The Taste of the Future. Culinary Compass for a Healthy Planet

Methodology report

The report was developed by corsus - corporate sustainability ltd. on behalf of WWF Germany as part of the studies "The Taste of the Future: A Culinary compass for a healthy planet"

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Content

Terminology

Food consumption:	Food consumption is defined as food consumed at the end consumer level, including all food consumed and disposed of in households.
Food intake:	Food intake is defined as all food consumed at the end consumer level, i.e. food purchased minus food disposed of in households.
Food waste:	Food waste is defined as food and food components that are not consumed but disposed of at the end consumer level (in households or outside the home). No distinction has been made between avoidable and unavoidable food waste at the end consumer level.
Food loss:	Food loss is defined as food that is disposed of across the value-adding chain in agriculture, food processing and trade. Loss occurring at the farm level, e.g. when crops are not harvested, is explicitly included. Though technically, these crops are not food yet and are therefore often not categorized as food loss, they are part of food consumption from an environmental perspective.
Market basket products:	Market basket products are food products sold on the retail level, e.g., baked goods, milk, nuts, bananas.
Agricultural products:	Agricultural products are products of agricultural crop production, e.g., wheat, apples, dates.

1. Introduction

Our current dietary habits are unsustainable. This is true from an environmental, social and health perspective. According to World Hunger Relief, one in 11 people worldwide suffered from hunger in 2019, while the prevalence of obesity worldwide has almost tripled since 1975 (WHO 2018). The impact our diet has on the environment is immense. Agricultural and food systems have a strong impact on all four of the planetary boundaries that have been crossed already – climate change, genetic diversity, land-system change, and biochemical flows, e.g. phosphorus and nitrogen (Steffen et al. 2015, Campbell et al. 2017).

Thus, agricultural production is responsible for roughly 25% of global greenhouse emissions (IPCC 2014). The anthropogenic loss of biodiversity is also closely linked to food production (Crist et al. 2017). (Intensive) agriculture is often associated with, among others, nutrient oversupply and pollution of (ground) water, land-use change, deforestation, monocultures, and intensive use of pesticides – all of which have a negative impact on biodiversity (Newbold et al. 2016, Dudley and Alexander 2017).

It follows that sustainable food production and consumption is an important building block of sustainable development (Reisch et al. 2013). It is essential that we transform our food systems in order to stay within the planetary stress limits (Rockström et al. 2017, 2020). Against this background, this study analyzes the environmental impact of the food system in Germany.

2. Objective

This study aims to (1) provide an analysis of the environmental impact of nutrition in Germany and (2) show how changes of our dietary behavior may influence this environmental impact (status quo).

To this end, we have examined the following parameters:

- Climate change (excluding emissions from land-use change)
- Greenhouse gas emissions from land use and land use change
- Water consumption and water scarcity
- Land use
- Biodiversity

To show the influence of changes in dietary behavior, the study considers three scenarios in addition to the status quo:

- flexitarian diet
- vegetarian diet
- vegan diet

All three scenarios were developed based on the EAT-Lancet Commission guidelines (Willet et al. 2019).

To the extent possible, the results have been compared with similar analyses carried out by WWF Germany in previous years (WWF 2015).

3. Approach

Our approach is based on the methodology described in Eberle & Fels (2016) and Jepsen et al. (2016). The impact of dietary habits on the environment and climate is considered based on the "market basket" of food consumed annually on average per individual in Germany. This market basket contains the sum of foods consumed on average over the course of one year. Food consumption includes all food consumed at end consumer level, i.e. the totality of food that is consumed or discarded in German households. The material flows of the foods in the market basket have been traced back to their origins in agricultural production (Figure 1).

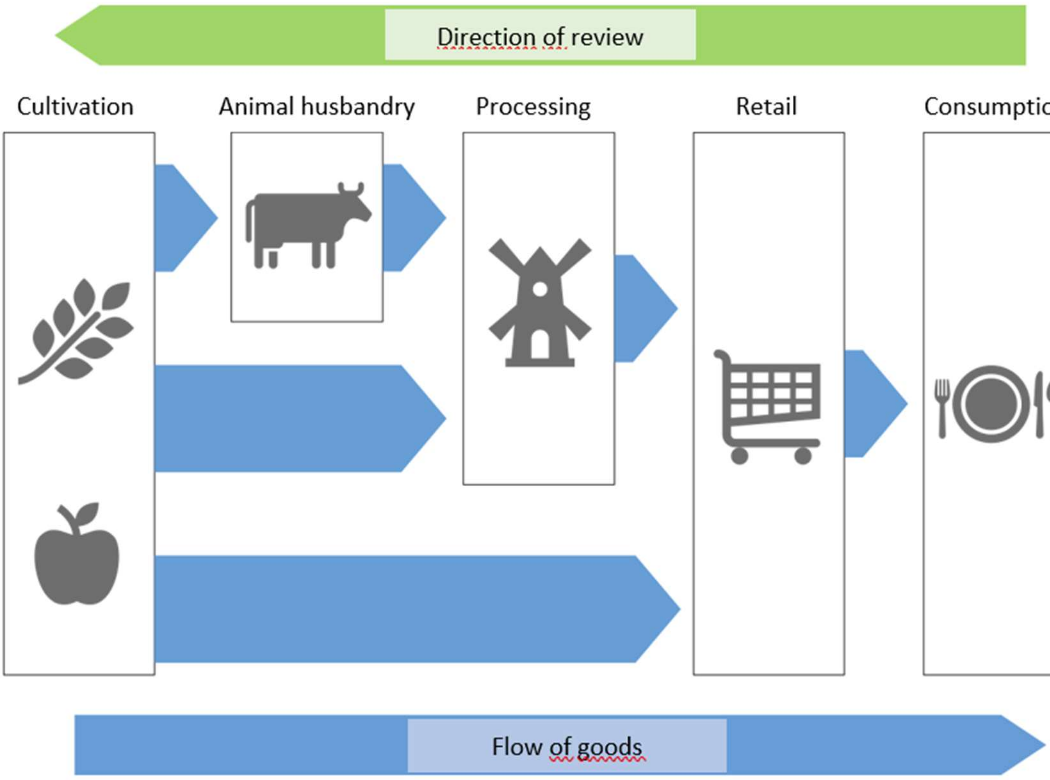

Figure 1: Approach to the calculation of environmental impacts.

The respective life cycles of the foods contained in the market baskets are of varying complexity. Thus, it is comparatively easy to trace the life cycle of an apple produced and consumed or discarded in Germany. As a rule, the apple is sold through German food retailers, who typically source it from wholesalers, who, in turn, source it directly from agricultural producers (either cooperatives or individual farmers). There are no additional processing steps; sometimes even the wholesale step is omitted.

In the case of the aforementioned apples, we'd first have to research the volume of apples consumed at the end consumer level as well as the losses across the life cycle in retail, wholesale, and agriculture. Based on the results, we can calculate the volume of apples that need to be produced to cover the demand for apples in Germany. To balance the environmental impact involved, however, we also need to know how the apples are stored and prepared in the household, the apples' journey from the orchard to the end consumer, the length (distance) of this journey, and the energy consumption for storage and logistics on site at the retailers. Last but not least, we need to know how the apples were grown in the orchard, which includes factors like energy consumption, water consumption for irrigation, the area needed and the fertilizers and pesticides used.

However, not all apples sold in Germany are produced in Germany. Some are sourced from other countries. Additional research is therefore required to determine the quantities sourced from individual countries, the corresponding environmental impact of agricultural production in each of the supplier countries, and the means of transport used to get the apples to Germany.

While plant-based foods in particular have comparatively simple lifecycles, animal-based foods like meat and dairy products are quite a different story. They always involve at least two more processing steps – livestock farming and product processing, e.g. dairy or meat processing. Animal husbandry requires feed (e.g. grass, grain, soy), which has to be grown and, in some cases, also requires further processing steps (e.g. soybean extraction). Plus, the co-products involved need to be considered. For example, dairy cows only give milk after calving at least once. This must also be reflected in the calculation. An allocation of the environmental impacts to the co-products is required at this point.

To make matters even more complex, the countries from which food is imported to Germany may vary from year to year as yields may fail due to climate and weather influences, resulting in price changes. This can lead to outliers in the resulting environmental impacts, e.g., when products are imported from far away. To compensate for such fluctuations, we based our analyses on three-year averages of the statistical data.

4. Method and scope

To analyze the environmental impact of food in Germany, a life cycle assessment was carried out in accordance with ISO 14040/44 for selected impact categories and life cycle inventory parameters.

The following describes the scope of the investigation.

4.1 Functional unit

The functional unit for the study is the average food market basket for one year per person.

The German food market basket reflects the average food consumption per person over the course of a single year in Germany. The food market basket includes all food consumed at the level of the end consumer. "Food consumed" includes both the ingested food and the generated food waste.

4.2 System boundaries

The system boundaries identify which processes are included in the investigation (within the system boundaries) and which are not considered (outside the system boundaries).

The system studied includes the cultivation of agricultural products through consumption and is divided into five stages (Figure 2):

- **Stage 1: cultivation**
  Includes the cultivation of plant-based agricultural products for food consumption, including inputs (fertilizers, water, etc.), energy and land. Transportation, food losses and direct emissions during this stage are also taken into consideration.
- **Stage 2: livestock farming**
  Includes feed consumption, energy consumption and transport, as well as food losses and direct emissions occurring at this stage.
- **Stage 3: processing**
  Food processing, including the energy required and the transport involved, as well as the food losses occurring at this stage.
- **Stage 4: trade & distribution**
  Includes wholesale and retail food trade, including the energy required, refrigerant consumption and transportation involved, as well as food losses incurred at this stage.
- **Stage 5: consumption**
  Includes journeys to the supermarket, the energy required to store and prepare food, cleaning of cooking and eating utensils, and food waste generated at this stage.

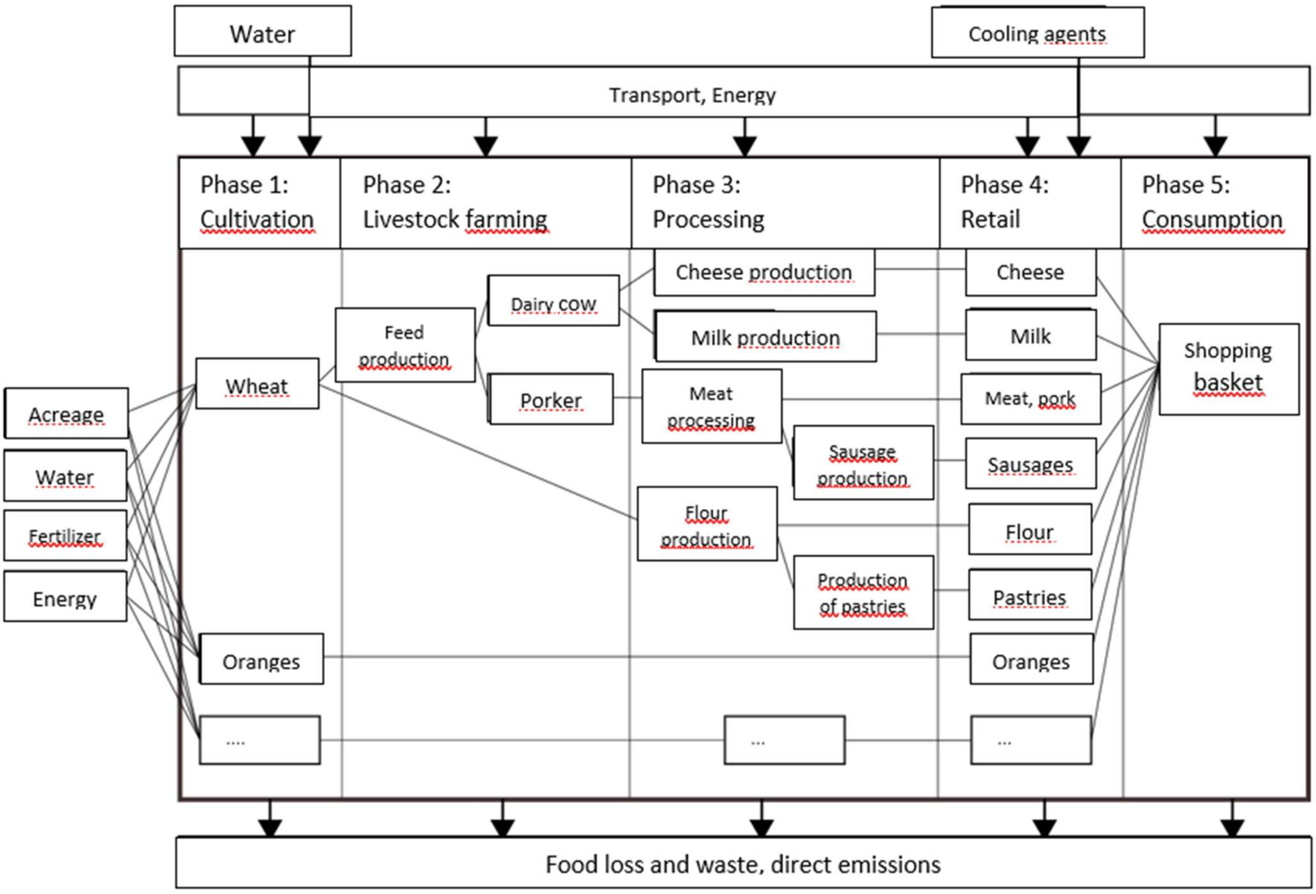

Figure 2: System boundaries of the study (shown by example products: Wheat, dairy and meat products, oranges).

