
Value Chain Surveys	Consumer and Value Chain Surveys (extensive, over 500 consumers and 100 value chain representatives interviewed)	Semi-structured questionnaires developed for interviews	Value Chain Surveys (limited, approx. 5 responses per chain)
Expert Group Validation Hosted by FAO REU on 22 November 2013, Budapest			

6.4 Country Study Results

Below are the summary results tables produced by each of the country studies showing the percentage of losses and waste estimated using the aforementioned approaches and methodology.

Armenia

For the purposes of this study, Armenia represents the low income group of ECA member countries, along with other southern Caucasian countries (Georgia, Azerbaijan), Moldova and south Central Asian states (Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan).

Armenia Country Study 2013, Summary Losses and Waste

Commodity Group	Agricultural production	Post-harvest and storage	Processing and packaging	Distribution	Consumption
Cereals	15%	5%	6%	7%	5%
Roots and Tubers	19%	6%	0%	3%	1%
Fruit and Vegetables	6%	4%	3%	4%	3%
Meat	1%	0.1%	1%	1%	1%
Fish and Seafood	20%	0.1%	0.2%	3%	1%
Milk	2%	0.1%	4%	2%	1%
Eggs	23%	1%	0.1%	0.1%	0.1%

As may be expected from low income countries the agricultural production phase was found to have the highest levels of loss across all agri-food chain phases. What is less intuitive is the extremely low levels of consumption phase losses, perhaps masked by reliance in the study on the consumer survey in which for reasons of cultural taboo, respondents may have under-reported their levels of household waste.

Turkey

For the purposes of this study, Turkey represents the middle income group of ECA member countries, along western Balkan countries (Albania, Bosnia Herzegovina, Croatia, Macedonia, Montenegro and Serbia), Kazakhstan and eastern European states (Belarus, Russia and Ukraine).

Turkey Country Study 2013, Summary Losses and Waste

Commodity Group	Agricultural production	Post-harvest and storage	Processing and packaging	Distribution	Consumption
Cereals	5.1%	4%	2%	1%	5%
Roots and Tubers	7%	6%	2%	3%	2%
Oilseeds and Pulses	15%	5%	7%	1%	4%
Fruit and Vegetables	20%	8%	10%	10%	5%
Meat	10%	0.2%	5%	0,5%	1%
Fish and Seafood	10%	0.02%	0.04%	0.01%	2%
Milk	10%	1%	1.5%	6%	1.5%
Eggs	6%	1%	2%	1%	0.01%

The Turkey country study also revealed highest loss levels in the agricultural production phase of all agri-food chains analysed, although with less extreme variations than in the Armenia country study. Also high were the processing, packaging and distribution stages of the horticultural chains, illustrating cold chain logistics challenges during the summer harvest period.

Ukraine

Like Turkey, Ukraine is classed for the purposes of this study as a middle income ECA member country. The summary results of the country study are presented in the following table.

Ukraine Country Study 2013, Summary Losses and Waste

Commodity Group	Agricultural production	Post-harvest and storage	Processing and packaging	Distribution	Consumption
Cereals	10.6%	5.4%	4.3%	4.2%	10.2%
Roots and Tubers	3.9%	8.0%	N/A*	9.8%	12.7%
Fruit and Vegetables	10.0%	18.9%	10.0%	7.2%	11.5%
Meat	9.2%	4.9%	6.4%	5.1%	3.8%
Dairy	16.7%	N/A*	6.0%	7.4%	7.6%

* Percentage loss/waste included in preceding/subsequent step

These results show agricultural production losses highest only in the cereals, meat and dairy sectors, with roots and tubers and fruits and vegetables experiencing considerably higher loss levels during post-harvest handling and storage and distribution, perhaps suggesting more serious cold chain constraints than in Turkey. Consumption level waste is also higher than that reflected in the Armenian and Turkish studies, perhaps resulting from a different approach to research on consumer habits.

6.5 Expert Consultation and Refinement

On 22 November, 2013, after the production of a draft synthesis paper by experts from the Department of Agricultural Economics of Kiel University, authors of the three country studies, along with FAO food loss and waste experts from Rome and Budapest offices, Hungarian officials and organizations involved in national and representation from the OECD food loss and waste initiative were invited to take part in an expert consultation.

At the consultation FAO initiatives in this sphere around the world were presented along with country study and preliminary synthesis study findings and requests were made for additional refinement in order to remove inconsistencies of approach. The group also worked to identify gaps in knowledge and methodology and key issues to be addressed in food loss and waste reduction. Some of the main issues identified were as follows:

- Almost all participants identified the lack of data at the country level as a major constraint to analysing FLW levels and potential FLW reduction interventions;

- It was agreed that refining definitions of food losses is important for the harmonization of country studies, e.g. losses at agricultural production (post-harvest losses) and the different type of animal losses should be clarified and country study findings amended to ensure a consistent approach;
- It was proposed to establish a forum to increase public and private partnership on food losses and waste. To support such a forum, a regional network on food losses and waste could be established, including a database of best practices and a regional (FAO/REU) contact point could be dedicated to respond on methodological matters if any inquiry comes;
- The separation of different producing groups (small, medium and large producers; modern, outdated and cottage processing and storage technologies), producer and consumer income levels, differing rural/urban food waste practises and cultural issues was also proposed;
- Overall, the predominance of dislocated smallholder producers and lack of investment in new technology throughout the supply chain were identified as key issues to be addressed in designing food loss and waste reduction initiatives in low and middle income countries of ECA;
- It was also agreed that a clearly stated objective of food loss and waste reduction should be agreed prior to determining firstly whether FLW reduction initiatives would contribute to such objective and secondly which policy interventions would contribute most;
- Further in-depth-analysis of causes of food losses should be conducted in order to establish whether such causes are related to either market or policy failure before deciding on intervention measures, taking into account the costs and benefits of addressing such causes;
- The issue of waste management (recycling) was also raised in cases where food losses and waste is either unavoidable or indeed economically rational.

Based on the refined data provided by the country studies, the food loss and waste assessment for ECA countries provided in the Global Study on Food Losses and Waste were revisited, with a focus on two areas of the methodology used in the Global Study, as follows.

Firstly, the Global Food Loss and Waste Study had divided FAO ECA member countries between two regional groupings, i.e. (1) Europe including Russia and (2) North Africa, Western and Central Asia. In revisiting the data, those ECA countries included in the North Africa, Western and Central Asia region by the global study were extracted and merged into the Europe including Russia region, while taking into account for their income status (high, middle or low) and assumptions made on their levels of food loss and waste in the global study.

Secondly the revisited assessment updated the FAOSTAT Food Balance Sheet (FBS) data used (2009) and adjusted the loss and waste percentages according to revised country study findings for Armenia, Turkey and Ukraine. The loss and waste percentages were then applied to country groupings by income level to provide updated and improved estimates of food loss and waste levels in the ECA region.

Using this updated and refined data and focusing on the FAO ECA member countries, the sections of this study that follow, will provide an assessment of the new data, as well as an analysis of the primary causes for the new loss levels identified, by phase of the value chain. Finally policy options and approaches for reduction in current levels of food losses and waste in the region are presented,

with acknowledgement to the key consideration of such policies being vetted for their responsiveness to either policy or market failure, rather than comprising attempts to remove economically rational levels of loss and waste.

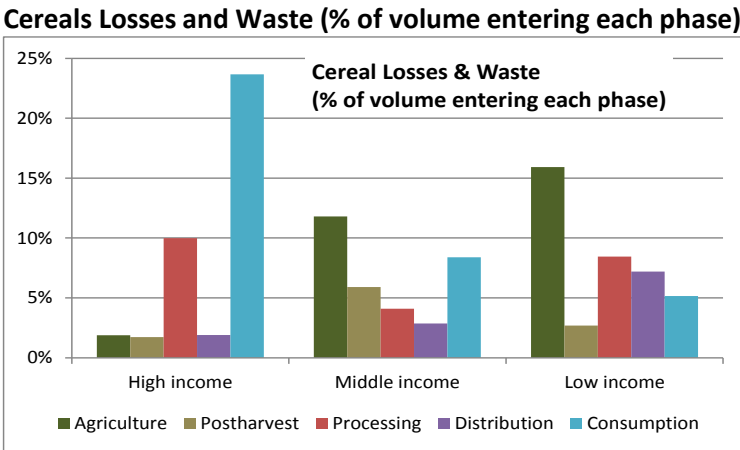
7. ASSESSMENT OF FOOD LOSSES AND WASTE IN EUROPE AND CENTRAL ASIA

This section provides an assessment of food losses and waste based on the Global Food Loss and Waste Study, with its low and middle income loss and waste levels revised as a result of the findings of the three country studies conducted by FAO REU during 2013. The assessment is presented by commodity grouping, i.e. (1) cereals, (2) roots and tubers, (3) oilseeds and pulses, (4) fruit and vegetables, (5) meat, fish and seafood and (6) dairy and eggs.

As the findings of the Global FLW study indicate, patterns of FLW differ based on the overall level of economic development. The update of FLW assessments in the ECA region took into consideration differences in the level of development, which has a substantial impact on the level and patterns of FLW. REU has a unique regional coverage, which includes a group of developed countries, and a larger target group of heterogeneous developing countries. To reflect this, the assessment was done for three sub-regions: (i) Developed countries: EU 27, the European Free Trade Association (EFTA) 8; (ii) Low income countries: Armenia, Azerbaijan, Georgia, Kyrgyzstan, Republic of Moldova, Tajikistan, Turkmenistan and Uzbekistan; (iii) Middle income countries: Belarus, Kazakhstan, Ukraine, South-East European countries and Turkey. The Russian Federation and Croatia although high income countries, were included in the group of middle income countries¹.

7.1 Cereals

The cereals commodity grouping for the ECA region comprises wheat, barley, maize, rye, oats and ‘other cereals’. While the grouping is the dominant commodity grouping in both volume and value of production, of the three most produced commodities, i.e. wheat, maize and barley, wheat is the commodity proportionally most used for human consumption (as opposed to use as an animal feed ingredient) and therefore was selected as the agri-food value chain for analysis in each of the country studies conducted in 2013.

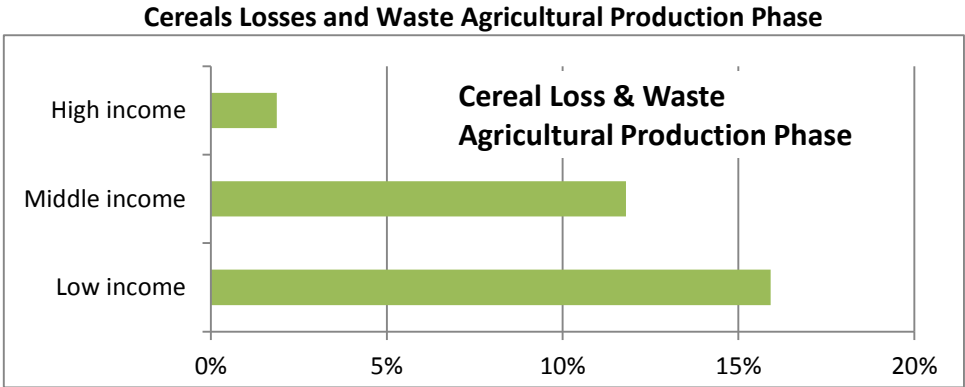


¹ 9 The latest homogeneous set of FAO food balance sheets available for the assessment was for 2009. Due to that, for the purpose of this assessment, neither Croatia nor Russian Federation, were included in the group of high income countries

As the graph above illustrates, for high income countries of the EU and EFTA waste at the consumption phase is highest, at nearly 25 percent waste of bread and other cereal products by consumers, followed by processing phase waste with a total of 10 percent losses and waste of grain and flour in the milling and baking industries, respectively. For middle income countries agricultural production stage losses dominate with 12 percent losses in the field and during the harvest, followed by consumption level losses of 8-9 percent. Low income countries show even higher levels of production phase losses, at which time over 15 percent of harvests are lost. Significantly lower level of consumption phase losses are reported, as might be expected, while processing and distribution phase losses are both between 7 percent and 9 percent.

Agricultural production

The agricultural production phase of the cereals agri-food chain is defined for the purposes of this study as the period from the moment a crop is ripe in the field to the time that it has been harvested. The graph below therefore presents the percentage of crops lost during this period.

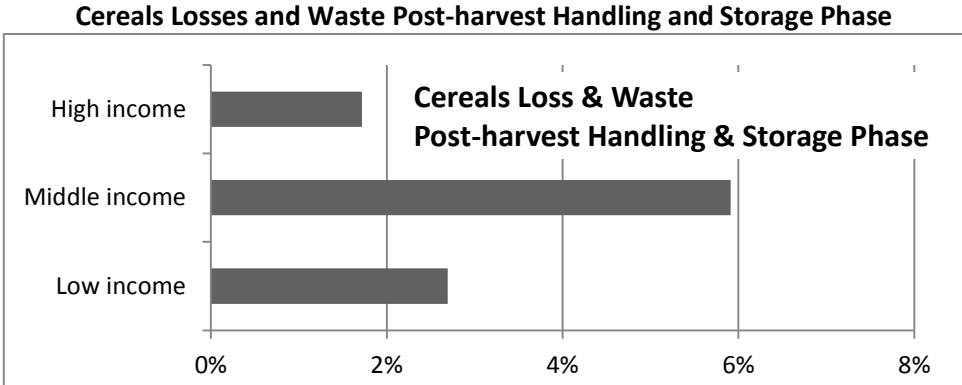


As may be expected, losses during this phase are significantly lower in high income countries of the region at less than 2 percent of the standing crop, growing to nearly 12 percent in middle income countries and nearly 16 percent in low income countries, including. Minimal losses in high income countries reflect the use of modern technology and losses that do occur can often be attributed to adverse weather during the harvest period and may therefore be considered unavoidable.

The Turkey and Ukraine country studies show a wide discrepancy in wheat producing farm structures in middle income countries, with 80 percent of Ukrainian wheat being produced by large commercial farms, which can run into hundreds of thousands of hectares in size and generally employ modern combines and truck fleets. Turkey, on the other hand remains dominated by smallholder wheat producers, who are more exposed to vagaries of availability of harvest machinery and outdated machinery. Low income countries, including Armenia show the highest levels of losses primarily resulting from the continued use of Soviet-era combines and trucks across the southern Caucasus and Central Asia and the low availability of even these harvest fleets, meaning that harvests are delayed and deteriorate as a result.

Post-harvest handling and storage

The post-harvest handling and storage phase of the cereals agri-food chain is defined for the purposes of this study as the period from the moment a crop has been harvested to the moment it leaves grain elevators or alternative storage for processing. The graph below therefore presents the percentage of grain lost during this period.



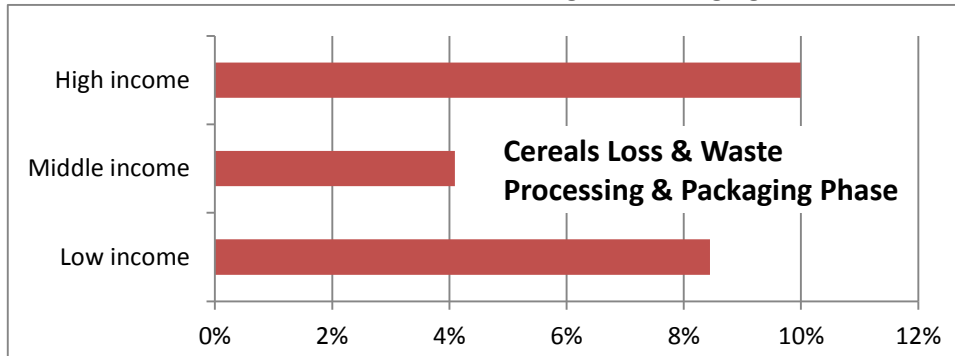
Again, as may be expected losses are lowest among high income ECA countries with low levels of losses (1.7 percent) in transport, unloading and loading and storage. Perhaps surprisingly low income countries appear to lose less (just under 3 percent) during this phase than middle income countries (nearly 6 percent).

This may be explained by the far lower volumes of wheat produced in countries of the south Caucasus and southern Central Asia, when compared with the production of middle income countries of the region such as Kazakhstan, Russia, Turkey and Ukraine. Low production levels and greater dependence on imported wheat may act an incentive to conserve grain and lower income levels may result in grain remaining in the food chain, when in countries of wheat self-sufficiency or surplus may be relegated to animal feed or discarded. In middle income countries, grain losses during this phase are attributed primarily to spillage and spoilage resulting from outdated transport, loading and unloading machinery and grain elevators, as well as poor practices and pilfering, particularly where such infrastructure remains in state ownership.

Processing and packaging

The processing and packaging phase of the cereals agri-food chain, is defined as the period from the moment a crop has left the grain elevator or storage facility to the moment it leaves either the flour mill (if it is destined to be sold to consumers as flour or cracked wheat) or the bakery or pasta production plant, if it receives secondary processing prior to consumption. The graph below therefore presents the percentage of grain lost during this period.

Cereals Losses and Waste Processing and Packaging Phase



The graph above shows that during this phase, high income countries lose or waste 10 percent of grain, flour and processed cereals products, as against 4 percent in middle income and nearly 8.5 percent in low income countries. The relatively higher level attributed to higher income countries can be considered waste rather than loss, being dictated by higher levels of secondary and tertiary (into ready foods) processing and higher quality requirements and consumer preferences, leading to the rejection of lower quality grains by flour mills and flours by bakeries and other secondary processors.

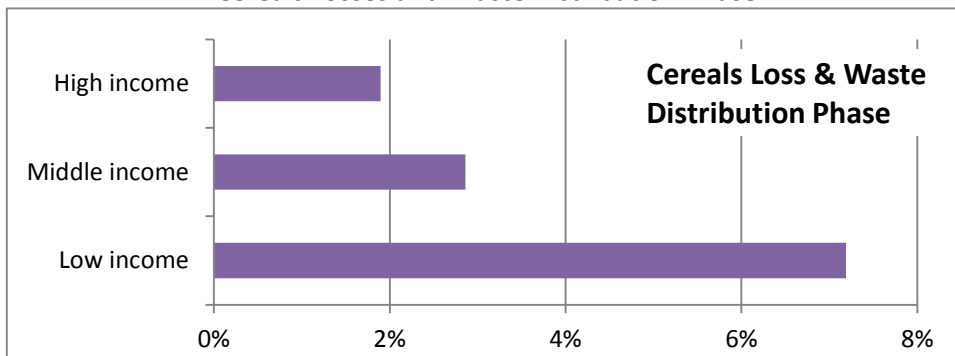
Product quality control will also result in the discard of misshapen or damaged products, which remain in the food chain in lower income countries. And supermarket practices of placing orders for foods that they later cancel result in oversupply and attendant waste during the processing phase.

Processing losses in middle and low income countries in large part result again from obsolete Soviet-era processing capacities, poor management and worker practices resulting in mistakes during such processes as mixing proportions and baking temperature and timing. The uptake of modern technology and practice, particularly among middle income countries in countries of the western Balkans and Turkey, is further likely to explain the discrepancy with lower income countries, where ageing facilities and continued state control contribute to relatively higher levels of losses.

