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# WATER FOOTPRINT OF FOOD PRODUCTS IN GERMANY

## 2000-2010

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Water footprint of food products in Germany

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# Introduction

Reporting of the natural asset "water" in Environmental-Economic Accounting is currently limited to water consumption by domestic producers in their manufacturing processes and by private households for their direct consumption, which afterwards is discharged as waste water into the environment. In addition to this approach, the present project reports on water consumption from the perspective of consumers[1]. As part of the project, total water consumption in Germany and abroad, i.e. water required for the production of imported goods abroad ("indirect water use") is determined and allocated to the final consumer goods and/or end-use sectors. With regards to the use of resources, this presentation is more comprehensive and is particularly suited to calculate indicators for a sustainable and effective use of natural resources.

The project highlights, in particular, global water consumption associated with the domestic consumption of food products in Germany. It also examines water consumption for various food categories (crops and food of animal origin) and food products.

The amount of water required for food products depends on conditions of production in the countries of origin and varies according to climatic conditions, farming, irrigation methods, and seed and fertilisers used. For this reason, a detailed analysis of food products is made according to countries of origin. In calculating the water footprint, a distinction is made between green (precipitation water) and blue water (process and irrigation water), the use of which has a different impact on the ecosystem. Alongside the burden caused by the demand for imported goods, the burden caused by the domestic production of crop and animal products in the food sector is analysed. This analysis takes account of both domestic conditions of production in the agricultural sector as well as specific water consumption in the food industry.

When considering indirect water consumption for food products, this project builds especially on findings of the Water Footprint Network, an association made up of a large number of scientists headed by Arjen Hoekstra (University of Twente). One aim of the network is that of developing general methods and concepts to calculate water footprints.[2] These methods and concepts were used as a basis for calculating indirect water use in relation to German consumption of food products. Especially the "water coefficients" for vegetal and animal products from Mekonnen/Hoekstra were used in the calculations[3]. A time series for the years 2000 to 2010 has been produced in order to highlight trends in total water use for food products.

[1] The project received funding from Eurostat: Theme 5.02, Lisbon strategy and sustainable development, Title: Support the development of indicator sets for monitoring national SD strategies, project No.: 50904.2010.004-2010.589

[2] http://www.waterfootprint.org/?page=files/home.

[3] Cf. Mekonnen, M.M. and Hoekstra, A.Y.: The green, blue and grey water footprint of crops and derived crop products, Value of Water Research Report Series No. 47 (Crops) und 48 (Animal Products), UNESCO-IHE, Delft, the Netherlands. Volume I and II, 2010.

The outline is limited to a short presentation of the conceptual foundations – definitions – of the water footprint. The focus lays on the presentation of the most important results of the water footprint calculations for the domestic production, imports and exports of agricultural and food products. A comprehensive description of the concepts and methods used in the footprint calculations, together with a detailed presentation of the results including a large set of tables in an annex, is given in the outright report on the research project[4].

[4] The detailed research report including an overview on the corresponding literature, the base data and a research on the possible use of input-output analysis is available from the Statistical Office of Germany (e-mail: ugr@destatis.de).

# 1 Conceptual foundations of the water footprint

The term 'virtual water' was introduced by John A. Allan[5]. It refers to water embedded in a good or service. Virtual water specifies how much water was used in the production of a good or service along the entire production chain. Originally, Allan used the concept to explain the absence of conflicts over water. Arjen Hoekstra of the University of Twente then developed the water footprint on the basis of this concept.

## 1.1 Definition of water footprint

The water footprint (WF) is the amount of water used directly and indirectly by a country, region or consumer group.[6] Accordingly, the indirect water footprint of a country is defined as the amount of water required for the production of goods and services by the inhabitants of a country. The direct water footprint is equivalent to the direct water use of a consumer or an economy. The water footprint of a country can be calculated by subtracting the amount of exported water from domestic water consumption and adding to this the amount of imported virtual water.

## 1.2 Definition of green, blue and grey water footprint

The water footprint is made up of the green and blue water footprint. The green water footprint is defined as rainwater and soil moisture that is available to crops. Effective precipitation is usually not equal to total precipitation, as, for example, some rainwater is lost through runoff and is not available to the crops. In addition, more water is available to the crops than that provided through precipitation, as water is also available for evapotranspiration through the soil moisture content.

The blue water footprint is defined as irrigation water from groundwater and surface water. According to this model, rainwater that seeps into the groundwater, or precipitation that runs off from the land into rivers and streams, becomes blue water. Based on this definition, the irrigation of crops using collected rainwater should be treated in the same way as pond water and therefore as blue water.

The green water footprint depends solely on effective precipitation and evapotranspiration of crops, while the blue water footprint is additionally influenced by irrigation.

[5] Allan, J.A.: Watersheds and problemsheds: Explaining the absence of Armed Conflict over water in the Middle East. Middle East Review of International Affairs, 2 (1), 1998

[6] Chapagain, A.K. und A.Y. Hoekstra (2004): Water footprints of nations. Volume 1: Main Report. Value of Water Research Report Series No. 16, UNESCO-IHE, Delft, the Netherlands

Often information is also provided on the grey water footprint. In contrast to the other two concepts, the grey water footprint is not an indicator of the water required by the crops, but rather a hypothetical concept relating to water quality. It calculates the amount of water required to dilute water pollutants caused by fertilisers or production processes to an environmentally-sustainable level. As a result, the grey water footprint can be regarded as an indicator of water pollution[7]. The grey water footprint is usually calculated for the pollutant most frequently used in production. The following outline focus on quantitative aspects of fresh water use for food products and therefore the grey water footprint is not considered any further.

[7] Hoekstra, A.Y., A.K. Chapagain, M.M. Aldaya, M.M. Mekonnen, (2009): Water Footprint Manual. State of the Art 2009. Water Footprint Network. Enschede, the Netherlands

# 2 Results

## 2.1 Overview

Table 1 shows at a glance the results of the calculation of the WF of vegetal and animal products of the output of domestic agriculture and the imports and exports of agricultural and food products.

