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Development of tools to prevent food waste

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Summary

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Abstract

In recent years the issue of food waste has received growing attention. In 2011, the Food and Agriculture Organization of the United Nations (FAO) published a report about global food waste which revealed that about 1.3 billion tons per year, or one-third of all food produced globally, is never eaten. At the same time, according to FAO estimates, more than 900 million people suffer chronic hunger. The losses of edible food are a central problem not only for moral and ethical reasons, but also from an environmental perspective. Production and processing of food entail serious environmental impacts which could be reduced significantly by lowering food loss rates.

Against this background, the project is the first to deliver a reliable estimate of the environmental impacts resulting from losses during production, distribution, and consumption of food for and by the German population.

Based on an analysis of existing proposals and further possibilities for binding governmental action, specific measures are proposed that are suitable for effectively reducing relevant food waste and that can be realized by the Federal Environment Ministry in the context of the German Waste Prevention Programme.

Kurzbeschreibung

In den letzten Jahren wird die Entstehung von Lebensmittelabfällen zunehmend als Problem wahrgenommen. Die Welternährungsorganisation (FAO) veröffentlichte 2011 Zahlen zu Lebensmittelabfällen weltweit. Demnach wird weltweit rund ein Drittel der erzeugten Nahrung weggeworfen; das entspricht 1,3 Milliarden Tonnen pro Jahr. Gleichzeitig hungern weltweit nach Schätzungen der FAO mehr als 900 Millionen Menschen. Die Verluste verzehrgeeigneter Lebensmittel stellen neben moralisch-ethischen Aspekten auch aus Umweltperspektive ein zentrales Problem dar. Mit der Erzeugung und Verarbeitung von Lebensmitteln gehen gravierende Umweltbelastungen einher, die durch Verringerung der Verlustraten deutlich gesenkt werden könnten.

Vor diesem Hintergrund erfolgte im Rahmen des Vorhabens erstmalig eine belastbare Abschätzung der Umweltwirkungen, die mit den Verlusten bei Herstellung, Distribution und Konsum der Lebensmittel der deutschen Bevölkerung einhergehen.

Basierend auf einer Analyse bestehender Maßnahmenvorschläge und der weiteren Möglichkeiten für verbindliches staatliches Handeln werden daneben konkrete Maßnahmen vorgeschlagen, die eine effektive Minderung relevanter Lebensmittelabfälle erwarten lassen und die vom Bundesumweltministerium im Rahmen der Umsetzung des deutschen Abfallvermeidungsprogramms ergriffen werden können.

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1 Background

In recent years the issue of food waste has increasingly become a topic of discussion. In 2011, the Food and Agriculture Organization of the United Nations (FAO) published data about global food waste which revealed that about 1.3 billion tons per year, or one-third of all food produced, goes to waste.[1] At the same time, according to FAO estimates, 925 million people suffer chronic hunger.

The Federal Ministry of Food, Agriculture, and Consumer Protection published a study on food waste in Germany in 2012 which showed that approx. 82 kg of food are wasted in private households per person each year.[2]

Against the background of the guiding principle of sustainable nutrition,[3] discarding food is often discussed by the broad public as an ethical problem: while people in other places of the world are starving to death, food that could perfectly well be eaten is wasted. Yet in light of the serious resource consumption due to food production, the food losses, which are not used for human nutrition, also pose a relevant environmental problem. Besides the consequences of intensive agriculture, such as monocultures or pesticide use, which dominate public perception, the losses are also reflected in greenhouse gas emissions from livestock farming and transportation. Such unnecessary consumption of natural resources can be reduced effectively by minimizing food losses in the various value-added chains.

According to the five-step waste hierarchy of the European Waste Framework Directive,[4] preventing waste in general and thus preventing food waste has top priority. This is also reflected in Article 29 of the European Waste Framework Directive, which requires Member States to establish waste prevention programs.[5.]

In July 2013, the German federal government passed an "Abfallvermeidungsprogramm des Bundes unter Beteiligung der Länder"[6] (AVP, Waste Prevention Programme of the German government with the involvement of the Federal Länder) on the basis of scientific background studies[7] and after hearing the stakeholders involved, in accordance with art. 33 Closed Substance Cycle and Waste Management Act[8]. In this program, the federal government makes the following concrete recommendation concerning food waste:[9]

"With a view to preventing food waste, concerted actions and agreements between public institutions and industry/trade are to be encouraged in order to minimize food waste occurring along the production

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1 Following Gustavsson et al. (2011): Global Food Losses and Food Waste.

2 Cf. Kranert et al. (2012): Ermittlung der weggeworfenen Lebensmittelmengen und Vorschläge zur Verminderung der Wegwerfrate bei Lebensmitteln in Deutschland.

3 See, for example, Eberle/Hayn (2007): Nachhaltige Ernährung ist umweltverträglich und gesundheitsfördernd, ethisch verantwortlich, alltagsadäquat gestaltet und ermöglicht soziokulturelle Vielfalt.

4 Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, OJ EU L of November 22nd 2008, p.3.

5 Cf. European Environment Agency (2014): Waste prevention in Europe — the status in 2013, EEA Report No 9/2014.

6 Cf. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2013): Waste prevention programme of the German government with the involvement of the Federal Länder, July 2013.

7 Among others: Dehoust et al. (2013): Substantive implementation of Art. 29 of Directive 2008/98/EC, UFOPLAN FKZ: 371032310, published as UBA-Text 81/2013.

8 Act to Promote Circular Economy and Safeguard the Environmentally Compatible Management of Waste, 24 February 2012, Federal Law Gazette (BGBl.) I, p. 212.

9 AVP, Section 4. I Recommended measures, p. 30.

and supply chain. The goal is to take the entire value-added chain—i.e., not only consumer behavior—into account in order to reduce food waste."

2 Goals and contents of the research project

The results of the present environmental research project are a contribution to the discussion about the occurrence of food waste and its prevention from the perspective of environmental protection.

The environmental impacts associated with the occurrence of food waste are quantified and described qualitatively, resulting in an initial robust basis for estimating the environmental relevance of waste prevention activities in this area.

In addition, possible prevention measures are derived from existing environmental law, examined, and evaluated. In the process, measures are identified that are appropriate for implementing, updating, and further developing the AVP.

3 Methodological approach for calculating the environmental impacts

Preparation of a "balance sheet" of the environmental impacts of food eaten or discarded can only be achieved on the bases of the life cycle of the food consumed[10].[11] The starting point for the analysis is the food consumed annually by final consumers in Germany by using the shopping basket of food as a reference. This is a statistical value that breaks down the food purchased—in other words consumed—annually by the final consumers according to amounts and types of food. The following figure shows the composition of the shopping basket:

[10] In the following, food consumption is defined as the sum of food eaten and food losses. Preventable and non-preventable losses are not differentiated.

[11] Methodologically speaking, this is a material flow analysis (MFA); the ReCiPe method is used to estimate impacts.