Figure 2 shows an example of the various processes inside the system boundaries for the starting products wheat and oranges:

- The wheat produced in stage 1 is processed in several ways down the line. It is used as animal feed in livestock farming (stage 2) or further processed into flour (stage 3), with different subsequent processing steps in each case.
- Oranges, on the other hand, are delivered directly to the food trade without further processing.

The following lie outside the system boundaries:

- Disposal or recycling of food losses and waste generated during the different stages;
- use of pesticides;
- water consumption in livestock farming, processing, the food trade (cleaning) and households (washing dishes, cooking);
- land used for non-agricultural processes (industry, trade, etc.);
- food packaging (product packaging and transport packaging).

4.3 Scope of coverage

The study covers the years 2015 through 2017. The 3-year timeframe was chosen to offset fluctuations in the composition of the food market basket, particularly at the level of the respective upstream chains. Insofar as data from other years are considered this has been identified.

Geographically, the study covers Germany and its market basket. For the upstream chains (cultivation and livestock farming), the respective country-specific conditions are considered. All further processes, including processing, trade and consumption, refer to the situation in Germany.

The technical coverage represents the status quo of the reference years.

4.4 Evaluated life cycle inventory parameters and impact categories

In line with the study objective, three life cycle inventory parameters and three impact categories have been evaluated.

4.4.1 Material balance sheet parameters

Water consumption

Water consumption is defined as the portion of freshwater consumption that is not returned to its same source – i.e., the amount of water that leaves the system and is therefore "consumed". This distinction is essential for considering water scarcity. This definition of water consumption is generally consistent with the specification of so-called "blue water" use in Mekonnen and Hoekstra (2010). "Blue water" describes water used for irrigation in agriculture, as opposed to "green water", which is defined as water from precipitation. Water consumption is listed by type of crop as well as country.

In aquacultures, the above definition of water consumption is typically not applicable as the water used is returned to the same system, albeit in a potentially different quality.

Land use

Land use refers to the use of an area over a defined period of time. The types of use may vary widely – from arable farming and mining to roads and residential land. For the purposes of this study, land use refers exclusively to agricultural land use for livestock and/or crops. Land use is listed by country and agricultural product. As a crucial balance sheet parameter for numerous environmental impact categories, including soil quality and biodiversity, land use is a good indicator (Meier et al. 2014).

4.4.2 Impact categories

The impact assessment assigns the results of the material balance sheet to their corresponding environmental impact categories and assesses their potential environmental impact. To calculate the environmental impact potential, individual inputs or outputs are characterized in relation to a key substance.

In the context of the study, potential environmental impacts are assessed for the impact categories climate change, emissions from land use changes, and water scarcity.

Climate change

The impact category climate change captures the effect of human-induced greenhouse gas emissions on the increase of radiative forcing through absorbed infrared radiation in the atmosphere. Increased radiative forcing leads to rising temperatures on the planet Earth, commonly referred to as the greenhouse effect.

The greenhouse effect is described by the greenhouse potential indicator. The global warming potential expresses the contribution of anthropogenic emissions to the greenhouse effect. It is expressed as the CO_2 equivalent. The life cycle assessment for this study considers the global warming potential for a time horizon of 100 years.

There are various gases responsible for the greenhouse effect. The study covers the so-called Kyoto gases (carbon dioxide, methane, nitrous oxide, fluorinated and perfluorinated hydrocarbons (HFCs, PFCs), sulfur hexafluoride) as well as nitrogen trifluoride. As the respective greenhouse impacts of these gases vary widely, the gases are characterized in terms of their specific global warming potential relative to carbon dioxide. The individual contributions are then aggregated to form the total global warming potential.

To provide an example, the impact of nitrous oxide develops over a period of 100 years is 265-fold more harmful effect than that of carbon dioxide. One kilogram of carbon dioxide plus one kilogram of nitrous oxide therefore equals an equivalent of 266 kilograms of carbon dioxide (1 plus 265), also written as 266 kg CO_2e (as in 266 kg CO_2 equivalent). The increase of radiative forcing is determined using the Intergovernmental Panel on Climate Change characterization model (IPCC, 2013).

There is general agreement in the scientific community on the impact category climate change and its scientific method of quantification. It is an impact category with a global effect – it is irrelevant where and in what concentration the greenhouse gas emissions occur, they have a global effect on the atmosphere. Furthermore, it is the impact category for which the most comprehensive and reliable information has been recorded to date. Due to all these circumstances, the impact category climate change can be classified as very objective, which overall supports the robustness of the results.

Greenhouse gas emissions resulting from land use change

The calculation of greenhouse gas emissions from direct land use change (dLUC) is based on the direct land use change assessment tool developed by Blonk Consultants (2014). This tool is used to calculate the extent to which land expansion (at the expense of other types of land) took place, based on country-specific data on statistically recorded harvest volumes for specific crop types and the cultivated areas required for this purpose. Land use change was calculated for the period under review, i.e., 1990-2010. Based on the results it is possible to determine how, for example, the increase in grape crops in Peru led to a conversion of land that was earlier used for other purposes (in this case, forest land). Land use changes from forest to permanent crops, pasture or arable land (i.e., deforestation) has significant impact on carbon contents above and below ground, leading to the corresponding CO2 emissions, which were taken into account here on a product- and country-specific basis.

Water scarcity

Water is distributed very unevenly around the world. Merely knowing how much water has been used does not allow us to make conclusions about the environmental impact associated of said water consumption. Water consumption is the amount of water that leaves the system and is not returned to its original source. When a cooling a power plant uses river water, some of that water will be returned to the river while some evaporates. The evaporated portion thus leaves the regional system. It is therefore essential to take local conditions into account, and in particular to consider water availability.

For the LCA presented here we used the AWARE impact assessment method (Boulay et al. 2017) to consider the environmental impact of water consumption. Water scarcity calculations based on the AWARE method consider water consumption in combination with regionally specific factors (characterization factors similar to those used for global warming potential). The characterization factor is determined by the ratio between available water and consumed water. Water demand includes both anthropogenic water consumption and natural water demand. The indicator "scarcity-weighted water consumption" in m^3 world equivalent indicates the potential of stripping other users of the water reservoir from water.

This study investigates the water consumption of agricultural processes. For this purpose, AWARE characterization factors from Boulay et al. (2019) specific to some crops and associated growing countries have been used.

Terrestrial biodiversity

Biodiversity describes the variety of life on earth. The protection and conservation of biodiversity is firmly anchored in the Sustainable Development Goals (SDGs) of the United Nations Agenda 2030. The loss of biodiversity is one of the four planetary boundaries that have already been exceeded and studies predict that the anthropogenic loss of biodiversity due to food production will increase as the world population grows (Crist et al. 2017).

Methods to estimate impacts of products and services on terrestrial biodiversity in LCAs have only been developed in recent years. This study applied the impact assessment method of Lindner et al. (2019), which calculates the quality difference in terms of terrestrial biodiversity of the land used for food production as compared to a reference value.

4.5 Allocation methods

Allocations are necessary wherever environmental impacts need to be allocated to more than one product without expanding the system.

Thus, dairy cattle not only produce milk – their meat, bones, horns, blood, and skins are also used after slaughter. Moreover, heifers must calve from time to time in order to give milk. Over the course of their lifetimes, they also produce manure and dung. These diverse environmental impacts therefore need to be allocated to multiple products, i.e., milk, meat, calves, manure in the case of dairy cattle.

Allocation can follow different methods, including economic allocation or allocation based on physical factors such as mass or energy.

The authors of the study used the mass-based allocation method, with the allocation based on dry-matter content for dairy products as a special case. As a result, the environmental impact of one kilogram of cheese is higher than that of one kilogram of yogurt, to name just one example. This allocation method is in line with the recommendations of the European Commission's Product Environmental Footprint Category Rules (PEFCR) for dairy products (Eda 2018).

An exception to the general rule of mass-based allocation is the economic allocation of the various environmental impacts of dairy cattle. In this case, the environmental impact is allocated to milk, meat and calves according to their respective market values.

All allocations used in this model are documented in Chapter 7.

4.6 Modeling

The LCA was modeled using Umberto LCA+ Version 10 software.

It must be noted that in modeling such a complex system we needed to simplify and base our model on the following assumptions, due in particular to the partial lack of data on material flows and/or environmental data:

- Assumption 1: All imports, with the exception of animal feed, happen at the food processing level. In the model, all processed foods consumed in Germany (e.g., sugar, bread and cheese), are processed in Germany.
  The reason for this simplification is twofold. First, there is no environmental data available for food processing in countries that export to Germany; second, statistics do not break down imports by product, quantities, and life cycle stages.[1] Moreover, the complexity of the modeling would increase without such a simplification as the value chain links "food processing" and, in part, "retail" would need to be modeled for every one of the countries that export to Germany.
  This assumption may lead to the following flaws:
  - The environmental impact of transport may be shifted "forward" along the life cycle, i.e., toward agriculture. As a result, the environmental impact attributed to agriculture (stages 1 and 2) may be too high. This affects the results for greenhouse gas emissions. Also, the resulting estimate for the overall environmental impact may be too high. For example, it is assumed that sugar beets, rather than sugar, are exported from France to Germany. This falsifies the overall impact as sugar is lighter and therefore causes lower emissions. On the other hand, underestimations may occur in the case of foods that are produced in Germany but processed abroad and then re-imported, as these were modeled as if processed in Germany. In these cases, transport emissions resulting from export and re-import were not considered.
  - The environmental impacts in food processing are estimated on the basis of German consumption data. These data may vary in both directions from consumption data in other countries. Furthermore, the energy production balance of food processing is based on conditions in Germany German (German electricity mix). This may also cause diversions in the resulting environmental impacts (in both directions).
- Assumption/simplification 2: Only countries accounting for at least three quarters of the total imports of a specific product are considered in modeling the proportional impact figures for importing countries. The main importers' respective "impact shares" were then extrapolated to 100%.
  Generally speaking, this assumption may lead to errors when export countries with disproportionately low or high the environmental impacts remain unconsidered. However, the overall error resulting from this assumption may be considered negligible.
- Assumption 3: The same approach was followed in the environmental impact balance of different food groups. In cases where the environmental databases that we

[1] In consequence, statistical data would need to be converted from values to quantities and allocations to products. This in turn would require further assumptions.

consulted contained no product-specific data, we extrapolated (to 100%) from the respective impact portion of the main products that together account for more than three quarters of consumption in the product group. An example for this approach is citrus fruits, which we mapped as oranges.
This approach may lead to error if, e.g., the environmental impact of a product in the product group that is not considered is disproportionately high or low. Overall, however, the error resulting from this assumption will be small.