Distribution

The distribution phase of the cereals agri-food chain begins the moment a crop has left the final processing plant or bakery to the moment of purchase by the consumer. The graph below therefore presents the percentage of cereal products lost or wasted during this period.

Cereals Losses and Waste Distribution Phase



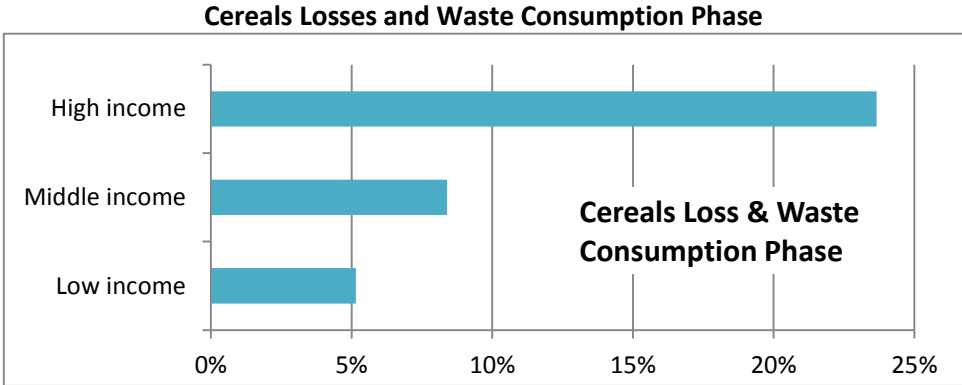
Relatively low levels of waste are encountered by high income countries of the region and those that are (less than 2 percent) can largely be attributed to over-ordering, particularly of bread, in order to

ensure a broad range of fresh breads for consumers to choose from. Increased in-house baking by supermarkets and other retail outlets in recent years will likely reduce such waste further.

Middle and low income countries see relatively higher levels of loss and waste during this phase, estimated at approximately 3 percent and 7 percent respectively. With almost no packaging of fresh bread, particularly in lower income countries and limited packaging even of pasta and biscuits products, which are to a large extent transported and stored prior to sale in sacks (pasta) and large plastic bags (biscuits) in unsanitary conditions, losses and waste can be seen to rise as distribution networks become less developed.

Consumption

The consumption phase of the cereals agri-food chain begins the moment a cereals product is purchased by a consumer and ends once the product is consumed. The graph below presents the percentage of cereal products lost or wasted during this period.



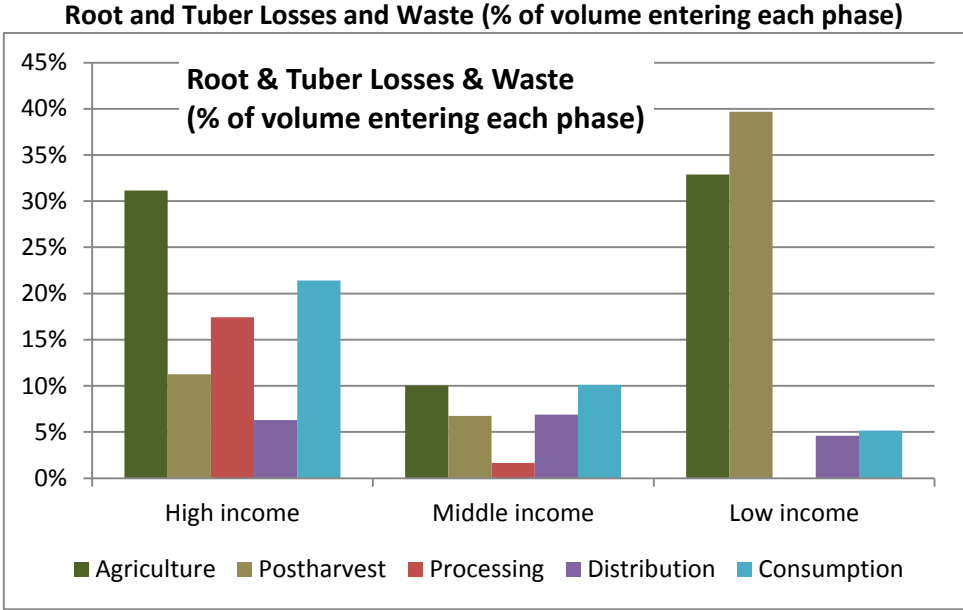
Oversupply, purchasing capacity and consumer preferences for fresh bread as well as higher discard rates of other cereals products result in nearly 25 percent wastage of cereals products by high income consumers. Levels of waste fall to 8.5 percent in middle income countries and as low as 5 percent in low income countries, although it was agreed by those who had developed the Armenia, Turkey and Ukraine country studies that such levels are likely to be underestimates, given social taboos on bread wastage in eastern Europe.

7.2 Roots and Tubers

The roots and tubers commodity grouping for the ECA region comprises a single product, namely potato, since the methodology developed for the Global Food and Waste Study classified sugar beet as an industrial crop and excluded it from evaluation. Further, other root vegetables produced in significant quantities in the region, including carrot and turnip were included in the fruit and vegetables commodity grouping. Potato was considered a key crop in terms of economic significance and food security in each of the country studies conducted in 2013 and therefore analysed by them.

Definitions of food loss and waste are of particular significance to the root and tuber (potato) agri-food chain, given the volumes of potatoes fed to domestic livestock, particularly in middle and low income former Soviet countries. While recent Save Food definitions of food loss exclude crops

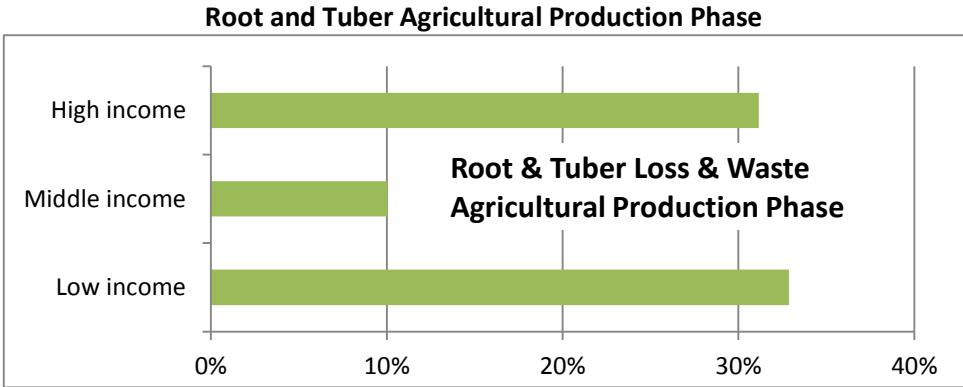
produced with the intention of using produce as animal feed, the definition of food waste includes the use of produce edible by humans as food waste.



As the graph above illustrates, for high income countries of the EU and EFTA waste at the production phase is highest, with just over 30 percent of crops lost or wasted during the harvesting process. Thereafter processing and packaging sees waste levels of over 17 percent as a result of high quality standards, offcuts and cancelled orders from retail chains. Middle and low income countries on the contrary see almost no processing and packaging loss or waste, primarily because potatoes are subject to little processing or packaging in such countries. Far higher are levels of loss during the agricultural production phase, at over 30 percent for low income and 10 percent for middle income countries and during the post-harvest handling and storage phase, which reaches nearly 40 percent in low income countries.

Agricultural production

The agricultural production phase of the potato agri-food chain, as for cereals and other crops is defined as the period from the moment a crop is ripe in the field to the time that it has been harvested. The graph below therefore presents the percentage of potato crops lost during this period.



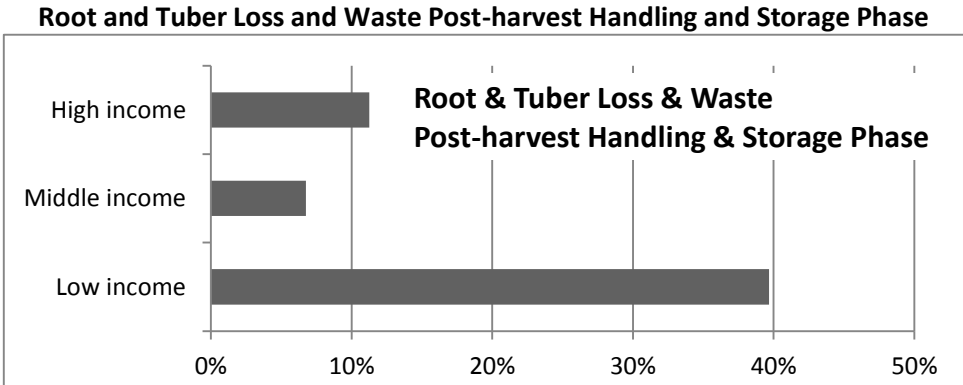
The graph above illustrates levels of over 30 percent loss and waste during the potato harvest in both high and low income countries. The factors explaining such levels, however, vary in that in high income countries rigorous standards relating to the weight, size shape and appearance, particularly of potatoes to be sold fresh, result in high levels of discard at this stage. An additional factor of high income country waste at this stage is overproduction by farmers, who ensure that they produce enough to honour their contracts with retailers, despite possible adverse weather condition and blight, by overplanting and often therefore producing more than they can market.

Low income countries on the other hand are characterized by large numbers of smallholder producers, employing outdated production technologies and subject both to disease and pest, as well as high temperatures during the harvest period and little or no access to pre-cooling facilities. The relatively low level of middle income country losses during this phase can be to some extent explained by lower quality standards and fewer forward contracting obligations on producers than in high income countries, as well as relatively more developed production and harvesting technologies than in low income countries.

Nevertheless, it is also considered that the exclusion of potatoes grown for the intended purpose of feeding domestic livestock deflates middle income country levels of loss, since much of the potato harvests in the major producing countries of Russia and Ukraine, dominated by smallholder households is subject to the same limitations as those in low income countries and during pre-harvest and harvest stages the bulk of the crop is edible by humans.

Post-harvest handling and storage

The post-harvest handling and storage phase of the potato agri-food chain is defined as the period from the moment a crop has been harvested to the moment it leaves its storage facility for sale fresh or for onward processing. The graph below therefore presents the percentage of potato lost or wasted during this period.

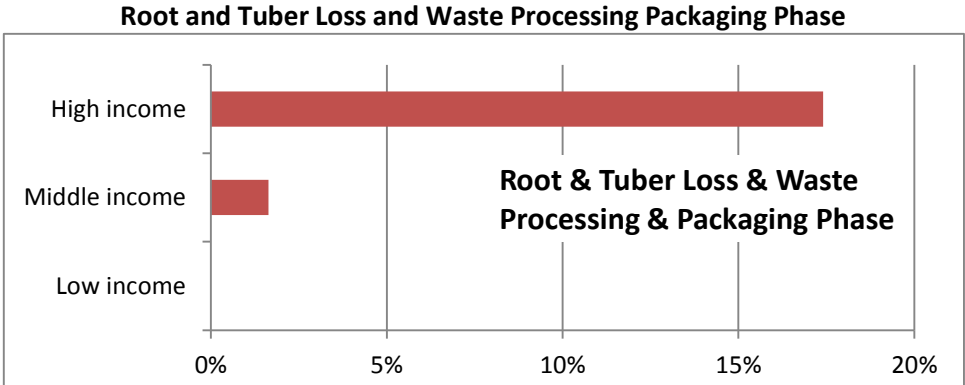


As the graph above illustrates, high income countries in the ECA region lose or waste approximately 11 percent of their potato crop during the post-harvest handling and storage phase. This for the most part results from rigorous secondary quality checks, as well as damage during washing, grading and sorting caused even by modern post-harvest equipment. At the other end of the spectrum, low income countries lose up to 40 percent of their harvest, primarily during winter storage, which is for the most part conducted in unventilated and non-refrigerated rural household cellars and is subject to attack by pests and fungus. Further, winter potato stock remaining once spring potatoes are available is for the most part simply discarded, usually in a heavily degraded condition.

As in the post-harvest phase, it is considered that while post-harvest handling (primarily by hand) processes may result in fewer losses than when machinery is used and while storage capacity may be superior to that available in low income countries, middle income countries losses and waste during storage (particularly in Russia and Ukraine) should not be underestimated as for the bulk of the potato harvest practices vary little from those in low income countries, although this again may be masked by the exclusion of product intended for animal feed from the definition of losses.

Processing and packaging

The processing and packaging phase of the potato agri-food chain is the period from the moment a crop has left the storage facility to the moment it leaves either the primary or secondary processing facility, if indeed it is subject to any processing. The graph below therefore presents the percentage of potato lost during this period.

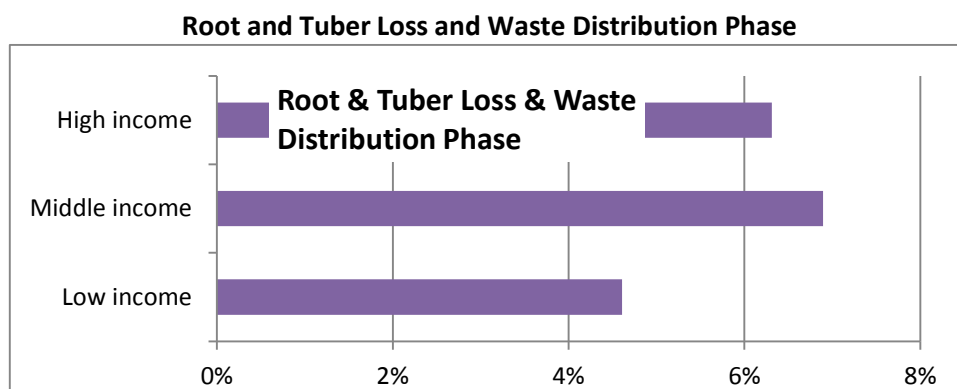


The graph above illustrates that in the ECA region, the wealthier a country, the higher the level of processing of potato and correspondingly, the higher the level of waste. While low income countries in the region have negligible levels of processing and a corresponding absence of waste during this phase, middle income countries, usually characterized by low levels of processing, usually in the form of potato crisp production, have slightly higher levels (2 percent) of losses and waste, caused by product rejection on quality grounds, mechanical and human error during processing and peeling and paring waste.

High income countries, but contrast, with high levels of processing, for crisps, chips and other products, as well as secondary processing involving cooking and inclusion in ready meals, have far higher levels, primarily of waste resulting from high quality standards involving sorting out of produce and peeling and offcut waste as well as rejection of orders by retail chains.

Distribution

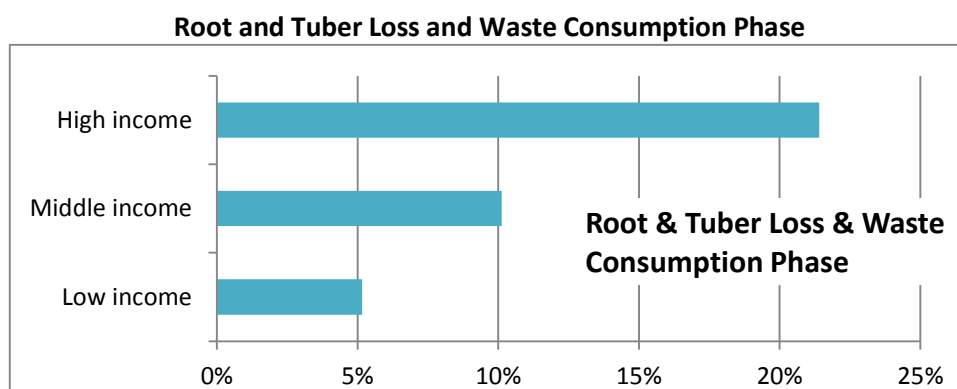
The distribution phase of the potato agri-food chain begins the moment a consignment has left its storage facility or the final processing plant to the moment of purchase by the consumer. The graph below therefore presents the percentage of potatoes and potato products lost or wasted during this period.



As the graph above illustrates, middle income ECA countries witness the highest levels of loss and waste (7 percent) during the distribution phase of potatoes, followed by high income countries (6 percent) and low income countries (4.5 percent). Middle income country losses arise primarily from transport damage due to poor packaging, cold chain, truck, road and market conditions, while high income country losses are more usually attributable to the cancellation of orders by retailers, incorrect packaging and excessive ordering, leading to expired produce in supermarkets. Low income countries, while their distribution systems are not superior to those of middle income countries are likely to discard less and also to transport less as a result of higher levels of consumption by smallholder producers.

Consumption

The consumption phase of the potato agri-food chain begins the moment potatoes or potato products are purchased by a consumer and ends once they are consumed. The graph below presents the percentage of such produce and products lost or wasted during this period.

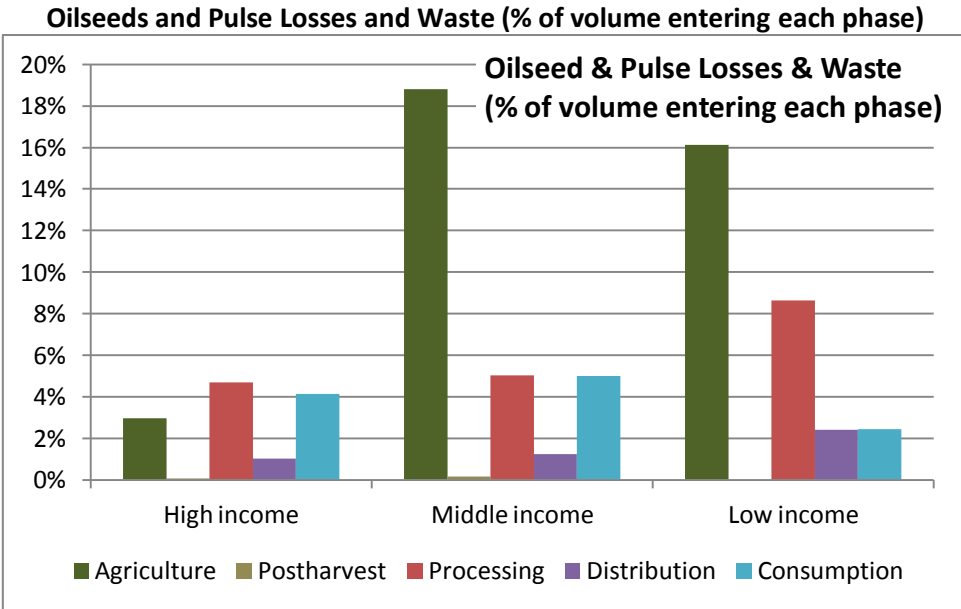


During the consumption phase, high income countries see the highest levels of waste, at 21 percent of produce purchased, compared to 10 percent in middle income and 5 percent in low-income countries. While this is in line with the argument that higher incomes lead to higher levels of purchase and more tolerance of waste, middle and low income waste levels are still high and can be explained both by poor storage conditions, for the most part in the home which lead to high levels cleaning, peeling and paring waste, when large parts of deteriorated produce has to be cut out before consumption.

