SELECTED MATERIAL STOCKS AND FLOWS: *FOOD WASTE*

Marion HUBER-HUMER, Silvia SCHERHAUFER, Gudrun OBERSTEINER, Nicole UNGER

University of Natural Resources and Life Sciences BOKU Vienna, Institute of Waste Management, Muthgasse 107, 1190 Vienna, Austria

Background

The year 2030 will be an important milestone for the food sector and its ambitious goals for global food supply and food waste management. The motivations for setting these goals are obvious: By 2030 demand for food will have increased worldwide by at least 20% compared to 2015 (Klytchnikova et al., 2015). However, at the same time climate change could cut crop yields in the same order of magnitude in many parts of the world due to extreme weather events and the depletion of arable land. An increasingly negative impact of climate change on global crop yields is expected from the 2030s onwards, with the highest impact and losses in crop yields in the second half of the century (Challinor et al., 2014). Additionally, losses in biodiversity and ecosystem services as well as of other forms of natural capital will occur at unprecedented rates. Thus, food security, particularly for the world's poorest, is at risk.

Consequently, one core of the **Sustainable Development Goals** (SDGs), the UN's development agenda for the 21st century, is to "End hunger, achieve food security and improve nutrition and promote sustainable agriculture" (second goal of the UN's 17 SDGs). Achieving this goal by the target date of 2030 will require a profound change of global food and agriculture systems. At the same time, a lot of food is wasted along supply chains. Figures presented on the UN Sustainable Development homepage indicate that 1.3 billion tonnes of food are wasted every year while almost 1 billion people go undernourished and another 1 billion go hungry. Concurrently, therefore, Sustainable Development Goal No. 12.3 of the UN focuses on the food waste sector and sets a target to halve per capita global food waste at the retail and consumer levels by 2030 and to reduce food losses along production and supply chains, including post-harvest losses. The **EU action plan for the Circular Economy** (EC, 2015) adopted this target of halving per capita food waste at the retail and consumer level by 2030 and specified three main issues to achieve this goal: (1) developing a common EU methodology to measure food waste, defining relevant indicators and creating a platform involving Member States and stakeholders to share best practice and evaluation progress; (2) clarifying EU legislation relating to waste, food and feed and facilitating food donations and feed production; (3) examining ways to improve the use and understanding of date marking in the food chain (e.g., "best before" label).

The reliable assessment of the amount of food waste per capita in EU member states will be an important basis for further scientific and political actions, particularly to track the achievements against the goals set by the UN and EU. The recently published and quite comprehensive European food waste study "FUSIONS" (Stenmarck et al., 2016) provides first data and specific estimates on food waste in the EU-28. According to this study, the amount of food wasted along the full value chain equals about 20% of the total food produced in Europe. Of that more than half is generated by households, and food waste from households, food services and the retail sector together make up about 70% of total food waste.

The production of food requires the use of resources such as fuels, land, water and raw materials that have associated economic and environmental impacts. Examples of environmental impacts during the agricultural stage are methane, e.g. from cattle farming due to enteric fermentation of ruminants, and nitrous oxides from the application of fertilisers. Both emissions contribute to climate change as do emissions related to energy for transport, storage and cooking of food in other steps of the food supply chain. Such and other emissions could be reduced if food was consumed instead of being wasted. An indicative estimation of the potential scale of the climate change impacts which are associated with food waste along the full value chain yields a figure of 186 million tonnes CO_2-equivalents (Scherhaufer et al., 2017).

However, food waste is not only a major concern from an environmental point of view. Given the fact that 800 million people on the planet are suffering from chronic undernourishment (FAO, 2014), it is not acceptable in today's society that food suitable for human consumption is wasted. Even in Europe food insecurity has become a central topic in many countries (Bromley et al., 2016). An increased risk of poverty (23.7 % of the population in the EU-28 were at risk of poverty or social exclusion in 2015 (Eurostat, 2016)) is leading to a rising demand for food aid programmes and food redistribution, such as via food banks, underlining the importance of such measures to secure food for people in need.

