Foodsteps

The Food Footprint 100

Discover the hidden impact of some of the UK's most popular food items

Report

Contents

Chapter 1

What is this report?

Foodsteps seeks to enable all parties across the food system to measure, and reduce, their carbon footprint - from farm to fork.

We are committed to driving change in the food system, and so we have for the first time publicly released some of our data - the carbon footprint of 100 food items as consumed in the UK. Each footprint is accompanied by a data quality score that accounts for the quality of underlying data.

Trust in the numbers is incredibly important if we want people to act on them. We are releasing this report to raise awareness, and to widen access, to our environmental impact database. By making it publicly available we hope to lower barriers to understanding environmental impact assessment. Our approach will reduce cost for our partners and provide them with insights to support further work in reducing food impact. Whether you are a food provider, or a food consumer, our work can help you take that first step on the road to reducing environmental impact.

To further build trust, we have released a data quality score alongside each number, so we can be honest with you about where a lot of good data is available and where it is not. Transparency about this will help drive progress towards priority areas when improving data. The footprints released here are open-access, and so we only ask that you specify the source when using them.

The 100 open-access carbon footprints from the Foodsteps database included here are a great starting point for looking at how impacts can vary across the food you serve and consume, but to start reducing them, it is first important to create a more detailed picture of the impact of your food. The full Foodsteps database contains the impacts of around 3,000 (and counting) food items, each of which can be tailored to production and consumption in any given location.

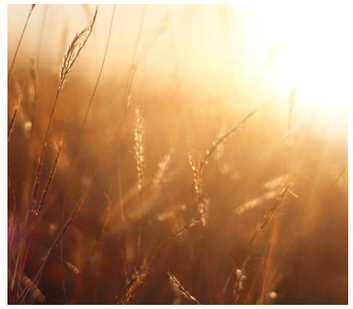
The full database provides the data needed for actionable insights ranging from looking at your ingredients, interrogating your supply chain or shifting your sales mix.

Chapter 2

About these numbers

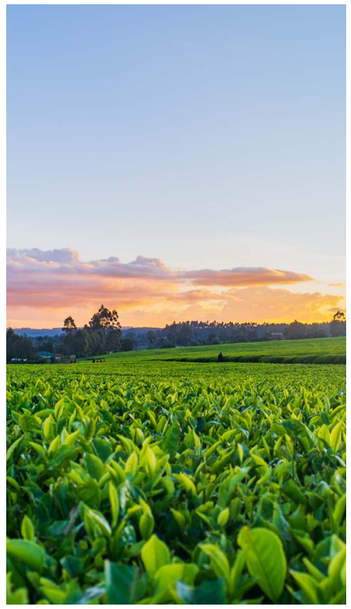
We have released a cradle-to-grave and cradle-to-retail carbon footprint for each item, in kg CO_2e per kg.

A **cradle-to-retail system boundary** includes the farm stage (including land-use change emissions and production of any inputs to the farm stage), processing, packaging, transport and retail impacts.



A **cradle-to-grave boundary** includes the cradle-to-retail system, as well as impacts of end-mile transport from retail to place of consumption, preparation impacts including any home storage, cooking and end-of-life disposal impacts of any food waste.

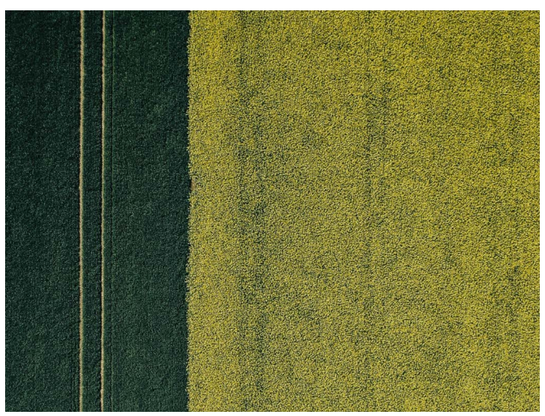
The functional unit for each carbon footprint is given in the results table, and must be respected when using these numbers on your own food data.



These footprints are for general items rather than those produced by a specific producer or bought at a given shop, and so should be seen as estimates rather than precise numbers for a given item in your shopping basket.

In this report, we have averaged UK sourcing across the year, whereas the true footprint at a given time will vary according to seasonal sourcing and growing conditions, and their influence on the production method of the food. The full Foodsteps database can return impacts for items sourced from specific countries, rather than the average UK sourcing mix. UK sourcing is estimated using international trade data and data on the volume of UK production by commodity.

As highlighted by our data quality scoring system, we have more data available on some items than others, which dictates a varying confidence level in the final impact figure.



Chapter 3

The impact of the food you eat

We used data from our database and national surveys to select the most popular food items, from the staples to the star performers, as well as a good spread of the things that will be in your menus, products and cupboards.

