A food loss and waste water footprint calculation tool for organisations in the UAE

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Thriving Solutions

Reimagining our food systems to sustain our future

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FOREWORD

Water is a shared resource that supports our communities and ecosystems and is vital to our food and drink system. Climate change and associated extreme weather events have led to an increase in both drought and flooding and freshwater quality continues to be put at risk largely driven by the agri-food sector. We also know that food loss and waste (FLW) is a global issue that has significant impacts on the natural environment, in particular water scarcity and degradation of various water resources. Today, 25% of freshwater resources used for agricultural production are to irrigate food that ends in the wastebin. This is at a time when the freshwater resources planetary boundary for both blue and green water has entered into the critical zone of uncertainty.

It has long been suggested that 'what gets measured gets managed'. Measuring the water footprint of the food that we produce as well as the food we import and subsequently waste is a crucial step to understanding this vital issue, and more importantly, empowering us to do something about it.

Through our experience with international partners, we know that guidance and support must be adapted to the specific context and geography in which we're working. This is why WRAP, Thriving Solutions and City, University of London have joined forces to create a Water Footprint Tool for food loss and waste in the United Arab Emirates (UAE); a country that is acutely aware of the climate and water impacts of FLW. The UAE's commitment to the transformation of its food system and tackling FLW is evident in its ambitious FLW reduction targets in its Strategy and its Nationally Determined Contribution, coupled with the launching of the national FLW initiative ne'ma. At COP28 the UAE put food systems transformation high on its agenda via the Declaration on Sustainable Agriculture, Resilient Food Systems and Climate Action.

Measuring the water footprint of FLW in the UAE will, we believe, empower individuals, organisations, and governments to make informed decisions, re-evaluate supply chains, and champion sustainable water management that resonates with the UAE's vision for a greener, more sustainable future.

This tool lays the foundation for guidance to organisations and governments in the UAE who are seeking to measure and tackle the water footprint associated with their FLW. If you haven't already, now is the time to commit and play your part.

We look forward to working with businesses, governments and other organisations in the UAE and the Arab region, as together we can accelerate progress on reducing the water footprint of our food and drink system and ensure that no good food goes in the bin.

BACKGROUND

1.0 The food loss and waste challenge

Food loss and waste (FLW) can be defined as the decrease in quantity or quality of food along the food supply chain, from production to consumption[1]. FLW has significant impacts on the environment, including the depletion of natural resources such as water, land, and biodiversity, and the emission of greenhouse gases (GHGs) that contribute to climate change. This report focuses on the connection between FLW and water footprint, which is a measure of the amount and quality of water used to produce goods and services.

According to the Food and Agriculture Organization of the United Nations (FAO), the global volume of FLW is estimated at 1.6 billion tonnes of primary product equivalents, with a global cost of $750 billion annually[2]. The global blue water footprint for the agricultural production of food wastage is about 250 km^3; 3.6 times the blue water footprint of total USA consumption[3].

UNEP estimates that 44% of food is lost or wasted in the Middle East region and the highest portion of waste (34%) is wasted at the consumption stage[4]. This is a region with an unfavorable natural resource base for agricultural production which is expected to worsen with climate change. The region imports a large percentage of its food at a considerable economic cost and is currently experiencing an increase in malnutrition including hunger.

In the United Arab Emirates (UAE), more than 90% of food is imported, and the food produced locally uses precious water resources[5]. Comparable to the other Arab regions food waste is very high and is estimated to be around 133 kilograms/ per person/ per year with the majority of that waste occurring in households[6].

In 2022, the Ministry of Climate Change and Environment, Emirates Foundation, and the Abu Dhabi Crown Prince Court, launched ne'ma, the National FLW Initiative[7]. ne'ma seeks to align the actions of government, private sector, NGOs, and communities to cut FLW across the whole value chain[8]. Its goal is to deliver on the UAE's target to reduce FLW by 50% by 2030. This ambitious target is officially communicated in the UAE's Nationally Determined Contributions (NDC) to the Paris Agreement.

1 The United Nations Food and Agriculture Organization (FAO) differentiates between food waste and food loss whereby Food loss is "The decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers and consumers", and Food waste is "The decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers."

2 FAO, "Food Wastage Footprint. Impacts on Natural Resources. Summary Report" (Food and Agriculture Organization of the United Nations (FAO) 2013)

3 FAO, "Food Wastage Footprint. Impacts on Natural Resources. Summary Report" (Food and Agriculture Organization of the United Nations (FAO) 2013)

4 United Nations Environment Programme (2021). The State of Food Waste in West Asia.

5 UAE MOCCAE (2023) "A Guide to Food Security in the UAE" Ministry of Climate Change & Environment Dubai, United Arab Emirates"

6 Forbes, H., and Quested, T. (2021). FoodWaste Index - Level 1.

7 ne'ma | National Food Loss and Waste Initiative (nema.ae)

8 "ne'ma | National Food Loss and Waste Initiative" https://www.nema.ae/

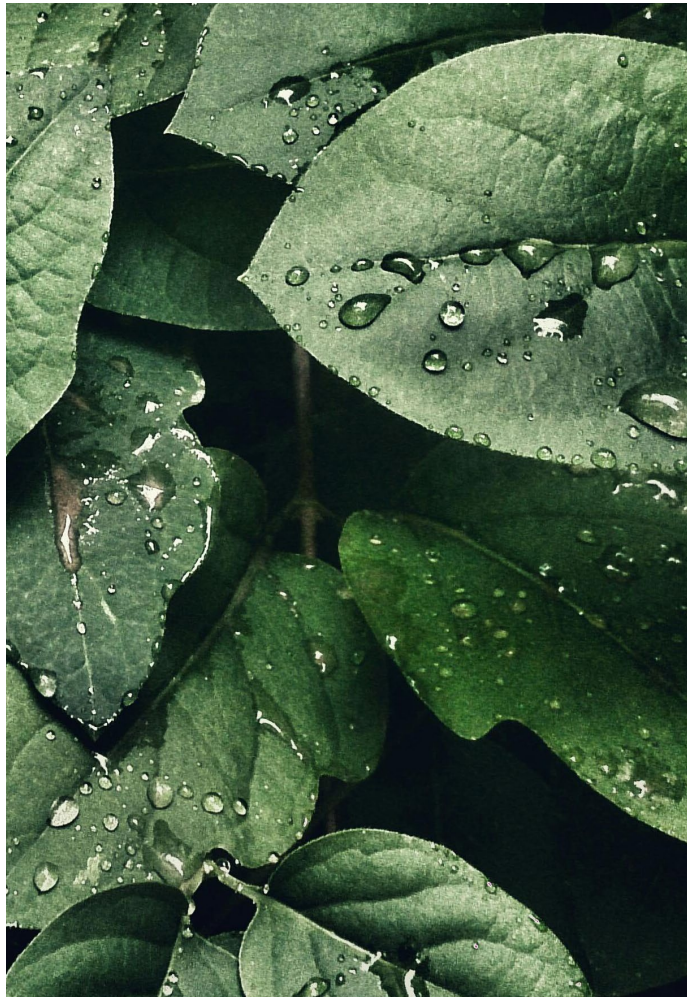
BACKGROUND

Today, we see an increasing drive by the private sector to join the climate action movement and reduce their greenhouse gases. This is observed by the increased number of companies undertaking GHG inventories. The private sector has also developed an increased recognition of the water footprint of FLW, however, quantification has not been as widespread as those measuring the GHG emissions associated with FLW. This is in part due to limited avilability of water footprint tools and resources to support organisations to quantify the water impact of FLW.

The Food Loss and Waste Accounting and Reporting Standard, also known simply as the FLW Standard, provides a common language and clear requirements for companies that are seeking to quantify and report their FLW. The FLW Standard requires companies to quantify and report their FLW in weight while recognizing the value of also quantifying and reporting FLW in alternative units of measure that are relevant to the company.

