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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Food Losses and Waste in Europe and Central Asia

Draft Synthesis Report

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Executive summary

1. Most people would agree that food waste is an ethical issue; in contrast, they may not mind other people using cars with high fuel consumption, which drain limited resources, or spending money on luxury clothes or jewelry. It seems engrained in our mental models that food waste has a negative impact on worldwide hunger. Therefore, it is not a surprise that policy makers in many countries and representatives of international organizations have been discussing this topic intensively in recent years.
2. Food losses and waste (FLW) has become a high-profile issue in both the public media and in policy debates. The EU and some other countries have even set specific targets for how much FLW should be reduced in a specific period of time.
3. The Food and Agriculture Organization of the United Nations (FAO), as the main organization for affairs concerning worldwide food and agriculture, has published several reports that express the significance of FLW. The main message of these reports is that:
 - a) The total amount of FLW was quantified in metric tonnes by adding up FLW for very different products. According to these studies, 30 percent of world food production is either lost or wasted.
 - b) Reducing FLW could help fight worldwide hunger and poverty and could also contribute to saving resources and mitigating climate change.
4. A literature review of the state of public debate in Europe and Central Asia has led to the following findings:
 - a) A clear definition of FLW is necessary to ensure accurate quantification and interpretation of the problem. The definition used in most studies follows the definition suggested in the relevant FAO documents. However, this does not lead to a realistic estimate of FLW. Firstly, according to the accepted definition, agricultural and food products that were planned for human consumption, but which are then used as feed due to screening or other reasons are classified as FLW. The same holds true for food that is distributed to the poor for charity. However, these subsets of FLW can indirectly contribute to human consumption as animals provide meat, milk and eggs. Moreover, distributing food to poor people can hardly be called waste.
 - b) Most studies estimate either total worldwide FLW or FLW in specific countries. The widely used method of aggregation is based on adding up FLW (tonnes) for individual food products. Measuring FLW in tonnes may not be meaningful if we want to highlight the importance of FLW for fighting hunger. It does not make much sense to aggregate tonnes of vegetables with tonnes of meat or other individual food products. A more reasonable measure would be the amount of calories that could be made available for human consumption.
 - c) The literature review did find discussions of a possible rationale for having an intentional system for measuring FLW. Private actors may try to maximize their profit and have to take into account additional economic costs – partly due to lower revenue or higher resource costs apart from costs for the raw agricultural product. There might be incentive incompatibility. The incentives for individuals lead to actions that are not in line with the interest of society at large.

- d) The literature review shows that nearly all studies – with the exemption of one – assume that reducing FLW would have no costs and would be a clear gain for the world community. However, there are many cases which clearly reveal that costs do occur.
- e) The literature review did not reveal how reducing FLW could be efficiently used to reduce hunger among the poor and/or to contribute to the mitigation of climate change. It is misleading to assume that the reduction of losses in one country could lead to an equal increase in food for the poor in other countries. Further research is needed to find efficient solutions.
- f) Public debate is partly reflected by the number of initiatives founded in the countries in question. There are numerous initiatives in Europe, but far fewer in Central Asia.

5. Reports commissioned by FAO:

- a) Out of the four reports commissioned by FAO, only three were available in October 2013: the report on Ukraine, the report on Armenia and the report on Turkey. The three reports provided useful information on FLW.
- b) All reports applied a wider definition of FLW than is generally accepted in the literature. The reports on Ukraine and Armenia clearly stated that they classify food that could have been produced – but was not produced due to poor farming practices – as FLW. The report on Turkey assumed this definition implicitly. There is indeed some rationale for using this wider definition, although it leads to a problem. It is known that farm performance and yields in any country, whether developed or developing, vary widely. Worldwide production would be much higher if all farmers were as efficient as the most talented and hardworking 5 percent in their countries. The question is whether it makes sense classify unproduced food as FLW?
- c) All three reports use the same method for collecting data on FLW; i.e. individual interviews, focus group meetings and official data. The three studies conclude that most losses occur at farm level. Farmers are either not aware of best practices or they do not have access to the financial means to introduce modern technologies.

6. Causes of FLW

The literature review failed to find explanations for the root causes of FLW based on market failure or policy failure. Instead, the causes of FLW in the individual steps of the supply chain were listed. This report introduces a new classification system. The causes are classified into six different rubrics:

1. Inadequate technology
2. Specific consumer preferences
3. High opportunity costs
4. Worldwide trends
5. High transaction costs
6. Education

Each group discussed whether FLW could be caused by market failure or policy, or whether it could be the failure adequately functioning markets and organizations.

7. Policy options

- a) Whether policy makers should do all they can design policies to avoid FLW is questionable. There are some good economic reasons to argue that it is economically rational and morally acceptable to accept some losses.
- b) In spite of the numerous studies available, research is still needed to help design policies for reducing FLW, increasing food security, reducing the use of vital resources and inducing

positive climate effects. The studies will most likely find that reducing FLW *per se* will not necessarily contribute to the objectives in the same way in all locations. The effect depends on the country under consideration, the origin of the FLW and the instruments chosen.

- c) Empirical studies can show which steps on a given supply chain suffer from the highest percentage of FLW. However, these figures can hardly be used to prioritize policy interventions. First, the costs for reducing loss and waste have to be taken into consideration, and these costs vary across countries and products. Second, savings in FLW are greatest if improvements are made in the supply chain steps that are closest to household level.
- d) If a wide definition of FLW is chosen (including food that was not produced due to poor farm practices) and identified as the main reason for high FLW, then the best initial option might be to improve the information and knowledge of farmers and the access to inputs, especially credits.
- e) Improving markets and market organization will also contribute to reducing FLW throughout the supply chain, including improved cooling, storage and transport facilities.

1. Introduction to the topic: the importance of FLW

Food is not seen as a normal economic product that can be produced in the same way as any other product and whose value is expressed solely by the price. Many people have in mind that they or their ancestors have suffered from starvation at some point in their lives and have developed emotional feelings about the issue. A variety of studies have been completed to highlight the magnitude of the problem of FLW, to initiate specific targets for reducing FLW, and to institute policies to meet the targets. Moreover, it is widely accepted that agriculture contributes climate change and uses up limited resources to a greater extent than is necessary for feeding the world's population.

The 2011 study on FLW commissioned by FAO reached the following conclusion: "The results of the study suggest that roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tonnes per year. This inevitably also means that huge amounts of the resources used in food production are used in vain, and that the greenhouse gas emissions caused by production of food that gets lost or wasted are also emissions in vain" (FAO, 2011). This publication seems to have shocked the international community and initiated further international and national studies as well as political initiatives.

The European Parliament is at the forefront of fighting against FLW. A resolution was approved by the Parliament's agriculture committee 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 European Parliament wants 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. It is somewhat surprising that the European Parliament seems to be the only governmental organization which contends that FLW could be reduced by supporting small- and medium-scale farms.

Several other institutions have declared their intent to reduce FLW:

- A report by the UK Government Office for Science has set the target to halve the amount of food waste by 2050, which would be equal to 25 percent of today's production. (Foresight, 2011).
- The 2011 European Commission Resource Efficiency Roadmap has set the target of halving edible food waste by 2020.
- In 2010 the World Economic Forum (WEF) announced its new vision for agriculture on the basis that agriculture contributes 30 percent of global greenhouse gas emissions, 40 percent of employment worldwide (and 70 percent for the poorest billion) and accounts for 70 percent of all water withdrawals" (WEF, 2010, quoted by Davis, 2013).
- OECD has started to build a preliminary data set on food waste, which includes 34 OECD member countries and China (OECD, 2013).
- UNEP, FAO and partners started a global campaign on reducing food waste in January 2013. It aims to reduce food waste and provides an information sharing portal for various worldwide initiatives. It targets food wasted by retailers, consumers and the hospitality industry throughout supply chain.

The public interest in the topic 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. Even though there have been more than 200 official publications and a lively national and international debate on FLW; the studies differ in country coverage, definition, methodology and policy recommendations. In light of this there is a need for stocktaking.

A number of FLW studies have focused on specific countries or regions. The findings of these studies show that a significant share of food is either lost or wasted. Estimates available for some countries suggest that between 30 and 40 percent of all food is lost or wasted. However, the reasons for this and where in the value chain the FLW occurs differ significantly from country to country. Causes of food waste at household level vary more than causes in other stages of the supply chain as a result of cultural practices, climate, diet and socio-economic factors (average size of household, household income, frequency of eating out, etc.) Causes of FLW at farm level vary from country to country due to differences in techniques used and type of production; wastage along the supply chain depends very much on the technical equipment used for transport, processing methods, type of products, cooling and storage facilities, among other factors.

Consequently, governments that want to institute policy measures aimed at reducing FLW have to know how much is actually wasted, at which points in the value chain FLW appears and what the causes are.

Reducing FLW could not only increase food availability at national and global levels, it could also reduce the resources needed to produce a given amount of food, thus increasing overall world welfare. Moreover, less FLW could also contribute to positive climate effects. "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"(EU, 2010).

Therefore, if these perceptions of the clear negative effects of FLW could be proven, there would hardly be any objection against policies to reduce FLW. Moreover, FLW is not only seen as an economic problem, but also as a moral one. There is loss and waste – which seems at least partly avoidable – in all countries, but significantly more in rich countries. At the same time, there are many poor and often hungry people on this planet. In light of this reducing FLW seems to be an ethical issue. The implicit assumption is that less FLW would actually lead to less poverty and hunger. This presumption has led many governments to announce targets for food losses. The EU is aiming to reduce current levels of FLW by 50 percent by 2050. FAO also considers reducing FLW to be a high-priority measure for reducing worldwide hunger.

However, whether this perception is rational from an economic point of view depends on some issues that have not yet been clarified. First, what is the most accurate way to determine the volume of FLW? Actually, there seems to be wide agreement on the methodology used. Most studies (see below) try to quantify FLW using a metric weight scale. This synthesis report will present some arguments against this measure.

Second, the best way to aggregate highly heterogeneous items has not yet been determined. Most studies aggregate in metric tonnes. Whether such an aggregate figure is meaningful depends on what the figure is used for. This issue has not been adequately discussed in the studies reviewed.