- Assumption 4: Production of feed components in other countries is identical as in Germany. This simplification was necessary first and foremost because researching the import data for each individual feed component producing country was beyond the scope of the project. However, the composition of the respective feed (e.g. proportions of wheat and soybean meal) was modeled according to country and species-specific data.

  This assumption results in the following errors:

  – An error (overestimate or underestimate) in the environmental impact results across all considered impact indicators and life cycle inventory parameters for countries with diverging (higher or lower) feed production volumes. However, based on the data used, it can be assumed that both effects cancel each other out in sum and a systematic overestimation may be ruled out.

  – Water consumption and land use for animal-based products have not been allocated per country. As a result of this simplification, Germany's impact share was overestimated.

- Assumption (simplification) 5: In poultry production, the share of meat from laying hens (soup chickens) is neglected. This leads to a slight overestimate for the environmental impact of poultry meat.
- Assumption 6: All overseas imports were transported by ship. This simplification is based on the fact that only a small proportion of food products are shipped by air. According to Keller (2010), almost 52,000 tons of foods were imported by air in 2008, that is only 0.12% of the total volume of foods consumed annually in Germany. The error resulting from this simplification is therefore assumed to be small. Nevertheless, this assigns somewhat lower environmental impacts to individual foodstuffs, especially fish.
- Assumption 7: The modeling for all foods is based on conventional production in agriculture; controlled organic cultivation (kbA) is not considered in the model. In 2018, controlled organic cultivation’s overall share of the total agricultural land in Germany was 7.3% (BLE 2012). When differentiated by product groups, the shares of organic production vary. The main reasons for this simplification are that (a) consumption and import data for organic products are not available for all foods, and (b) current environmental data for organic products are not consistently available in the database used. This leads to errors, particularly on the level of agriculture, as processing and distribution are largely identical or specific data for organic production are unavailable. Still, the resulting flaw cannot be classified as very high because organic products merely account for a small part of the food product shopping basket, and agricultural production of organic food is also associated with environmental impacts.

- Assumption 8: Food is bought exclusively in supermarkets. Purchases at farmers' markets or directly at farms were not considered.
- Assumption 9: When looking at imports, it should be noted that some countries, especially Belgium and the Netherlands, exports products Germany that they can produce only on a small scale, if at all, due to the climatic conditions (e.g. cocoa). This is due to the fact that these countries have large ports in Antwerp and Rotterdam. As there is a demand for these products in these countries, too, they import larger volumes than they export. For modeling purposes, it was simplistically assumed that 100% of all exports have been imported previously. This leads to a slight overestimation of the environmental impact of extended transport distances. In addition, this results in a slight distortion of the agricultural impacts.
- Assumption 10: This study considers both unprocessed and processed food products. However, the consumption of convenience products such as pizza, canned or frozen meals is not considered. This means that the energy required to manufacture the products (pre-cooking, pre-baking, etc.) is not considered, resulting in an underestimation of energy consumption at the processing level (phase 3).

4.7 Assessment of the impact on terrestrial biodiversity

To determine the impact on terrestrial biodiversity, the occupation (required area multiplied by duration of use) is linked to a characterization factor. The characterization factor is composed of a land-use specific biodiversity value (BV_{LU}) and the ecoregion factor (EF). BV_{LU} indicates the difference in biodiversity potential of a specific land use compared to a reference value. The local biodiversity value is quantified here via the degree of naturalness, which is described in the method via different levels of hemeroby (modification of nature by humans). The crucial factor here is the type of land use (forestry, arable land, mining, resource extraction). The local impacts identified are then placed in a global context via ecoregion factors, putting different ecosystems and their ecological value in relation to each other. The impact category indicator is expressed as Biodiversity Value Increment (BVI) times area and time (BVI*m²*a). The formula for the calculation is:

$$BV_{glo} = (1 - BV_{LU}) * EF * Occupation$$

The individual parameters and the method behind their assignment are described below.

Hemeroby levels

The concept of hemeroby describes the anthropogenically induced changes of natural ecosystems. According to Fehrenbach et al. (2015), hemeroby levels can be defined according to land use classes. In this study, land use classes were assigned based on hemeroby levels according to Fehrenbach et al. (2015), with adjustments according to Lindner et al. (2020). Here, hemeroby level 2 means great closeness to nature, whereas hemeroby level 7 describes maximum distance from nature.

Table 1: Assignment of local biodiversity value according to hemeroby and land use classes.

Degree of hemeroby	Land use categories				BV_{LU}
	Forest/ Forest	Grassland/ savannah	Farmland	Mining and quarrying	
1 – non-disturbed	Virgin forest or forest no longer used	/	/	/	1,000
2 – very weakly influenced	Close to nature forestry	Near-natural greenspace management	/	/	0,983
3 – weakly influenced	Extensive forestry	Extensive grassland use	Highly diverse agroforestry systems	/	0,950
4 – moderately influenced	Medium-intensity forestry	Medium-intensity grassland use	Extensive agriculture	/	0,884
5 – strongly influenced	Intensive forestry	Intensive grassland use	Medium-intensity agriculture	High structural diversity	0,754
6 – very strongly influenced	/	/	Intensive agriculture	Low structural diversity	0,500
7 – extremely disturbed	/	/	/	Sealed or devastated areas	0,000

Thus, virgin forest not used by humans is assigned the lowest hemeroby level (1), a parking lot, the highest hemeroby level (7). Agricultural and forestry land uses are placed on the spectrum, according to their respective degree of use. Each type of use is classified on a fixed range: arable land, for example, is on a range between 3 to 6, therefore, it may not be considered a natural ecosystem even when used extensively. Forestry processes range from 1 to 5. Even an intensively managed forest offers more opportunities for biodiversity than, say, greenhouse tomato farming.

As the global share of ecologically sustainable agriculture and forestry is very low, the study assumes that food products are produced through intensive use only. The resulting hemeroby levels are highlighted in Table 1.

Areas for mining or quarrying, buildings, and roads were not considered.

Ecoregion Factors

As a second parameter, the method's characterization factor grades local biodiversity impacts on biodiversity on a global scale, resulting in the ecoregion factor. WWF defines over 800 terrestrial ecoregions[2] based on influencing factors such as climate, geology and historical species development. These ecoregions are classified by biome types, of which there are 14, allocated to eight biogeographical regions.

[2] https://www.worldwildlife.org/biome-categories/terrestrial-ecoregions

Each ecoregion is assigned a value according to Lindner et al (2019). The value describes the ecological value of the area and includes an assessment based on parameters such as the percentage of wetlands, forest, areas without roads, and the global probability of extinction.

Ecoregions are not geographically aligned with country borders. Accordingly, numerous countries comprise several ecoregions. In the present study, the agricultural land use was divided by country on the basis of the data available (yield data from the Food and Agriculture Organization of the United Nations (FAO)). In order to better map the allocation of the ecoregion factor, a country- and product-specific aggregation of the ecoregion factors was used in this study. This is based on area-differentiated crop data from MapSPAM[3], which provides crop area data for 42 products on a 10 x 10 km^2 grid. An area-weighted aggregation of ecoregion factors per country and MapSPAM product was calculated by assigning each grid element to a country and ecoregion.

MapSPAM's agricultural products do not correspond 100% to the agricultural products used in the model.

Table 2 shows the assignment and comparison of the two product systems. The attribute “Fit” indicates a match between products, e.g., in the case of soybeans (MapSPAM: soyb). In all other cases, products are assigned to the parent food category. Thus, broccoli is assigned to the category “vegetables” (MapSPAM: vege).

[3] https://www.mapspam.info/

Table 2: Comparison of agricultural products in the model with MapSPAM products.

Agricultural product	Code MapSPAM	MapSPAM term	Match
Beans	opul	Other pulses	Proxy
Apples	temf	Temperate fruit	Proxy
Bananas	bana	Banana	Fit
Broccoli	vege	Vegetables	Proxy
Cashew nuts	trof	Tropical fruit	Proxy
Dates	rest	Rest of crops	Proxy
Peanuts	grou	Groundnuts	Fit
Peas	opul	Other pulses	Proxy
Barley	barl	Barley	Fit
Grass	rest	Rest of crops	Proxy
Cucumbers	vege	Vegetables	Proxy
Oats	ocer	Other cereals	Proxy
Hazelnut	rest	Rest of crops	Proxy
Cocoa	coco	Cocoa	Fit
Carrots	vege	Vegetables	Proxy
Potatoes	pota	Potato	Fit
Cabbage	vege	Vegetables	Proxy
Corn	maiz	Maize	Fit
Almonds	rest	Rest of crops	Proxy
Olives	rest	Rest of crops	Proxy
Oranges	trof	Tropical fruit	Proxy
Palm fruit	oilp	Oil palm	Proxy
Peaches	trof	Tropical fruit	Proxy
Rapeseed	ocer	Other cereals	Proxy
Rice	rice	Rice	Fit
Rye	ocer	Other cereals	Proxy
Soy	soyb	Soybean	Fit
Sunflowers	sunf	Sunflower	Fit
Spinach	vege	Vegetables	Proxy
Tomatoes	vege	Vegetables	Proxy
Grapes	temf	Temperate fruit	Proxy
Walnuts	rest	Rest of crops	Proxy
Wheat	whea	Wheat	Fit
Sugar beets	sugb	Sugar beet	Fit
Onions	vege	Vegetables	Proxy

Land use

The characterization factor is multiplied by occupation. Occupation reflects how much area is required and how long this area is used to provide the required product quantities for consumption. The unit is occupation (m^2*a).

5. Market basket and scenarios

The analysis of the environmental impact of food in Germany is based on the food consumed by a German person on average per year, represented by the food market basket. The composition of the status quo food market basket is based on BMEL statistical data of the years 2015, 2016 and 2017, from which we calculated annual averages.

5.1 Data basis for the status quo market basket

The market basket represents the basis of the system. Supply statistics from the German Federal Ministry of Food and Agriculture (BMEL, 2017-2019) provide the most up-to-date data for food consumption in Germany and therefore were used to determine the food composition of the market basket. BMEL statistics list the quantities of individual foods consumed in Germany in a given year.

To compensate for annual fluctuations, a three-year average of the BMEL data was calculated. The BMEL supply balances are reported in marketing years for plant-based products, and calendar years for animal-based products. We chose the three-year periods for which most data were available, i.e., 2015/16 through 2017/18 for plant-based products and 2016-2018 for animal-based. Data gaps for specific products were filled in with data from other years. Table 3 lists the years from which the data originate.

It is not possible to consider all foods included in the statistics, the main reason being that the resulting system would be too complex and detailed. Furthermore, there are no environmental data available for all the foods included, and upstream chains cannot be fully traced and mapped.

We therefore focused on the foods that account for the largest share of the total consumption in each category, e.g., "fruit". The sum of all foods considered in a food category corresponds to at least 75% of the food consumption. For some product groups, only a total value is listed in the statistics (e.g., nuts, citrus fruits). To ensure consistency with the other product groups, the consumption of individual foods in these categories was determined using trade and consumption data from the United Nations Food and Agriculture Organization (FAO)[4] . The 75% criterion was also applied here.

BMEL statistics include data from food processing and trade, plus data for the majority of natural or minimally processed products (e.g. flour, meat, apples, onions). Data on canned foods were attributed to the appropriate food category. Highly processed foods that have undergone multiple processing steps, e.g., sausage or pasta made from wheat flour, are not included. However, these are the products that are included in the market basket, which is defined at the consumer level as representative of average annual food consumption in Germany.