The FLW Standard has issued 'Connecting Food Loss and Waste to Greenhouse Gas Emissions: Guidance for Companies' which is a valuable tool to support companies in the food system undertaking a GHG inventory as it provides step-by-step instructions that helps companies understand, connect, calculate, describe and communicate the scale and relevance of their FLW in GHG emissions.

Companies measuring their FLW and pursuing initiatives to manage it will also benefit by being able to estimate the GHG emissions associated with their FLW. It also enables companies to track reductions in GHG emissions associated with reductions in FLW.



2.0 Differences between greenhouse gas (ghg) emissions and water footprints

Greenhouse gas emissions (GHGE) are the gases that trap heat in the atmosphere and contribute to global warming and climate change. GHGE can be measured in terms of carbon dioxide equivalent (CO_2e), which is a unit that expresses the impact of different greenhouse gases in relation to carbon dioxide. GHGE can be calculated for different stages of the food system, such as production, processing, transportation, storage, consumption, and waste.

Water footprint is a measure of the amount of water consumed and polluted during the production of a good or service. Water footprints can be divided into two main types: blue and green. Blue water footprint refers to the use of surface or groundwater sources, such as irrigation. Green water footprint refers to the use of rainwater and soil moisture, such as rainfall. A water footprint can also be calculated for different stages of the food system and can be expressed in terms of litres (L) or cubic meters (m^3) of water per unit of product.

The differences between GHGE and water footprints are mainly related to the sources and impacts of the environmental resources. GHGE are mainly derived from the combustion of fossil fuels and the emission of biogenic methane and nitrous oxide from agricultural activities. GHGE have a global impact, as they affect the atmospheric concentration of greenhouse gases and the radiative forcing of the Earth. Water footprints are mainly derived from the withdrawal and contamination of freshwater resources, such as rivers, lakes, and aquifers. Water footprints have a local or regional impact, as they affect the availability and quality of water for human and ecological use.

The geography of production matters for both GHGE and water footprints, as different regions have different climatic conditions, soil types, water availability, and energy sources. For example, producing rice in a humid and rainy area may have a lower blue water footprint but a higher green water footprint and higher GHGE than producing rice in a dry and sunny area. Similarly, producing beef in a grass-fed system may have a lower GHGE but a higher water footprint than producing beef in a feedlot system.

The importance of GHGE and water footprints for environmental impact assessments is that they provide a way to quantify and compare the environmental effects of different products, processes, and scenarios. Environmental impact assessments can help companies to identify the hotspots and trade-offs of their activities, to set targets and indicators for improvement, and to communicate their environmental performance to stakeholders and consumers. By using GHGE and water footprints, companies can also align their strategies with the global and national goals for mitigating climate change and ensuring water security.

3.0 Food loss and waste and the sustainable management of water

The UN Sustainable Development Goals (SDGs) aim to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains by 2030 (SDG 12.3)[9]. Achieving this target would also contribute to other SDGs related to water, such as ensuring availability and sustainable management of water and sanitation for all (SDG 6), protecting and restoring water-related ecosystems (SDG 6.6), and increasing water-use efficiency across all sectors (SDG 6.4).

To reduce FLW and to sustainably manage water resources, various complimentary actions are needed at different levels of the food system, from producers to consumers. Some examples of possible actions are:

- Improving agricultural practices and technologies
- Enhancing storage and transportation infrastructure
- Adopting better packaging and labelling standards raising awareness and education among consumers
- Promoting circular economy models such as reuse and recycling of food waste
- Supporting policy interventions and incentives that encourage FLW reduction[10].

By taking these complimentary actions to reduce FLW, we can not only save water resources for other uses or for future generations, but also improve food security, nutrition, health, livelihoods, and environmental quality for ourselves and future generations.

The type and origin of food, as well as the stage of the supply chain where the loss or waste occurs, can alter the amount of water used in the production and processing of the food[11]. This means that when food is lost or wasted, these sourcing factors can mean different amounts of water are lost or wasted. For example, cereals require lower amounts of water inputs than meat or dairy products; and food produced in arid regions requires more additional water than food produced in humid regions, and so have higher water footprints. When these high-water foods are wasted, the water that was used in their production is wasted[12].

9 12.3 Food Loss & Waste | SDG 12 Hub accessed December 18, 2023
10 EU Platform on Food Loses and Food Waste., Key Recommendations for Action" (EU Platform on Food Losses and Food Waste 2019)
11 World Bank, "Addressing Food Loss and Waste: A Global Problem with Local Solutions" (World Bank, Washington, DC 2020)
12 Marston LT and others, "Reducing Water Scarcity by Reducing Food Loss and Waste" (2021) 5 Frontiers in Sustainable Food Systems

4.0 What is a water footprint?

A water footprint is a method of accounting for water use. It helps people compare the different purposes that our limited freshwater resources are used for. Previous comparisons made with water footprints have included the direct and indirect water use of specific processes, products, companies, or industrial sectors. Typically, water footprints include water consumption and pollution throughout the full production cycle from the supply chain to the end-user[13].

The global standard on water footprint assessment was developed by the Water Footprint Network (WFN). Under the WFN definition, a water footprint consists of three sub-components that measure different sorts of water use: blue water, green water, and grey water.

Blue water in agriculture is the consumptive use of irrigation water taken from ground or surface water. It is either evaporated, incorporated into a product, or taken from one body of water and returned to another, or returned at a different time.

Green water is the rainwater directly used and evaporated by non-irrigated agriculture, pastures, and forests. It is particularly relevant for agricultural, horticultural and forestry products.

Grey water is the freshwater needed to assimilate pollutants in order to reach quality standards. It therefore accounts for the direct and indirect release of pollutants into freshwater sources. Due to the unpredictability of grey water sources, this tool only accounts for green and blue water.

13 A good introduction to the water footprint concept is provided by the Water Footprint Network see https://www.waterfootprint.org/water-footprint-2/what-is-a-water-footprint/ Likewise, see FAO, "Food Wastage Footprint. Impacts on Natural Resources. Summary Report" (Food and Agriculture Organization of the United Nations (FAO) 2013) for Water Footprint use to measure Food Loss and Waste

5.0 How to use this publication and tool

This publication and accompanying tool support people across the food supply chain, particularly those calculating water footprint and setting science-based targets, to:

- Better understand and connect FLW reductions with their efforts to reduce systems-wide water use.
- Calculate and communicate the environmental benefits of FLW reductions.
- Link those benefits to their science-based water use reduction targets.

This tool is designed so that an organisation can easily navigate to those sections that are most relevant for the organisation's particular situation.

This document contains guidance and recommendations about:

How to calculate the water associated with FLW. Section 6.0 provides the basic steps and calculations for estimating the blue and green water footprints associated with FLW and/or its reduction. This includes identifying the FLW-associated blue and green water footprints from the food supply chain and from FLW destinations.

How to communicate about the water footprint benefits of FLW reductions. Organisations are increasingly stating their interest in fighting water scarcity and pollution by reducing FLW, sometimes to help achieve sustainable water management targets. This is particularly important for the UAE which is severely water scarce. Its renewable freshwater resources are at 16 cubic meters (m^3) per capita[14] and available water resources that utilise desalination are at 525 cubic meters (m^3) per capita[15]. Sections 7.0 and 8.0 provide recommendations for government (7.0) or food businesses and other stakeholders (8.0) in the UAE seeking to communicate about the contribution of FLW to water footprint reduction efforts.

14 World Bank. (n.a), Renewable internal freshwater resources per capita (cubic meters)

15 World Bank. (n.a), Renewable internal freshwater resources per capita (cubic meters)

6.0 The UAE water footprint tool

The following sections summarise the structure of the tool including the geographic regions and food groups (section 6.1), a description of who can use the tool (section 6.2), the data required by the user (section 6.3), and a step-by-step guide on how to use the tool (section 6.4). Further details on the methodology and underlying data in the tool are provided in the Annex 1.