Current data on food waste

Data on food waste has been recently investigated in various studies. Organisations such as the United Nations Food and Agricultural Organisation (FAO) and the Waste Resource and Action Programme (WRAP) have published extensively on food waste in Europe in recent years. Other research institutions and universities, mainly from Northern (Finland, Sweden, Norway, Denmark) and Central (Austria, Germany, Switzerland) European countries have conducted specific national studies on food waste. However, published data are not easy to compare due to inconsistencies in the definition of food waste and the applied research methodology (Schneider, 2013). A main discrepancy in the definition of food waste relates to the starting point of the food supply chain (e.g., including pre-harvest activities). For example, animals which die or are killed before they are placed on the market (e.g., male chicks which cannot be used for egg production) or plants which are not harvested because of low market price or which do not fulfil visual quality standards are not considered food and are, consequently, not defined as food waste (Schneider, 2013).

A widely recognised study by FAO illustrates that globally one-third of all food produced for human consumption is lost and wasted (FAO, 2011; Gustavsson et al., 2013). This study used Food Balance Sheets by FAOSTAT and literature data on food waste, and estimated total food loss and waste for each food supply chain step and for specific food commodities for the entire supply chain (including pre-harvest losses). The results show that approximately 140 million tonnes of food losses and waste occurs in Europe.

The European project FUSIONS used another approach for calculating food waste. There the approach was to identify appropriate studies on food waste data with robust and comparable methodology on a national scale for each step of the supply chain, subsequently scaling up to provide an estimate for the EU-28 ("bottom-up approach"). The project calculated that a total of 87.6 million tonnes of food waste is produced annually in the European Union, with an approximate 95% confidence interval of ±13.7 Million tonnes (Stenmarck et al., 2016). This represents the total amount of food waste occurring at the levels of primary production (post-harvest), manufacturing, wholesale, retail and distribution, as well as in households and food service, and is worth an estimated 143 billion Euro. It amounts to 173 kilograms of food waste per person in the EU-28. However, there is still moderately high uncertainty concerning this estimate since - despite the improved availability and quality of national

food waste data in some member states - many data gaps still exist. Stenmarck et al. (2016) detected that data of sufficient quality only exist for up to a quarter of EU Member States. Moreover, there is still a lack of harmonised definitions and consistent quantification methodologies, making a scaling up of results at the European level difficult. Data for the processing sector show considerable uncertainties due to the fact that only four member states provided information with sufficient data quality. For this level in the supply chain there is definitely a need for more robust data. Moreover, the commissioner of the Directorate-General for Health and Food Safety recently stated that EU data on food waste is still "insufficient" and there is a "need for data to monitor" (Gassin, 2017).

Food waste considered in Stenmarck et al. (2016) is defined as food and inedible parts of food removed from the food supply chain to be recovered or disposed of, including crops ploughed in/not harvested, composted or anaerobically digested (bioenergy production), incineration with energy recovery (co-generation), incineration without energy recovery, disposal to sewer, landfill or discarded to sea. Losses prior to harvest and other by-products and waste which are removed along the supply chain to be used as animal feed, biobased materials or for biochemical processing are not included in the figure of about 88 million tonnes. The system boundaries and estimated quantities of Stenmarck et al. (2016) are illustrated in Figure 1. Thus according to our understanding, one of the main differences between the FAO-study (Gustavsson et al., 2013) and FUSIONS (Stenmarck et al., 2016) seems to be that FUSIONS only focuses on post-harvest waste, while the FAO-study goes further and also includes losses during pre-harvest phases.

