A Resource-Effective Food Sector in Sweden – measuring how much food is lost or goes to waste

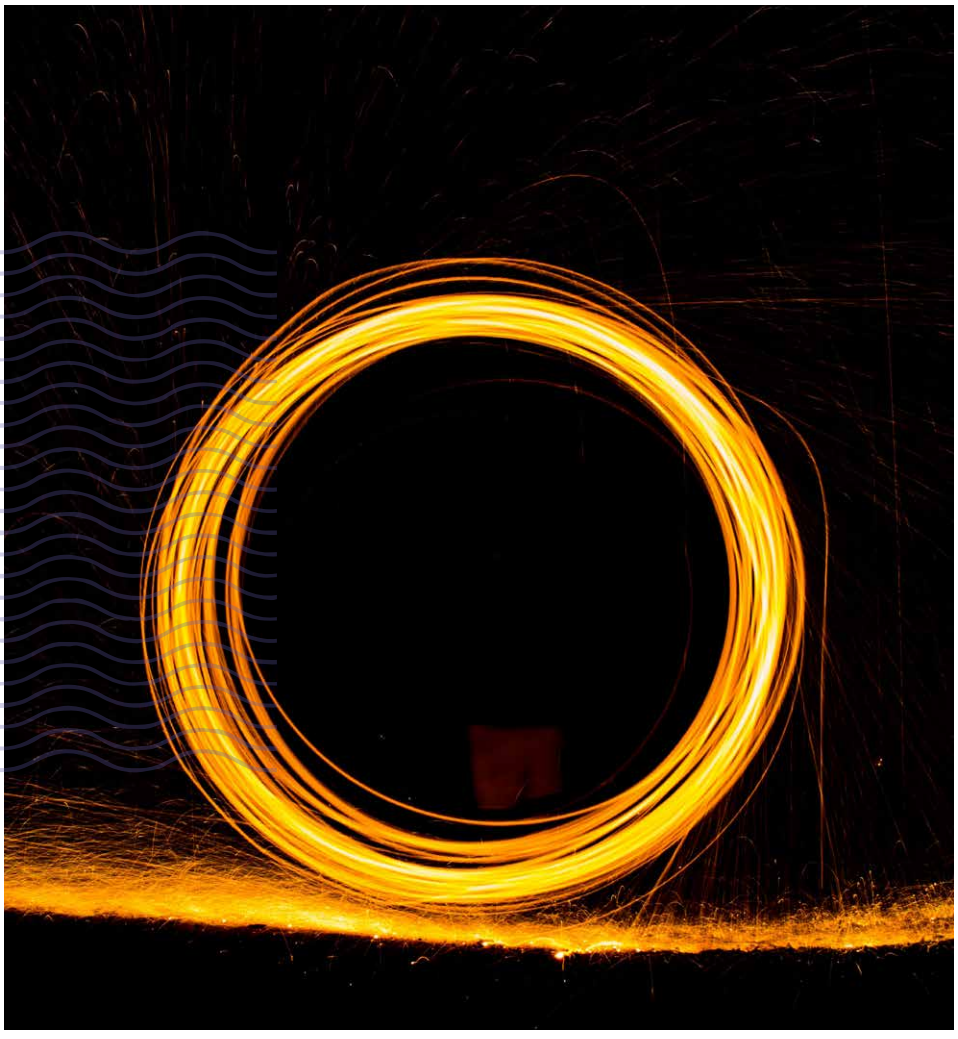
A sector report from the IVA project Resource Effectiveness and the Circular Economy (ReCE)

THEME:
CLIMATE-RESOURCES

JANUARY 2020

IVA
Royal Swedish Academy of Engineering Sciences

Contents



Foreword: Resource Effectiveness and the Circular Economy

»The purpose of the project is to strengthen Sweden's competitiveness in a future with finite resources in line with the UN's Sustainable Development Goals.«

The Royal Swedish Academy of Engineering Sciences' project *Resource Effectiveness and the Circular Economy* has assembled more than 50 companies, organisations and public authorities around the **vision** of Sweden being the leading nation as a resource-effective, circular society. The **purpose** is to strengthen Sweden's competitiveness in a future with finite resources in line with the UN's Sustainable Development Goals.

The project's **goals** are: to create a platform for resource effectiveness and circularity; to draw conclusions on Sweden's resource options in public policy, research and industry based on initiatives that are under way, and to create collaboration and forward motion.

Resource Effectiveness and the Circular Economy builds on the IVA project *Resource Efficient Business Models – Greater Competitiveness* from 2014–2016. That project presented the significant potential that exists to make society considerably more resource efficient and to generate new commercial opportunities and business models. It defined five material flows (biomass from wood, steel, concrete, food and textiles) to show where flows are "leaking" and thus where commercial opportunities exist through more effective resource management.

This project continues the work of the previous one, using the same sector breakdown and exploring the commercial opportunities that were identified. It is divided into five subprojects: mobility, facilities, food, textiles and plastics. This report will present analysis and observations from the Mobility subproject. The most important conclusions from all of the subprojects will be compiled and presented as the project's recommendations for a broader societal transformation in a joint synthesis report.

The five subprojects have gathered representatives from the entire value chain to participate in individual work groups. They come from the private and public sectors and from the research community. IVA's work is based on a scientific approach and draws from relevant research, but also involves critical analysis of other issues of relevance. Source references are included where appropriate. The project's results come out of an intense programme of workshops and work group meetings involving a large number of people.

The reason for this initiative from IVA is that resource effectiveness and circularity are both crucial for a future with greater global prosperity. One particularly important aspect is ensuring that we successfully improve efficiency in material management and advance material development. To support this, we also need to design new business models and identify commercial opportunities that will stay relevant many years into the future, meet the UN's Sustainable Development Goals and allow us to remain within the planetary boundaries.

We need sustainable systems that can deliver resources to meet the real needs of society. To achieve this we need a long-term system perspective and an overall understanding of, and system of managing, society's resource flows. We need to take a holistic approach in which all aspects in the production chain are included – from material extraction and raw materials, the design phase, manufacturing, business models and financing, through the user phase to the recycler and back to a new producer. This requires cooperation between all actors, as well as clear rules to create the right incentives and market conditions. We also need to accelerate, and better understand the benefits of, digitalisation, innovation and new business models that focus on resource effectiveness.

A lot is already happening – both internationally and around Sweden – with numerous initiatives and projects examining how resource effectiveness and circularity can be in-

troduced in various sectors. But there is no unifying arena to show the need for a systemic change and where different perspectives can come together. IVA believes that a platform for cooperation between the private sector, the research community, the political sphere and the public sector is essential in order to achieve a resource-effective and circular society. Actors within such a platform are also the project's overall **target group**.

Resource Effectiveness and the Circular Economy was launched at the beginning of 2018 and will continue until mid-2020.

The project's definition of resource effectiveness and the circular economy

Resource effectiveness[1] and circular economy[2] are two distinct concepts under the same umbrella. A measure that supports the circular economy often also supports resource effectiveness. In this project we regard resource use within the planetary boundaries as the overarching goal. In order to manage any conflicting objectives in future development it is important for there to be clarity and an understanding of systems.

The primary focus of this report is more effective management of the value of society's and nature's resources beyond, for example, mere volumes or mass. Unless otherwise stated, this also includes the concept of a circular economy. In cases where conflicting objectives between the concepts are identified, they are described.

Geissdoerfer et al, for example, define circular economy below mainly in terms of the circulation of materials:

> *A regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.*[3]

The project's premise is that resource effectiveness takes priority over the circulation of materials. We believe that it is important to include the user phase in the definition – not just the production phase; to include business models and services – not just physical products:

> *A performance economy goes a step further by selling goods (or molecules) as services through rent, lease and share business models. ... In addition to design and reuse, the performance economy focuses on solutions instead of products, and makes its profits from sufficiency, such as waste prevention.*[4]

The project believes that this perspective is missing in some circular economy definitions, even if it is sometimes considered an implicit aspect. One example is the average car which is parked 95 percent of the time. We do not improve the efficient use of resources by merely recirculating the materials the car is made from – no matter how good we get at it. The effective use of resources ("resource effective-

1 *Europa 2020 – A strategy for smart, sustainable and inclusive growth COM (2010)*, and *A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy COM (2011)*. There is unfortunately no actual definition of resource effectiveness.

2 Kirchherr, J., Reike, D., Hekkert, M., 2017, "Conceptualizing the circular economy: An analysis of 114 de nitions", in *Resources, Conservation and Recycling* 127, pp. 221–232.

3 Geissdoerfer, M., Savaget, P., Bocken, N. and Hultink, E., 2017, "The circular economy – A new sustainability paradigm?" in *Journal of Cleaner Production* 143 (1), p. 759.

4 Stahel, W., "The circular economy", 23 Mars 2016, in Nature 531, pp. 435-438 (https://www.nature.com/news/the-circular-economy-1.19594; accessed 10 December 2019).

ness" = using resources as efficiently as possible while also avoiding negative environmental impact) must be improved.

As Florian Lüdeke-Freund et al. wrote in their article entitled "A review and typology of circular economy business model patterns":

> *The circular economy may not be a final goal, but rather part of an ongoing process to achieve greater resource efficiency and effectiveness.*[5]

This is a theory the project is happy to endorse.

For the project:

Åke Svensson, Chair
Caroline Ankarcrona, Project Manager
Jan Nordling, Project Manager

The subproject's work group

Chair: **Ann-Karin Modin Edman**, Arla Foods
Project Managers: **Kristoffer Gunnartz** – consultant, Addverbal
Katarina Rosenqvist – Swedish Food Retailers Federation
Per Liljedahl/**Anna Burholm** – Sodexo
Sara Sundquist – Swedish Food Federation
Karin Bildsten – Axfood
Carolina Sachs – consultant, formerly with Axfoundation
Louise Ungerth – consultant, sustainability and food loss expert
Åsa Stenmarck – IVL Swedish Environmental Research Institute
Karin Östergren – RISE

5 Lüdeke Freund, F., Gold, S. and Bocken, N., 2018, "A Review and Typology of Circular Economy Business Model Patterns", in *Journal of Industrial Ecology*, Volume 23, Issue1, February 2019, pp. 36-61.

Summary

»A profitable food supply chain with long-term sustainability must have an understanding of its resource flows.«

Global production and consumption of food today is a justified aspect of human impact on the environment, climate and the planet's natural resources. Still, we handle the food that is produced in such a way that one third of it never reaches our tables. Estimates show that this is food for a value of USD 1,200 billion annually which, as it moves through the food supply chain, gives rise to up to 10 percent of greenhouse gases due to human activity,[6] consumes a quarter of all fresh water used in agriculture[7] and would be enough to annually feed the world's 900 million starving people four times over.[8]

För att hantera det omfattande resursslöseriet i livsmedelskedjan har FNs medlemsstater inom ramen för Agenda 2030 skrivit under delmål 12.3. I detta måldokument står det att mänskligheten senast till år 2030 ska *"halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses"*.

To manage the huge waste of resources in the food supply chain, the UN member states have signed onto target 12.3 in Agenda 2030. The target document describes the following target for humanity: "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses".

In this report we have chosen to replace the two terms "food loss" and "food waste", which are used by the FAO when describing efforts to achieve the SDG target 12.3. In the Swedish framework we have instead chosen to refer to "lost food" and "wasted food" as translations of the two Swedish terms "matsvinn" and "matavfall" which are used by the Swedish authorities.

WASTED FOOD IS AN UMBRELLA TERM THAT CAN BE DIVIDED INTO TWO SUBCATEGORIES

- Lost food, i.e. the parts of the food that could have been consumed by humans.
- Unavoidable waste from food sources, consisting of the inedible parts of the wasted food (gristle, bones, peel etc). In the proposed framework the term "unavoidable waste from food sources" does not include waste of non-food origin (for example packaging).

The subproject has made this choice as we have determined that the definitions of the terms "food loss" and "food waste" exclude substantial fractions of the food that leaves the food supply chain without being consumed by humans. They also exclude a portion of the unavoidable waste from food sources that arises in the food supply chain. The subproject has concluded that parts of these excluded resource flows should be taken into account in efforts to achieve resource-effective and sustainable production and consumption of food.

The subproject would, however, like to stress that the translations of the Swedish terms "matsvinn" and "matavfall" used in this report must be seen as a preliminary solution as there is currently no established agreement at the Swedish national and municipal levels on how these Swedish terms match the FAO's terms "food loss" and "food waste".

The focus of this report has not been on producing solutions for practical ways to start reducing the amount of

6 FAO, 2017, *Food wastage footprint & Climate Change* (http://www.fao.org/3/a-bb144e.pdf; accessed 20 December 2019).

7 FAO, 2016, *Installment 2 of Creating a Sustainable Food Future Reducing Food Loss And Waste*. Working Paper.

8 FAO, *Seeking end to loss and waste of food along production chain* (http://www.fao.org/in-action/seeking-end-to-loss-and-waste-of-food-along-production-chain/en/; accessed 20 December 2019).

lost food and unavoidable food waste in the food supply chain. In recent years thousands of companies, innovation and research projects, public agencies and food consumers have already started working on this.

The subproject has instead concentrated on a different challenge. In order to be able to even set a measurable target like 12.3 – and to monitor progress – we need to know how much "lost food" and "unavoidable food waste" occurs along the food supply chain. To measure this at the national or international level requires rules and definitions so that everyone is measuring in the same way.

With these insights as the starting point, the food subproject established three goals:

1. Produce a proposal for a national framework for how companies in the Swedish food supply chain are to measure and report their lost food and inevitable waste of food.

2. Identify and document solutions that are available to make measurement based on the proposed framework possible in practice throughout the food supply chain.

3. Help to establish a platform for a voluntary agreement, aimed at enabling companies in the Swedish food supply chain to start measuring the amount of lost and wasted food, and to set measurable targets to reduce it.

All three goals have been achieved within the framework of the project and are presented in separate chapters in this report (see pages 24, 50 and 58).

During the course of its work the subproject has also made a number of observations on and analysed the circumstances that we consider of significance for Sweden's ability to reach its environmental goals, implement its food supply strategy, turn the national action plan to reduce the amount of lost food into practice and meet the UN SDG 12.3 target. Based on this, the subproject has drawn a number of conclusions and produced recommendations and calls for action.

1. To begin with the subproject can note that all the way up to government agency level there appears to be uncertainty about how the Swedish term "matsvinn" (translated as lost food in this report) should be interpreted in relation to the two English terms "food waste" and "food loss", which are used in the 12.3 target of the UN Food and Agriculture Organization (FAO). According to the FAO's definitions, neither of these terms corresponds to the Swedish definition of "matsvinn". The Government needs to quickly task the three agencies that have produced national action plans to reduce the amount of "matsvinn"[9] (Swedish Environmental Protection Agency, Swedish National Food Agency and the Swedish Board of Agriculture) with finding a way to resolve this interpretation problem.

2. The subproject can also note that the Government has still not presented any quantitative future goals for how much Sweden must reduce the amount of food lost at the national level by 2030. It is essential to do this in order to understand how Sweden intends to contribute to achieving the UN's 12.3 target. In June 2019 the Swedish Environmental Protection Agency was tasked with producing a Swedish target for reducing the amount of lost food. According to the information available to the subproject, a proposal was to be presented by 28 February 2020.

9 Swedish National Food Agency, 2018, *Fler gör mer. Handlingsplan för minskat matsvinn 2030*, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-merhandlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 20 December 2019).

3. Since Sweden is obligated to follow the EU's Waste Framework Directive, the point of departure of the subproject's proposed framework must be that the Swedish food supply chain measures and reports the amount of lost and wasted food in a way that corresponds to the EU's requirements.

4. The subproject does, however, want to urge the Government and relevant agencies to take steps to ensure that the actors in the food supply chain also start to measure the resource flows that are not currently included in the EU's waste legislation. According to the subproject's interpretation, this means food and inedible parts of food that leave the food supply chain to go to the production of animal feed, biofuel and biochemical products. These flows are not visible today in the statistics and there is therefore a risk that they will fall outside of Sweden's and the EU's efforts to reach the 12.3 target.

5. In order to measure the flows of lost and wasted food that are outside the EU's waste legislation, it is necessary to be able to separate this data from the figures the Swedish Environmental Protection Agency is required to deliver to the EU. According to the subproject, this could be resolved if all actors measure how much lost and wasted food that go to one of the nine areas of use – in this report called "destinations" – described in the proposed framework (see section "Destinations – Where does the lost and wasted food go?"). This solution would make it possible to separate the fractions that the Swedish Environmental Protection Agency is tasked with reporting to the EU, at the same time as it would be possible to produce a "broader" picture of the flows that leave the food supply chain without being consumed by humans.

6. In the subproject's framework proposal the assessment is made that it is preferable for measurement and reporting of lost and wasted food to be done on a voluntary basis. Experience from the work of the British organisation WRAP (Waste and Resources Action Programme) in several countries shows that urging companies in the food supply chain to enter into voluntary agreements can be a very effective way to get them to start measuring, reporting and setting measurable targets to reduce the amount of their lost and wasted food.[10] The voluntary aspect of the proposed Swedish framework should, however, only apply to whether a company is willing to measure or not. It should not apply to how or what should be measured. This must be based on common definitions and rules, which are presented in the proposed framework.

7. To get companies in the Swedish food supply chain to be willing to measure their lost and wasted food, the subproject urges the Government to produce control mechanisms that motivate, facilitate and reward food companies that start measuring. The Government should also take the initiative for new forms of financial support to stimulate development of new solutions that make it easier for smaller resource-intensive companies to measure and report their lost and wasted food. This could, for example, involve new technology, new cooperation, or new ways of using existing technology.

8. The subproject would also like the Government, relevant authorities, as well as industry organisations and companies in the food supply chain to get involved in the ongoing efforts to build a platform for a voluntary agreement. The idea of the platform is to get companies in the

10 WRAP website, 2019, *What is Courtauld Commitment?* (http://www.wrap.org.uk/content/what-is-courtauld; accessed 20 December 2019).

food supply chain to set common targets for measuring and reducing their lost and wasted food. Here, the subproject would like the Government to take the first step and contribute at least half of the funding that will be needed to put an actor in charge of organising, managing and following up efforts to implement the Swedish agreement.

9. The subproject would like the Government to appoint a key actor with national responsibility for compiling all of the measurement data reported from the various parts of the food supply chain on both lost and wasted food. This requires a change in the current order where the Swedish Environmental Protection Agency is responsible for lost food (matsvinn) issues, while the Swedish National Food Agency is responsible for matters relating to wasted food (matavfall). The subproject has identified significant synergies in having a single agency identifying and documenting these two waste categories, particularly as lost food is a subset of the total amount of wasted food. The subproject suggests that the Swedish Environmental Protection Agency, which is already responsible and has routines for compiling data on the total amount of wasted food, be given this expanded overall responsibility.

The proposed framework in this report contains a series of proposed rules and definitions of key terms to define and delineate the large resource flows in the food supply chain. Where, for example, is the line between what is considered "food" and what should or should not be called "wasted food" or "lost food"? The subproject is well aware that a framework of this type constitutes a control mechanism, which could have a major impact on future conditions in and development of the food supply chain. The subproject would therefore like to emphasise that the intention of the proposed framework is to build a more resource-efficient food supply chain. The purpose is not to force control mechanisms on the food supply chain that could reduce competitiveness and profitability.

The project's conclusions are the result of an intense programme of analysis and documentation, workshops, meetings and referral processes involving a large number of individuals. If this work has required support from other sources, these are mentioned in the text. The work began with a work group with representatives from companies, organisations and research institutes with substantial knowledge of resource efficiency and waste within the food supply chain.

The food subproject – approach, vision and objectives

»Reducing lost food is the fasted and perhaps most implementable step we can take towards the goal of a resource-effective food supply chain that is sustainable in the long term.«

The role of the food supply chain in a sustainable society

Sustainable production and consumption of food is a key piece to the puzzle in efforts to reach the 17 Sustainable Development Goals established within the framework of the UN's Agenda 2030 (see Figure 1). Global food production today uses 11 percent of the surface of the planet;[11] it accounts for 70 percent of human consumption of fresh water[12] and gives rise to one third of greenhouse gas emissions from human activity.[13]

Our food production today is one of the most important areas to address to slow down desertification, soil erosion, deforestation,[14] ddecimation of life in our oceans,[15] depletion of the Earth's biodiversity[16] and the accelerating problem of increased antibiotic resistance.[17] Sustainable production and consumption of food also constitutes a basic foundation in the work to eradicate global hunger, improve people's health and fight widespread diseases such as diabetes and cardiovascular disease.

CONSEQUENCES OF FOOD PRODUCTION

- 40 percent of all antibiotics produced in the world are used in the meat industry. This makes the food supply chain one of the greatest threats undermining the prevention of antibiotics resistance.
- Today 66 percent of global agricultural production is dependent on just nine types of crops.
- Human exploitation has led to a dramatic decline in marine life. The WWF estimates that the global population of fish and other marine life has been halved since 1970.

Source: National Research Council 1980, FAO 2019, EU 2013.

11 FAO, 2003, *World agriculture: towards 2015/2030. An FAO perspective* (http://www.fao.org/3/y4252e/y4252e06.htm; accessed 20 December 2019).