**Table 1: Water footprint (WF) of vegetal and animal products of agriculture and food industry: output, external trade and domestic consumption 2010**

| | WF (green) in mn m³ | WF (blue) in mn m³ | WF (total) in mn m³ |
|---|---|---|---|
| **Domestic output 1)** | | | |
| Crops | **42,038** | **989** | **43,027** |
| including: fodder 2) | 25,990 | - | 25,990 |
| **Exports** | | | |
| Crops | 37,688 | 1,476 | 39,164 |
| Animals | 25,190 | 1,308 | 26,498 |
| Sum | **62,877** | **2,784** | **65,661** |
| from imports | | | |
| Crops | 19,457 | 412 | 19,869 |
| Animals | 9,503 | 549 | 10,052 |
| Sum | **28,960** | **961** | **29,921** |
| **Imports** | | | |
| Crops 3) | 78,010 | 3,931 | 81,941 |
| including: fodder 2) | 18,836 | 251 | 19,087 |
| Animals | 20,311 | 1,163 | 21,475 |
| Sum | **98,321** | **5,094** | **103,415** |
| **Net imports (Imports-Exports)** | | | |
| Crops | 40,322 | 2,455 | 42,777 |
| Animals | -4,878 | -145 | -5,023 |
| Sum | **35,444** | **2,310** | **37,754** |
| **Domestic consumption** | **77,482** | **3,299** | **80,781** |
| **for information:** | | | |
| **WF fodder 3)** | **44,826** | **251** | **45,077** |
| **Water consumption private households 4)** | | 3,103 | **3,103** |

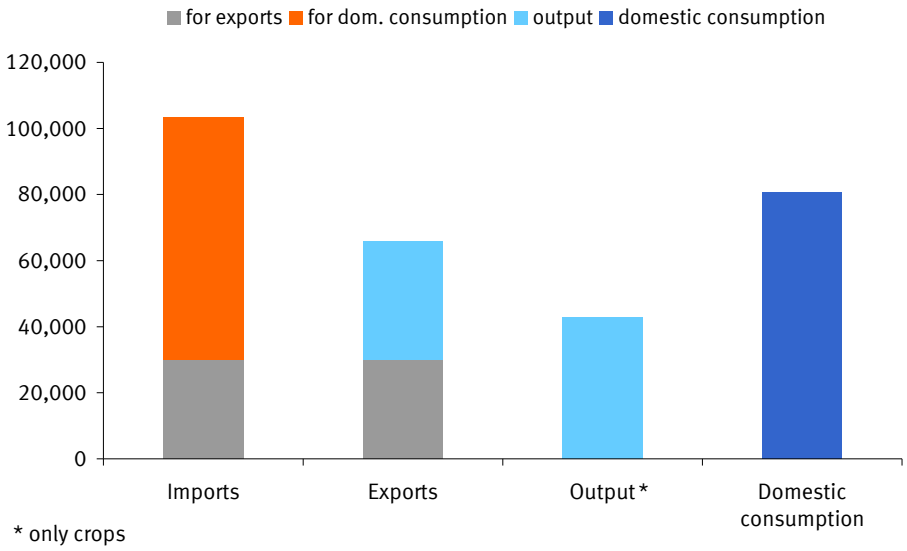
1) Only crude materials, excl. Water use in food industry.
2) 2009.
3) Incl. cotton.
4) Domestic consumption
5) 2007, from public water supply.

In 2010 the WF of domestic output of agriculture accounts for 43 billion m³. The WF consists predominantly of green water, which is evapotranspiration from rainwater. Only a minor part – 989 million m³ (blue water) – were domestically used for irrigation purposes. The WF of imported agricultural products (incl. WF of food products and blue water in food industry) totals up to 103 billion m³ – more than double the footprint of domestic output of agricultural products. A significant part of the imports – about 30 billion m³ – was domestically used in the production of food products for export.

With a WF of 66 billion m³ the exports tops the WF of total domestic crop output. One reason for this is the high WF of incorporated imported intermediate products. In addition, the WF of exports also contains the process water used in the food industry.

By taking into account domestic output and trade in products this results in a WF of domestic consumption of barely 81 billion $m^3$ – which is almost double the footprint of domestic (crop) output (Figure 1).

**Figure 1: Water footprint of crops and animal products of agriculture and food industry 2010 (million $m^3$)**




More than half of the WF of domestic crop output – 26 billion $m^3$ – is related to fodder. Another 19 billion $m^3$ water has to be attributed to imports of fodder. This results in a total WF of 45 billion $m^3$ – which even exceeds the WF of total domestic output.

The overwhelming part of the WF of vegetal and animal products is related to green (rainfall) water. Nevertheless at the production of German imports blue irrigation and process water is used too. With a volume of 5.1 billion $m^3$ this outvalues clearly the volume of water used by German households (2007: 3.1 billion $m^3$ water from public suppliers).

## 2.2 Water consumption for domestic production – crops and crop products

**Supply-side calculation of the water footprint of agricultural commodities**

The supply balance sheets for agricultural products and other information from German agricultural statistics reveal that in 2010 around 44 million tonnes of cereal, plus 133 million tonnes of animal fodder and roughage (e. g. field peas, sugar beet, etc.), 2.6 million tonnes of fruit and 14.5 million tonnes of vegetables (including 10 million tonnes of potatoes) were produced (Table 2).

In 2010, in Germany 42 billion m³ of green water were consumed in the production of agricultural commodities. Of this, a third was attributed to cereal production (see Figure 2). The blue WF was just under 1 billion m³ in the same year. Of this, 35 % was attributed to vegetable production and 32 % to cereal production (see Figure 3). While it is true that the specific blue water content of cereal is low, the considerable volumes produced result in a considerable blue WF for domestic production.