6.1 Regions and food groups in the tool

This tool provides the capacity to calculate the blue and green water footprints for 27 food groups for both purchased food and food waste. Foods can be grown in the UAE or imported from one of nine other regions. The regions and food groups covered in the tool are summarized in Table 1.

6.2 Who can use the tool?

A government or policy maker in the UAE could use this tool to calculate the water footprint of food purchased, eaten, wasted, or redistributed for a city, region, or country. Governments can also calculate the water footprint of locally produced food and the water footprint of imported food separately.

Food businesses can use this tool to calculate the water footprint of food purchased, eaten, wasted, or redistributed by their business.

6.3 What data do I need?

If the user has data on the weight of food waste

To use the tool for the purpose of a water footprint assessment for a city, region, country, or business the user would need to have food production and/or purchase data (or other dietary data related to food produced, purchased, or consumed) and the amount of imports vs domestically produced foods. The weight of this food can then be allocated to the 27 food groups to estimate blue or green water footprints for food purchased. Likewise, if a government user has measured the weight of FLW in their city, region, or country[16] the volumes of food wasted and redistributed can be input into the tool (separated by the various waste treatment or redistribution destinations). This can then be used to calculate blue or green water footprints related to this waste for a city, region, or country.

If the user has no data on the weight of food waste

If the user does not have specific weight of food waste, an established food loss and waste ratio to purchase, consumption or production can be used as a proxy to calculate a weight of food wasted[17]. This weight can then be either sorted to the 27 food groups for a more accurate blue or green water footprint calculation, or all of the weight assigned to the “Mixed waste category” for a general blue or green water footprint calculation.

16 Destinations can include Anaerobic digestion / codigestion; Composting / aerobic processes; Incineration / controlled combustion; Land application; Landfill; Sewer / wastewater treatment; and Redistribution. See World Resources Institute, “Food Loss and Waste Accounting and Reporting Standard” (WRI 2016)

17 See section 7.2 and “INFERENCE BY CALCULATION” in Hanson, C., Lipinski, B., Robertson, K., Dias, D., Gavilan, I., Gréverath, P., Ritter, S., Fonseca, J., VanOtterdijk, R., Timmermans, T. and Lomax, J., 2016. Food loss and waste accounting and reporting standard.

Table 1. Geographic regions and food groups covered in the tool

Regions	Food groups	Food groups (continued)
1. UEA	1. Alcoholic beverages	21. Olive Oil
2. North Africa	2. Beans and pulses	22. Rice
3. Rest of Africa	3. Beef	23. Roots and Tubers
4. West Asia	4. Bottled water**	24. Soft drinks**
5. Rest of Asia	5. Butter & Cream	25. Sugar
6. Europe*	6. Cakes, Biscuits & Desserts**	26. Tea
7. North America	7. Camel	27. Vegetables
8. Latin America	8. Cheese **	
9. Oceania	9. Chicken & Poultry	Additional categories for Waste Input Sheets
10. Rest of the world	10. Coffee	28. Mixed Waste
	11. Dates	29. Redistribution
	12. Eggs	
	13. Fish and seafood**	
	14. Fruit	
	15. Fruit juices**	
	16. Grains, Breads & Pasta ex. Rice	
	17. Lamb	
	18. Meat - other (inc. pork)	
	19. Milk & Yoghurts	
	20. Oils (other)	

* Europe includes countries of the European Union – rest of the countries in Europe were excluded.

** Data sourced from wider literature. Please see Data Sources and assumptions section for more information.

6.4 Step-by-step guidance on how to use the tool

This part provides the basic steps and calculations for estimating the blue and green water footprints associated with FLW and/or its reduction using this tool.

Note:
Be careful with the units: purchases should be in kilograms (kg) or litres (L). In-country partners should work with the organisation, for example, a hotel to get their purchase ledger which might be in units or monetary units and will need to be pre-converted to kg through price/kg or weight/unit.

The food loss and waste water footprint calculation tool for organisations in the UAE is an excel file (.xlsx), that has multiple sheets. This section summarises the content of each sheet and how to use it.

Front sheet summary

This sheet provides a summary of calculations performed in the tool. As shown in Figure 1, this sheet provides a summary of calculations performed in the tool including:

- Total weight (kg) of food purchased
- Green and blue water footprints of food purchased (L)
- The amount of wasted food (kg)
- Green and blue water footprints of wasted food (L)
- Amount of redistributed food (kg)
- Green and blue water footprints of redistributed food (L)

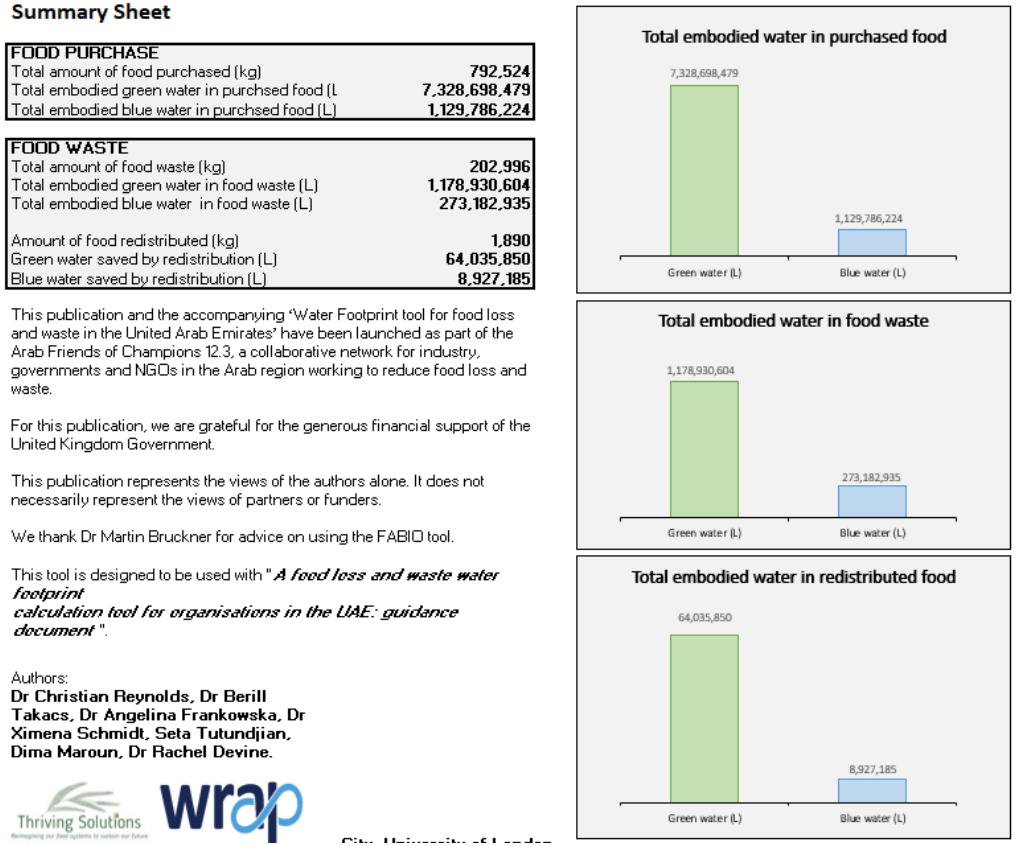


Figure 1. The 'Front sheet summary' includes summary data and graphs for green and blue water footprints of purchased food, food waste, and redistributed food.