To allocate the products in the BMEL statistics (e.g., flour) to all relevant market basket products (e.g., pasta, baked goods, flour), we used the sample survey on income and consumption (EVS, 2013), allocating the total amount (quantity) of flour to EVS products according to the latter's shares in the relevant food category. This step allowed us to base the study on the more recent BMEL data, as the most recent EVS is based on data from 2013 and the next EVS will not be published before 2021 (based on data from 2018).

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[4] Access the database at: www.fao.org/faostat/en (last accessed: November 3, 2020)

Since this report is intended to evaluate nutrition scenarios according to EAT-Lancet along with the status quo, some products that fall below the 75% criterion were subsequently added from the BMEL statistics to the final market basket in order to be able to sufficiently cover all categories of the EAT-Lancet recommendations.

In summary, the following procedure was used to determine the basket of goods:

1. Determination of the three-year average of the BMEL supply balances
2. Determination of the most important products for the food categories (at least 75% share)
3. Adjustments based on FAO data
4. Projection according to EVS products
5. Classification and extension according to EAT-Lancet

Table 3 lists all products in the final market basket along with the data sources used and data years. Product consumption data is listed in Table 6.

Table 3: Allocation of market basket products to data sources used

Market basket products	BMEL data	Data vintages BMEL	Additional data sources / comments
Cereals			
Rice	Rice	2015/16-2017/18	
Wheat flour	Durum and common wheat flour	2015/16-2017/18	
Wheat-flour baked goods			
Wheat pasta			
Rye flour	Rye flour	2015/16-2017/18	
Rye-flower baked goods			
Oatmeal	Oats	2015/16-2017/18	
Maize	Maize	2015/16-2017/18	
Potato starch	Potato starch	2015/16-2017/18	
Roots or starchy vegetables			
Potatoes	Potatoes	2015/16-2017/18	
Vegetables			
Dark green vegetables			
Broccoli	Flower, kale & broccoli	2015/16-2016/17	Added for EAT-Lancet
Spinach	Spinach	2015/16-2016/17	Added for EAT-Lancet
Cucumbers	Cucumbers	2015/16-2016/17	
Red & orange vegetables			
Tomatoes	Tomatoes	2015/16-2016/17	
Carrots	Carrots, beetroot	2015/16-2016/17	
Other vegetables			
Cabbage	Green cabbage, red cabbage, savoy cabbage, kohlrabi, Chinese cabbage	2015/16-2016/17	
Onions	Onions	2015/16-2016/17	
Fruit			
Apples	Apples	2015/16-2017/18	
Peach	Peach	2015/16-2017/18	
Grapes	Grapes	2015/16-2017/18	
Bananas	Bananas	2015/16-2017/18	
Oranges	Citrus	2015/16-2017/18	Adjustment according to FAO trade statistics
Raisins	Dried fruit	2015/16-2017/18	Adjustment according to FAO trade statistics
Dates			

Table 3: Allocation of market basket products to data sources used (continued)

Market basket products	BMEL data	Data vintages BMEL	Additional data sources / comments
Dairy products			
Milk	Whole and semi-skimmed milk	2016-2018	
Yogurt	Sour milk, kefir, yogurt and mixed milk products and mixed milk drinks	2016-2018	
Cream	Cream products	2016-2018	
Butter	Butter, milk fat, milk fat spread products	2016-2018	
Cheese	Cheese	2016-2018	
Milk powder	Dried milk products	2016-2018	
Condensed milk	Condensed milk products	2016-2018	
Protein sources			
Meats & Sausages			
Beef	Beef and veal	2016-2018	
Pork	Pork	2016-2018	
Poultry	Poultry meat	2015-2017	
Sausages (incl. lard/bacon)	Proportionate from: Beef, veal, pork and poultry gel meat		
Eggs	Eggs and egg products	2016-2018	
Fish	Fish and fish products	2015-2017	
Pulses			
Peas	Pulses	2015/16-2017/18	
Beans			
Tofu			
Groundnuts	Nuts	2015/16-2017/18	Nuts according to BMEL
Nuts			
Almonds	Nuts	2015/16-2017/18	Distribution according to FAO consumption statistics
Hazelnuts			
Cashew			
Walnuts			
Added fats			
Palm oil	All oils and fats	2016-2018	Distribution according to FAO consumption statistics
Olive oil			
Rapeseed oil			
Sunflower oil			
Soybean oil			
Added sugars			
Sugar	Sugar, incl. beet juice	2015/16-2017/18	
Other			
Cocoa	Cocoa solids	2015/16-2017/18	

5.2 EAT-Lancet market basket database.

To be able to model changes in environmental impacts resulting from a change in diet, we defined three scenarios in addition to the status quo. These scenarios are based on the EAT-Lancet Commission' recommendations for a healthy diet (Willet et al. 2019):

- Flexitarian diet according to EAT-Lancet
- Vegetarian diet according to EAT-Lancet
- Vegan diet according to EAT-Lancet

These diets were translated into average annual food market baskets for one individual. In defining the food composition of these scenario market baskets, we aimed to reflect the current diet in Germany for the respective scenario as closely as possible while still complying with the respective EAT-Lancet specifications. As this led repeatedly to conflicts in practice, we defined a set of rules that were applied in the order listed below:

1. Willet et al. (2019) define an average diet of no more than 2,500 kcal per person per day. This value is kept approximately constant.
2. The recommendations also define a calorific value for each food group in the diet (in kcal). This value is also adhered to wherever possible.
3. If possible, the composition of the market basket does not exceed maximum specified daily consumption quantities or fall below minimum consumption quantities.
4. The following, additional rule was applied to the vegetarian and vegan market baskets: kcal remaining after allocation to the other categories were distributed among the group's fruits and vegetables according to their respective proportions.
5. If possible, the distribution in the food groups in the German market basket is adopted.

Following these rules, we created the three EAT-Lancet market baskets used in calculating the environmental impacts of the three scenarios (Appendix).

Translating the EAT-Lancet Commission' recommendations into the scenario baskets was based on the EAT-Lancet Commission's recommendations (Table 4), the available statistical consumption data, and the energy content of individual foods in the market baskets according to the data listed in Table 5.

Table 4 EAT-Lancet Commission consumption recommendations (Willet et al. 2019).

	Min	Average	Max	caloric intake
	[g/day]	[g/day]	[g/day]	[kcal/day]
Whole grains	232	232	232	811
Rice, wheat, maize & other			232	811
Tubers or starchy vegetables	0	50	100	39
Potatoes & cassava	0	50	100	39
Vegetables	200	300	600	78
Dark green vegetables	66,667	100	200	23
Red & orange vegetables	66,667	100	200	30
Other vegetables	66,667	100	200	25
Fruits	100	200	300	126
All fruit	100	200	300	126
Dairy foods	0	250	500	153
Whole milk or derivative equivalents (e.g. cheese)	0	250	500	153
Protein sources	25	209	461	726
Beef & lamb	0	7	14	15
Pork	0	7	14	15
Chicken & other poultry	0	29	58	62
Eggs	0	13	25	19
Fish	0	28	100	40
Legumes	0	100	225	426
dry beans, lentils & peas	0	50	100	172
soy foods	0	25	50	112
peanuts	0	25	75	142
Tree nuts	25	25	25	149
Added fats	20	51,8	91,8	450
Palm oil	0	6,8	6,8	60
Unsaturated oils	20	40	80	354
Dairy fats (incl. in milk)			0	
Lard or tallow	0	5	5	36
Added sugars	0	31	31	120
All sweeteners	0	31	31	120
TOTAL				2503

Table 5: Energy content of foods in kcal

Food	kcal per 100g	Food	kcal per 100g
Apples	52.00	Milk (3.5%)	64.00
Bananas	90.00	Milk powder	495.00
Beans (field bean)	127.00	Olive oil	900.00
Broccoli	34.00	Oranges	50.00
Butter	742.00	Palm oil	884.00
Cashew	575.00	Peach	48.00
Dates	266.00	Rapeseed oil	900.00
Eggs	151.00	Rice (long grain raw)	277.00
Peas	84.00	Beef (roast)	125.00
Peanuts	581.00	Rye (flour)	324.00
Fish (Haddock)	91.00	Raisins	322.00
Cucumbers	12.00	Cream (30%)	292.00
Oats (oatmeal)	339.00	Pork (shoulder)	153.00
Chicken	161.00	Soybean oil	900.00
Hazelnuts	635.00	Soy products/tofu	76.00
Yogurt (1.5%)	47.00	Sunflower oil	900.00
Cocoa	337.00	Spinach	27.00
Carrots	31.00	Tomatoes	24.00
Potatoes (boiled)	73.00	Grapes	71.00
Potato starch*	321.00	Walnuts	678.00
Cheese (Gouda)	376.00	Wheat (all-purpose flour. i.e. German what flour type 405)	343.00
Cabbage (green cabbage)	30.00	Sausage (incl. bacon) (Bratwurst)	320.00
Condensed milk (7.5%)	96.00	Sugar	400.00
Corn (flour)	332.00	Onions	33.00
Almonds	611.00		

Source: https://www.bmi-rechner.net/kalorientabelle.htm, excluding palm oil (http://www.ernaehrung.de/lebensmittel/de/Q150000/Palmoel.php) and soybean oil (assumed to be the same as canola oil).

As the EAT Lancet recommendations are for daily consumption, the translation into market basket was made using the daily consumption quantities. The conversion to the functional unit (one individual in Germany) was based on the number of inhabitants in Germany[5], adding the amount of food waste at household level. Food composition was based on the status quo market basket (Table 6).

5 Average population over the three years 2015-2017: 82,329,667.

Table 6: Status quo market basket (amount consumed, amount ingested, and energy intake).

Food(group)	Consumption per capita and year [kg]	Amount ingested per capita and day [g].	kcal per capita and day
Cereals (total)	**107.5**	**253.7**	**857.5**
Rice	5.3	12.4	34.5
Wheat flour	9.8	23.0	79.0
What-flour baked goods	64.6	152.0	521.3
Wheat pasta	8.1	19.0	65.3
Rye flour	1.2	2.9	9.4
Rye-flour baked goods	8.7	20.5	69.6
Oatmeal	3.2	7.6	25.6
Corn	2.9	6.8	22.6
Potato Starch*	3.7	9.4	30.1
Roots or starchy vegetables (total)	**37.3**	**72.4**	**52.9**
Potatoes	37.3	72.4	52.9
Vegetables (total)	**109.5**	**212.8**	**55.2**
Dark green vegetables (total)	*18.0*	*35.0*	*6.5*
Broccoli	3.6	7.0	2.4
Spinach	2.5	4.9	1.3
Cucumbers	11.9	23.2	2.8
Red & orange vegetables (total)	*67.4*	*131.1*	*33.8*
Tomatoes	50.1	97.5	23.4
Carrots	17.3	33.6	10.4
Other vegetables (total)	*24.0*	*46.7*	*14.9*
Cabbage	8.3	16.2	4.9
Onions	15.7	30.5	10.1
Fruit (total)	**104.2**	**211.5**	**136.1**
Apples	33.3	67.5	35.1
Peach	6.5	13.3	6.4
Grapes	9.2	18.6	13.2
Bananas	20.4	41.4	37.3
Oranges	33.2	67.3	33.7
Raisins	1.2	2.8	9.0
Dates	0.2	0.6	1.5
Dairy products (total)	**123.5**	**294.0**	**535.0**
Milk	51.5	122.6	78.4
Yogurt	29.9	71.1	33.4
Cream	5.8	13.9	40.5
Butter	5.9	14.1	104.9
Cheese	24.2	57.6	216.8
Milk powder	4.9	11.8	58.3
Condensed milk	1.2	2.9	2.8