12 FAO, 2017, *Water for Sustainable Food and Agriculture A report produced for the G20 Presidency of Germany* (http://www.fao.org/3/a-i7959e.pdf; accessed 20 December 2019).

13 Nature, 2012, *One-third of our greenhouse gas emissions come from agriculture- Farmers advised to abandon vulnerable crops in face of climate change* (https://www.nature.com/news/one-third-of-our-greenhouse-gas-emissions-come-from-agriculture-1.11708; accessed 20 December 2019).

14 Svenska Dagbladet, 2019, *En miljon djur- och växtarter hotas av utrotning. Men vad innebär den förlorade biologiska mångfalden för oss människor – och vad kan vi göra åt saken?*, publicerad 2019-05-12 (https://www.svd.se/djur-och-vaxter-dor-ut--sa-kan-vi-undvika-en-katastrof; accessed 20 December 2019).

15 EU, 2013, *Europaparlamentets och Rådets Förordning (EU) nr 1380/ – om den gemensamma fiskeripolitiken*. Se artikel 15 om "Landningsskyldigheten" (https://eur-lex.europa.eu/legal-content/SV/TXT/PDF/?uri=CELEX:32013R1380&rid=1; accessed 20 December 2019).

16 FAO, 2019, *The state of the world´s biodiversity for food and agriculture – FAO commission on genetic resources for food and agriculture*. Assessments 2019 (http://www.fao.org/news/story/en/item/1180463/icode/; accessed 20 December 2019).

17 National Research Council, 1980, *The Effects on Human Health of Subtherapeutic Use of Antimicrobials in Animal Feeds* (https://www.ncbi.nlm.nih.gov/books/NBK216502/; accessed 20 December 2019).

Figure 1: How working towards target 12.3 – to reduce global food loss and food waste – can help us reach the other 16 Sustainable Development Goals that the United Nations Development Programme (UNDP) has set up within the framework of its work on Agenda 2030. Source: UN 2019.

Resource effectiveness in the food supply chain

One of the most effective, and in the short-term perhaps most implementable actions to reach the goal of a sustainable global food supply chain, is increasing resource efficiency throughout the chain – i.e. reducing the extensive waste of finite natural resources that is happening all over the globe.

IMPORTANT TO VOLUME OF FOOD LOSS

In a new report the UN Intergovernmental Panel on Climate Change (IPCC) points out that reducing food loss and waste is an important factor in efforts to create a global food supply chain that can feed a growing population within the planetary boundaries.

Source: IPCC 2019.

At the global level

According to rough estimates from the UN FAO, a third of the food that is produced in the world never reaches our tables.[18] It instead leaves the food supply chain to be burned, deposited in a landfill or used in the production of animal feed, bioenergy or biochemical products. The Boston Consulting Group has calculated that 1.6 billion tonnes of food, for a value of USD 200 billion leaves the food supply chain without being consumed by humans as was the intention (see Figure 2).[19] Some of this is due to "unnecessary" overproduction of food which increases the pressure on the environment, the climate, the Earth's finite natural resources and biodiversity (see fact box).

CONSEQUENCES OF LOST FOOD

The annual production of the 1.6 billion tonnes of food that is not eaten:

- accounts for 8 to 10 percent of all greenhouse gases that we emit;
- consumes a quarter of all fresh water used in agriculture;
- would be enough to feed the world's 900 starving people four times over;
- is ranked by the Project Drawdown research organisation as the third largest contributor to human emissions of greenhouse gases into the atmosphere.

Source: FAO 2017, FAO 2016, FAO, Seeking end to loss and waste of food along production chain, FAO, 2013.

In Europe

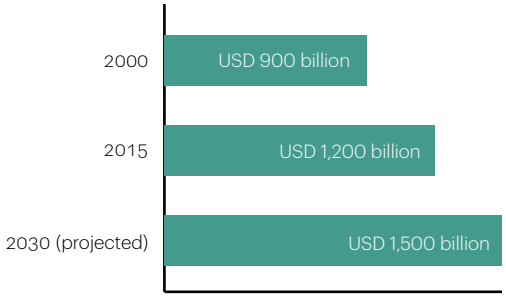
At the EU level a study within the framework of the FUSION project in the EU's Seventh Research and Innovation Programme shows that 88 million tonnes of food per year in the EU countries, for an estimated value of EUR 143 billion, leaves the food supply chain without being consumed.[20]

18 FAO/SIK, 2011, *Global Food Losses and Food Waste – Extent, Causes and Prevention* (http://www.fao.org/3/a-i2697e.pdf; accessed 20 December 2019).

19 Boston Consulting Group, 2018, *Tackling the 1.6-billionton food loss and waste crisis* (http://image-src.bcg.com/Images/BCG-Tackling-the-1.6-Billion-Ton-Food-Waste-Crisis-Aug-2018%20%281%29_tcm22-200324.pdf; accessed 20 December 2019).

20 Article 2 of Commission Delegated Decision (EU) – 3 May 2019 – supplementing Directive 2008/98/EC of the European Parliament and of the Council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste. Final version. (Preliminary document).

Figure 2: According to Boston Consulting Group (BCG) the value of the 1.6 billion tonnes of food that never reaches our table every year is USD 1,200 billion. According to BGC's predictions there is a risk that this (resource leakage) will increase to 2.1 billion tonnes, for a value of USD 1,500 billion by 2030 if the trend is not broken. Source: Boston Consulting Group (2018).



In Sweden

In Sweden the latest statistics from the Swedish Environmental Protection Agency show that in 2016 there was almost 1.3 million tonnes of food waste (the Agenda 2030 definition), representing an average of 129 kg per person (see Figure 3).[21] This food waste (the Agenda 2030 definition) includes both inedible parts of food such as peel, bones or coffee grounds and avoidable food waste i.e. food and beverages that could have been consumed. In Swedish the latter category is usually referred to as "matsvinn", which in the report has been translated as "lost food".

Significant differences between where in the food supply chain food is wasted

According to statistics compiled by the Swedish Environmental Protection Agency, almost 75 percent of food loss and food waste (Agenda 2030 definition) in the Swedish food supply chain occurs on the consumer side.[22] In a global perspective there is a greater spread between the different parts of the food supply chain, but the main area is primary production, i.e. earlier (upstream) in the food supply chain flow (see Figure 4).[23]

Large knowledge gaps and uncertainties in the statistics

The statistics for food loss and other food waste (Agenda 2030 definitions) occurring in the food supply chain should be taken very seriously. It is, however, important to remember that these figures are based on estimates associated with uncertainty. This applies to statistics at the global level, at the EU level and from the Swedish food supply chain.

At the national level, the volume of food loss and food waste (Agenda 2030 definitions) occurring varies significantly depending on where we consider our own food supply chain to begin and end. In terms of the food we eat or produce here in Sweden, much of the food loss and food waste (Agenda 2030 definitions) that is linked to it occurs outside our borders. In other words, before the food we import has reached Sweden or after the food we produce here has been exported to other countries.

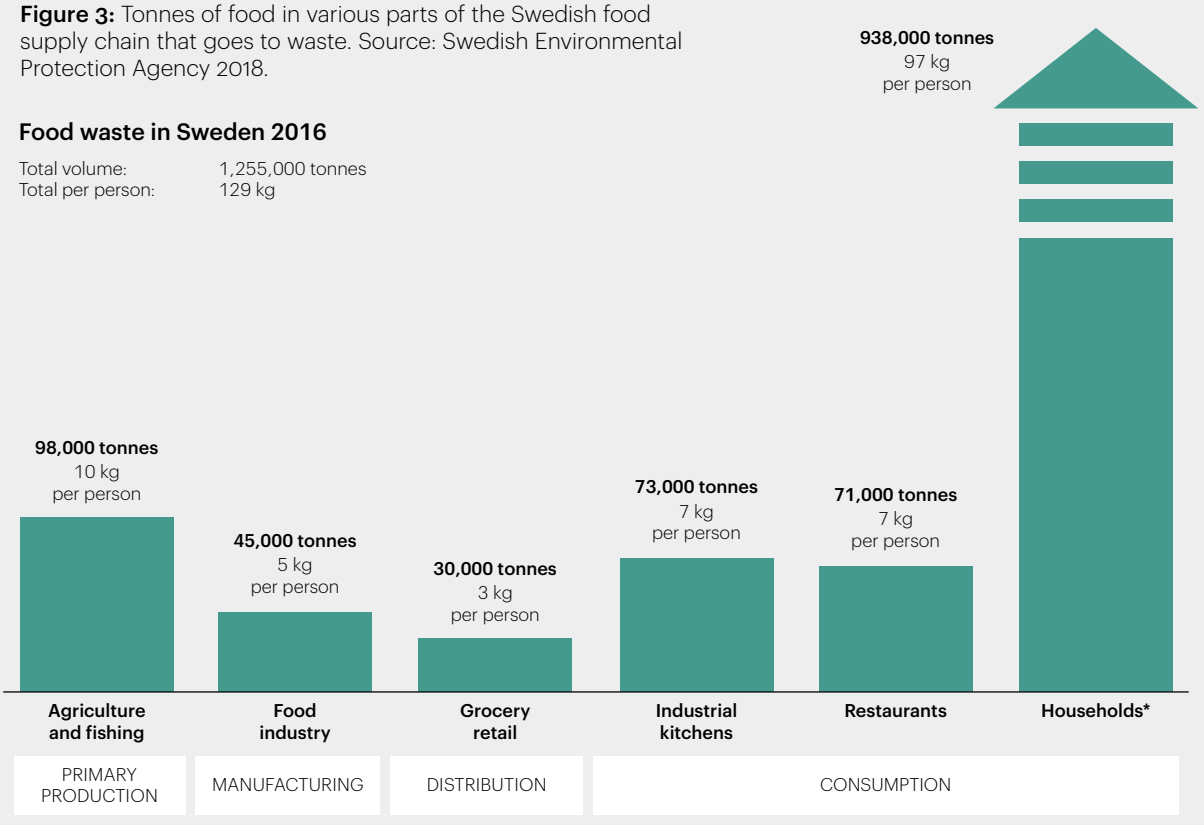
In the previous project Resource Efficient Business Models – Greater Competitiveness, an attempt was made to identify

21 Champions 12.3 website (https://champions123.org/target-12-3/; accessed 20 December 2019).

22 Swedish Environmental Protection Agency, 2018, *Matavfall i Sverige – uppkomst och behandling 2016* (https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-8811-8.pdf?pid=22466; accessed 20 December 2019).

23 Boston Consulting Group, 2018, *Tackling the 1.6-billionton food loss and waste crisis* (http://image-src.bcg.com/Images/BCG-Tackling-the-1.6-Billion-Ton-Food-Waste-Crisis-Aug-2018%20%281%29_tcm22-200324.pdf; accessed 20 December 2019).

Figure 3: Tonnes of food in various parts of the Swedish food supply chain that goes to waste. Source: Swedish Environmental Protection Agency 2018.

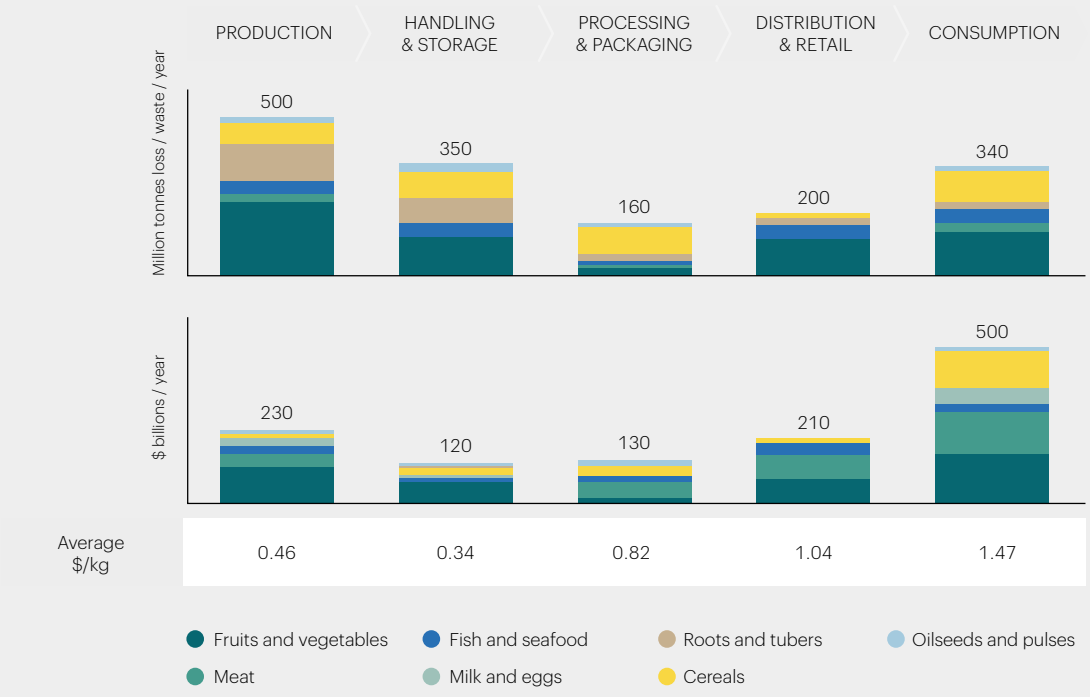


* Including food waste that goes down the drain.

and document the resource flow in tonnes throughout the Swedish food supply chain (see Figure 5 on page 19).[24] This included flows that leave the food supply chain in the form of food loss and food waste (Agenda 2030 definitions). The result shows that there are major data gaps for these flows in all parts of the food supply chain. (These are illustrated by some of the green and red arrows with question marks in Figure 5 on page 19.) The conclusion is that it is difficult today to make an estimate of the total amount of food loss and food waste (Agenda 2030 definitions) occurring in the food supply chain.

24 Royal Swedish Academy of Engineering Sciences (IVA), project Resource Efficient Business Models – Greater Competitiveness, 2016, *Food – a sector report* (https://www.iva.se/globalassets/info-trycksaker/resurseffektivaaffarsmodeller/rask-branschrapport-livsmedel.pdf; accessed 20 December 2019).

Figure 4: Tonnes of food that is lost or goes to waste in the various parts of the food supply chain from a global perspective. Source: Boston Consulting Group 2018.



National and international goals and control mechanisms

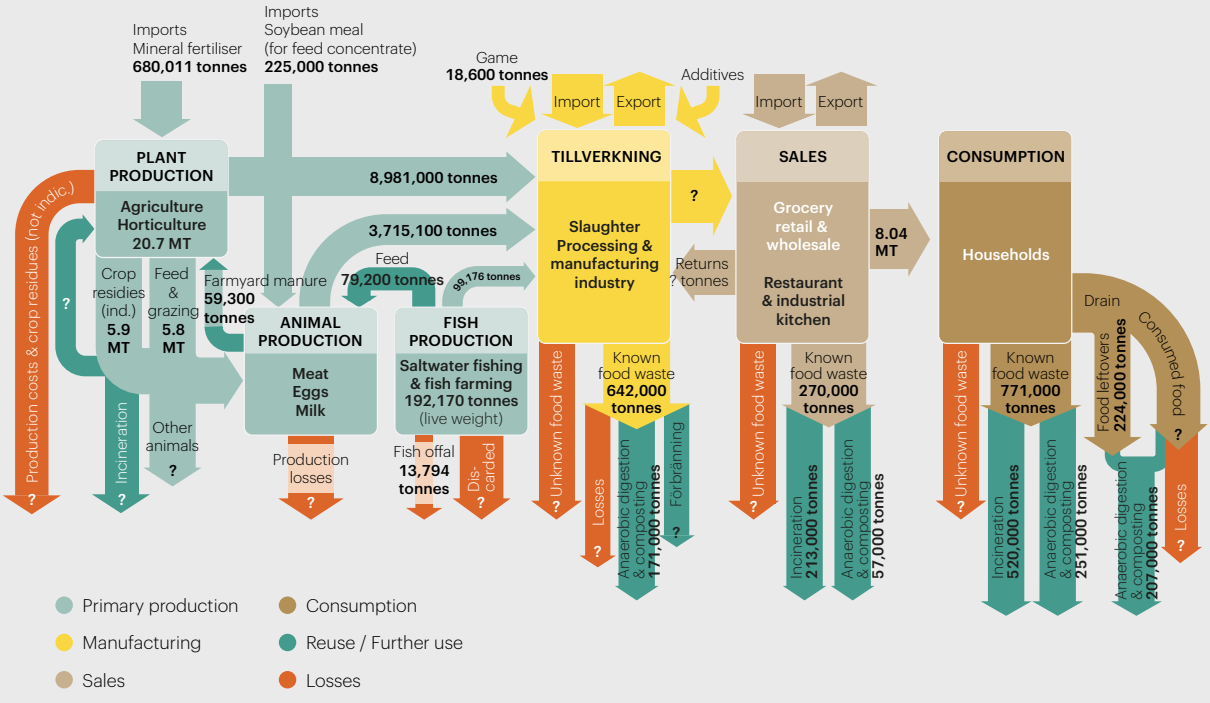
The loss and waste of food occurring in the food supply chain is something that has in recent years been taken very seriously – both internationally and in Sweden. This shows, if nothing else, how many initiatives have been taken to set sustainable goals for today's production and consumption of food. The same applies to the creation of new control mechanisms that could promote efforts to achieve these goals. Some of the most important ones are described below:

At the global level

- Agenda 2030 and the Global Sustainable Development Goals. In 2015 the UN General Assembly adopted the resolution on Agenda 2030 which consists of 17 Global Sustainable Development Goals. One of the targets – SDG target 12.3 – has the following ambition: "By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses". Since it was presented, this proposal has been an important driver for many of the goals and control mechanisms

Figure 5: Flows in tonnes of biological materials through the various parts of the Swedish food supply chain. The red and dark green arrows show "losses" in the form of lost and wasted food that leaves the food supply chain without being consumed by humans. The arrows with question marks indicate unknown flows where there is no data on the number of tonnes.

Source: Royal Swedish Academy of Engineering Sciences (IVA), Resource-Efficient Business Models – Greater Competitiveness, 2016.



Comments: It should be noted that the way in which the food supply chain is divided up in the figure shown differs somewhat from how it is divided up in this report (see the section "Loss and waste of food can only occur in the food supply chain"). Nor do we in this report call the flows that leave the food supply chain "losses" as in the figure. Instead we have chosen to call them "food that leaves the food supply chain without being consumed by humans".

established over the past five years around the world.[25]

At the EU level

- **The EU's revised Waste Framework directive** – In 2018 the EU presented a new directive on waste which, among other things, requires mandatory collection of food-based waste, including food loss (Agenda 2030 definition), from the beginning of 2023.[26]

- **EU FUSIONS** – An EU project aimed at building a European cooperation platform to speed up efforts to reduce food loss and food waste (Agenda 2030 definition) in member states and increase their resource efficiency.[27]

- **EU Circular Economy Action Plan** – In 2015 the European Commission adopted an action plan aimed at maximising the value and the use extracted from raw materials, products and waste, for example in the food supply chain.[28]

- **EU Platform on Food Losses and Food Waste** – This is part of the EU's Circular Economy Action Plan, aimed at taking steps that contribute to reaching the UN target 12.3 to halve food loss and food waste by 2030. One of the platform's goals is to promote cooperation between companies in the food supply chain that want to take action to reduce their food loss (Agenda 2030 definition). Another important goal is to produce a proposal for common standards to measure food waste (Agenda 2030 definition) in all parts of the food supply chain.[29]

- **Closing the loop** – A European action plan for circularity that contains proposed legislation on reducing waste and increasing recycling and reuse to stimulate the EU's transition to a circular economy. The plan includes proposed measures to create more closed resource cycles and to reduce food waste (Agenda 2030 definition).[30]

- **Refresh** – Resource Efficient Food and Drink for the Entire Supply Chain – A European research programme aimed at producing knowledge and solutions to help reach the UN goal of halving food loss (Agenda 2030 definition) by 2030.[31]

- **The Commission Delegated Decision** – on supplementing Directive 2008/98/EC of the European Parliament and of the Council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste (Agenda 2030 definition).[32]

25 Champions 12.3 website (https://champions123.org/target-12-3/; accessed 20 December 2019).

26 EU, 2018, *Europaparlamentets och Rådets Direktiv (EU) 2018/851 av den 30 maj 2018 – om ändring av direktiv 2008/98/EG om avfall* (https://eur-lex.europa.eu/legal-content/SV/TXT/?uri=CELEX:32018L0851; accessed 20 December 2019).

27 FUSION website (http://www.eu-fusions.org/; accessed 20 December 2019).

28 EU, 2019, *Report from the Commission to the European parliament, the Council, the European economic and social committee and the committee of the regions – on the implementation of the Circular economy Action Plan (SWD 2019 Final)* (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1551871195772&uri=CELEX:52019DC0190; hämtad 2019-12-20).

29 Article 2 of Commission Delegated Decision (EU) – 3 May 2019 – supplementing Directive 2008/98/EC of the European Parliament and of the Council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste. Final version. (Preliminary document).

30 Mistra – Closing the loop (https://closingtheloop.se/; accessed 20 December 2019).

31 REFRESH, 2019, *REFRESH – Resource Efficient Food and dRink for the Entire Supply CHain* (https://eu-refresh.org/; accessed 20 December 2019).