We also added in a few of our personal favourites. For more detail on this, see 'calculation method' at the end of the report.

The dietary categories

Bakery (inc. Grains & Chocolates)

Dairy & Eggs

Drinks (inc. Wine & Juice)

Fruit & Vegetables (inc. Legumes)

Nuts & Seeds

Oils, Sauces & Condiments

Plant-Based Alternatives

Pork & Poultry

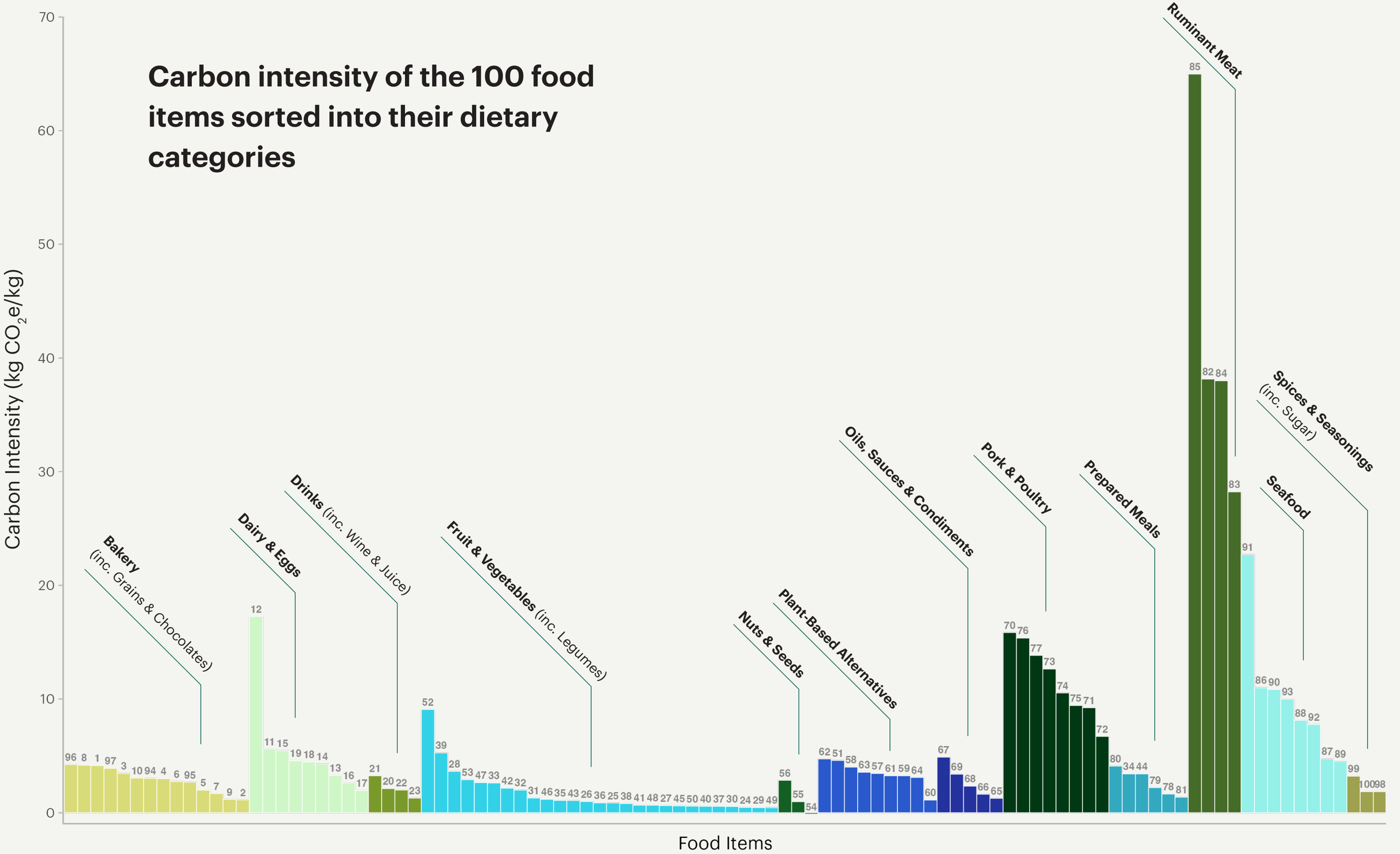
Prepared Meals

Ruminant Meat

Seafood

Spices & Seasonings (inc. Sugar)

Carbon intensity of the 100 food items sorted into their dietary categories

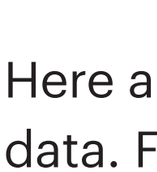


Here are some interesting highlights from the data. For more detail on the 100 food items and their impacts, read on to the end - click here to skip to the numbers.