Table 6: Status quo market basket (consumption quantity, amount ingested, and kcal each per capita and day), continued

Food(group)	Consumption per capita and year [kg]	Amount ingested per capita and day [g].	kcal per day
Protein sources (total)	**81.8**	**173.2**	**337.9**
Meats & sausages (total)	*55.3*	*116.7*	*212.0*
Beef	7.5	15.8	19.8
Pork	11.2	23.6	75.6
Poultry	8.2	17.3	26.2
Sausages (incl. lard/bacon)**	28.4	59.9	90.4
Eggs	*12.9*	*27.2*	*41.1*
Eggs	12.9	27.2	41.1
Fish	*6.5*	*13.6*	*12.4*
Fish	6.5	13.6	12.4
Legumes (total)	*3.8*	*8.1*	*25.7*
Peas	1.9	3.7	3.1
Beans	0.3	0.7	0.8
Tofu		0.0	0.0
Groundnuts	1.6	3.7	21.8
Nuts (total)	*3.2*	*7.5*	*46.7*
Almonds	1.2	2.8	17.2
Hazelnuts	0.8	2.0	12.4
Cashew	0.6	1.5	8.4
Walnuts	0.5	1.3	8.6
Added fats (total)	**17.1**	**43.0**	**385.1**
Palm oil	3.8	9.5	83.8
Olive oil	0.7	1.8	16.3
Rapeseed oil	4.9	12.3	111.0
Sunflower oil	3.4	8.6	77.8
Soybean oil	4.2	10.7	96.2
Added sugars (total)	**29.0**	**73.1**	**292.4**
Sugar	29.0	73.1	292.4
Other* (total)**	**2.8**	**7.1**	**23.8**
Cocoa	2.8	7.1	23.8
TOTAL	612.6	1,340.7	2,675.9

Legend: * Potato starch is included in cereals due to its use as a starch; ** Sausages incl. bacon & lard; *** Foodstuffs that play a role in Germany but could not be assigned to any of the categories.

One rule in the creation of the EAT-Lancet market baskets forbade exceeding the maximum specified consumption amount per day, if possible. This rule was adhered to with the exception of cereals, for which the specified maximum consumption was slightly exceeded in the flexitarian basket. Also, in the flexitarian market basket, the energy content of bacon and lard was included in the product category "sausage" (fat content: 30%).

The vegetarian market basket was defined based on the following steps (listed in order):

1. Consumption of meat and fish was set to 0.
2. The amount of cereals consumed was set at 232 g per person per day.
3. Added fats were set at a maximum of 6.8 g palm oil; the remainder was distributed among the remaining vegetable fats. In total, a maximum of 390 kcal was not exceeded.
4. For sugar, the kcal maximum was observed.
5. For protein sources, a maximum amount consumed was set for nuts, and an average amount consumed was set for tofu. The remaining kcals were allocated to legumes (without tofu) and eggs according to their shares in the status quo market basket.
6. For legumes, the maximum consumption amount (100g) was set for peas and beans, and the remaining kcals were allocated to peanuts.
7. The kcals remaining after allocation for the other categories were allocated to potatoes, dairy products, fruits, and vegetables according to their shares in EAT-Lancet.
8. For potatoes, this was limited by the calculated kcal maximum.
9. For fruits, allocation was based on the calculated kcal maximum and shares in the status quo market basket.
10. Milk and dairy products were allocated according to the calculated kcal maximum and their shares in the status quo market basket.
11. For vegetables, the calculated kcal maximum was allocated according to EAT-Lancet shares of green, red and other vegetables. Within these three subcategories, allocation was based on kcal values and shares in the status quo market basket.

The vegetarian market basket was defined based on the following steps (listed in order):

1. Consumption of animal-based products was set to 0.
2. The amount of cereals consumed was set at 232 g per person per day.
3. Added fats were set at a maximum of 6.8 g palm oil; the remainder was distributed among the remaining vegetable fats. In total, a maximum of 390 kcal was not exceeded.
4. For sugar, the kcal maximum was observed.
5. For protein sources, a maximum amount consumed was set for nuts, and an average amount consumed was set for tofu. The remaining kcals were allocated to legumes (without tofu) and eggs according to their shares in the status quo market basket.
6. For legumes, the maximum consumption amount (100g) was set for peas and beans, and the remaining kcals were allocated to peanuts.

7. The kcals remaining after allocation for the other categories were allocated to potatoes, fruits, and vegetables according to their shares in EAT-Lancet.
8. For potatoes, this was limited by the calculated kcal maximum.
9. The kcal for fruit had to be reduced to stay within the maximum limit of 300 g. The remaining kcals were allocated to vegetables. Allocation of fruits was based on their shares in the status quo market basket.
10. For vegetables, the calculated kcal maximum was allocated according to EAT-Lancet shares of “green”, “red (and orange)” and “other” vegetables. Within these three subcategories, allocation was based on kcal values and shares in the status quo market basket.
11. The max. consumption quantity of 200g was adhered to for dark green vegetables, thereby reducing the kcal. The remaining kcals were added to the group “other vegetables”.
12. The max. consumption quantity of 200g was adhered to for red and orange vegetables, thereby reducing the kcal. The remaining kcals were added to the group “other vegetables”.
13. For “other vegetables”, the maximum consumption amount of 200g was observed.

The following graph shows a comparison of the proportions of plant-based and animal-based foods in the market baskets. Animal-based products are further subdivided into meat and sausage products, fish, and other animal-based foods.

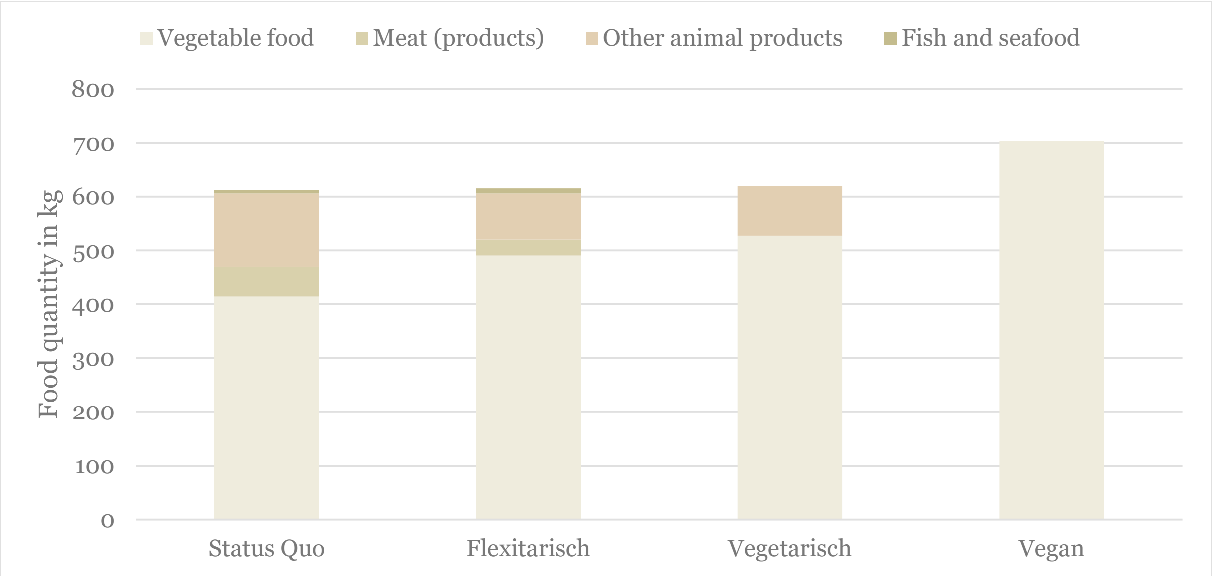

Figure 3: Shares of plant-based and animal-based foods in the market baskets.

When translating the EAT-Lancet Commission's recommendations into market baskets, it becomes obvious that too many calories are consumed in Germany today, as the status quo market basket comprises around 2,680 kcal per capita and day (Table 6). The average caloric intake in Germany is almost 10% higher than recommended. What becomes even more obvious is that the average person in Germany eats too much meat and not enough vegetables. Current meat consumption in Germany is significantly higher than the maximum recommended by the EAT-Lancet Commission (flexitarian market basket), while vegetable consumption is significantly lower. A closer look at vegetable consumption in Germany reveals that consumption of dark green vegetables in particular should be increased significantly.

A more detailed scrutiny of protein sources, including meat and sausage products, other animal-based products (e.g., eggs, milk and dairy products), fish, legumes and nuts, shows that two-thirds of the protein requirement in Germany today is covered by meat and sausage products. According to the EAT-Lancet Commission' recommendations for a flexitarian diet, meat and sausage products should account for no more than 25% of all protein sources. With legume consumption, the image is inverted: meeting the recommendations would require an almost 20-fold increase in consumption. Likewise, the consumption of nuts should be increased significantly.

6. Data bases across the value chain

Data quality had to meet the following requirements: all data should match the reference timeframe, generation/production location (geographic coverage), and current state of technology (technological coverage) as closely as possible while representing the highest possible levels of consistency and validity.

6.1 Consumption stage

The consumption stage includes the journey to the supermarket, food storage, food preparation, dishwashing, and food waste generated.

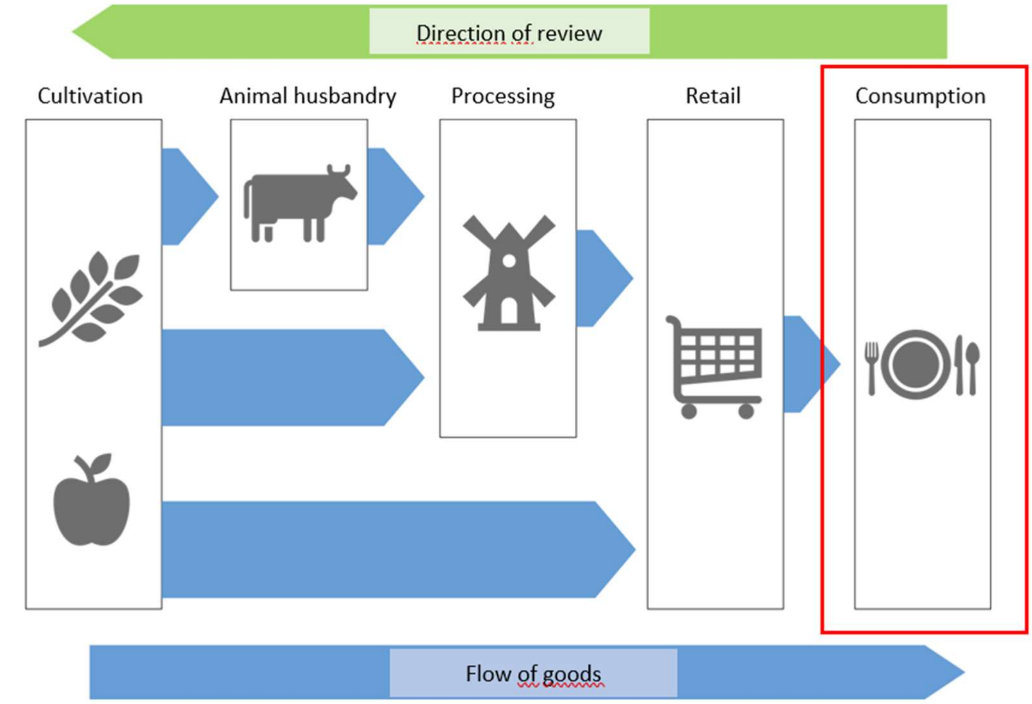

Figure 4: Consumption stage

Journey to the supermarket

The journey to the supermarket was modeled based on Nobis and Kuhnimhof (2018). To this end, we determined the average amount of kilometers driven to the supermarket for groceries per capita and year. The underlying assumption war that 50% of supermarket journeys are attributable to food purchases. The resulting number of kilometers per person is 382.7 km.