Third, the studies generally assume that the volume of FLW could be reduced with no costs or at least negligible costs. This issue will also be discussed in this synthesis report.

Fourth, the reviewed references and the three submitted reports do not discuss how the quantified FLW could contribute to achieving specified objectives. It is unlikely that any given reduction in food losses could be transferred to poor people in developing countries. Bearing this mind, whether reduced food losses could actually be transferred – directly or through market forces – to the hungry somewhere on this planet should be discussed.

Fifth, it is a widely held perception that there is a moral problem: wastage of food on one side and hunger on the other side. However, even if there is wide agreement, the point is debatable, not in substance but in relative terms. One may ask whether wasting food is the main issue which distinguishes morality seen from a societal point of view and individual behavior and – even more important – whether there might be more efficient alternatives to reducing FLW and at the same time close the gap between economics and morality.

The report is structured as follows: Chapter 3 presents a review of the existing literature, focusing on commonalities and differences. The focus will be on differences in definition, methodology, evidence and conclusions. In addition, the literature review will identify some further research needs in order to clarify open questions. Chapter 4 of the report is on the “Presentation of the FAO assessment of food loss and waste in Europe and Central Asia”. FAO intends to enlarge the knowledge on food losses and waste and has commissioned reports on Europe and Central Asia. The selection of the countries – Ukraine, Armenia and Turkey – was based on the assumption that the problem of food losses and waste differs across countries and that policies should be country-specific. Chapter 5 deals with the causes of FLW, proposing a classification of causes that could be used to institute target-oriented policies. Chapter 6 discusses policy options for reducing food losses and waste. Based upon this study, further research needs that are targeted at clarifying open questions will be identified. The report is only partly based on analyzing literature. It also focuses on possible ways to improve the methodology, data collection, interpretation of data and use of the information for policy decisions.

2. Literature review of the state of public debate in Europe and Central Asia

The public debate about FLW is reflected in two parts: the number of studies and publications devoted to FLW (3.1) and the initiatives founded in the countries in question (3.2).

2.1 Literature review

A growing number of publications are devoted to FLW. A thorough review is provided in Parlitt et al. (2010) and by the FUSIONS project (Fusions, 2013a), in which a total of 221 publications were identified as relevant. The publications can be separated into journal publications and the so-called grey literature. So far, peer reviewed journal publications have played only a minor role (about 15 percent) and centre on the journals *Waste Management* and *Food Policy*. Grey literature is generally not peer reviewed and the quality of the publications varies substantially. Most studies are commissioned by international or national organizations and are conducted by researchers from universities or collaborations of several project partners. Interestingly, the studies are commissioned by organizations that work in areas that are not suffering from food insecurity such as the EU. Very few studies are carried out by professional economists.

It is widely recognized that there are major losses of food along supply chains all over the world. FAO (2011) estimates that worldwide, one-third of all edible food is lost every year. More specifically, in developing countries, most FLW occurs at the beginning of the supply chain, while in developed countries, FLW occurs more often at the retail and household levels (FAO, 2011; OECD, 2013). But so far, the precise extent of FLW is still being debated (FAO, 2011; Rutten, 2013). Furthermore, several major discussion points and gaps can be identified in the literature, which will be addressed in this report.

In order to provide a structured overview of the literature, the review will be grouped by aspects that are or should be central to the public debate of FLW. Most importantly, the **aims of the studies** differ (3.1.1). A major point of discussion is the **definition of FLW**, which varies greatly from study to study (3.1.2). Furthermore, the **data collection and quality** differs (3.1.3). Also, the **methodology of aggregation** for FLW (3.1.4) is subject to an intense discussion (Koester, 2013a). In addition, there are different opinions regarding the **causes of FLW (3.1.5)**. While most studies identify large amounts of FLW, only a few studies go one step further and point out actual **courses of action to limit FLW (3.1.6)**. Even fewer studies discuss how food surpluses in some regions can be **transferred (3.1.7)** to regions with food shortages.

1.1.1 Aims of the studies

There are major differences concerning the aims of the studies for analysing and documenting FLW. Several studies, especially those originating from developed countries, are motivated by social or ethical reasons. It is often stated that it is unethical for food to be wasted in some parts of the world while people suffer hunger in other areas (e.g. Kranert et al., 2012). However, it is surprising that given this motivation, none of the studies discusses how reducing FLW in some regions may actually help people that suffer from hunger (see a further discussion in 3.1.7).

Other studies aim at improving food security¹ (e.g. Ukrainian study, FAO, 2013). 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. However, these studies do not discuss how the surplus could be transferred to regions with food shortcomings. Another aim is to increase resource efficiency (e.g. FAO, 2013). The resources that are used to produce foods that are ultimately wasted could be better used for something else. Finally, several studies are motivated by environmental factors, such as reducing CO₂ emissions or eutrophication by producing less food that ultimately goes to waste.

1.1.2 Definition of FLW

There is no consensus on the definition of FLW (OECD, 2013). The definitions employed vary across countries, the stage of the supply chain and research projects: Over 100 different definitions of “food loss” and “food waste” have been collected by FUSIONS. Finding a universally applicable definition is key to understanding country specifics (OECD, 2013). In light of this, one of the aims of the FUSIONS initiative is to provide common ground for a definition. Generally, food loss relates to a decrease in food quantity or quality so that the food is no longer available for human consumption. Food waste refers to losses due to behavioural issues (Parlitt et al., 2010). The EU waste directive 2008/98/EC defines waste as “any substance or object which the holder discards, intends to, or is required to discard”. As a result, FUSIONS participants suggest employing the term “food wastage”, defined as follows: “any food and inedible parts removed from the food supply chain”. In greater detail, the following points are subject to discussion:

- **Distinction between “edible” and “inedible”**

So far, no consensus has emerged as to whether to include or exclude inedible parts such as banana skins. The FUSIONS definition of “food wastage” considers inedible parts as wastage because they could potentially be used for human consumption once the limitations due to limiting technology are overcome. However, for example, some parts of animals that are not used for human consumption are instead used for a variety of other products (see Meindertsmas, 2007, e.g. soap, concrete, bread, paint). Should this be labelled as food waste or not? For example, Hodges et al. (2011) only consider edible parts not available for human consumption as food waste.

- **Food used for animal feed**

While the majority of studies, including those by FAO, consider food that could be eaten by humans but that is used to feed animals as waste (e.g. Stuart 2009; Parfitt et al., 2012), other studies do not count this as waste (e.g. Silvennoinen et al., 2012).

- **Storage**

Storing food results in unavoidable losses. For example, potatoes lose water and weight during storage. Thus, eating potatoes during the harvesting seasons and importing potatoes during the other seasons results in fewer “food losses” than storing potatoes. But it is highly questionable whether importing potatoes really increases our welfare (Koester, 2012).

¹ FAO’s definition of food security: “Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.”

- **Consumption habits**
Some people dislike eating apple or potato skins. This type of waste is generally considered avoidable food waste. Would it really help hungry people if some people changed their consumption habits? (Koester, 2012)
- **Excessive human consumption**
Some people consume more calories than is actually considered healthy. The question is whether the excess calorie consumption should also be labelled as waste or not. Parfitt et al. (2010) and Barthel et al. (2010) regard overeating as food waste while in the FUSIONS project; it is regarded as inefficiency rather than waste.
- **Usage of improper technology**
If milk production decreases due to mastitis (FAO 2011), this is counted as FLW. In light of this it can also be asked whether reduced harvests due to incorrect input use (fertilizer and agricultural pesticides) should also be counted as FLW.

1.1.3 Data collection methods and data quality

As data collection methods are generally not standardized, a large number of different approaches have evolved. In general, data collection methods are rarely validated. Even though most studies mention that the data would be representative for a bigger region, this is neither proved nor tested further. Thus, the quality of data varies significantly and rating the quality of the data provided in the publications is impossible.

The methods for assessing the amount of FLW can be grouped into quantitative and qualitative categories. Quantitative methods directly measure the amount of FLW while qualitative methods rely predominantly on information provided by interview partners. The applied methods of data collection depend largely on the targeted part of the supply chain and the specifics of the country or region in question (Kranert et al., 2012).

Quantitative methods generally aim at actually collecting samples of wasted food. For example, the WRAP initiative sampled the FLW of several English households (WRAP, Final report, 2008). The advantage of quantitative methods is that they provide very detailed estimates of FLW. The disadvantage of this approach is that it is often very expensive. The advantage of qualitative methods such as interviews is that they are easier to implement, although the information is often less reliable.

To facilitate the comparison across studies, the FAO (FAO, Save Food Initiative) issued a guideline for small-scale agriculture and fisheries subsectors: First, secondary data should be screened ("**Screening**"). On the basis of the results of the screening, surveys to collect information from different stakeholders via questionnaire and own observations should be carried out ("**Survey**"). In addition, the specific amount of food loss should be sampled ("**Sampling**"). Finally, a synthesis should be done in order to develop a prediction of the total amount of FLW and to estimate models for certain locations ("**Synthesis**").

1.1.4 Aggregation

In addition to the question of defining FLW, the method of aggregation is a further point of discussion in the literature. So far, no standard protocol for measuring food loss and waste has been developed (WRI, 2013). Dependent upon the specific scope a study seeks to address, different methods of aggregation emerged: FLW is most often aggregated on the basis of weight or value and only exceptionally on the basis of caloric equivalents. Other studies convert FLW into greenhouse gas emissions or water use (Parfitt et al., 2010). Each of the methods of aggregation has certain advantages and disadvantages.

The majority of studies simply aggregate **the weight** of FLW. For example, Buzby and Hyman (2012) calculate the weight of edible food losses in the US, and Kranert et al. (2011) carry out a similar analysis for Germany. Adding up the number of kilograms is certainly a straightforward way but suffers from major drawbacks. For example, producing 1 kilogram of meat uses more resources than producing 1 kilogram of potatoes (Koester, 2013a). Thus, the weight of FLW does not necessarily allow for conclusions regarding how many people could have been fed using the food that was lost or wasted. Unfortunately, this method is currently dominating other approaches as this type of data is most readily available. As the conclusions that can be drawn from this method are very limited, it is no longer recommended.