6.4 Step-by-step guidance on how to use the tool

Food Purchase - Input sheet

This sheet has two components:

- Rows 7 to Row 33: A summary table of all food purchased per month (kg), split into 27 Food categories.
- Row 38 onwards: A data entry section where you enter purchased food products (Item names, Column A), classify them into one of 27 Food categories (Column C), and input the Origin of purchased item (Column E), as best as possible. You can then add the monthly purchases in kg for up to 1 year (Column G to R). Column S provides a TOTAL weight (in kg) of the purchased item over the year. To add new products, add new Item names (Column A), and classify them into their correspondent Food category (Column C), including the Origin of the purchased item (Column E).

If your item changes purchase country origin, please add a new item as a new row, as this will be considered a new item for the purposes of water footprint calculations.

Purchase-based food inventory

Instructions

1. Be careful with the units: purchases should be in kgs or litres.
2. Please make sure to ALWAYS select one option from the dropdown menu for "Food category" (Column C 39 - downwards) and "Origin of purchased item" (column E 39 -downwards) otherwise the tool will not be able to calculate the water footprint.

Food category	Amount purchased (kg)	Total amount purchasted (kg)
Alcoholic beverages	62240	792,524
Beans and pulses	849	
Beef	1160	
Bottled water	0	
Butter & Cream	10	
Cakes, Biscuits & Desserts	46000	
Camel	10	
Cheese	3620	
Chicken & Poultry	14856	
Coffee	17827.2	
Dates	6300	
Eggs	0	
Fish and seafood	21006	
Fruit	57540	
Fruit juices	50686	
Grains, Breads & Pasta ex. Rice	47950	
Lamb	10	
Meat - other (inc. pork)	0	
Milk & Yoghurts	39500	
Oils (other)	69048	
Olive Oil	0	
Rice	14856	
Roots and Tubers	21447.2	
Soft drinks	242000	
Sugar	15064	
Tea	2400	
Vegetables	58145	

Data collection Year 1

Food category	January	February	March	April	May	June	July	August	September	October	November	Decem
Alcoholic beverages	4,350	4,800	4,850	4,900	4,950	5,150	5,400	5,250	5,475	5,590	5,705	5,8
Beans and pulses	30	10	20	-	155	600	34	-	-	-	-	
Beef	70	180	60	100	100	100	100	100	95	90	85	
Bottled water	-	-	-	-	-	-	-	-	-	-	-	
Butter & Cream	10	-	-	-	-	-	-	-	-	-	-	
Cakes, Biscuits & Desserts	3,000	4,500	4,000	3,000	4,500	4,000	3,000	4,500	4,000	3,000	4,500	4,0
Camel	10	-	-	-	-	-	-	-	-	-	-	
Cheese	300	300	320	300	300	300	300	300	300	300	300	3
Chicken & Poultry	1,356	1,252	1,148	1,044	940	1,100	1,260	1,420	1,580	1,356	1,252	1,1
Coffee	1,627	1,502	1,378	1,253	1,128	1,320	1,512	1,704	1,896	1,627	1,502	1,3
Dates	400	450	500	550	600	600	600	600	560	520	480	4
Eggs	-	-	-	-	-	-	-	-	-	-	-	
Fish and seafood	2,006	1,752	1,648	1,544	1,440	1,600	1,760	1,920	2,080	1,856	1,752	1,6
Fruit	4,860	5,160	4,980	4,800	4,620	4,860	5,160	4,980	4,800	4,620	4,440	4,2
Fruit juices	4,000	4,352	4,324	5,646	3,244	4,354	3,424	5,432	4,000	4,352	4,324	3,2
Grains, Breads & Pasta ex. Rice	4,050	4,300	4,150	4,000	3,850	4,050	4,300	4,150	4,000	3,850	3,700	3,5
Lamb	10	-	-	-	-	-	-	-	-	-	-	
Meat - other (inc. pork)	-	-	-	-	-	-	-	-	-	-	-	
Milk & Yoghurts	3,500	3,650	3,400	3,417	3,367	3,317	3,267	3,217	3,167	3,117	3,067	3,0
Oils (other)	5,832	6,192	5,976	5,760	5,544	5,832	6,192	5,976	5,760	5,544	5,328	5,1
Olive Oil	-	-	-	-	-	-	-	-	-	-	-	
Rice	1,356	1,252	1,148	1,044	940	1,100	1,260	1,420	1,580	1,356	1,252	1,1
Roots and Tubers	1,927	1,802	1,698	1,553	1,428	1,620	1,812	2,004	2,196	1,927	1,802	1,6
Soft drinks												
Sugar												
Tea												
Vegetables	4,940	5,300	5,000	4,905	4,680	4,950	5,260	4,990	4,800	4,620	4,440	4,2

Purchases in kg

Item names	Food category	Origin of purchased item	January	February	March	April	May	June	July	August	September	October	November	Decem
Sirloin steak	Beef	UAE	70	180	60	100	100	100	100	100	95	90	85	
Coca-Cola 500 ml bottle	Soft drinks	North Africa	20,000	22,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,0
Potatoes	Roots and Tubers	Africa	300	300	320	300	300	300	300	300	300	300	300	3
Beer	Alcoholic beverages	UAE	4,050	4,300	4,150	4,000	3,850	4,050	4,300	4,150	4,375	4,490	4,605	4,7
Chicken	Chicken & Poultry	UAE	1,356	1,252	1,148	1,044	940	1,100	1,260	1,420	1,580	1,356	1,252	1,1
Fruit		West Asia	4,860	5,160	4,980	4,800	4,620	4,860	5,160	4,980	4,800	4,620	4,440	4,2

Figure 2. The 'Food Purchased – Input sheet' allows the user to input the total amount of food purchased (in kg) per month and assign the food category and origin of purchase.

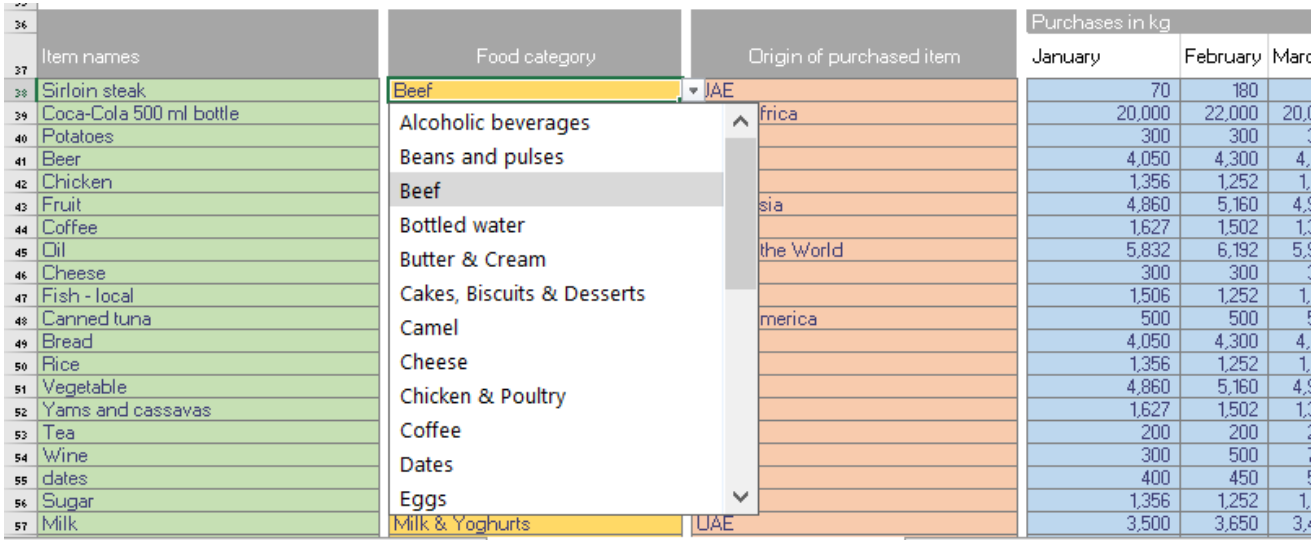


Figure 3. Dropdown option for Food Category on the 'Food Purchased – Input sheet'.