1. Farm focus

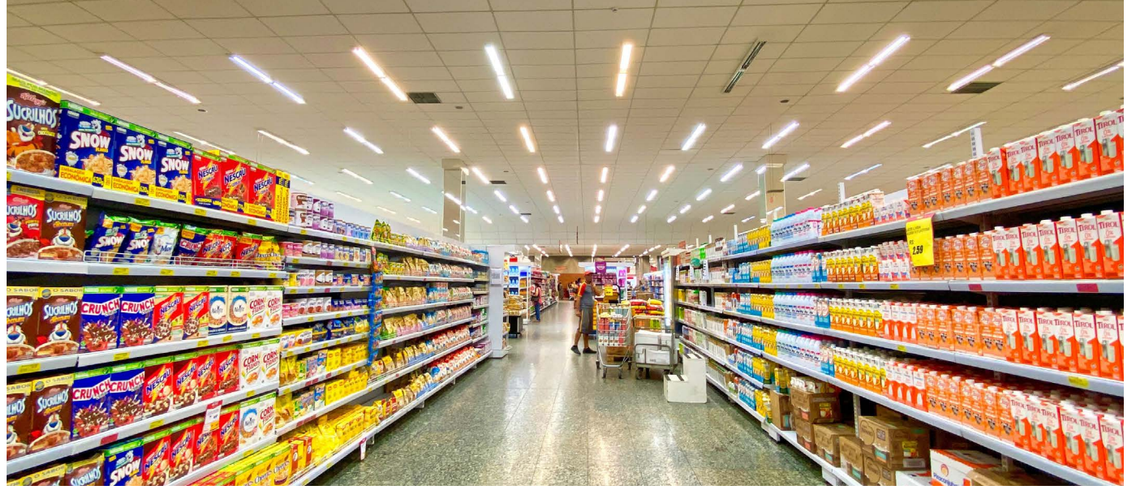
It matters how your food is produced.

By the time you pick them up off a shelf in the UK, tomatoes grown in the Mediterranean, such as in Italy, have as little as 22% of the impact of tomatoes that are grown in heated greenhouses closer to home in the UK. This is because growing tomatoes in a heated greenhouse consumes more energy than growing them in the heat of the sun. This farm-stage effect on the impact of the tomato far outweighs the additional emissions due to the increased transport distance to your plate. For the average tomato eaten in the UK, 70% of the cradle-to-grave footprint occurs on the farm, while 5% is due to the transport to the shop and 3% the transport to your door. When you're looking to reduce your impact, it's important to look beyond what you're eating and consider how it is made.



70%

of the cradle-to-grave footprint of a UK tomato occurs on the farm



2. Wrap it up (in the right stuff)

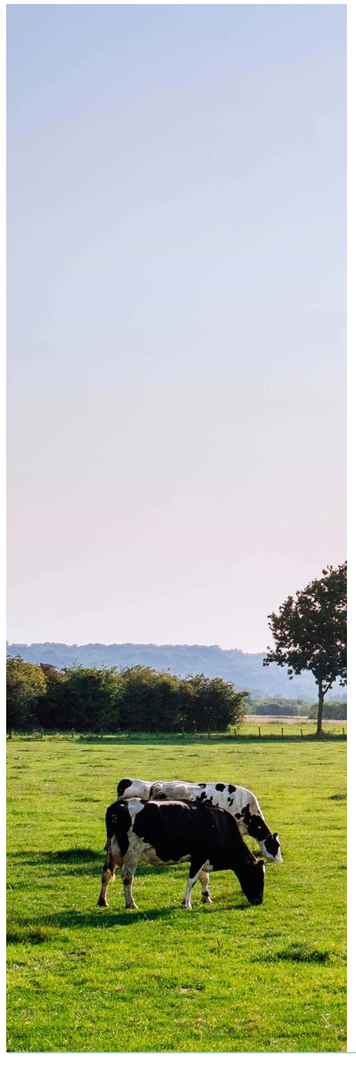
Sometimes, packaging can be a large source of the environmental impact.

For baked beans in an aluminium can and red wine in a screw-top bottle, the packaging makes up around half of the cradle-to-grave footprint. Just like the ingredients in a recipe, components of your packaging should be designed and sourced with care, using low-impact materials and designed to be as low-weight as possible. Our footprints for the packaging account for average recycled content and average recycling rates in the UK, but increasing both of this and the recycled content of the packaging can substantially reduce its impact. If you make an aluminium can from recycled materials and then recycle it when you're done with it, it will have a lower environmental impact (⅓ to be exact) compared to a can made from new aluminium that's thrown in a general waste bin.

Over half

of the cradle-to-grave footprint for baked beans in an aluminium can comes from the packaging

3. Moving meat consumption (without changing your favourites)



A typical pork sausage has a carbon footprint 4 times the size of that of a plant-based sausage. Sounds like a lot? Well, a typical beef burger has a carbon footprint 6 times the size of a meat-free burger.