32 Article 2 of Commission Delegated Decision (EU) – 3 May 2019 – supplementing Directive 2008/98/EC of the European Parliament and of the Council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste. Final version. (Preliminary document).

At the national level (in Sweden):

- **A national strategy for sustainable consumption** – In 2016 the Ministry of Enterprise, Energy and Communications presented a national strategy to promote environmentally, socially and financially sustainable consumption. The strategy focuses on three main areas, one of which is food. The other two areas are transport and housing.[33]

- **A national food strategy** – in 2017 the Ministry of Enterprise, Energy and Communications presented a long-term strategy towards 2030, "which will contribute to the potential for all of the food supply chain to be fully utilised". The overall goal for the food strategy is to create "a competitive food supply chain in which total food production increases while relevant national environmental goals are reached, to create growth and employment and contribute to sustainable development throughout the country".[34]

- **A national action plan to reduce the volume of lost food (matsvinn)** – as part of the national food strategy presented by Swedish Environmental Protection Agency, Swedish Board of Agriculture and Swedish National Food Agency in June 2018. The action plan, which was produced by a government commission, includes proposed actions for how Sweden will reduce its volume of lost food (matsvinn) by 2030. The proposed actions cover all parts of the food supply chain – from producer to consumer.[35]

The subproject's vision, goals and boundaries

Vision

The work of IVA's Food subproject has been based on contributing to a vision of a Swedish food supply chain that is as resource-effective as it can possibly be. The subproject's work group has therefore based its work on the goal of Sweden exceeding the UN's 12.3 target:

> *"By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses"*

Targets

The subproject's contribution to this is based on reaching three targets:

Target 1: To produce a proposal for a framework to measure lost and wasted food in all parts of the Swedish food supply chain. This target includes presenting the subproject's proposals to relevant authorities and ministries, and encouraging the actors in the food supply chain to start applying the framework.

Target basis: There are several good reasons to produce a national framework for measuring lost and wasted food:

33 Finansdepartementet, 2016, *Strategi för hållbar konsumtion, 2016:6* (https://www.regeringen.se/4a7e12/globalassets/regeringen/dokument/finansdepartementet/pdf/2016/strategi-for-hallbar-konsumtion/strategi-for-hallbar-konsumtion--tillganglighetsanpassad.pdf; accessed 20 December 2019).

34 Ministry of Enterprise, Energy and Communications, 2016, *En livsmedelsstrategi för Sverige – fler jobb och hållbar tillväxt i hela landet – Kortversion av regeringens proposition 2016/17:104* (https://www.regeringen.se/4908a0/contentassets/89c5b3e5d23f473d843d12f12379d07b/livsmedelsstrategin_kortversion_170130.pdf; accessed 20 December 2019).

35 Swedish National Food Agency, 2018, *Fler gör mer. Handlingsplan för minskat matsvinn 2030*, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-merhandlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 20 December 2019).

- To begin with it is a basic requirement in order to drive and follow up on progress towards the UN's 12.3 target, which Sweden has signed on to.

- It is one of the concrete measures that is proposed by the Government's national action plan to reduce the volume of lost food (matsvinn).[36]

- It responds to an expressed desire from several of the industry organisations in the food supply chain.[37]

- IVA's proposed framework thus also constitutes, for Sweden, a concretisation of the proposal for EU-wide definitions and methods to measure food loss and food waste (Agenda 2030 definitions), which the EU Platform on Food Losses and Food Waste (FLW) presented in autumn 2019.[38]

Target 2: To contribute to producing solutions that make it possible to measure and report lost and wasted food in all parts of the food supply chain.

Target basis:

- In cases where there are no practicable solutions today, new solutions will be needed to measure and report lost and wasted food as easily and cheaply as possible so that this can be implemented by the majority of companies in all parts of the food supply chain.
- Exploring the possibility of new solutions to measure and report lost and wasted food is also an important piece in the puzzle in efforts to reach the EU's revised Waste Framework Directive regarding mandatory collection of food waste by 2023.

Target 3: To help build a platform for a voluntary agreement. The idea of the platform is to encourage companies in the food supply chain to set common targets for measuring and reducing the volume of lost and wasted food.

Target basis:

- The subproject's efforts to help build a platform is an important first step in Sweden's work towards meeting the goals set within the framework of the EU Platform on Food Losses and Food Waste: Support and promote cooperation between companies in the food supply chain that want to take action to reduce their food loss (Agenda 2030 definition).[39]

- It is also a step towards ensuring that Swedish food companies do not become less competitive in the future. Similar platforms are already being built in around 15 countries led by the British organisation WRAP.[40]

- Creating a platform to get companies in the food supply chain to work actively towards a more resource-efficient and more circular economy was also one of the

36 Swedish National Food Agency, 2018, *Fler gör mer. Handlingsplan för minskat matsvinn 2030*, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-merhandlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 20 December 2019).

37 Svensk dagligvaruhandel, 2018, *Dagligvaruhandelns input till Regeringens handlingsplan för ett halverat matsvinn till år 2030*, pressmeddelande 2018-02-12 (https://www.svenskdagligvaruhandel.se/wp-content/uploads/Svensk-Dagligvaruhandels-input-till-handlingsplan-matsvinn.pdf; accessed 20 December 2019).

38 Article 2 of Commission Delegated Decision (EU) – 3 May 2019 – supplementing Directive 2008/98/EC of the European Parliament and of the Council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste. Final version. (Preliminary document).

39 EU, 2016, *EU Platform on Food Losses and Food Waste – terms of reference, 26 April 2016* (https://ec.europa.eu/food/safety/food_waste/eu_actions/eu-platform_en; accessed 20 December 2019).

40 WRAP Global, 2018, *Building partnerships, driving change – voluntary approach to cutting food waste* (http://www.wrap.org.uk/sites/files/wrap/A_voluntary_approach_to_cutting_food_waste.pdf; accessed 20 December 2019).

main goals set for IVA's past project *Resource Efficient Business Models – Greater Competitiveness*.[41]

Boundaries

The subproject's ambition has been to produce frameworks and solutions to measure and report lost and wasted food throughout the Swedish food supply chain – from primary production to consumer. Despite the fact that households are part of the chain where loss and waste of food occurs (see Figure 3), this report has focused most of its attention on measurement and reporting by companies – i.e. the other five parts of the food supply chain (see section "Loss and waste of food can only occur in the food supply chain"). This is not because measuring lost and wasted food in households is less important. It is because the possibility of measuring this in the five previous parts of the food value chain varies to a greater extent and requires more effort to sort out.

The report is mainly focused on two target groups:

- Politicians, actors funding research, industry organisations and other actors with the means and the ability to help make measurement and reporting easier and a higher priority throughout the food supply chain.
- Food companies, waste companies, authorities, industry organisations and other actors who themselves have a reason to measure and report data on lost and wasted food.

Work process

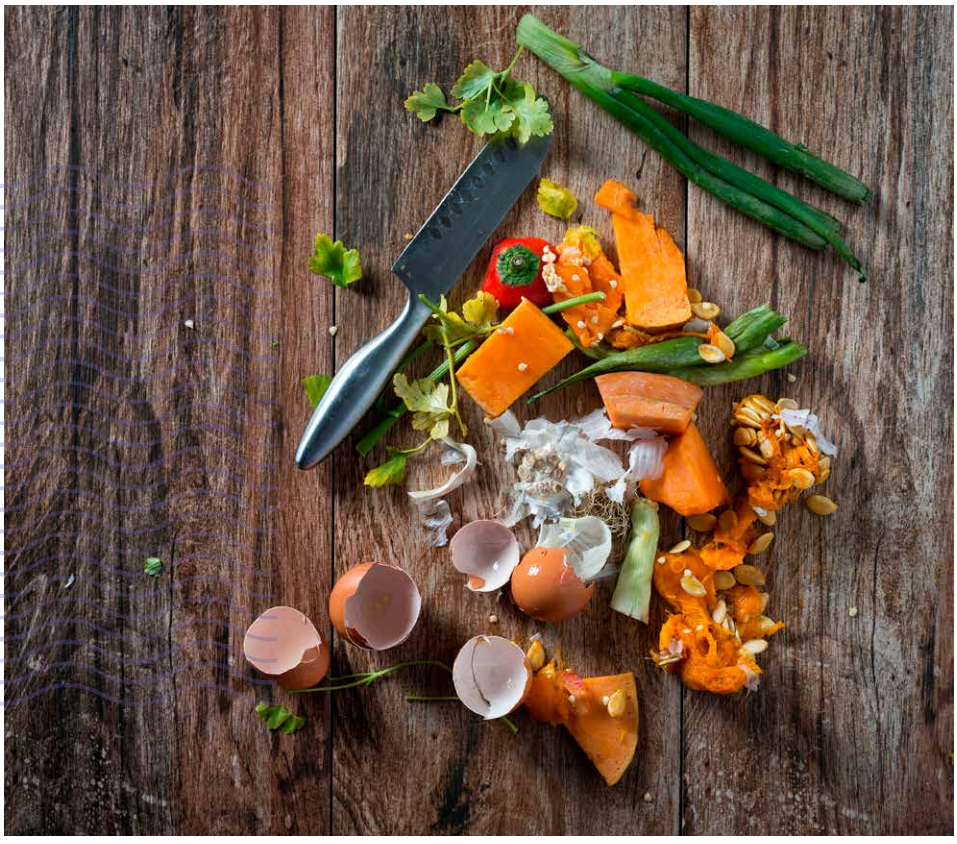
The project's conclusions are the result of an intense programme of workshops, meetings and referral processes involving a large number of individuals. If this text has required support from other sources, this information is included in the text. The work has been conducted by a work group including representatives from companies, organisations, authorities and research institutes who are either active in the food supply chain or have substantial knowledge of resource efficiency and waste within the food supply chain.

The results presented in the three following chapters are based largely on the outcomes of five large workshops, each involving 30–50 expert participants. They were held during the two years that the project has been under way.

When it comes to the proposed framework for measuring and reporting lost and wasted food in the food supply chain, which is presented in the next chapter, a priority has been getting feedback from the actors who are expected to be the recipients of the results. There has been ongoing dialogue with the three public agencies, the Swedish Environmental Protection Agency, the Swedish National Food Agency and the Swedish Board of Agriculture, who are responsible for the Government's action plan to reduce food loss.[42] The proposal has also been referred for responses, with more than 100 actors from the food supply chain, researchers, public agencies and organisations having had the opportunity to read it and express their opinions.

41 Royal Swedish Academy of Engineering Sciences (IVA), project Resource Efficient Business Models – Greater Competitiveness, 2016, *Food – a sector report* (https://www.iva.se/globalassets/info-trycksaker/resurseffektivaaffarsmodeller/rask-branschrapport-livsmedel.pdf; accessed 20 December 2019).

42 Swedish National Food Agency, 2018, *Fler gör mer. Handlingsplan för minskat matsvinn 2030*, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-merhandlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 20 December 2019).



Proposed framework for measurement and reporting of lost and wasted food in the Swedish food supply chain

»Common rules to measure lost and wasted food in the food supply chain are essential for Sweden's ability to drive efforts to reach the UN's 12.3 target of halving food losses by 2030.«

Starting point

In recent years more and more companies who work with food have started to measure and document the volume of their lost and wasted food. In most cases this has taken place at the local level, e.g. in municipal institutional kitchens or within individual companies or groups of companies. But these measurements are still being made based on a range of different rules and definitions of what should be measured – and how to do it.

Actors in the private sector and the political sphere, the public sector and academia have all for many years emphasised the need to create a common standard for how lost and wasted food should be measured and reported.[43, 44]

The first goal set by the subproject was therefore to contribute to the creation of a national measurement standard. Producing a "standard" does, however, involve meeting specific legal requirements that the subproject has not had the ability to live up to. The aim has instead been to produce a proposal for a framework for measuring lost and wasted food in all parts of the Swedish food supply chain.

MEASUREMENT METHODS FOR PUBLIC MEALS

In 2018 the Swedish National Food Agency announced a proposal for a national method to measure food losses. It is, however, only for use within the framework of public meals (hospitals, schools and nursing homes).

Source: Swedish National Food Agency 2018.

In order for a framework of this kind to be relevant and practicable, it needs to meet a number of criteria. It must:

- Contribute to reaching the sustainability and resource efficiency goals that Sweden has established and is bound by.
- Adhere to relevant legislation, requirements and control mechanisms – both in Sweden and at the EU level.
- Include measurement rules that are relevant and reasonable for companies in all parts of the food supply chain to work according to.

43 Swedish National Food Agency, 2018, *Fler gör mer. Handlingsplan för minskat matsvinn 2030*, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-merhandlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 20 December 2019).

44 Svensk dagligvaruhandel, 2018, *Dagligvaruhandelns input till Regeringens handlingsplan för ett halverat matsvinn till år 2030*, pressmeddelande 2018-02-12 (https://www.svenskdagligvaruhandel.se/wp-content/uploads/Svensk-Dagligvaruhandels-input-till-handlingsplan-matsvinn.pdf; accessed 20 December 2019).

- Relate to the definitions of key terms and boundaries that are already being used by public agencies in Sweden as well as within the EU and UN.
- Produce measurement data that meets the EU requirements – and that can be combined with the statistics produced in other EU nations.

The subproject has also taken care to produce a proposed framework that accords with other standards for measuring food loss and food waste (Agenda 2030 definitions), which may be of importance as far as Sweden is concerned. We have chosen to base the subproject's proposed framework on the Food Loss and Waste Accounting and Reporting Standard – in this report abbreviated to the FLW Standard.[45] The FLW Standard is the proposal for an international food standard for food loss and food waste (Agenda 2030 definition) that was produced by, among others, FAO, UNEP, the World Resources Institute, the EU and the British organisation WRAP..

One clarification that should be made is that the proposed framework presented in this report can be considered a first version and will likely need to be developed. It may, for example, be necessary to supplement or adapt it to be applicable in certain parts of the food supply chain where conditions may be different from other parts. In the meantime, until these adjustments are made, the subproject hopes that this first version will serve as a framework for how companies in the food supply chain that are measuring and reporting lost and wasted food should proceed.

The framework's definitions and boundaries

In order to use the proposed framework it is necessary to understand the key terminology that it is built around. The definitions of these terms will bring clarity about what is to be measured and within which boundaries. Here is a description of the key terms and how they relate to each other.

SIX KEY TERMS

Six key terms that need to be defined to understand and use the proposed framework: "wasted food", "lost food", "unavoidable waste from food sources", "food supply chain", "food" and "inedible parts".

Wasted food and lost food

The term **"wasted food"** refers to all food and all of the "inedible parts" (bones, gristle, peel etc.) that may be part of a food, or that are associated with the production of a food, but that leave the food supply chain without being consumed by humans.

The term "wasted food" can in turn be divided into to two subcategories (see Figure 6):

1. **"Unavoidable waste from food sources"** which consists of "inedible parts" i.e. parts that cannot reasonably be expected to be consumed by humans. This includes, for example, peel, bones, gristle, skin, coffee grounds or certain types of offal. In the proposed framework the term **"unavoidable waste from food sources"** does not include waste of non-food origin (packaging material for example).

45 World Resources Institute et al., 2016, *Version 1.0 – Food Loss and Waste Accounting and Reporting Standard* (https://www.wbcsd.org/contentwbc/download/3968/53079; accessed 20 December 2019).

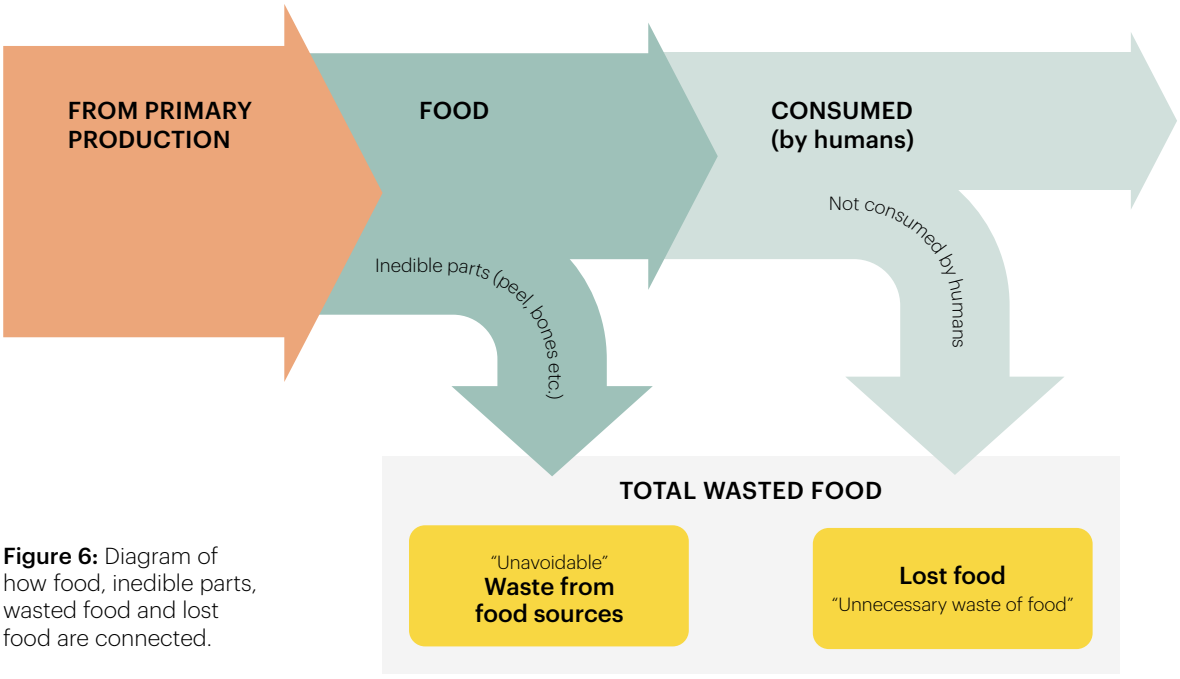


Figure 6: Diagram of how food, inedible parts, wasted food and lost food are connected.

2. **"Lost food"** which consists of food that could have been consumed by humans but for various reasons has left the food supply chain for some other purpose.

The term **"Food"** refers to all substances or products, regardless of whether they are processed, partly processed or unprocessed, that are intended – or can reasonably be intended – to be consumed by humans. .

The term **"inedible parts"** refers to all parts that are attached to the food when they leave primary production, but that cannot be expected to be edible for humans. This could include peel, bones, certain types of offal, coffee grounds and bodily fluids.

Confusion about what is or is not food

In some cases, despite the fact that there seems to be a clear definition, in practice it may still be hard to determine what is "food" and what is "inedible parts". It may also be difficult to determine what can be considered "lost food" (that could have been consumed) and what can be con-

WHAT COUNTS AS FOOD?

Food includes beverages, chewing gum and all substances, including water, that are intentionally added to food during its production, preparation and processing. Food does not include:

- Animal feed
- Live animals, unless they have been treated to be released into the market as food
- Pre-harvest plants
- Pharmaceuticals
- Cosmetics
- Tobacco and tobacco products
- Narcotics
- Residual and foreign substances

sidered "unavoidable waste from food sources" (consisting of inedible parts):

- What can be considered "edible" or "inedible" is often linked to cultures and traditions, and these may vary and change over time.

  Example: In China chicken feet are considered a delicacy by many. In Sweden, on the other hand, most consumers consider chicken feet to be an inedible part of the bird.

  Svensk Fågel AB has estimated the value of exporting chicken feet left over in its own production to the Chinese market at around SEK 100 million.[46]

- In many cases it could also be difficult to separate the "edible" parts from the parts that are "inedible" when determining what to consider lost food or unavoidable waste from food sources.

  Example: A discarded, brown-spotted banana consists of "inedible" skin covering the "edible" fruit. A half-eaten pork chop that is thrown away consists of both "edible" meat and "inedible parts" like gristle, sinews and bone.

To manage this potential confusion about what is considered lost food or unavoidable waste from food sources, the subproject has, in the proposed framework, decided to leave the issue of how these terms should be distinguished from each other open for further discussion and development. This may involve, for example, deciding whether it is necessary to adapt the respective terms to the conditions that apply in different parts of the food supply chain. Can, for example, a pig farmer use the same definition of lost food as a wholesale company or a corner shop?

One thing that is absolutely necessary when making changes or additions to the definitions presented in the proposed framework is that this is done in a way that does not jeopardise the ability to compile measurement data from different industries or different parts of the chain. It must also be done in such a way so that the definitions used do not jeopardise the ability to compile data that can be reported to the EU. The task of making any changes to key terminology definitions should therefore be managed by a government agency, preferably in cooperation with relevant representatives from the food supply chain and the academic world.

For now the subproject suggests applying the following basic rules to determine what should be measured as lost food or unavoidable waste from food sources.

- If an "inedible" part is attached to a food when it is thrown away, it should be measured as lost food.

  Example: Bone, gristle, skin, offal, fish offal, potato peel and blood should be measured as lost food if it is still part of a piece of meat, a fish or a potato that is thrown away.

- If an "inedible" part, on the other hand, is separated from the food when it is thrown away it should be counted as unavoidable waste from food sources.