Another approach, which is seldom applied, is to aggregate **the values** of FLW by determining retail prices of products (Buzby and Hyman, 2012; WARP, 2008). In this case, it is problematic that only a small share of the retail price actually reflects the value of the product itself. For example, cereals that cost USD 1 at farm level will cost USD 7 at retail level due to processing, trading, storage and advertising costs (Koester, 2013a). Thus, the value of food lost at the farm level is much lower compared to FLW at the retail level solely due to the value added. Consequently, drawing conclusions on the basis of food values might be misleading.

Very few studies aggregate **caloric equivalents** (Kummu et al., 2012; Lipinski et al., 2013; WRI, 2013). Caloric equivalents allow for much more precise estimates of the potential of FLW to feed other people. However, the data collection is more complex.

Other studies that highlight the resources that are lost due to FLW convert FLW into **greenhouse gas emissions** (WARP, 2009) or **water use** (Lundqvist, 2008). This type of aggregation highlights a certain aspect of the problem. However, the conversion requires additional data and might not be available for all countries. Thus, these approaches might not be suited for a broader range of studies.

1.1.5 Causes for FLW

With regard to the sources of FLW, two major views can be identified, and the question is whether there is a market or policy failure or not. According to the OECD (2011), the amount of FLW is the result of rational behaviour of all economic agents (households and producers). Given current consumer preferences, prices and available amounts of food, it might be optimal for the individual to not use some amount of food.

However, other studies implicitly argue that there is a market failure (Koester, 2012; Koester, 2013b). For example, Urutyan (FAO, 2013, FAO) identifies the farmers' lack of knowledge and the lack of

proper mechanization as the key causes for FLW in Armenia. Thus, the market fails to provide enough financial resources meaning that farmers are able to invest in technical equipment that reduces FLW. Furthermore, an assessment of FLW in Ukraine calls for reform of the agricultural land market, financial support for agricultural producers and increased market transparency for the prices of food products and product wholesale markets. For example, in 2012, Ukrainian smallholder milk farmers received subsidies for investments in better milking techniques.

1.1.6 Potential courses of action

Most studies identify potential actions that can be undertaken to reduce FLW. However, most discussions remain at the surface. Costs and benefits of certain actions are seldom evaluated. A notable exception is Kitinoja (2010, WFLO); in joint efforts with the World Food Logistics Organization and the University of California, several projects were carried out that were aimed at improving market access and incomes of small farmers of horticultural crops in Africa and South Asia by promoting the adoption of better post-harvest technologies. For each proposed measure, costs and benefits were evaluated and the rate of return on investment was identified.

However, most studies propose rather superficial measures like raising the awareness of the problem in developed countries and increasing education and financial support for farmers in developing countries.

Wasting food might imply wasting resources. Thus, most studies focus on saving scarce resources such as water. However, the studies do not discuss whether alternative measures might also reach the proposed aims. For example, why do we need so much clothing in developed countries (Koester, 2013a)? Cotton requires high levels of irrigation and land. Often, we buy new clothes just because we want to have a new look that corresponds to the current fashion trends. Potentially, it could be much more efficient to raise awareness about the misuse of resources in other product categories instead of trying to reduce food waste.

1.1.7 Transferring food surpluses to areas with food needs

The public debate on FLW in developed countries is often motivated by hunger in developing countries (Kranert et al., 2012). However, none of the studies discuss how the efforts to reduce FLW could benefit areas with unmet food needs. At regional level in developed countries, food banks redistribute the food surplus of retailers to low income families. But the question of how reduced household food waste in developed countries could help hungry African families remains unanswered.

2.2 Initiatives

To raise awareness, initiatives to reduce FLW have been implemented by several international, supra-national and national organizations. This reflects the fact that FLW has evolved into a high-profile public issue. However, at national level the initiatives are predominantly concentrated on Europe. In almost every European country, there is an initiative such as WRAP in the UK. At the opposite end of the spectrum, there are almost no comparable initiatives in Central Asia. This is a strong indicator that the public debate on FLW is weaker in Central Asia than in Europe.

Existing Initiatives	
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
United Kingdom	"Feeding the 5000": The Gleaning Network, "The Pig Idea", "Waste & 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	-
Mongolia	World Environment Day

3. Presentation of the FAO assessment of food loss and waste in Europe and Central Asia

This chapter contains a review of the three country studies (Armenia, Turkey, Ukraine) commissioned by FAO. Important points that are subject to discussion are the definition of FLW that is employed (3.1 and 3.2), the objectives of the studies (3.3), the relationship between FLW and the efficient use of resources (3.3), the relationship between FLW and food security (3.5), the methodology for quantifying FLW (3.6), the selection of supply chains (3.7), methodology for collecting data (3.8), selected findings (3.9) and the interpretation of the findings (3.10).

3.1 Definition of FLW

The definition of food losses and waste is crucial for quantification; it is also important for interpreting the causes of food losses and waste as well as for the design of policies to reduce it.

The definition of food losses and waste used in the studies differs in one important point from the definition proposed by FAO.

It is quite clear that there is some freedom to select a specific definition. However, the definition should be in line with the objectives of the study. If the study aims to contribute towards reducing worldwide starvation and hunger, the definition should focus on calories that could be saved somewhere and made available to the hungry.

If, on the other hand, reducing food losses and waste is supposed to contribute to reducing resource use and reducing climate effects, the definition might be different. Moreover, the policies instituted to achieve the different objectives may differ widely. Therefore, it is logical to review alternative definitions with respect to compatibility with the objectives of the study.

The most relevant FAO document defines FLW as follows: “Food losses refer to the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption. Food losses take place at production, post-harvest and processing stages in the food supply chain. Food losses occurring at the end of the food chain (retail and final consumption) are termed food waste, which relates to the behavior of retailers and consumers. Food waste and losses are measured only for products that are used for human consumption, excluding feed and parts of products which are not edible. Based on this definition, food losses and waste are the masses of food lost or wasted in those parts of food chains that work with edible products used for human consumption. Therefore, food that was originally meant for human consumption but which is removed from the human food chain is considered as lost or wasted even if it is then directed to a non-food use (feed, bioenergy...). This approach distinguishes planned non-food uses from unplanned non-food uses, which are hereby accounted under losses.” (FAO, 2011, p. 2).

This definition is not in line with the objective of reducing worldwide hunger. The definition clearly says that food that was originally planned for human consumption is lost if used as feed for animals. If some products originally intended for human consumption are fed to animals, they can still contribute to the human diet in the form of meat, eggs or milk. Thus, human consumption is less negatively affected than if food were thrown away. Of course, some calories get lost if food is

diverted to feed, but if the latter is considered a food loss, the loss to the human food supply is then overestimated.

The rationale of the definition is even less convincing if food taken out of the normal supply chain is donated to charity. Obviously, some poor people are fed and, thus, it hardly makes sense to classify food that was diverted from the typical supply chain – but ultimately consumed by humans – as FLW. Another aspect of food loss and waste relates to reducing resource use and negative impacts on the environment. The FAO definition of food loss and waste does not lead to an indicator that is closely correlated to resource use and climate change. Food loss caused by the production of ruminants has different effects than food loss from the production of vegetables. Moreover, animals may be fed quite extensively, grazing on the steppes in Mongolia, or may be fed intensively with concentrates in Europe which were transported from South America or the US. Therefore the general message is as follows: The definition of food losses and waste that FAO uses does not lead to a reasonable indicator that allows conclusions to be drawn on the potential for reducing hunger and/or the potential to save resources and reduce to climate change.

In contrast to FAO, the authors of the Armenian, Ukrainian and Turkish studies decided to accept a somewhat wider definition. The author of the study on FLW in Turkey implicitly used the same definition. The studies include losses that occur in field production due to plant and animal diseases contracted after reaching maturity (Ukrainian Study, p. 7 and Armenian Study, p. 10) and livestock production reduced by diseases. There are good arguments for using this wider definition. The authors argue that food production would be higher if farmers used adequate technologies (spraying some crops, such as wheat and corn, or applying veterinary services for improving the health of animals and thus productivity). The authors claim that food production would be significantly higher if production potential was more adequately utilized. This argument is plausible and points implicitly to one important aspect. If reducing food losses is supposed to improve food security and increase the efficient use of resources, it makes sense to assess the total production line, including input use, agricultural production and all other steps in the supply chain. Widening the definition of food losses in this way could reveal the potential for reducing losses that is much higher than if a narrower definition were used. Moreover, it might be much easier to exploit the potential for reducing food loss in the wider sense. Improving production potential by using optimal inputs is in the interest of farmers. Therefore, policies should be instituted that help farmers increase their profit and at the same time contribute to more efficient use of scarce resources and food security. This line of thought leads to the conclusion that any definition – even if the author is free to select his or her own definition – should be in accord with the objective of the study.

3.2 Problems with the wider definition of FLW

When using the wider definition and, thus, taking into account the unused production capacity due to inadequate use of inputs and use of obsolete techniques, two problems arise. First, it implies that all farms should produce at optimal levels, using best practices. However, it is difficult to find out how much the agriculture sector in a specific country or worldwide could actually produce. It is nearly impossible to quantify unexploited production potential. Second, this wider definition goes far beyond what can normally be considered as food loss or waste. Figures would be highly inflated. The outcome would likely be that FLW would be highest in developing and transition countries. It seems somewhat strange that the authors of the Turkey report list “insufficient precipitation in October and

April” (Tatlidil,F.F., I.Dellal, and Z. Bayramoglu, 2013, p. 41) as one cause of FLW. Indeed, that is loss, but not a subset of FLW as generally defined.

3.3 Objectives of the studies

The objectives have been defined as follows:

Ukrainian study: “The objective of the study is to identify critical points and patterns of food losses and waste along selected food supply chains in Ukraine, which have the largest impact on food security and food supply in the country. For that purpose the country study aims to provide an overall assessment of food losses and waste and its impact on food security and food supply, as well to identify and analyze critical points for food losses and waste along selected agri-food chains”.

