WATER FOOTPRINT®
CALCULATOR

METHODOLOGY

FOR GRACE'S WATER FOOTPRINT OF FOOD GUIDE

Introduction *(back to top)*

GRACE's Water Footprint of Food Guide is an interactive web app that gives people an idea of all the water required to produce the food they eat every day. The Guide contains more than 100 common foods and beverages typical of the American diet, and for each item provides a total water footprint, a breakdown of water footprint components, and context about water used in production.

Water is one of the world's most precious and over-stressed resources, and agriculture and food production is the sector that consumes the most water. The Guide was created to inform people about the connection between food and water, a relationship that many people might not fully understand.

This online tool was created for educational purposes and is intended for use by teachers, students, researchers, and the media, among others.

What is a water footprint?

The water footprint concept accounts for two types of water "consumed." The first type is direct water use in which water is seen and felt, such as water from the kitchen faucet. The second type is indirect water use — also called virtual water use — which includes all the water required at every step of production to create goods and services, including agriculture and food production.

Growing and producing food as well as manufacturing consumer goods can require huge amounts of virtual water, which makes up the vast majority of water consumed by a person, business, product or, as the Guide illustrates, food item. This is important because, on average, a person's diet comprises the largest share of their water footprint.

The total water footprint is broken down into three component parts:

- Blue water footprint: The amount of surface water and groundwater required (evaporated or used directly) to produce an item.
- Green water footprint: The amount of rainwater required (evaporated or used directly) to make an item.
- Grey water footprint: The amount of freshwater required to dilute the wastewater generated in manufacturing, in order to maintain water quality, as determined by state and local standards.

Take water for pasta sauce, as an example. The water footprint not only includes the water to grow the tomatoes, but also the water to grow the other ingredients and the water needed for the processors to turn all of the ingredients into pasta sauce.

Note that the vast majority of a food item's water footprint is made up of water consumed in farm fields and animal agriculture operations (primarily water for animal feed, but also for drinking, cleaning, etc.). While so much water is consumed on farms, due to data limitations, the information available to calculate the water footprint of most of the Guide's food items includes the agricultural water consumed by crop and animal production, which ends at the farm gate and doesn't necessarily include water used in packaging, transportation, etc. Also note that the water footprint of animal products (meat, eggs and dairy) is due largely to the type and quantity of feed that animals eat.

Development of the Guide *(back to top)*

The Guide uses the water footprint framework as conceived by Arjen Hoekstra. It's through the work of Hoekstra and researchers affiliated with the Water Footprint Network (WFN) that the water footprint methodology and data exists, and it's from these sources that the data is drawn. (See SELECT SOURCES section below for reports, studies and resources.)

Steps in the Process

Food Item Selection

The first step was to select food items to appear in the Guide. Because GRACE focuses primarily on the United States, the foods chosen reflect those in a typical American diet. The data used in the Guide builds on United Nations' FAOSTAT data that categorizes foods as commodities, which means they tend to be unprocessed or lightly processed foods. In that way, the foods that are available for the Guide don't always translate to ready-made foods that end up on store shelves or kitchen plates. So, for example, water footprint data is not available for boxed, highly processed macaroni and cheese, nor for packaged specialty sausages. But the data is available for the separate ingredients, such as the water footprint data for pasta and cheese, as well as for pork without additives.

After the foods were selected, each item's water footprint data was gathered from the respective source and calculated. The original data was presented in metric units (liters, kilograms, grams) and was then converted to American standard units (gallons, pounds, ounces). Water footprint values were reduced to meet a somewhat common American portion of 4 ounces, which is displayed in both gallons and liters. Liquid portions were reduced to 8 fluid ounces (5 ounces for wine). Finally, the percentage for each item's blue, green and grey water footprints were determined as part of the total water footprint.

The descriptions for each food item were assembled to provide some insight into why a food item's water footprint might be higher or lower. First, each food item's top-producing countries and US states were ranked by economic value. Then, details were given about production methods and how they impact different parts of an item's water footprint (references for all data and information available here).