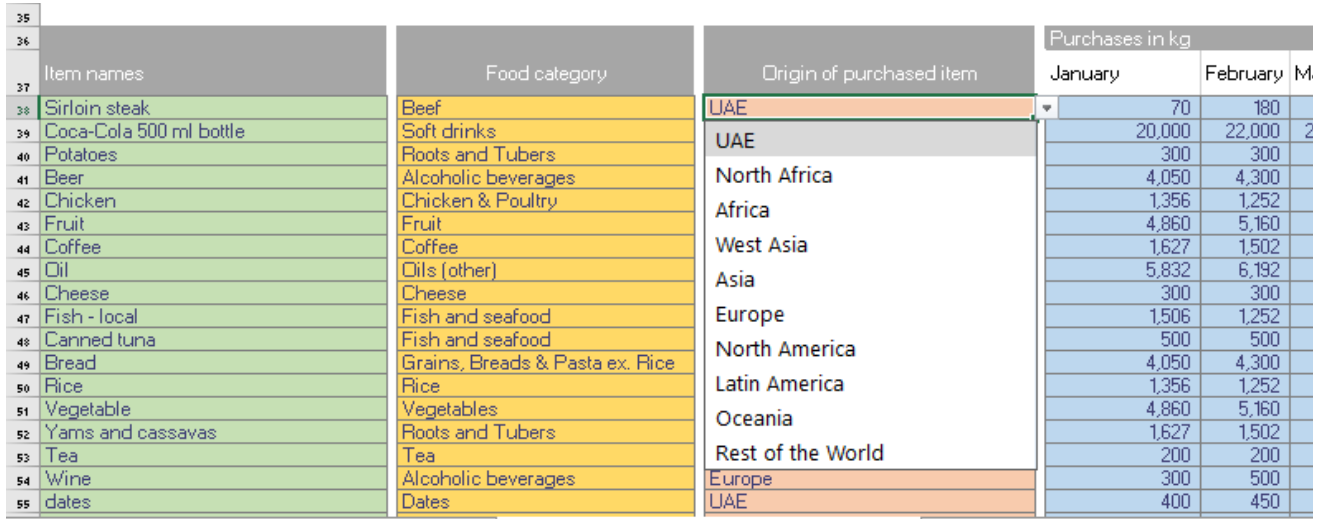
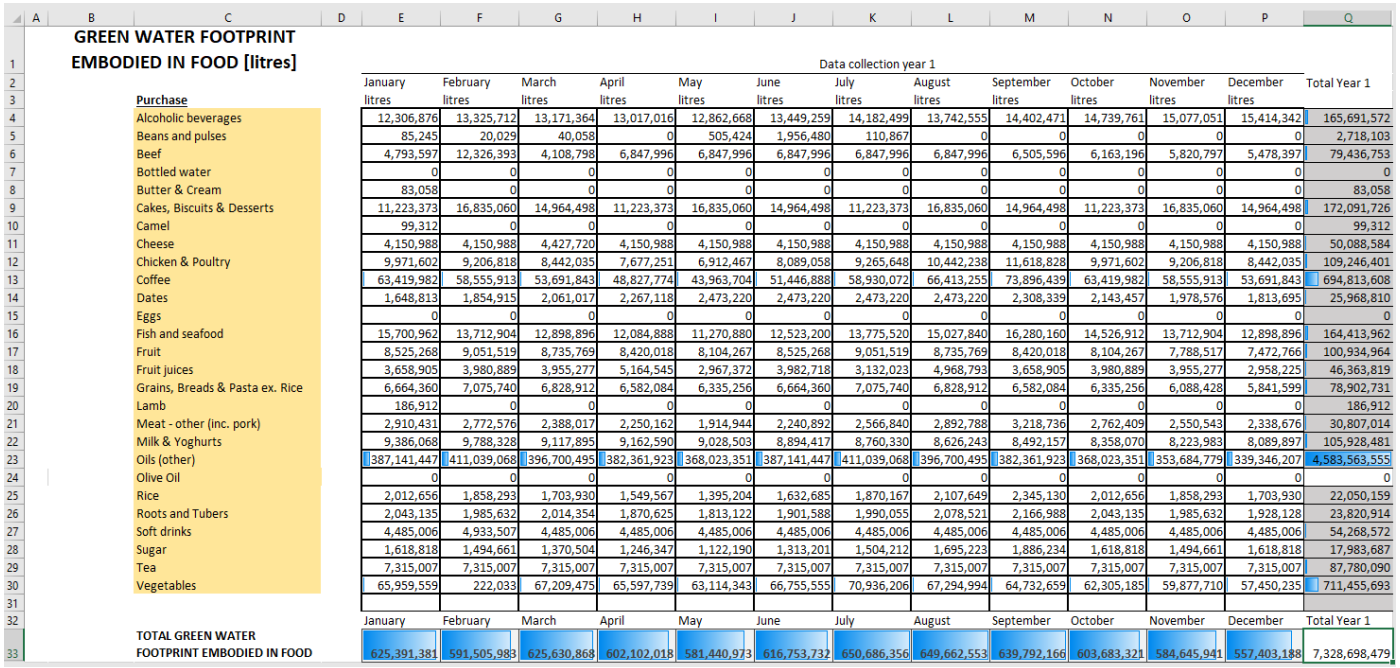


Figure 4. Dropdown option for Origin of purchased item on the 'Food Purchased – Input sheet'.

6.4 Step-by-step guidance on how to use the tool



GREEN WATER FOOTPRINT EMBODIED IN FOOD [litres]