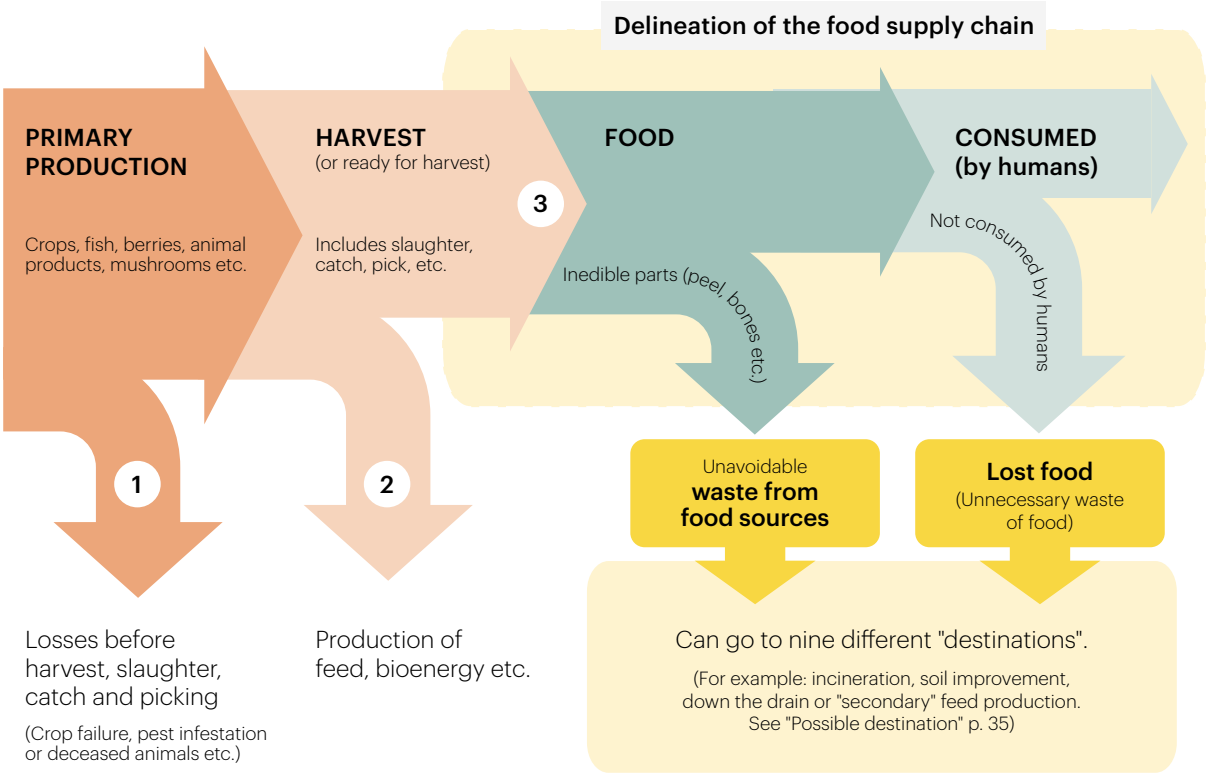
  Example: Coffee grounds, potato peel, bones, skin, offal and fish offal should be measured as other food waste if these parts are separated from the animal, fish, coffee bean or potato when they are thrown away.

46 Tidningen Land, 2016, *Grönt ljus för export till Hongkong*, published 18 March 2016 (https://www.landlantbruk.se/lantbruk/gront-ljus-for-export-till-hongkong/; accessed 20 December 2019).

Figure 7: Three flows from primary production. The material that leaves primary production can be divided up into three flows:

Arrow 1: Pre-harvest losses, slaughter and catch losses, etc.
Arrow 2: Material that goes to the production of animal feed, bioenergy etc. (i.e. products that were never intended to be food for humans)
Arrow 3: Material that goes into the "food supply chain" to become food.

(Read more about the nine "destinations" that lost and wasted food go to in the section *Destinations – Where does lost and wasted food go?*)



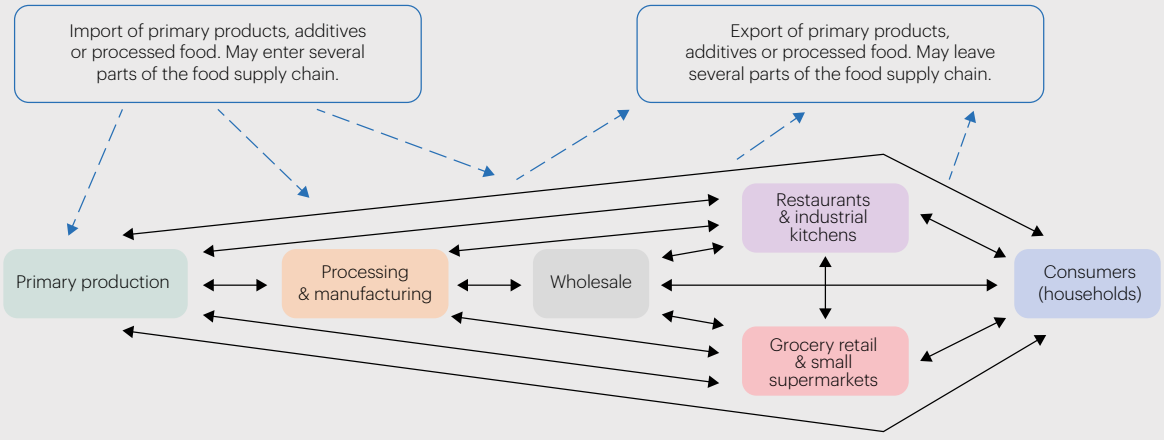
Loss and waste of food can only occur in the food supply chain

In the subproject's proposed framework, loss and waste of food can only arise from material that has left primary production (i.e. that has been harvested, slaughtered, picked or caught) with the intention of it going into the "food supply chain" to become food (for human consumption) (see Figure 7).

In the proposed framework we have chosen to divide the food supply chain into six parts. These consist of the different stages that a food may pass through on the way from primary production to the consumer (see Figure 8). From a geographical perspective the proposed framework's definition of the term "food supply chain" does not reach beyond Sweden's borders. This means that loss and waste of food arising before the food being imported to Sweden has reached this country is not included in the meas-

FIGURE 8: SIX PARTS OF THE FOOD SUPPLY CHAIN

The black arrows show transport routes between the different parts. The blue arrows show import and export of primary products, additives or processed food that may enter, or leave, several parts of the chain.



Primary production – includes plant production (reuse and garden cultivation), animal production (meat, eggs, milk), fish (saltwater, freshwater and farmed) and hunting, private fishing, and mushroom and berry picking. This refers to only the parts of primary production that are harvested, trapped, caught or picked to enter the food supply chain, i.e. meant to become food that can be eaten or drunk by humans. The part of primary production that produces things that are not intended to be food, such as animal feed, bioenergy or biochemical products, are not considered part of the food supply chain (see Figure 7).

Industrial – the part of the chain that includes abattoirs, cleaning-, processing- and production facilities. The industrial part of the chain may also include packing facilities, unless these are part of primary production operations, in which case they are counted as part of primary production.

Grocery retail and small supermarkets – including petrol stations, kiosks, cafés and fast food chains.

Wholesale – includes all parts that involve intermediaries between the other parts of the food supply chain. This may be warehouse management, wholesale businesses or transportation.

Restaurants and industrial kitchens – includes restaurants, hotels and industrial kitchens in the public meal service (e.g. for schools and hospitals).

Consumers – includes household consumption at home. Consumption of food outside the home is not included here.

urement in this framework. The same applies to loss and waste of food that occurs after food produced in Sweden has been exported to other countries. On the other hand, the framework includes loss and waste of food in imported food sources if the waste or loss only occurs after the food has reached Sweden (see the section "Geographical borders and measurement responsibility").

Two flows that are not counted as loss or waste of food

In the subproject's proposed framework loss and waste of food can only occur from material that has been harvested, slaughtered, picked or caught with the intention of it going into the food supply chain, i.e. it is intended for human consumption.

Not everything that is produced in primary production is, however, intended to go into the food supply chain to become food. There are other flows that leave primary production without being consumed by humans, but that still cannot be counted as lost or wasted food. In the proposed framework the subproject has identified two such flows (see Figure 7):

Arrow 1. Crops or animal products that are intended to be food, but that are lost before they can be harvested, slaughtered, caught or picked. This could, for example, be crops that die or are damaged due to crop failure or pest infestation, or animals that die due to disease or injury.

Arrow 2. The crops and animal products (or parts of these), that are cultivated or raised right from the start for other purposes than to become food. These may, for example, be intended for use in the production of animal feed, bioenergy or other biochemical products. NB: Food from this flow should not be confused with animal feed that is produced from food and inedible parts that went into the food supply chain from the start to become food, but that then left the chain as lost or wasted food, (see "secondary feed production" in Figure 7), or section "Two additional flows requiring further discussion" regarding "destinations").

Two additional flows requiring further discussion

In addition to the flows described in Figure 7, there are two others that the proposed framework has not fully explored.

1. One flow is crops that are cultivated to become food, but are either left in the ground or ploughed back in for post-harvest soil improvement because the producer believes that these will not meet the market's quality standards or be able to be sold for a profit.

2. The other flow is crops where the producer at the time of the harvest does not know if they will be sold on as food or if they will go to other destinations. These could be root vegetables or cereals where the market's fluctuating demand or fluctuating raw material prices may determine whether the producer can sell these as food, or if the harvest will go to other destinations – such as to produce feed, paper pulp, biofuel or other biochemical products.

With respect to both of the above flows, the subproject sees a need for further discussion on how these should be categorised. The subproject is well aware that the boundaries for what can be counted as lost or wasted food constitute a control mechanism that could have a major impact on future conditions in the food supply chain. We believe, for example, that allowing farmers to sell their harvest for use in the area that pays the most is an important aspect in achieving competitive and profitable food production.

Here the subproject would like to point out the fact that the intention of the proposed framework is to build a more resource-effective food supply chain, not to force control mechanisms on the food supply chain that could reduce their future competitiveness and profitability.

Destinations – Where does the lost and wasted food go?

To reach the goal of a resource-effective and sustainable food supply chain, it is not sufficient to merely take stock of

how much loss and waste of food occurs. It is equally important to map where it goes when it leaves the food supply chain. If we do not eat the food, what is it used for? And what value is created or lost when we make these choices? What are the most resource-efficient and sustainable ways of using these resources?

Answering the questions above is complicate, but research and practical experience of resource effectiveness and circular solutions has already led to several proposals for so-called "waste hierarchies" or "waste pyramids" (see Figure 9). These hierarchies rank various areas of use, or "destinations" for lost and wasted food that leaves the food supply chain. The ranking is based, among other things, on what level of resource effectiveness or value-creation a certain destination contributes to. The higher up the inverted waste pyramid, the better (see Figure 9).

In the proposed Swedish framework the subproject has identified nine different "destinations" where the food that is lost or wasted in the food supply chain may go:

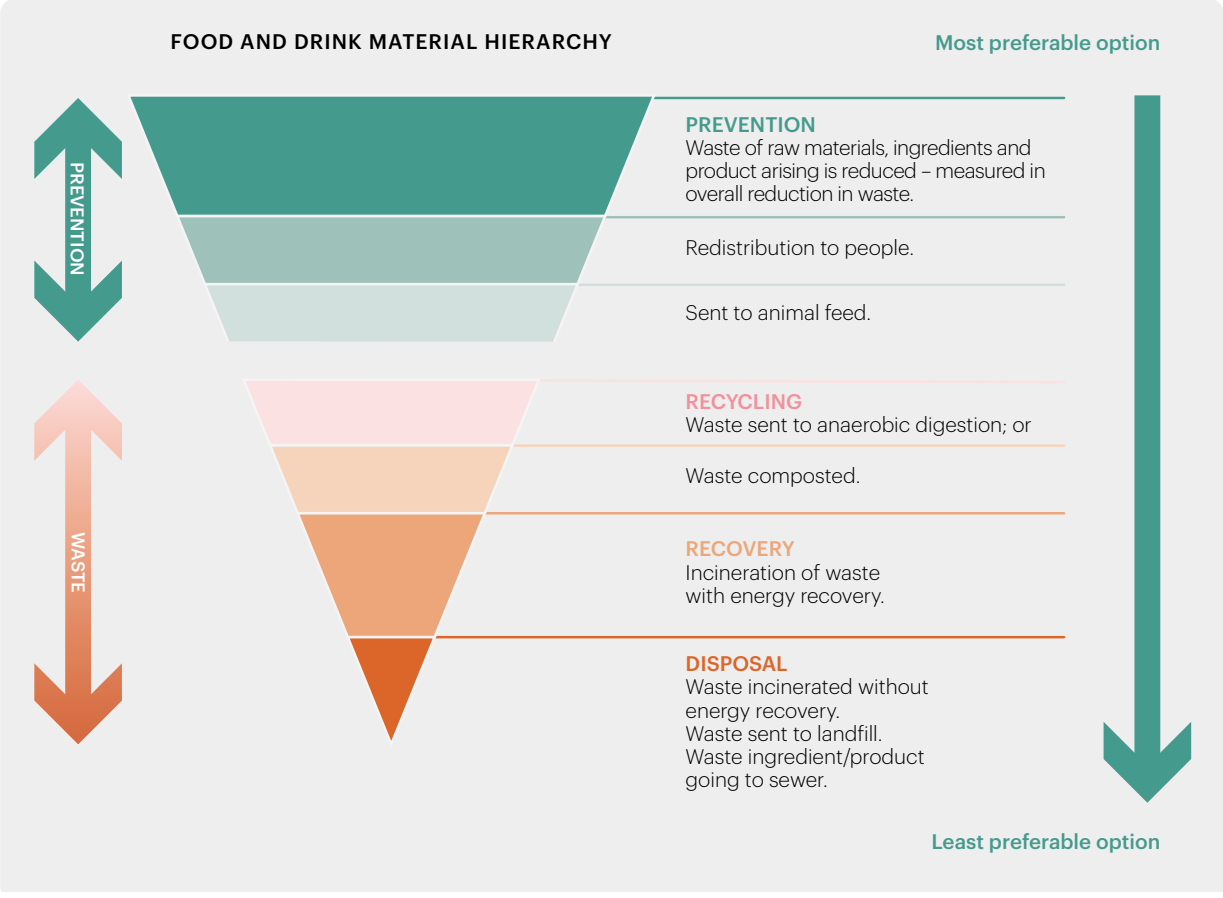


Figure 9: The British organisation WRAP's (Waste and Resources Action Programme) diagram of the food supply chain waste hierarchy. The upside down pyramid shows how resource-effective and value-creating different ways of handling wasted food are. Green is "best" and red is "worst". Source: WRAP website 2019.

POSSIBLE DESTINATIONS

Animal feed | Bio-material/processing | Codigestion/anaerobic digestion

Composting/aerobic digestion | Controlled combustion | Land application

Landfill | Not harvested/plowed-in | Refuse/discards/litter | Sewer/wastewater treatment

1. **Feed** – This refers to feed produced from lost and wasted food , in other words biological material that was originally intended to be food. Feed produced from crops or animal products that were never intended to be food is not included here (see arrow 2 in Figure 7).

2. **Biobased material/biochemical processes** – This refers to lost and wasted food that is taken out of the food supply chain to be used as a resource to produce bio-based material or biochemical products. Examples are: leather, feathers, soap, cosmetics and biodiesel.

3. **Anaerobic digestion/fermentation** – This includes the production of biofertiliser and biofuels (such as biogas and bioethanol) produced from lost and wasted food under anaerobic (oxygen-free) conditions. Anaerobic digestion/fermenting can also give rise to protein-rich products that can be used to produce animal feed.

4. **Composting** – Biodegradation of lost and wasted food under anaerobic (oxygen-free) conditions. The end product is biomaterial that can be used for soil improvement.

5. **Incineration** – Lost and wasted food that goes to controlled incineration plants where it is turned into energy.

6. **Dumping** – Food that is harvested, caught or slaughtered, but that is dumped because it is not considered to be the right type or right quality, or to have sufficient commercial value. This could be crops or animal products that are dumped or burned outside of controlled facilities for this purpose. This category also includes harvested crops that are eaten by pests. This waste destination could also include discarded fish dumped back into the sea after being caught. Professional fishermen have, however, been banned from this practice outside the EU since 2019.

7. **Soil improvement/not harvested** – Organic materials already harvested (potential food) that is spread, sprayed or ploughed into the ground with the intention of improving the soil quality on land intended for food production.

8. **Sewer** – Lost and wasted food (in solid or liquid form) that goes down the drain. This includes lost and wasted food that goes to waste water treatment plants.

9. **Other** – This incudes lost and wasted food that goes to destinations not listed above.

IN WHICH PRODUCT GROUPS IS FOOD LOST

The grocery retail chain Axfood registers the food that passes through the system based on 16 different product groups.

1. Bread
2. Ready meals/fast food
3. Fruit & vegetables
4. Dairy
5. Cheese
6. Cooked meats
7. Meat
8. Fish
9. Groceries
10. Baby food
11. Beverages
12. Frozen food
13. Snack food
14. Confectionary
15. Refrigerated vegetarian
16. Beer/wine/spirits

The nine destinations in the proposed Swedish framework were defined based on the destinations that have been identified within the framework of the FLW Standard.[47]

In the proposed Swedish framework the subproject has either deleted or clarified some of the destinations, as these are either against the law in Sweden, or in conflict with the definitions of the food supply chain that are used in the framework:

- The landfill destination has been removed as depositing organic waste is not permitted under Swedish law (with some exceptions).
- The animal feed destination has been clarified. Feed in the Swedish framework only refers to feed produced from lost and wasted food, in other words biological material that was originally intended to be food. Feed produced from crops or animal products that were never intended to be food are not included here (see arrow 2 in Figure 7).

Source – Where does the loss and waste of food occur?

In order to reduce the amount of loss and waste of food that occurs it may also be useful to identify where it comes from. In which part of the food supply chain, in which product categories, or in which processes within specific parts of the chain has it occurred. This type of measurement is already being done in several parts of the food supply chain, for example within grocery retail.

The framework's definitions – comparison with EU, FAO and FLW

One important consideration in order for the proposed framework to be able to be used in practice is that it must be based on definitions that are not in any significant way in conflict with the laws and regulations in place – at either the national or EU level. It is also important to determine how the key terms in the proposed framework accord with those used within the framework of the UN's 12.3 target, which is part of Agenda 2030 and the 17 Global Sustainable Development Goals (SDGs) which Sweden has signed onto.

Food waste and food loss according to the EU

One fundamental requirement in order for the subproject's proposed food loss and other food waste measurement

47 World Resources Institute et al., 2016, *Version 1.0 – Food Loss and Waste Accounting and Reporting Standard* (https://www.wbcsd.org/contentwbc/download/3968/53079; accessed 20 December 2019).

framework to be practicable is that it accords with the way in which the EU considers what can be counted as "waste". The EU's revised Waste Framework Directive[48] states that waste is:

> *"any substance or object which the holder discards or intends to or is required to discard".*

However, Article 6 the Waste Framework Directive describes circumstances where "waste" ceases to be waste. This applies if the material is used for "specific purposes" or when "a market or demand exists for such a substance or object".[49]

This means that a large portion of the food and inedible parts that leave the food supply chain without being consumed by humans cannot be classified as food waste according to the EU. Based on the subproject's interpretation, this would include material that goes to the production of feed, biofuel or biochemical products.

It is also worth noting that the EU has decided to refrain entirely from defining the term "lost food" (as defined in this report), stating that the term is linked to subjective or cultural values that make it difficult to define.

Food waste and food loss according to FLW Standard

Within the FLW standard the term "food loss and food waste" is used to summarise the food and inedible parts that leave the food supply chain without being consumed by humans.[50] The FLW Standard has decided to leave the matter of what exactly the term encompasses open to the respective users to determine.

What is clear, however, is that the definitions of the terms "food" and "inedible parts" used by the FLW Standard are identical to the definitions used within the proposed framework presented in this report.

Food waste and food loss according to the FAO and Agenda 2030

Comparing the "food loss and food waste" with the terms used by FAO – The Food and Agriculture Organization of the UN and Agenda 2030 in work towards reaching the 12.3 target is not all that simple either.

In the 12.3 target the term "food loss and waste" is used, but the difference being that here the term is divided into two parts that are linked to two different parts of the food supply chain (see Figure 10).

- The term **"food loss"** within the 12.3 target means food and inedible parts that leave the food supply chain without being consumed by humans. But this only applies to the first half of the chain – in other words, from harvest, slaughter and catch, up to and including processing, production and wholesale.

- The term **"food waste"** refers to the food and inedible parts that leave the food supply chain without being consumed by humans in the second half of the chain – in other words, grocery retail, restaurant, industrial kitchen and supermarket, to the consumer (see Figure 10).