Armenian study: “Improving the efficiency of the food supply chain and reducing losses in this process will help to bring down the cost of food to the consumer, which is a very big issue in countries like Armenia where poor families spend most of their income on food”.

Turkish study (p. 8): “The objective of the study ... is to assess food losses and waste emerging at critical points in food supply chain for commodity groups specified by FAO in Turkey, which have the largest impact on food security and food supply in the country”.

Thus, the studies aim to quantify FLW and thereby contribute to improving food security and increasing food supplies in the countries. The authors are in accord with the widely held perception, and also with most official statements and publications (see chapter 3), in assuming that food loss implies an inefficient use of resources and that reduced food loss contributes positively to food security. Nevertheless, it is worthwhile challenging this perception because it may have repercussions on the data needed to design policies in order to achieve food security by reducing food losses and waste. The main question is whether there is a clear functional relationship between reducing FLW and the stated objectives. The answer to this question may be important for defining losses and waste from an economic point of view and for designing policies.

3.4 The relationship between food loss and waste and efficient use of resources

Policies will be more efficient if the instruments are targeted and, instead of only focusing on the benefits, also take into account the potential economic costs of reducing food waste. These economic costs may differ significantly depending on the causes of losses and waste. For example, considering the losses incurred in the supply chain for fruit due to lack of cooling systems. It seems plausible that farmers and traders are interested in reducing losses in this regard. Failure to invest in cooling systems may be down to inadequately functioning markets as contractors may not have sufficient access to credit or because the investments will only pay off if vertical markets are well integrated. Eliminating such causes of market failure is not only in the interest of the society at large, but also in the interest of those actors involved in production, trading and processing. Therefore, it is likely that the benefits of reducing food loss and waste depend on the causes of food loss and on the measures available for reducing loss and waste.

The characteristics of a product change along the supply chain. For example, a potato in a retail shop is economically different from the same potato on the farm. Services and processing activities are

added while the potato is moved along the supply chain. Such services include transport, storage, retail, and trading.

The relationship between the added services and the raw product is partly fixed and partly substitutable. For instance, a food retailer can select to stock food items several times daily in order to offer fresh vegetables and other items at all times during the day. The retailer is also able to collect fairly accurate information about the daily flow of its food items, thus minimizing food waste. However, in order to do this, the retailer has to devote more resources to purchasing and storing food items. Delivery companies would also have to use more resources, as transport and labor costs would increase with the frequency of deliveries. Consequently, less food loss would lead to a higher volume of complementary services. Similarly, at the consumer level, buying food products daily would mean buying only the quantity of fresh food needed for that day, and minimizing food waste. However, there are transaction costs associated with buying food daily, which the consumer may weight against the cost of food waste resulting from shopping less frequently. Therefore, consumers may consider buying food once a week and accepting that some waste will occur either because less food is eaten by the household than expected or because food may have to be thrown away when it is no longer fresh. Therefore, reducing food waste in shops and in the home would come at the cost of using more non-food resources. These examples highlight that it may be economically efficient to accept some food losses and waste” (Koester, 2012).

Consequently, there is no clear relationship between the amount of food loss and waste for an individual product or group of products and the contribution to the objective of “efficient use of resources”. However, it might be that there is a clear relationship between food loss and waste and food security as implied by the objective “contributing to food security”.

3.5 The relationship between food losses and waste and food security

Food security is defined as follows by the World Food Summit, FAO; UNDP and World Bank, among others: “Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (World Food Summit, 1996; FAO, 2008). This definition clearly implies that food security is not necessarily related to the availability of food at macro-level (nationally or internationally), but to access to food by those households that may have problems getting enough food to enjoy an active and healthy life. Consequently, reduction of food loss or waste will only improve food security if and only if it improves the food situation of those suffering from food insecurity. Obviously, reduction of losses does not directly affect the food situation of the poor. Strangely enough, it might even have the opposite effect if the quantified loss includes food donated as charity or sold at marked-down prices.

Often, it is assumed that reducing food losses and waste will reduce market prices and poor households will be able to buy more food. However, this argument implicitly assumes that domestic prices are determined by domestic supply and demand. That is certainly true in a closed economy, but not for tradables in an open economy. Domestic prices may not change at all if domestic supply of food changes; import or export prices determine market prices in an open economy. Moreover, reducing quantified food losses does not always increase supply of food on the market to the same extent. If processors or retailers reduce losses – even if this is costless, like manna from heaven – it helps to reduce costs and to increase profits of the businesses, but does not necessarily lead to a greater market supply. If FLW were reduced in a closed economy, market prices would go down and

market supply would be lowered. Therefore, there is no clear functional relation between reducing food losses and the availability of food at national level, even in a closed economy. The functional relationship between food losses and access by the poor to food is even weaker. Certainly, it depends on whether the reduction in food loss is due to perishable products that are produced by poor households or at least consumed by them.

One may argue that the world is like a closed economy and it can be concluded that reduction of food loss has the potential to help starving people. However, whether it really helps depends on how the amount of food saved in some countries – mainly in the rich ones – can actually be shifted to the hungry in poor countries. There is no efficient way to transport the raw and processed food saved at different steps of the supply chain to the poor in other countries. If it were possible, it would be a huge food aid project with some negative effects in the receiving countries. Moreover, one has to recognize that the consumption pattern of hungry populations in poor countries is different from that in rich countries. In light of this, what alternative are there?

It might be argued that resources saved through reduction of food loss and waste implies an overall saving of resources. Hence, countries that save resources in their countries could help the starving population in other countries. Indeed, if there is a net savings, taking into account the potential resources needed to save food, the rich countries could just ask those who saved to hand over the saved money to the government and the government could send it to the poor countries to feed the starving population. This alternative leads to two caveats, however: It is unlikely that any government would be able to collect an amount equal to the value of saved resources from those who saved food. Moreover, if the rich countries wish to save resources to benefit the hungry in poor countries, they should investigate how resources could be saved in the most efficient way. It is unlikely that the most efficient resource-saving alternative is reduction in food loss and waste. Savings from using less clothing, energy, jewelry and packing material could be some of the more efficient alternatives.

3.6 Methodology to quantify food losses and waste

FLW accrues for individual food items along the supply chain and thus it can be identified at single steps in the supply chain or along the entire supply chain. The authors of the studies decided to quantify FLW for individual groups of products along the whole supply chain. This was measured in kilograms or tonnes and then vertically aggregated along the supply chain.

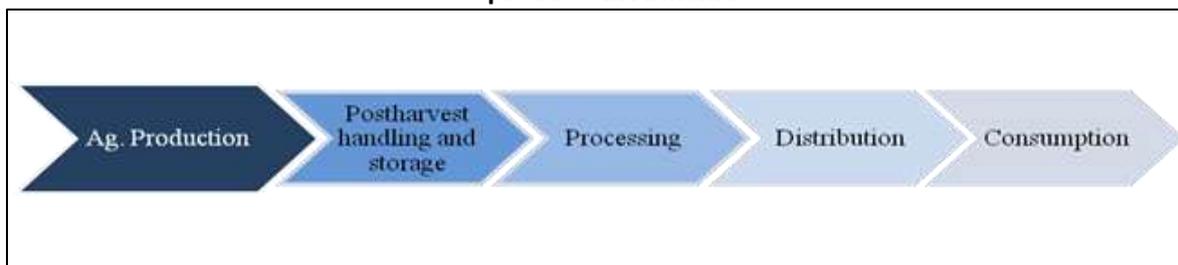
Aggregating FLW at individual steps of the supply chain for individual products or groups of products may not result in quantifying the economic loss in resources needed to produce a given amount of food. If a product moves along the supply chain from the field to the fork, the product changes its economic character. Moving down the supply chain, services such as grading, trading, storing, processing, selling and transporting are added. Therefore, if the study aims at identifying economic costs incurred due to loss and waste of food, it also has to include the wastage of all resources along the supply chain. Focusing only on the agricultural raw product will result in an underestimation of resources wasted. **Consequently, the data presented in the studies could be a lower estimate of the loss of resources in economic terms if the loss could actually be avoided without increases in economic costs.**

3.7 Selection of supply chains

The authors essentially used the methodology established by FAO, starting with the commodity grouping of FAO food balance sheets. It would have been very labour intensive to quantify FLW for all agricultural commodity groups and products and to come up with an estimate of total FLW for the country. Therefore, the authors selected five to eight commodity groups and commodities based on presumed relevance. The commodities included differ somewhat based on the country-specific relevance. Product groups that were included in all studies are cereal (mainly wheat), roots and tubers, oilseeds and pulses, fruit and vegetables, meat, fish and seafood, and milk and eggs. However, it was not possible to collect detailed information for all individual products included in a commodity group. Consequently, the quantified FLW for the individual commodity groups could be considered as a lower bound estimate of total FLW in the country under consideration, but only under the assumption that the vertical aggregation along the supply chain is meaningful.

The data for loss and waste was generally collected along the value chain. The individual steps are depicted in Figure 1.

Figure 1: Stages in value chain and FLW elements in each stage for vegetable commodities and products in Armenia



Source: Armenian Study, 2013, page 10.

The Ukrainian study is noteworthy for differentiating one step in the supply chain. The authors introduced the following differentiation at farm level for selected supply chains:

- Modern producer, former collective, small holder and processed fruit for fruits and vegetables (apples).
- Modern producer, former collective, smallholder, processed meat for meat (pork) and milk/yoghurt, cheese, home processing for milk.

This differentiation leads to very important information as evidenced by the collected data. It makes little sense to design policies to address special problems in a sector if the sector is very heterogeneous and the problem to be addressed only concerns some parts of the sector. Governmental intervention might possibly reduce market failure in some parts of the sector, but could lead to policy failure in other parts of the sector. As a general rule, it can be stated that average variables can hardly be used for policy design if the variance among these variables is large.