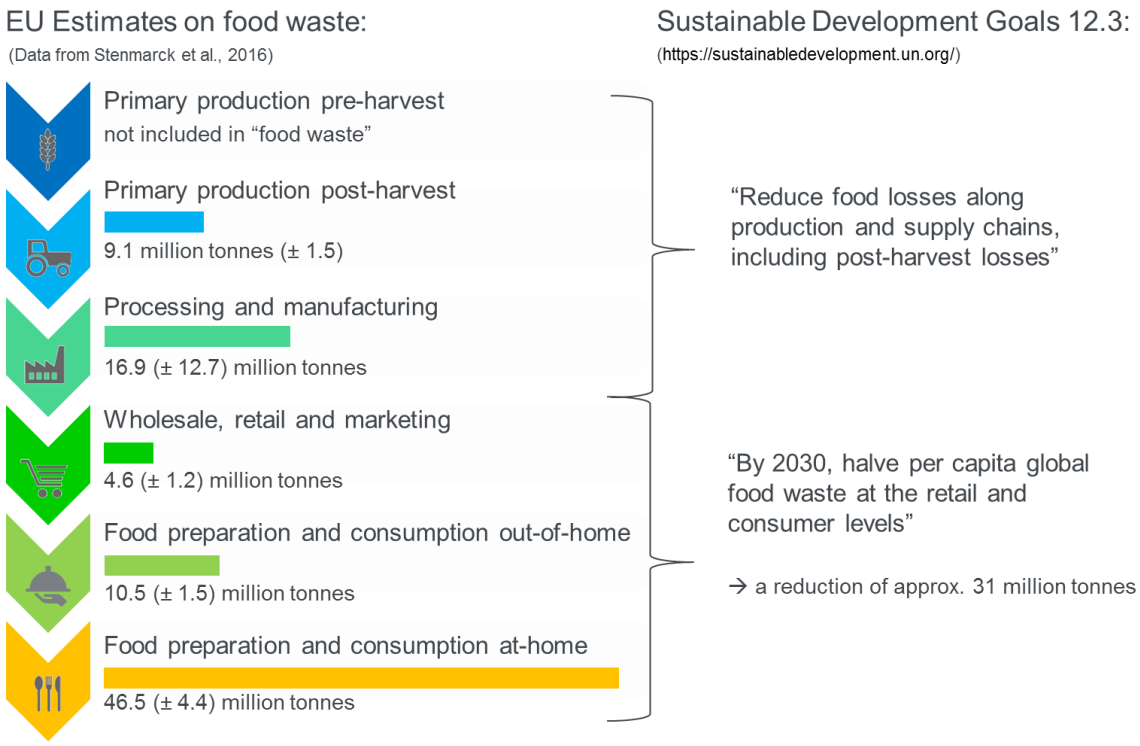

Figure 1. System boundaries aligned to FUSIONS definitional framework and FUSIONS data on food waste

According to the data of Stenmarck et al. (2016), food waste occurs mainly in households in the EU-28 (about 47 million tonnes). Together with food services and the retail sector it accounts for 70% of EU food waste. These sectors are specifically addressed by the UN Sustainable Development Goal 12.3 and its target to halve food waste at retail and consumer levels. Based on current data, this requires a reduction of approximately 31 million tonnes of food waste by 2030. In addition, a reduction along the rest of the supply chain shall also be achieved.

Specific management hierarchy for food losses and food waste

At EU level, discussions on hierarchic steps relevant for food/food waste and their alignment with and deviation from the common waste hierarchy have already commenced since the common waste hierarchy given by the EU Waste Framework Directive seems to be too limited in its definitions and does not appear suitable for food or food waste as many more steps of utilisation and valorisation need to be considered within a circular economy perspective. However, with regard to the different definitions for food losses and waste as well as other side flows (any other food or inedible parts of food) removed from the food supply chain, a proper hierarchy for food and food waste management is not easy to define.