7.3 Oilseeds and Pulses

Within the oilseeds and pulses commodity grouping as it relates to the ECA region, pulses including peas and beans are dwarfed in terms of volumes produced as well as value and importance for human consumption when compared with oilseeds. The latter category is dominated by sunflower seed and oil in terms of importance for human consumption, but also includes rape and mustard seed and soybeans.

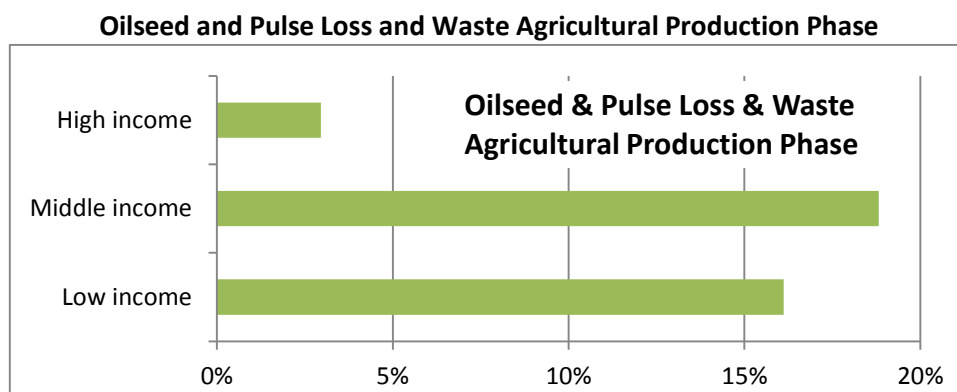
Despite the prominence of Ukraine in sunflower seed and oil production, this agri-food chain was not selected for in-depth analysis in the country studies conducted by FAO during 2013, as a result of the large scale and modern production, processing and distribution technology and networks employed and the correspondingly lower levels of losses and waste, as well as because of the lower level of contribution to food security, due to lower levels of consumption of edible oils relative to other foodstuffs.



As the graph above illustrates, loss and waste levels across all phases of the agri-food chain for oilseeds and pulses are below 10 percent, with the exception only of post-ripening and harvest losses in middle and low income countries of ECA, which rise to 19 percent and 16 percent respectively. Indeed the only other phase during which loss and waste levels rise above 5 percent is during processing and packaging in low income countries, the same phase also seeing the next highest levels of losses and waste in both middle and high income countries of the region.

Agricultural production

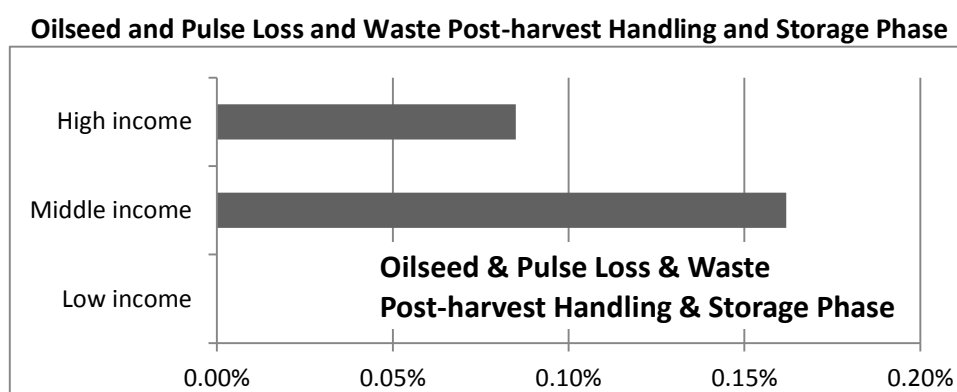
The agricultural production phase of the oilseed and pulse agri-food chain, as with other crops is defined as the period from the moment a crop is ripe in the field to the time that it has been harvested. The graph below therefore presents the percentage of crops lost during this period.



As mentioned above, the agricultural production phase sees the highest loss levels across all phases of the oilseed and pulse agri-food chain in middle and low income countries, where it accounts for 19 percent and 16 percent of the ripened crop. Although at least in middle income countries harvest and logistics machinery is being upgraded, shortage of machinery and use of outdated combines and trucks can lead to losses both through spillage and through late harvest and subsequent deterioration of the crop. In addition, extreme weather, including excessive rain as well as arid conditions during the pre-harvest period can have a major impact on yields, particularly where suitable varieties have not been employed.

Post-harvest handling and storage

The post-harvest handling and storage phase of the oilseed and pulses agri-food chain is the period from the moment a crop has been harvested to the moment it leaves storage for processing. The graph below therefore presents the percentage of oilseed s and pulses lost during this period.

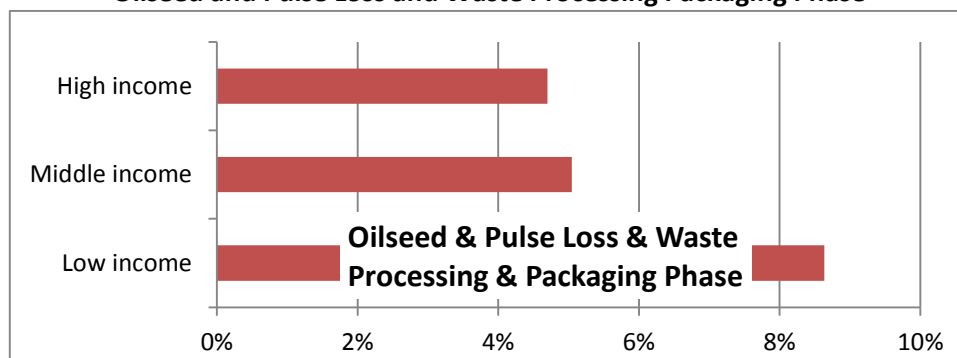


As the graph above illustrates, losses are negligible during this phase across all country groupings, at less than 0.2 percent. This is partly a result of almost no intervention requirements between harvest and processing and partly because for the most part drying and storage facilities are modern and technologies and management up to international standards due to foreign investment in leading regional producers such as Ukraine.

Processing and packaging

The processing and packaging phase of the oilseed agri-food chain includes transport to the processors as well as processing, bottling of edible oils and loading of trucks for distribution or export. The graph below presents percentage losses during these processes.

Oilseed and Pulse Loss and Waste Processing Packaging Phase

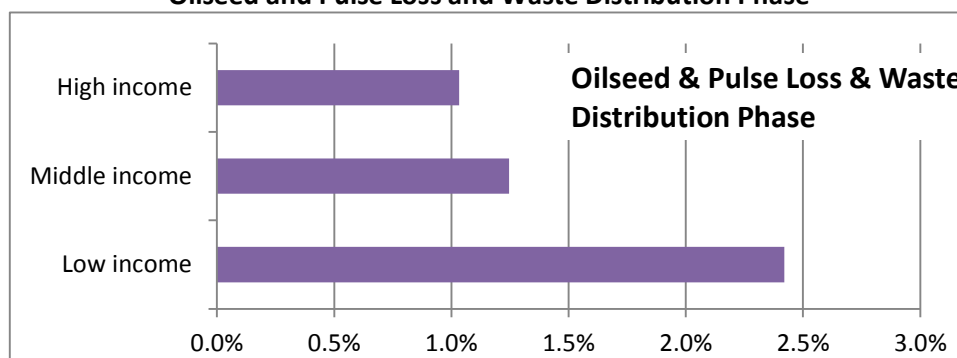


As the graph illustrates losses and waste are low and almost indistinguishable between high and middle income edible oil producing countries in the region, again because either of major international players investing in processing capacity in middle income countries of eastern Europe or because of the import of modern facilities by local producers, particularly in the Balkan region. Low income country processing is more prone to losses, with levels rising to nearly 9 percent, as a result of older technologies and management practices and higher exposure to poor physical infrastructure and utilities.

Distribution

The distribution phase of the oilseed agri-food chain comprises the processes of transportation and storage between the processing facility and purchase by consumers. Loss and waste levels during this period are reflected in the graph below.

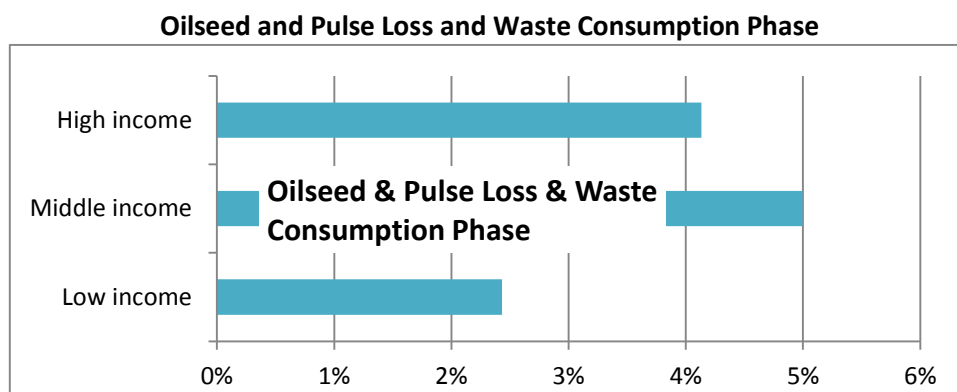
Oilseed and Pulse Loss and Waste Distribution Phase



As a result of plastic bottling of edible oils and widespread packing of bottles in protective cardboard boxes as well as the relatively longevity of oil products in comparison with fresh foods, very low levels of loss and waste are experienced even by low income countries for such products. Damage to packaging through increasingly poor road infrastructure and storage conditions in middle and low income countries can explain the rising level of losses from 1 percent in high income countries to 1.2 in middle income countries and 2.4 in low income countries.

Consumption

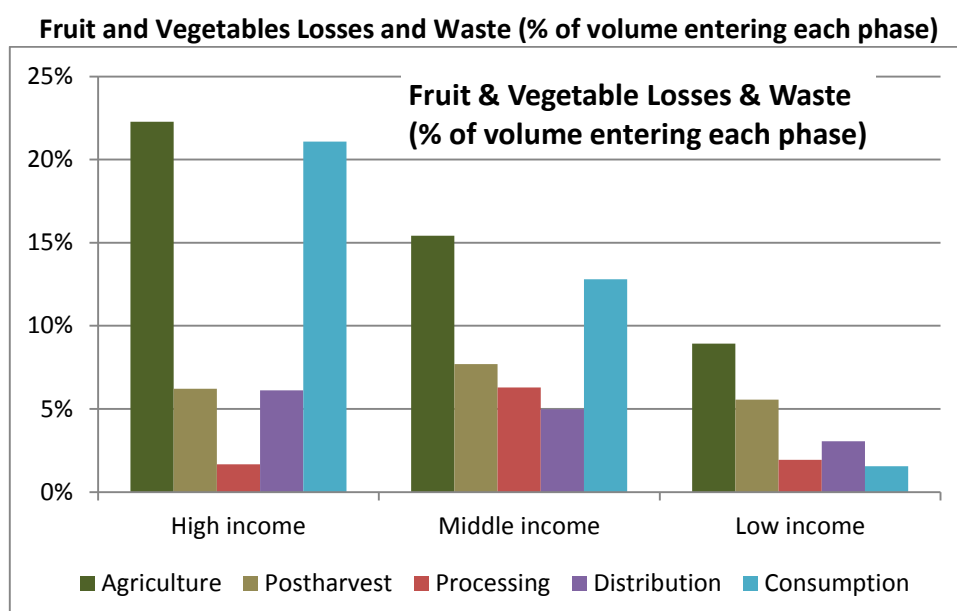
As with other products, the consumption phase for edible oils begins from the moment they are purchased by consumers and ends with their consumption. Loss and waste levels are reflected in the graph below.



Again due to the prevalence of modern packaging across the region and to the long storage life of edible oils, loss and waste levels are 5 percent or below in all country categories. Interestingly the middle income has the highest level of waste during this phase, perhaps due to more sparing purchase and use by high income and low income consumers, for health and wealth reasons respectively.

7.4 Fruits and Vegetables

Within the fruits and vegetables commodity grouping, key products in volume and value terms for ECA regional producers include cabbage, carrot and onion among winter vegetables, cucumber and tomato among salad vegetables and apples, table grapes and berries among fruits. From these key products, the country studies conducted by FAO during 2013 identified apple (Armenia and Ukraine), tomato (Armenia and Turkey) and olives/olive oil (Turkey) as key products for in-depth analysis, based on their importance in volumes, value, income generation, nutrition and relative exposure to losses and waste.

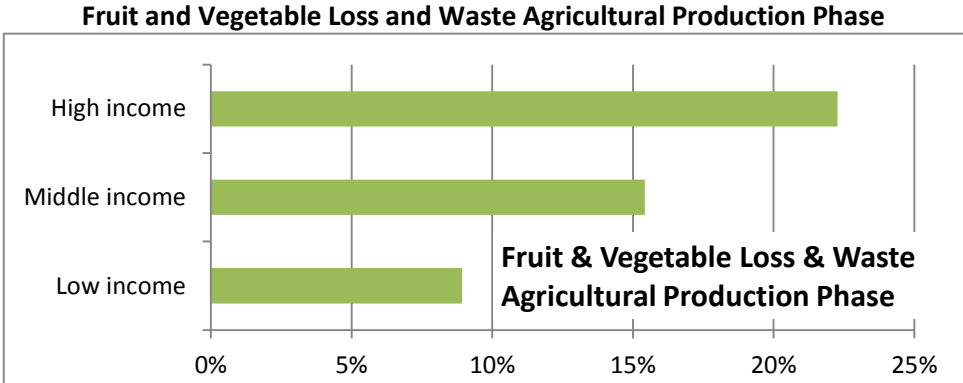


As in the potato agri-food chain assessed above, high income ECA countries witness high levels of waste at the agricultural production and consumption ends of the supply chain, both over 20 percent of the volumes of production entering each phase, as a result of high quality standards, overproduction and excessive purchase by consumers.

Middle income countries also see high production and consumption phase losses, both over 10 percent as well as an increasing level of post-harvest handling and storage losses of approximately 7 percent as a result of cold chain logistics issues and poor storage capacity. Low income countries major issues are during the production and post-harvest and storage phases (both over 5 percent losses), although overall losses and waste appear to decrease with decreasing country income levels.

Agricultural production

As with other non-animal products, the agricultural production phase in the fruit and vegetable agri-food chain comprises the period from the moment of ripening of fruit and vegetables to the completion of its harvest. The graph below shows relative loss and waste levels during this phase by country income level in the ECA region.



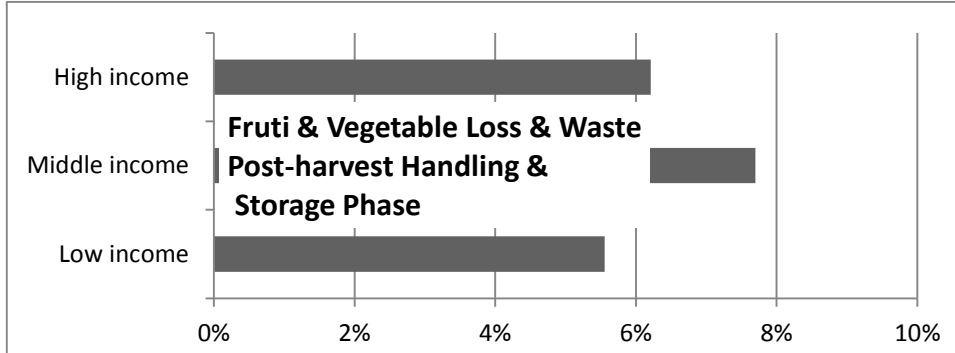
Although the graph above suggests that high income countries lose or waste substantially more during this phase than middle and low income ECA countries, with levels of 22 percent as against 15 percent and 9 percent for middle and low income countries, the explanations for such losses and waste vary widely. The Global Food Loss and Waste Study argued that the key cause for waste during this phase in high income countries was discarding or relegation to animal feed of edible produce on the grounds of size, shape, weight and colour as well as overproduction in order to ensure delivery of contracted volumes irrespective of adverse weather or blight.

The country studies conducted by FAO during 2013 in middle and low income countries, however, identified quite different explanations for loss levels encountered by horticultural producers, ranging from market price fluctuations making it unprofitable to harvest crops during the peak season, to tree fruits being too high to access by pickers, to pests, degradation and heat damage both prior to and immediately after the harvest, exacerbated by a marked absence of pre-cooling capacity across the western Balkans and former Soviet Union.

Post-harvest handling and storage

The fruit and vegetable post-harvest handling and storage includes transport to post-harvest facilities, washing, grading and storage and loading on to transport to processing facilities or wholesale and retail markets. Relative loss levels by country grouping are provided in the graph below.

Fruits and Vegetable Loss and Waste Post-harvest Handling and Storage Phase

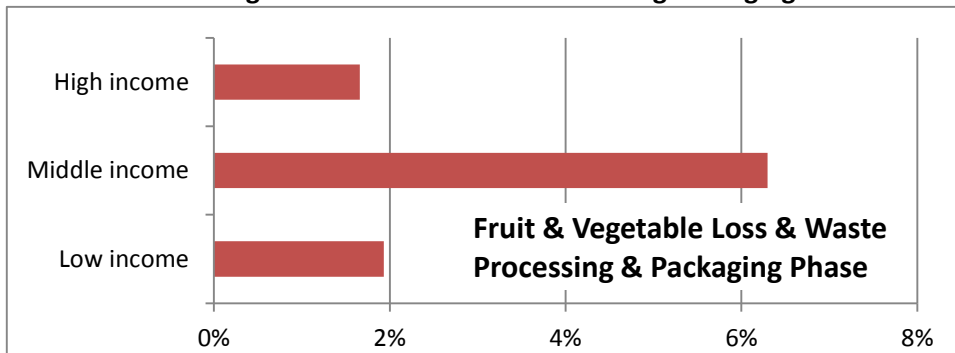


During this phase of the horticultural agri-food chain, ECA countries of differing income levels are seen to encounter roughly similar overall levels of loss and waste, all falling between 5 percent and 8 percent of harvested crops. But again, while high income losses may arise from mechanized post-harvest processes and additional sorting out of non-uniform produce at this stage, low and middle income countries are victim of huge under-capacity in temperature and ventilation controlled transport and storage capacity (Ukraine has only 30 percent of the required capacity according to experts interviewed), resulting in high levels of losses to degradation and pests of fruit and vegetables that go into medium term storage through the winter and losses through heat damage to perishable summer fruits and vegetables.

Processing and packaging

The processing and packaging phase of the horticultural chain includes, where applicable the packaging of fresh fruit and vegetables prior to transportation to markets, as well as any processing and/or conserving of horticultural produce, to the point it is loaded for market.