Figure 1: Final consumers' shopping basket

In order to be able to draw conclusions concerning potential differences regarding environmental impacts caused by food losses in the two places where food is consumed, the shopping basket is divided into consumption at home—in-house consumption (IHC)—and consumption in restaurants, cafeterias, and the like—out-of-home consumption (OHC).

These two shopping baskets are different, both in terms of the amount of food consumed and its composition. Significantly more food is consumed at home (456.72 kg per capita per year) than away from home (70.47 kg). People also eat more meat and fish as well as more bread and cereal products away from home than at home. These details concerning the shopping baskets and the losses associated with them are shown in Table 1.

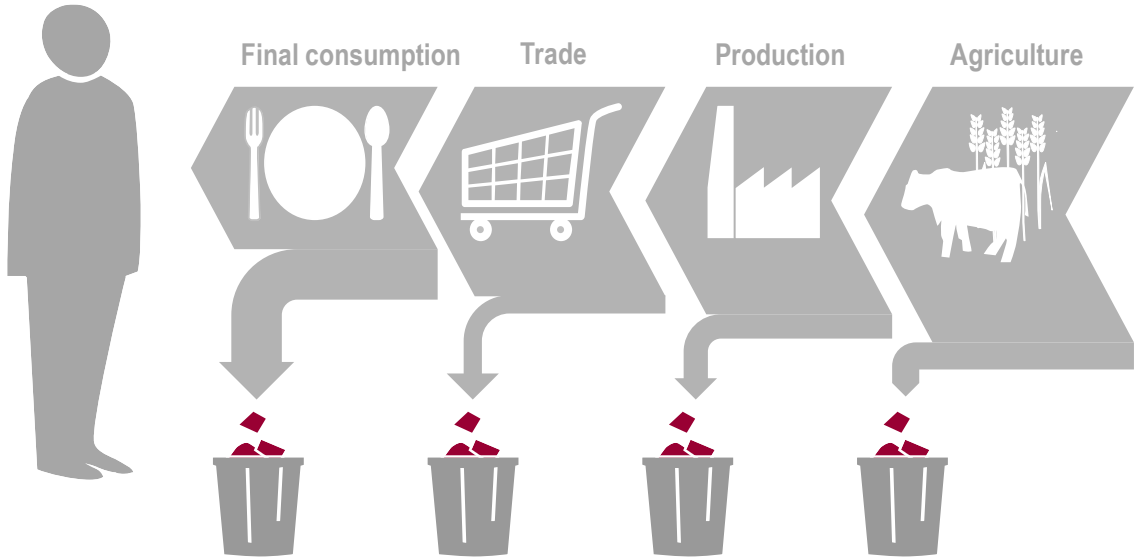
Table 1 Shopping baskets for IHC and OHC as well as food losses

Product group	IHC [kg per capita and year]	Shares of total consumption (IHC)	OHC [kg per capita and year]	Shares of total consumption (OHC)
Bread and cereal products	104.61	22.9%	28.30	40.2%
Meat and meat products	41.50	9.1%	9.82	13.9%
Fish and fish products	5.49	1.2%	2.08	3.0%
Dairy products and eggs	144.06	31.5%	7.93	11.3%
Fats and oils	6.97	1.5%	6.97	9.9%
Fruit	60.29	13.2%	2.42	3.4%
Vegetables and potatoes	87.90	19.3%	12.78	18.1%
Sugar	5.90	1.3%	0.19	0.2%
Total consumption	**456.72**	**100.0%**	**70.47**	**100.0%**

Product group	IHC [kg per capita and year]	Shares of total consumption (IHC)	OHC [kg per capita and year]	Shares of total consumption (OHC)
Of which losses	76.00	16.64%	23.61	33.5%

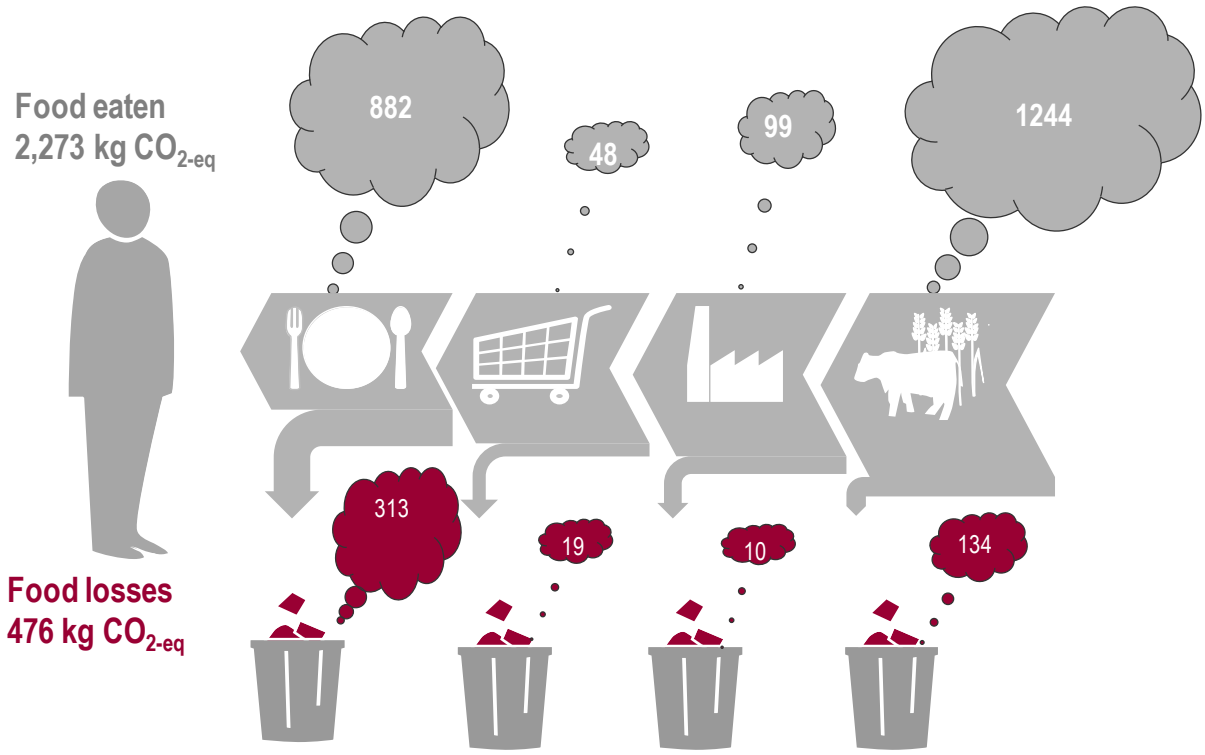
Taking these shopping baskets as a starting point, and taking the upstream steps of the value-added chain including their losses there into account, it is possible to calculate the required primary agricultural production for these amounts of food. Figure 2 illustrates this approach.