Diverse recommendations for a hierarchy specifically focusing on food waste have already been stipulated by governments and organisations (e.g. WRAP). Their common priority is to reduce food waste, followed by redistribution and use as animal feed, before recycling as compost or in anaerobic digestion, incineration with energy recovery and, finally, diverse disposal options (e.g. incineration without energy recovery, landfill, discard to sea/land). Such considerations indicate that many measures can already be applied before food becomes waste. These **prevention measures** can be distinguished between (1) measures to avoid overproduction and purchasing beyond actual needs (e.g., abstinence and optimisation during food production and shopping tailored for markets and personal needs), (2) direct reuse activities, meaning food which is used again for the same purpose for which it was conceived (redistribution for human consumption, e.g., through charities), and (3) measures to reduce the amount of food becoming waste by, e.g., valorizing food into biobased materials by means of biochemical processing as well as directly feeding to animals. Plant based substances from the agri-food industry as well as food of non-animal origin which are no longer intended for human consumption are not regarded as waste according to the proposal of the new Directive 2008/98/EC on waste and are allowed to be fed to animals (subject to Regulation (EC) No.767/2009). The feeding of food of animal origin to animals is only allowed for certain food products and under certain conditions to ensure the safety and health of animals (subject to Regulation (EC) No 1069/2009).

Another issue that needs pointing out is “home-composting” of food waste at the household level. From a regulatory and definition perspective, “food waste” that is treated within the household (e.g., compost heap in the garden), and thus not introduced to a formal waste collection system, is not accounted for as waste and can consequently be deemed to be a “waste prevention measure”. However, from a “technical” point of view, this option is usually regarded as recycling.

Figure 2 shows an example of an advanced hierarchy for “food waste” (right side) including “prevention”, “redistribution” and “animal feed”, based on the current considerations at the European Platform on Food Losses and Food Waste (Andriukaitis, 2017).

The legal definition of when a material becomes waste is important because it sets the context and limitations (e.g., in the form of obligations and restrictions by EU law in the context of waste) which need to be taken into account when outlining further activities. A measure at the **preparation for reuse** level (food has already become waste) of the food waste hierarchy can be, e.g., insects fed by food waste and directly used as a protein source for human consumption (currently not allowed in EU legislation). Sometimes the preparation of food waste for animal feeding is also assigned to this level. However, the feeding of food waste to animals is, with some exceptions, currently not allowed in the EU as feed containing meat wastes which are not heat-treated could transmit certain diseases (e.g. foot-and-mouth disease, African swine fever). This was the case in the foot-and-mouth epidemic in the

UK in 2001, after which the EU banned the use of food waste as animal feed, giving priority to hygiene regulations ensuring food safety. According to the law (subject to Regulation (EC) No. 1069/2009), some food wastes that demonstrably bear no risk of contamination with animal products are still permitted for use as animal feed (e.g. waste bread). Yet this represents only a small proportion of all EU food waste according to Salemdeeb et al. (2017). Secure feed from food waste could replace conventional feed, and as a consequence can reduce the environmental impacts of grain- and soybean-based feeds (Salemdeeb et al., 2017). The European Commission has already acknowledged the importance of facilitating the use of former food as animal feed. An EU guideline scheduled for autumn 2017 should help to overcome obstacles to this practice due to legal uncertainty and unnecessary administrative burden (Andriukaitis, 2017). However, due to these uncertainties, the level "preparation of food waste for reuse" is currently hardly addressed and included in discussions on an advanced and precise food loss and waste hierarchy.

If prevention of food waste or other measures for food waste reduction are not possible, then food waste should be treated in the most sustainable and efficient way. Examples include composting and anaerobic digestion and the subsequent application to soil. By producing compost of approved high quality (in accordance with quality criteria, e.g., set in the Austrian compost directive - see BMLFUW (2001)), a product (high quality compost) is generated and is therefore no longer regarded as waste (end-of-waste status). The management of food waste in such **recycling** facilities is dependent on several local factors, such as the collection system installed, the waste composition and quality, as well as climatic conditions. Moreover, since food waste usually requires an admixture of bulky compounds (e.g., wood pieces) for a proper composting process (need of sufficient air-filled pore volume), the availability of such compounds is additionally an important issue.

Between the recycling and disposal level in the food waste hierarchy there are operations such as waste incineration with energy recovery, followed by waste incineration without energy recovery. The least preferable treatment of food waste is disposal, where environmental impacts, e.g. from methane production due to the decomposition of food waste in landfills, might occur and no valuable resources are recovered.