The selection of the products was based on the assumed perception of the relevance for loss and waste. It has to be noted that the selection had to be based on the educated guesses of the authors as there is no way to find out a priori what the result of research might be. An alternative procedure would have been to focus on special commodities and on selected steps in the supply chain on the basis of a smaller pilot study. As it is, it would be advisable to use the results of the study to scrutinize the findings concerning a priori presumptions on commodity selection and steps of the supply chain.

3.8 Methodology for collecting data

Data was collected in the following steps of the supply chain as shown in Figure 2.



Source: Armenian Study, 2013, p. 10

This approach is quite straightforward. However, how data can be collected at individual and critical points of loss is an open question. Official data has not been collected so far. However, FAO uses conversion factors to measure the amount of food losses moving along the supply chain for calculating the food balance sheets (FAO, 2011, Global Food Losses and Food Waste). However, it is not clear how FAO collected this information and whether it has been updated. It is obvious that the studies on collecting food loss data cannot rely on the FAO conversion, but rather have to use primary data. However, it would have been informative to compare the conversion factors with the collected data. Anyway, it has to be decided what method should be used to provide adequate information and how the data set satisfies the requirements of representativeness. Generally, the recommendation as laid down by FAO (2011)² and documented by FAO (no year) have been accepted. The data was collected using the following procedure:

- I. Preliminary Screening of Food Losses (“Screening”). Based on secondary data, documentation and reports, and expert consultations (by phone, e-mail, in person) without field travel.
- II. Survey Food Loss Assessment (“Survey”). A questionnaire exercise differentiated for producers, processors or handlers/sellers (i.e. warehouse managers, distributors, wholesalers, retailers), complemented with ample and accurate observations.
- III. Load Tracking and Sampling Assessment (“Sampling”). For quantitative and qualitative analyses at any step in the supply chain.
- IV. Monitoring and Solution Finding (“Synthesis”). Used to develop a monitoring system and intervention programme for food losses, based on previous assessment methods.”³

The authors of the studies used all of these data collection methods. It seems that interviews ranked high. The author of the Armenian study interviewed, among others, 506 customers, to get information on FLW at the consumption level. Most information seems to be based on expert interviews at research institutes, administrations, farms, processors, traders and retailers. One may wonder whether these interviewees have accurate information or just provide “guesstimates,” taking into account the personal interests in publicizing food loss and waste. There is no information available on whether the interviewers were able to check the validity of the data.

It is certainly a huge task to collect all this data. There is little doubt that the findings are of interest. However, at this point of the analysis, one may ask whether the results are representative. If it is stated that the loss is of a specific production step, it may be much lower or higher as no information on the representativeness of the sample is given and a high variance can be expected. Nevertheless,

² Diei-Ouadi, Y. and Mgawe, Diei-Ouadi, Y. I., 2011; Post harvest fish loss assessment in small-scale fisheries. A guide for the extension officer FAO Fisheries and Aquaculture Technical Paper 559.

³ FAO, no year, Food Loss Assessments – Extent, Causes and Solutions Case studies in the Small-scale Agriculture and Fisheries Subsectors. Guidelines on Tools and Methodology. P. 3.

if the difference across products and on the individual steps of the supply curve are large, it can also be assumed that this is true for the whole set.

A critical question concerns the aggregation of losses accrued at the individual steps along the supply chains. As elaborated above, the goods at different steps of the supply chain are not identical in economic terms; 1 kilogram of food lost at farm level squanders fewer resources than 1 kilogram of waste at retail or consumer levels.

3.9 Selected findings of data

Some results of the studies deserve to be highlighted. The results of the Ukrainian study are presented in Table 2.

Table 2: Food losses and waste in Ukraine

Commodity grouping (product)	Producer category	Agricultural production	Postharvest handling and storage	Processing and packing	Distribution	Consumption
Cereals (wheat)	Large producer	2.5-5%	0.5-1.25%			
	Medium producer	10-40%	5-10%	5-10%	4-10%	5-15%
Roots and tubers (potato)	Modern producer	20%	5-10%	2-5%	2-7%	5-10%
	Former collective	20%	20%	5%	5-10%	10-15%
	Smallholder	10%	20-30%	5%	5-10%	10-20%
Fruit and vegetables (apple)	Modern producer	10%	10-20%	5%	5%	5-10%
	Former collective	10%	30-40%	5%	10-20%	5-10%
	Smallholder	5-10%	30-40%	5%	5-20%	5-10%
	Processed fruit			15-22%	1-5%	5%
Meat (pork)	Modern producer	10-15%	15-22%	1-5%	5-10%	5%
	Former collective	20-25%	15-22%	1-5%	5-15%	5%
	Smallholder	5-10%	0-5%	5-15%	10-20%	5%
	Processed meat			10-15%	2-5%	2-5%
Milk	Milk/yoghurt	10-30%		3-15%	8-11%	5-10%
	Cheese	15-35%	See previous / next column	10-20%	5-10%	5-10%
	Home processing	15-35%		15-30%	10-20%	10-15%

Source: Ukrainian Study, p. 51.

Table 3: Food loss and waste in Armenia

	Ag. production	Post-harvest handling and storage	Processing and packaging	Distribution	Consumption
Wheat	15%	5%	6%	7%	5%
Potatoes	19%	6%	0%	3%	1%
Tomatoes	3%	2%	3%	2%	1%
Apples	5%	4%	6%	2%	1%
Beef	1%	0.10%	1%	1%	1%
Fish	20%	0.10%	0.20%	3%	1%
Milk and milk products	2%	0.10%	4%	2%	1%
Eggs	23%	1%	0.10%	0.10%	0.10%

Source: Armenian Study, p. 4.

Table 4: The percentages of food loss in Turkey

	Ag. Production	Post-harvest handling and storage	Processing and packaging	Distribution	Consumption
Cereals	5.10%	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%	0.20%	5%	0.50%	1%
Fish and seafood	10%	0.0%2	0.04%	0.01%	2%
Milk	10%	1%	1.50%	6%	1.50%
Eggs	6%	1%	2%	1%	0.01%

Source: Turkish study, p. 5

What are the key lessons learned?

- In Ukraine, huge variances exist in lost production depending on the organization of the farm in question.
- The highest losses (percentages) are documented in all countries at producer level.
- At the consumer level huge differences exist in FLW between Ukraine on the one hand and Armenia and Turkey on the other. The fact that FLW at consumer level is very low is surprising. It may be that excess food that was fed to animals was not considered as FLW.

3.10 Interpretation of the findings

The three studies do not provide information on the aggregated amount of FLW. Keeping in mind the discussion above, this is not a loss at all; the problem of aggregation is very difficult to solve. Further studies might be needed to address this problem.

However, one issue deserves discussion. The three studies clearly show that the volume of FLW is lowest on the consumer level. This information may lead policy makers to focus instruments at this level. However, this might not be the most efficient policy. Reducing 1 percent of food loss at a specific level will lead to quite different changes in total FLW.

Table 5: The effect of food loss on the consumer level (schematic example)

Wheat		
Ag. production	Total production (in tonnes)	100
	Loss in %	15
	Loss in t	15
Post-harvest handling and storage	Loss in %	5
	Loss in t	4.25
Processing and packaging	Loss in %	6
	Loss in t	4.85
Distribution	Loss in %	7
	Loss in t	5.13
Consumption	Loss in %	5
	Loss in t	3.53
	Total loss in t	32.76

Source: Authors' representation

Table 5 provides information on one specific product; namely wheat. Losses are highest at farm level. To give an example, if we assume that total production is 100 tonnes and that 15 percent is lost and that losses are by far the highest at farm level, then if policy makers focused on farms and reduced losses by 5 percent, 5 tonnes could be saved. If losses were reduced at the consumer level by 5 percent, total demand at this step of the supply chain would also drop by 5 percent. However, the

important point is that the demand at farm level would drop much more sharply (32.76 percent). The decline in final demand leads to reduced losses in all stages of the value chain.

The schematic example clearly shows that it might be misleading to focus mainly on those steps of the supply chain where losses are highest. Moreover, one has to take into account the cost of reducing losses. If consumers change their habits by becoming aware of the implications of avoiding losses, it could be most economically efficient to focus on the consumer level.

The three reports implicitly assume – even if they do not use this term – that the main cause of FLW is due to market failure in the individual steps of the supply chain, and in particular at farm level. The authors overestimate the potential gain due to the chosen definition of food loss; namely, including unused capacity due to lack of knowledge or lack of modern techniques. Lack of knowledge and lack of modern technology are also seen as main causes of FLW in the other steps of the supply chain. This information certainly has some value, but it is not sufficient for instituting efficient policies. More research is needed.

4. Systematization of the causes of food losses and waste

As illustrated in chapter 2, many publications are available that examine the reasons for food loss and waste. The purpose of this chapter is to provide an overview of the most significant reasons for FLW and to put these reasons into an economic systematization. This systematization is illustrated in table 1. Afterwards, we discuss whether these reasons are due to policy or market failures or if they are related to economics, meaning that they are not caused by policy or market failures. The main reasons for food losses and waste are grouped into the following (economic) categories:

- Inadequate technology
- Specific consumer preferences
- High opportunity costs
- Worldwide trends
- High transaction costs
- Education
- Social aspects

At the end of this chapter, a deeper look at the milk value chain serves as a case study on the potential causes of FLW for this product.

4.1 Inadequate technology

Inadequate technology covers all causes of FLW that can be attributed to insufficient technological procedures. One of the main reasons for FLW within this category is **poor storage facilities** at all steps of the supply chain (BCFN, 2013). For example, if farmers have no storage facilities, they have to sell their products immediately after harvest. If they find no commercial consumer at this point in time, the bulk of the harvested products will spoil.

Another reason for FLW that arises at all steps of the supply chain is poor cooling systems. If it is not possible to ensure proper temperature and humidity, most products start to spoil very quickly and become more vulnerable to insect infestation. Outdated and substandard technologies also cause FLW. In this regard there is a big gap between developing and developed countries. Different techniques for preparing the soil, seeding, and cultivation can result in a huge variance in yields. In developing countries in particular, farmers often have to use outdated harvesting technology (such as old harvesters, or none at all).