**Table 2: Quantity produced and water footprint of crop-based agricultural commodities**

| | Produced quantity in 1,000 t | | WF (blue) in 1,000 m³ | | WF (green) in 1,000 m³ | |
|---|---|---|---|---|---|---|
| | 2000 | 2010 | 2000 | 2010 | 2000 | 2010 |
| **Total: Crops** | **187,608** | **194,621** | **1,183,857** | **989,756** | **40,886,369** | **42,038,228** |
| Cereals | 45,315 | 44,206 | 484,479 | 321,095 | 24,124,252 | 23,866,482 |
| Fodder and roughage | 122,918 | 133,341 | 191,738 | 265,401 | 14,053,163 | 16,294,787 |
| Fruits | 2,323 | 2,614 | 62,637 | 59,157 | 1,171,658 | 492,458 |
| Vegetables | 17,052 | 14,460 | 445,004 | 344,103 | 1,537,296 | 1,384,501 |

Cereal is by far the most important export item in the case of agricultural commodities. In 2010, cereal exports represented 93 % of all exports of agricultural commodities in terms of volume. 13 % of the green WF and 4 % of the blue WF of agricultural commodities were attributed to exports.

**Table3: Exports and water footprint of agricultural commodities**

| | Exports in 1,000 t | | WF (blue) in 1,000 m³ | | WF (green) in 1,000 m³ | |
|---|---|---|---|---|---|---|
| | 2000 | 2010 | 2000 | 2010 | 2000 | 2010 |
| **Total: Crops** | **14,681** | **11,980** | **131,211** | **36,384** | **7,451,713** | **6,475,892** |
| cereals | 14,029 | 11,244 | 121,743 | 24,237 | 7,204,329 | 6,358,516 |
| Fodder and roughage | 7 | 1 | 12 | 2 | 433 | 80 |
| Fruits | 276 | 131 | 5,151 | 3,944 | 213,714 | 62,671 |
| Vegetables | 369 | 604 | 4,305 | 8,201 | 33,237 | 54,625 |

**Figure 2: Green water footprint of agricultural raw materials (domestic production) 2010**

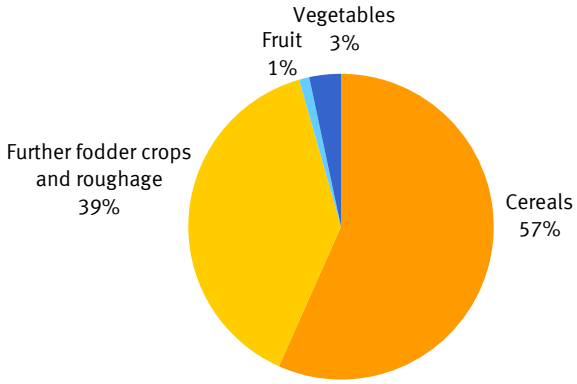
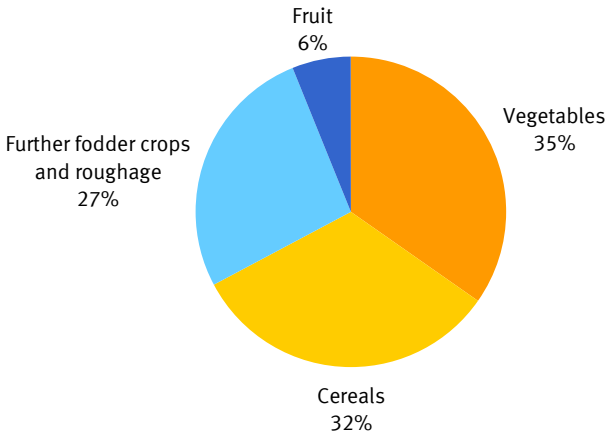



**Figure 3: Blue water footprint of agricultural commodities (domestic production) in 2010**



## 2.3 Water consumption for domestic production – animals

The WF of animal products accrues from the feeding and soaking of the livestock. The WF of animal products – meat, milk, eggs – can be calculated on basis of the water content of domestic and imported fodder by animal species.

In 2009, 135.8 million tonnes of animal feed were used to feed livestock in Germany (Table 4). Of this 87.4 % was derived from domestic production and 12.6 % from imports. The majority, a good 76 %, is fed to cattle, of which almost 29 % was fed to beef cattle, 38 % to cows and female cattle, and 9 % to calves. 16.1 % of the animal feed supply was assigned to pigs, 3.8 % to poultry, 1.9 % to horses and 2 % to sheep and goats.

Feedstuff consumption by animal species depends, on the one hand, on the number of livestock in the particular animal category, and, on the other hand, on the particular specific feedstuff consumption.

**Table 4: Use of fodder by type of animal 2009**

| Object | Feeder cattle | Dairy cows a.o. female cattle | Young cattle | Fattening pigs | Laying hens | Hens for fattening | Horses | Sheeps/ goats | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **1,000 heads** | | | | |
| **Number of animals** | **4,814** | **6,112** | **2,018** | **20,144** | **38,464** | **76,162** | **542** | **2,351** | **150,606** |
| | | | | | **1,000 tonnes** | | | | |
| **Fodder, total** | **38,882** | **52,126** | **12,463** | **21,861** | **2,327** | **2,838** | **2,559** | **2,758** | **135,815** |
| Domestic production | 35,305 | 48,909 | 11,359 | 14,894 | 1,546 | 1,460 | 2,315 | 2,656 | **118,445** |
| Imports | 3,578 | 3,216 | 1,103 | 6,967 | 781 | 1,378 | 244 | 102 | **17,369** |
| Cereals | 2,070 | 5,174 | | 15,445 | 1,811 | 905 | 388 | 78 | **25,871** |
| Pulses | 73 | 35 | | 87 | 8 | 4 | 0 | 1 | **209** |
| Concentrated feed | 5,093 | 3,113 | 1,370 | 4,534 | 508 | 1,929 | 237 | 135 | **16,919** |
| Linseed cake | 2,786 | 1,703 | 750 | 2,481 | 278 | 1,055 | 130 | 74 | **9,256** |
| Other | 2,307 | 1,410 | 621 | 2,054 | 230 | 874 | 107 | 61 | **7,663** |
| Root crops | 645 | 323 | | 273 | | | 32 | 17 | **1,290** |
| Green fodder | 30,020 | 43,144 | 8,577 | | | | 1,715 | 2,316 | **85,773** |
| Silage maize | 14,517 | 20,863 | 4,148 | | | | 830 | 1,120 | **41,477** |
| Other | 15,504 | 22,281 | 4,430 | | | | 886 | 1,196 | **44,296** |
| Straw | 981 | 337 | | | | | 174 | 200 | **1,692** |
| Milk | | | 2,515 | 1,521 | | | 12 | 12 | **4,061** |
| Whey | | | 1,512 | 915 | | | 7 | 7 | **2,441** |
| Other | | | 1,003 | 607 | | | 5 | 5 | **1,619** |
| | | | | | **in %** | | | | |
| **Fodder, total** | **28.6** | **38.4** | **9.2** | **16.1** | **1.7** | **2.1** | **1.9** | **2.0** | **100** |