The modal split, i.e., the allocation of km/person to means of transport, was also determined on the basis of Nobis and Kuhnimhof (2018). Journeys to the supermarket by foot and bicycle account for only 3% each and are neglected. This results in a model split of 78% car journeys and 22% public transport. For modeling purposes, joint trips undertaken by several individuals were not considered, and all public transport journeys are assumed to be by bus. We estimate the resulting error to be small.

Energy consumption for food storage, preparation and dishwashing on the household level

Product storage was modeled using data from Kemmler et al. (2017). The most recent data are from 2014. The average energy consumption per person for the following appliances was determined:

- Refrigerators: 87.9 kWh per capita and year
- Fridge-freezer combo: 50.76 kWh per capita and year
- Freezers: 68.09 kWh per capita and year

Energy consumption for meal preparation and dishwashing was modeled using data from Kemmler et al. (2017). The most recent data is from 2014. The average energy consumption per person for the following appliances was determined:

- Toasters: 9.9 kWh per capita and year
- Extractor hoods: 12.38 kWh per capita and year
- Microwaves: 11.14 kWh per capita and year
- Cooking, total: of which
  - Electric stoves: 138.67 kWh per capita and year
  - Gas stoves: 40.86 kWh per capita and year
- Coffeemakers: 34.67 kWh per capita and year
- Dishwashers: 73.05 kWh per capita and year

Food waste

Food waste is allocated to the defined product categories based on the information provided by Eberle and Fels (2016) following Kranert et al. (2012). As this study does not distinguish between at-home and out-of-home consumption (IHC/OOHC) and the respective food waste generated, the data in Eberle and Fels (2016) were added up, weighted according to the quantities consumed in IHC and OOHC.

Data sets

Table 7 lists all data sets used in relation to the consumption stage.

Table 7: Data sets used to model the consumption stage

Process	Database	Record	Time reference
Journey to the supermarket, car	Ecoinvent 3.6	Market for transport, passenger car [RER].	2012
Journey to the supermarket, public transport		Market for transport, regular bus [GLO]	2011
Energy consumption, refrigerators	Ecoinvent 3.6	Market for electricity, low voltage [DE]	2014
Energy consumption, fridge-freezer combo			
Energy consumption, freezers			
Preparation, Toaster	Ecoinvent 3.6	Market for electricity, low voltage [DE]	2014
Preparation, fume hood			
Preparation, microwave			
Preparation, electric stove			
Preparation, coffee maker			
Washing-up, dishwasher			
Preparation, gas stove, conversion kWh to kg	GEMIS 5.0	Fossil gas, generic	1994
Preparation, gas stove, gas supply in kg	Ecoinvent 3.6	Market for natural gas, from low pressure network (<0.1 bar), at service station [GLO].	2011

6.2 Retail stage

The retail sector includes food wholesalers (WS) and food retailers (FR). The model considers energy consumption for food storage and presentation as well as transport (Figure 5).

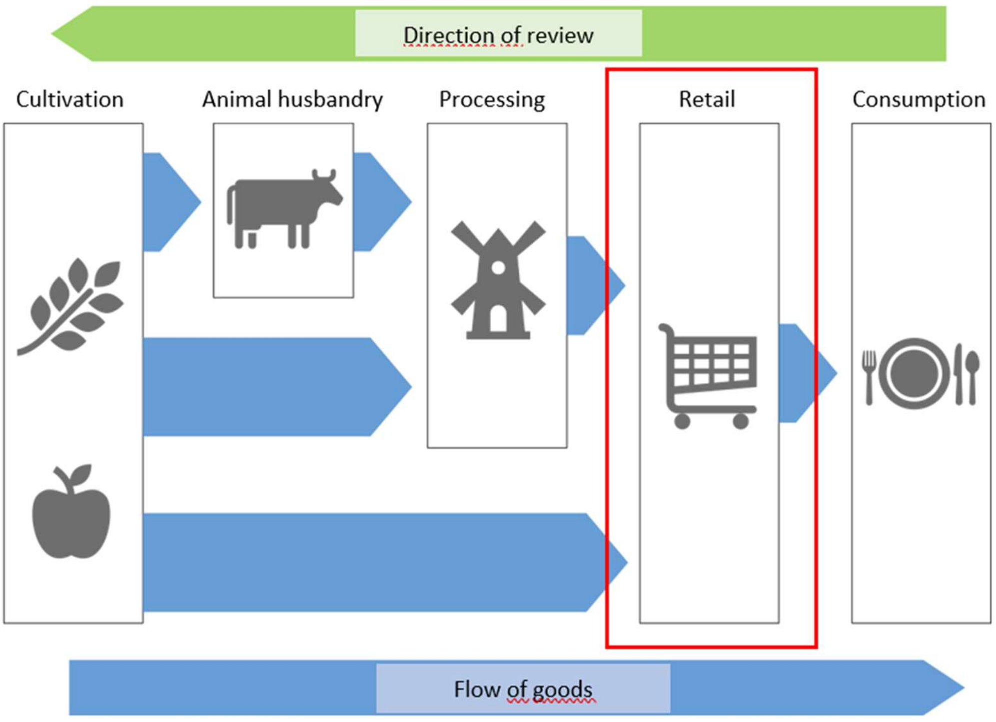

Figure 5: Retail stage

As a data source, we used the International Institute for Sustainability Analysis and Strategy's (IINAS) GEMIS 5 database (IINAS 2020). Energy supply proper is mapped with Ecoinvent 3.6 data sets. Energy consumption includes energy for refrigeration and freezing as well as general energy consumption, e.g., for lighting.

Energy consumption wholesalers

Data on energy consumption at the wholesale level are available in GEMIS 5 for most products (IINAS 2020). Where data for specific products were unavailable, the working assumption was that the respective energy consumption is of the same order of magnitude as that of similar food products. Table 8 lists GEMIS datasets used as well as assumptions.

Table 8: Data sets used for energy consumption in wholesale trade and assumptions made

Products	Assumed equivalent	GEMIS 5 data set NG Kühllager\...
Eggs		DE-Eier-2015
Meat products, poultry		DE-Masthähnchen-frisch-2015
Meat products, pork		DE-Schwein-frisch-2015
Meat products, beef		DE-Rind-frisch-2015
Sausage		DE-Wurst-2015
Milk		DE-Milch-2015
Yogurt, cream	Milk	DE-Milch-2015
Cheese		DE-Käse-2015
Butter		DE-Butter-2015
Tofu	Sausage	DE-Wurst-2015
Bananas		DE-Bananen-importiert-2015
Oranges		DE-Orangen-2015
Peach, grapes	Bananas	DE-Bananen-importiert-2015
Peas, beans, apples, cabbage, carrots ten, onions, broccoli, spinach,	Vegetables and fruit	DE-Gemüse-frisch-2015
Tomatoes		DE-Tomaten-frisch-2015
Cucumbers	Tomatoes	DE-Tomaten-frisch-2015
Potatoes		DE-Kartoffeln-frisch-2015
Fish and seafood		DE-Fisch-Fang-Meer-EU-tiefgekühlt-2015

Energy consumption in food retailing

At the food retail level, energy consumption was allocated according to storage type and storage duration:

- non-refrigerated, refrigerated, frozen storage, and
- short, medium and long average storage times

Table 9 lists GEMIS data sets used, allocations and assumptions made.

Table 9: Data sets used for energy consumption at the food retail level

Products	Bearing type	Storage period	GEMIS dataset: NG trade…
Wheat-flour baked goods, rye-flour baked goods, corn	Uncooled	Short	DE-Brot-misch-2015
Apples, peach, grapes, bananas, oranges, peas, beans, cabbage, carrots, onions, tomatoes, cucumbers, broccoli, spinach	Uncooled	Medium	DE-Orangen-2015
Wheat flour, rye flour, wheat pasta, potato starch, oatmeal, rice, whole milk powder, condensed milk, olive oil, rapeseed oil, sunflower oil, soybean oil, palm oil, raisins, dates, peanuts, almonds, hazelnuts, sugar, cocoa, potatoes	Uncooled	Long	DE-Reis-importiert-2015
poultry products, pork meat products, beef meat products, sausage, tofu, eggs, milk, cream, yogurt, butter	Chilled	Medium	DE-Wurst-2015
Cheese	Chilled	Long	DE-Käse-2015
Seafood	Frozen	Short	DE-Fisch-Fang-Meer-EU-tiefgekühlt-2015

Energy mix

The energy mix for food wholesale and retail is based on several GEMIS 5 data sets (IINAS 2020) linked to energy data sets from Ecoinvent 3.6. All datasets used are listed in Table .

Table 10: Data sets used for modeling the energy mix in the wholesale and retail food sector.

<table>
<tr><th>Process</th><th>Database</th><th>Dataset</th><th>Time reference train</th></tr>
<tr><td>Energy and refrigerant consumption, wholesale</td><td>GEMIS 5</td><td>NG-Kühlen-DE-2015</td><td>2015</td></tr>
<tr><td>Electricity consumption, generic, food wholesale and retail</td><td>Ecoinvent 3.6</td><td>electricity, medium voltage [DE]</td><td>2014</td></tr>
<tr><td>Energy and refrigerant consumption, food retail, non-refrigerated</td><td rowspan="4">GEMIS 5</td><td>NG-Handel\DE-Energie-mix ungekühlte Produkte-2015</td><td>2015</td></tr>
<tr><td>Energy and refrigerant consumption, food retail, refrigerated</td><td>NG-Handel\DE-Energie-mix Kühlprodukte-2015</td><td>2015</td></tr>
<tr><td>Energy and refrigerant consumption, food retail, frozen</td><td>NG-Handel\DE-Energie-mix TK-Produkte-2015</td><td>2015</td></tr>
<tr><td>Fuel mix, food retail</td><td>NG-Handel\Brennstoff-mix-DE-2015</td><td>2015</td></tr>
<tr><td>Fossil oil, fuel mix, food retail</td><td rowspan="3">Ecoinvent 3.6</td><td>heat production, light fuel oil, at boiler 10kW condensing, non-modulating [Europe without Switzerland]</td><td>1991</td></tr>
<tr><td>Fossil gas, fuel mix, food retail</td><td>heat production, natural gas, at boiler atmospheric non-modulating <100kW [Europe without Switzerland]</td><td>2000</td></tr>
<tr><td>Fossil oil, fuel mix, food retail</td><td>market for heat, district or industrial, other than natural gas [Europe without Switzer land]</td><td>2011</td></tr>
</table>

Food Losses
Wholesale and retail-level losses were allocated to food products based on Kranert et al. (2012) following the procedure in Eberle and Fels (2016).

Shipping
Shipments to wholesalers and from wholesalers to retailers were mapped based on average domestic shipping.

This average was modeled based on an average transport distance and average shares of rail, inland shipping and road transport. These were based on an analysis of statistical data (Destatis 2019) for agricultural, forestry, fishery, food and beverage products transported in 2018.

For road transports (by truck), transport shares were allocated to emission standards based on Federal Motor Transport Authority statistics (KBA 2019). Transports that meet the EURO 5 standard were neglected as they only account for a minor share of the transports. Table 11 lists the data sets used for transports.

Table 11 Data sets used for transports within Germany

Process	Database	Record	Time reference
Road freight transport (trucks), EURO 5	Ecoinvent 3.6	transport, freight, lorry >32 metric ton, EURO5 [RER]	2009
Road freight transport (trucks), EURO 6		transport, freight, lorry >32 metric ton, EURO6 [RER]	2009
Inland waterway freight transport		transport, freight, inland waterways, barge [RER].	1998
Rail freight transport		transport, freight train [EN]	2000

6.3 Food Processing
Food processing (Figure 6) includes energy consumption for processing. Required consumables and materials, e.g. cleaning chemicals, were not considered.