Table 5: Systematization of the most significant reasons for FLW

Systematization	Reason	Step of the supply chain	Example
Inadequate technology	Poor storage facilities	Production Distribution Consumption	No storage building Poor cooling systems Poor cooling systems
	Outdated and substandard technology	Production Processing	Inefficient harvester Milk spilled during pasteurization and processing
	Lack of processing facilities	Processing	Low capacities to process all fresh products
	Inappropriate pest management	Production	Food eaten by pests
Specific consumer preferences	High quality standards	Production Processing Consumption Consumption	Crops sorted out after harvest if they do not meet the quality standards Edible food products sorted out as not suitable for processing Edible products sorted out due to size or shape Low demand for fat meat
	Abundance and consumer attitudes	Consumption Consumption	High demand for buffets with fixed prices People prefer fresh bread instead of one- or two-day-old bread
	Stockpiling	Consumption	People often buy more food than they consume
High opportunity costs	Acceptance of waste is rational for private actors	Production Distribution	Market prices lower than harvesting costs Waste of some products is cheaper than a more frequent delivery
	Premature harvesting	Production Consumption	Need for cash Food deficiency
Worldwide trends	Urbanization	All	Greater distance between place of production and consumption
	Superior diets	Consumption	Increasing demand for more perishable food products (meat, fish, fruits, vegetables)
High transaction costs	Contractual agreements	Processing, Distribution	Take back systems between suppliers and distributors
	Incorrect planning of purchases	Consumption	Purchases of excessive quantities of foods to take advantage of promotional offers
Education	Low level of agricultural education	Production	Insufficient techniques for preparing the soil, seeding and cultivation
	Inadequate professional training of sales staff	Distribution	No proper stock rotation procedures
	Incorrect projections of demand for food products	Processing, Distribution	Some quantities are not sold before the expiration date
	Limited knowledge to consume more efficiently	Consumption	How to use leftovers from meals in another way

Source: own representation

As a consequence, edible crops are left in the fields, plowed into the soil, or eaten by birds, mice, or other animals (Parfitt et al., 2010). If the harvesting technology is too poor, crops can be damaged during harvesting and may have to be rejected if they do not meet quality standards.

Regarding milk, especially during the processing stage, many food products can spoil due to outdated technology and infrastructure. For example, if infrastructure (barely passable roads) and processing technologies are inadequate, the bulk of milk may be spilled before or during the pasteurization process. Another problem, particularly in developing countries, is the **lack of processing facilities**; which leads to the inability to process all harvested crops in a timely manner. **Inappropriate pest management** is also a significant reason for FLW during the production process, because an increase in pests or diseases leads to reduced yields (BCFN, 2013).

As just illustrated, inadequate technology causes FLW; thus, some of the inputs are not used effectively. At first glance, this squandering of resources seems to reduce the welfare of the end consumer, which would imply a market failure. However, there are some situations in which applying inadequate technology could be economically reasonable, meaning that a market failure may not exist.

The loss of agricultural products at the farm level due to substandard production technology or poor storage facilities may be rational from a private and social point of view if the commercial and social value of this loss is less than the required costs to avoid this type of loss. The same line of argumentation holds for the other reasons for FLW within this category.

On the other hand, if it is economically reasonable to avoid losses that occur due to poor storage facilities or outdated and substandard technology, and the losses are still at a high level; this could be evidence of a policy failure. For example, a market failure exists if farmers are willing to modernize their technical facilities, but cannot due to poor access to the credit market. Another important point is that the supply chain may be underdeveloped due to market and policy failures. A commodity trader will only build up enough storage facilities if he or she can reasonably expect adequate incoming commodities. The farmer could fail to reach the minimum amount of incoming commodities if producers offer only small units and produce for their own demand.

4.2 Specific consumer preferences and willingness to pay

Consumer preferences are the main reason for FLW in developed 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** and all crops that fail to meet these standards are sorted out after the harvest (BCFN, 2013). The same happens at the next step of the supply chain. If edible food products are not suitable for processing, they will be wasted or used for non-food purposes (BCFN, 2013). Also, many edible food products are wasted at the last step of the value chain. The causes of this household waste are manifold: Consumers prefer to buy 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. Among the edible food products, most food is thrown away after preparation, i.e. as excess left on the plate after eating, as excess prepared but not

served, or as products opened but not finished. In terms of uncooked food, the most common sources for food waste are fruits, vegetables, and salads. **Abundance and consumer attitudes** are another reason for FLW that can be attributed to consumer preferences. Especially in developed countries, the demand for buffets with fixed prices is increasing. The harm of those buffets is that they usually involve the preparation of a larger amount of food than is really necessary. Aesthetic standards also contribute to food waste. For example, Tristram Stuart (“Understanding the Global Food Scandal”, 2009) illustrated the case of the production of carrots. If carrots have a slightly irregular bend, they 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. In the next step, the carrots have to pass through a photographic sensor that reveals any defects. Carrots that are not bright enough in color or are broken are not considered appropriate for human consumption and are used as animal feed.

People are buying too much food in general; special offers like “Buy one, get one free” promote this behavior. Thus, inadequate **stockpiling** in households is another main driver for FLW (BCFN, 2013). Additionally, stockpiling encompasses the problem of improper food storage and poor attention to the instructions on the labels, leading to a significant shorter shelf life.

Even for this category, there are some reasons why these losses could be economically reasonable, meaning that the losses do not imply a market failure. At farm level, it could be economically reasonable to sort out undersized potatoes because consumers are more willing to pay for large potatoes. This selection is economically reasonable if the revenue for the larger unsorted quantity is less than the revenue for the smaller but sorted quantity and if the spread between these revenues is higher than the cost for the selection process.

4.3 High opportunity costs

In some cases, the **acceptance of waste is rational for private actors**, meaning that a market failure does not exist. The harvesting process is associated with a variable cost component. These harvesting costs occur only if the crops are actually harvested. In time periods of very low market prices for certain crops, it could be profitable not to harvest the crops, especially if these crops have positive effects on the next crops in the crop rotation process. For the distribution sector, it could also be rational to accept some waste. The optimal strategy for avoiding food waste is a high-frequency delivery rate to grocery stores with small quantities. However, a high-frequency delivery rate is associated with high costs; thus, it could be more profitable to order larger quantities to avoid too many deliveries. On the other hand, this kind of ordering behavior could result in large quantities of merchandise not being sold before the expiration date. Even at household level, some waste could be reasonable. FLW could be reduced if people shopped every day and bought just the food they needed for the day. Doing so, they could better plan what they really need. But daily shopping is linked to high costs; thus, from the household’s perspective, it may be more economically reasonable to do the shopping once a week or once every two weeks even if this leads to some food waste.

The opportunity costs of **premature harvesting** are missed yields. This source of food loss and waste is a considerable problem, especially in developing countries. Farmers have to harvest before the optimal harvest point because they are desperate for cash or need the food to support their families. This food may also incur a loss in nutritional and economic value, and may be wasted if it is not

suitable for consumption. The immediate need for cash, in particular, implies a market failure on the credit market.

4.4 Worldwide trends

As **urbanization** increases worldwide, the distance between the place of production and the place of consumption becomes considerably greater. These long distances cause high food losses in developing countries. This is evidence of a policy failure, since adequate infrastructure is a governmental responsibility. To minimize losses, the commodities that farmers produce have to reach the consumers quickly and efficiently. In reality, in many locations, infrastructure is poor and there are not enough wholesale, supermarket, and retail facilities to provide suitable storage and sales conditions for food products. Wholesale and retail markets in developing countries are often small, overcrowded, unsanitary and lack cooling systems (FAO, 2011). However, this source of FLW should not be considered evidence of a market failure, because modernization of the supermarkets would be much more expensive than the expected revenues resulting from the improvements.

A worldwide trend toward changing the composition of people's diets is also a source of FLW. The demand for **superior diets** is especially strong in transition countries such as Brazil, India, and China. Instead of starchy diets, consumers are increasingly eating meat, fish, and fresh products, such as fruit and vegetables, all of which are more perishable (BCFN, 2013).

4.5 High transaction costs

Special **contractual agreements** cause high transaction costs and lead, in some cases, to FLW. Take-back systems between suppliers and distributors, for example, which give the distributors the right to return unsold merchandise that has exceeded a given level of remaining shelf life cause FLW because distributors will always order larger quantities than they really need (BCFN, 2013). Incorrect planning of purchases by households is also associated with high transaction costs. In particular, purchases of excessive quantities of food to take advantage of promotional offers causes FLW, because some of the food will not be consumed before it spoils (BFCN, 2013).

4.6 Education

Inadequate education at all stages of the food value chain is another cause of FLW. A **low level of agricultural education** implies that the techniques that farmers use for preparing the soil, seeding, and cultivation are insufficient. These improper techniques result in lower yields and FLW (Parfitt, Barthel, Macnaughton, 2010). FLW can also be caused by **inadequate professional training of sales staff**, who may not display the merchandise in an appropriate way or perform proper stock rotation procedures (BCFN, 2013). Improper stock rotation procedures may include, for example, the staff not moving products with an earlier sell-by date to the front of a shelf. Consequently, if the products with a later sell-by date are in the front of the shelf, they will be sold first and the older products will stay in stock. If a product is still on the shelf after its sell-by date, it will have to be thrown away. A huge problem at the household level is that many consumers do not know how to use food efficiently. For example, they do not know how to use leftovers from meals in another way or how to create dishes with the ingredients that are available (BFCN, 2013). Another cause for household waste is incorrect interpretation of the food label. It is very difficult to distinguish between the phrases "best if used by" and "use by". "Best if used by" relates to an evaluation of the food quality and "use by" refers to the food safety. Consumers prefer food products with a longer remaining shelf

life. This behavior contributes to an increase in unsold merchandise and thus to wasting food that would otherwise have been perfectly edible (BFCN, 2013).

This source of FLW is the result of policy failures. If governments were to mandate education in the agricultural sector, FLW could be reduced. Another starting point to reduce FLW could be uniform and clearly defined labels that replace the labels “best if used by” and “use by”.