The water content – green and blue water – of the animal feed (excluding drinking water) was 45.1 billion m³ in 2009 (see Table 5). Of this 58 % (26 billion m³) was attributable to domestically produced animal feed and 42 % (19.1 billion m³) to imported animal feed. Therefore, the import share of the water content of the animal feed is higher than the import share of the animal feed volumes. These higher shares of imports in water content can be traced back to relatively high water requirements for the production of concentrated animal feed, e.g. linseed cakes and cereals.

## Table 5: Water-footprint of livestock from fodder and watering places 2009

| Object | Feeder cattle | Dairy cows a.o. female cattle | Young cattle | Fattening pigs | Laying hens | Broilers | Horses | Sheeps/ goats | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1,000 heads | | | | |
| **Number of animals** | **4,814** | **6,112** | **2,018** | **20,144** | **38,464** | **76,162** | **542** | **2,351** | **150,606** |
| | | | | | million m³ | | | | |
| **Fodder, total** | **10,801** | **12,716** | **3,609** | **12,987** | **1,431** | **2,271** | **711** | **551** | **45,077** |
| Cereals | 1,092 | 2,730 | | 8,149 | 955 | 478 | 205 | 41 | **13,650** |
| Pulses | 39 | 19 | | 46 | 4 | 2 | 0 | 1 | **111** |
| Concentrated feed | 4,728 | 2,890 | 1,272 | 4,210 | 471 | 1,791 | 220 | 126 | **15,709** |
| Linseed cake | 4,280 | 2,617 | 1,152 | 3,811 | 427 | 1,621 | 199 | 114 | **14,221** |
| Other | 448 | 274 | 121 | 399 | 45 | 170 | 21 | 12 | **1,489** |
| Root crops | 27 | 13 | | 11 | | | 1 | 1 | **54** |
| Green fodder | 4,915 | 7,063 | 1,404 | | | | 281 | 379 | **14,042** |
| Silage maize | 2,903 | 4,173 | 830 | | | | 166 | 224 | **8,295** |
| Other | 2,011 | 2,890 | 575 | | | | 115 | 155 | **5,747** |
| Straw | | | | | | | | | |
| Milk | | 0 | 932 | 571 | | | 5 | 4 | **1,512** |
| Whey | | 0 | 415 | 251 | | | 2 | 2 | **669** |
| Other | | 0 | 518 | 314 | | | 3 | 2 | **837** |
| Drinking water | 54 | 119 | 10 | 61 | 6 | 7 | 5 | 6 | **269** |
| **Total** | **10,855** | **12,834** | **3,619** | **13,048** | **1,437** | **2,278** | **717** | **557** | **45,346** |
| | | | | | in % of total livestock | | | | |
| **Total** | **23.9** | **28.3** | **8.0** | **28.8** | **3.2** | **5.0** | **1.6** | **1.2** | **100** |

The water content of animal feed is made up almost exclusively of green water (99 %). Blue water comprises only 1 % of the total water content. For domestically produced animal feed, it is assumed that no irrigation water is used. For imported animal feed, it is assumed that blue water is used alongside green water, as arable crops are irrigated in some of the countries of origin.

## Figure 4: Water-footprint of fodder by type of livestock 2009

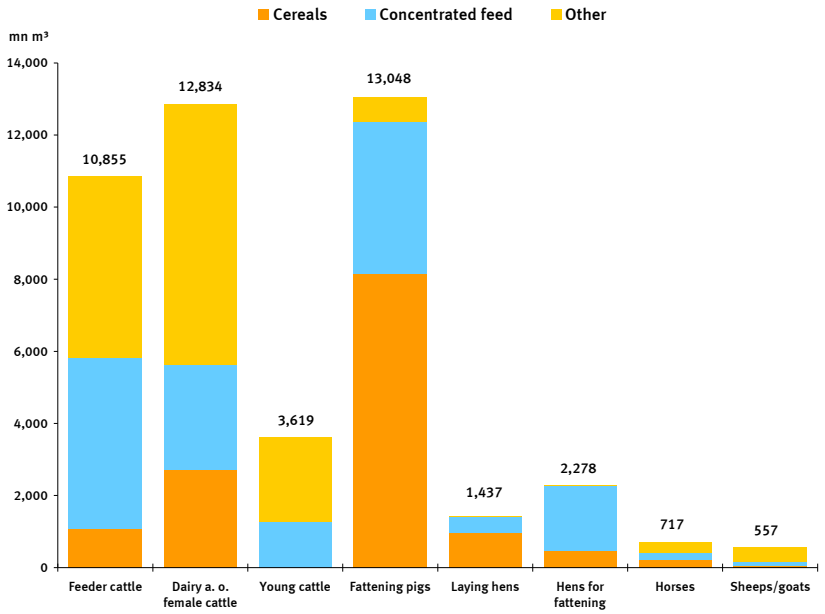


Table 6, Section A shows the WF of livestock based on animal feed and drinking water in m³ per tonne of animal feed for the year 2009 and over the entire lifespan of the animals. Beef cattle have the highest WF per year (2,255 m³/animal/year). Cows and other female cattle have a slightly lower WF per year (2,100 m³/animal/year). The lowest WF is attributed to laying hens (32 m³/animal/year) and broilers (37 m³/animal/year). Sheep and goats have a WF of 237 m³/animal and year.

The total WF of livestock fed on domestically produced animal feed fell by 9.4 %, while that of imports rose by 24 % in the period from the year 2000 to 2009. This development is explained by the rise in imported animal feed, such as concentrated animal feed. By contrast, consumption of domestically produced green fodder heavily decreased.