A lot goes into rearing an animal, and in the case of cows or sheep, a fair amount of greenhouse gases come out the other end too. This is why it's important to consider where you could swap your meat items for meat-free alternatives. As a starting point, you could consider meat burgers blended with pulses as a way to reduce the impact of your mouthful. For example, if your beef burger was blended to constitute 25% lentils, this would reduce its impact by 23%. If it was 50%, this reduction in impact would be 46%.

4. In the oven? Or time to sous-vide...

Many studies look at how producing food affects the environment, but cooking at home can also have a big impact.

A 2020 paper[1] found that the impact of cooking can range from 6-61% of the cradle-to-grave footprint, depending on the cooking method and the item being cooked. In this report we see impacts as high as 34% for some hob-cooked pumpkins, or 47% for a vegetable stock cooked from scratch. Consumers can cook things in a lot of different portion sizes, and by a lot of different methods, which is why it's important to assess cradle-to-grave and consider advising consumers on lower carbon cooking methods for your food. A move towards lower cooking emissions is an exercise in energy efficient ways of cooking, and for that reason it can help with the bills too. For example, we have modelled the potatoes in this report as being cooked on the hob for 20 minutes - but if they were roasted for 45 minutes instead, this would have a 56% greater cooking impact. For electric appliances, oven-roasting would use around 0.44 kWh more electricity, which is worth around £0.15 at time of writing.[2] If a similar saving were made at every dinnertime, you could be looking at a £54 saving each year.

34%

of the assessment can be attributed to cooking in the case of some hob-cooked pumpkins

47%

for a vegetable stock cooked from scratch

5. Which wine for me?

It takes more grapes to make a bottle of white wine compared to a bottle of red wine.

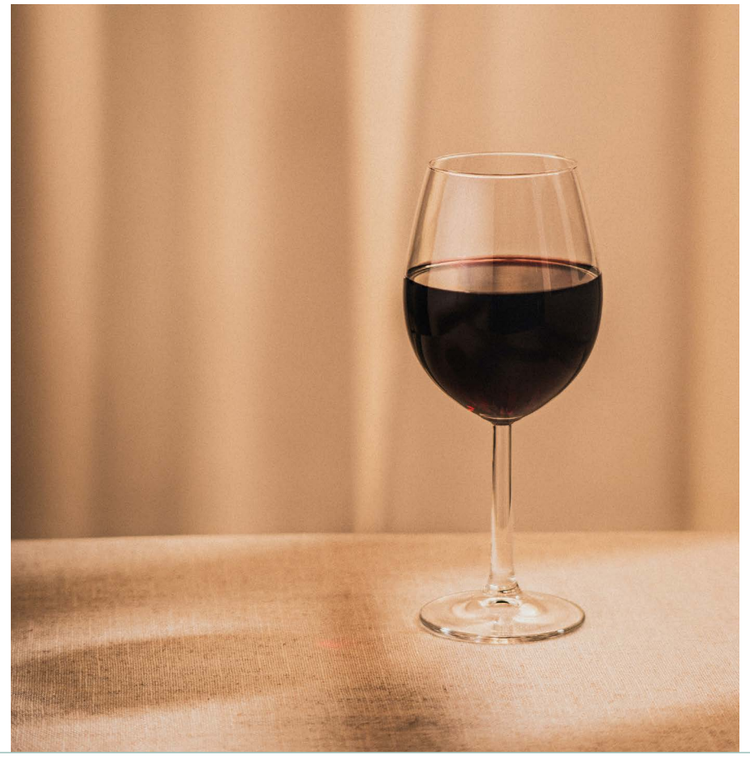
This means that more fertilisers, pesticides, fuel, and other vineyard inputs are used in producing a bottle of white wine. Hence a higher footprint. This is why it's essential to be specific about exactly what item you're footprinting - just saying 'wine' misses out on this detail.

The carbon footprint of white wine is

53%

higher

than the carbon footprint of red wine in the Foodsteps database



6. Nuts on the right ground

In some cases nut plantations can produce nuts with a negative carbon footprint.

In some cases this will outweigh the emissions from the rest of the life cycle of the nut. This is because the nut trees sequester carbon dioxide, and so land that is converted to nut plantations may draw down more carbon due to the change in land use. What's more is that animals can graze beneath the trees in what is known as a silvopastoral system to provide land for both pasture and nut production. This effect is not seen when nut plantations are grown on land that was previously storing significant amounts of carbon; for example, deforestation to create nut plantations would not positively impact the environment. This is why it is important to look right back up your supply chain to understand the land history of the nut plantation producing your nuts.

7. Buttering up the margarine

Butter has a carbon footprint 5 times the size of margarine - what you put on your toast matters.