4.7 FLW along the milk supply chain

This illustration of potential sources of FLW focuses on the milk supply chain because milk is very important in Ukraine, Armenia, and Turkey. The milk supply chain includes a large number of small farmers and the need for immediate delivery to the final consumer or to the processing plant. It is also a highly seasonal product (Armenia study). Another important characteristic of this supply chain is a clear dichotomy in milk production techniques and thus losses in Ukraine between 80 percent of milk produced by smallholders and 20 percent produced by commercial farmers (Ukraine study).

a) Agricultural production

For nearly all food products, agricultural production is the first step in the supply chain. The main drivers for FLW at this step of the supply chain are inadequate production techniques. Considering the milk supply chain, potential causes of FLW are animal mortality and animal disease (mastitis). These losses, which lead to decreased milk production, are the consequence of market failures, due to the lack of information and inadequate education of the farmers. Thus, better education could prevent these types of losses. Other sources of FLW at this step of the value chain are poor milking techniques, obsolete equipment, and the absence of cold storage capacity (FAO Ukrainian study).

b) Collection and transportation

The next step of the supply chain encompasses the collection and transportation of the raw milk to the dairies. Poor cold tank quality and inferior cooling systems can lead to significant losses and spillage before the milk can be processed in the dairy. In India, for example, milk is often transported by rickshaws without any cooling systems. Transporting milk in such a warm climate without proper cooling causes high rates of loss.

c) Processing and packaging

The majority of raw milk is processed in dairies, which are subject to strict directives regarding sanitation and cooling systems. Thus, the majority of losses occurring in these commercial dairies are due to mechanical failures leading to milk spillage during the process of pasteurization and processing (e.g. making cheese) or incorrect planning leading to overproduction. Indeed, especially in developing countries, a significant amount of milk is still processed by small farmers and cottage dairies, which bottle the milk in used plastic bottles and usually do not have cooling systems.

d) Distribution

At the distribution stage, losses are again caused by the lack of cooling as well as by outdated or unsold milk (Ukrainian study, FAO 2013).

e) Consumption

At the household level, the biggest source of FLW is the waste of food that is thought to be outdated, especially due to incorrect interpretation of the phrases “use by” and “best before”. This holds particularly true for fast-spoiling dairy products. In developing countries, many households do not have a refrigerator, which increases milk loss significantly. A third big source of dairy product waste and loss is plate waste that occurs, for example, when people leave a portion of their breakfast cereal uneaten.

5. Discussion of policy options for reducing food losses and waste

This chapter starts with a general recommendation. Afterwards, specific options for each step of the supply chain are discussed.

5.1 General recommendation

The literature review revealed that there are many publications on FLW, although these are of varying quality. Moreover, some problems have not yet been adequately solved. Therefore, **further research is needed**. There are open questions concerning the following issues:

As yet there is no universally accepted general definition of food loss and waste that matches the various aims of different studies, such as contributing to food security, saving resources or mitigating climate change.

It is not clear how food loss and waste of a specific agricultural product, such as pork, which will undergo many changes along the supply chain, can be identified and quantified. The method used so far neglects the fact that some parts of the pig may be considered wasted, yet they are ingredients in non-food products, such as soap (compare chapter 3).

Regarding the discussion on the causes of FLW in chapter 4, there may be economical reasons for some FLW. Thus, we can only recommend policy options that are directed at solving policy or market failures.

As yet there is no appropriate measure for aggregating FLW for individual products along the supply chain? Specific products, e.g. potatoes, might be physically identical at different points of the supply chain, but from an economic point of view, they are different. Does it really make sense to aggregate these economically different products in a metric measure, that neglects to recognize that the resource use for the same physical product differs along the supply chain?

How different products, such as meat or potatoes, could be aggregated on alternative steps of the supply chain has not been clarified.

Most of the reviewed studies claim to have evidence that hunger, resource use and negative climate effects would be reduced by reducing FLW. However, there is no evidence that demonstrates how reduced FLW could be translated into the desired effects or how this could be done efficiently. Moreover, there is no evidence of how costly it may be, first, to reduce FLW and, second, to make it effective for achieving the stated objectives.

There is little doubt that the aims of reducing FLW are widely accepted and many people see it as an ethical issue. This perception may have inspired policy makers to focus heavily on policies to reduce FLW. However, it seems that this may distort the goal of finding the best possible alternatives. Further research could reveal how wealthier countries could more efficiently contribute to the stated objectives through activities other than just reducing food loss and waste.

5.2 General approach

It can be debated whether governments should intervene in any economic activity. Intervention is always based on a value judgment. An actual situation is compared with a desired situation and the intervention is supposed to close the gap. Thus, the intervention includes some important value judgments: First, the desired situation is explicitly or implicitly assumed and, second, it is assumed that the government is able to select the most efficient instruments to close the gap. Concerning the selection of instruments, any government may be constrained by the established order of the economy and, thus, by the role of the government and the role of markets.

In investigating measures to reduce food loss and waste, the following criteria could be introduced: There might be a need for governmental intervention if there is a lack of **incentive compatibility**. The term indicates that individual actions are based on incentives, but if private (market) incentives do not lead to the consequences that society expects, incentive compatibility is not warranted. Therefore, a lack of incentive compatibility may be a necessary condition for governmental interference in a market economy. However, it is also not a sufficient condition. Intervention may lead to negative side-effects, partly produced by administrative costs, including monitoring and enforcing costs, in addition to economic costs. Such economic costs occur if, for example, food is fed to animals and therefore, according to the present definition, is categorized as lost. If this category of food loss has to be reduced, there will either be a reduction in animal production (meat, milk or eggs) or other feed has to be used. A similar case prevails if governments reduce waste that has been used for charity for the poor. Reducing the food loss would either lead to suffering among the poor or increased ailments in some other way. Such economic costs may generally arise if governments interfere in the name of reducing food losses. Strangely enough, this aspect has not been taken into account in the studies that proposed measures to reduce food loss and waste. There is no free lunch!

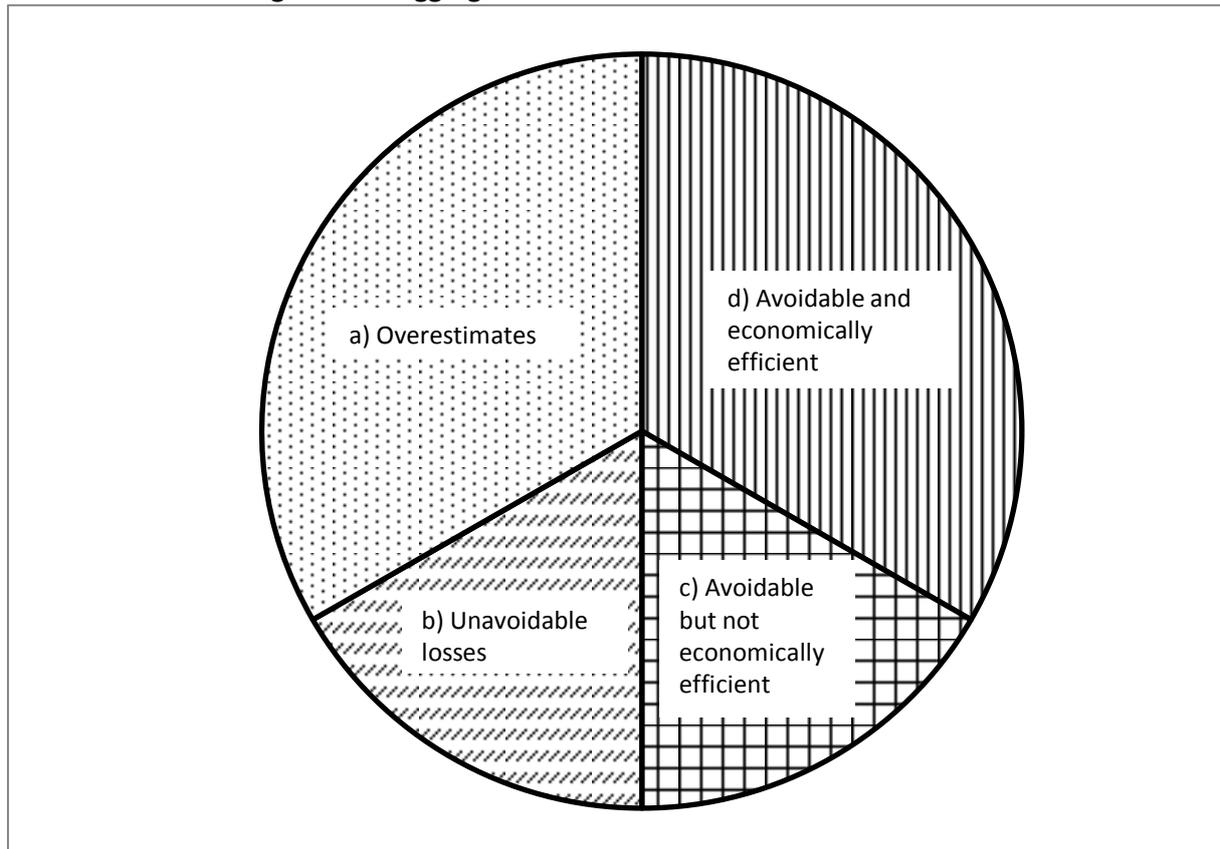
Moreover, if policy measures are implemented to help achieve the stated objectives, namely to reduce worldwide hunger and/or to reduce resource use and contribute to climate improvement, reducing food losses and waste is not sufficient. Moreover, it has to be clarified how the food that is saved could actually help the hungry. How could reducing food losses in rich countries be used to feed hungry people in poor countries?

Accepting some food losses and waste could be economically efficient given the present state of information, technology and consumer preferences.

It may be difficult to institute policies that are not in the interest of those who are expected to act according to new laws or regulations. Such case will prevail if some food losses and waste is in the interest of actors at the different steps of the value chain. However, it may be that this situation only exists bearing in mind the present state of information, technology and consumer preferences.

The relationship between added services and the raw product on alternative steps of the value chain is partly fixed and partly substitutable. The importance of this fact can be illustrated in the different steps along the supply chain. It could be a good strategy to classify the total food loss quantified, as suggested by the FAO method, into the following segments (See Figure 2).