Purchase	January litres	February litres	March litres	April litres	May litres	June litres	July litres	August litres	September litres	October litres	November litres	December litres	Total Year 1
	Data collection year 1												
Alcoholic beverages	12,306,876	13,325,712	13,171,364	13,017,016	12,862,668	13,449,259	14,182,499	13,742,555	14,402,471	14,739,761	15,077,051	15,414,342	165,691,572
Beans and pulses	85,245	20,029	40,058	0	505,424	1,956,480	110,867	0	0	0	0	0	2,718,103
Beef	4,793,597	12,326,393	4,108,798	6,847,996	6,847,996	6,847,996	6,847,996	6,847,996	6,505,596	6,163,196	5,820,797	5,478,397	79,436,753
Bottled water	0	0	0	0	0	0	0	0	0	0	0	0	0
Butter & Cream	83,058	0	0	0	0	0	0	0	0	0	0	0	83,058
Cakes, Biscuits & Desserts	11,223,373	16,835,060	14,964,498	11,223,373	16,835,060	14,964,498	11,223,373	16,835,060	14,964,498	11,223,373	16,835,060	14,964,498	172,091,726
Camel	99,312	0	0	0	0	0	0	0	0	0	0	0	99,312
Cheese	4,150,988	4,150,988	4,427,720	4,150,988	4,150,988	4,150,988	4,150,988	4,150,988	4,150,988	4,150,988	4,150,988	4,150,988	50,088,584
Chicken & Poultry	9,971,602	9,206,818	8,442,035	7,677,251	6,912,467	8,089,058	9,265,648	10,442,238	11,618,828	9,971,602	9,206,818	8,442,035	109,246,401
Coffee	63,419,982	58,555,913	53,691,843	48,827,774	43,963,704	51,446,888	58,930,072	66,413,255	73,896,439	63,419,982	58,555,913	53,691,843	694,813,608
Dates	1,648,813	1,854,915	2,061,017	2,267,118	2,473,220	2,473,220	2,473,220	2,473,220	2,308,339	2,143,457	1,978,576	1,813,695	25,968,810
Eggs	0	0	0	0	0	0	0	0	0	0	0	0	0
Fish and seafood	15,700,962	13,712,904	12,898,896	12,084,888	11,270,880	12,523,200	13,775,520	15,027,840	16,280,160	14,526,912	13,712,904	12,898,896	164,413,962
Fruit	8,525,268	9,051,519	8,735,769	8,420,018	8,104,267	8,525,268	9,051,519	8,735,769	8,420,018	8,104,267	7,788,517	7,472,766	100,934,964
Fruit juices	3,658,905	3,980,889	3,955,277	5,164,545	2,967,372	3,982,718	3,132,023	4,968,793	3,658,905	3,980,889	3,955,277	2,958,225	46,363,819
Grains, Breads & Pasta ex. Rice	6,664,360	7,075,740	6,828,912	6,582,084	6,335,256	6,664,360	7,075,740	6,828,912	6,582,084	6,335,256	6,088,428	5,841,599	78,902,731
Lamb	186,912	0	0	0	0	0	0	0	0	0	0	0	186,912
Meat - other (inc. pork)	2,910,431	2,772,576	2,388,017	2,250,162	1,914,944	2,240,892	2,566,840	2,892,788	3,218,736	2,762,409	2,550,543	2,338,676	30,807,014
Milk & Yoghurts	9,386,068	9,788,328	9,117,895	9,162,590	9,028,503	8,894,417	8,760,330	8,626,243	8,492,157	8,358,070	8,223,983	8,089,897	105,928,481
Oils (other)	387,141,447	411,039,068	396,700,495	382,361,923	368,023,351	387,141,447	411,039,068	396,700,495	382,361,923	368,023,351	353,684,779	339,346,207	4,583,563,555
Olive Oil	0	0	0	0	0	0	0	0	0	0	0	0	0
Rice	2,012,656	1,858,293	1,703,930	1,549,567	1,395,204	1,632,685	1,870,167	2,107,649	2,345,130	2,012,656	1,858,293	1,703,930	22,050,159
Roots and Tubers	2,043,135	1,985,632	2,014,354	1,870,625	1,813,122	1,901,588	1,990,055	2,078,521	2,166,988	2,043,135	1,985,632	1,928,128	23,820,914
Soft drinks	4,485,006	4,933,507	4,485,006	4,485,006	4,485,006	4,485,006	4,485,006	4,485,006	4,485,006	4,485,006	4,485,006	4,485,006	54,268,572
Sugar	1,618,818	1,494,661	1,370,504	1,246,347	1,122,190	1,313,201	1,504,212	1,695,223	1,886,234	1,618,818	1,494,661	1,618,818	17,983,687
Tea	7,315,007	7,315,007	7,315,007	7,315,007	7,315,007	7,315,007	7,315,007	7,315,007	7,315,007	7,315,007	7,315,007	7,315,007	87,780,090
Vegetables	65,959,559	222,033	67,209,475	65,597,739	63,114,343	66,755,555	70,936,206	67,294,994	64,732,659	62,305,185	59,877,710	57,450,235	711,455,693
	January	February	March	April	May	June	July	August	September	October	November	December	Total Year 1
TOTAL GREEN WATER FOOTPRINT EMBODIED IN FOOD	625,391,381	591,505,983	625,630,868	602,102,018	581,440,973	616,753,732	650,686,356	649,662,553	639,792,166	603,683,321	584,645,941	557,403,188	7,328,698,479

Figure 5. The 'Food Purchased – Green WF' sheet shows the green water footprint embodied in food by month and food category. There is an identical sheet for the blue water footprint called 'Food Purchased Blue WF'.

The "Food Purchased - Green WF" and "Food Purchased - Blue WF" sheets

These two sheets provide a summary of the total green or blue water footprint embodied in the 27 Food categories (Row 4 to 30), expressed as litres, for the data recorded on the *Food Purchases - Input* sheet. The water footprint on a monthly (Column E to P) and yearly (Total Year 1, Column Q) basis for each food item is provided. Row 33 displays the Total water footprint embodied in food, expressed as litres, for each month (Column E to P) and for the year (Column Q).

6.4 Step-by-step guidance on how to use the tool

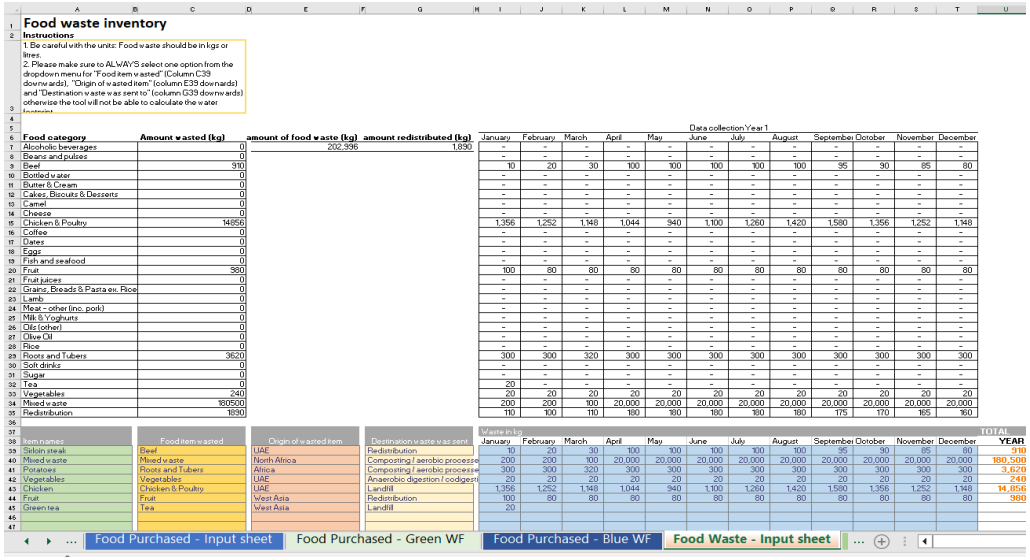


Figure 6. The 'Food Waste – Input sheet' allows the user to input the total amount of food waste (in kg)

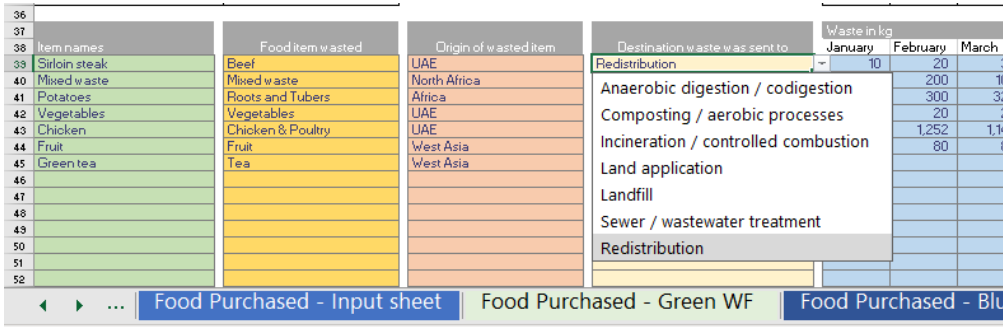


Figure 7. Dropdown option for Destination waste was sent to on the 'Food Waste – Input sheet'.

Food Waste - Input sheet

This sheet has two components:

- Rows 7 to Row 35: A summary table of the weight of all food waste generated per month (kg), split into the 27 Food categories (Row 7 to 33) as well as additional categories for: Mixed waste (Row 34) and Redistribution (Row 35).
- Row 38 onwards: A data entry section. First, enter the food item (Item names, Column A); then classify the Food item wasted into one of the 27 Food category (Column C) or as Mixed waste, and input the Origin of the wasted item (Column E), as best as possible. Finally, enter the destination of the waste (Destination waste was sent to, Column G) choosing one of the destinations options as per the Food Loss and Waste Measurement Protocol[18]. You can add the monthly waste generated in kg for up to 1 year (Column I to T). Column U provides a TOTAL weight (in kg) of food waste generated over the year for that specific item.