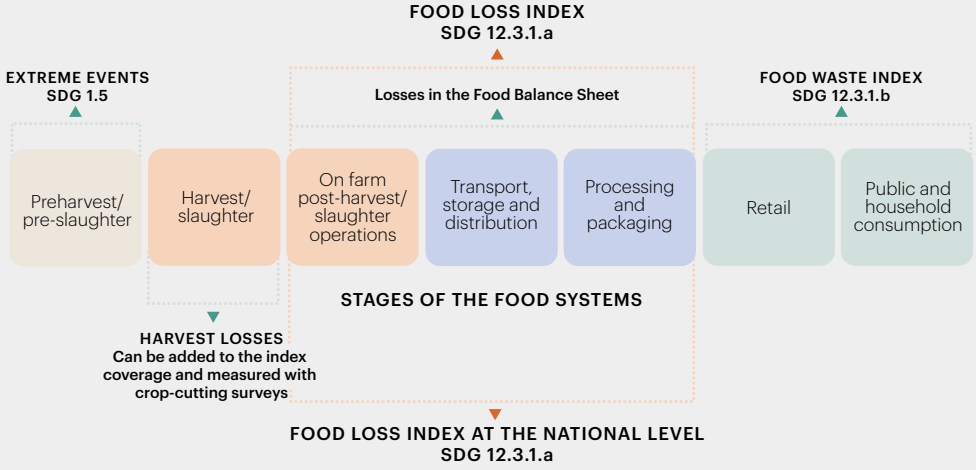
Unlike the EU and the proposed Swedish framework, FAO has chosen to measure the two subcategories based on

48 EU, 2018, *Europaparlamentets och Rådets Direktiv (EU) 2018/851 av den 30 maj 2018 – om ändring av direktiv 2008/98/EG om avfall* (https://eur-lex.europa.eu/legal-content/SV/TXT/?uri=CELEX:32018L0851; accessed 20 December 2019).

49 EU, 2018, *Europaparlamentets och Rådets Direktiv (EU) 2018/851 av den 30 maj 2018 – om ändring av direktiv 2008/98/EG om avfall* (https://eur-lex.europa.eu/legal-content/SV/TXT/?uri=CELEX:32018L0851; accessed 20 December 2019).

50 World Resources Institute et al., 2016, *Version 1.0 – Food Loss and Waste Accounting and Reporting Standard* (https://www.wbcsd.org/contentwbc/download/3968/53079; accessed 20 December 2019).

Figure 10: Diagram of the parts of the food supply chain that are included in the **FLI** (Food Loss Index) and **FWI** (Food Waste Index). Source: FAO 2019.



[i] Losses occur during harvesting, for example in the case of cereals damaged during cutting or in the process of sorting or grading.

[ii] Loss factors have been compiled in a database made openly available at www.fao.org/food-loss-and-waste/flw-data

SOURCE: FAO, 2018

two difference indexes, where two completely different bodies within the UN will each have responsibility for one (see Figure 10):[51]

1. **Food Loss Index (FLI)** will be managed by the FAO.
2. **Food Waste Index (FWI)** will be managed by the UNEP, the UN Environment Programme.

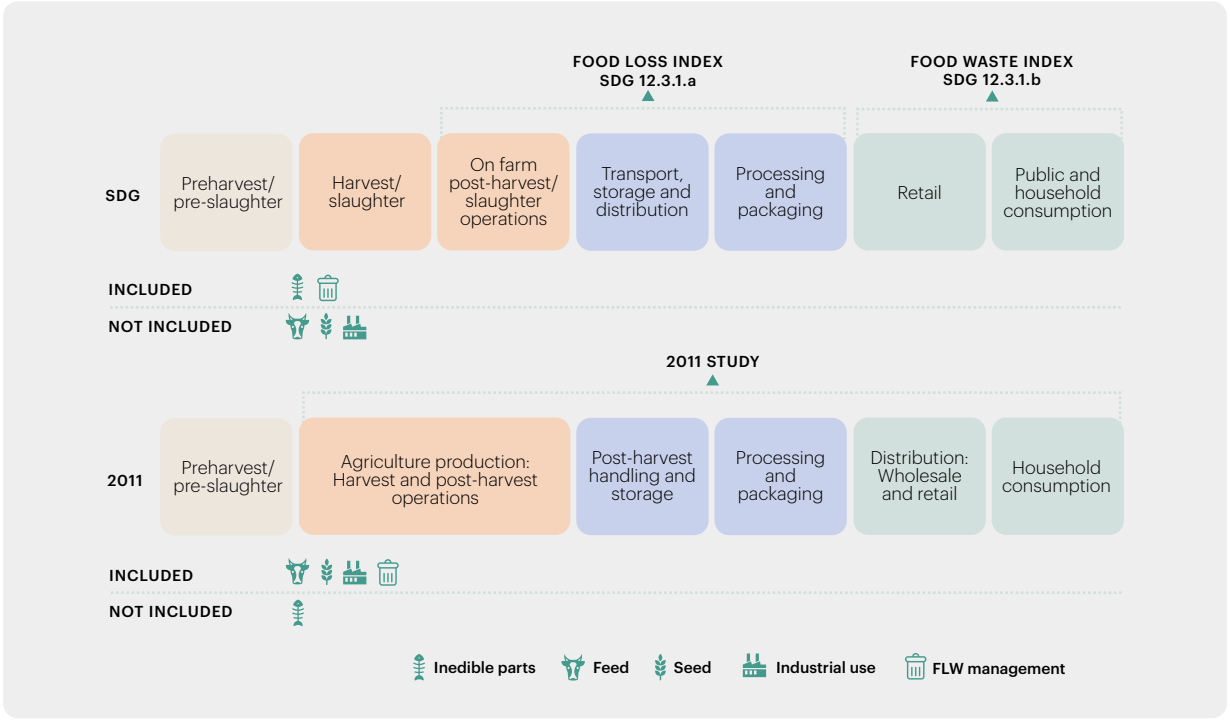
By the time this report is published the work of turning the FLI from theory into practice, i.e. measurement of "food loss", will have progressed much farther than the work of measuring "food waste" based on the FWI.[52]

An additional complicating factor is that FAO is in the process of preparing new rules for how "food loss" and "food waste" are to be measured and what will be included in the respective terms:

51 FAO, 2019, *The state of food and agriculture – moving forward on food loss & waste reduction.*

52 FAO, 2019, *The state of food and agriculture – moving forward on food loss & waste reduction.*

Figure 11: Comparison between what was measured in the UN's estimate of food loss and food waste in 2011, and what is intended to be measured within the framework of the 12.3 target. Source: FAO 2019.



- With respect to the FAO measurements, in late autumn 2019 a document was published to announce that the organization had changed its definitions of what is included in the terms "food loss" and "food waste". In FAO's earlier substantial "Food Loss and Food Waste" measurement presented in 2011, only food was included; in other words, only edible food that left the food supply chain without being consumed. According to the rules that the FAO now says should be followed in efforts to reach the 12.3 target, the inedible parts of food that leave the chain without being consumed should also be included (see Figure 11).

The framework – measurements, boundaries and responsibility

Measurements

In a sustainable food supply chain the primary goal should be to save resources in production and consumption of food to the greatest extent possible. This applies both to the products produced in the food supply chain, and the resources in the form of, for example, land and water required to produce the food.

This can be discussed in terms of how the value of the resources leaving the food supply chain without being con-

ALTERNATIVE INDICATORS

Within the framework of the FLW standard an online tool has been produced to recalculate tonnes of food loss and food waste into lost calories or environmental and climate impact.

Source: Food loss and waste protocol, 2019.

sumed by humans should be measured. In work on meeting the UN 12.3 target the measurement chosen is weight (tonnes).[53] But instead of presenting the number of tonnes that leave the food supply chain, a decision was made to present this in the form of an index showing tonnes as a percentage of total food production. In other words: the percentage of the tonnes of food produced overall that has left the food supply chain without being consumed by humans.

According to this type of calculation it is possible, on the one hand, to avoid an increase in total food production resulting in successful measures to reduce loss of food not showing up in the statistics. On the other hand, this method could make it seem as if the volume of lost food has decreased, despite the fact that, overall, more tonnes of food have left the food supply chain without being consumed by humans.

FAO has also experimented with the possibility of adding economic parameters, where different categories of food are assigned different economic weight, depending on how valuable they are considered to be. An attempt has also been made to measure loss and waste of food based on how many lost calories it represents, or how much land would be needed to produce the uneaten food.[54]

In the proposed Swedish framework the basic requirement for all measurement of lost and wasted food is that it is expressed in terms of weight (kilo or tonne). In the opinion of the subproject, this is the simplest measurement to find functioning measurement methods for.

The subproject does, however, want to urge the agency given responsibility for compiling the data from the food supply chain to explore the possibility of producing standards for recalculating into tonnes the volumes that are measured using other values. In order for this type of recalculation to be considered practicable, it is needs to be done in a credible way.

Timeframe for reporting measurement data

In the proposed framework the basis rule for all measurement or estimates of lost and wasted food is that it should be done in such a way that the data collected can be compiled on the basis of one calendar year. The data reported must, in other words, show how much lost and wasted food has occurred from 1 January to 31 December in one and the same year. This is in line with the requirements for measurement and reporting of food waste (EU definition) established by the EU.[55]

In the parts of activities within the food supply chain where it is not possible to measure and aggregate lost and wasted food on an annual basis, there must be an option to make additions or exceptions. A few examples:

- How often measurement must take place in order to obtain the data on an annual basis should be adapted to the conditions in each part of the food supply chain. There are several factors to consider

53 FAO, 2019, *The state of food and agriculture – moving forward on food loss & waste reduction.*

54 FAO, 2019, *The state of food and agriculture – moving forward on food loss & waste reduction.*

55 Article 2 of Commission Delegated Decision (EU) – 3 May 2019 – supplementing Directive 2008/98/EC of the European Parliament and of the Council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste. Final version. (Preliminary document).

here. It may, for example, depend on whether the measurement is to be made by the individual company in the food supply chain or if this will be done by an external actor. It could also be a question of how long lost and wasted food can be stored, how often it can or must be collected, and who is responsible for doing this.

- For the organisations within the food supply chain that are not able to measure or report on an annual basis, it should be possible to adapt data collection to the conditions that apply in the specific part of the chain. This could, for example, be where crops are cultivated, or animals or fish raised that cannot be harvested, picked, caught or slaughtered every year.

- In cases where it is not possible to produce aggregated data for each year, an alternative timeframe should be established for each such category of actor that works in their specific case. The solution chosen should be designed so that collected data can be recalculated to fit into the annual statistics from other parts of the food supply chain.

- For each actor category that cannot deliver data on an annual basis, there should also be a standard for recalculating or adapting this deviating data so that it is compatible with the annual statistics and can be included in them. Exactly how this recalculation will work should be determined by the actor category in question in cooperation with the actor/agency that is given responsibility for collecting and compiling the annual statistics.

Geographical borders and measurement responsibility

The proposed Swedish framework is based on the approach that measurement and reporting is only to apply to the lost and wasted food arising within the nation's geographical borders. Allowing for exceptions and additions, the subproject suggests setting boundaries according to the following principles:

- Companies that import food, or raw materials and additives for food production in Sweden, do not need to report the loss and waste of food occurring in the value chain before the products reach Sweden.

- When exporting food, raw materials or additives to food produced in Sweden, the exporting company does not need to report the loss and waste of food occurring after the products have left Sweden.

In terms of the loss and waste of food occurring when products are transported within Sweden's borders, the basic rule in the proposed framework is that responsibility for measuring this is to rest with the party that owns the products, or the materials, being transported.

Observations and analysis

Observations about measuring wasted food

When it comes to measuring wasted food the EU's approach is clear: According to the revised Waste Framework Directive all of the EU member states are responsible for measuring how much food waste (EU definition) occurs in total in the food supply chain. According to the new minimum requirements, every member state is to produce national statistics annually of the total volume of food waste throughout the food supply chain. There is also a requirement for each country, at least every four years, to measure and report how much food waste (EU definition) occurs in the respective part of the food supply chain.[56]

56 EU, 2018, *Europaparlamentets och Rådets Direktiv (EU) 2018/851 av den 30 maj 2018 – om ändring av direktiv 2008/98/EG om avfall* (https://eur-lex.europa.eu/legal-content/SV/TXT/?uri=CELEX:32018L0851; accessed 20 December 2019).

NUMBER OF SMALL BUSINESSES IN THE FOOD SUPPLY CHAIN

According to the Swedish Food Federation there are around 4,600 industrial enterprises in the Swedish food supply chain. Of these, around 1,300 are sole proprietorships. 85 percent have fewer than 10 employees and in 2017, 78 percent of industrial enterprises had fewer than 20 employees.

Source: Swedish Agency for Economic and Regional Growth, 2018.

Here it is, however, important to remember that what is considered food waste according the EU criteria only applies to the material that falls under the definition of "waste" in the new Waste Framework Directive. According to the EU a significant portion of the food and the inedible parts that leave the food supply chain without being eaten can neither be classified as wasted food nor as lost food, as defined in the framework proposed in this report.[57]

Measuring the volume of wasted food is an important tool in order to map the level of resource effectiveness in the Swedish food supply chain. It is also an important tool in order to determine where in the food supply chain action is needed to improve effectiveness. This may in turn help to boost profitability and the international competitiveness of Swedish food.[58]

Measuring how much food goes to waste is, however, associated with varying degrees of challenges, which in turn depend on the different conditions in the various parts of the food supply chain:

- The subproject considers the conditions for measuring the volume of wasted food to be good in some parts of the chain, for example for stores in a grocery retail chain, major food industries or industrial kitchens and large restaurants.
- In other parts the subproject believes that measuring the volume of wasted food is associated with significant challenges. This could be the case in small food companies that do not have resources, personnel or capacity to implement such measurements. Examples are small industries, kiosks or small farms, small grocery shops, small supermarkets or restaurants. The same is true for individual households.
- In cases where individual actors in the food supply chain do not have the capacity to measure the amount of food they are wasting, this could be handed over to an external party, such as a waste company that collects the waste. A proposal of how this could work in certain parts of the chain is presented in the chapter "Practical solutions for measuring and reporting lost and wasted food".

Another basic requirement in order to measure the volume of wasted food in different parts of the food supply chain is defining who bears measurement responsibility.

Examples:

- When measuring waste occurring when food is imported or exported. This is food wasted after the products arrive in Sweden (import) or before they leave Sweden (export).
- When measuring food being transported between different actor groups within Sweden.

57 EU, 2018, *Europaparlamentets och Rådets Direktiv (EU) 2018/851 av den 30 maj 2018 – om ändring av direktiv 2008/98/EG om avfall* (https://eur-lex.europa.eu/legal-content/SV/TXT/?uri=CELEX:32018L0851; accessed 20 December 2019).

58 Champions 12.3, 2018, *The business case for reducing food loss and waste* (https://champions123.org/wp-content/uploads/2017/03/report_-business-case-for-reducing-food-loss-and-waste.pdf; accessed 20 December 2019).

- When measuring food that is returned to the producer.

A clear division of responsibility is also necessary to guarantee that the wasted food arising is not measured twice in the statistics.

Observations about measuring lost food

There are no requirements today for measuring lost food – neither at the national level nor within the EU. In EU legislation the decision was made to not even produce a definition of the term "lost food" as defined in the proposed framework. The EU has made the assessment that this term is much too difficult to define as it is based on subjective and cultural values.

Measuring lost food, is also a significantly more complicated and resource-intensive process than measuring the total amount of wasted food. Measuring lost food requires making an estimate or separating the edible parts of the food from the inedible parts and measuring it separately, which requires more work by the companies performing the measurements. This is especially true for smaller companies in the food supply chain which often do not have the possibility, resources or sufficient knowledge to be able to separate edible parts from inedible parts.

The subproject still makes the assessment that measurement of lost food in the Swedish food supply chain is an important piece of the puzzle to drive Sweden's efforts for more resource-effective and sustainable production and consumption of food. The subproject also considers it necessary for Sweden to be able to drive and monitor work on the national action plan to reduce the volume of lost food (matsvinn).[59]

The challenges and therefore the need for solutions to measure lost food vary, however, significantly between different parts of the food supply chain:

- In certain parts of the food supply chain the subproject believes that there is relatively good potential for measuring lost food today. Grocery retail is one example. Some actors are already using warehouse management systems that have the potential to record how many kilos of the food that comes into the warehouse and store are not sold. The subproject has therefore concluded that grocery retailers should consider whether a simpler approach can be accepted, where all food that is not sold or returned can be considered to be lost food. This solution is based on a simplified idea of each kilo of food coming into the store being classified as edible food or beverages.[60] There are, however, some challenges that need to be addressed in order for the lost food statistics produced in this way to be considered credible. How, for example, will it be possible to exclude the weight of the packaging that is still around the food that is sold/or not sold? Another question is how to handle the inedible parts of the waste that actually occurs in grocery retail. This could, for example, be inedible parts that are separated from food in the warehouse and at the service counter where unpackaged fish, meat, cheese etc. are handled in the same way as within the food production industry.

- Throughout the food supply chain there is also a need to find rules and solutions to manage and measure the lost food consisting of liquid products that go down the drain.

59 Swedish National Food Agency, 2018, *Fler gör mer. Handlingsplan för minskat matsvinn 2030*, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-merhandlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 20 December 2019).

60 Food loss and waste protocol, 2019, *FLW Value Calculator* (http://www.flwprotocol.org/why-measure/food-loss-and-waste-value-calculator/; accessed 20 December 2019).

- In other parts of the food supply chain measuring lost food requires other methods or technical solutions, which we will explore in more detail in the chapter "Solutions to measure and report lost food and unavoidable food waste in practice". The Subproject's analysis shows that there are already solutions today that should work from a purely technical perspective. Some have already been shown to work in practice, although they are associated with challenges that need to be tackled in order for these methods to be fully practicable on a large scale.

Observations about reporting and recipients of measurement data

In order to obtain an accurate picture of how much loss and waste of food occurs in the Swedish food supply chain, it is not sufficient to merely create solutions for how to measure in all parts of the chain from a purely practical point of view. Nor is it sufficient to have a framework that ensures that all actors measure in the same way, based on the same definitions. The companies that measure must also be prepared to share their data, and practical solutions must be available for doing that. There also needs to be one or more actors with responsibility for collecting all of this data and compiling it at that the national level.

Here again, the subproject believes that the ability to achieve the above value depends on whether the data is for the total volume of wasted food or just the part that could be considered lost food (edible for humans) that is to be reported.

In terms of reporting the total volume of wasted food, the subproject has already noted that there is an EU requirement where Sweden must be able to deliver compiled statistics of the amount of food waste (EU definition) that occurs in the Swedish food supply chain every year. There is also a requirement that Sweden, at least every four years, must be able to deliver data on how much food waste (EU definition) occurs in the respective parts of the food supply chain.[61] If Sweden chooses to comply, this would in turn reasonably require that data from measurement of all parts of the food supply chain be delivered in some way to a central actor that could compile this data. Today data on food waste (EU definition) is collected on a less detailed scale, with the Swedish Environmental Protection Agency as the recipient.

In the chapter "Practical solutions for measuring and reporting lost and wasted food", the subproject's analysis shows that, from a purely technical perspective, there are methods that could make it possible to both collect and report the total volume of wasted food throughout the food supply chain. In many cases in should in theory be possible to do this down to the individual company level, and even down to individual households, i.e. single-family homes. The same analysis also indicates that these technical solutions are associated with challenges that must be dealt with if they are going to be implemented and used in practice.

When it comes to reporting the lost food data in question things are, as already noted, more complicated. Since the EU has chosen not to define what counts as lost food, it does not require Sweden to deliver any such data. But the subproject believes that there is value in actors in the Swedish food supply chain documenting the flow of lost food in order to achieve resource effectiveness. Measuring and reporting lost food is also an important factor in the ability of government agencies to drive and monitor efforts to implement the national action plan for reduced lost food (matsvinn).

Just as in the case of the total amount of wasted food, the subproject's analysis shows that, from a purely technical

61 Article 2 of Commission Delegated Decision (EU) – 3 May 2019 – supplementing Directive 2008/98/EC of the European Parliament and of the Council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste. Final version. (Preliminary document).