Portion Sizes

The portion size – serving size in the US – is 4 ounces (113 grams) by mass for food, and 8 fluid ounces (237 milliliters) by volume for beverages, except for wine, which is 5 fluid ounces (148 milliliters). These portion sizes were used in the Guide because they're close to the amount of food someone in the US might consume during one or two meals or snacks. These portions are approximated since the US Food and Drug Administration no longer recommends serving sizes. The portion sizes provide a way to standardize the numbers across food items. (For some foods, this rationale doesn't completely hold, for example with, say, butter or garlic, unless those items are consumed liberally.)

Portions for dried beans, peas and pulses (i.e., pulses, generally) are normalized by figuring their reconstituted or "cooked" mass since that's how they're actually eaten. The assumption is that 1 ounce of dried pulses is roughly equivalent to 3 ounces reconstituted, so in order to find the water footprint of a 4 ounce equivalent of cooked pulses, the dried pulses are divided by 16 (ounces per pound) then multiplied by 1.3 ounces.

Size Labels

The labels of Small (S), Medium (M) and Large (L) for foods and beverages are based on the following water footprint ranges:

- Small is less than 20 gallons (<20 gallons)
- Medium is 21 to 75 gallons (21 to 75 gallons)
- Large is greater than 76 gallons (>76 gallons)

After reviewing the data and comparing foods, water footprint sizes seemed to form natural groupings. Based on these groupings, what were considered reasonable separations were made between the Small, Medium, Large groups. Note that even though a water footprint of 20 gallons or less is labeled "Small," that is still a significant amount of water.

Filtering and Sorting

At the top of the Guide's web page, filtering and sorting functions are available for the user to view the information in different ways. Users can filter out and view categories of food, like Meat and Eggs, Fruits and Berries, Prepared Foods, and so forth. Food items can be sorted either by Water Footprint size or Alphabetically.

Sorting items by water footprint allows users to arrange food starting with those items that have the largest values. Sorting by water footprint size gives the user an understanding of food types that take more or less water to produce. For example, all the meat and nut items are in the "Large" water footprint group. Sorting food items alphabetically makes it easier to find a specific food item.

General Notes and Caveats

About the Data

- From these WFN-affiliated reports, the Guide's water footprint data are high-level and based on global averages which were used because: 1) numerous food items are produced abroad and then imported into the United States; and 2) the Guide's information can be made more accessible to an international audience.
- All water footprints are rounded up to the nearest whole number from 0.5 and higher, and down to the nearest whole number from 0.4 and lower. Results and average values are subject to rounding, and in the case of the percentages for Blue, Green and Grey Water Footprints, they may not total 100 percent.
- The Guide's food data and information are estimates, and considered educational; the best available data was used at the time of the Guide's creation. To get the most precise water footprint for a food item, a complete water footprint assessment of a food's production must be conducted, with assistance and data from the producer. It's notable that, over time, as the discipline of water footprinting is advanced by scientists and practitioners and as technology, water efficiency and water conservation improve, the water footprints of many foods will tend to become smaller.

About the Water Footprint of Meat and Other Animal Products

The water footprint data of meat and other animal products is based on taking an average of the water footprints of three types of animal production systems under which most items are produced. The three system types include industrial (intensive), grazing (extensive), and mixed.

Grazing, or extensive animal agriculture, refers to raising animals on land or pasture where animals are relatively spread out and mainly forage for food. Industrial, or intensive animal agriculture, refers to raising animals in concentrated areas or facilities in which their environment is relatively controlled and they are given formulated feed. In a mixed system, an animal spends part of its life grazing, then it is "finished" in an industrial system (a feedlot).

Each animal, product and production system has a different water footprint associated with it, which, to a large extent, depends on several factors, including: the kind and quantity of feed eaten by the animal; how the feed was produced; the blue, green and grey water footprint of the feed production; etc.

In order to determine the water footprint of a specific product, a producer would have to know the water requirements for everything it took to make that specific product (for example, the water requirements of all the feed and how it was produced, the energy requirements, the water requirements of all packaging, processing and transportation, the pollution associated with each step, etc.). This is an unrealistic expectation, therefore, global averages are used in calculations.