To add new products, add a new item in Item names (Column A) and classify it into the 27 Food category or mixed waste in Food item wasted (Column C); then enter the Origin of wasted item (Column E), and the destination of the waste (Destination waste was sent to, Column G).

> If your wasted item changes the country of origin, please add a new item as a new row, as this will be considered a new item for the purposes of water footprint calculations.

18 Destinations can include Anaerobic digestion / co-digestion; Composting / aerobic processes; Incineration / controlled combustion; Land application; Landfill; Sewer / wastewater treatment; and Redistribution. See World Resources Institute, "Food Loss and Waste Accounting and Reporting Standard" (WRI 2016)

The "Food Waste - Green WF" and "Food Waste - Blue WF" sheets

These two sheets provide a summary of the total green or blue water footprint embodied in the Wasted Item (Column C), classified in the 27 Food categories or Mixed waste or Redistribution (Row 4 to 32), expressed as litres for the data recorded on the Food Waste - Input sheet. Water footprint on a monthly (Column E to P) and yearly (Column Q) basis of each wasted item are provided. Row 34 displays the Total water footprint embodied in food waste, expressed as litres, for each month (Column E to P) and for the year (Column Q).

Appendix- Notes on water values

This sheet shows the summary data of the blue and green water footprint Litres per kg purchased or wasted food (L/kg purchased or wasted food) for 27 food groups and 10 regions. This also contains notes on the data assumptions made which are also provided in Annex 1 of this document.

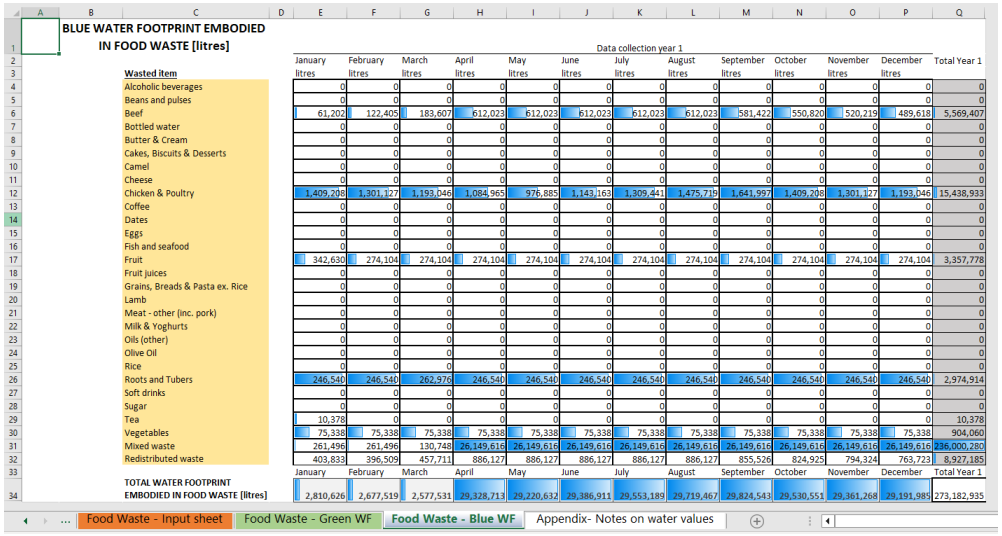


Figure 8. The 'Food Waste – Blue WF' sheet shows the blue water footprint embodied in food waste. There is also a sheet for the green water footprint called the 'Food Waste Green – WF' sheet.

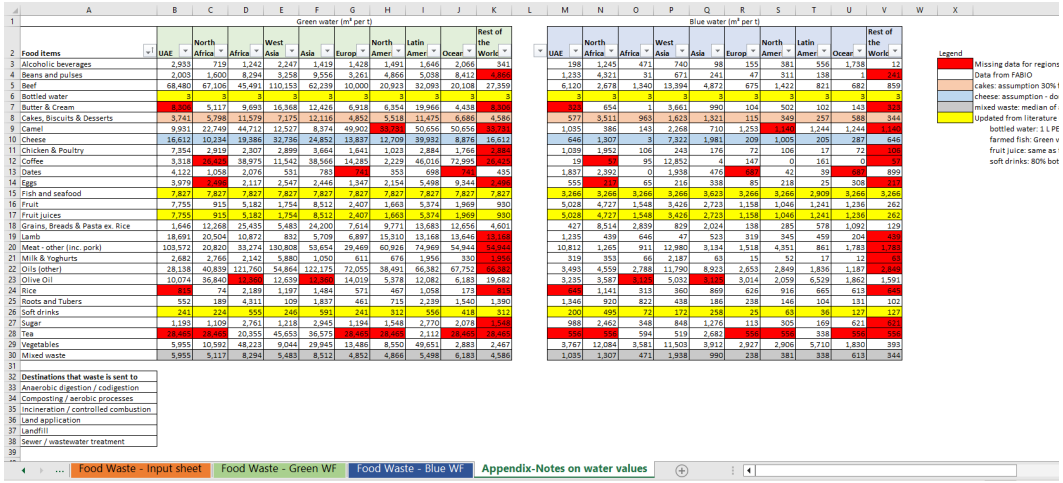


Figure 9. The 'Appendix – Notes on water values' sheet shows the data sources and assumptions behind the water footprint values used in the tool.

7.0 Communicating the benefits for governments.

Blue and green water footprints matter to the UAE government as the country is one of the most water-scarce countries in the world, with an average annual rainfall of only 78 mm and renewable water resources per capita of only 16 m^3, compared to the global average of 5,500 m^3. At the same time, the UAE's agricultural sector[19] is a significant user of the country's limited and precious resources, accounting for approximately nearly half (~48%) of the freshwater withdrawals in the UAE[19].

Despite agriculture's large water footprint, the sector produces less than 15% of the UAE's food. The remaining 85% is sourced through imports. This makes the UAE vulnerable to fluctuations in global food prices and availability, as well as potential disruptions in food supply chains due to climate change, conflicts, or pandemics.

The UAE is committed to achieving food security and sustainable development, as reflected in its National Food Security Strategy 2051 adopted in 2018[20], which includes amongst its objectives developing a comprehensive national system based on enabling sustainable food production through the use of modern technologies; enhancing local production; and activating legislation and policies to reduce waste.

The UAE Water Security Strategy 2036 adopted in 2017 is committed to reduce total demand for water resources by 21% and increase the water productivity index to USD 110 per cubic meter (m^3)[21]. Given that the agricultural sector is the largest water consumer, it is imperative to increase the water productivity in the sector if the UAE is to achieve the objectives of its strategy.

8.0 Communicating the benefits for businesses and other stakeholders

Blue and green water footprints matter to UAE hospitality, restaurants, and food producers because they reflect the environmental impact of their food choices and practices. By reducing the water footprint of their food, they can contribute to the UAE's food security and sustainable development goals, as well as enhance their reputation and customer satisfaction. Institutions across the UAE are also joining the "Ne'ma Pledge" launched by the Emirates Foundation to reduce food loss and waste.

The UAE's hospitality, restaurants, and food manufacturers and producers can play a vital role in supporting the UAE's food security and sustainable development goals by reducing the water footprint of their food. They can do this by adopting various measures, such as:

- Choosing food products that have a lower water footprint, such as fruits, vegetables, grains, and beans, over those that have a higher water footprint, such as meat, dairy, and eggs.
- Where appropriate, sourcing food products locally and seasonally, rather than importing them from other regions, to reduce the transportation and storage costs and emissions associated with food. For example, more than 80% of food in the UAE is imported from other regions, leading to a high environmental footprint.
- Reducing FLW, which is estimated to be around 44% in the Arab region. During holidays FLW may increase to 50%.[22]

19 Our World in Data based on UN Food and Agricultural Organization (FAO) AQUASTAT
20 UAE (2018). National Food Security Strategy 2051.
21 UAE (2017). The UAE Water Security Strategy 2036.
22 United Nations Environment Programme (2021). The State of Food Waste in West Asia.