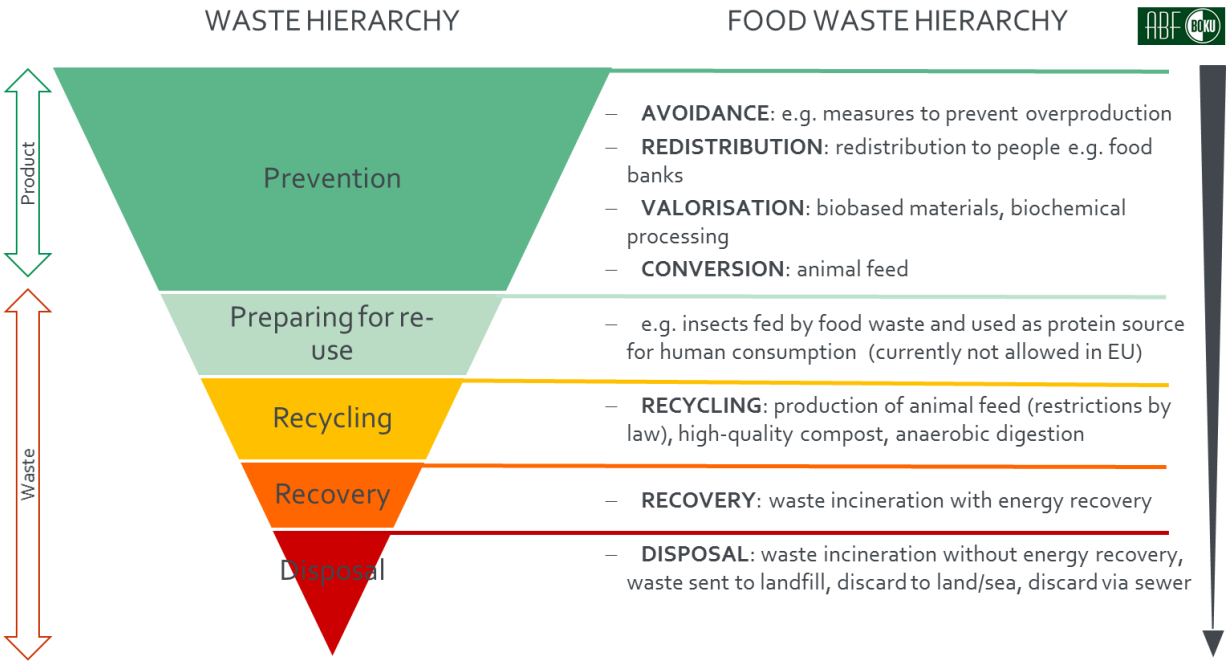

Figure 2. Proposed management hierarchy for food and food waste aligned to Waste Hierarchy of the EU Waste Framework Directive

Challenges in understanding the potential for food waste prevention

Food waste prevention is first priority in the proposed food waste hierarchy. Both the EU commission and the "European Platform on Food Losses and Food Waste" are dedicated to food waste prevention (Andriukaitis, 2017). However, determining which "food waste" is actually avoidable and how it can be prevented (food waste prevention potential) is not obvious in many cases. The production and processing of food, for example, generates "side flows"[1] of both inedible and edible parts of food which are often unavoidable. For the sake of resource efficiency, those unavoidable side flows should be valorised into higher value purposes (prevention) than into compost or biogas (recycling). The valorisation of un-avoidable side-flows and food waste often depends on a number of intrinsic (e.g. composition-related characteristics and quantities of food waste) and extrinsic factors (e.g. technological feasibility, access to infrastructure, economic incentives and costs or markets for valorised products). Furthermore, it is important to know the scale of environmental and economic effects for evidence-based decision making in the use of food resources[2].

In general, food waste can be classified into edible and inedible parts of food as well as avoidable and unavoidable food waste, whereas definitions are not always consistent (Lebersorger and Schneider, 2011). Determining avoidable and unavoidable parts of food waste is important in order to assess the actual prevention potential of food waste. Total estimates of food waste usually cover both edible and inedible parts of food, and thus provide no suitable data basis for decision finding in waste prevention. Data at this disaggregated level on food waste in Europe as well as consistent and binding definitions are still lacking, which hinders a reliable estimation of the genuine prevention potential of food waste in the EU.