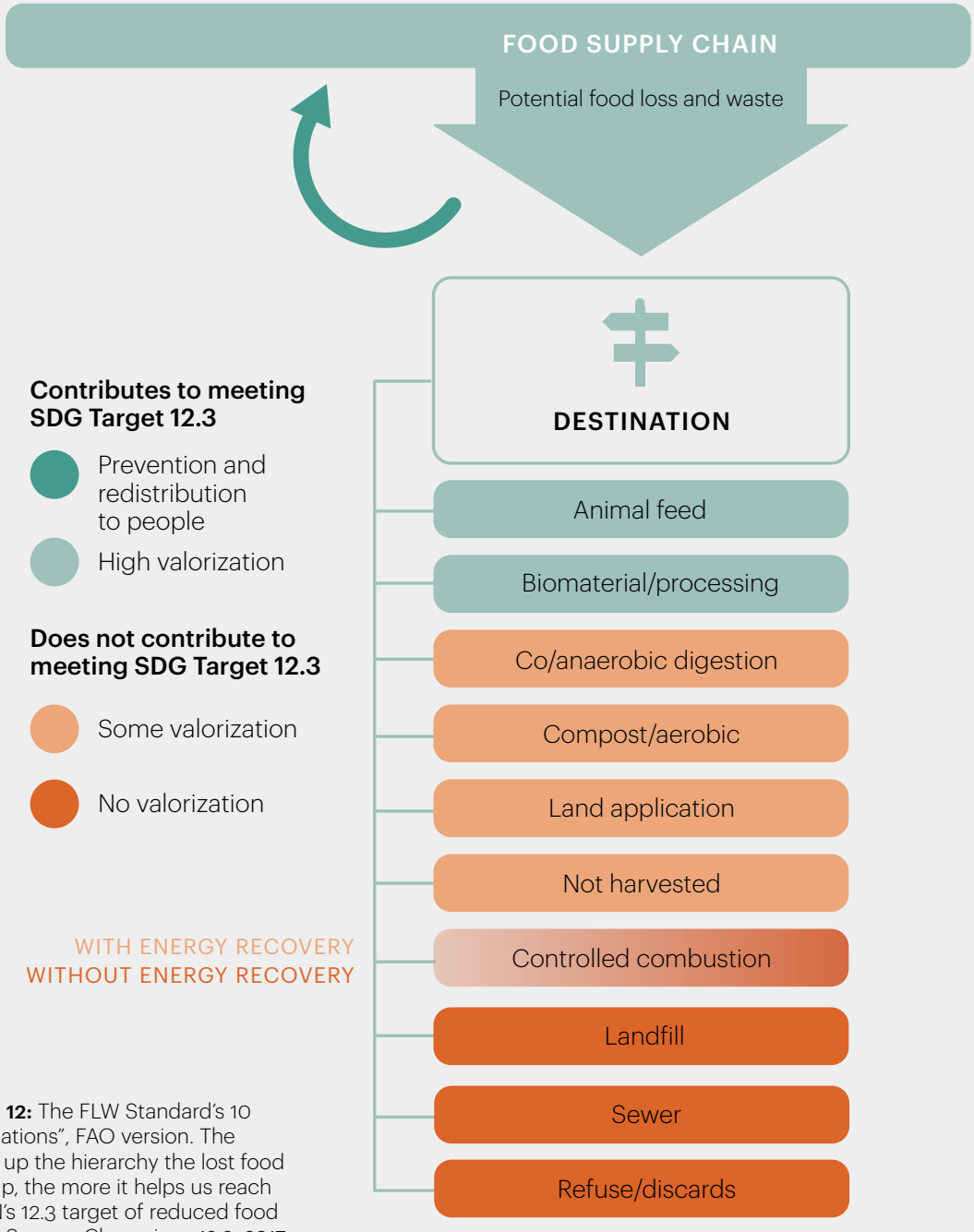


Figure 12: The FLW Standard's 10 "destinations", FAO version. The higher up the hierarchy the lost food ends up, the more it helps us reach the UN's 12.3 target of reduced food losses. Source: Champions 12.3, 2017.

perspective, there are methods that could make it possible to collect and report data on how much lost food occurs in all parts of the food supply chain. There are, however, numerous challenges that need to be dealt with in order to use these methods in practice. Read more in the Chapter "Practical solutions for measuring and reporting lost and wasted food".

The subproject would again like to refer to the experiences gained within the framework of WRAP's Courtauld Commitment. Here it was possible to demonstrate, through platforms for voluntary agreements, that it is not only possible to get hundreds of food companies to start measuring their food loss, but by spreading knowledge about the benefits of sharing data, they were also able to get the companies to do this in the absence of any legal obligation or "punishing" control mechanisms. These conclusions are based on the subproject's personal communication with individuals at the top of the WRAP organisation.

When it comes to responsibility for collecting and compiling data from the food supply chain, the subproject has made the assessment that this responsibility should go to one or several parties that meet certain basic requirements:

- An actor that has the expertise and experience in collecting large amounts of data, analysing it and compiling it into statistics that are accurate and useable.
- An actor that has the trust of the food industry and the Government to handle the data volumes that will be collected.

Observations about the UN definitions of food waste and food loss

The subproject can conclude that all the way up to the government agency level there is uncertainty about how the Swedish term "matsvinn" (translated as "lost food" in this report) should be interpreted in relation to the two English terms "food waste" and "food loss", which are used in the UN 12.3 target to "halve per capita global food waste at the retail and consumer levels and reduce food loss along production and supply chains, including post-harvest losses".[62] It is clear that the term "matsvinn" used by Swedish government agencies does not corresponds to the terms "food loss" or "food waste" – neither individually nor combined. The term "matsvinn" (translated "lost food" in this report),[63] for example, only refers to that which is edible, while both of the terms "food loss" and "food waste" used by the FAO include inedible parts (see Figure 11).

The subproject sees a significant need for the Government, in cooperation with experts in agencies and academia, to quickly decide on Sweden's position with respect to the confusion of terms. It should be a reasonable requirement for Sweden to coordinate its national initiatives to reduce the volume of matsvinn (lost food) with the efforts being made within the framework of Agenda 2030 and the 12.3 target.

Observations on the FLW Standard's destinations and the 12.3 target

In the section "Destinations – Where does the lost and wasted food go?" we describe the 10 destinations for lost and wasted food that the FLW Standard has identified. These

62 Swedish National Food Agency, 2018, *Fler gör mer. Handlingsplan för minskat matsvinn 2030*, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-merhandlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 20 December 2019).

63 FAO, 2019, *The state of food and agriculture – moving forward on food loss & waste reduction*.

10 destinations are also used by the FAO to evaluate how much a certain destination (for the lost and wasted food that has occurred) can contribute to reaching the UN 12.3 target.[64]

According to the FAO hierarchy (see Figure 12) the two top layers (the light green destinations in the illustration) make valuable contributions towards reaching target 12.3 by 2030. However, the subproject finds this evaluation problematic. The subproject believes that a goal of 0 percent food loss (FAO definition) is impossible to achieve, and would perhaps not even lead to a more resource-effective food supply chain – if all aspects of the term resource effectiveness are taken into account. Here the subproject would like to argue that the only measure that can really be expected to help meet UN 12.3 target is preventing loss of food, or redistributing rejected/surplus food so that it is consumed (the dark green arrow in Figure 12).

Recommendations

Recommendations for measuring wasted food

The subproject has determined that it is not possible to produce a full picture of how much wasted food (based on the proposed framework's definition) that occurs in the Swedish food supply chain without measuring the flows that are not currently included in the EU's waste legislation. These flows are also excluded from what the EU requires of member states in terms of delivering food waste measurement data.

In the proposed framework we therefore suggest the following:

1: The basic approach to measuring wasted food, as defined in the proposed framework, should be that what is measured and reported is the material that can be classified as "food waste" according to the EU's definition.

- Here the subproject does, however, want to urge the Government and relevant agencies to take steps to ensure that the actors in the food supply chain also start to measure the resource flows that are not currently included in the EU's definition of what can be classified as food waste. According to the subproject's interpretation this refers to potentially edible food that leaves the food supply chain to go to the production of animal feed, biofuel and biochemical products. These flows are not visible today in the statistics and there is therefore a risk that they will fall outside of Sweden's and the EU's efforts towards the 12.3 target.

- If these additional flows are measured it is, however, important to ensure that the data collected does not become unusable for the Swedish Environmental Protection Agency, which bases its work on the EU definition of what is classified as food waste. According to the subproject this could be resolved if all actors who measure their wasted food indicate the amount of food and inedible parts that go to either one of the nine destinations described in the proposed framework (see section "Destinations – Where does the lost and wasted food go?"). This solution would make it possible to separate the fractions that the Swedish Environmental Protection Agency has to report to the EU, at the same time as it would be possible to produce a "broader" picture of the flows that leave the food supply chain without being consumed by humans.

64 Champions 12.3, 2017, *Guidance on Interpreting Sustainable Development Goal Target 12.3*. (https://champions123.org/wp-content/uploads/2017/10/champions-12-3-guidance-on-interpreting-sdg-target-12-3.pdf; accessed 20 December 2019).

2: In the subproject's framework proposal we have made the assessment that measurement and reporting of wasted food should preferably be done on a voluntary basis. We base this argument on the documented experiences that show that legislation and compulsion are not always the best way to achieve a fast transition to a more sustainable and resource-effective society. A better approach may be to build on the voluntary aspect, in combination with spreading knowledge about what the companies that take action to achieve this kind of transformation can gain from it. Experiences gained by the British organisation WRAP are an example of this. There, within the framework of the Courtauld Commitment, platforms have been built for voluntary agreements. Through these, hundreds of food companies have started measuring their lost and wasted food and have set targets to reduce them.[65]

The subproject would like to clarify that the voluntary aspect of the proposed Swedish framework only applies to the issue of whether or not a company is willing to measure the amount of food it wastes. The way in which wasted food is measured or what will be measured is not something that should be determined on a voluntary basis. This must be done according to the common rules and definitions presented in the proposed Swedish framework.

The subproject would also like to underscore that the proposed framework presented in this document should be regarded as a first version that will likely need to be refined and supplemented. To achieve a framework that works in practice it will, for example, be necessary for some definitions, boundaries and measurement methods to be adapted to the conditions in different parts of the food supply chain. These adaptations should not, however, be made by individual actors. This must be done based on decisions arrived at jointly at the industry level or within a certain part of the chain. It should also be done with input from external experts from academia or an appropriate government agency.

3: To get companies in the Swedish food supply chain to be willing to measure the amount of food they waste and set targets to reduce it on a voluntary basis, the subproject would like to see the following measures and initiatives:

- The food industry, in cooperation with the Government, academia and relevant agencies and organisations, should help to establish a Swedish platform to produce a voluntary agreement, similar to the way WRAP did this. Work on this is already under way and is described in the chapter "A national platform for a voluntary agreement".

- Food companies that have relatively good resources should go first and show what can be gained by starting to measure and reduce the amount of food wasted.

- Politicians should prepare control mechanisms that facilitate, motivate and reward food companies that measure and report the amount of food wasted.

- The subproject would also like to see politicians taking the initiative for new forms of financial support to stimulate development of new technology that makes it easier for smaller resource-intensive companies to measure the amount of food wasted and take part in the reporting process.

4: The subproject recommends that legislation requiring measurement and reporting should only be used if it becomes apparent that a voluntary agreement solution is not resulting in sufficient numbers of companies in the food supply chain starting to measure the amount of food wasted.

5: Finally, the subproject would like to urge the food industry to produce a common set of rules for who "owns" the process, i.e. who has responsibility for measuring wasted food.

65 WRAP website, 2019, *What is Courtauld Commitment?* (http://www.wrap.org.uk/content/what-is-courtauld; accessed 20 December 2019).

To address this, the subproject would like to encourage industry organisations within the respective parts of the food supply chain to produce a set of practices or rules. This work should be carried out in cooperation with representatives from a selection of companies in the part of the food supply chain in question.

Recommendations for measuring lost food

Since the EU has not produced its own definition of the term lost food, as defined in the proposed framework, it does not require the member states to measure and deliver such data. The subproject still believes that measuring lost food in the Swedish food supply chain is an important piece of the puzzle to drive efforts for more resource-effective and sustainable production and consumption of food. This applies to both individual companies and at the national level. The subproject also considers measuring lost food necessary in order for Sweden to be able to drive and monitor work on the national action plan to reduce lost food (matsvinn).[66]

Based on the above, the subproject is proposing the following:

1: Measurement of lost food should be based on the definition presented in the proposed framework. In other words: Lost food is all food that is not consumed by humans but instead leaves the food supply chain to go to one of the nine destinations presented in the chapter "Destinations – Where does the lost and wasted food go?".

2: The subproject urges the Government, if this has not already taken place, to assign three agencies: the Swedish Environmental Protection Agency, the Swedish Board of Agriculture and the Swedish National Food Agency, the task of working with experts in academia and the food supply chain to determine as quickly as possible how the Swedish term "matsvinn"(defined as "lost food" in the proposed frame work) accords with the two terms "food loss" and "food waste" that the FAO uses in frameworks to work towards UN target 12.3 in Agenda 2030.

3: The subproject also recommends – in the same way as in measuring wasted food – that measuring lost food should initially be done on a voluntary basis. The voluntary aspect should, however, only apply to the issue of whether or not a company is willing to measure lost food. It should not apply to how or what should be measured. This must be based on common definitions and rules, which are presented in the proposed framework.

4: Also in measuring lost food, the subproject would like to see initiatives that can increase the willingness of food companies to measure on a voluntary basis. This can be done by for example:

- Using the platform for a voluntary agreement presented in the chapter "A national platform for a voluntary agreement". Here the subproject believes that it is important to find a number of food companies from different parts of the chain who can go first and show what can be gained by entering into a voluntary agreement to start to measure and reduce the volume of their lost and wasted food.
- Politicians, in cooperation with the food industry, produce control mechanisms and "carrots" to encourage food companies to start measuring and reporting their loss of food.
- Politicians take the initiative for new forms of financial support to stimulate development of new technology and new collaboration that make measuring lost food easier for companies, or parts of the chain, in areas where there are currently major challenges.

66 Swedish National Food Agency, 2018, *Fler gör mer. Handlingsplan för minskat matsvinn 2030*, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-merhandlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 20 December 2019).

5: Legislation requiring measurement and reporting should only be used if it becomes apparent that a voluntary agreement solution is not resulting in the industry starting to measure lost food fast enough in order to reach established environmental, climate and sustainability goals.

6: Just as in the case of measuring wasted food, the subproject wants to urge experts to provide input for the proposed framework's rules and definitions. This applies, for example, to the need to make adaptations and changes to the proposed framework so it can be used in all parts of the food supply chain in practice. The subproject recommends that this process be managed by the industry organisations in the respective parts of the chain in cooperation with a representative from a selection of food companies, academic experts and under the supervision of an appropriate government agency.

Recommendations for reporting and recipients of data

1. The subproject would like the Government to appoint a key actor to be responsible at the national level for compiling all of the data reported from the various parts of the food supply chain. This applies to reporting of both lost food and wasted food, and requires a change in the current order, where work on lost food (matsvinn) and wasted food issues is divided up between two different agencies. Today the Swedish Environmental Protection Agency is responsible for food waste (EU definition) issues, while the Swedish National Food Agency is responsible for matters relating to lost food (matsvinn). The subproject considers there to be significant synergies to be gained by having one single agency identifying and documenting both categories, particularly as lost food is a subset of the total volume of wasted food. The subproject suggests that the Swedish Environmental Protection Agency, which is already responsible for and has routines for compiling data on total food waste (EU definition), also be given responsibility for compiling the national lost food data.
2. Regarding responsibility for collecting data from the food supply chain, the subproject suggests that this task to be given to one or more of the actors in the SMED (Swedish Environmental Emissions Data) consortium. SMED, which consists of representatives from IVL Swedish Environmental Research Institute, SMHI, Statistics Sweden and the Swedish University of Agricultural Sciences, is already responsible for collecting data on food waste (EU definition) for the Swedish Environmental Protection Agency. There are, however, opportunities to supplement the data collection via new channels. One such opportunity could be to allow data collection to take place within the framework of work on the platform for the voluntary agreement, which is being developed under the leadership of IVL (see the chapter "A national platform for a voluntary agreement").
3. Also when it comes to reporting data on lost and wasted food, the subproject's assessment is that this should preferably be done on a voluntary basis. Here too, the voluntary aspect should only apply to the issue of whether or not a company is willing to measure food loss. Individual companies should not be free to determine what to measure. This must be done according to the common rules and definitions presented in the proposed framework.
4. To get as many companies as possible to be willing to share their data, the subproject urges both the political sphere and the private sector to produce mechanisms to strongly incentivise companies in the food supply chain to share their data on lost and wasted food.
5. The subproject also proposes a platform for the voluntary agreement, which IVA has contributed to under the leadership of IVL Swedish Environmental Research Institute, to be used to spread information about what companies willing to share their data can gain from doing so (see the chapter "A national platform for a voluntary agreement").

Recommendations on reporting based on destinations and sources

1. In the chapters "Observations about measuring lost food" and "Recommendations on measuring lost food", the subproject has already emphasised the importance of food companies, and companies that produce or handle lost and wasted food in the food supply chain, not only measuring total loss and waste, but also how much goes to different destinations.

2. If the nine destinations that the Swedish framework has defined are not considered relevant to a certain type of organisation or part of the chain, the subproject would welcome a further discussion on how the destinations can be adapted to work better. We would like to encourage industry organisations to lead such an initiative.

3. The subproject would also like to encourage food companies or waste companies that already record which destinations the waste goes to, to share their measurement experience and solutions.

4. The subproject also wants to encourage more companies in the food supply chain to start recording the volume of lost and wasted food occurring within different product groups or activities. We would also like to encourage food companies that already do this to share their measurement solutions.

5. To make it possible to aggregate data on sources of lost and wasted food, the subproject suggests producing lists of product categories or areas of operation where waste or loss occur, and to do this as quickly as possible. This will probably require each part of the food supply chain to produce its own list relevant to its specific types of operations. It would be beneficial for this to be done by industry organisations in each part of the chain in cooperation with a representative selection of companies within that part.

Recommendations on the FAO's waste hierarchy relating to the 12.3 target

The subproject would like to urge the Ministry of Enterprise, Energy and Communications to address at the EU level the need for adopting a more exacting assessment of which stages in the FLW food waste hierarchy could contribute significantly to meeting the UN's 12.3 target (see Figure 12). The chapter "Observations on the FLW Standard's destinations and the 12.3 target" describes the FAO's assessment that loss and waste that goes to the production of feed and biochemical products can be considered to be contributing to meeting the 12.3 target of reducing food loss and food waste (FAO definitions) that occurs in the food supply chain.

The subproject believes that a goal of zero percent lost food is impossible to achieve. It is also reasonable to believe that lost and wasted food going to the production of feed, biofuel or biochemical products is helping to increase resource effectiveness and value creation more than if the same materials were sent to destinations lower down the waste hierarchy (see Figure 12 in the chapter "Observations on the FLW Standard's destinations and the 12.3 target"). The subproject would, however, like to argue that the only measure that should be considered as contributing to meeting the UN 12.3 target to reduce food loss is preventing food loss from occurring, or finding solutions for redistributing food so that it is consumed (the dark green arrow in Figure 12).

Practical solutions for measuring and reporting lost and wasted food

»Potential solutions already exist for measuring and reporting the amount of lost and wasted food in several parts of the food supply chain.«

The need for new solutions and innovation

The other goal of the three established by the subproject was to perform an analysis to answer the three questions of key significance in terms of implementing requirements for measuring and reporting lost and wasted food in all parts of the food supply chain.

1. Are there already solutions for making these measurements?

2. Are the existing solutions sufficiently easy and inexpensive so that using them for measurement will be practicable in all parts of the chain?

3. If this is the case, what needs to be done to produce solutions where the threshold for use is sufficiently low?

These questions were explored by the subproject's work group in the first stage of the project. The results of the work groups' work were discussed and evaluated at workshops with representatives from all parts of the food supply chain. One conclusion from these workshops is that the potential solutions for measuring and reporting of the total amount of wasted food will differ from the potential solutions for sorting and measuring the fraction of lost (potentially edible) food separately. The subproject has therefore chosen to handle the two different measurement situations individually.

FOOD SCALES AT IKEA

Furniture store Ikea has installed a system to weigh and register lost food at its restaurants. The initiative is an important step towards its goal of halving food loss it its stores by 2022. In spring 2019 the technology was installed at more than half of the company's 420 stores in 52 countries. Since the initiative was launched Ikea has managed to prevent 1.4 million tonnes of food loss, which is the equivalent of three million saved meals.

Source: Aktuell Hållbarhet, 2019.

Solutions for measuring and reporting wasted food

There are several technical solutions today that make it possible to measure wasted food:

Several companies today sell systems with scales and software that can be used to weigh and record the volume of food wasted within an organisation. There are smaller systems that can be placed on a desk or on the floor and that can be used, for example, by institutional kitchens, restaurants and smaller supermarkets. There are also larger systems that not only weigh and record weight data, but also compost wasted food and turn it into potentially sellable fertiliser products.

SOUTH KOREA – WORLD CHAMPION IN FOOD WASTE SORTING

In several cities in South Korea residents in apartment buildings throw their food waste into special refuse bins which they open using an ID code. The bins then weigh the food waste automatically and send a bill to the household each month. The fewer kilos of food waste they generate, the lower the bill.

Source: World Economic Forum 2019.

SCALES IN REFUSE COLLECTION VEHICLES

Most Swedish municipalities use refuse collection vehicles that can weigh each refuse bin they collect and scan them to see which customer they belong to. Today the system is used, among other things, to produce data to determine how much each customer should pay for the refuse collection service. This is used for houses, housing association homes or building owners. With this technology the wasted food cam be weighed and registered down to the individual customer level.

Source: Avfall Sverige 2014.

PILOT PROJECT IN SWEDISH MUNICIPALITIES

In 2018 the Swedish Environmental Protection Agency, IVL Swedish Environmental Research Institute and Statistics Sweden (SCB) carried out a pilot project to see if the existing technology in municipal refuse collection vehicles could be used to gather data on how much food is wasted by consumers whose refuse is collected by the municipality. In cooperation with technology company EDP, their solution was tested on a large scale in three municipalities in the west of Sweden. All of the data that has been collected by the municipal vehicles has been processed using special software that can classify the information and send it on to SCB.

Source: Personal communication, 2019. Lars Vilkund – Environmental economics and environment, division for regions and environment at Statistics Sweden.