Figure 2: Approach for analyzing the value-added chains for food



Natural resources are used at each step of the value-added chain as well as for the transports required between these steps. The food actually eaten in the end as well as the losses that accrue on the path to consumption are each responsible for the environmental impacts that have occurred up to that particular step. The following figure illustrates this, using the example of greenhouse gas emissions.

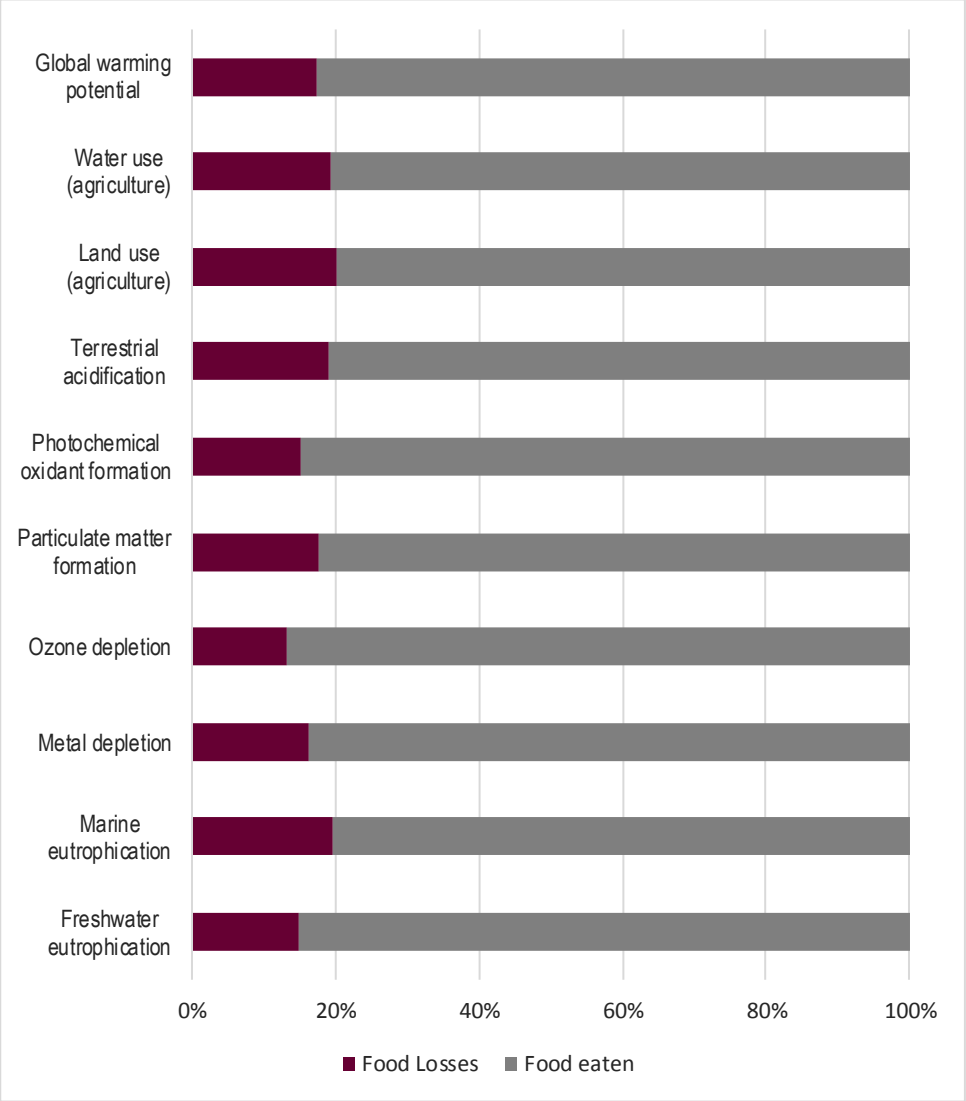
Figure 3: Greenhouse gas emissions along the life cycle (food eaten and food losses) per capita



4 Key results of the estimation of environmental impacts of food losses

Overall analysis of food losses reveals that 13 to 20 percent (depending on the impact indicator/parameter) of the environmental impacts of food consumption in Germany are attributable to the food losses occurring in the various supply chains.

Figure 4: Percentages of environmental impacts of food consumption in Germany due to food eaten and food losses (for different impact categories)



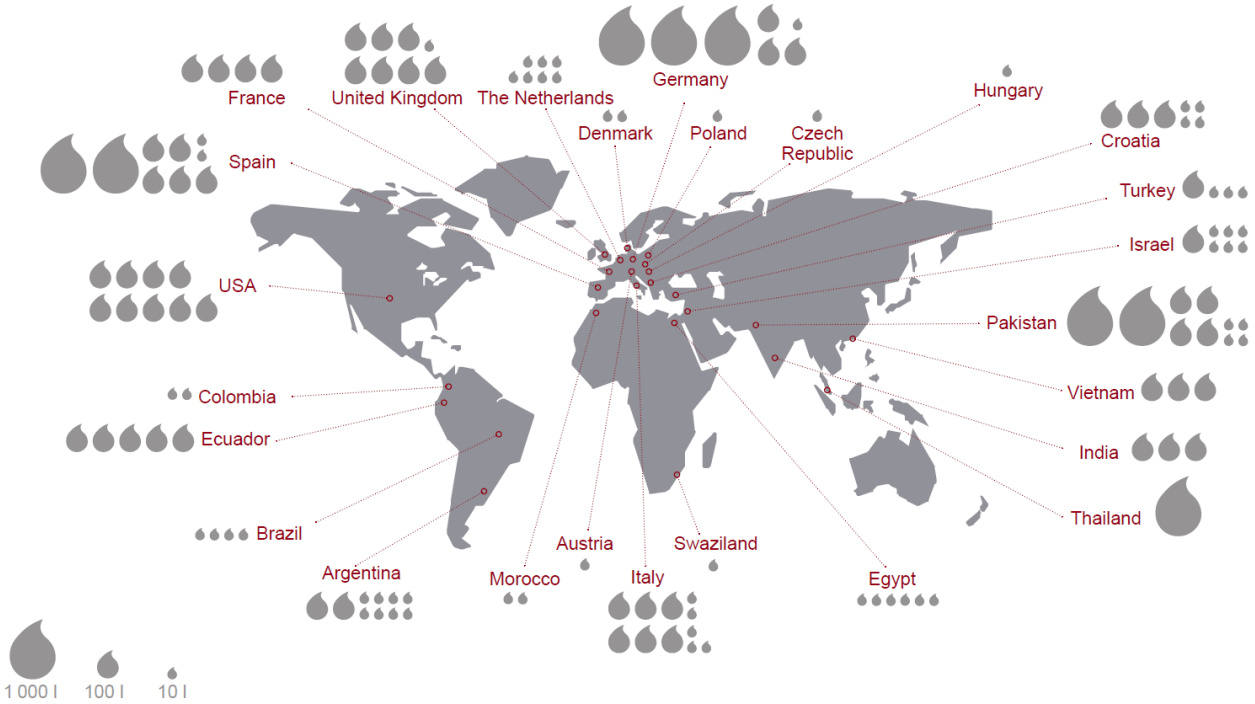
The results of the environmental impact analysis relating to the global warming potential, use of agricultural land, and agricultural water use display the strongest validity in terms of the available basic data and can be interpreted best.