A detailed Austrian study on household waste shows that up to 57% of the food waste found in residual waste bins at households is avoidable (Schneider et al., 2012). However, the share of avoidable food waste even at household level, where most accurate data from sorting analysis of residual household waste is available in Austria, is uncertain as so many further disposal options need to be taken into consideration in order to get a holistic picture of avoidable food waste potential; e.g., some food waste is separately collected in bio-waste bins (separate collection of biogenic waste) or disposed of somewhere else (e.g., sewer, home composting).

Another Austrian study on food waste in the food service sector (Hrad et al., 2016) investigated 50 businesses in the hospitality sector and provided the first numbers on the share of avoidable and unavoidable food waste in this context: the avoidable food waste in this study ranged between 51% (in hotels and restaurants) to 87% (canteen kitchen). The share of unavoidable food waste was mainly dependent on kitchen practises such as the use of semi-prepared food compared to fresh food for meal preparation. Leftovers from buffet tables and plates (in particular soups or starch side dishes) and residues of beverages, which count as an avoidable part of food waste, are another hotspot in the hospitality sector.

[1] Definition of Davies et al. (2017): « A material flow of food and inedible parts of food from the food supply chain (FSC) of the driving product, including wasted driving product, and also final disposal of inedible and edible parts of unconsumed food product after use, e.g. plate leftovers. The stakeholder in the FSC producing this flow tries to have as little as possible of it, "the less, the better" applies for this flow. «

[2] The EU-project REFRESH is currently investigating the valorisation of the most relevant food waste streams in Europe and to determine its economic and environmental impacts (www.eu-refresh.org).

These examples illustrate the complex set of influences that determine the amount of avoidable food waste, and similar complexities apply to all sectors of the food supply chain. Moreover, the term "quality" of food waste needs to be interpreted carefully as differences may exist in definitions used. Despite the lack of reliable and comprehensive data at the European level, some national "hotspot" studies indicate a considerable amount of avoidable food waste and thus a considerable potential to prevent food waste. Vanham et al. (2015) estimate the share of avoidable food waste at consumption level in Europe to be approximately 80%.

In order to better prioritise and target prevention measures as well as to assess food waste prevention progress over time, it will be necessary for Member States to measure food waste levels (including the differentiation between avoidable and unavoidable) on a regular basis with standardised quantification approaches[3]. A harmonised approach for food waste quantification is also targeted by the EU Action Plan of the Circular Economy.

Food waste drivers as barriers to food waste prevention

In addition to data gaps and a lack of common definitions as discussed previously, further barriers, especially to food waste prevention, currently exist. To overcome the barriers, it is necessary to identify food waste drivers in all sectors along the supply chain. Potential drivers identified in the scientific literature relate to technology, business management and economy, legislation as well as to consumer behaviour and lifestyles (Canali et al., 2014). Examples for food waste drivers in technology include livestock mortality, improper climate conditions for agriculture, inappropriate packaging, and damage during transport. With respect to the institutional context, the lack of infrastructure and facilities, poor information exchange, rejections of deliveries/returns can all be named. Operational and legislation reasons can be found in relation to business and food consumption (e.g, regulations with respect to food being prepared, but not served in catering), as well as economy and taxation policies, marketing standards and dates labelling. In a social context consumer preferences and behaviour/attitude as well as social norms and knowledge can be mentioned. Canali et al (2014) highlighted that the drivers identified constitute a wide and multifaceted problem involving all sectors of the supply chain. It is not possible to pick out just one or a few main determinants that are clearly responsible for food waste. It is rather a combination of many interconnected causes, which makes it difficult to identify single powerful measures and instruments for food waste reduction. Moreover, specific decisions to support food waste reduction can often have unintended impacts on further steps and rebound effects may occur. For example, subsidies for food waste that go to anaerobic digestion may result, on the one hand, in food waste being prevented from being landfilled or sent to waste incineration without energy recovery; on the other hand, higher ranking options like animal feeding would be neglected. The ambition of such subsidies to enable valorisation at a higher waste hierarchy level than disposal succeeded but it equally hampered an even higher-ranking option, e.g., use as animal feed.