On the market there are also several different systems with scales and software that can be installed in automatic refuse bins or refuse collection vehicles that collect waste containers. There is ID technology in refuse collection vehicles and bins making it possible to weigh and register how much waste each customer throws away. The refuse containers have an ID code that each user needs to enter to open the container. The solution in refuse collection vehicles is based on a unique IT tag on each customer's container.

On a less specific basis there is also technology that can register the total weight of waste in each refuse collection vehicle. This technology is installed, for example, at waste plants where each vehicle has to drive onto a large scale in the ground before it empties waste and returns to collect more.

Today a number of methods are also being used to estimate how much food is wasted in certain parts of the food supply chain. These methods are based on random sampling in a certain part of the chain to see how much waste occurs there. This data is then used to extrapolate the total amount of food wasted along the entire food value chain.

A review of existing solutions shows that from a technology perspective there is no problem to weigh wasted food or to compile collected data at everything from a national level down to individual customers. Starting in 2023 there will also be an EU requirement for all food waste (EU definition) to be sorted into separate containers, which will make it easier to weigh. This applies both at the household level and for companies in the food supply chain.

In Sweden the Government has up to now only decided to make separation of food waste (EU definition) a requirement for households by 2021.[67] Avfall Sverige (Swedish Waste Management Association) has, however, urged the Government to increase the national requirement without delay to match the EU requirement, i.e. to include companies and public sector actors in the food supply chain.[68] In some municipalities, such as Stockholm City, a proposal has been presented to implement this.[69]

Weighing wasted food separately opens up new possibilities for producing control mechanisms that incentivise companies and households to reduce their food waste, and perhaps in doing so, automatically reduce the lost (edible) food fraction as well. It could, for example, be possible to expand and develop existing attempts to raise waste charges, making it more expensive for customers to fill a food waste container.

Using scales and software in refuse collection vehicles could create a system that could ease the burden on individual customers to weigh and report wasted food themselves. This system could be used for individual companies as well as property owners and single-family households.

Solutions for measuring and reporting lost food

As we noted earlier in this report, singling out and measuring lost food (the edible part of the wasted food) is a greater challenge than measuring all fractions of wasted food at the same time. In order to measure lost food separately, one of the following are required:

- The existence of implementable solutions to separate lost food (edible parts) from the unavoidable fractions of wasted food (inedible parts).
- Or reliable methods to estimate how extensive the loss of food is without separating it from the unavoidable (inedible) fractions of wasted food.

If the edible parts (lost food) are separated from the unavoidable (inedible) fractions of wasted food, it can be weighed using the same technical solutions that are available for weighing the total volume of all fractions of wasted food. If, however, the edible parts cannot be separated, other solutions will be needed. Here are a few alternatives:

- Many larger retail grocery companies already use systems that make it possible to record all incoming and outgoing products by category. Using these

RANDOM SAMPLE ANALYSIS CAN PROVIDE AN APPROXIMATE PICTURE

The Swedish Environmental Protection Agency has for many years used random sample analysis to estimate how much food waste occurs in Swedish households. The process involves separating food waste from other household waste. The same process could, however, be used to take a step further and separate lost food from other food waste.

67 Sveriges rikes lag, 2018, *SFS 2018:1466, Förordning om ändring i avfallsförordningen (2011:927).*

68 Avfall Sverige, 2018, *Skrivelse: Uppmaning till regeringen om att besluta om heltäckande reglering av krav avseende utsortering av matavfall samt tillhandahållande av utsorteringssystem för utsorterat matavfall* (https://www.avfallsverige.se/fileadmin/user_upload/Remissvar_skrivelser/2018/20181101_Matavfall.pdf; accessed 20 December 2019).

69 Miljöpartiet de gröna, 2018, *Obligatorisk matavfallsinsamling i Stockholm från år 2021*, pressmeddelande publicerat 2018-12-03 (https://www.pressmachine.se/pressrelease/view/obligatorisk-matavfallsinsamling-i-stockholm-fran-ar-2021-9352; accessed 20 December 2019).

systems they can measure how much food is not sold – i.e. that goes to something other than being consumed by humans. There are also theoretical possibilities to calculate the combined weight of these products.

- Today there are also methods for estimating how much lost food there is in the total waste volumes, without the need for separating it or for all customers to measure it. This can, for example, be done via random sample analysis, where the volumes of lost food from a small number of customers are carefully analysed. This data can then be used to estimate the amount of lost food occurring in larger contexts, such as in certain types of operations or a certain part of the food supply chain.

- In terms of separating and measuring lost food in municipal institutional kitchens, pilot studies carried out in several locations around the country have shown that this is entirely implementable.[70]

In the Nordic Matvett project, methods have been defined to produce key ratios and to calculate what percentage of the total flow of wasted food may consist of lost food (edible parts). This could, for example, apply to industrial processes where lost food is mixed with other fractions of wasted food and water.[71]

Also in the case of lost food, separating it and weighing it separately could offer new opportunities to motivate companies in the food supply chain to take measures to start reducing the amount of food that is lost. For example:

- Having a better sense of the extent of lost food would allow us to quantify how much money could be saved or earned by reducing the loss.

- If we know how much lost food individual companies give rise to, it would also be possible to produce financial control mechanisms to encourage or compel them to reduce their volume of lost food.

Observations

Although there are technical solutions to measure and estimate lost and wasted food, these solutions are associated with challenges that need to be handled in order for different measurement technologies to be used in practice. A few examples:

1. In both Sweden and the EU in a few years' time there will be laws on separating food waste from other waste (EU definitions). At this time, however, there are – neither in Sweden nor the EU – no concrete plans for proposed legislation or mechanisms to encourage or compel companies to separate their lost food and measure it separately.

2. In institutional kitchens, pilot projects to separate and weigh wasted or lost food have shown that making the process work in day-to-day operations requires both resources and knowledge. It requires for example:

    - Investments in technology
    - Space for the technology and containers for storing lost and wasted food before it is removed.
    - Human resources to separate and weigh lost food.
    - Knowledge on what parts of the total volume of wasted food can be classified as lost food (edible parts).

70 Personal communication, 2018, Emelie Eriksson at Swedish National Food Agency – National centre of excellence for meals in the healthcare, education and care sectors, department for sustainable food habits. Eriksson has been in charge of the Swedish National Food Agency's pilot project to develop a method to measure food loss in municipal institutional kitchens.

71 Östfoldforskning, 2018, *Veileder for kartlegging av matsvinn i matindustrien*. Rapportnummer OR.10.18. (https://www.matvett.no/uploads/documents/OR.10.18-Veileder-for-kartlegging-av-matsvinn-i-matindustrien.pdf; accessed 20 December 2019).

- Knowledge on how to use the technology and weigh and record the loss.
- Employees who are motivated to do the work of weighing every day.
- Demonstrate a financial improvement for the company/organisation.

Insights, incentives and support are needed here so that companies can invest in technology and training.

3. Within the food industry, where margins are often small, personnel costs constitute a large percentage of turnover. This makes it even more difficult for these companies to allocate personnel hours to sorting and weighing food loss. The same applies to small farms that are often run by one person on a part-time basis.

4. Scaling up the technology to allow refuse collection vehicles to measure and report wasted food requires investment by the waste collection companies. One possibility here is to design control mechanisms that stimulate such investments.

5. Many food supply actors, such as restaurants, cafés or kiosks rent their premises from a property owner who is not always prepared to provide sufficient space for each business in the property to have a separate container for lost food. This makes it more difficult to implement a solution where each company has its own container ID-tagged for the refuse collection vehicle to record data from it.

6. Corner shops and small supermarkets, kiosks, petrol stations or fast-food restaurants also face a challenge in that many customers take the food and beverages with them to consume somewhere else. This means that part of the lost food occurs outside the establishment and often ends in waste paper bins and is therefore not measured.

7. In the food industry, there is a need to find solutions to also measure the liquid forms of wasted or lost food, as can occur in cleaning processes and when wasted food is rinsed down the drain. There is also a need for solutions in households to measure lost and wasted food that goes down the drain.[72]

8. Households also need methods to measure or estimate how much lost food that remains in packaging that is thrown away.

9. Smaller industries with smaller volumes of lost food are not always able to make significant savings or financial gains, which in turn can make them less motivated to separate their lost food and measure it.

Recommendations

Based on the technologies and the potential solutions that are available or possible to build on, the subproject has identified a number of measures that we believe need to be implemented to make it possible to require measurement and reporting of lost and wasted food throughout the Swedish food supply chain.

1. Several municipalities in Sweden have demonstrated that the technology of scales and software in refuse collection vehicles can be used to measure wasted food down to the individual customer level, such as individual companies or single-family homes. Experience from municipalities have also shown that investments in technology can be financially motivated because, among other things, it can be

72 Swedish Environmental Protection Agency, 2018, *Matavfall i Sverige – uppkomst och behandling 2016* (https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-8811-8.pdf?pid=22466; accessed 20 December 2019).

used for multiple purposes at the same time, for example both to measure and report waste and to create weight-based invoices. A pilot project being run by the Swedish Environmental Protection Agency, IVL and Statistics Sweden also shows that, despite certain challenges, it is possible to use the technology to specifically estimate the volume of wasted food and to report the compiled data to the authority responsible. The subproject would prefer for those actors already involved to take steps to study if it is possible to scale up the solution in question and to test it in more of the country's municipalities.

2. The Swedish Environmental Protection Agency has already shown that it can use random sample analysis to estimate how much food waste (EU definition) occurs in Swedish households every year. The subproject proposes that steps be taken to see if the same method can be used to estimate what percentage of total wasted food consists of lost food (edible parts) – both in households and in other parts of the food supply chain where this may be relevant.

   The subproject would also like to see a study carried out to investigate if "standard amounts" could be used to indirectly estimate, at individual consumer level, what percentage of total wasted food consists of lost food (edible parts). This could perhaps be achieved through random sample analysis on one occasion (or several). An estimated percentage could be set for each individual company, as an average for companies in a certain category, or for a certain part of the food supply chain. Once this is done, the estimated percentage could be applied to the actual number of kilos of wasted food that is collected from each customer on each individual occasion.

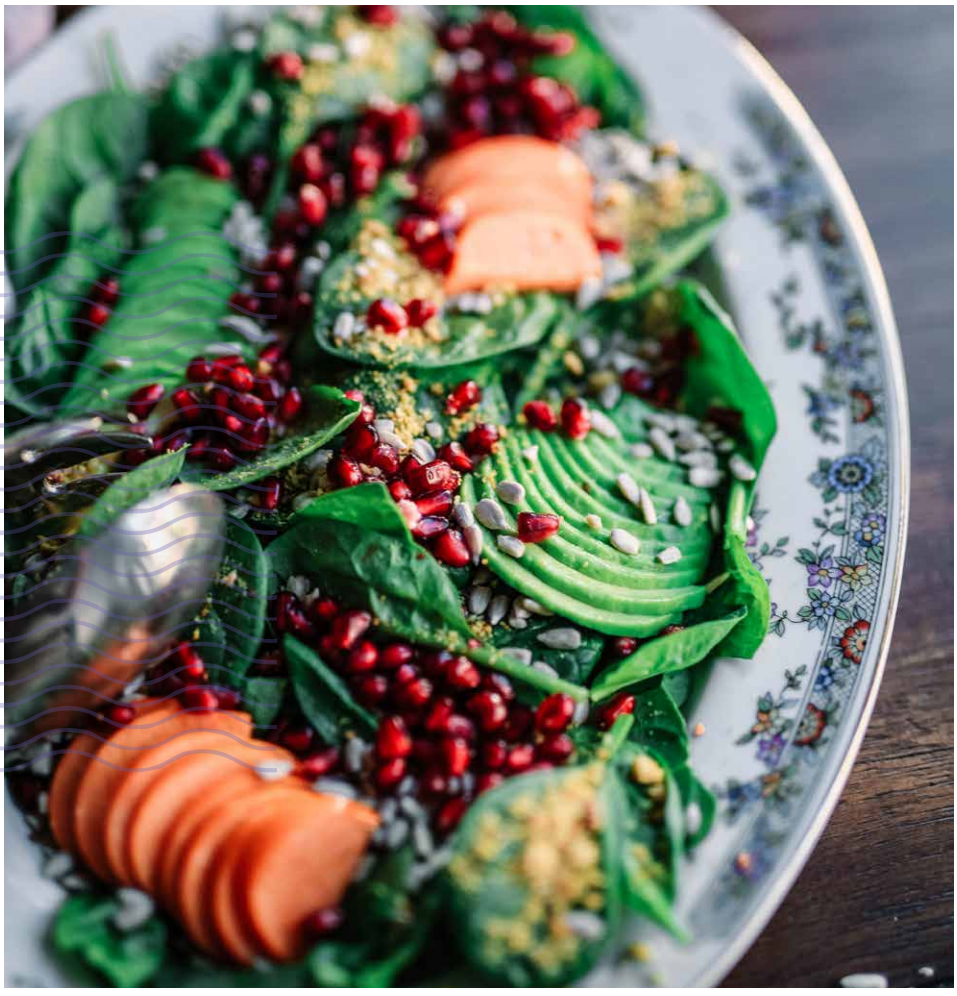
   The subproject would like to urge the Swedish Environmental Protection Agency and the Swedish National Food Agency to consult the companies that are currently performing random sample analysis, first

of all to see if the standard solution is implementable and also if it would enable more accurate estimates to be made of lost food, both at the national level and for individual companies in the food supply chain.

3. Property owners and companies in certain parts of the food supply chain have expressed the fact that it is hard to separate lost food (edible parts) from the inedible fractions of the wasted food because they do not have enough space for the containers needed. The subproject therefore wants to urge municipal authorities to look into purchasing or manufacturing containers that take less space.

4. The pilot project and the subproject's dialogue with companies in several parts of the food supply chain show clearly that a lack of knowledge and financial incentives are an obstacle for the separation of different fractions of wasted food from each other. This applies mainly to the process of separating lost food from unavoidable food waste, i.e. to separate edible food from inedible parts. The subproject would like to see clear information and support materials being produced to make it easier for organisations in the food supply chain to know how to sort and measure. It will probably be necessary to produce different information and guidance for different part of the chain. The subproject wants to encourage the Swedish Environmental Protection Agency, the Swedish National Food Agency, the Swedish Board of Agriculture and Avfall Sweden to take the initiative to produce these materials. This could be done in cooperation with the industry organisations.

5. The subproject also wants to urge actors funding research, such as Vinnova, Formas and Mistra, to consider how they can contribute to the development of new, innovative communication solutions through targeted calls for research and innovation funding proposals.



A national platform for a voluntary agreement

»Voluntary commitments may be the fastest way to get companies in the food supply chain to start measuring and setting targets to reduce the amount of food they lose and waste.«

The last of the three goals that the Food subproject set was to contribute to the creation of a national cooperation platform to get Swedish food companies to set targets for measuring and reducing lost and wasted food. In the UK the organisation WRAP has been working on building such platforms for voluntary agreements for almost 15 years. In the Courtauld Commitment project through WRAP a large number of food companies have signed voluntary agreements that have resulted in a radical reduction in food loss nationally. Similar projects have, with WRAP's help, already been set up or are being set up in nine other countries: Germany, Spain, China, the Netherlands, Norway, Austria, France, Hungary and Italy.[73]

In spring 2019 IVL Swedish Environmental Research Institute received funding to work with WRAP, Statistics Sweden and 20 or so food companies, agencies, research actors and industry and professional organisations to produce a proposal for how to design a voluntary agreement for the Swedish food supply chain. The participants in the project include the Swedish National Food Agency, Swedish Environmental Protection Agency, WWF, Ministry of Enterprise, Energy and Communications, Swedish Board of Agriculture, Orkla Foods Sweden, Arla Foods, Avfall Sverige, Martin & Servera, Sodexo, Atria, Menigo, Visita, Swedish Food Federation, Sveriges Bryggerier, Swedish Food Retailers Federation, Compass Group, LRF – and IVA.

The subproject's contribution

Ever since the project application was submitted by IVL the IVA subproject has been involved in the process led by IVL. This work has been facilitated by the fact that several of the individuals who are leading efforts towards the Swedish agreement are also part of the work group for IVA's subproject. During the course of this work the subproject has been able to contribute by lowering the threshold to engage important key actors with a connection to a more resource-effective food supply chain. Several of the people who have joined the IVL project were already in various ways participating in the work of the subproject.

In the voluntary agreement process developed by WRAP, three important steps have been identified that the companies involved need to take to reduce the volume of their lost and wasted food:

1. Invest in methods to start measuring how much food is lost or wasted.
2. Set a target for the size of the reduction of lost and wasted food they want to achieve.
3. Start taking steps to reach the reduction targets that are set up.

To create a credible foundation to estimate and compare data from different food companies, it will be necessary for all of them to measure the amount of lost and wasted food in the same way.

In producing the Swedish platform for voluntary agreements, the idea is for participating food companies to be encouraged to use the measurement framework that IVA has produced.

Recycling, industrial symbiosis and innovative environments

One aspect that IVA is hoping to achieve when building a platform for voluntary agreements is that it will contribute to greater cooperation and greater knowledge transfer between companies in the food supply chain, but also with actors connected to the food supply chain's

73 WRAP website, 2019, *What is Courtauld Commitment?* (http://www.wrap.org.uk/content/what-is-courtauld; accessed 20 December 2019).

efforts to be more resource-effective, sustainable and competitive.

In the platforms that WRAP has helped to produce in other countries, one focus area was to promote cooperation and partnership between food companies, government agencies and the research community. This has, for example, involved finding innovative solutions to spread knowledge about how food companies and the community can not only reduce the amount of food that is loss and wasted, but also maximise recycling and highlight the usefulness and value of the waste that still occurs.[74]

Increased profitability and competitiveness

One important factor to drive and motivate companies in the food supply chain to measure and report their lost and wasted food is to spread awareness of what they can gain by doing so. This is therefore one of the main aims of establishing the Swedish platform for a voluntary agreement. There are many examples of what increased awareness about resources that are lost, or poorly used, can lead to. This applies both at the societal level in general and down to individual businesses in the industry.

In the partnership projects that WRAP has acted as a catalyst for, it has become clear that there is big financial potential in establishing platforms for common agreements on reducing food loss and other food waste. It has been possible to show that this can lead to increased profitability, increased competitiveness and brand new commercial opportunities for the companies that join the platforms and are prepared to set measurable reduction targets.

Case: In an analysis performed by the World Resources Institute (WRI),[75] an examination was made of the costs and gains for 700 food companies in 17 countries who have taken steps to reduce the amount of food they lose or waste. The companies in the study spanned several parts of the food supply chain – from manufacturing industry to grocery retail, wholesalers and institutional kitchens to hotels and restaurants. The result showed that the companies studied gained an average return of 14 kronor for every krona they invested to reduce their loss and waste. This figure may seem surprisingly high. The subproject has not been able to verify this, other than in the report referred to.[76] In addition, most of the companies in the study reported that they recovered their money within the first 12 months after investing.

Among other things, the gains came from the following:

- The companies did not need to purchase food that they could not subsequently sell.
- They were incentivised to produce new food products made from food that was previously discarded.
- They reduced their waste management costs.

Measuring and sharing data is key

The report from WRI draws the conclusion that one of the most important drivers to get companies to start taking action to reduce loss and waste of food is to get them to invest in tools that can show how much waste and loss of food occurs in their own operations.

Within the cooperation that WRAP is coordinating, the participating food companies were encouraged to share their data – and also to publish the reduction in the volume of loss and waste of food that they managed to achieve. Ex-

74 WRAP website, 2019, (http://www.wrap.org.uk/about-us/what-we-do; accessed 20 December 2019).

75 Champions 12.3, 2018, *The business case for reducing food loss and waste* (https://champions123.org/wp-content/uploads/2017/03/report_-business-case-for-reducing-food-loss-and-waste.pdf; accessed 20 December 2019).

76 Champions 12.3, 2018, *The business case for reducing food loss and waste* (https://champions123.org/wp-content/uploads/2017/03/report_-business-case-for-reducing-food-loss-and-waste.pdf; accessed 20 December 2019).

perience shows that transparency around data can help to make companies more competitive and profitable.

A few examples:

- Reporting their success in being more resource-efficient and sustainable can help to build a company's brand.
- Openly reporting data can create an opportunity for individual companies to see how their resource effectiveness efforts compare with those of other companies in the same segment. This can in turn help to encourage companies to become even more resource-efficient. It is likely though that certain companies will not be willing to publish this type of "efficiency data", e.g. for competition-related reasons.

AIM TO RISE UP THE WASTE HIERARCHY

The swedish company Karma is one of many new companies whose business concept is based on selling food that would otherwise be lost, thus helping to reduce the amount of food that goes to waste. But this also requires companies that are upstream in the chain to continue using processes that give rise to loss of food.

The US company Planetarians has found a way to make protein-rich chips out of inedible residual products from the manufacture of sunflower seed oil.

Source: Food Business News 2019.

New commercial opportunities

Another benefit of creating platforms for knowledge transfer and sharing data on food that is lost and wasted could be that it helps to create business opportunities and business models.

When many companies in the food supply chain share their measurement data, they open up new opportunities to see where in the food supply chain the loss and waste of food is occurring. This in turn could be a tool for finding recipients that can ensure the lost food is used for human consumption, or that the unavoidable part of the waste is used as high up the waste hierarchy as possible.