The WF of the livestock over the entire lifespan of the animals depends on the average age and weight/size of the animals. For example, cows and female cattle have the highest WF at 9,449 m³, as their average lifespan is 4.5 years. Cattle have a lifespan of 2.4 years and a WF of 5,411 m³. The lifespan of other animals is very much shorter and therefore their WF is very much lower.

**Table 6: Water footprint of animals and animal products 2009**

| Object | Feeder cattle | Dairy cows, oth. female cattle | Young cattle | Fattening pigs | Laying hens | Broilers | Horses | Sheeps/ goats |
|---|---|---|---|---|---|---|---|---|
| Life period (years)..... | 2.4 | 4.5 | 0.5 | 0.8 | 1.5 | 0.17 | | 0.7 |
| A. WF (in m³) | | | | | | | | |
| Animal/year..... | 2,255 | 2,100 | 1,793 | 648 | 37 | 30 | 1,323 | 237 |
| Animal..... | 5,411 | 9,449 | 897 | 518 | | 5 | | 166 |
| B. WF of products: m³/tonnes | . | | | | | | | |
| Volume of slaughterings..... | 14,594 | 4,144 | 6,630 | 3,327 | | 3,543 | | 4,404 |
| Eggs..... | | | | | 1,810 | | | |
| Milk..... | | 529 | | | | | | |
| Meat..... | 16,216 | 5,014 | 7,366 | 3,697 | | 2,347 | | 4,893 |
| Sausage..... | 17,838 | 5,515 | 8,103 | 4,066 | | 2,582 | | 5,383 |

In relation to produced slaughter volumes (Table 6 Section B), beef cattle have the highest WF (14,594 m³/tonnes slaughter weight). The WF of pigs (3,327 m³/tonne/slaughter volume) and broilers (3,543 m³/tonne/slaughter volume) make up only a quarter of the WF of cattle. As cattle have a long fattening period and consume a lot of concentrated animal feed and green feed, this is reflected in a higher specific WF.

When calculating the WF of cows and female cattle, the total WF is divided between the slaughter volume and the produced milk on the basis of their share of the total volume. For the slaughter volume and the produced milk, the value of the goods produced over the total lifespan of an animal is calculated. As the produced milk makes up a very much higher share of the value (87 % of the total value of the produced milk and cow meat) than the cow meat (13 %), the WF of cows and female cattle (4,144 m³/tonne) is very much lower in relation to slaughter volume than that of beef cattle. The WF of eggs is 1,810 m³/tonne of eggs.

Table 6, section B, also shows the WF of meat for direct consumption and of sausage products[8]. The WF of marketable meat varies significantly depending on animal species. Beef has a WF of 16,216 m³ per tonne of meat, pork 3,697 m³ per tonne and broiler meat 2,347 per tonne. The WF of meat from sheep and goats is 4,893 m³ per tonne.

For meat and sausage production, the food industry uses water in various processes (incorporating water into products, cooling, operating machines, cleaning). Compared with green and blue water used in the production of animal feed, this blue water only makes up a share of around 0.2 % (63 million m³) of the total water used in the production of animal products.

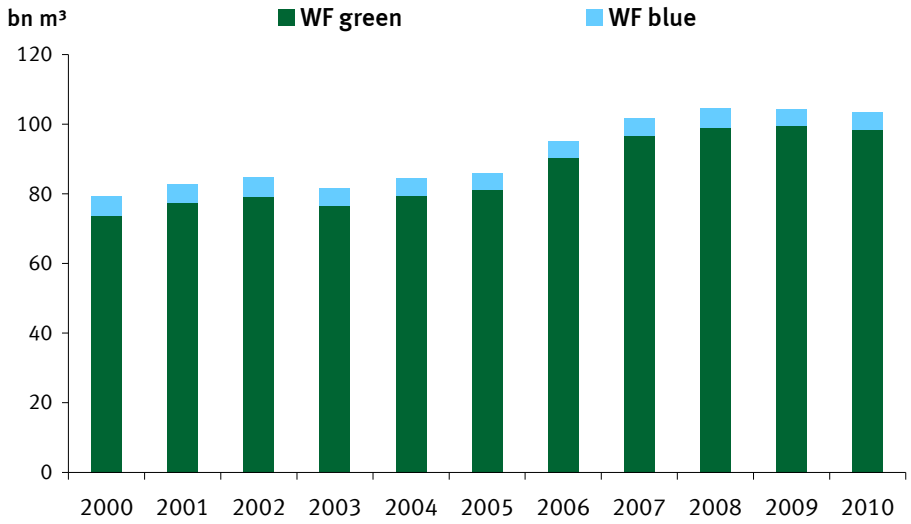
[8] Excluding blue water used by the food industry.

## 2.4 Water consumption for imported goods

The results of the WF calculations for imports show that Germany imported around 103 billion m³ of virtual water with agricultural and food products in 2010. This volume is equivalent to approximately twice the water volume of Lake Constance. 95 % of indirect water imports were imports of green water, while 5 % represented imports of blue water. Indirect water exports totalled around 62 billion m³ in 2010. By comparison: around 50 billion m³ of water were used for the domestic production of agricultural commodities. As additional blue water is used in the processing of agricultural commodities, the water volume used by exports is higher than the WF of total agricultural commodities. In addition, exports also contain an import share and therefore water consumed abroad.

Between the years 2000 and 2010 imports of agricultural and food products rose from 46.7 million tonnes to 65.7 million tonnes. Of these, imports of cereal and beverages recorded a particular sharp increase. While imports of blue water have hardly changed since the year 2000, imports of green water have risen by 25 %.

**Figure 5: Indirect water imports of agricultural and food products 2000 to 2010**




Most blue water is imported with imports of fruits and nuts. Other foreign trade categories with which considerable volumes of blue water are imported include sugar and sugar products as well as unprocessed cotton. This demonstrates that high import volumes are not necessarily accompanied by high imports of indirect water. Although the physical import volume for unprocessed cotton is very low, and in 2010 only 47 thousand tonnes were imported, indirect water imports with cotton are very significant (see Table 7). Cereal, which represented the biggest import category in physical volumes in 2010, reported a relatively low blue WF

.