Fruit and Vegetable Loss and Waste Processing Packaging Phase

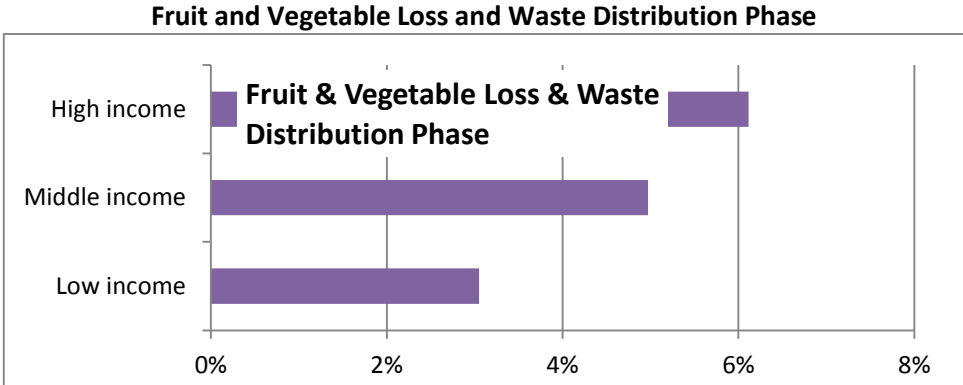


The graph above shows that high and low income ECA countries lose relative low levels of horticultural produce during processing and packaging (both under 2 percent), in high income countries likely as a result of high technology processing and control systems, while in low income countries it is more likely a result of simpler practices (such as pickling) and less stringent control of products processed

Middle income countries, however, are subject to over 6 percent losses during this phase canning, juice and puree production, primarily as a result of product spoilage in transit or storage, mechanical failure and human error during processing and poor utilities provision, including power outages during production.

Distribution

The distribution phase of the horticultural value chain marks the period from the loading of produce from its place of packing or processing (or from the farm, if it is not packed for sale) to the moment of purchase by a consumer. Relative loss levels by ECA country income category are illustrated below.



Perhaps surprisingly, the highest level of loss or waste during the horticultural distribution phase is witnessed in high income ECA countries. This is for the most part fresh produce, wasted as a result of over-ordering by retail chains in order to ensure a wide variety and full shelves in flagship fresh fruit and vegetable departments. Seasonal demand also drives retail ordering in high income countries and the difficulty in foreseeing, for example how many Brussels sprouts will be purchased by UK consumers over the Christmas period, again leads to erring on the side of excessive orders by retail chains. A further factor, identified by the Global Food Loss and Waste Study is poor refrigeration, meaning that often cold-sensitive produce are stored at excessively low temperatures and heat-sensitive products at excessively high temperatures.

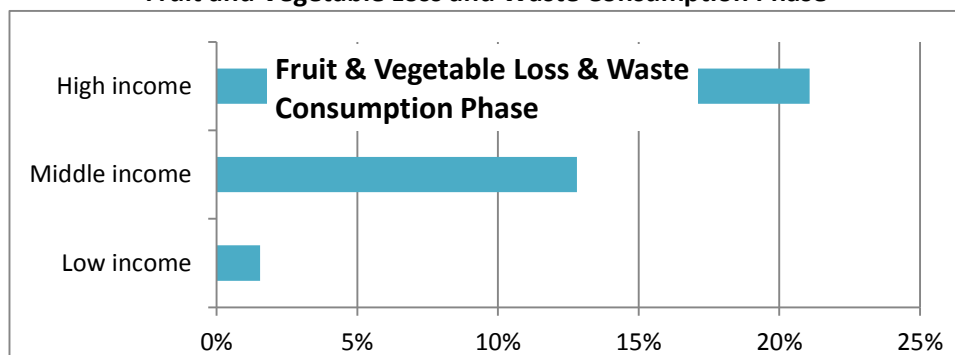
Loss levels during this phase in middle and low income countries mask losses initiated during this phase, but not realized until the consumption phase. An absence of chilled transportation and with the bulk of fresh fruit and vegetables in such countries being traded in open air markets and sold without any refrigeration and substandard packaging takes its toll on produce, causing losses.

Consumption

The consumption phase of the horticultural agri-food chain lasts from the moment of purchase by consumers of fresh or processed fruit and vegetables to the moment of consumption. Relative loss levels are provided in the table below.

Again, and in line with the broad findings of the Global Food Losses and Waste Study, high income ECA countries are seen to experience the highest levels of waste during this phase, at over 20 percent. This level falls to 13 percent in middle income countries and as low as 2 percent in low income countries.

Fruit and Vegetable Loss and Waste Consumption Phase

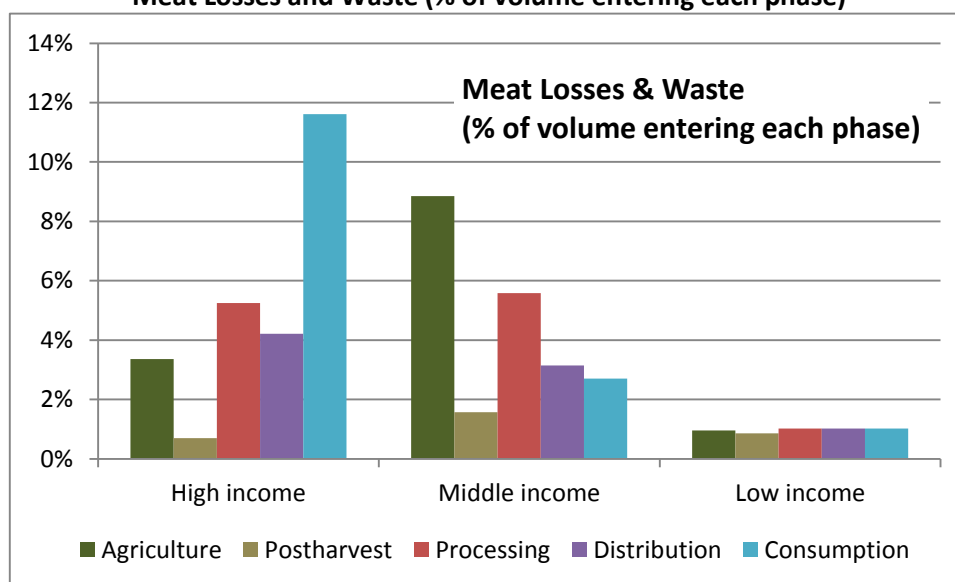


But further, unwary or price-conscious customers buying such produce take on the loss, having to discard purchased products a maximum of 24 hours after purchase or having to cut out a large part due to degradation.

7.5 Meat

Within the meat commodity grouping, key products in volume and value terms for ECA regional producers are beef and veal, pork, mutton and lamb and poultry as well as processed and cured meat products. Of these, the country studies conducted by FAO during 2013 identified beef (Armenia and Turkey) and pork meat and products (Ukraine) as key products for in-depth analysis, based on their importance in volumes, value, income generation, nutrition and relative exposure to losses and waste.

Meat Losses and Waste (% of volume entering each phase)

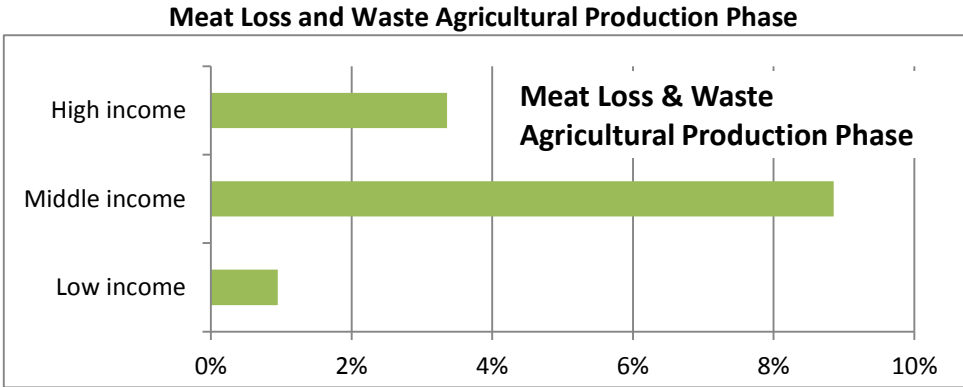


For meat and meat products, high income ECA countries witness the highest levels of loss and waste during the consumption phase (nearly 12 percent), followed by the processing and distribution phases (at 5 percent and 4 percent respectively). Middle income ECA countries experience far higher levels of losses during agricultural production (nearly 9 percent) and marginally higher levels during processing (5.5 percent). Interestingly, low income countries report loss and waste levels at below 1

percent at each phase of the agri-food chain, perhaps reflecting fewer discards of non-meat animal parts and higher levels of consumption of degraded produce as a result of relatively higher prices for such products.

Agricultural production

The agricultural production phase for meat agri-food chains requires some clarification of definition, in that this study followed the Global Food Loss and Waste Study methodology by including ‘animal death during breeding’. This seems to be excluded from the definition of food loss developed in January 2014 by the Save Food project, which states that meat losses can only be considered when ‘animals are on the farm (in the field, sty, pen, shed or coop) ready for slaughter; this means that taking the animals to the abattoir is a post-harvest activity, and slaughtering is agro-processing’. Under the latter definition, it appears that the agricultural production phase losses could only include any losses in the period between animals being ready for slaughter and being loaded for transport to the abattoir.

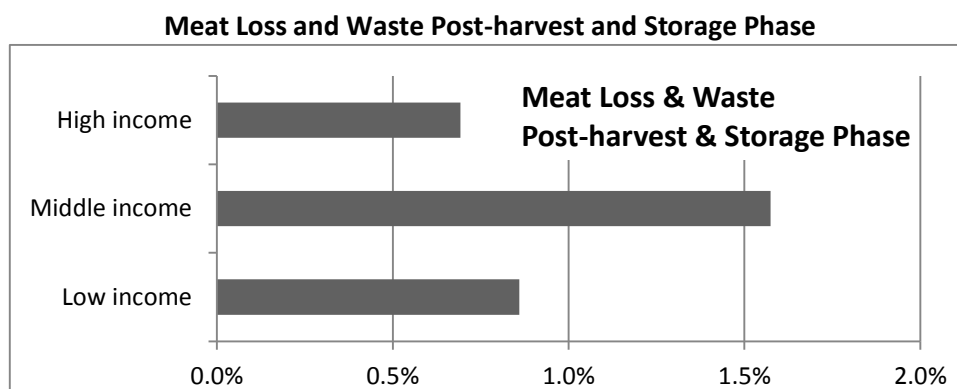


The graph above shows relative loss and waste levels during agricultural production, taken to include animal death during breeding. While high income countries experience a moderate 3 percent losses during breeding, middle income countries have a higher rate of losses due to less refined breeding practices and lower response rates to complications during pregnancy and birthing. Low income country losses at just under 1 percent appear unrealistically low, although this may be explained to some extent by an increased penetration of smallholder producers, who are relatively more attentive to maintenance and breeding issues than those on unreformed middle income collective livestock farms.

Post-harvest handling and storage

The post-harvest handling and storage phase of meat agri-food chains includes losses due to death during transport to slaughter and condemnation. Relative loss levels by country income category are provided in the table below.

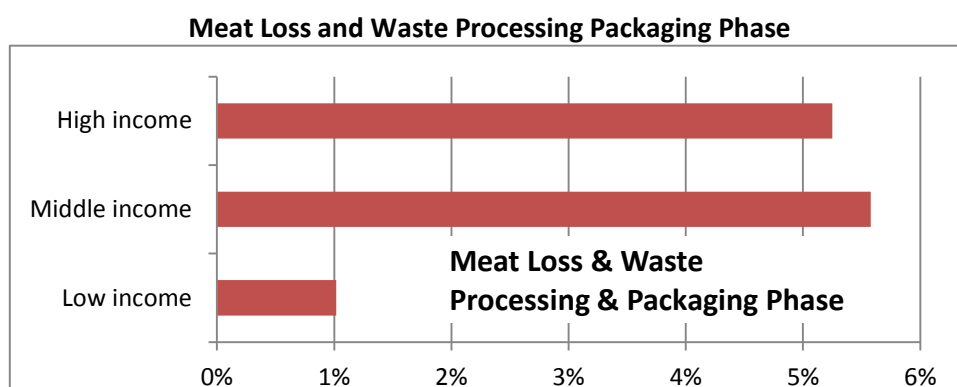
Transportation losses of livestock are generally caused by extended distances to slaughter facilities, poor road infrastructure and use of non-specialized trucks and fastenings. As may therefore be expected, high income ECA countries witness the lowest levels of losses during this phase (0.7 percent), compared to over 1.5 percent in middle income countries.



Again the relatively low (0.8 percent) losses in low income countries may be a result of relatively higher levels of on-farm slaughter by smallholder producers and therefore low levels of transportation to slaughter.

Processing and packaging

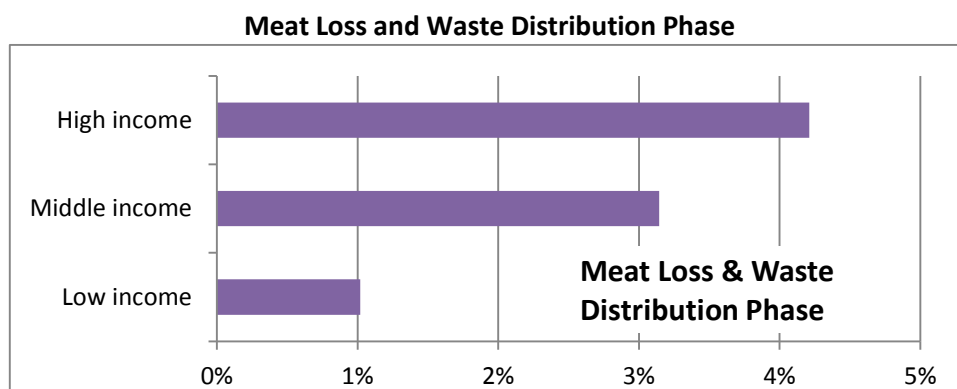
Losses and waste during the processing and packaging phase of meat agri-food chains refer to trimming spillage during slaughtering and additional industrial processing (e.g. sausage production). The relative losses and waste by ECA country category are illustrated below.



While the loss and waste levels of high and middle income countries are both in the range 5-6 percent during the processing and packaging phase, the causes vary in that high income country losses result from higher quality standards, wasteful offcuts and retailer over-ordering, while those in middle income countries result more from poor sanitation, cold storage and mechanical and human error during processing. Losses and waste, particularly in middle income countries also masks the discard of up to 20 percent of the body mass of animals, comprising offal and other edible parts, by commercial abattoirs. Smallholders in both middle and low income ECA countries are less wasteful and multiple dishes and conserves have been developed to minimize animal product waste.

Distribution

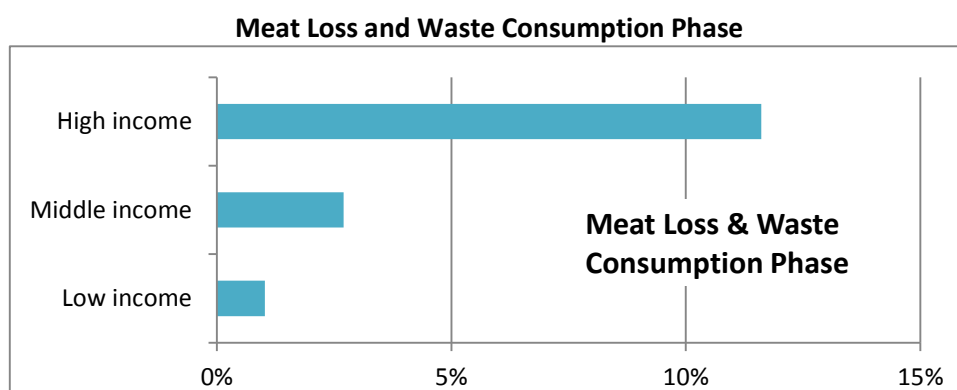
The distribution phase of meat agri-food chains begins with loading of final products for market at their final butchery or processing facility and ends with their purchase by consumers at the retail stage. The graph below provides the relative loss and waste levels during this phase by country income level.



At over 4 percent, high income country losses are higher at this stage than their lower income peers, largely due to more strictly observed use by dates. Despite poorer sanitation, cold storage, transportation and packaging, middle and particularly low income countries (at 3 percent and 1 percent losses respectively) pass on losses to consumers by treating meat and products to appear fresh, cooking and processing old fresh meat and engaging in secondary grey market activities that keep meat in the food chain, even when it may already be a risk to public health.

Consumption

The meat chain consumption phase begins with the purchase of meat or meat products by a consumer and ends with its consumption. The relative loss and waste levels are illustrated in the graph below.

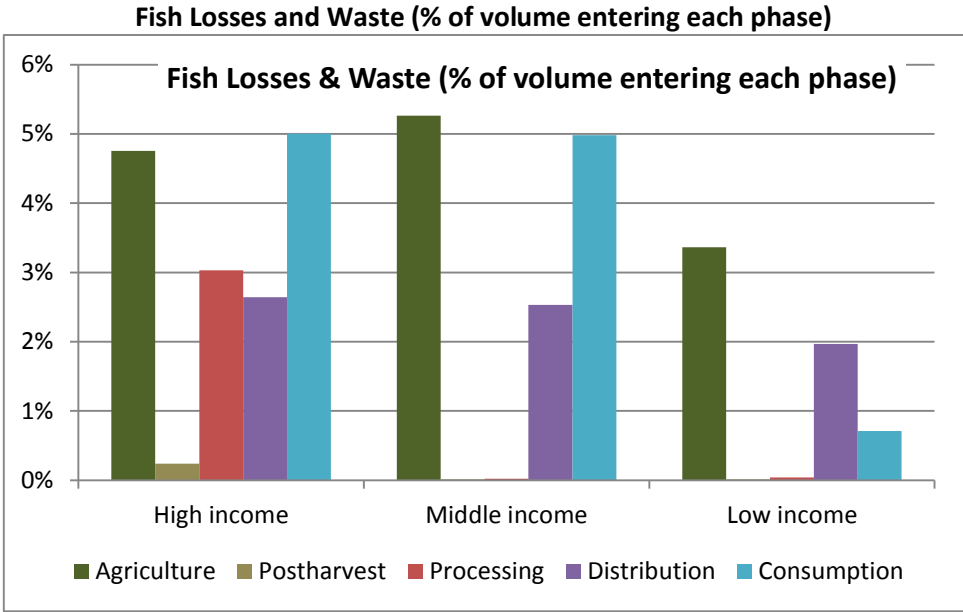


Bearing out earlier conclusions, high income consumers are more prone to over-buying meat and discarding it while it may still be edible. The level of 12 percent waste in high income countries falls dramatically to 3 percent in middle income and 1 percent in low income countries, reflecting far more conservative buying habits and more scrupulous eating habits of high cost meat and products by lower income consumers.