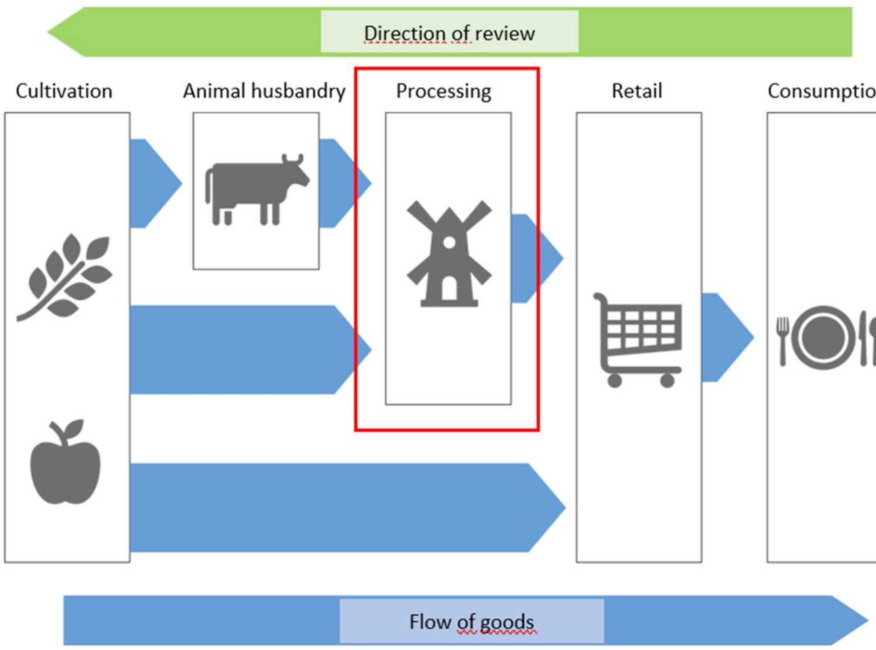

Figure 6: Processing stage

Energy consumption

The data for "Energy consumption of the manufacturing food industry" (Statistisches Jahrbuch for the years 2014-16, BMEL, 2014-2016) were used to quantify the environmental impacts of food processing. These datasets are based on surveys of all food processing companies with 50 or more employees. They include year-on-year data on primary energy consumption, differentiated by seven energy sources and 38 economic sectors within the German food industry. To determine the associated environmental impacts, emission-relevant energy sources were offset against the corresponding emission factors according to GEMIS (annual reference: 2015) (IINAS 2020). Product-specific values for the functional unit (1 kg) were determined by dividing the total values by the respective production quantities.

Processing of the following products is modeled based on BMEL energy consumption data:

- Meat products (poultry, pork, beef)
- Sausage
- Dairy products (milk, yogurt, cream, butter, cheese, whole milk powder, condensed milk)
- Fish
- Tofu (based on curd preparation)
- Flour, wheat, and rye
- Baked goods made from wheat and rye flours
- Pasta made from wheat
- Potato starch

- Oat flakes (based on grinding and hulling mills)
- Sugar
- Rice (based on grinding and hulling mills)
- Cocoa (based on the production of confectionery)
- Olive, rapeseed, sunflower and soybean oils (based on production of oils and fats)
- Palm oil (based on production of margarine)

The specified energy sources were based on Ecoinvent 3.6 data sets. Table 12 lists the data sets that were used.

Food Losses

Losses at the processing level are based on Gustavsson et al. (2011). As the study only considers processing in Germany, loss rates for Europe were used. An average yield of 50% is assumed for fish and seafood processing.

Shipping

Shipping to and between manufacturing plants were modeled as domestic German shipping (see Shipping in wholesale and retail).

Table 12: Data sets used for modeling energy consumption at the processing level

Process	Database	Record	Time reference
Heat production from fossil oil	Ecoinvent 3.6	heat production, heavy fuel oil, at industrial furnace 1MW [Europe without Switzerland]	2001
Heat production from coal		heat production, at hard coal industrial furnace 1-10MW [Europe without Switzer land]	1988
Heat production from natural gas		heat production, natural gas, at industrial furnace >100kW [Europe without Switzer land]	2000
Electricity		market for electricity, low voltage [DE]	2014
Renewable energies, voltage transformation		electricity voltage transformation from high to medium voltage [EN]	2012
Renewable energies, mix	GEMIS 5	El-mix-EN-2018	
Renewable energies, photovoltaic	Ecoinvent 3.6	electricity production, photovoltaic, 570kWp open ground installation, multi-Si [DE]	2008
Renewable energies, offshore wind power		electricity production, wind, 1-3MW turbine, offshore [DE]	2000
Renewable energies, water power		electricity production, hydro, run-of-river [DE]	2012
Renewable energies, onshore wind power		electricity production, wind, 1-3MW turbine, onshore [DE]	2005

6.4 Agricultural production

Agricultural production includes the cultivation of agricultural crops (chap. 6.4.1**Fehler! Verweisquelle konnte nicht gefunden werden.**) and livestock farming. Fish production and fishing were also assigned to livestock farming (chap. 6.4.2), as were imports, which were assumed to be at the level of agricultural products.

6.4.1 Agricultural crop cultivation

Agricultural crop cultivation includes the agricultural production of crop products for direct human consumption, processing, and for use as feed in livestock farming (Figure 7).

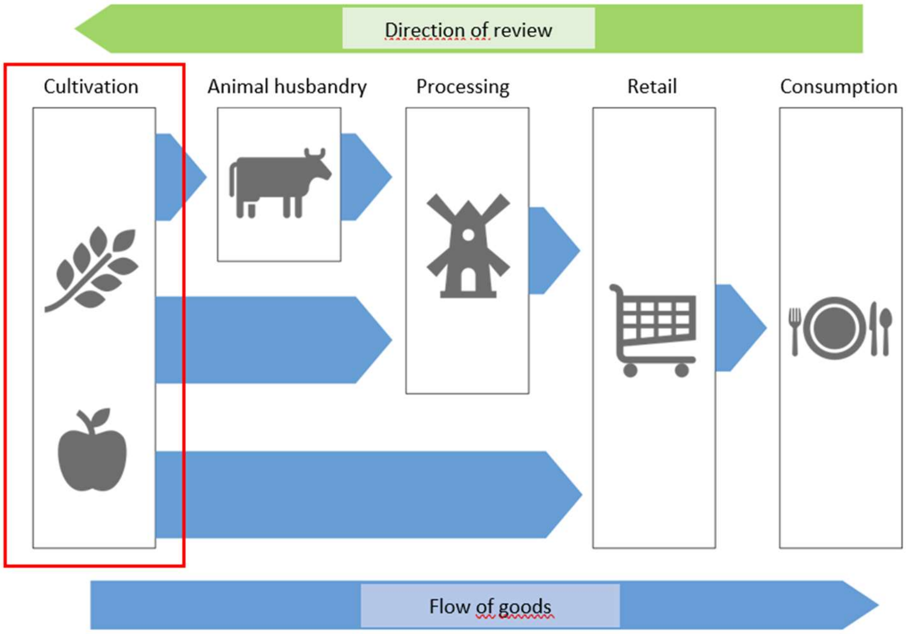

Figure 7: Agricultural production: Cultivation of agricultural crop products

The consumption data needed for the study, including energy and fertilizer consumption, were taken from the susDISH database of the Institut für nachhaltige Land- und Ernährungswirtschaft (Institute for Sustainable Agriculture and Food) (INL 2020), which provides data for most products and countries of origin. In cases where data for a specific agricultural product were unavailable for one country but available for other countries, cultivation is modeled based on the assumption that the consumptions in cultivation for this country are comparable to countries with similar climatic conditions. Agricultural products' countries of origin were determined via FAO trade statistics (FAO 2020a).

Energy consumption

The study considers the primary energy consumption of the following processes in agriculture:

- Provision and combustion of diesel fuel for tractors and other agricultural machinery (combines, harvesters, etc.)
- Energy use for pumping irrigation
- Greenhouse energy use
- Energy use for cooling and storage

As it was not possible to differentiate between mechanical and electrical energy consumption within the scope of this study, primary energy consumption in total was modeled as mechanical energy. The resulting error is estimated to be small, since the share of electrical energy, if any, is low for most processes.

Mechanical energy was modeled based on the combustion and provision of diesel fuel using the data sets listed in Table 13.

Table 13: Data sets used for modeling mechanical energy in agriculture.

Process	Database	Record	Time reference
Diesel supply	Ecoinvent 3.6	market for diesel, low-sulfur [Europe without Switzerland]	2000
Diesel combustion	GEMIS 5	Dieselmotor-generisch-Landwirtschaft (Endenergie)	2000

Land use/yields

Yield data were calculated as an average for the period 2015-2017, based on FAO yield statistics (FAO 2020b).

Water use

Water withdrawal for irrigation was modeled at the country and product level using data from Mekonnen and Hoekstra (2010).

Fertilizer

Production of potassium, phosphate and nitrogen fertilizers used was mapped based on datasets from Ecoinvent 3.6. Table 14 lists the data sets used for this purpose.

Table 14: Data sets used for modeling fertilizer production.

Process	Database	Record	Time reference
Potassium fertilizer	Ecoinvent 3.6	market for potassium fertilizer, as K2O [GLO]	2012
Phosphate fertilizer		market for phosphate fertilizer, as P2O5 [GLO]	2011
Nitrogen fertilizer		market for nitrogen fertilizer, as N [GLO]	2011

Direct emissions

Data on direct emissions of ammonia, biogenic carbon dioxide, nitrous oxide (laughing gas), and biogenic methane were taken from the susDISH database (INL 2020) and integrated into the model as direct emissions.

Greenhouse gas emissions from land use changes

Data for greenhouse gas emissions from land use effects (LU) and direct land use change (dLUC), collectively referred to as LULUC, were taken from the susDISH database (INL 2020) and integrated into the model as direct emissions.

Emissions from land use and land use change are based on the country-based land expansion of different agricultural products in the period 1990-2010. The analysis looks at the degree of average land expansion over this period as well as areas that are claimed additionally (forests, peatlands, or other agricultural land). This results in average LULUC emissions per land increase for individual agricultural products in the country under consideration. By determining the average land yield in the period 2009-2011, LULUC emissions can then be related to the production quantity of specific agricultural products. The results were used in this study to determine LULUC emissions for the products in the average food basket in Germany.

Example: 135 kg of soybeans are harvested for the status quo basket and consumed in the form of soybean oil and animal feed. 52% of this quantity (70.2 kg) originate from Brazil. To determine the dLUC emissions, this number is multiplied by the product-specific dLUC factor for soybean cultivation in Brazil of 4,634 g GHG emissions from direct land use change per kg soybeans.

Food losses

Losses at the agricultural product level were assigned to producing countries or regions and food categories according to Gustavsson et al. (2011). Losses in agricultural production as well as in postharvest handling and storage were considered. For apples, potatoes and wheat from German cultivation, the study uses the more precise data from Peter et al. (2013).

6.4.2 Animal husbandry

Animal husbandry includes the production of feed, energy consumption in livestock farming, and direct emissions. Fish/seafood production are also included here.