**Table 7: Blue water footprint and Imports of agricultural products in 2010**

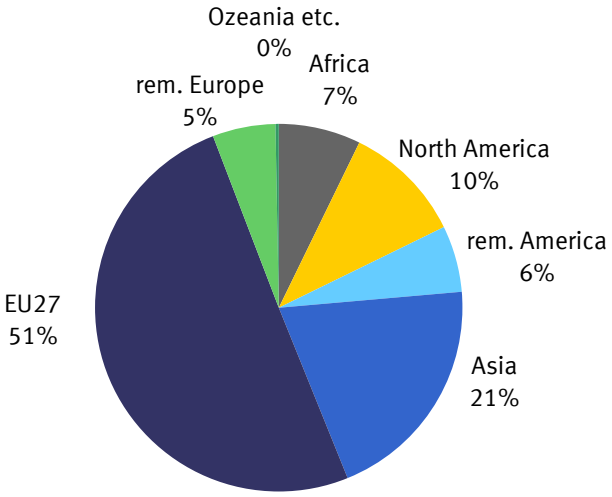
| Trade Statistics Chapters | WF (blue) in 1,000 m³ | | Imports in 1,000 t | |
|---|---|---|---|---|
| | WF blue | Rank | Imports | Rank |
| Fruits and nuts | 990,943 | 1 | 5,854 | 5 |
| Sugar and sugar confectionary | 550,886 | 2 | 1,705 | 11 |
| Cotton | 462,468 | 3 | 47 | 23 |
| Meat | 386,836 | 4 | 2,375 | 10 |
| Preparations of vegetables, fruit etc | 381,262 | 5 | 3,427 | 9 |
| Cereals | 378,740 | 6 | 8,375 | 1 |
| Dairy products | 289,908 | 7 | 4,448 | 7 |
| Animal & vegetabke oils & fats | 267,840 | 8 | 3,888 | 8 |
| Preparations of cereals | 163,878 | 9 | 1,510 | 12 |
| Vegetables | 134,369 | 10 | 4,724 | 6 |
| Coffee, tea etc | 128,944 | 11 | 1,359 | 13 |
| Oil seeds & oleaginous fruits | 121,582 | 12 | 7,136 | 3 |
| Beverages, spirits etc | 112,514 | 13 | 6,802 | 4 |
| Live animals | 108,623 | 14 | 965 | 16 |
| Cocoa and cocoa preparations | 78,732 | 15 | 1,059 | 15 |
| Live plants | 58,689 | 16 | 1,158 | 14 |
| Misc. edible preparations | 45,881 | 17 | 849 | 19 |
| Preparations of meat | 28,034 | 18 | 692 | 20 |
| Tobacco etc | 22,952 | 19 | 268 | 21 |
| Waste from the food ind.; prep. animal fodder | 22,235 | 20 | 7,221 | 2 |
| Products of the milling industry | 20,147 | 21 | 907 | 17 |
| Other vegetable textile fibres | 37 | 22 | 12 | 24 |

Around 77 % of total imports of blue water are attributed to imports of crop products and 23 % are attributed to imports of animal products. In the case of imports of green water, 80 % of indirect water imports are attributed to crop products and 20 % to imports of animal products. Green water is mainly imported with cocoa, vegetable fats as well as coffee and tea.

In addition to the subject of the most water-intensive agricultural and food products, the regions and countries in which the water is used are of special interest. Around half of the imports of blue water for crop products in 2010 comes from EU27 countries, 20 % from Asia and 16 % from the American Continent (see Figure 6).

Changes in indirect water imports according to global regions show that Asia's share has dropped significantly (from 32 % to 21 %). Meanwhile, water use in Europe and Latin America has risen and Africa’s share has fallen slightly. An important factor in this development is the drop in imports of unprocessed cotton between the years 2000 and 2010, which was mainly imported from Asia. In place of these imports, imports of processed cotton and textiles from Asia have increased considerably in the same period. A detailed study of water use by the textile industry would be beneficial in this context.

**Figure 6: Imports of blue water of vegetal products by world regions 2010**




While most oilseed and oleiferous fruits were still imported from North America in the year 2000, North America's share of the imports fell by almost 50 % by 2010. Instead, there has been a rise in imports from Latin America and Europe. Due to the higher share of green water used in the production of oilseed and oleiferous fruits in Europe and Latin America, indirect blue water imports have fallen significantly and indirect green water imports have risen.

The most important countries for imports of blue water are Spain, France, the United States and Italy (Figure 7). Green indirect water imports mainly come from Brazil, the Netherlands, Indonesia and the Côte d'Ivoire (see Figure 8).