7.6 Fish and Seafood

Within the fish and seafood commodity grouping, key products in volume and value terms for ECA regional fisheries and fish farmers range from pelagic and semi-pelagic Atlantic, Mediterranean, and Baltic species to crustaceans and molluscs and freshwater fish. Of these, the Turkey and Armenia

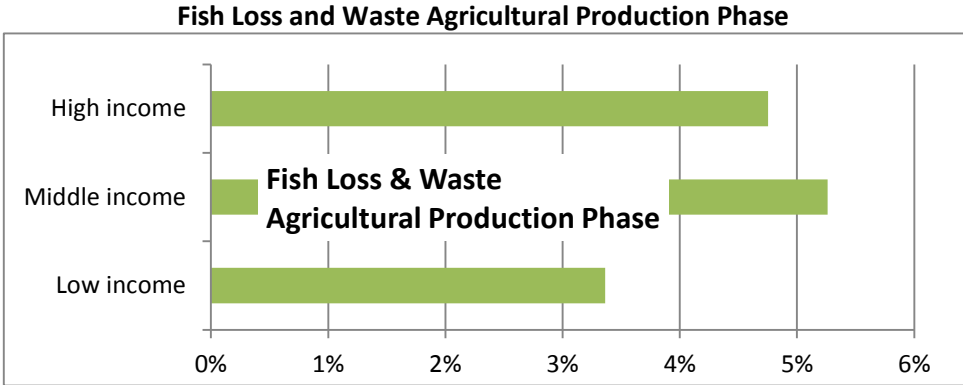
country studies conducted by FAO during 2013 included fresh fish in their analyses of losses and waste.



In high and middle income countries the agricultural production and consumption phases witness the highest loss and waste levels for fish and seafood products, accounting for 4.5-5.5 percent of the volume of produce entering these food-chain phases. In low income countries agricultural production losses also pose a challenge, although at a lower 3 percent level. Across all income country levels cold chain and distribution logistics result in 2-3 percent losses, while processing losses are only witnessed in high-income economies, largely due to the absence of fish processing in lower income countries.

Agricultural production

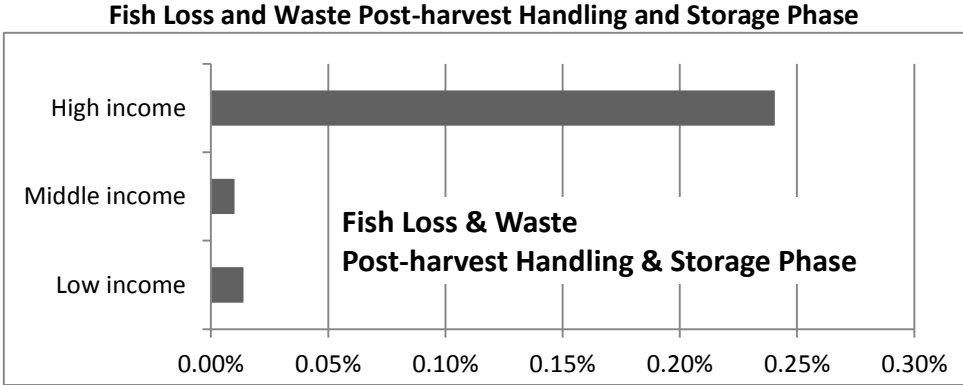
The agricultural production phase for the fish and seafood food-chain begins when fish is either mature in the pond or ensnared in the net. It therefore includes discards and losses of mature fish stocks on farms. Relative losses during this phase are presented in the graph below.



While high income country losses are largely explained by discards, particularly of marine caught wild fish, middle and low income losses are explained more by poor technology on fish farms, leading to overstocking or disease among mature fish populations. Fish farming is the only source of local fish in land-locked middle and low-income countries of the Balkans, central Asia and the southern Caucasus.

Post-harvest handling and storage

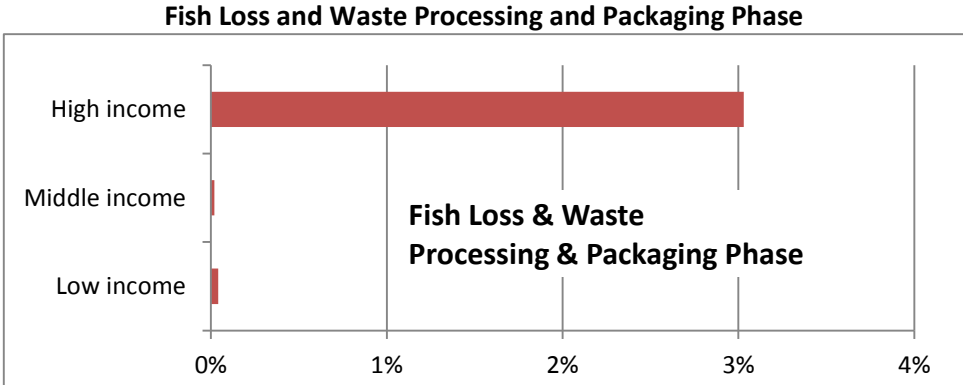
The post-harvest handling and storage phase of the fish and seafood chain includes spillage and degradation during icing, packaging, storage and transportation after landing. Relative loss levels by country income level are illustrated in the graph below.



Losses during this phase are minimal across all country income groupings, at less than 0.25 percent. Perhaps surprisingly middle and low income countries register even fewer losses than high income countries, although, given the absence of the processing and packaging phase in such countries, losses during this phase are likely included in their relatively higher loss disclosure during the subsequent distribution phase, when damage and degradation during icing and packing become evident.

Processing and packaging

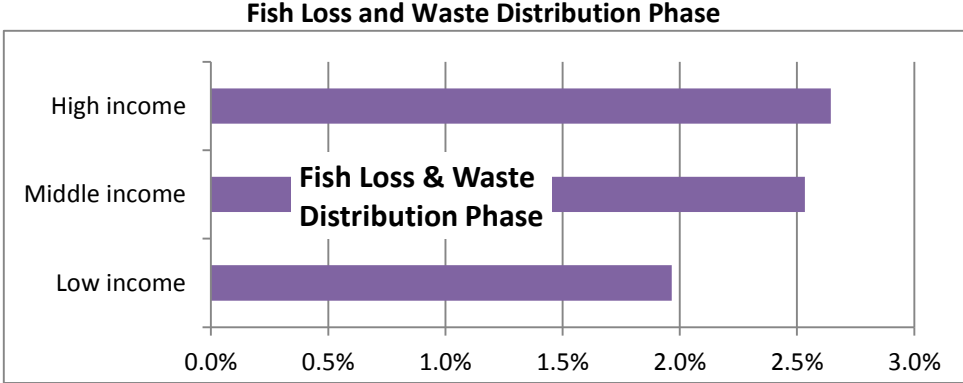
Losses during the processing and packaging phase of the fish and seafood chain refer to losses during industrial processing such as canning or smoking. Relative loss levels in this phase by country income category are presented in the graph below.



As mentioned, while even in high income countries losses are at a low 3 percent level, perhaps reflecting superior processes employed due to the high value of fish and seafood products, middle and low income countries show zero waste during this phase. Perhaps explicable by very low levels of fish processing in middle and low income countries, what losses do take place in canning and smoking may also be masked by practices such as personal staff liability for losses, which mean that they are not reflected in processors' accounts.

Distribution

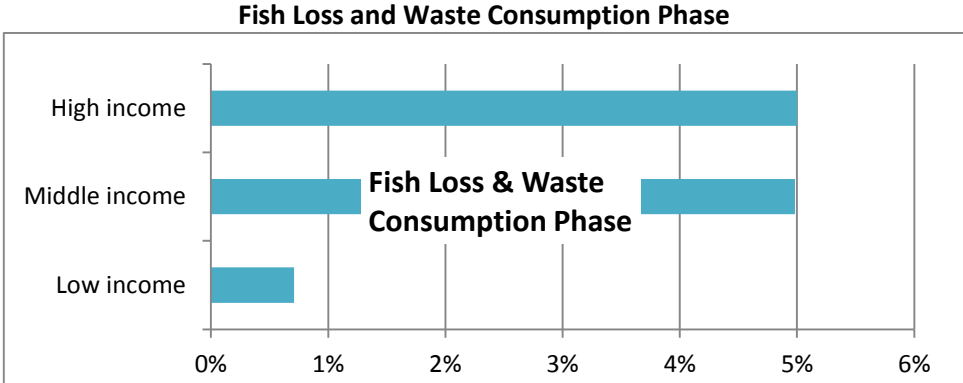
As in other chains, the distribution phase for fish and seafood includes transportation to and storage at wholesale and retail markets prior to sale to consumers or catering facilities. The relative loss and waste levels are illustrated in the graph below.



Between 2 percent and 3 percent losses are witnessed during this phase for all three country income categories, although the low income countries are at the lower end of this scale. This illustrates the perishability of fresh fish, which even modern technologies and regular purchasing practices by consumers and caterers cannot reduce further. That said, from the Armenia and Turkey country studies, it is clear that there is room for improvement in logistics, packaging and cold storage practices in middle and low income countries.

Consumption

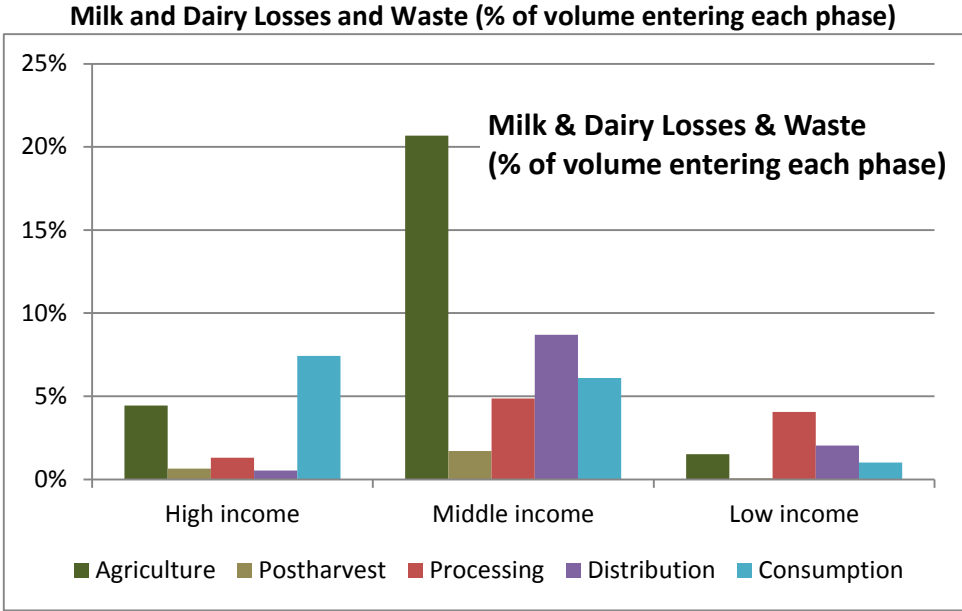
The consumption phase of the fish and seafood chain begins with purchase by consumer or caterer and ends with consumption. Relative loss and waste levels are illustrated in the graph below.



While both high and middle income countries experience similar levels of loss and waste (approximately 5 percent), it is likely that such levels are comprised more of waste of edible product in high income countries and more of discard of degraded product due to poor distribution infrastructure in middle income countries. Low income countries witness less than 1 percent of losses and waste perhaps due to the scrupulous purchasing (only fresh) and consumption (no waste) habits of low income consumers.

7.7 Milk and Dairy

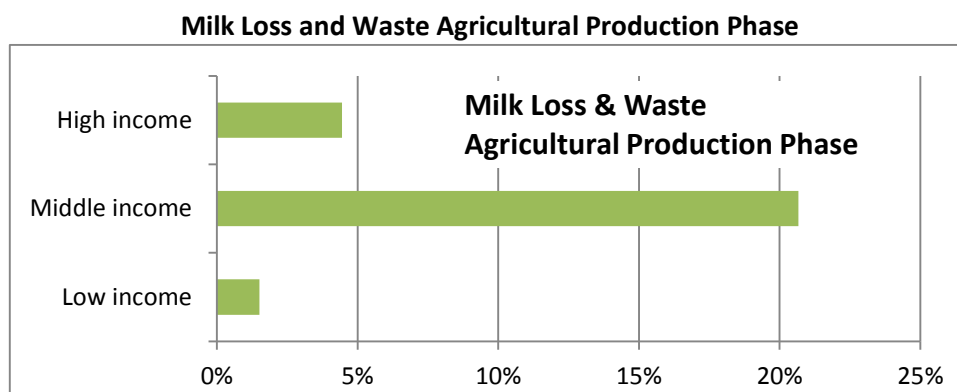
Within the milk and dairy commodity grouping, key products in volume and value terms for ECA member countries include fresh and long-life milk, sour milk products and yoghurts and cheese. The Armenia, Turkey and Ukraine studies conducted by FAO during 2013 all included analysis of the milk and dairy product agri-food chain in their analyses of losses and waste, given their importance in volumes, value, income generation, nutrition and relative exposure to losses and waste.



As in other food chains, high income countries witness their highest levels of loss and waste in the dairy sector during the consumption phase, with estimated losses and waste at 7 percent of produce purchased. 4 percent losses are seen in the agricultural production phase with minimal losses and waste between the farm and retail. Middle income countries see the highest levels of losses among all income groupings and food chain phases during agricultural production (over 20 percent), primarily due to poor cattle management and milking practices. Processing, distribution and consumption losses are also 5 percent and higher, reflecting technological and cold chain deficiencies, leading to losses and shorter storage and shelf-lives of products. Interestingly low income countries witness the lowest levels of losses, perhaps a reflection of household consumption of milk by smallholder producers. Processing, where it occurs, shows the highest levels of losses, due to poor sanitation and primitive technologies.

Agricultural production

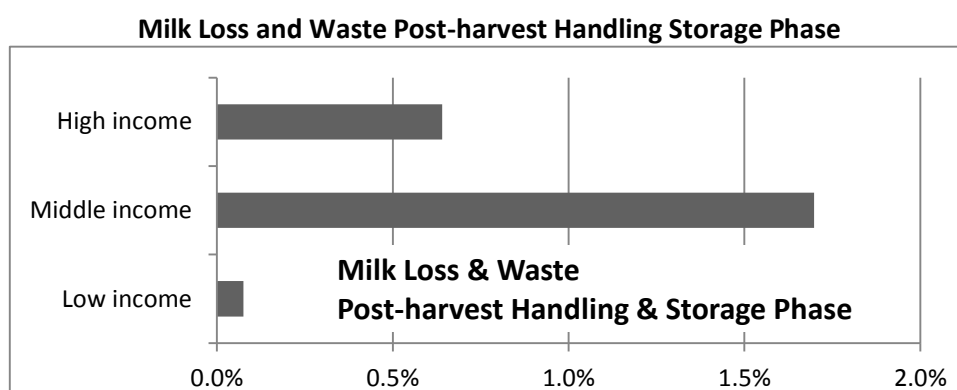
The definition of losses during the agricultural production phase of the milk and dairy agri-food chain, like those for the meat chain, require reconciliation. The Global Food Losses and Waste Study, the methodology for which this study follows, defines losses during this phase as including decreased milk production due to dairy cow sickness (mastitis), while the recent Save Food definition does not consider losses to be counted until milk has been drawn from the udder.



This discrepancy, particularly in that the Global Study appears to include a range of loss causes relating to cattle health and maintenance, may explain the large discrepancy between losses illustrated by the graph above. While it can be expected that high income countries lose considerably less during production due to improved practices and technology, it is nevertheless likely that middle and low income country studies used differing interpretations of the Global Study definition as smallholder cattle maintenance and milking practices, accounting for the bulk of milk production in both middle and low income countries, do not differ substantially between middle and low income countries.

Post-harvest handling and storage

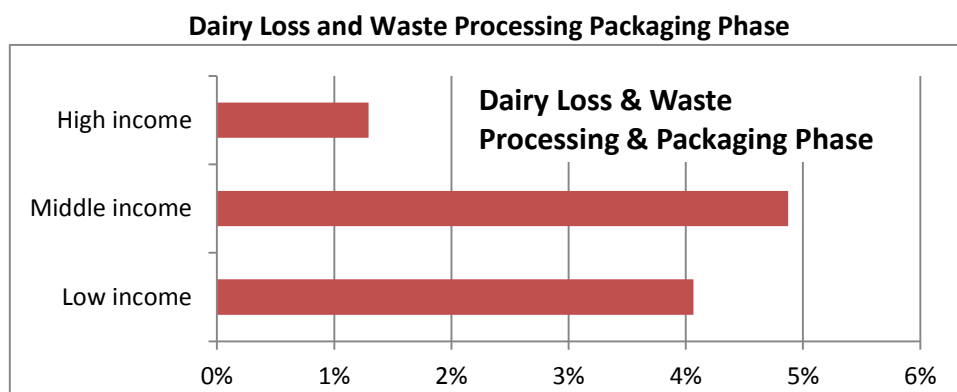
The post-harvest handling phase of the milk and dairy defines losses as referring to spillage and degradation during transportation between farm and distribution. The relative loss levels between ECA income country groupings are illustrated by the graph below.



Loss levels across country groupings are low during transportation between farm and distribution, with even the highest losses, those of middle income countries below 2 percent of volumes loaded. Despite considerably lower quality and higher initial degradation of milk loaded in middle and low income countries as a result of inadequate cooling after milking, the shortage of milk in such countries leads dairies to accept milk of far lower quality than in high income countries.

Processing and packaging

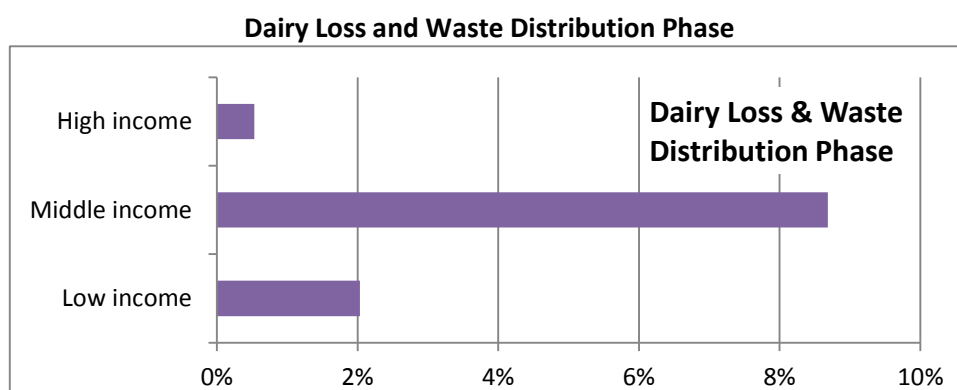
Losses during the processing and packaging phase of the milk and dairy food chain refer to spillage during industrial milk treatment (e.g. pasteurization) and milk processing to e.g. cheese and yoghurt. Relative loss levels during this phase by income country grouping are illustrated in the graph below.



Middle and low income countries both experience loss levels of between 4 percent and 5 percent during the processing and packaging phase, compared to high income country losses of just over 1 percent. Middle and low income losses are due in large part to mechanical and human error during processing, which lead to entire batches of produce spoiling. Overproduction when introducing new products, as a result of fixed minimum machinery capacity, is also a cause of waste, particularly in middle income countries.