The greenhouse gas emissions from food consumption in Germany make up approx. 23 percent of the country's annual direct greenhouse gas emissions; food losses alone cause greenhouse gas emissions corresponding to approx. 4 percent of Germany's total emissions.

The amount of water required to produce the food consumed in Germany corresponds to approx. one-third of household water consumption in Germany[12]; this corresponds to just under half the amount of water in Lake Starnberg near Munich. Water use caused by food losses accounts for approx. one-fifth of water consumption in Germany. This corresponds roughly to twice the amount of water taken annually from Lake Constance for drinking water.

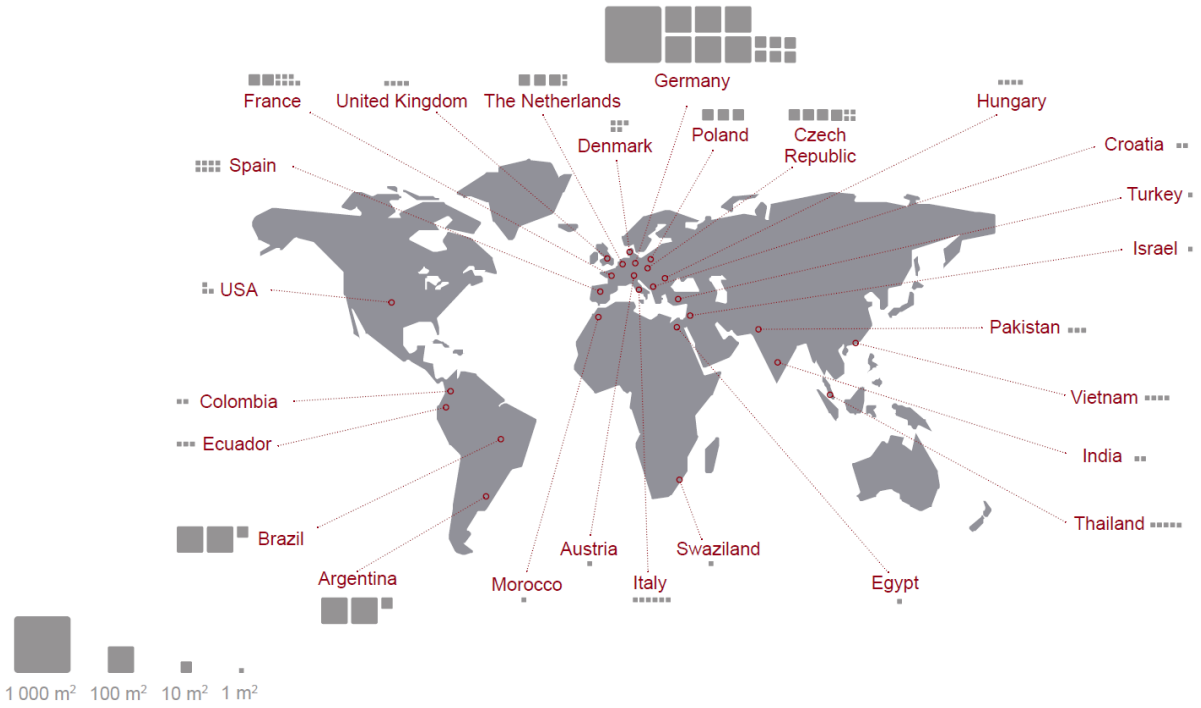
[12] According to BDEW, the German Association of Energy and Water Industries (www.bdew.de), water consumption amounted to 129 liters per person per day in 2010.

Figure 5: Global water use for food consumption in Germany



The amount of agricultural land used globally for our food consumption corresponds to 60 percent of Germany's land area; food losses account for just under one-fifth of this land area, or almost the size of Lower Saxony.

Figure 6: Global land use for food consumption in Germany



In concrete figures, the losses attributable to food consumption in Germany result in the following environmental resource consumption:

Table 2: Environmental resource consumption attributable to food losses in Germany

Environmental resource consumption	Amount per capita and year	Total amount per year for the population in Germany
Global warming potential	0.5 t	38,340 kt
Use of agricultural land	500 m^2*a	43,000 km^2*a
Agricultural water use	2,700 l	216 million m^3

The following must, however, be taken into account when interpreting these results: not all food losses can be prevented[13]; the water is used not only in Germany, but globally; and the land used to produce food for consumption in Germany is not located solely in Germany, but worldwide as well.

The results of the life-cycle analyses per kilogram of food show that products of animal origin cause higher potential environmental impacts in almost all of the impact categories and parameters considered than plant products. The only exception is greater water consumption by plant-based foods. This is evident in particular concerning the amount of agricultural land used: production of animal-based foods requires eight times more land per kilogram of food than production of plant-based foods. The differences are also remarkable concerning greenhouse potential (four times as high). This means that losses of animal-based products result in significantly greater environmental impacts than losses of plant-based products.

Figure 7: Comparison of the greenhouse gas emissions of food losses from animal-based and plant-based food products (in kg CO_2-equivalent per kg of food)