To determine the global average water footprint of meat and other animal products, a weighted average of the water footprints of food items produced under each system was calculated by researchers. So, for example, the global water footprint of cheese from cow's milk comes from the average of cheese produced in the three production systems with a greater proportion of the average given to the production system that makes the most cheese.

Calculations *(back to top)*

Water Footprint (WF) of Food Items, By Mass

Food Item WF liters/pound =
Total WF liters/kilograms/liter x (2.2 kilograms/1 pound)

Food Item WF liters/4 ounce serving (113 grams) =
Food Item WF liters/pound x (1 pound /16 ounces) / 4

Food's WF gallons/4 ounce serving =
WF liters/4 ounce serving x (1 gallon/3.785 liters)

For Dried Peas and Beans: Using the calculation above:
Dried Peas and Beans WF gallons/4 ounce serving =
WF gallons/4 ounce serving x 1.3 (see discussion above)

Water Footprint (WF) of Beverages, By Volume

Beverage Item WF gallons/gallons =
Total WF liters/liter x (3.785 liters/gallons) x (1 gallon/3.785 liters)

Beverage Item WF gallons/8 fluid-ounce serving (237 milliliters)
Beverage Item WF gallons/gallon / (1 gallon/128 fluid ounces) / 16

For Wine: Using the calculation above:
Wine WF gallons/5 fluid ounce serving =
WF gallons/5 fluid ounce serving x 0.625 (see discussion above)

Blue, Green and Grey Water Footprint (WF) Percentages

- Total WF = Blue WF + Green WF + Grey WF
- Blue WF as a percentage of Total WF = Blue WF / Total WF
- Green WF as a percentage of Total WF = Green WF / Total WF
- Grey WF as a percentage of Total WF = Grey WF / Total WF

Select Sources About Food and Water Footprints

(back to top)

- Hoekstra, Arjen and Water Footprint Network. **Product Gallery.** Accessed 2/11/2022:
  - https://waterfootprint.org/en/resources/interactive-tools/product-gallery/

- Mekonnen, M.M. and Hoekstra, A.Y. (2011) **The Green, Blue and Grey Water Footprint of Crops and Derived Crop Products.** Hydrol. Earth Syst. Sci., 15, 1577–1600, 2011
  - www.hydrol-earth-syst-sci.net/15/1577/2011/
  - https://doi.org/10.5194/hess-15-1577-2011
  - https://waterfootprint.org/media/downloads/Mekonnen-Hoekstra-2011-WaterFootprintCrops.pdf

- Mekonnen, M.M. and Hoekstra, A.Y. (2010) **The Green, Blue and Grey Water Footprint of Crops and Derived Crop Products, Value of Water Research Report Series No. 47.** UNESCO-IHE, Delft, the Netherlands.
  - **Main Report Volume 1:**
    https://waterfootprint.org/media/downloads/Report-48-WaterFootprint-AnimalProducts-Vol1.pdf
  - **Volume 2: Appendices:**
    https://www.waterfootprint.org/media/downloads/Report47-WaterFootprintCrops-Vol2.pdf

- Mekonnen, M.M. and Hoekstra, A.Y. (2010) **The Green, Blue and Grey Water Footprint of Farm Animals and Animal Products, Value of Water Research Report Series No. 48.** UNESCO-IHE.
  - **Main Report Volume 1:**
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  - **Appendices Volume 2:**
    https://waterfootprint.org/media/downloads/Report-48-WaterFootprint-AnimalProducts-Vol2.pdf

ABOUT US

The Water Footprint Calculator (WFC) seeks to raise awareness about how people in the United States use water throughout their day. The free tool illustrates how everyday actions – from washing dishes to watering the lawn to buying groceries – impact water use. The WFC also provides water-saving tips, lesson plans and other content to promote sustainable water use.

The WFC was created by the nonprofit GRACE Communications Foundation (GRACE), which develops innovative strategies to increase public awareness of the critical environmental and public health issues created by our current industrial food system, and to advocate for more sustainable alternatives.

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watercalculator.org

GRACE Communications Foundation

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