Distribution

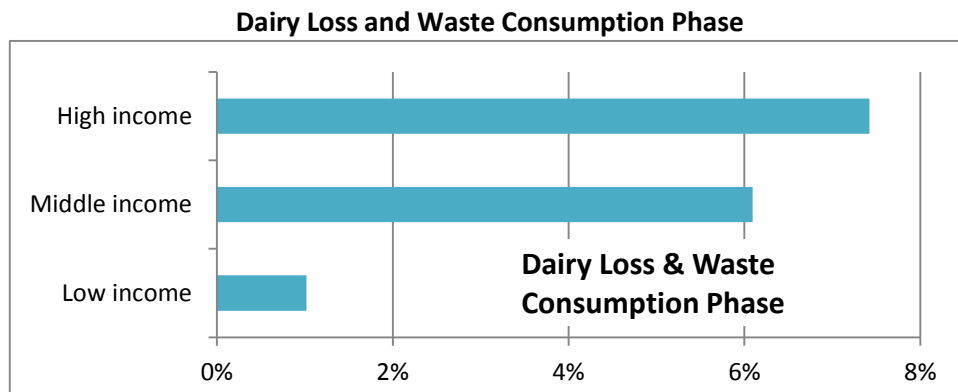
As in other agri-food chains, losses and waste in the distribution phase for milk and dairy phase includes losses and waste in the market system, at e.g. wholesale, supermarkets and retailers. Relative loss and waste levels by ECA country grouping are illustrated by the graph below.



Once again middle and low income countries far outstrip high income countries in loss levels during milk and dairy product distribution. While high income countries witness losses of under 1 percent of produce dispatched by dairies, losses in low income countries rise to 2 percent and those in middle income countries to nearly 9 percent. Here, as in the meat value chain, the primary cause of losses is absence of sanitation and refrigeration in transport and at the retail stage, particularly where produce is sold through open markets or kiosks rather than retail chains.

Consumption

The consumption phase of the dairy chain begins with purchase of milk and dairy products by the consumer and ends with their consumption. The graph below illustrates relative loss levels by ECA country income grouping.



During this phase, in line with the overall trends presented in this and previous studies, the highest levels of waste are to be found in high income countries (over 7 percent), due to over-purchasing and strict adherence to sell-by and best-before dates (sometimes confused) by consumers. Middle income countries are also relatively wasteful (at 6 percent), but to some extent their waste can be considered a loss caused by poor quality inputs, packaging and cold storage at earlier stages of the food chain, which lead to quick spoilage of produce once purchased. Low income countries witness the lowest level of loss and waste at 1 percent of milk and dairy produce purchased, showing the highest aptitude to find means to consume even spoiled milk and dairy produce.

8. MAIN CAUSES OF FOOD WASTE AND LOSSES IN THE REGION

The main causes of food waste and losses among middle and low income countries in the region are analysed below, by category of factor. Attention is given to what are considered 'avoidable' losses, rather than losses caused by freak weather (e.g. storms after crop ripening or extreme temperatures or during harvest), unless these can be mitigated by technology or improved practises.

8.1 Resources and Technologies

As noted in the afore-going section, the bulk of losses in middle and lowing income ECA countries are evidenced at the agricultural production and post-harvest handling and storage stages of food supply chains. These result in large part from an insufficient supply of modern harvest, post-harvest and storage machinery and equipment.

Exacerbating this absence of investment in technological upgrades are the overall investment climate and difficulty of doing business in many south-east European and former Soviet states, compounded by discouragingly high rates of interest (often over 20 percent per annum) charged by commercial lenders to value chain actors and the prohibitively high levels (up to 50 percent per annum) charged by commercial lenders and credit unions to small producers, SME actors and market entrants.

Agricultural production

In the grain sector, this applies to the combine and grain truck fleets, as well as to grain elevators, for which outdated and substandard technology continues to be used as a result of the shortage of investment in more efficient machinery and facilities. Industry leaders stated that although the number has fallen considerably in recent years, Soviet era combine harvesters (or those over 20 years old) that can lose up to 30 percent of a standing crop are still in use in middle income countries and are particularly prevalent in low-income countries. Overall industry representatives complained of a marked shortage of combines leading to overworking of the existing fleet and slow northward progress of the harvest from earlier harvest regions in the south. Research conducted by the Ukrainian Academy of Agrarian Sciences shows that loss rates through delays to harvest can rise to 30 percent of wheat harvests, if crops are left standing between 17-20 days in the field.

Outdated harvest machinery, poor timing and harvesting practises as well as inadequate transport from the field also result in high loss levels in the root and tuber and fruit and vegetables groupings, particularly where it relates to soft fruits and salad vegetables, such as tomato. Interestingly, as smallholder producers dominate this sector, unless crops are left un-harvested due to overproduction, low prices and a lack of cold storage, harvest losses are relatively lower as a result of hand harvesting and shorter transportation distances on smallholder farms.

Pests are also a particular threat to fruit and vegetable harvest that could be addressed by the introduction of improved pest control technologies to reduce particularly bird damage to tree crops and insect, rodent and fungal damage to root crops. A significant factor in harvest losses of tree crops is the continued production on old and tall trees, of which higher branches are not accessible

to harvesters. Investment in modern dwarf varieties as well as harvest technology and improved harvesting techniques could reduce such losses substantially.

Whilst acknowledging difficulties with the definition of agricultural production phase losses outlined in the previous section and depending upon the breadth of interpretation of such definitions, losses in the meat and milk value chains arise from poor feed, maintenance and veterinary technologies, particularly among middle and low income producers, as well as late or non-introduction of milk substitutes and weaning of calves as well as primitive and unsanitary milking conditions and equipment in the dairy agri-food chain.

Post-harvest handling and storage

The insufficient supply of modern post-harvest equipment and storage capacity is particularly pronounced in fruit and vegetable (including potato) grouping and the absence of modern milking equipment and milk cooling capacity is likely the largest single cause of losses in the dairy sector. Losses in these sectors are particularly pronounced as fruit, vegetable and milk producers are overwhelmingly small producers, who lack the access to modern practises, technology and sanitation to address critical loss points.

The immediate threat to fruit, vegetables and potatoes after harvest is temperature, particularly in southerly countries of the region, such as south-central Asia, Turkey and the Balkans. Poor timing of harvest (i.e. if left until the middle part of the day or later), compounded by the almost universal absence of pre-cooling facilities available to small farmers results in either immediate spoilage or substantially reduced storage or shelf life of the products.

Further, many low and income countries in the region are forced to import fresh fruit and vegetables, including apples, grapes, peaches, onions and potatoes, despite that they produce competitive products of their own. This is a result of inadequate investment in pre-cooling and refrigerated transport to ensure that product is delivered to market in good condition, as well as the shortage of temperature and ventilation controlled storage, to allow produce to be stored beyond the unprofitable post-harvest supply peak. Indeed, retail outlets complain that during the March-May period they are forced to import large amounts of apple and potato, when prices in the region start to rise as a result of lack of decent local product before the early season produce harvests in spring.

Given the extremely high proportions of fruit and vegetables produced by smallholder farmers in low and middle income ECA countries, their storage practises are also a major cause of losses and waste. The case of potatoes in Ukraine is an important example. After initial hand-sorting, potatoes are stored primarily in cellars 2-5 metres underneath rural dwellings for the winter. To a lesser (and falling extent) potatoes are also stored in sack-loads for the winter by city dwellers on covered apartment balconies and other cool, dark places. Losses primarily to rot in such primitive storage are estimated at 20-30 percent.

Household producers interviewed admitted that likely only 30 percent of their potatoes were consumed by humans, the remainder being relegated to animal feed, used as fertilizer or simply thrown away during post-harvest sorting, storage or in spring when new potatoes become available. Although it can be argued that smallholders deliberately over-produce in an effort to ensure a food safety net both for themselves and their livestock, if edible produce fed to animals is considered a

loss or waste, simple improvements to household storage facilities, could make a major impact on losses in for such products and an increase in commercial temperature and ventilation controlled facilities could help mitigate losses caused by bumper harvests, such as 2011, when due to the fall in prices resulting from levels of supply, up to 30 percent of the crop was left un-harvested.

Representatives of leading supermarkets in Ukraine, for example, complained that after the New Year there are only five national suppliers able to offer quality potato. Supermarket apple sales are even more dominated by imported produce (one retail source suggested that 95 percent of apples sold by Ukrainian supermarkets are imported) due to the poor quality of mechanically harvested and non-refrigerated local produce.

In the high value olive and olive oil sector, critical for Turkey, the fourth largest producer in the world, and to a lesser extent for other eastern Mediterranean and Adriatic low and middle income countries, oil quality is negatively affected and losses generated as a result of fermentation and unexpected taste and aroma stemming from such practices as erroneous piling up of produce in prior to processing. Other factors negatively affecting product quality include high temperature in storing and tanks that cause sedimentation.

In low and middle income countries in particular the dairy sector also suffers from a lack of investment in improved sanitary regimes and equipment at dairies and the absence of adequate cold storage capacity impacts not only horticultural and dairy but also results in one of the larger loss points in the meat commodity chains, in that installation of freezer capacity at slaughterhouses would allow storage of blood, organs and other by-products that can be used for processed meat products, thus reducing the substantial dressing percentages currently wasted.

Losses in the post-harvest handling phase in the cereal and oilseed commodity groupings, while lower than in the fresh product groups, also arise from outdated transport and storage capacity, with truck fleets and elevator capacities in middle and low income countries often over 20 years old and issues in sealing and covering grain transported by truck, rail or barge and outdated loading and unloading equipment.

Outdated and insufficient infrastructure is also a loss factor for grains destined for export where rail networks, rail cars and port infrastructure (particularly storage facilities) are often insufficient for the increasing demands made by growing exports by major exporters such as Turkey and Ukraine. While some major players have made significant investments in elevators, river barges and export terminals, state rail and port infrastructure is often antiquated and restricted in expansion potential, by its central location in port cities.

Processing and packaging

Middle and low income ECA countries encounter similar infrastructure and technology issues in the processing phase of cereals agri-food value chains. Although most former state-run milling and baking facilities in the region have now been privatised, they nevertheless often operate 20-30 year old machinery. Industry operators in Ukraine estimated that 50 percent of current facilities still require upgrades to technology.

Losses therefore occur as a result of mechanical failure, particularly in control of mixing proportions and baking temperature and timing. Bakeries interviewed stated that only some 2-3 percent of flour

supplied is rejected on quality grounds (primarily as a result of excessive moisture and low gluten levels) and that even poor quality flour can be used in the production of dumplings, pancakes and other products and so may not be lost to human consumption.

Prior to its retail, packaging of bread in low and middle income ECA countries is rarely practised and even biscuits, pasta and other cereal products are often sold in bulk to retail outlets and markets, with attendant breakage, loss and discard waste. The absence of suitable packaging results from a lack of investment in packaging technology. The production of long-life, packed bread is also rare, due both to an absence of demand and of technology.

Processing of potato, a key crop across former Soviet Republics and in Turkey, limited to pre-fried crisps and very low levels of friable chip and use as an ingredient into ready foods. The restraint on this value-added alternative market for potato use in countries that see high levels of losses and waste is again the absence of investment in technology by the private sector, despite success stories of entrepreneurs who have invested in potato processing from Kosovo to Kyrgyzstan.

Processing and conservation of fruits and vegetables is important both to smallholder producers and consumers purchasing commercially processed products, particularly through the winter months in low and middle income ECA countries. Here again, in addition to 'natural waste' due to edible parts such as skin being discarded, major causes of losses and waste identified in both Armenia and Turkey were poor ventilation, cooling, sorting and packaging technology and materials

The main cause of losses in the production of meat and dairy products and fruit juices in the region also centres on outdated processing technologies, combined with human error and power outages. In smaller fruit processing facilities still using Soviet era technology approximately 10 percent of consumable produce is discarded as a result of spoilage during processing as a result of technical failure or mistakes made by workers.

Distribution

At the distribution phase it is again fresh and unpackaged produce requiring cold storage (fruit, vegetables and meat) that is most prone to losses, although losses of meat and dairy produce is often reduced by mal-practise by retailers and secondary markets for out-of-date produce. Losses of such products in this phase are also masked as product deterioration and short-shelf lives are passed on to consumers and translate into household level waste.

Packaging of winter vegetables in low and income ECA countries is minimal in storage, transport, wholesale and retail, with the overwhelming majority of vegetables passing from storage containers to large mesh sacks and direct through regional and local markets to consumers. This, when combined with an ageing and non-refrigerated truck fleet, long distances to market, poor road infrastructure and an absence of cold storage capacity at markets, leads to substantial crush and spoilage losses during transportation and handling of the heavy sacks.

Fruits and summer vegetables fare little better, particularly produce (over 50 percent) sold through markets rather than commercial retail, which across the former Soviet Union is subjected to packaging, transportation and pre-sale storage in reused banana boxes without refrigeration, leading to some 10-30 percent in losses due to crushing, bruising and accelerated deterioration, with the

percentage higher for more perishable products and in low income countries due to high temperatures and lack of sanitation.

The distribution phase sees the highest levels of losses in the fresh tomato agri-food chain in both Armenia and Turkey. As the Armenian country study spells out, 'produce is kept in boxes under the direct sun, or, as the best option, under a covered boot, which is still not good enough for protecting tomatoes'. The practice known across the former Soviet Union as the 'Gazelle Grill', with 'Gazelle' being a Russian make of transit van used by small traders who sleep in the front and transport and store produce purchased speculatively from farmers in the back until it is sold. Even in commercial retail outlets, however, local produce is rarely refrigerated while on display and loss levels, while lower than for produce sold through markets, is also significant.

In meat and fish supply chains, the distribution phase also witnesses high loss levels, due to low levels of packaging and cold chain infrastructure and the high perishability and subsequent inedibility, particularly of fish and fish products. Meat destined for retail outlets is transported swiftly and ordered by retailers carefully, given regulations limiting shelf life after slaughter. While vacuum packing of fresh meat can extend its shelf-life to 10 days (twice as long as regulations permit for unpacked meat, it is used minimally in the region, primarily given its perceived cost.

Based on country study findings, it is estimated that less than 50 percent of meat is currently sold through supermarkets in low and middle income ECA countries. Meat and meat products sold through local markets supply is subject to substandard refrigeration, packaging and sanitation in both transportation and storage. Fresh meat sold by smallholder producers, who have slaughtered the animals themselves is even more at risk as it is stored without refrigeration prior to collection by traders.

As in the meat supply chain, the distribution phase of the milk/dairy supply chain is characterised by relatively low levels of losses during logistics, i.e. spoilage or damage in transit. Given the poor road conditions (particularly in larger countries) and the predominance of aged European trucks whose refrigeration capacity is reduced and falling, one would expect losses at this stage to be higher. Low recorded losses mask significant reduction in the shelf life of all fresh Ukrainian produce and therefore increased waste at the level of retail and consumption.

Losses of milk and milk products produced and sold by cottage industries on local markets are significantly higher at the distribution stage due to primitive packaging and almost total absence of cold storage. Packing is also identified as the key cause of losses of fresh eggs during distribution, with road and truck conditions contributing sub-standard cartons or even loose transportation.

Consumption

Given the high prevalence of modern domestic refrigerators among urban consumers in middle and low income ECA countries, as well as purchasing habits which are more regular and less excessive than those in high income countries, relatively low levels of waste are caused by technological and resource issues, particularly in urban households.

As mentioned in the foregoing section, however, urban domestic waste is increased by reduced shelf life particularly of fresh fruit, vegetable, meat and dairy products resulting from inadequate post-harvest handling, packaging and cold chain during earlier agri-food chain phases, meaning that meat

and dairy discard and over peeling and cleaning of fruit and vegetables could be reduced significantly, if improved technologies were introduced between harvest and retail sale of fresh produce.

In rural areas, particularly in more remote and deprived regions, domestic refrigerators are more dated and less efficient and underground cellars are still the norm for domestic storage of all but the most perishable (or purchased) products. Although closely related to issues raised above under causes for losses in smallholder storage, losses and waste caused by spoilage and loss to vermin of poorly packaged fresh and processed produce stored without refrigeration, ventilation or sanitary conditions are significant.

Although such losses and waste are reduced by products and dishes developed for and consumer organisms acclimatised to produce that would be considered spoiled in much of high-income ECA, initiatives leading to increased use of modern domestic refrigeration and small-scale storage technologies would have a substantial impact on reducing household losses and waste, particularly in rural areas.

8.2 Management, Marketing and Product Development

Management, marketing and product development were also emphasized in country studies that pointed out poorly qualified management and labour responsibility for major losses, particularly in on-farm losses across all commodity groupings arising from poor and outdated management and labour practises.

With the exception of a very few industry leaders in each agri-food chain, an absence of good management processes, which impacts labour practises generally, is apparent throughout the cold chains through which fresh horticultural, meat and dairy products pass as well as in the wheat-flour-bread chain, where staff turnover, pilfering and unsanitary practises result in increased levels of losses right up to the level of retail and the 'fast profit' approach to business management results in low wages and lack of worker training that in turn breeds mistakes and encourages a 'don't care' attitude and high turnover of workers.

Investment in management training and subsequently staff training by newly trained management is therefore required as part of any drive to reduce losses and human resources and staff motivation policies as well as work-flow processes require analysis and improvement. Management training should also include training in business development and investment, in order for managers to calculate the benefit to their businesses of investing in the new technologies, such as those listed in the afore-going section, as well as vacuum packaging to extend the shelf life of fresh meat.

Agricultural production

Losses at the stage of agricultural production are to a large extent caused by farmers' conservative and traditional production methods and practices. In wheat, for example, improper selection of varieties and application and timing of other inputs and the harvest itself result not only in post ripening losses during the agricultural production phase of the agri-food chain, but also to a loss in quality or the initiation of deterioration, which result in the crop later being relegated to animal feed.

Low technical knowledge in relation to pre-harvest practices is identified by the Armenia country study as being a major cause of losses to crops, with the example given of the practice of irrigating prior to harvest, which can cause fungi that can spoil a sizable portion of the harvest.

Poor timing of harvest as a result of low technical knowledge of small and medium producers was also identified by the Armenia country study as a major cause of losses, although the scale of such losses depends to a large extent on the climatic conditions during the harvest period. Examples include late harvesting leading to overripe fruits and vegetables and degraded field crop quality. An example is research on cereals losses conducted in Ukraine, which shows a 4 percent loss of winter wheat crop caused by a delay of up to seven days rising to 27 percent losses, if the harvest is delayed to 20 days after the crop's ripening. Early harvesting, on the other hand, sometimes caused by farmers responding to falling prices as the harvest season begins, can lead to premature drying and weight loss in under-ripe fruits.

In animal husbandry, poor management and conduct of feeding, breeding, maintenance and health regimes as well as on-farm hygiene and milking practises contribute to major losses, particularly among the dominant smallholder livestock producers of middle and low income countries. Rural-urban migration again in middle and low-income countries and stereotyping means that the rural youth often seek careers other than farming, leaving agricultural production to older generations, who are less open to new technologies and practises. The shortage of qualified extension service providers compounds these shortcomings in input selection and good agricultural practise.

Post-harvest handling and storage

In the grain and oilseed commodity groupings, losses are fewer during post-harvest and handling relative to other commodities, primarily due to the larger scale and more modern management of grain dryers and elevators across the region. Poor grain drying practises and treatment for storage, nevertheless increase losses as do continued pilferage of grain as well as other products by workers of larger state and commercial facilities.