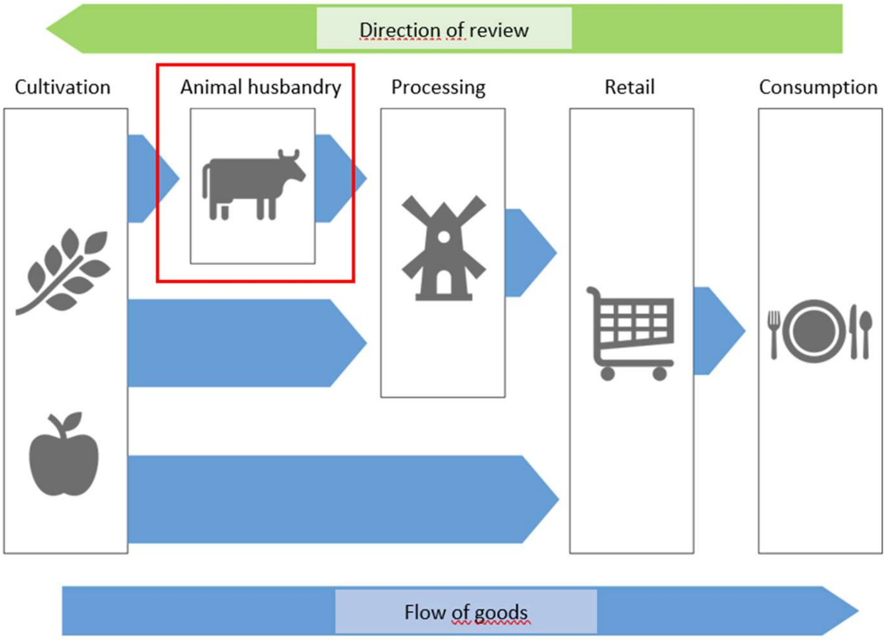

Figure 8: Agricultural production: animal husbandry

The data needed for modeling, e.g., energy and fertilizer consumption and direct emissions from livestock farming, were taken from the susDISH database (INL 2020). Countries of origin of animal-based products were determined via FAO trade statistics (FAO 2020a).

Feed

Feed composition was adopted from GEMIS 5 (IINAS 2020). Feed composition data is available in GEMIS 5 for the regions Western Europe, Central and Eastern Europe (CEE), Northern Europe, Southern Europe and Germany, with Germany being part of Western Europe. Table 15 lists the allocations of all relevant animal-based products and countries to the above-mentioned regions.

Table 15: Assignment of GEMIS feed data records to animals and countries

Animal	Country	GEMIS dataset Tierhaltung\...
Broilers	Germany	Masthähnchen-Westeuropa-2010
	Netherlands	
	Belgium	
	Brazil	
	Austria	
	Poland	Masthähnchen-CEE-2010
Laying hens	Germany	Legehenne (Ei)-Westeuropa-2010
	Netherlands	
	Poland	Legehenne (Ei)-CEE-2010
Fattening pigs	Germany	Mastschwein-Westeuropa-2010
	Netherlands	
	Denmark	Mastschwein-Nordeuropa-2010
Beef cattle	Germany	Mastbulle-Westeuropa-2010
	Netherlands	
	Austria	
	France	
	Belgium	
	Poland	Mastbulle-CEE-2010
	Denmark	Mastbulle-Nordeuropa-2010
Dairy cows	Germany	Milchkuh (Milch)-Westeuropa-2010
	Belgium	
	Austria	
	Czech Republic	Milchkuh (Milch)-CEE-2010
	Poland	
	Denmark	Milchkuh (Milch)-Nordeuropa-2010

Energy consumption

Data on energy consumption in livestock husbandry was adopted from the same GEMIS datasets as feed composition data (Table 3).

Modeling followed the same process as modeling for agricultural production (chap. 6.4.1).

Direct emissions

Direct emissions from livestock farming include ammonia, biogenic carbon dioxide, nitrous oxide (laughing gas), and biogenic methane. The respective data was adopted from the susDISH database (INL 2020) and integrated into the model as direct emissions.

Food Losses

Livestock losses were assigned to producing countries or regions and food categories according to Gustavsson et al. (2011)

Fish/seafood production and fishing

As the BMEL statistics only provide an aggregate for the consumption of fish and seafood, the differentiation between into wild fish catch and aquaculture products was based on the main imported products reported in the FAO fish and seafood database (FishStatJ 2020).

2015-2017 fish and seafood data were averaged. The five products with the largest import volumes were considered in the study. Of these five products, 70% of consumption in Germany comes from wild catch and 30% from aquaculture. The main exporting countries for the five products are modeled in addition to Germany.

The shares of German wild catch and products from German aquacultures are taken from BMEL data (BMEL, 2017-2019). The shares of imports are taken from FAO data (FAO 2020b).

As fish and seafood account for only a very small share of the German market basket, the error resulting from these simplifications is estimated to be small.

For fishing, the mechanical energy consumption of the vessels until landing is modeled. For aquaculture, energy consumption and land use, resulting nitrogen emissions, and direct emissions from feed production are modeled. The values here for are from the susDISH database.

Table 16 lists the datasets used to model fisheries and aquaculture.

Table 16: Data sets used for modeling fisheries and aquacultures.

Processes	Database	Record	Time reference
Mechanical energy, fishing	Ecoinvent 3.6	market for diesel, burned in fishing vessel [GLO]	2016

Import shares

Food products consumed in Germany come from many different countries. This study considers more than 30 agricultural products from over 50 countries. All imports were all assumed to be at the agricultural product level. The share of imported products is derived from BMEL supply statistics (BMEL, 2017-2019). All exports from Germany were assumed to be 100% produced domestically. All imports were attributed to domestic consumption. The countries of origin of imported raw materials were determined using FAO trade statistics (FAO 2020a). In the case of re-imports (cocoa via Belgium), the trade data for the countries of transit were also determined using FAO statistics.

Fish and seafood imports were determined using the FAO's FishStatJ (2020) database.

Shipping

Shipments from abroad to Germany were modeled as follows:

- Transport by sea:
  - Calculation of the transport distance from the capital to the largest port using Google Maps, covered by truck
  - Calculation of sea transport distance from the largest port to Rotterdam by means of www.sea-distances.org, covered by sea vessel
  - Calculation of the transport distance from Rotterdam to Frankfurt am Main, covered by truck

- Transport by land:
  - Calculation of the transport distance from the capital to Frankfurt am Main, covered by truck

Table 17 lists the data sets used for modeling.

Table 17: Data sets used for modeling imports of raw materials

Process	Database	Record	Time reference
Road freight transport (trucks), Europe without Germany	Ecoinvent 3.6	market for transport, freight, lorry >32 metric ton, EURO5 [RoW]	2011
Road freight transport (trucks), EU		market for transport, freight, lorry >32 metric ton, EURO5 [RER]	2011
Sea freight transport		market for transport, freight, sea, container ship [GLO]	2007

7. Allocations

In addition to mass allocation, the study uses the following allocation methods:

- Economic allocation: This allocation method was chosen for the allocation of environmental impacts to the various products in dairy production. The allocation was carried out as in Eberle and Fels (2016):
  - Milk: 88%
  - Retired dairy beef and veal: 12%
- Allocation by dry matter content: This allocation method was chosen for the allocation of environmental impacts to the different products resulting from dairy processing. It was adopted along with processing data from the susDISH data base.
- Allocation by energy content: This allocation method was used to allocate the environmental impacts to the different products resulting from the production of extraction meals and oils (rapeseed, palm fruit, soy, sunflower). The allocation was based on GEMIS 5 data (IINAS 2020).

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9. Appendix

Status quo market basket and the respective market baskets for the three EAT-Lancet scenarios (food consumption).

Food (group)	Status quo market basket Consumption per capita and year [kg]	Scenario I: Flexitarian market basket Consumption per capita and year [kg]	Scenario II: Vegetarian market basket Consumption per capita and year [kg]	Scenario III: Vegan market basket Consumption per capita and year [kg]
Cereals	**107,52**	**100,10**	**96,44**	**96,44**
Rice	5,29	4,92	4,74	4,74
Wheat flour	9,78	9,10	8,77	8,77
Wheat-flour baked goods	64,57	60,08	57,89	57,89
Wheat pasta	8,09	7,52	7,25	7,25
Rye flour	1,23	1,15	1,11	1,11
Rye-flour baked goods	8,73	8,12	7,82	7,82
Oatmeal	3,21	2,99	2,88	2,88
Corn	2,90	2,70	2,60	2,60
Potato starch*	3,73	3,51	3,39	3,39
Roots or starchy vegetables	**37,28**	**25,18**	**27,19**	**43,78**
Potatos	37,28	25,18	27,19	43,78
Vegetables	**109,49**	**151,14**	**163,24**	**282,77**
Dark green vegetables	*18,03*	*58,71*	*63,40*	*94,26*
Broccoli	3,59	11,67	12,61	34,52
Spinach	2,51	8,18	8,83	19,20
Cucumbers	11,93	38,85	41,96	40,54
Red & orange vegetables	*67,45*	*55,50*	*59,94*	*94,26*
Tomatos	50,15	43,80	47,30	70,08
Carrots	17,30	11,70	12,64	24,18
Other vegetables	*24,01*	*36,94*	*39,90*	*94,26*
Cabbage	8,34	13,63	14,72	32,72
Onions	15,67	23,31	25,17	61,54
Fruit	**104,16**	**100,19**	**108,20**	**137,89**
Apples	33,30	35,58	38,43	44,05
Peach	6,54	7,57	8,18	8,66
Grapes	9,19	7,19	7,77	12,16
Bananas	20,45	12,62	13,63	27,05
Oranges	33,25	36,95	39,90	43,98
Raisins	1,19	0,21	0,23	1,65
Dates	0,24	0,05	0,06	0,34
Dairy products	**123,47**	**79,54**	**85,90**	**0,00**
Milk	51,47	41,14	44,44	0,00
Yogurt	29,87	32,51	35,11	0,00
Cream	5,82	1,02	1,10	0,00
Butter	5,93	0,41	0,44	0,00
Cheese	24,21	3,29	3,56	0,00
Milk powder	4,94	0,51	0,55	0,00
Condensed milk	1,22	0,65	0,70	0,00

Continued: status quo market basket and the respective market baskets for the three EAT-Lancet scenarios (food consumption).

Food (group)	**Status quo market basket** Consumption per capita and year [kg]	**Scenario I: Flexitarian market basket** Consumption per capita and year [kg]	**Scenario II: Vegetarian market basket** Consumption per capita and year [kg]	**Scenario III: Vegan market basket** Consumption per capita and year [kg]
Protein sources	**81,77**	**126,23**	**104,05**	**108,02**
Meats & sausages	*55,35*	*30,05*	*0,00*	*0,00*
Beef	7,52	6,29	0,00	0,00
Pig	11,21	6,29	0,00	0,00
Poultry	8,22	9,98	0,00	0,00
Sausages (incl. lard/bacon)**	28,40	7,49	0,00	0,00
Eggs	*12,92*	*5,65*	*5,84*	*0,00*
Eggs	12,92	5,65	5,84	0,00
Fish	*6,47*	*9,38*	*0,00*	*0,00*
Fish	6,47	9,38	0,00	0,00
Legumes	*3,85*	*71,18*	*87,79*	*97,61*
Pea	1,92	40,06	40,06	40,06
Bean	0,34	7,07	7,07	7,07
Tofu	0,00	0,00	10,32	20,64
Peanuts	1,59	24,05	30,34	29,84
Nuts	*3,18*	*9,96*	*10,41*	*10,41*
Almonds	1,20	3,75	3,92	3,92
Hazelnuts	0,83	2,60	2,72	2,72
Cashew	0,62	1,94	2,02	2,02
Walnuts	0,54	1,68	1,76	1,76
Added fats	**21,58**	**18,20**	**19,78**	**19,78**
Palm oil	4,76	2,68	2,68	2,68
Olive oil	0,91	0,84	0,93	0,93
Rapeseed oil	6,19	5,71	6,30	6,30
Sunflower oil	4,34	4,01	4,42	4,42
Soybean oil	5,37	4,95	5,46	5,46
Added sugars	**29,03**	**11,84**	**11,84**	**11,84**
Sugar	29,03	11,84	11,84	11,84
Other* **	**2,80**	**2,79**	**2,79**	**2,79**
Cocoa	2,80	2,79	2,79	2,79
TOTAL	**617,09**	**615,19**	**619,42**	**703,30**

Legend: * Potato starch is included in cereals due to its use as a starch; ** Sausage incl. bacon & lard; *** Foodstuffs that play a role in Germany but could not be assigned to any of the categories.