Figure 2: Disaggregation of food and waste loss - schematic



- a) Governments may need improved information on the magnitude of the problem. It does not make economic sense to aggregate different product losses in tonnes. This aggregate does not provide information about how many people could actually be nourished if losses were reduced. Aggregation in kilocalories would be a better measure, but even this has some serious limits. It does not indicate whether the amount of calories could actually be saved and made available to hungry people in the country of concern or on other continents. Governments may decide to forgo aggregation across different products and instead focus on specific products and supply chains that seem to yield the most benefits. Moreover, to avoid overestimation of FLW, it does not make sense to focus only on **planned** food production. Neither does it make sense to classify food used for animal feed as lost if the animals in question ultimately contribute to the human food supply. The same argument holds if some food is given to charity or sold at reduced prices. A more adequate definition for policy actions would start with quantification of those losses that actually lead to reduction of calories available for human consumption.
- b) FLW that is technically avoidable, but unavoidable in a market economy due to economic reasons. These losses also contribute to an overestimation of total food loss. Some FLW is unavoidable in a market economy as many agricultural products are produced in seasons and consumed over a longer period of the year. Wiping out this loss completely would necessitate importing food from other countries out of season. Therefore, it might be more economically efficient to store products within the country and accept storage and transport losses. Farmers and traders may have to sort products according to size and visual nature in

order to attract buyers and to maximize profit. It might be difficult to reduce this part of FLW, but some possibilities do exist (see below).

- c) FLW that is technically avoidable, but economically not efficient. Losses occur in retail shops because some bread, vegetables and fruit cannot be sold on the same day that they are put out on the shelves. Retailers could reduce losses if they were to reorder several times a day or if they were to accept running out of some products in the late hours of a day. The same holds for households; if they shopped daily, they would waste less food.

FLW that could be reduced, and costs for reducing it would be lower than the sales value of the saved food.

5.3 Food loss and waste at farm level

Farmers can reduce food losses and waste if they forgo screening of raw products like potatoes or vegetables at the farm and try to sell the total quantity to retailers or consumers. However, if they did this, farmers would find out that they were only able to sell their products at lower prices or not at all, thus making a lower profit. It may be in the farmers' interest to accept some food loss and use it – whenever possible – to feed animals. The same consideration holds if farmers prefer to accept some harvest losses. Avoiding this loss may also reduce farm profit. Seed producers may contribute to lower FLW if they manage to offer seed that produces more homogeneous products, such as potatoes of the same size and wheat that can consistently be used for bread production instead of being used as feed wheat.

Policy options: Some farmers may have to accept losses in the field or losses due to inadequate technologies for cultivation and harvesting. Making investments to reduce these losses might be profitable for farmers and even for society at large, but farmers may suffer from credit constraints. Governments could consider supporting access to credit. However, the best alternative would not be to grant credit subsidies. Instead, governments could help banks safeguard some credit. It would be the task of the bank to prove the creditworthiness of the investors and to ensure that the credit is used to reduce food losses and waste.

The most efficient way to reduce FLW at farm level might be to avoid lower yields due to insects, rodents, inadequate seeds, cultivation and fertilizer use. The education of farmers might be a good strategy in some countries. However, it may take a long time to achieve progress. Supporting extension services with very well-trained extension specialists should rank high on the list of priorities. It is not likely that short-run gains could be reached in developing countries. A good extension service has to rely on research findings. Many developing and transition countries may make research a high priority. It may be argued that transition countries have a long-standing reputation in natural science, and there may not be a need to extend research efforts in agricultural science and economics. There are two counter-arguments: First, research in any country gains significantly from adaptation of international research findings to the specific situation in the country. Therefore, international exchange and cooperation is needed. The main prerequisite for constructive international cooperation in research is knowledge of English and publication in this language. Unfortunately, not much progress has been made over the last two decades (compare the findings by Koester, U. et al., 2010 and Nivievskiy, O. and U. Koester, 2012). Research could be considered the Achilles heel of a competitive agricultural and food sector and for the reduction of FLW.

5.4 Food and waste loss on the wholesale and stock keeper level

Wholesale traders and stock keepers could try to reduce FLW by shortening the period of time between buying and selling. However, merchants may try to make profits and they know that buying today and selling some time unavoidably includes some risk. In general, the chance of profit is higher if more risky deals are undertaken. However, higher risks cannot only lead to higher loss of income, but also to products being lost. Stockpiling for some period of time reduces the weight of most agricultural products and introduces the danger of loss due to insects, rodents and other animals. Moreover, hazardous climate conditions may reduce the volume and lower the quality. Wheat that was stockpiled for use in bread may be used as feed wheat and thus increase food losses. This loss is an unavoidable side-effect of a functioning supply chain. Of course, it may be that losses are too high from an economic point of view, mainly because vertical markets are not well integrated.

Policy option: Governments could reduce losses at this step of the supply chain by providing adequate public and merit goods that improve the functioning of markets. The risk for market agents will be lower if they have access to hedging possibilities. Therefore, if governments of specific country moves towards free and predictable trade, traders may have the possibility to hedge on futures markets in other countries. The consequence would be lower levels of risk and less FLW. Governments in some countries might support the establishment of additional wholesale markets and collection centers, which could result in reduced FLW. The provision of market information and schemes for classification of products may also be effective in reducing food losses.

5.5 Food and waste loss on the retailer level

Food retailers can decide to order food items several times daily in order to offer fresh vegetables and other items at all times during the day. They are also able to collect fairly accurate information about the daily flow of its food items, thus minimizing food losses. However, in order to do this, retailers would have to devote more resources to purchasing and storing food items. Delivery companies would also have to use more resources, as transport and labor costs would increase with the frequency of deliveries. Consequently, lower food losses would lead to a higher volume of complementary services. It might well be that retailers have to accept losses – in particular in developing or transition countries – because they do not have adequate storage facilities. Alternatively, trade flows could be very slow and, meaning that fast orders and deliveries are not possible. Improving the functioning of markets, setting up wholesale markets and improved access to credit could help to reduce FLW.

Retailers in some countries may have to accept high FLW due to the low quality of produce delivered to them. There is no quality testing system and corresponding classification system in all countries. Therefore, some quantities, such as fruit and vegetables, bought by the retailer cannot be sold.

Policy option: Governments could put policies in place to reduce market imperfections and improving the organizational structure could help to reduce FLW. Policy makers could significantly reduce FLW at retail level if consumers were better informed on the meaning of “use best before date” or “expiration date” or “sell-by date”. Customers tend to prefer to stay on the safe side and buy products with a date that is not close to the date specified on the package. The provision of better information and using descriptions that are less misleading would help. Bakeries and shops selling bakery products in Germany take advantage of a new method to forecast sales. 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 about 20 percent.

5.6 Food losses and waste at household level

The situation is similar at the household level. If consumers bought food products daily, they could reduce food losses. However, there are transaction costs associated with buying food daily, which the consumer may weigh against the cost of wasted resulting from shopping less frequently. Therefore, consumers may consider buying food weekly and accepting that some food waste will occur either because less food is consumed or because food may have to be thrown away due to loss of freshness. Thus, reducing food waste by buying more often would come at the cost of using more non-food resources. These examples highlight that it may be economically efficient to accept some food waste at household level. In light of this, it could be difficult to set rules or laws that change the behavior of the profit- or utility-making entities.

Policy option: FLW in private households is high in developed countries. Moreover, reducing FLW at this level will yield the highest aggregated gain along the supply chain. Some people want to change their handling of food, although there is not much to suggest that this intention will lead to significant effects. Most people react to incentives and not to appeals. However, it is likely that some households are not well informed about the meaning of “best used before date” and how to use left-over food for preparation of meals. Better information and education may contribute to less FLW. Furthermore, consumers need to be informed about the best storing practices and new technologies to maximize storability (e.g. new refrigerators).

5.7 Food loss in restaurants

Restaurants often offer very large portions, accepting that some consumers will not finish their meals. An alternative could be to reduce portion sizes generally or to offer consumers the option to order different size portion. It is most likely that owners of restaurants have considered these alternatives. If they have opted for one specific approach, namely offering only large portions and accepting food waste, they seem to expect that this is the best alternative from their point of view. However, it might be worthwhile to inform restaurant owners and cooks about experiments with different portion sizes. One important determinant of food waste in restaurants is specific legislation in some countries. It is understandable that food that has been served once cannot be served again, even if it has not been touched. However, legislation differs from country to country; e.g. it has been against the law to feed left-over food to animals in Germany since 2006 and in Switzerland since 2011. It might be of interest to learn whether the new legislation has led to the desired effects; namely, the improved health of animals.

Policy option: What could the government do to avoid this food waste? If possible, inform owners of restaurants that, based on empirical studies, it is more profitable to offer either smaller portions or to offer different sized portions. Additionally, forecasting daily demand may help to optimize food purchases and reduce FLW. 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 that need to be stored. If the menu is changed seasonally, customers will still have the same variety to choose from.

5.8 Setting Priorities along supply chains

If 1 ton of food has to be moved from the field to the consumer, some loss and waste will occur in all steps. If, for example, the waste at consumer level amounts to 10 percent, avoiding this waste would also reduce the losses that occurred at all steps up the chain. Therefore, you get a higher multiplier by reducing losses at consumer level than at farm level. This is the case even if the loss in percent is lower on the consumer level than on the farm level. A pure comparison of the percentage loss on the alternative steps of the supply chain does not indicate how much loss can actually be saved by reducing the loss on one specific step of the value chain.

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Annex: Terms of References

The paper should contain, but not necessarily be limited to, the following sections:

- (i) Executive summary,
- (ii) Introduction of the topic indicating the importance of FLW
- (iii) Summary of the state of public debate and literature on food losses and waste,
- (iv) Presentation of the FAO assessment of food losses and waste in Europe and Central Asia,
- (v) Presentation of the causes of food waste and losses in the region,
- (vi) Discussion of policy options for reduction of food losses and waste.