By reducing the water footprint of their food, any UAE-based organisation, can not only save water and money, but also improve their environmental performance and social responsibility. They will also be contributing to the UAE official commitment for halving their food loss and waste by 50% by 2030 as per the country's Nationally Determined Contribution. By communicating about their positive impact, they can also attract more customers who are conscious of their food choices and their impact on the planet. By reducing food loss and waste we reduce the water footprint of food which also reduces the associated agrochemicals utilised for producing food including fertilizers, pesticides, herbicides, fungicides, antibiotics, and growth hormones. Furthermore, any associated health risks of the agrochemicals are also reduced, thus contributing to advancing the health and well-being of the people and wildlife, as well as the resilience and prosperity of the nation.

Annex 1:

Data sources and assumptions

The data presented in this tool represent average blue and green water intensities of crops for the years 1996-2005, using the 2020 crop supply-use, trade and processing structures from the Food and Agriculture Biomass Input Output model (FABIO). FABIO is a global set of trade-linked physical flow supply and use tables and physical flow input-output tables capturing detailed supply chain information for 130 raw and processed agricultural and forestry products covering 191 countries and one 'rest of world' region[23]. The main data sources for FABIO are agricultural statistics from FAOSTAT[24]. The FABIO database has environmental information for each of the 24,000 commodities, in four resource categories: 1) primary biomass extraction (in tonnes), 2) land use (in hectares, ha), 3) blue water use (in m3), and 4) green water use (in m3). The water footprint data in FABIO are sourced from Mekonnen and Hoekstra (2011)[25] and represent average blue and green water intensities of crops for years 1996-2005.

Whilst FABIO has 130 products, there are seven non-food items such as tobacco, rubber, and wool. In the tool presented in this document, non-food items were excluded leaving 123 products. The average blue and green water intensities for the 123 food products were calculated by water use for each country/product[26]. These were then aggregated into 10 regions by weighting them according to imports (tonnes) into the UAE. This enabled imports for intermediate use to be considered in the final water footprints.

The 10 regions and 123 food products were then aggregated to 27 food group categories. If more than one item matched the classification, the average of all matching items was used to represent the water footprint of that category. The reporting units for the UAE water footprint tool is Litres per kg[27].

It should be noted that blue and green water footprints for the following categories are not included in FABIO: cakes and biscuits, fish and seafood, bottled water, cheese. Therefore, water footprints for these categories were estimated using data from other, similar food categories. For example, the footprint for "Fruit Juices" uses data from the "Fruit" category. These assumptions are summarised in Table 2. A "mixed waste" category has also been created to assist with estimations of FLW water footprints where no other information was available on origin or waste composition.

23 Bruckner, M., Wood, R., Moran, D., Kuschnig, N., Wieland, H., Maus, V., Börner, J., 2019. FABIO – The Construction of the Food and Agriculture Input-Output Model. Environmental Science & Technology 53(19), 11302-11312.

24 FAOSTAT. Food and Agriculture Organization of the United Nations. FAOSTAT Statistics Database. 2019

25 Mekonnen, M.M. and Hoekstra, A.Y. (2011) National water footprint accounts: the green, blue and grey water footprint of production and consumption, Value of Water Research Report Series No. 50, UNESCO-IHE, Delft, the Netherlands.

26 average blue and green water intensities for the 123 products were calculated using the Leontief Inverse Matrix multiple, a type of mathematical equation used in input-output models.

27 Whilst FABIO reports in m3 per tonne this is equivalent to Litres per kg and so no conversion was necessary.

Table 2. Food categories and assumptions used in the water footprint tool.

Categories	Assumptions
Cakes and biscuits	Water footprint was equivalent to a combination of 30% flour, 30% sugar, 30% butter and 10% eggs.
Cheese	Water footprint was double the value supplied to butter and cream.
Bottled water	1 L PET assuming + 0.8L for energy linked to processing, transport, and cleaning operations[28].
Soft drinks	Water footprint values of 80% bottled water, and 20% sugar.
Fish and seafood	Farmed fish values are used for all fish and seafood. Green water value for Mexico used for every region[29]. Blue water value for Latin America is based on data from Mexico[30], and a wider Asia blue water value for Asia[31]. For the rest of the regions, we assumed a median of these two values.
Fruit Juices	Fruit water footprint values used.
Mixed waste	Median of all other food water footprint values.

For some geographic regions and food products there were data gaps for the UAE, suggesting that the UAE currently imports limited amounts of the product from that specific region. In these instances, median values of the available data from other regions were used. These are summarised in Table 3.

28 Tandon, S.A., Kolekar, N. and Kumar, R., 2014. Water and energy footprint assessment of bottled water industries in India. Natural Resources, 2014.

29 Guzmán-Luna P, Gerbens-Leenes PW and Vaca-Jiménez SD, "The Water, Energy, and Land Footprint of Tilapia Aquaculture in Mexico, a Comparison of the Footprints of Fish and Meat" (2021) 165 Resources, Conservation and Recycling 105224

30 Guzmán-Luna P, Gerbens-Leenes PW and Vaca-Jiménez SD, "The Water, Energy, and Land Footprint of Tilapia Aquaculture in Mexico, a Comparison of the Footprints of Fish and Meat" (2021) 165 Resources, Conservation and Recycling 105224

31 Poore J and Nemecek T, "Reducing Food's Environmental Impacts through Producers and Consumers." (2018) 360 Science 987

Table 3. Regions used in the water footprint tool and products for which there were data gaps.

Region	Product(s) for which there were data gaps
UEA	Butter, rice, tea
North Africa	Coffee, eggs, tea
Africa	Olive oil
West Asia	N/A (complete)
Asia	Olive oil
Europe	Dates, tea
North America	Camel, tea
Latin America	N/A (complete)
Oceania	Dates, tea
Rest of the world	beans & pulses, butter & cream, camel, chicken & poultry, coffee, eggs, lamb, meat - other (inc. pork), milk & yoghurts, oils (other), rice, sugar, tea
Fish and seafood	Farmed fish values are used for all fish and seafood. Green water value for Mexico used for every region. Blue water value for Latin America is based on data from Mexico, and a wider Asia blue water value for Asia. For the rest of the regions, we assumed a median of these two values.

ACKNOWLEDGEMENTS

About WRAP

Our vision is a thriving world in which climate change is no longer a problem. WRAP is a climate action NGO working around the globe to tackle the causes of the climate crisis and give the planet a sustainable future. We were established in the UK in 2000; we now work in 40+ countries.

About Thriving Solutions LLC

Thriving Solutions is a social enterprise established by two Arab women dedicated to decarbonizing our economy, safeguarding biodiversity, advancing food-nutrition-water security, as well as supporting SDG 2030 and ESG priorities, with a focus on the Arab region. Our services help companies and municipalities implement nature-based solutions and adopt innovations that eliminate waste and pollution, regenerate ecosystems, transition to circular food systems, and sequester carbon. Vision: circular, regenerative food systems. Mission: To reimagine local, regional and global agri-food systems, to sustain our future. You can learn more about us on www.thrivingsolutions.earth

About City, University of London

City, University of London is a public research university in London, United Kingdom, and a member institution of the federal University of London. The Centre for Food Policy is an interdisciplinary centre dedicated to improving food policy worldwide. We explore how the food system really works in practice. The Centre for Food Policy is one of the very few places in the world dedicated to exploring how the food system really works in practice and what policies are needed to make it work effectively. https://www.city.ac.uk/research/centres/food-policy

This publication and the accompanying 'Water Footprint tool for food loss and waste in the United Arab Emirates' have been launched as part of the Arab Friends of Champions 12.3, a collaborative network for industry, governments and NGOs in the Arab region working to reduce food loss and waste.

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