This is because the milk going into butter is produced by cows, animals whose ruminant digestion leads to significant amounts of methane being produced throughout their life cycle, a potent greenhouse gas. In response to this, there is a tremendous amount of effort in some areas of the livestock industry going into reducing the impacts of meat and dairy it produces through innovations like feed additives or going back to farming roots with regenerative production practices. All in all it's important to consider whether you could reduce your impact by using margarine or a butter and plant-oil blended product instead of butter - you'll probably save money as well.

Butter has a carbon footprint

5 times

the size of margarine

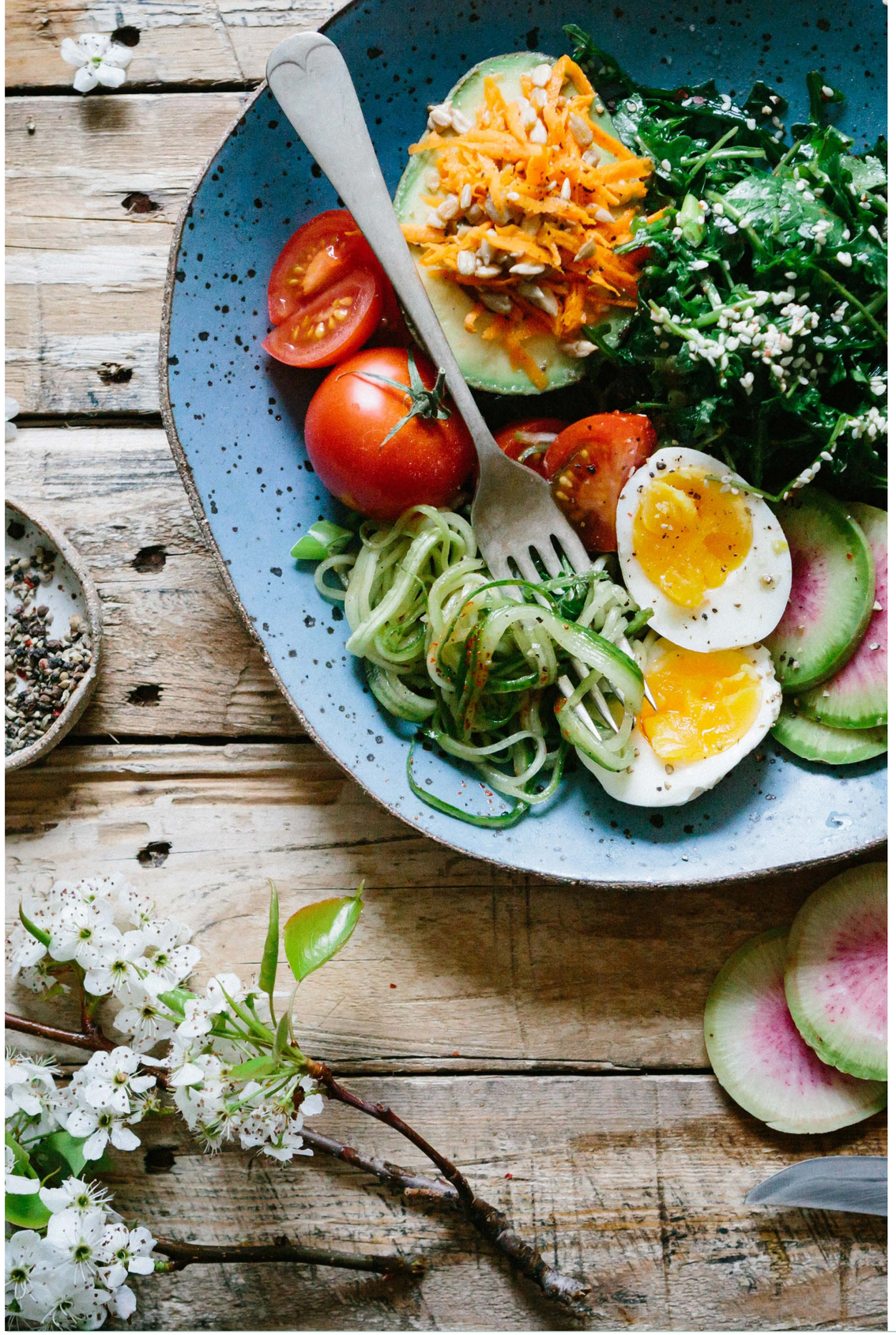
8. The sweetest thing

Sugar made from sugar cane has a

73% higher

impact than sugar made from sugar beet

This is primarily due to the high land use change emissions that tend to be embodied in sugar cane production, due to burning of forests and changes in carbon stock. Sugarcane production has led to massive biodiversity loss due to the clearing of tropical rainforests and seasonal forests in order to cultivate the cane. Sugar beet has a lower land use change impact as smaller areas have been cleared for sugar beet production. This is because sugar beet has only been cultivated more recently, and tends to be grown on land that was already used for agriculture.[3] This may, however, lead to knock-on effects of increased land-use elsewhere due to displacement of agricultural production preceding the growing of sugar beet.