While losses of livestock produce during this phase are minimal, in fresh horticultural value chains, poor management and labour practise contribute to the vast product losses particularly during storage. Both smallholder horticultural producers using basement stores and enterprises based on former communist-era depots use the same storage areas year after year with little or no treatment of the premises for fungi and disease. Ventilation and pest control regimes are also poorly understood in both middle and low income countries of the regions, contributing to early degradation and blight of produce, an example being the loss to rodents of 20 percent of the potato harvest in one district of Armenia as it lay in the field after harvest and during storage.

Processing and packaging

Human error was identified as a secondary main cause of losses (after poor technology) in the processing phase of all agri-food chains analysed. This is manifested by the mistakes by operators of processing machinery in timing, temperature, sanitation, transfer and adding of ingredients, quantities and so on, all of which lead to spoiling of produce whether it is cereal, fruit, vegetable, milk or meat based.

Such error arises from both lack of training and worker discipline, but also to shortcomings in human resource and process management practices, again particularly on small and medium enterprises. An example is the manager of a small Ukraine apple processor in southern Ukraine, who stated that in smaller fruit processing facilities still using Soviet era technology approximately 10 percent of consumable produce is discarded because of spoilage during processing, resulting from technical failure or mistakes made by workers. This can rise to 15 percent if power outages stop processes for over two hours, meaning that a whole batch can be spoiled. Such causes of loss are particularly acute at critical processing points such as setting of cheeses and filtering of edible oils.

A further key cause of losses in fruit and vegetable value chains, but which also applies to processing, packaging and transportation of all products is poor practice during loading and unloading leading to dropping and damaging even packaged produce, even temporary storage of product in unfavourable conditions (temperature, light, sanitation); poor maturation practices and inclusion of rotten and damaged products, which spoil entire batches.

Distribution

Although denied by retailers, a key cause of loss in the distribution phase of the cereals agri-food chain, as identified by bakeries, is the practise of over-ordering, particularly by larger retail chains in order to have a large amount of fresh bread on display for consumers. Unsold bread, returned to bakeries it was argued can only be used for production of breadcrumbs, the cost of production of which makes it unprofitable, resulting in such returned product generally being passed on for use as animal feed.

As mentioned above poor loading, unloading and transportation practise by workers and undue delays caused by poor management planning are a major cause of losses during distribution particularly of perishable fresh fruit and vegetables and fragile eggs and especially during the summer harvest season, a cause of loss compounded by poor transport infrastructure, packaging and loading machinery.

In animal product agri-food chains, levels of losses in shops and supermarkets are hard to estimate, given shelf-life extension practises such as blending fresh meat with spices to be sold as mince or marinade, using meat that has passed its sell-by date in ready foods or sausages, cooking meat that has reached its sell-by date for sale and simply selling fresh meat after its sell-by date. It is even credibly rumoured that there is an active market for 'old' meat, which is then processed or cooked and made 'good'.

Similar malpractice is alleged in relation to dairy products which consumer claim are simply relabelled with new sell-by dates in order to extend shelf lives, leading to higher waste levels at the household level. Although such allegations were not proven in country studies, the notorious sensitivity of food retail chains to any photography (particularly documentary film-making) on their premises belies a concern as to what might be found.

Such practises result in part from the relative higher value of meat and dairy products and from the fact that losses of waste meat and meat products, unlike losses of non-animal products, are often not passed back to their suppliers through the return of unsold produce, but carried by the retailer itself.

In the particularly perishable fish value chain, the Turkish study noted deficiencies in record keeping by fish markets, poor market management, ineffective control mechanisms and distribution by incompetent intermediaries as major causes of losses alongside cold chain failures.

Consumption

Consumer practices leading to waste identified in middle and low income ECA countries include traditional methods of peeling fruit and vegetables, which could be eaten with the skin. That said in some instances, consumers are forced to cut out and discard large proportions particularly of root vegetables and fruits, as a result of spoilage during earlier phases of food chains.

A further practice that leads to spoilage of fresh food is the cutting of excessive amounts of bread, cold meat and sausage, cheese, vegetables and fruits for display on the table (a practice particularly pronounced in former Soviet countries as a show of homeliness and hospitality).

Additional practices causing substantial waste of bread and fresh fruit are buying excessive amounts of bread, sometimes due to the absence of part loaves in shops, and storing fruit in bowls on tables, rather than in fridges.

Product Development

In the sphere of product development, middle and low income countries of the ECA region and particularly medium and small-scale producers are hampered in non-animal production by the lack of information on optimal varieties and the continued production of varieties that cannot compete in appeal, quality or longevity with European and other regional imports with which they must compete on commodity markets or retail shelves, resulting in wholesale, retail and consumer rejection of local produce and ultimately its relegation to waste.

Similarly in meat and milk production, few farms are raising specialized meat or milk breeds for cattle or modern pig or sheep breeds and whilst the latter can be justified to some extent by local preferences for more fatty meat or other characteristics, beef in particular is largely imported, partially as a result of the absence of specialized beef producers.

In processing, the capacity of processing equipment often determines a minimum batch volume, meaning that the introduction of new food products often results in over production during the early months of introduction of a new product and building of market demand. This leads to unnecessary waste and was noted particularly by larger modern dairies, including Danone. The high fragmentation of the dairy market and subsequent extreme competition between large numbers of dairies and trademarks also leads to their overstocking of products on retail shelves in order to hold shelf space against competition and subsequent waste.

8.3 Value Chain Coordination and Supply Logistics

The fragmented nature of agri-food production caused by the breakup of former state and collective farms across former communist countries of the western Balkans and former Soviet Union during the 1990s and the slow pace of consolidation into commercial farms lead to major challenges in value chain coordination as a result of the huge numbers of small producers.

In relatively unreformed Soviet production and processing structures still exist in countries such as Belarus, Turkmenistan and Uzbekistan, rendering value chain and supply logistics a less important cause for losses. In such countries, investment in new technologies and outdated management and labour practises, as discussed above are therefore the leading causes for losses and waste. In addition, such highly controlled production chains characterized by state directives on what to plant, whilst attempting to overcome issues relating to over and under supply of produce, can also result in major losses by producers not responding to market generated demand indicators from consumers.

Turkey is the only country not falling into the category of former communist state production system either reformed and dismantled or preserved. The Turkey country study nevertheless identifies small and fragmented farms and low level of agricultural cooperation as one of the most serious structural problems in Turkish agriculture, which means that similar supply chain issues are encountered as in former communist countries where state and collective farms have been broken down into small plots and distributed to rural households.

As value chain coordination and supply logistics issues vary widely between commodity groupings, based on their relative levels of integration, the sub-sections below are structure by commodity grouping rather than by agri-food chain phases.

Cereals and oilseeds

In many low and middle income countries because of clear economies of scale in mechanization of all phases in the value chain, the cereals and oilseeds commodity groupings lead the way in terms of consolidation of production, with the emergence of large and vertically-integrated production, logistics and storage enterprises employing modern production techniques and machinery as well as post-harvest handling, storage and primary processing capacity. This results in relatively lower levels of losses arising from value chain failure in cereals and oilseeds commodity groupings, particularly as what cereals are produced by smallholder producers are for the most part produced with the intended use of harvested produce being feed for domestic livestock and therefore not considered a loss to the human food chain, according to the definition of loss and waste employed by this study.

Despite the relatively modern and integrated cereals and oilseed value chains in the region, considerable coordination is required, particularly between government and private sector producers and between governments of the region in order to establish best practises and the type of early warning and response system required to combat threats from disease and pests, such as such as the sunn pest or corn bug *Eurygaster integriceps*, which not only impacts the level of grain harvested but also the quality of the grain, reducing gluten levels by over 25 percent and rendering it usable at best for animal feed.

In addition, if countries are to increase production and export of cereal and oilseed commodities and products and realize the vast potential of countries such as Russia, Ukraine and Kazakhstan in cereal and oilseed production, major public-private investment will be required in certified grain storage capacities, specialized road, rail and barge carriers for grain as well as in improved logistics connections and storage infrastructure at the main ports and inland export terminals of the region.

Losses and waste at the distribution and consumption phases, particularly of bread represents are critical loss points in the cereals agri-food chain and poor value chain coordination between bakeries

and retail chains were identified in the Ukraine country study as a major cause of loss during distribution. Interviews with bread retailers suggested relatively low levels of losses in distribution, with bread being delivered to retail outlets several times a day at regular times, allowing outlets to regulate their receipt and prevent overstocking. Further they stated that bread not sold by retail outlets is taken back by bakeries and for the most part reprocessed into dry bread products for further use. As in other countries, consumer preference for bread 'fresh from the oven' is leading retailers to produce more on their own premises, which can be better controlled to respond to actually purchasing thus reducing waste.

Discussions with bakeries, however, revealed that up to 10 percent of bread supplied to larger retailers is returned as a result of over-ordering in order to have a large amount on display for consumers, with smaller outlets returning very little by comparison. They further pointed out that such returned bread can only be used for production of breadcrumbs, the cost of production of which makes it unprofitable, so that returns are generally passed on for use as animal feed.

Fruits and vegetables

Because of its high labour requirement and fragility of crops, fruit and vegetable production or market gardening is dominated by smaller producers even in high income countries. Nevertheless the dominance often of over 90 percent of production in middle and low income countries of the ECA region by poor rural households and the lack of coordination between such producers to ensure standardized quality produce in commercial volumes as well as value chain coordination and cold chain logistics challenges at every stage of post-harvest agri-food chains are the largest causes of losses and waste in this agri-food chain and perhaps across all agri-food chains.

The horticultural agri-food chains are predominantly characterised by wholesalers contacting individual farmers at the time of harvest and collecting un-chilled produce in non-refrigerated vehicles for transportation to wholesale markets or storage facilities. The lack of producer organization in order to standardize production (variety selection, fertilizer and pesticide application and timing, harvest timing), enabling them to engage directly with processors or retailers or to develop joint pre-cooling and storage capacity not only causes extremely high levels of losses and waste due both to spoilage immediately after the harvest and also to shortened shelf life and higher levels of consumer waste.

The Turkey country study underlines the need for increased development of producer cooperative development in this sector, using the model of southern EU countries, which over decades have developed and consolidated smallholder horticultural production, post-harvesting handling, processing and distribution. The study argues that as unorganized actors, small farmers do not have competitive advantage in either input purchase or output sale. At the stage of agricultural production, high input prices prevent such yield increasing initiatives and practices as the use of certified seed and fertilizers. Small profit margins and low volumes of production in turn preclude new investments and use of advanced technology.

During sorting and packaging and prior to processing, non-standard and poor quality produce is discarded. Apple processors interviewed in preparation of the Ukraine country study stated that some 5-7 percent of apples supplied are rejected on delivery to processing facilities and are

thereafter likely used either for animal feed or discarded. Such losses arise as a result of poor quality inputs used by large numbers of uncoordinated smallholder suppliers.

Supply chain logistics causes of losses particularly of fresh produce include the poor long and short-term storage facilities discussed in the previous section, as well as sub-standard packaging, truck fleets and road infrastructure, which during the height of the summer cause major losses during storage and distribution stages of horticultural supply chains.

In low and middle income ECA countries, fresh horticultural produce, as it is non-standard and often blemished, even if naturally, cannot compete with imported fruits and vegetables, produced, prepared and packaged according to standardized modern practices. In high income countries of the region, where requirements for standardization in size and shape of produce by retailers are more strict, rejection of produce during distribution is a larger cause of waste, while in middle and low income countries produce is often accepted, with a percentage markdown on price based on the level of substandard produce in a delivery or produce not sold as a result of its non-competitive appearance on shelves is simply returned to suppliers or discarded.

Meat, fish and seafood

Meat production, at least of meat sold through wholesale/retail chains in low and middle income ECA countries, like in cereal and oilseed agri-food chains, is increasingly characterized by larger producers, with households that rear poultry, pigs or cattle for meat distributing little such produce beyond their extended families. As a result dysfunctional value chain and supply logistics result in relatively few losses in meat agri-food chains than in horticultural and dairy chains, where smallholder producers dominate production.

Cold chain issues nevertheless apply, particularly to the large volumes of meat still traded through local markets where sanitation and refrigeration are poor, particularly in lower income countries (the Armenia country study stated that 'most fresh food in Armenia is sold in open air fresh markets'). Indeed, even medium-sized meat producers are put off supplying retail chains by delayed payment regimes and the need to provide transport, preferring to sell to traders and on to local markets as do smallholders, although the latter lack even refrigeration after slaughter.

In relation to fish, cold chain logistics failure, caused by inadequate refrigeration and sanitation is a more pronounced cause of losses, particularly during distribution, as noted by both Turkish and Armenian country studies, with the Armenia study stating that it is the cause for the highest levels of losses in the fish value chain.

Dairy and eggs

The commodity groupings where smallholder producers still dominate and therefore where coordination is most challenging and leads to the greatest losses to marketable food products is in the horticultural chains and in dairy production. Eggs, like poultry are produced primarily by large commercial farms and therefore despite their fragile nature, are less subject to losses arising from poor agricultural and post-harvest handling practises in particular.

In the dairy sector undersupply of milk by smallholders, particularly in winter, means that dairies are forced to offer collection service and accept even substandard milk, but the absence of refrigerated

collection points and coordination of small milk producers into cooperatives, which could be used as vehicles for improving production practises and winter feed regimes, result in major losses of potential winter supply and oversupply in summer or when trade restrictions reduce market demand.

Supply chain logistics is also a major challenge for fresh milk and dairy produce requiring refrigeration. The dairy agri-food chain is impacted by the shortage of refrigerated transport, substandard packaging and handling and storage running from the farm to retailers and consumers. As the representative of leading dairies from the region stated, improved logistics could extend the current 7 day shelf life of fresh milk and 10 days for yoghurt to the EU norms of 15 days for milk and 30 for yoghurt.

The Turkey country study underlines the need for increased development of producer cooperative development in the dairy sector too, using the model of EU and North American countries, which over decades have developed and consolidated dairy cooperatives in milk production, post-harvesting handling, processing and distribution. The study argues that as unorganized actors, small farmers do not have competitive advantage in either input purchase or output sale. At the stage of agricultural production, high input prices prevent access to veterinary and medicinal services and low profit margins and production volumes in turn preclude new investments and use of advanced technology.

8.4 Consumer Preference and Oversupply

As mentioned in the supply chain logistics section above, consumer preferences are identified by the Kiel University study as the main reason for food losses and waste in high income ECA countries. As a consequence, all steps of the supply chain have to adjust their production, processing, or distribution to these preferences.

Consumers demand high quality standards, meaning that all crops not meeting these standards are sorted out after the harvest. The same happens at later supply chain stages and if edible food products are not suitable for processing, they will be wasted or used for non-food purposes. Also, many edible food products are wasted at the last step of the value chain. The cause of this household waste is that consumers prefer to buy the food products with a longer remaining shelf life. This leads to an increase in unsold merchandise and thus to waste of food that would otherwise have been perfectly edible.

Oversupply is another cause of high income country food waste that can be attributed to consumer preferences, as illustrated by restaurant buffets with fixed prices that usually involve preparation of a far larger amount of food than is necessary. Oversupply and low prices also encourage consumers to buy excessive amounts of food which cannot then be consumed, particularly through promotional offers such as “Buy one, get one free”.

Another source of food waste is aesthetic standards. The Kiel University study uses Tristram Stuart’s “Understanding the Global Food Scandal” illustration of carrots, which if they have a slightly irregular bend, are removed from production and set aside for animal feed. The reason for this is that consumers prefer straight carrots so that they can peel the full length in one easy stroke. Carrots also

are subject to photographic sensor testing that reveals any defects and those found not bright enough in colour or are broken are not considered appropriate for human consumption and are relegated to animal feed.

The Kiel University study, however, argues that food waste caused by consumer preference can be economically rational and therefore not warrant policy intervention to reduce. At the farm level, the study argues, it would be economically rational to sort out smaller potatoes, for example, if consumers are prepared to pay more for large potatoes. The decision by a producer or middleman to do so is economically rational, if the price paid for the larger volume of unsorted potatoes is lower than the price paid for the smaller volume of sorted potatoes and if the difference between such prices is higher than the cost of sorting out the smaller potatoes.

8.5 Trade and Taxation Policies

While trade and taxation policies vary widely across the ECA region, the following broad groupings of countries can be made. First is the EU, which includes almost all high income ECA countries and is characterised by free internal trade in products and services, high levels of public sector support to producers and upgrades to market infrastructure, high and enforced standards for product safety and quality and barriers to the import of non-EU produce on EU markets. The second grouping comprises the middle income western Balkan countries, Turkey and recently Georgia and Moldova, which are engaged with the EU in accession, pre-accession or eastern partnership agreements, that approximate regulation of standards, support infrastructure development and reduce trade barriers with the EU.

The third grouping is the Russian-led customs union, currently including Russia, Belarus and Kazakhstan and likely to be joined by Armenia and Kyrgyzstan, which allows free trade among members and employs the former Soviet 'Gos' standards. And finally there are countries including Azerbaijan, Tajikistan, Turkmenistan, Ukraine and Uzbekistan, which are either not formally aligned with such trade groupings or their alignments are at a relatively early stage of development. Such countries, while most independent in their trade and taxation policies are also the most vulnerable to the policies of their neighbours and those of the larger trading blocks.

Key factors driving trade policy and its impact on loss and waste levels, particularly as it relates to exports are driven firstly by state controls on exports, particularly in strategic sectors, such as grain; secondly by protectionist policies of other countries in the region, particularly on meat and dairy products; and thirdly by import quotas and quality certification requirements of the trade blocks. The Ukraine country study provided illustrations of the impact of such public sector interventions on levels of food loss and waste, as described below.

In the grain sector, the country study highlighted state attempt to control grain exports through the imposition and control of a quota system in 2011, which led to great consternation among producers and reduced levels of wheat available on international markets. Not only, given the shortage of adequate long-term storage, did such policies result in considerable losses of grain, but the impact of such intervention both on food security in Ukraine's export markets in Asia and Africa and on the

investment climate and levels of investment in loss-reducing technology in agri-food chains in Ukraine, were certainly both negative.

The study also illustrated how the bans on imports of Ukrainian cheese by Russia in 2012 affected levels of food loss and waste as cheese producers drastically cut back on milk purchases, resulting in a sharp reduction in prices offered to producers by dairies and smallholder farmers reacted by refusing to sell and discarding their milk and/or slaughtering dairy cows. Russia's concerns relating to Ukrainian cheese were justified by claims of excessive levels of palm oil in the cheeses, a claim denied by Ukrainian dairies and government officials. Stricter control of production processes by the private producers and monitoring by Ukrainian government would have helped pre-empt such a ban and reduce its term of effect.

Excessive supervision, particularly of more perishable agri-food produce such as soft fruits at borders is also a major cause of food loss and waste. This is sometimes caused by anachronistic regulation, requiring high levels of checks, sometimes by deliberate government policy and sometimes simply by rent-seeking behaviour of border control agencies.

Quality standards and certification requirements, particularly for imports into EU markets also result in large amounts of losses, particularly in years when harvests, particularly of horticultural products, including potato and apple are strong and supply in the EU's eastern neighbours far outstrips demand on their national markets. Current trade arrangements mean that losses in such bumper years can be major, leading to calls both for reduced trade barriers and increased product certification by producers and traders.