Consequently, market-based instruments such as economic incentives or taxes can have a strong impact on the option chosen for the utilization of food/food waste along the food waste hierarchy. Before such instruments are implemented, their consequences should be assessed from an overall system perspective. Legal instruments may have one of the strongest influences on the management of food and food waste, as the examples of the Italian or French laws to fight food waste have shown. Thus, EU Member States need to take well-considered actions to encourage management options that

[3] The EU-project FUSIONS established a FUSIONS Food Waste Quantification Manual including practical guidelines which Member State authorities can apply to standardise quantification approaches at each stage of the food supply chain (Møller et al, 2014).

deliver the best overall environmental outcome and which are justified by life-cycle thinking (compare Waste Framework Directive).

According to Canali et al. (2014), a driving factor of food waste generation can be attributed to the industrial production, processing and distribution of food, which are designated for large urban markets and based on mass production. The immense increase of productivity and efficiency in the agricultural and food sector during the past few decades has resulted in a very complex (global) and non-transparent organisation of the supply chain, which seems to be one of the main current barriers to implementing reduction measures at the upper supply chain level. It also influences the attitude and behaviour at consumer level. Food has become more and more an "opulence good" in our consumer society and is not treated with the respect it deserves.

Outlook and Recommendations

Circular economy at the moment is a vision, a concept, but not a tool. That means that this concept needs to be transformed into a framework with clear goals and tasks at a macro-, meso- and micro-level taking all stages of the life-cycle into consideration to thereby become a practicable and effective tool.

However, before we consider establishing achievable goals, proper tasks and framework conditions for optimised food waste handling, we must keep in mind that food waste exhibits different characteristics from other waste types, making "established" closed loop recycling unfeasible. Due to its characteristics, the logistics associated with food waste is different and more challenging compared to other waste fractions since the time factor is in many cases a determining issue (e.g., usually food waste cannot be transported overseas for specific treatment and is not globally traded). Unlike other commodities, food waste can only rarely be stockpiled until a suitable buyer and proper "reuse or recycling options" are found or until market prices are favourable. There is either no or only a short-term possibility of stockpiling. Some food products have shelf lives of several years, but the majority of foodstuffs have relatively short cycles from production to consumption and disposal. The aligning of supply and demand in this resource is driven by local circumstances. Quantity, quality, timing, form, location, costs of food (waste) occurring in one location will need to match the local demand for this waste. At the same time, food security needs to be ensured, which in turn makes it necessary to aim for a certain amount of food overproduction in order to manage fluctuations in yields (e.g. due to weather conditions or customer demand).

Moreover, before suitable and comprehensive targets can be described, there is a need to clearly and transparently map out the entire supply network, showing the feedstock used to produce foods and all side flows (by-products, losses or wastes). While data relating to the actual food product are easier to find, the side branches of the supply chain, i.e. the routes of side flows, their current valorisation, utilisation and disposal routes need to be further researched, including what resources (materials, energy, etc.) are recovered through these (quantity and quality). Furthermore, how and where they re-enter the market, and for what purpose, needs to be established. For instance, animal fats can be utilised for gelatine production, cosmetics or pharmaceutical products as well as for renewable fuels. What are the mechanisms that determine the route a side flow will take (physical, geographical, economic, etc.)? Only when these factors and networks have been properly described will it be possible to effectively use tools and methods to assess the effects of changes and, in turn, to make informed decisions necessary for sustainably optimising the effectiveness of the (food) supply chains.

And finally, there is a need to identify what resources will be scarce in future and what the human needs and demands of the society will be, as well as how side flows from the food supply chain and food wastes could address this scarcity and these needs. Any targets should be output/effect oriented.