9. How do you eat?

It is worth highlighting that impacts of the 100 food items herein vary across dietary lines - plant-based items are consistently lower impact than animal-based options, with ruminant meat (beef and lamb) leading to the highest impacts of all.

This is because animal products require significant amounts of feed to be produced, with their own impacts. Furthermore, the enteric fermentation process in ruminant animals like cows and sheep releases a significant amount of methane, a potent greenhouse gas.

What is interesting is that there is significant variation within categories as well, which indicates the importance of going deeper than just cutting out meat when trying to reduce the impact of the food you eat.

Chapter 4

The 100 items

Table 1 below lays out the footprints of the 100 food items, along with our DQS (Data Quality Score) for each item.

For more information on abbreviations and methodology, see 'calculation method'.

Results show that

the farm stage

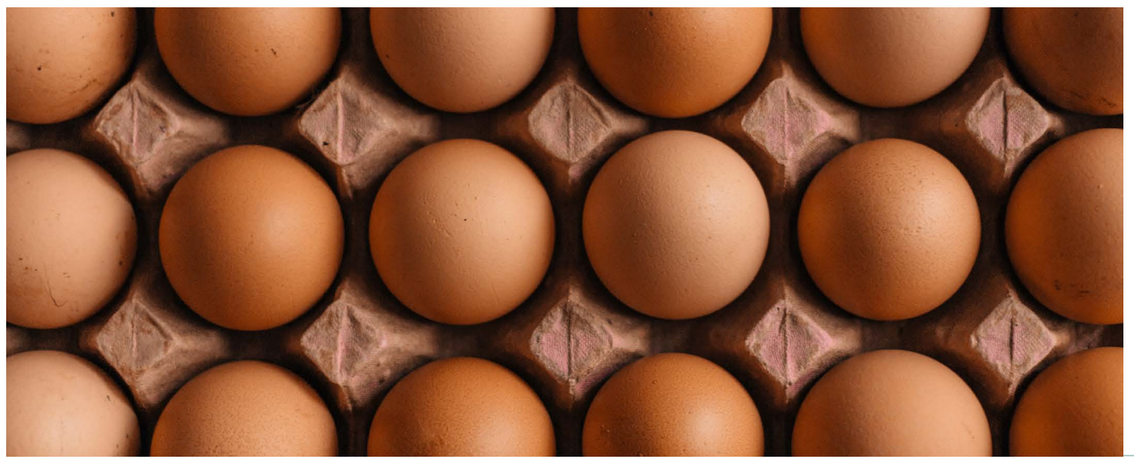
is commonly the highest in impact

Bakery (inc. Grains & Chocolates)

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
Baked Vanilla Cheesecake	1	1 kg of edible meal	3.42	**4.15**	PP Tub	5.4
Chocolate Sponge	4	1 kg of edible meal	2.87	**3.00**	PP Tub	6.0
Lemon Sponge Cake	6	1 kg of edible meal	2.50	**2.74**	PP Tub	6.1
Brioche	3	1 kg of bread	3.22	**3.45**	LDPE Bag	6.2
Cornflour	5	1 kg of flour	1.85	**1.99**	LDPE Bag	6.3
Digestive Biscuits	95	1 kg of biscuits	2.53	**2.68**	PP Wrapping	6.4
Wheat Flour	9	1 kg of flour	1.03	**1.17**	LDPE Bag	6.7
Rice	8	1 kg of uncooked rice	3.94	**4.19**	LDPE Bag	7.0
Yorkshire Puddings	10	1 kg of yorkshire puddings	2.47	**3.05**	LDPE Bag	7.1
Milk Chocolate	96	1 kg of chocolate	4.11	**4.24**	PP Wrapping	7.1
Dark Chocolate	94	1 kg of chocolate	2.91	**3.03**	PP Wrapping	7.2
Oats	7	1 kg of rolled oats	1.56	**1.69**	LDPE Bag	7.4
White Chocolate	97	1 kg of chocolate	3.79	**3.91**	PP Wrapping	7.7
Bread	2	1 kg of bread	0.99	**1.14**	LDPE Bag	8.7

Dairy & Eggs

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
Yoghurt	17	1 kg of yoghurt	1.85	**1.96**	PP Tub with LDPE Lid	6.3
Butter	11	1 kg of butter	5.50	**5.61**	PP Tub with LDPE Lid	6.3
Ice Cream	15	1 kg of ice cream	5.36	**5.46**	PP Tub with LDPE Lid	6.3
Cream	13	1 kg of cream	3.18	**3.28**	PP Tub with LDPE Lid	6.6
Custard	14	1 kg of custard	4.17	**4.29**	Aluminium Tin	7.5
Milk	16	1 kg of milk	2.53	**2.63**	PET Bottle with PP Lid	8.7
Cows Cheese	12	1 kg of cheese	17.17	**17.28**	PE Tray with PE Film	8.7
Scrambled Eggs	19	1 kg of cooked scrambled eggs	4.42	**4.58**	Ingredient (Egg, Butter) packaging	7.4
Eggs	18	1 kg of eggs	4.31	**4.47**	Cardboard Box	8.4