The investment policy and overall investment climate in many middle and low income ECA countries mitigates against loss-and waste reducing investments in new technologies and practises at all stages of agri-food chains. IFC Doing Business rankings of low and middle income ECA countries for ease of doing business and for protecting investors are for the most part depressing, although countries like Georgia show that dramatic reductions in the level of red tape in business start-up and regulation, in the corruption of state organs and in practises such as corporate raiding are possible, if governments show political will and act accordingly.

In terms of tax policy, given the central role of agriculture in the socio-economy, particularly of middle and low income ECA countries, special tax regimes and exemptions and direct budgetary support programmes are designed to support producers and attempt to reduce losses and waste, such as subsidies for investment in production upgrades, special exemptions for cooperatives, credits and lease options offered for investment in post-harvest handling and processing technology and co-financing of storage and logistics infrastructure. Thus, although non-EU producers are at a decided disadvantage in terms of competing with their heavily subsidized EU neighbours, they are often relatively well supported in comparison to those in other sectors of the economy.

The caveat expressed by many value chain actors in the middle and low income country studies, however, was that many potential beneficiaries, particularly the large numbers of smallholder producers lack the experience and connections to navigate the opaque and labyrinthine application procedures in order to access such support and larger and more successful businesses often turn down such assistance, fearing that engaging in government programs may expose them to predatory government monitoring of such joint investments.

A final feature of government policy related to both trade and taxation that acts as a major cause of losses and waste across all commodity groupings is failure to invest in publicly-owned infrastructure. This includes road maintenance and clearance during winter, which have repeatedly been identified in the foregoing analysis as a major cause of losses, particularly of perishable produce. In addition poorly maintained electricity grids resulting in regular power outages pose a major challenge and cause of loss and waste, particularly at the storage and processing stages of agri-food supply chains.

8.6 Food Safety and Quality Standards

Product quality plays a major role in losses and waste in all commodity groups analysed in this study. Cereals, oilseeds and vegetables, primarily those produced in low and middle income ECA countries, are relegated to animal feed on both local and international markets given their poor quality and are large quantities of harvested produce is simply discarded as a result of blight and degradation. Processors, ranging from bakeries to meat processors, but most markedly dairies, cheese and fruit juice producers bemoan the lack of quality of inputs, resulting in large part from the fragmented nature of production on numerous small farms lacking standardized approaches to production to allow the supply of commercial quantities of inputs at basic quality standards.

Food safety and quality standards in former communist ECA states have been characterized since the introduction of market reforms by overcomplicated regulation and control by multiple agencies, often as a result of overlapping or competing responsibilities of national ministries of agriculture and health. This has resulted in confusion among private sector agri-food chain actors, rent-seeking incentives for the regulators and a broad non-conformity of practise with regulation. As we have seen above, this in some cases this has led to a reductions in waste, as sub-standard products or those that have passed their sell-by dates remain in the market and are consumed, despite the hazard this poses to public health.

Further, the introduction of a streamlined and simplified system for the identification and rectification of hazard points in food safety and quality would have a major impact on the reduction of losses and waste across all agri-food chains. Regulations, such as those envisaged by the draft Ukrainian Law on Food Production, developed with input from Ukrainian and international experts should therefore be developed to establish the principles of traceability, recall and HACCP for food products 'from field to plate' under a single phytosanitary-veterinary service.

Introduced over a several years, such systems could simplify national systems of checks according to standardised hygiene and manufacturing checklists and increase penalties for non-compliance. Further sampling and testing would be reduced and rather than being applied to all food companies, it would be based on risk, meaning that if a company has a good record or its food products are less potentially hazardous, such a company will be tested less frequently or rigorously. Such systems would also encourage companies to improve their own systems through applying principles of GlobalGAP and HACCP, which are beginning to be adopted by market leaders. Such certification programmes would in turn help reduce losses by opening export markets for excess production as well as increasing incomes in agri-food production and processing.

Initiatives highlighted by the Turkey country study in this sphere include the introduction of quality-based pricing by state and private traders and processors. An example is the introduction by the state Soil Products Office (TMO) of the criteria of protein content while purchasing wheat from farmers, thus stimulating the production of superior wheat. Similar reform is being introduced in bread production, through reform of flour standards to changing consumer preferences. The study states, however, that quality-based pricing does not apply to all commodity groupings including dairy, which does not pay a premium for milk quality based on analysis of somatic cells, microbial numbers, protein and fat content and as a result fail to stimulate production of higher quality milk, which would result in lower levels of loss and waste throughout the milk-dairy value chain.

9. POLICY OPTIONS AND APPROACHES FOR REDUCTION OF FOOD LOSSES AND WASTE

The sets of actions and policy proposals outlined below can be divided into those that apply to most if not all food chains analysed (sections 9.1 and 9.2); those that target specific stages of agri-food chains (9.3); and those related to monitoring and coordination of interventions (9.4). In this relation, a clear recommendation emerging from research conducted by Kiel University and discussed at the regional expert consultation in Budapest on 22 November 2013 was to establish clear objectives for FLW reduction in ECA in order to facilitate the design of targeted reduction initiatives and to ensure that critical loss points targeted by policy interventions were caused by either market or policy failure, rather than being either unavoidable or indeed economically rational.

In keeping with the focus of this paper on low and middle income ECA countries, given the relatively low level of research conducted to date on them, except where otherwise specified, the following policy options are of particular relevance to low and middle-income countries of the ECA region, although they remains applicable, particularly to more recent EU members, which still face post-communist transition challenges.

9.1 Stimulating Investment in Technology Upgrades

Probably the greatest single cause of losses and waste in middle and low income ECA countries has been the shock caused by the collapse of communist-era vertically integrated state/collective agri-food structures, their subsequent privatization and the difficulties faced primarily by their new owners in attempting to transform or replace them with modern loss and waste-reducing technologies and processes.

This applies equally to agricultural production and harvesting, whether in the sphere of livestock or crop production, to post-harvest handling (grading, storage, packing) to all linkages in cold chains for fresh meat, dairy and fruit and vegetable produce, to processing and wholesale/retail structures.

To address this, the following initiatives are recommended, to be coordinated between leading and lagging private sector enterprises, government stakeholders at central, regional and local levels and international community representatives, including technical assistance projects and international financial institutions.

Investment climate improvement and access to finance

In the sphere of improving the investment climate, the lead needs to be taken by national governments. Not only will this require concrete steps in terms of broader issues of rule of law, property rights and contract enforcement, but perhaps more immediately, direct threats to existing and potential investors can be addressed by individual and coordinated action by ministries and agencies on the issues of business start-up and registration and particularly on permitting and inspection regimes and overlapping authority. Certainly there is reason to be enthusiastic in relation to new draft laws on for example food inspection, but bureaucratic obstacles to doing business in the

region remain a severe constraint to the considerable investments required to reduce losses and waste at the production, post-harvest handling and storage phases of agri-food chains.

In recent years there are positive examples of successes by the private sector in the attraction of international investment from both the private sector and international financial institutions into new loss-reducing facilities in cereals, fruit and vegetables, meat and milk production logistics and processing. Both potential investors and authorities and consultancies active in the sphere could coordinate more closely in the identification and pre-screening of additional investment targets among existing businesses.

Across central and eastern Europe there are also good examples of regional and local authorities attracting foreign direct investment in Greenfield sites offered for sale or long-term lease for the development of processing and logistics hubs, an area in which EU accession and eastern partnership countries have strong advantages given the opening of EU markets to their produce.

Further, in ECA countries of Central Asia such as Turkmenistan and Uzbekistan, where the public sector still controls a significant proportion of agricultural production, there are interesting examples of large government orders of modern European harvest machinery under which suppliers such as German combine harvester producer Claas are required to build factories in the countries in question and train local engineers in machinery manufacture.

Increased coordination between those developing and implementing existing government support programs aimed at reducing losses with sources of commercial credit and grant funding could also be used to increase the impact and reduce the risk of such investments. Further, models for risk-sharing between commercial lenders (banks and credit unions), agri-input suppliers and agri-food wholesalers and producers can also be used to develop new products encouraging longer-term investments in loss-reducing production and post-harvest handling technologies.

Further, Direct government support to access to credit schemes for small and medium producers and traders need not involve credit subsidization, but rather risk sharing through the provision to commercial banks of credit guarantees, leaving it to the banks to establish the creditworthiness of the investors and to ensure that the credit will be used to reduce food loss or waste.

Improving quality and quantity of supply

One of the key causes of losses and waste, particularly in the fresh (meat, dairy and fruit and vegetable) produce agri-food chains is the splintered nature of production and the difficulty of ensuring an adequate supply of standardised and quality produce to enter the second (post-harvest handling and storage) phase of such supply chains. Dairies are forced to collect milk from hundreds of owners of individual cows every day and supermarkets cannot find large enough suppliers of horticultural produce with whom to conclude longer term supply contracts.

Producer organization development is therefore key to consolidating supply, improving production and post-harvest processes and reducing losses in the early stage of these agri-food chains. While ministries of agriculture as well as leading traders and processors support such initiatives, further effort needs to be placed on showcasing successful cooperative and marketing group models and supporting investment by them in standardization of production, quality control, joint marketing and post-harvest handling (pre-cooling) investments. Continued work by international agencies as well as

national governments and lead producers and processors in GlobalGAP and HACCP information and accreditation is therefore required.

9.2 Upgrading the Skills of and Stimulation of Food Chain Personnel

Ageing Soviet-trained head technical specialists and a tide of under-stimulated manual workers characterise the agri-food workforce in former Soviet states of the ECA region and even in the western Balkans and Turkey skill sets and human resource practises are only belatedly being updated. This is a sphere where it is felt that the private sector, that has most to gain in reducing losses and waste that impact its bottom line, could play a far more active role.

Examples from across the region exist of successful engagement of producers and processors with local technical secondary schools in establishing apprenticeship programs under which pupils are allowed to train at local companies prior to the more promising being hired for work. Similarly companies pay scholarships for further qualification of those they consider worth the investment in return for a commitment to work for the sponsor on gaining a relevant qualification. Such initiatives benefit from flexibility of local and national authorities in allowing pilot projects and flexibility in amending curricula to reflect employer demand for new skill sets.

Additionally, inducements both in the form of performance-related pay and disciplinary procedures can be applied. An innovative approach taken by one dairy farmer in Kyrgyzstan was to invest in housing to encourage families to commit to long-term employment opportunities in the area around his main cattle holding. And for higher level specialists and managers, medium-level enterprises need to follow the lead of those who have adopted international best practise in technological and personnel development by investing in skills upgrades and exposure to modern technologies and practises for their technical and business managers.

At the level of production and smallholder processing and storage, losses particularly those due to insects, rodents, poor inputs and outdated agronomic and storage practises can be addressed through improved extension services. While in most medium and low income ECA countries state supported extension services are hampered by a shortage of funding and access to information on modern practises, the experience of countries such as Albania and Kosovo in the western Balkans and Kyrgyzstan in central Asia, where extension services have been developed by private sector agri-input and machinery suppliers, is informative.

In all of these activities, close coordination of government, educational establishments and job centres, the private sector, their representative associations and international educational and technical exchange programs is required. Further, EU member states could also place more emphasis on educational exchanges and skills-transfer programs for low and middle income managers and practitioners.

9.3 Loss and Waste Reduction in the Distribution and Consumption Phases

The following actions and proposals aim to address food losses and waste at the final two phases of agri-food chains and involve regulatory development, enforcement and communications initiatives that can be developed, financed and implemented jointly by private representatives, government and consumer organisations. As the Kiel University study underlined, loss and waste reduction during these phases will have the highest aggregate impact on overall loss and waste levels, given the number of litres of milk produced, for example, for every kilogram of cheese that reaches a retail shelf. This is also the area of activity that will likely have the greatest impact on high income ECA country waste levels, given that such countries witness their highest levels of loss and waste during the distribution and consumption phases, although it is also of considerable importance, particularly for middle income countries of the regions.

Regulation and forecasting

Levels of losses and waste during the distribution phase are generally lower in middle and low income EC countries than in EU member states, but this was explained by some agri-food chain actors to be as a result of an established secondary market for sub-standard and expired produce in non-EU countries. While such secondary markets can be viewed as positive transfer mechanisms reducing waste by offering cheaper food to poorer segments of society, they not only have considerable public health implications, but also mask wasteful practises of over-ordering by retail chains.

Potential actions to counter such activities would be for the government and/or consumer organisations to engage retail chains and their suppliers to discuss new practises such as lowering prices as products near their sell-by or best-before dates. Such initiatives could be supported by revising regulations on expiry dates and increasing fines for breaching them, at least to levels where it they exceed the cost of having produce officially destroyed, as well as cracking down on relatively open outlets for expired produce. Provision of market information and schemes for classification of products may also be effective in reducing food losses.

An illustrative example of loss reduction through sales market forecasting is that of German bakeries and shops selling bakery products. Some companies offer daily forecasts for individual retail shops based on weather forecast, calendar day, special events and other variables. A non-representative survey found that orders of shops and bakeries based on these forecasts have helped to lower loss of bakery products by approximately 20 percent.

Raising consumer awareness

Consumer awareness campaigns could also be developed to explain expiry dates, high-risk expired produce and how to minimize waste in the home. The aforementioned actions could further be supported by joint initiatives by consumer organisations, government health and product safety authorities and industry associations to inform the general public of current systems of expiry dates, government control regulations and initiatives and related public health issues, as well as informing them of the benefits of improved buying, storage (particularly of fresh bread and fruit) and cooking

practises in relation to reducing waste, saving money and protecting family health. Monitoring of the results of the recent 'War on Bread Waste' in Turkey could also be informative in this regard.

Raising catering provider awareness

Governments in conjunction with industry associations could also conduct awareness among HoReCa managers that based on empirical studies it is more profitable to offer either smaller portions or to offer customers the choice of selecting portion size. Additionally, forecasting the daily demand may help to optimize food purchases and reduce food losses and waste. Furthermore, restaurant owners should be encouraged to offer a limited number of dishes that change according to the season or locally available foods. The lower the number of dishes, the fewer ingredients there are that need to be stored. If the menu is then changed seasonally, the customers will still have the same variety to choose from.

9.4 Monitoring and Reporting of Food Losses and Waste

A recommended mechanism for monitoring and reporting food losses and waste is engagement of the network of national associations dedicated to supporting private sector agri-food chain actors in business development and advocacy. These are active and outspoken across most of the ECA region and expressed knowledge and interest in the issue of food losses and waste during the conduct of the country studies, as it touches their memberships directly in lost revenues and identifies key areas of infrastructure and policy for improvement.

A group of up to ten associations in a single country, representing all stages of the key agri-food chains could therefore be engaged to conduct a baseline study and thereafter annual anonymous monitoring of a cross-section of association members to allow benchmarking and progress reporting to a forum including government and civil society/consumer organisations and relevant international stakeholders. Such fora could then identify priority interventions and coordinate their implementation using the staff of forum representatives, as well as interested stakeholders from the sector across the country in question.

To effect such initiatives, low- and middle-income ECA governments could be encouraged to play a catalytic role by establishing the fora for food loss and waste reduction. Through such fora, aimed at targeted agri-food chains, government can facilitate value chain coordination and networking and encourage improved business practises, particularly in post-harvest agri-food chain phases, including work on 'sell by' dates and showcasing best industry practises.

FAO REU could also consider establishing an ECA or ECA low and middle-income network to coordinate food loss and waste monitoring and reduction initiatives by interested countries in the region. Such a network could coordinate adoption of food loss and waste definitions and methodology, while refining them for use in individual countries and agri-food chains. It could also provide capacity building and guidance for interested country initiative groups and encourage the sharing of experience in best practises and lessons learned across the region.

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Indicative list of initiatives to reduce food losses and waste in Europe and Central Asia

International Level	
FAO	SAVE FOOD
FAO, UNEP and partners	“Think.Eat.Save. Reduce your footprint”, The Global FoodBanking Network
Supranational Level	
EU	EU-Fusions
EU	European retailer’s action to prevent food waste
EU	EPCAS Food Waste Initiative
EU	Avoiding food waste: how to improve the efficiency of the food chain in the EU
EUFIC	Clymbol - Role of health-related claims and symbols in consumer behaviour
EUFIC	Recapt - Closer co-operation to strengthen the global competitiveness of the European food sector
EUFIC	Connect4Action - Connecting stakeholders with interests in food to improve multidisciplinary dialogue
EUFIC	Chance - Affordable, nutritious foods for those at risk of poverty
EUFIC	EuroDish - Studying the need for food and health research infrastructures in Europe
EUFIC	Inprofood - Towards sustainable food research
National Level	
Austria	“Lebensmittel sind kostbar”/“Food is precious”
Belgium	-
Bulgaria	“Responsible Usage of Resources – from Food to Fuel – Certain Way of Sustainability“

Croatia	-
Cyprus	("Cyprus Sustainable Tourism Initiative" (CSTI))
Czech Republic	"Daily Menus for Homeless"
Denmark	"Stop spild af mad" / "Stop Wasting Food"
Estonia	-
Finland	"Saa syödä" / "License to Eat"
France	National pact against food waste, "Stop Food Wastage"
Germany	"Zu gut für die Tonne"/ "too good for the bin", Wir retten Lebensmittel, Essenswert, "Close Bakery", "Wir lieben Lebensmittel" (Edeka)
Greece	BOROUME: "Saving Food, Saving Lives" / "We can"
Hungary	<i>Hungarian Food Bank Association</i> , Store operations blueprint (Tesco)
Ireland	National Waste Prevention Programme (NWPP), National waste management plan, foodwaste.ie: "Less Food Waste-More profit", "STOP Food Waste campaign" (SFW)
Italy	Last Minute market, Un anno contro lo spreco, "Buon Samaritano" / "Good Samaritan", "Bennet", "Pasto Buono" / "Good Meal"
Latvia	-
Lithuania	The Lithuanian Food Bank
Luxembourg	"Stop Food Waste Luxembourg"
Malta	-
Netherlands	"Save Food from the Fridge", „Taste the waste“, "Damn food Waste", "Preventing food waste and optimising residual waste streams"

Poland	Federation of Polish Food Bank, “Stop wasting food” (Edelman Poland)
Portugal	“Menu Dose Certa” / “Menu right dose”, “Fruta Feia” / “ugly fruit”
Romania	Blythswood Romania: Foodbank
Slovakia	The Food Bank of Slovakia
Slovenia	Slovenian Foodbank
Spain	“More food, less waste”, “Food is too good to waste”, Food Banks
Sweden	Eurest: restaurant and food campaign
Turkey	Campaign on Preventing Bread Waste
United Kingdom	“Feeding the 5000”: The Gleaning Network, “The Pig Idea”, “Waste and Resources Action Programme” (WRAP), “Love Food, Hate Waste”, “Approved food”:Food redistribution programme, “FareShare“: Food redistribution programm, “Food Cycle“
Kazakhstan	-
Kyrgyzstan	-
Tajikistan	Tree-Planting Initiative
Turkmenistan	-
Uzbekistan	-
Armenia	-
Azerbaijan	-
Georgia	-