What should be achieved? What will be needed in resources, including, e.g., open spaces, biodiversity, etc. Valorising and utilising outputs from the food supply chain makes sense if something useful is gained. This usefulness cannot be (solely) defined by physical properties but needs to be seen in its societal and economic context. Producing compost from food waste only makes sense if a concept on how the material should re-enter the economy is part of the considerations. Good quality soils are a key 'input' into an efficient food supply chain and compost could be a way to improve future food security and the agricultural system in general. That means we have to move - also in the context of food waste - from supply-driven thinking to a demand-lead change in supply systems, focusing on sustainability and effectiveness.

To achieve a **secure food supply chain with minimal losses and food wastage**, ideas and options have already been identified, e.g., in the EU project FUSION, in diverse EU stakeholder consultation processes or, for example, in the Austrian Waste Management Plan (2011 and draft 2017). In the following list of recommendations, some of the main common issues as well as new aspects for a circular economy, including food and food waste, are addressed. On the whole, the following should be undertaken:

- **Measure and monitor food waste for an improved data base** in order to create reliable decision support tools without, however, implementation of specific quotas as long as there are big differences or high data uncertainties in EU countries
- Focus on **regional/local food supply chains and autarchy, and flexibility** for specific niche activities
- While food waste should be reduced along the whole value chain and by every stakeholder, a **focus** must be put **on post-consumer food waste** as this is the sector with the most food waste and also with the most potential for reduction (more than half of it is expected to be avoidable; this corresponds to an amount of approx. 27 million tonnes of food waste in Europe which could be reduced by prevention measures)
- Include instruction on all aspects of food already in school curricula to convey the basics of the origin, processing and consumption of food as one means of **influencing future behaviour;** food must become a more appreciated good again and should not be regarded as a product of opulence
- Create **clear and concise legislation** (also trading standards and taxation), particularly with respect to food donations and redistribution (EU guidelines to facilitate food donations; EU guidelines to optimise safe use of food in feed (both guidelines in preparation))
- Build and **expand dialogue and networks at EU-level** (e.g. to increase visibility of projects, EU Platform on food losses and food waste (sharing of best practices on Commission Food Waste website))
- Promote **social innovation projects** to reduce food waste and increase awareness within communities
- Prepare effective and meaningful communication and improved **information for consumers** (e.g. better understanding and use of date marking, clear food labelling)
- Create **interconnected networks between (over)supply and demand** between all stages along the supply chain
- Support **demand-orientated valorisation of food waste**

- Use **food waste as feedstock for compost production** to improve soil quality (increase organic matter content) as an important basis for sustainable and secure food production in the EU

These ideas will be essential to comprehensive food waste prevention activities and optimised handling of food waste in the future. However, these aspects do not represent the whole story. For a real transformation to a circular economy, we need more disruptive changes, which can only be initiated with the help of innovative ideas and unconventional approaches. We have to think outside the box of established dogmas and societal behaviours at all levels of the supply chains and at all stages of the life-cycle. As the consumer is a key catalyst for change in the economy, and as we know from current data that a lot of food waste is generated at the consumer level, our consumption patterns and lifestyles are especially in need of being rethought and reformed as well.

Conclusion

- ► Global pressures to ensure food security and reduce the environmental impact make it imperative to address wastage of resources in the form of food waste.
- ► Per person 173 kg of food waste are generated in the EU, adding up to 88 mio t.
- ► More than half (53 % or 46.5 t) of all food waste occurs at household level.
- ► International targets to halve food waste at retail and consumer level mean that about 31 mio t of food waste need to be avoided by 2030. This can only be achieved if food waste at consumer level is drastically reduced.
- ► Actions at all stages of the food supply chain by all stakeholders are needed and efforts to re-engage consumers with food are required.
- ► Unavoidable food waste and other side flows from the food supply chain should be utilised and aligned to the principles of a food waste hierarchy, be demand led and evaluated for their social, environmental and economic impacts to minimise trade-off and rebound effects.
- ► Transparent mapping out and aligning of supply and possible demand for food waste across industries and regions is required to plan utilisation (e.g., surpluses arising from planned overproduction as a consequence of guaranteeing food security), rather than simply reacting to unforeseen quantities of food waste.

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