Drinks (inc. Wine & Juice)

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
White Wine	21	1 litre of wine	3.15	**3.25**	Glass Bottle with Aluminium Lid	6.9
Red Wine	20	1 litre of wine	2.02	**2.13**	Glass Bottle with Aluminium Lid	7.0
Orange Juice	23	1 kg of juice	1.16	**1.28**	PET Bottle with PP Lid	4.5
Lemon Juice	22	1 kg of juice	1.88	**2.00**	PET Bottle with PP Lid	4.9

Fruit & Vegetables (inc. Legumes) (continued)

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
Lemons	27	1 kg of fresh fruit/vegetable	0.50	**0.63**	No Packaging	7.1
Strawberries	31	1 kg of fresh fruit/vegetable	1.18	**1.30**	PE Tray	7.1
Olives	28	1 kg of fresh olives	3.51	**3.64**	PE Tray with PE Film	7.5
Oranges	29	1 kg of fresh fruit/vegetable	0.32	**0.45**	No Packaging	7.6
Kiwifruits	26	1 kg of fresh fruit/vegetable	0.83	**0.99**	LDPE Bag	7.6
Bananas	25	1 kg of fresh fruit/vegetable	0.73	**0.86**	LDPE Bag	8.2
Pineapples	30	1 kg of fresh fruit/vegetable	0.39	**0.55**	No Packaging	8.5
Apples	24	1 kg of fresh fruit/vegetable	0.32	**0.47**	No Packaging	8.7
Artichoke Hearts	32	1 kg of artichoke hearts	1.70	**1.98**	LDPE Bag	3.8
Garlic	41	1 kg of fresh fruit/vegetable	0.47	**0.67**	No Packaging	5.0
Tomato Puree	52	1 kg of puree	8.95	**9.09**	LDPE Squeeze Tube with PP Lid	5.8
Chopped Tomatoes	39	1 kg of chopped tomatoes	4.98	**5.26**	Aluminium Tin	5.8
Avocados	33	1 kg of fresh fruit/vegetable	2.49	**2.62**	LDPE Bag	5.9
Peppers	47	1 kg of fresh fruit/vegetable	2.46	**2.65**	LDPE Bag	6.3
Sweet Potatoes	50	1 kg of soil free tuber	0.30	**0.58**	No Packaging	6.9

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
Cucumbers	40	1 kg of fresh fruit/vegetable	0.43	**0.56**	LDPE Bag	7.3
Cauliflower	38	1 kg of fresh fruit/vegetable	0.62	**0.81**	LDPE Bag	7.4
Lentils	42	1 kg of dry pulse without pod	1.85	**2.17**	LDPE Bag	7.4
Cabbages	36	1 kg of fresh fruit/vegetable	0.67	**0.87**	LDPE Bag	7.4
Broccoli	35	1 kg of fresh fruit/vegetable	0.92	**1.09**	LDPE Bag	7.6
Onions	45	1 kg of fresh fruit/vegetable	0.43	**0.60**	No Packaging	7.7
Pumpkins	49	1 kg of fresh fruit/vegetable	0.16	**0.45**	No Packaging	7.9
Peas	46	1 kg of dry pea without pod	1.02	**1.18**	LDPE Bag	8.0
Carrots	37	1 kg of fresh fruit/vegetable	0.36	**0.56**	LDPE Bag	8.0
Lettuce	43	1 kg of fresh fruit/vegetable	0.91	**1.07**	LDPE Bag	8.4
Tomatoes	53	1 kg of fresh fruit/vegetable	2.77	**2.91**	PE Tray with PE Film	8.9
Potatoes	48	1 kg of soil free tuber	0.37	**0.66**	No Packaging	9.0

Nuts & Seeds

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS	
Cashew Nuts	55	1 kg of shell free dry nut	0.85	**0.97**	LDPE Bag	6.0	
Almonds	54	1 kg of shell free dry nut	-0.24	**-0.12**	LDPE Bag	7.3	
Sunflower Seeds	56	1 kg of seeds	2.73	**2.85**	LDPE Bag	7.8	