4.1 The impact of geographical origin and cultivation techniques on environmental impacts

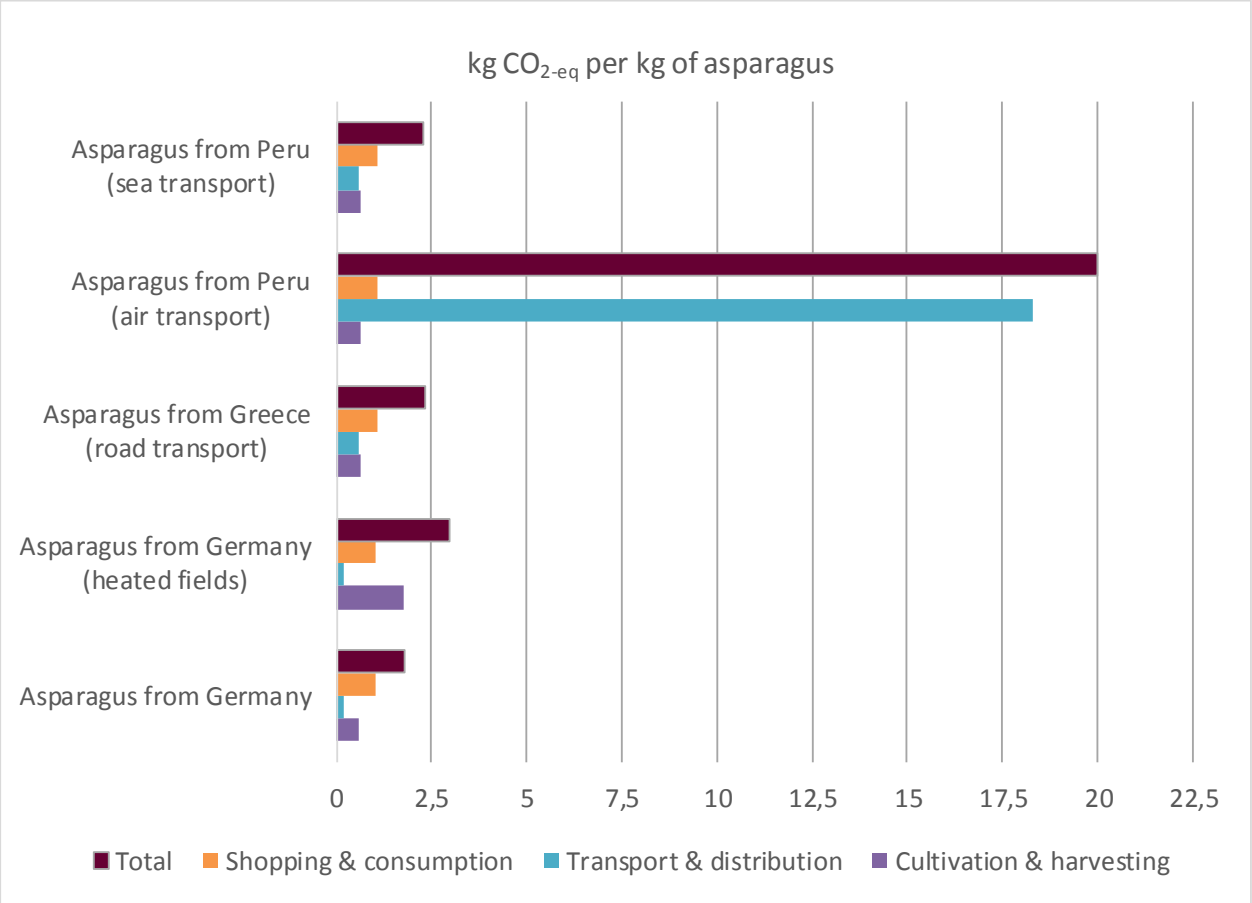
The example of asparagus consumption illustrates the impact of various cultivation techniques and geographical regions of origin on the environmental impacts of food production and thus also of losses.

[13] According to the study by Kranert et al. (2012): Ermittlung der weggeworfenen Lebensmittelmengen und Vorschläge zur Verminderung der Wegwerfrate bei Lebensmitteln in Deutschland, approximately half of all food losses are preventable.

While asparagus flown in from South America is responsible for substantial greenhouse gas emissions because of the high levels of emissions from air transport, the difference between the emissions from trucking from Greece and transporting by ship from South America is only small. The asparagus harvested in season in Germany has the best environmental performance.

However, this rule of thumb does not hold for domestic asparagus from heated cultivation. Even if the heat (warm water) used for heating the fields is waste heat that can be considered emission-free, the electric pumps that pump the warm water through the fields consume a substantial amount of electricity. The greenhouse gas emissions of the heated asparagus are thus 30 percent higher than for asparagus imported by ship from South America or by truck from Greece.

Figure 8: Asparagus consumption—greenhouse gas emissions depending on geographical origin, type of transport, and cultivation technique



4.2 Conclusions from the environmental evaluation of the occurrence of food losses

From an environmental perspective, the following conclusions can be drawn concerning the prevention or reduction of food waste:

- Food losses from animal-based products are associated with significantly higher environmental impacts than food losses from plant-based products. For this reason, preventing them should be granted higher priority.
- The percentage of food losses per product used is significantly higher for away-from-home consumption compared to at-home consumption. At the same time, good handling practices, careful planning and/or other forms of offering and serving food products to consumers can achieve a

reduction of food losses quite easily. For this reason, measures for preventing losses should focus primarily on this area.

- Efforts should be made to improve the data for the shopping basket of food goods for away-from-home consumption to enable better determination of the percentage of food losses and better tracking of developments.
- Some of the value-added chains for food are very long and have numerous steps. The environmental impacts of a food increase with each processing and/or transportation step. Preventing the loss of one kilogram of ready-to-eat potatoes by consumers has a greater effect than preventing the loss of one kilogram of potatoes in agriculture. For this reason, preventing losses of products with long value-added chains should be granted higher priority.
- As a rule, in the case of fresh products (e.g., regionally grown asparagus), there are fewer food losses from spoilage. The environmental impacts of foods consumed can be reduced by avoiding long supply chains with many steps.
- The available data on food losses is unsatisfactory, especially for the food processing industry. In order to set priorities for reduction efforts rationally and based on environmental relevance, it is essential to determine the amounts of waste occurring, differentiated according to production areas and types of food. The same is also true of food wholesaling and retailing as well as away-from-home consumption; data differentiated according to the amounts of food waste are not available for these areas, either.

5 Measures proposed

Eleven current secondary studies were evaluated for this study, and a total of 113 proposed measures were identified which could in principle be suitable for contributing to a relevant reduction of food losses.

However, a comparative evaluation of these proposals revealed that a rather limited number of approaches actually different in substance underlie the large number of individual proposals.[14] These approaches can be differentiated roughly as follows:

- Measures for designing a (policy) framework
  e.g., definition of quantified reduction goals (including clarification of terms and concepts); increase of the economic value (taxes/fees); mandatory requirements for food industry operations; dialogues and forms of cooperation concerning waste prevention
- Measures relating to individual aspects
  e.g., support of food banks, adaptation of (waste-generating) marketing standards, labeling of low-waste products, changes to the best-before date, adaptation of hygiene standards to prevent waste, use of appropriate serving sizes in OHC, support for research on solutions preventing waste
- Measures for increasing appreciation of food
  e.g., awareness campaigns, integration in vocational education and training, support of small-scale/regional (direct) marketing structures

In addition, there are proposals for more structurally oriented measures, e.g., the establishment of a (government-funded) agency that would bundle and implement such measures, or the suggestion that all relevant government agencies collaborate in a coordinated fashion.

[14] This is due in particular to the fact that many of the available studies refer to other studies. However, only some of them explicitly mentioned this fact. As a result, identical proposals for measures, which are presented slightly differently, are often to be found.

A comparison of the number of non-binding measures, i.e., voluntary measures and measures involving appeals or information, to that of (legally) binding measures reveals that the majority of proposals are of a less binding nature. In addition, in the case of most of the proposed measures aiming at binding legal rules and regulations, it remains unclear or open how they can or should be translated into binding legal regulation.

That the tools developed are "vague," i.e., undifferentiated, arises from the fact that (almost) all of the measures proposed to date are theoretical approaches that are not based on practical experience with implementation. This has particularly serious consequences for the "identification of effective measures towards the reduction of relevant amounts of food waste" because it means that it is not possible to gain any insights about the practical efficacy and potentially existing difficulties in implementation by evaluating the secondary studies.

5.1 Development of measures on the basis of available legal instruments

In order to fill the existing gap relating to legal instruments as the basis for possible reduction measures, the present study examines legal opportunities and available instruments.