**Figure 7: Imports of blue water for crops and crop products by countries of origin 2000 and 2010 (million m³)**

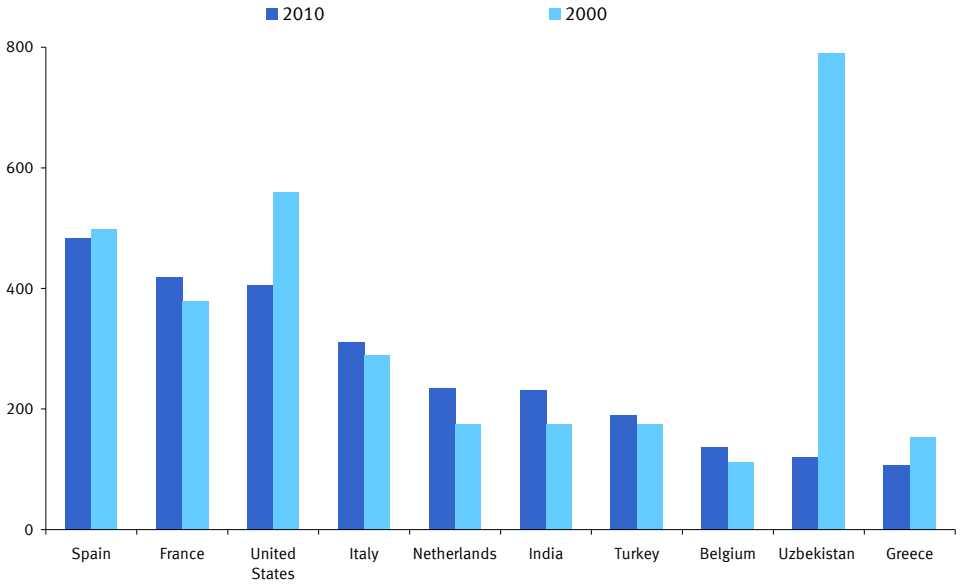
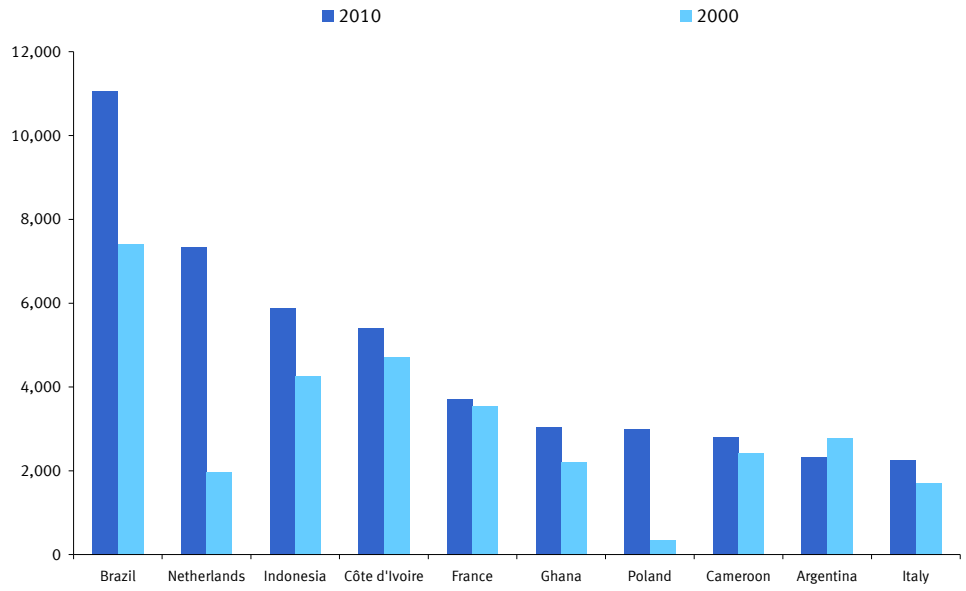


**Figure 8: Imports of green water for crops and crop products by countries of origin 2000 and 2010 (million m³)**



## 2.5 Water consumption for exports

With its exports of agricultural and food products, Germany exported around 2.8 billion m³ of blue water and 62.8 billion m³ of green water in 2010. These figures also include water consumption abroad by imported inputs involved in the production of the export goods. As imported inputs have a slightly higher water content than domestic inputs, water use for exports is slightly higher than it would be if imported inputs were not included in the calculation.[9]

Exports of indirect water rose from 46.6 billion m³ to 65.6 billion m³ between the years 2000 and 2010. This increase is accompanied by a 10 % rise in the volume of exports of agricultural and food products in the same period. Green water makes up a 96 % share of the water exports (see Figure 9)

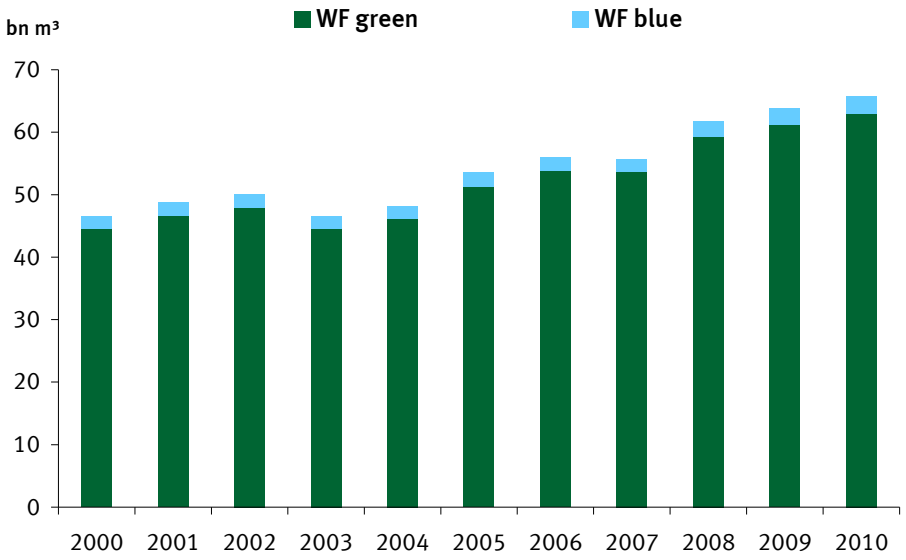
Compared with indirect water imports in 2010 of around 103 billion m³, this means that Germany is a net importer of indirect water. This is true both for green and blue water. In the case of animal products, however, Germany is a net exporter of indirect water. In 2010, 25 billion m³ of green water was exported with animal products, while only 20 billion m³ of green water was imported with animal products. This export surplus also results from the fact that a significant proportion of crop-based animal feed is imported, used as feed domestically and then exported once again as an animal product. In the case of imports, meanwhile, the WF of animal feed is shown in crop products.

**Table 8: Water footprint of exports and imports of agricultural and food products 2010**

| | WF (green) in 1,000 m³ | WF (blue) in 1,000 m³ | WF (total) in 1,000 m³ |
|---|---|---|---|
| **Exports** | | | |
| Crops | 37,687,783 | 1,475,794 | 39,163,577 |
| Animals | 25,189,660 | 1,308,218 | 26,497,878 |
| **Sum** | **62,877,443** | **2,784,012** | **65,661,455** |
| **Imports** | | | |
| Crops | 78,009,720 | 3,930,954 | 81,940,673 |
| Animals | 20,311,293 | 1,163,424 | 21,474,717 |
| **Sum** | **98,321,013** | **5,094,378** | **103,415,390** |
| **Net imports (Imports-Exports)** | | | |
| Crops | 40,321,937 | 2,455,160 | 42,777,096 |
| Animals | -4,878,367 | -144,794 | -5,023,161 |
| **Sum** | **35,443,570** | **2,310,366** | **37,753,935** |

[9] The WF of exports excluding imported upstream activities was 2.5 billion m³ for blue water and 59.5 billion m³ for green water in 2010.