In a food supply chain that is aiming to reduce its waste of resources, it is important, however, to focus on finding new business models or commercial opportunities that are not based on continued generation of lost food. The focus should instead be on finding ways to avoid loss of food from occurring, and to create new value from the unavoidable waste that will occur.

Benefits for society

The gains to be made from setting targets to reduce loss of food may also be evident on a more general socioeconomic level. In the UK a campaign was launched in 2007 to reduce the amount of lost food in the country's households. Five years later the country had achieved a 21 percent reduction in the volume of lost food. The financial savings achieved were estimated to be 250 times larger than the amount society had invested in achieving the reduction.[77] It was in part about the savings that households could make by purchasing less food – since people took better care of the food they actually bought. Because less food needed to be produced, it was also possible for society to save on the indirect costs associated with managing the consequences of food production: climate impact, soil erosion, increased water consumption, reduced biodiversity, eutrophication and overfishing in our oceans etc. A fresh calculation produced by the World Business Council for Sustainable Development and others estimates that these indirect costs for today's food production are USD 1,200 billion every year.

77 Champions 12.3, 2018, *The business case for reducing food loss and waste* (https://champions123.org/wp-content/uploads/2017/03/report_-business-case-for-reducing-food-loss-and-waste.pdf; accessed 20 December 2019).

According to the Council's forecast, these indirect costs will increase by USD 1,600 billion by 2050 – unless the global food system is radically transformed.[78]

Financing and implementation

In terms of work on creating the Swedish platform for voluntary agreements, the idea is for coordination of this to largely be financed through "membership fees". The fees are to be paid in by public sector actors, academic institutions, organisations and the companies in the food supply chain that join the effort.

The idea is for half of the funds raised to come from the companies, institutions and organisations participating. The hope is that the other half will come from the government agencies and ministries that are also part of the effort.

In September 2019, 18 companies, organisations and agencies had joined in the effort to design a voluntary agreement: The Swedish National Food Agency, Swedish Environmental Protection Agency, WWF, Ministry of Enterprise, Energy and Communications, Swedish Board of Agriculture, Orkla Foods Sweden, Arla Foods, Avfall Sverige, Martin & Servera, Sodexo, Atria, Menigo, Visita, Swedish Food Federation, Sveriges Bryggerier, Swedish Food Retailers Federation, Compass Group and LRF.

The goal is to have a proposal for an agreement ready in February/March 2020 and then to get as many companies in the food supply chain as possible to sign it. The idea is to encourage the companies that sign it to use the proposed framework presented in this report to measure and report the amount of the lost or wasted food. Work on the voluntary agreement will continue to be headed by IVL with support from WRAP and Statistics Sweden during the project period.

Recommendations

The subject regards investment in a platform that encourages companies in the food supply chain to work more resource-effectively and to set targets for reducing the amount of lost food lost as an important part of the effort to implement the Swedish food strategy. This should also be considered an important aspect of efforts to drive the Government's action plan to reduce the amount of food that is lost.

The project would therefore like to:

1. Urge the Government and relevant authorities as well as industry organisations and companies in the food supply chain to get involved in the efforts to build a platform for a voluntary agreement.
2. The subproject would like to urge the Government to take the first step and contribute at least half of the funds that will be needed to have an actor responsible for organising, managing and following up efforts to implement the Swedish agreement. We believe this is important to increase incentives for the private sector to participate in and allocate a portion of their own financial resources to it.

Finally, the subproject wants to encourage the Government, as soon as possible, to appoint an actor that can be given a mandate to manage the process of producing the voluntary agreement that IVL has started. The subproject believes there are benefits in the actor appointed to manage the process doing so in cooperation with a pool of experts who can provide additional innovative ideas and academic expertise, and to help further gain the confidence of the food supply chain in the platform and willingness to participate in it.

78 The food and land use coalition, 2019, *Growing Better: Ten Critical Transitions to Transform Food and Land Use – The Global Consultation Report of the Food and Land Use Coalition*, September 2019 (https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf; accessed 20 December 2019).

References

Website and research sources
Personal interviews

Website and research sources

Aktuell Hållbarhet, 2019, Smart lösning minskade matsvinnet på Ikea med 1,4 miljoner kilo published 2019-01-15 (https://www.aktuellhallbarhet.se/smart-losning-minskade-matsvinnet-pa-ikea-med-14-miljoner-kilo/; accessed 2019-12-20).

Avfall Sverige, 2014, Miljöstyrande taxa? En vägledning till viktbaserad avfallstaxa inför beslut, vid införande och drift (https://www.avfallsverige.se/kunskapsbanken/rapporter/rapportera/article/miljostyrande-taxa-en-vagledning-till-viktbaserad-avfallstaxa-infor-beslut-vid-inforande-och-drift/; accessed 2019-12-20).

Avfall Sverige, 2018, Report: Uppmaning till regeringen om att besluta om heltäckande reglering av krav avseende utsortering av matavfall samt tillhandahållande av utsorteringssystem för utsorterat matavfall (https://www.avfallsverige.se/fileadmin/user_upload/Remissvar_skrivelser/2018/20181101_Matavfall.pdf; accessed 2019-12-20).

Boston Consulting Group, 2018, Tackling the 1.6-billion ton food loss and waste crisis (http://image-src.bcg.com/Images/BCG-Tackling-the-1.6-Billion-Ton-Food-Waste-Crisis-Aug-2018%20%281%29_tcm22-200324.pdf; accessed 2019-12-20).

Champions 12.3 website (https://champions123.org/target-12-3/; accessed 2019-12-20).

Champions 12.3, 2017, Guidance on Interpreting Sustainable Development Goal Target 12.3. (https://champions123.org/wp-content/uploads/2017/10/champions-12-3-guidance-on-interpreting-sdg-target-12-3.pdf; accessed 2019-12-20).

Champions 12.3, 2018, The business case for reducing food loss and waste (https://champions123.org/wp-content/uploads/2017/03/report_-business-case-for-reducing-food-loss-and-waste.pdf; accessed 2019-12-20).

Champions 12.3, 2019, SDG Target 12.3 on food loss and waste: 219 Progress report – An annual update on behalf of Champions 12.3. (https://champions123.org/wp-content/uploads/2019/09/champions-12-3-2019-progress-report.pdf; accessed 2019-12-20).

EEA, 2019, Europa 2020 – A strategy for smart, sustainable and inclusive growth COM(2010), and A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy COM(2011). Dock finns tyvärr ingen direkt definition på resurseffektivitet. (https://www.eea.europa.eu/policy-documents/com-2010-2020-europe-2020; accessed 2019-12-20).

Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. See Article 2 (https://eurlex.europa.eu/LexUriServ/LexUriServ.

do?uri=CONSLEG:2002R0178:20060428:SV:PDF; accessed 2019-12-20).

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. See Article 6 (https://eur-lex.europa.eu/legal-content/SV/TXT/PDF/?uri=CELEX:32008L0098&from=EN; accessed 2019-12-20).

Regulation (EU) No 1380/2013 of the European Parliament and of the Council of 11 December 2013 on the Common Fisheries Policy. See Article 15 Landing obligation (https://eur-lex.europa.eu/legal-content/SV/TXT/PDF/?uri=CELEX:32013R1380&rid=1; accessed 2019-12-20).

EU, 2016, EU Platform on Food Losses and Food Waste – terms of reference, 26 April 2016 (https://ec.europa.eu/food/safety/food_waste/eu_actions/eu-platform_en; accessed 2019-12-20).

Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste (https://eur-lex.europa.eu/legal-content/SV/TXT/?uri=CELEX:32018L0851; accessed 2019-12-20).

Article 2 of Commission Delegated Decision (EU) – 3 May 2019 – supplementing Directive 2008/98/EC of the European Parliament and of the Council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste. Final version. (Preliminary document).

EU, 2019, Report from the Commission to the European parliament, the Council, the European economic and social committee and the committee of the regions – on the implementation of the Circular economy Action Plan (SWD 2019 Final) (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1551871195772&uri=CELEX:52019DC0190; accessed 2019-12-20).

FAO, Seeking end to loss and waste of food along production chain (http://www.fao.org/in-action/seeking-end-to-loss-and-waste-of-food-along-production-chain/en/; accessed 2019-12-20).

FAO, 2003, World agriculture: towards 2015/2030. An FAO perspective (http://www.fao.org/3/y4252e/y4252e06.htm; accessed 2019-12-20).

FAO, 2013, Food Wastage Footprint – Impacts on Natural Resources. Summary report (http://www.fao.org/3/i3347e/i3347e.pdf; accessed 2019-12-20).

FAO, 2016, Instalment 2 of Creating a Sustainable Food Future Reducing Food Loss and Waste. Working Paper.

FAO, 2016, World agriculture: towards 2015/2030 – an FAO perspective (http://www.fao.org/3/y4252e/y4252e06.htm; accessed 2019-12-20).

FAO, 2017, Food wastage footprint & Climate Change (http://www.fao.org/3/a-bb144e.pdf; accessed 2019-12-20).

FAO, 2017, Water for Sustainable Food and Agriculture A report produced for the G20 Presidency of Germany (http://www.fao.org/3/a-i7959e.pdf; accessed 2019-12-20).

FAO, 2019, The state of food and agriculture – moving forward on food loss & waste reduction.

FAO, 2019, The state of the world's biodiversity for food and agriculture – FAO commission on genetic resources for food and agriculture. Assessments 2019 (http://www.fao.org/news/story/en/item/1180463/icode/; accessed 2019-12-20).

FAO/SIK, 2011, Global Food Losses and Food Waste – Extent, Causes and Prevention (http://www.fao.org/3/a-i2697e.pdf; accessed 2019-12-20).

Finansdepartementet, 2016, Strategi för hållbar konsumtion, 2016:6 (https://www.regeringen.se/4a7e12/globalassets/regeringen/dokument/finansdepartementet/pdf/2016/strategi-for-hallbar-konsumtion/strategi-for-hallbar-konsumtion--tillganglighetsanpassad.pdf; accessed 2019-12-20).

Food Business News, 2019, Upcycling upstart on the upswing, published 2019-03-22 (https://www.

foodbusinessnews.net/articles/13519-upcycling-upstart-on-the-upswing; accessed 2019-12-20).

Food loss and waste protocol, 2019, FLW Value Calculator (http://www.flwprotocol.org/why-measure/food-loss-and-waste-value-calculator/; accessed 2019-12-20).

FUSION website (http://www.eu-fusions.org/; accessed 2019-12-20).

Geissdoerfer, M., Savaget, P., Bocken, N. och Hultink, E., 2017, "The circular economy – A new sustainability paradigm?" in Journal of Cleaner Production 143 (1), p. 759.

Grid Arendal, 2019, Projected agriculture in 2080 due to climate change (https://www.grida.no/resources/6829; accessed 2019-12-20).

IPCC, 2019, Climate Change and Land: An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Summary for Policymakers (https://www.ipcc.ch/site/assets/uploads/2019/08/4.-SPM_Approved_Microsite_FINAL.pdf; accessed 2019-12-20).

Kirchherr, J., Reike, D., Hekkert, M., 2017, "Conceptualizing the circular economy: An analysis of 114 definitions", i Resources, Conservation and Recycling 127, pp. 221–232.

Royal Swedish Academy of Engineering Sciences (IVA), project Resource Efficient Business Models – Greater Competitiveness, 2016, Food – a sector report (https://www.iva.se/globalassets/info-trycksaker/resurseffektiva-affarsmodeller/rask-branschrapport-livsmedel.pdf; accessed 2019-12-20).

Swedish National Food Agency, 2018, Fler gör mer. Handlingsplan för minskat matsvinn 2030, published June 2018 (https://www.livsmedelsverket.se/globalassets/matvanor-halsa-miljo/miljo/matsvinn/fler-gor-mer-handlingsplan-for-minskat-matsvinn_20180618.pdf; accessed 2019-12-20).

Swedish National Food Agency, 2018, Det som mäts är det som syns – ny nationell metod för matsvinnsmätning i storkök, press release published 2018-12-05 (https://www.livsmedelsverket.se/om-oss/press/nyheter/pressmeddelanden/det-som-mats-ar-det-som-syns-ny-nationell-metod-for-matsvinnmatning-i-storkok; accessed 2019-12-10).

Livsmedelsföretagen, 2018, Compilation of Statistics Sweden's statistical data base, April 2018 (https://www.livsmedelsforetagen.se/branschfakta/; accessed 2019-12-20).

Lüdeke- Freund, F., Gold, S. and Bocken, N., 2018, "A Review and Typology of Circular Economy Business Model Patterns", in Journal of Industrial Ecology, Volume 23, Issue 1, February 2019, pp. 36–61.

Miljöpartiet de gröna, 2018, Obligatorisk matavfallsinsamling i Stockholm från år 2021, press release published 2018-12-03 (https://www.pressmachine.se/pressrelease/view/obligatorisk-matavfallsinsamling-i-stockholm-fran-ar-2021-9352; accessed 2019-12-20).

Mistra – Closing the loop (https://closingtheloop.se/; accessed 2019-12-20).

National Research Council, 1980, The Effects on Human Health of Subtherapeutic Use of Antimicrobials in Animal Feeds (https://www.ncbi.nlm.nih.gov/books/NBK216502/; accessed 2019-12-20).

Nature, 2012, One-third of our greenhouse gas emissions come from agriculture – Farmers advised to abandon vulnerable crops in face of climate change (https://www.nature.com/news/one-third-of-our-greenhouse-gas-emissions-come-from-agriculture-1.11708; accessed 2019-12-20).

Swedish Environmental Protection Agency, 2018, Matavfall i Sverige – uppkomst och behandling 2016 (https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-8811-8.pdf?pid=22466; accessed 2019-12-20).

Swedish Environmental Protection Agency website, 2019, Etappmålen (https://www.naturvardsverket.se/Miljoarbete-i-samhallet/Sveriges-miljomal/Etappmal/; accessed 2019-12-20).

Ministry of Enterprise, Energy and Communications, 2016, En livsmedelsstrategi för Sverige– fler jobb och hållbar tillväxt i hela landet – Brief version of government bill 2016/17:104 (https://www.regeringen.se/4908a0/contentassets/89c5b3e5d23f473d843d12f12379d07b/livsmedelsstrategin_kortversion_170130.pdf; accessed 2019-12-20).

REFRESH, 2019, REFRESH – Resource Efficient Food and dRink for the Entire Supply CHain (https://eu-refresh.org/; accessed 2019-12-20).

Government of Sweden, 2016, En livsmedelsstrategi för Sverige – fler jobb och ökad tillväxt i hela landet (https://www.regeringen.se/4908a0/contentassets/89c5b3e5d23f473d843d12f12379d07b/livsmedelsstrategin_kortversion_170130.pdf; accessed 2019-12-20).

Science Direct, 2017, Conceptualizing the circular economy: An analysis of 114 definitions (https://reader.elsevier.com/reader/sd/pii/S0921344917302835?token=4CC3168FF249A7CC70DF46225482D18BEA8DA7F26D119EC1BAD30EB34B4DB6C07EEFD2EBED9D151A5012F1DD89755B0F; accessed 2019-12-20).

Stahel, W., "The circular economy", 23 March 2016, in Nature 531, pp. 435–438 (https://www.nature.com/news/the-circular-economy-1.19594; accessed 2019-12-10).

Svenska Dagbladet, 2019, En miljon djur- och växtarter hotas av utrotning. Men vad innebär den förlorade biologiska mångfalden för oss människor – och vad kan vi göra åt saken?, published 2019-05-12 (https://www.svd.se/djur-och-vaxter-dor-ut--sa-kan-vi-undvika-en-katastrof; accessed 2019-12-20).

Svensk dagligvaruhandel, 2018, Dagligvaruhandelns input till Regeringens handlingsplan för ett halverat matsvinn till år 2030, press release 2018-02-12 (https://www.svenskdagligvaruhandel.se/wp-content/uploads/Svensk-Dagligvaruhandels-input-till-handlingsplan-matsvinn.pdf; accessed 2019-12-20).

Sveriges rikes lag, 2018, SFS 2018:1466, Förordning om ändring i avfallsförordningen (2011:927).

The food and land use coalition, 2019, Growing Better: Ten Critical Transitions to Transform Food and Land Use – The Global Consultation Report of the Food and Land Use Coalition, September 2019 (https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf; accessed 2019-12-20).

Tidningen Land, 2016, Grönt ljus för export till Hongkong, published 2016-03-18 (https://www.landlantbruk.se/lantbruk/gront-ljus-for-export-till-hongkong/; accessed 2019-12-20).

Swedish Agency for Economic and Regional Growth, 2018, Forskning och innovation för en livsmedelssektor i världsklass – En studie kring hur man skapar en innovativ och framgångsrik livsmedelssektor i ett hållbart samhälle (https://swedenfoodarena.se/wp-content/uploads/Forskning-och-innovation-livsmedelssektorn.pdf; accessed 2019-12-20).

UN, 2019, Sustainable Development Goals (https://sustainabledevelopment.un.org/?menu=1300; accessed 2019-12-20).

UN, 2019, World Population Prospects 2019 – Highlights (https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf; accessed 2019-12-20).

World Economic Forum, 2019, South Korea once recycled 2% of its food waste. Now it recycles 95% (https://www.weforum.org/agenda/2019/04/south-korea-recycling-food-waste/; accessed 2019-12-20).

World Resources Institute med fler, 2016, Version 1.0 – Food Loss and Waste Accounting and Reporting Standard (https://www.wbcsd.org/contentwbc/download/3968/53079; accessed 2019-12-20).

WRAP, 2017, The business case for reducing the food loss and waste – A report on behalf of the Champions 12.3. (http://www.wrap.org.uk/sites/files/wrap/Report_The%20Business%20Case%20for%20Reducing%20Food%20Loss%20and%20Waste.pdf; accessed 2019-12-20).

WRAP, 2019, Guidance on interpreting sustainable development goal target 12.3. (https://champions123.org/wp-content/uploads/2017/10/champions-12-3-guidance-on-interpreting-sdg-target-12-3.pdf; accessed 2019-12-20).

WRAP Global, 2018, Building partnerships, driving change – voluntary approach to cutting food waste (http://www.wrap.org.uk/sites/files/wrap/A_voluntary_approach_to_cutting_food_waste.pdf; accessed 2019-12-20).

WRAP website, 2019, (http://www.wrap.org.uk/about-us/what-we-do; accessed 2019-12-20).

WRAP website, 2019, The food and drink material hierarchy (http://www.wrap.org.uk/content/why-take-action-legalpolicy-case; accessed 2019-12-20).

WRAP website, 2019, What is Courtauld Commitment? (http://www.wrap.org.uk/content/what-is-courtauld; accessed 2019-12-20).

Östfoldforskning, 2018, Veileder for kartlegging av matsvinn i matindustrien. Rapportnummer OR.10.18. (https://www.matvett.no/uploads/documents/OR.10.18-Veileder-for-kartlegging-av-matsvinn-i-matindustrien.pdf; accessed 2019-12-20).

Personal interviews

Personal communication, 2018, Emelie Eriksson at Swedish National Food Agency – Nationellt kompetenscentrum för måltider i vård, skola och omsorg, Avdelningen för hållbara matvanor (National centre of excellence for meals in the healthcare, education and care sectors, department for sustainable food habits). Eriksson has been in charge of the Swedish National Food Agency's pilot project to develop a method to measure food loss in municipal institutional kitchens.

Personal communication, 2019, Karin Bildsten, sustainability strategy at Axfood. Bildsten is also a member of the work group that has prepared this report.

Personal communication, 2019, Lars Viklund – Miljöekonomi och miljö, Avdelningen för regioner och miljö på Statistiska centralbyrån. (Environmental economics and environment, division for regionas and environment at Statistics Sweden).

The Royal Swedish Academy of Engineering Sciences (IVA) is an independent academy whose mission is to promote the engineering and economic sciences and the advancement of business and industry. In cooperation with the business community and academia, IVA initiates and proposes measures to improve Sweden's industrial expertise and competitiveness. For more information about IVA and the Academy's projects, see the website www.iva.se.

Published by: The Royal Swedish Academy
of Engineering Sciences (IVA), 2020
Box 5073, SE-102 42 Stockholm, Sweden
Tel. +46 (0)8 791 29 00

IVA publishes various types of reports within the framework of its activities. All reports are fact-checked by experts and then approved for publication by IVA's President.

IVA-M 519
ISSN: 1100-5645
ISBN: 978-91-89181-01-4

Project Management: Kristoffer Gunnartz
Text: Kristoffer Gunnartz
Editor: Joakim Rådström
Co-ordinator: Gustaf Wahlström, IVA
Illustrations: Moa Sundkvist & Jennifer Bergkvist
Photos: Shutterstock.com & Unsplash.com
Layout: Pelle Isaksson, IVA

This report is available to download as a pdf file at www.iva.se

Royal Swedish Academy of Engineering Sciences

in cooperation with

FORMAS

IKEM
Innovations- och kemindustrierna i Sverige

MISTRA
Stiftelsen för miljöstrategisk forskning

SVENSKT NÄRINGSLIV

Teknikföretagen

tillväxtverket

VASAKRONAN

VINNOVA
Sveriges innovationsmyndighet

FORSK