This involves the following steps:

- Definition of a framework for analysis for examining possible legal instruments
  This step focuses on approaches that can be initiated by government agencies and that are sufficiently binding, so that they result in waste-prevention activities on the part of the (market) actors addressed by the approaches;
- Examination of the applicability of existing rules and regulations in (environmental) law for the area of food production and use for achieving the effects intended as a matter of principle;
- Derivation of opportunities for applying the tools suitable in principle;
- Elaboration and evaluation of concrete proposals for measures on the basis of the previous steps of the analysis, including the evaluation of the secondary studies and the discussions with experts in the relevant fields.

The examination of available (legal) instruments conducted according to this procedure reveals that the existing legal framework in Germany provides a number of opportunities for binding government action, concerning both the creation of the urgently needed robust information and the implementation of "best handling and management practices" in food-industry establishments. However, the effective application of these tools requires the corresponding political decisions on the part of legislature.

5.2 Measures proposed by the authors of the present study

With a view to these results, and aware of the desire of numerous actors on the level of the Federal Länder and in cooperation networks on the topic for support from the federal level in the areas of fundamentals and definition of a framework, the authors of the present study propose to the Federal Environment Agency and the Federal Environment Ministry a set of five measures in the context of further implementation of the AVP:

5.2.1 Measure I: Analyses of the existing situation and derivation of "best practices" for selected areas of the food industry

A documentation of "best practices" in terms of waste-preventing process management and handling practices should be prepared for selected areas of the food-manufacturing and food-processing industries.

This type of compilation of waste-preventing "best practices," which in addition includes typical practical reference values for the relevant waste rates or the like, constitutes a key point of reference

both for possible regulatory interventions[15] and for cooperative efforts towards waste prevention involving both governmental and food-industry actors.[16] Thus, this measure also serves directly to implement the general "waste prevention measures in businesses" recommended in the AVP as well as the "concerted actions and agreements between public institutions and industry and trade" that are more specific to food.[17]

The authors of this study recommend the development of reference documents on waste-preventing best practices specifically for selected areas of the food-processing industry in the context of this measure. The information available to date on waste rates[18] suggests that they should focus especially on establishments involved in OHC.[19]

When formulating best practice, it is in some cases possible to draw on existing pilot projects (e.g., for cafeterias); in addition, relevant sector analyses are to be carried out[20] in order to develop core requirements and parameters on this basis that are robust and transferable, and thus verifiable.

In light of the existing pressure to act in the area of food waste prevention, if a robust set of information for fact-based planning of further measures is to be generated within a reasonable time frame, it appears sensible to implement these measures in a manner coordinated between the federal and the Länder levels. This could mean that following the applicable process of coordination, the federal government and various Länder would conduct relevant surveys, each in different sectors of the food industry that could then be assembled to create an overarching analysis of the existing situation.[21]

Informative representations of good management practice and the relevant reference values developed on the basis of the analyses of the existing situation must be prepared; they should be differentiated for the various types of operations, food processing processes, and forms of distributing and serving food. Active, cooperative collaboration with the market actors in the relevant sectors during this process would be a reasonable approach.

5.2.2 Measure II: Initiation of a high-level round table on prevention of food losses

This involves a bundle of measures with the following elements:

- Clear political definition of the desired overarching reduction goals and high-priority areas of action. At least the EU Commission's 30% reduction goal[22], which serves as orientation, should be defined as a binding national target by the responsible ministries and/or the federal govern-

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15 For example, the formulation and application of requirements for implementation in accordance with Section 5 Paragraph 1 Sentence 1 No. 3 Federal Immission Control Act as well as potentially necessary ordinances in accordance with Section 22 Federal Immission Control Act.

16 For example, the formulation and monitoring of substantial reduction goals and reduction measures.

17 For both, cf. AVP, p. 30.

18 As has been frequently explained, the information available in the context of discussions about preventing food waste is not (yet) sufficient in terms of its degree of detail—both in terms of the amounts of waste and in terms of the composition of the waste for the different types of operations—for policy-makers to conclusively set priorities for such activities.

19 From the perspective of environmental relevance, in particular those sectors are important in which animal-based products, i.e., meat in particular, are processed.

20 The results available to date from individual studies of businesses used as examples should be called into question in terms of their broad transferability to other cases, both because of the relatively small numbers of businesses and because the businesses participating in the studies tended to be proactive pioneers.

21 Proceeding in this way, with the goal of generating substantially new information using a division of labor, would be significantly more efficient overall that the situation to date.

22 This refers to the proposal for a 30% reduction goal in the Communication of the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Towards a circular economy: A zero waste programme for Europe" (COM/2014/0398 final) of 2 July 2014.

ment, and it should be made more concrete, as far as possible, by means of a clear benchmark and interim goals.

- Initiation of a round table on the prevention of food losses with high-level representatives at least from:
  1. the ministries involved (consumer protection, environmental protection, and economic affairs) at the federal and the Länder levels,
  2. food wholesalers and retailers (representatives of the large chains as well as regional businesses),
  3. the food-manufacturing sector, and
  4. the food-processing sector.
- Cooperative support of the process (limited in terms of space and time) of determining the amounts and types of food waste in the various sectors of the industry [23]
- Joint formulation of differentiated subsector-related reduction goals and the corresponding reduction measures.
- Establishment of a transparent and informative reporting and monitoring system to monitor the jointly formulated reduction strategy and to support external reporting.[24]

The authors of the present study recommend that this bundle of measures be taken up as soon as possible. Before starting discussions at the "round table", the willingness of key actors of the food industry to participate and actively support it is to be ascertained. This also includes clarifying possible reduction goals for which consensus could be achieved at such a "round table".[25]

5.2.3 Measure III: Integration of waste prevention in the practical implementation of food hygiene

Conflicting goals may exist in areas where the implementation of protective and preventive food hygiene measures and the efforts to waste as little edible food as possible overlap.[26] For this reason, it is reasonable to work towards the following goal: the aspect of discarding edible food or food commodities should be granted appropriate importance when making the required trade-offs in situations where the implementation of food-hygiene requirements provides scope for discretion.

In the practice of food-establishment operations as well as governmental implementation, best-practice guidelines provide orientation for concrete procedures when implementing food-hygiene requirements. Such guidelines are an important element in the concept underlying the European

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[23] According to the expert opinion of the authors of this study, systematic, government-initiated analyses of the existing situation as described in Measure I are essential, and this is also true in the context of the cooperative approach of Measure II. The expert discourse on food waste prevention shows clearly that even within the bodies of industry trade associations, such information is, with a few exceptions, not available.

[24] For example, in the context of periodic reports on the implementation of the national AVP.

[25] Such a consensus should encompass at least the joint development and implementation of measures for effectively reducing food waste occurring in Germany as well as an agreement on a reporting system for documenting the reductions achieved.
The identification of robust facts about the existing situation as well as the establishment of a transparent and robust monitoring system for food waste occurrence would be more ambitious goals.