**Figure 9: Water footprint of exports of vegetal and animal products 2000 to2010**




Meat, sugar and sugar products, as well as waste from the food industry are the main foreign trade items in the export of blue water and accounted for more than half of Germany's blue water exports in 2010 (see Table 9). In the case of exports of green water, 50 % is attributable to waste from the food industry, meat as well as cocoa and cocoa preparations.

If the WF of exports of agricultural and food products is broken down according to origin, around 65 % of the WF of exports is shown to be of domestic origin. This figure is 58 % for animal products which is lower than the 72% attributed to crop products (see Figures 10, 11). There are, however, considerable differences between individual foreign trade categories. For example, the import share in the WF of cotton, tobacco or coffee is 100%, while the import share for other items is very low. Notable among these are the import share of nil for beverages and alcoholic liquids and the low import share of sugar and sugar products (see Table 9).[10]

[10] Fruit and vegetable juices are allocated to foreign trade chapter 20: Preparations of vegetables and fruit.

## Table 9: Water footprint (blue water) and exports in 2010

| CN-Code | Description | WF (blue) 2010 in 1,000 m³ | | thereof imports | Exports 2010 in 1,000 t | |
|---|---|---|---|---|---|---|
| | | WF blue | Rank | WF blue | Exports | Rank |
| 02 | Meat | 598,438 | 1 | 369,831 | 3,339 | 5 |
| 17 | Sugar and sugar confectionary | 592,196 | 2 | 1,952 | 2,211 | 7 |
| 23 | Waste from the food ind.; prep. animal fodder | 383,650 | 3 | 51,132 | 7,800 | 3 |
| 19 | Preparations of cereals | 255,544 | 4 | 20,403 | 2,050 | 10 |
| 04 | Dairy products | 239,157 | 5 | 91,823 | 5,721 | 4 |
| 18 | Cocoa and cocoa preparations | 148,686 | 6 | 67,622 | 902 | 14 |
| 20 | Preparations of vegetables, fruit etc. | 118,301 | 7 | 60,744 | 1,835 | 11 |
| 52 | Cotton | 88,270 | 8 | 88,270 | 8 | 22 |
| 21 | Misc. edible preparations | 57,264 | 9 | 34,586 | 1,268 | 12 |
| 16 | Preparations of meat | 48,336 | 10 | 37,578 | 648 | 17 |
| 15 | Animal & vegetabke oils & fats | 46,222 | 11 | 32,380 | 2,138 | 8 |
| 09 | Coffee, tea etc. | 36,795 | 12 | 36,795 | 594 | 18 |
| 01 | Live animals | 34,823 | 13 | 0 | 656 | 16 |
| 10 | Cereals | 32,251 | 14 | 30,812 | 11,902 | 1 |
| 24 | Tobacco etc. | 27,800 | 15 | 27,800 | 278 | 20 |
| 11 | Products of the milling industry | 20,373 | 16 | 956 | 2,079 | 9 |
| 07 | Vegetables | 20,024 | 17 | 628 | 2,245 | 6 |
| 22 | Beverages, spirits etc. | 13,479 | 18 | 0 | 9,881 | 2 |
| 08 | Fruits and nuts | 13,234 | 19 | 9,667 | 960 | 13 |
| 12 | Oil seeds & oleaginous fruits | 5,908 | 20 | 0 | 889 | 15 |
| 13 | Lac; gums, resins etc. | 3,262 | 21 | 0 | 37 | 21 |
| 06 | Live plants | 0 | 22 | 0 | 369 | 19 |
| 14 | Vegetable plaiting materials | 0 | 22 | 0 | 0 | 24 |
| 53 | Other vegetable textile fibres | 0 | 22 | 0 | 1 | 23 |

## Figure 10: Blue WF for exports 2010

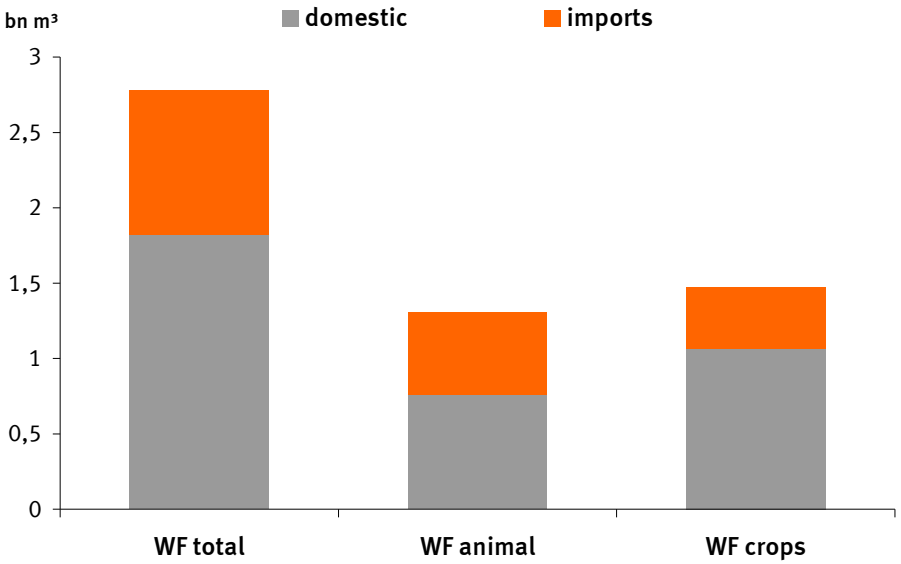


Figure 11: Green water footprint of exports of agricultural and food products 2010 by origin