[26] Such overlaps exist, for example, in areas where food that is even only potentially hygienically compromised must be discarded in order to implement the precautionary principle; or if food is no longer classified as edible after a certain period of time, e.g., at service counters; or if standards prove to be obstacles to reclassification and utilization of suitable raw materials.

Regulation on the hygiene of foodstuffs[27]. According to Articles 8 and 9 of that regulation, guidelines can be prepared, developed, and disseminated at the European or the national level, respectively.

In practice, the majority of guidelines relevant to the various processes of food manufacture and use are prepared or proposed by trade association bodies at national level and are being reviewed by the responsible bodies of the federal Länder according to the "procedure for reviewing guidelines for good procedural practice" set forth in Section 5 of the General Administrative Regulation on Food Hygiene[28].[29]

In the guidelines, best-practice requirements and procedures have been formulated exclusively in terms of food-hygiene considerations (to date). Cross-ministry coordination would make it possible to review in which way waste-prevention aspects could be reflected in such guidelines and thus be implemented concretely in terms of food law.

5.2.4 Measure IV: Support of food bank concepts by limiting liability risks

Food banks collect qualitatively unobjectionable food that could not be sold by wholesalers and retailers and give it to the needy. There are currently more than 900 food banks in Germany, most of which are not-for-profit organizations. Across Germany, they support more than 1.5 million people in need with food.[30]

For example, food donated by retailers is handed out by the food banks, usually free of charge. The best-before date of many of these food items has passed or is about to pass. If retailers carefully examine these food products and explicitly mention this issue to the food bank operators, this does not pose a legal problem. However, if rotten food items are contributed to a food bank by mistake and are then given to a person in need, causing this person to suffer damage to his/her health, the retailers' liability for damages cannot be generally excluded.

According to representatives of wholesalers/retailers as well as food banks, it should be assumed that the remaining legal uncertainty means that some food products that could be given to food banks in fact are not. In light of the ecological and social win-win situation resulting from not-for-profit food banks being provided with food that is still edible, it seems desirable for society as a whole to remove, as far as possible, potential obstacles to wholesalers/retailers donating such food to food banks.

The authors of this study believe that it appears sensible to review in depth whether the establishment of a liability fund financed in equal parts by the government and retailers could be an effective means to address this problem. A fairly low financial commitment—due to the surely low probability of occurrence—could provide a clear signal of both the joint responsibility of the government and the business community and society's appreciation of the concept of food banks.

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27 Regulation (EC) No. 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs, OJ EU L 139 of 30 April 2004, p. 1.

28 General administrative regulation on the implementation of official monitoring of compliance with hygiene regulations for animal-based food and on the procedure for reviewing best procedural practice guidelines (AVV Lebensmittelhygiene – AVV LmH) of 9 November 2009, last amended by administrative regulation of 20 October 2014 (BAnz AT 07. 11. 2014 B2).

29 Depending on the area for which the guidelines are applicable, different Länder are responsible for coordinating this review. These responsibilities are set down in Appendix 5 to the AVV LmH. For example, Bavaria is responsible for coordination in the area of the food service industry, institutional food services, and fast food outlets.

30 Cf. Bundesverband Deutsche Tafel e. V., http://www.tafel.de/.

5.2.5 Measure V: Development of information modules on environment-related significance of food wastes

A consistent estimate of the environmental impacts of the occurrence of food waste was prepared for the first time in this project. This shows, impressively and differentiated according to various impact categories and regional impact areas, the environmental consequences of food being discarded in terms of environmental inputs that went into producing them.

This information may be considered as an important contribution by the Environment Ministry to raising awareness on the part of consumers and market actors in terms of careful, waste-preventing handling of food.

If the above-mentioned information is to reach this broad audience, it needs to be presented in easily comprehensible form and to be disseminated by means of appropriate information campaigns.

In light of the large number of ongoing efforts to provide information and raise awareness about food waste, the authors of this study do not consider it necessarily expedient for the Environment Ministry to launch a new, additional campaign. Even today, it can be observed that interested citizens tend to be confronted with information overload and the corresponding difficulties in finding expert orientation.

Against this background, it appears advisable to review whether the information generated can be integrated in a targeted fashion in ongoing information campaigns and other ways in which information is provided by agencies at the federal or Länder level.

6 Conclusion

The estimates conducted on the environmental impacts of food consumption in Germany clearly demonstrate that food losses entail serious climate impacts and additional resource use. For example, the food losses cause greenhouse gas emissions corresponding to roughly 4 percent of Germany's total emissions. In the breakdown of food losses available to date, the large amount of waste in away-from-home consumption in particular is striking: roughly one-third of the food consumed here is not eaten in the end.

The legal analysis shows that German environmental law offers ways to effectively call for both generating an informative set of information on types and amounts of waste and implementing good management practice in the establishments involved in the food industry. With a view to possible non-binding approaches, the authors of this study recommend the establishment of a round table with high-level members as well as other measures in order to implement the German AVP. In this context, it should be explored whether these two key aspects could also be implemented on a voluntary basis and still be sufficiently binding and informative. A reduction goal should be set as a point of reference for such activities; the goal should use the EU Commission's proposals for a 30% reduction of food losses as a point of orientation.

Appendix: Additional information and facts on food losses and their environmental impacts

Figure 9: Material flows and loss rates in the value-added chains (IHC)

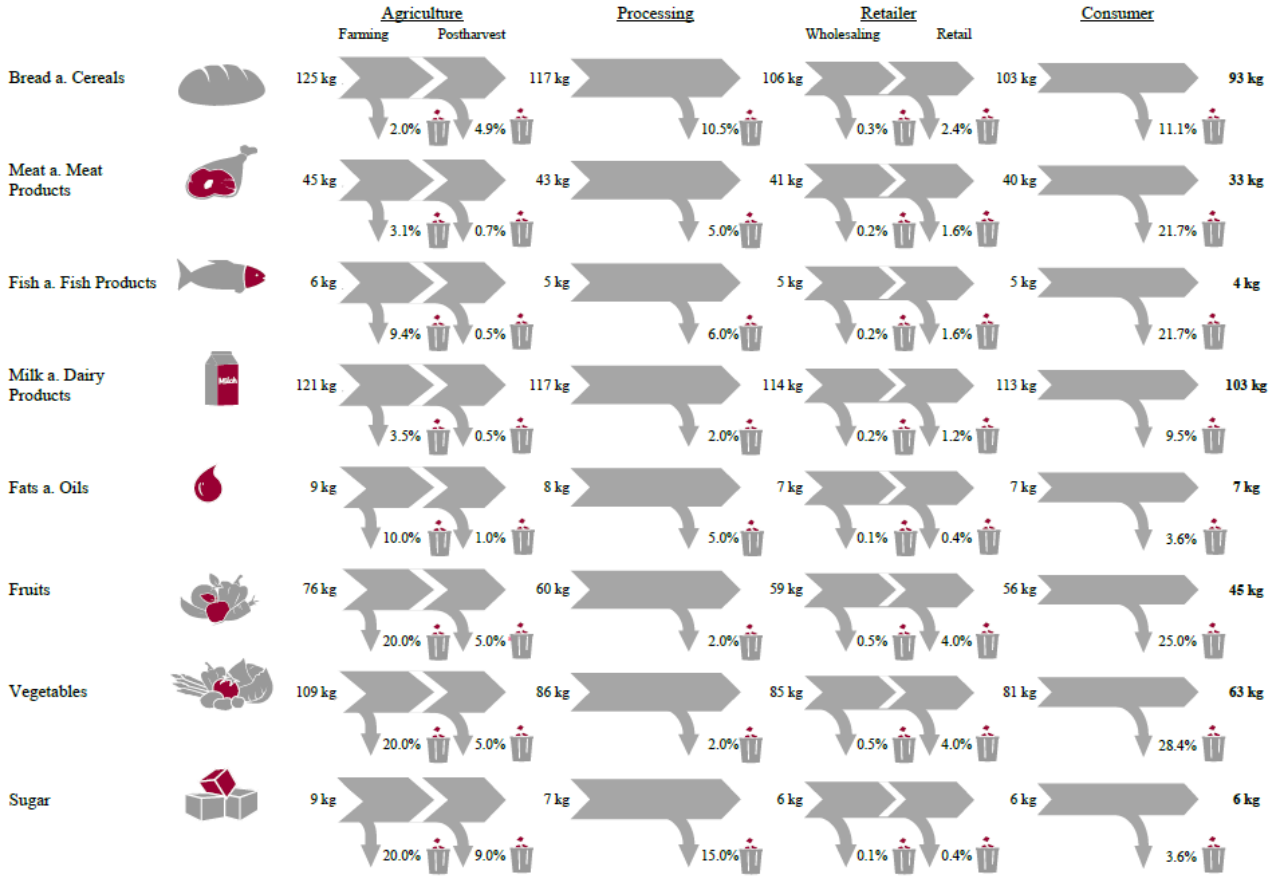

Figure 10: Material flows and loss rates in the value-added chains (OHC)

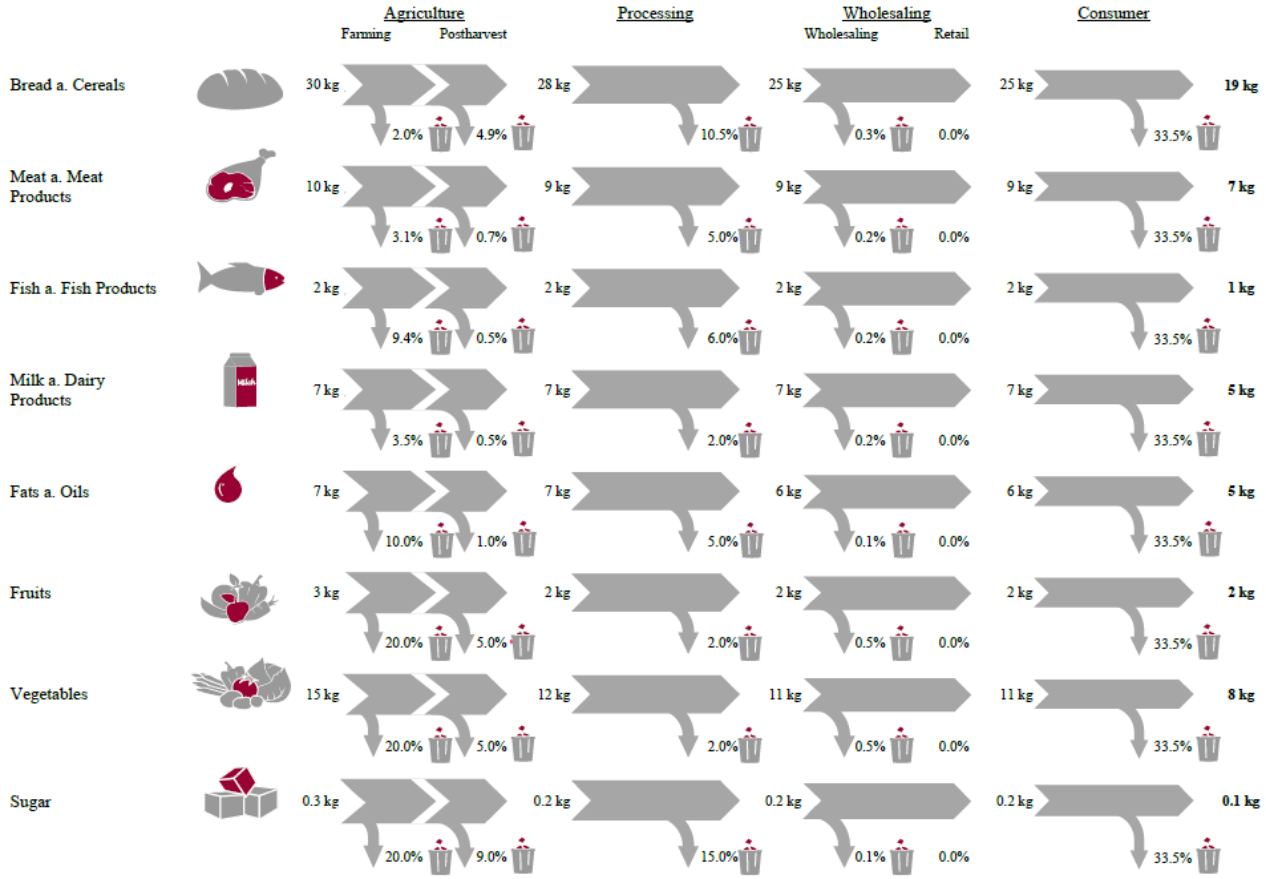

Table 3: Environmental impacts due to food losses per person per year, by life-cycle phases

Impact category (parameter)	Unit	Agriculture	Processing	Trade (whole-sale, retail)	Consump-tion	Total
Global warming potential	kg CO_2 equivalents	313	19	10	134	476
Fossil depletion	kg oil equivalents	54	4	3	48	109
Freshwater eutrophication	kg phosphor equivalents	0.030	0.014	0.009	0.1	0.154
Marine eutrophication	kg nitrogen equivalents	0.188	0.037	0.025	0.028	0.255
Metal depletion	kg Fe equivalents	4.1	0.2	0.2	6.8	11.3
Ozone depletion	mg CFC-11 equivalents	11.9	0.884	0.548	12.2	25.5
Particulate matter formation	kg PM-10 equivalents	0.52	0.01	0.01	0.11	0.65
Photochemical oxi-dant formation	kg NMVOC	1.83	0.67	0.66	6.32	9.47
Terrestrial acidification	kg SO_2 equivalents	3.00	0.03	0.01	0.29	3.33
Land use (agriculture)	m^2*a	539				539
Water use (agriculture)	l	2,689				2,689