Oils, Sauces & Condiments

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS	
Barbecue Sauce	57	1 kg of sauce	3.09	**3.46**	Glass Jar with Aluminium Lid	4.4	
Sweet Chilli Sauce	64	1 kg of sauce	2.84	**3.10**	Glass Jar with Aluminium Lid	5.4	
Green Pesto	58	1 kg of pesto	3.84	**4.01**	Glass Jar with Aluminium Lid	6.3	
Mango Chutney	59	1 kg of sauce	3.10	**3.25**	Glass Jar with Aluminium Lid	6.4	
Margarine	60	1 kg of margarine	1.02	**1.12**	PP Tub with LDPE Lid	6.8	
Mayonnaise	61	1 kg of sauce	3.14	**3.25**	Glass Jar with Aluminium Lid	7.6	
Olive Oil	62	1 litre of oil	4.61	**4.73**	Glass Bottle with Aluminium Lid	7.7	
Rapeseed Oil	63	1 litre of oil	3.44	**3.56**	Glass Bottle with Aluminium Lid	8.9	
Tomato Ketchup	51	1 kg of sauce	4.38	**4.60**	Glass Jar with Aluminium Lid	6.5	

Plant-Based Alternatives

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
Plant-based Burgers	67	1 kg of uncooked burger	4.69	**4.89**	Cardboard Box with PE Wax	4.7
Coconut Yoghurt	66	1 kg of yoghurt	1.52	**1.63**	PP Tub with LDPE Lid	4.9
Plant-based Sausages	68	1 kg of uncooked sausage	2.13	**2.34**	Cardboard Box with PE Wax	4.9
Coconut Milk	65	1 kg of coconut milk	1.17	**1.27**	PET Bottle with PP Lid	5.7
Tofu	69	1 kg of tofu	3.22	**3.39**	PE Tray with PE Film	8.1

Pork & Poultry

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
Salami	76	1 kg of salami	15.25	**15.36**	PE Tray with PE Film	5.8
Bacon	70	1 kg of fat and bone-free meat and edible offal	15.70	**15.85**	PE Tray with PE Film	5.8
Chicken Goujons	72	1 kg of edible meal	6.41	**6.71**	Cardboard Box with PE Wax	5.8
Ham	73	1 kg of fat and bone-free meat and edible offal	12.53	**12.64**	PE Tray with PE Film	5.8
Turkey	77	1 kg of fat and bone-free meat and edible offal	13.63	**13.84**	PE Tray with PE Film	7.5
Pork Sausages	75	1 kg of uncooked sausage	9.22	**9.43**	PE Tray with PE Film	7.7
Chicken	71	1 kg of fat and bone-free meat and edible offal	9.03	**9.24**	PE Tray with PE Film	8.4
Pork	74	1 kg of fat and bone-free meat and edible offal	10.33	**10.54**	PE Tray with PE Film	8.8

Prepared Meals

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS	
Falafels	78	1 kg of falafel	1.38	**1.65**	PP Tub	5.5	
Granola	79	1 kg of edible meal	1.98	**2.21**	LDPE Bag	5.7	
Jelly	80	1 kg of jelly	3.73	**4.10**	PE Tray with PE Film	5.9	
Onion Bhaji	81	1 kg of onion bhaji	0.94	**1.37**	PP Tub	6.4	
Mushy Peas	44	1 kg of mushy peas	3.05	**3.42**	Aluminium Tin	4.8	
Baked Beans	34	1 kg of edible meal	3.27	**3.42**	Aluminium Tin	6.2	

Ruminant Meat

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS	
Salt Beef	85	1 kg of fat and bone-free meat and edible offal	63.39	**64.98**	PE Tray with PE Film	5.7	
Lamb	84	1 kg of fat and bone-free meat and edible offal	37.80	**38.00**	PE Tray with PE Film	7.9	
Beef Burgers	83	1 kg of uncooked burgers	27.88	**28.23**	PE Tray with PE Film	7.9	
Beef	82	1 kg of fat and bone-free meat and edible offal	37.95	**38.15**	PE Tray with PE Film	8.3	

Seafood

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
Fish Fingers	**88**	1 kg of fish fingers	7.85	**8.12**	Cardboard Box with PE Wax	5.8
Salmon	**92**	1 kg of edible fish	7.61	**7.76**	PE Tray with PE Film	6.3
Basa	**86**	1 kg of edible fish	10.83	**10.99**	PE Tray with PE Film	6.4
Hake	**90**	1 kg of edible fish	10.68	**10.84**	PE Tray with PE Film	6.7
Cod	**87**	1 kg of edible fish	4.58	**4.74**	PE Tray with PE Film	6.7
Haddock	**89**	1 kg of edible fish	4.34	**4.50**	PE Tray with PE Film	6.8
Trout	**93**	1 kg of edible fish	9.82	**9.98**	PE Tray with PE Film	7.5
Prawns	**91**	1 kg of head-free meat	22.57	**22.70**	PE Tray with PE Film	7.7

Spices & Seasoning (inc. Sugar)

Food item	Graph Index Number	Functional unit of analysis	Cradle-to-retail impacts (kg CO2e/kg)	Cradle-to-grave impacts (kg CO2e/kg)	Modelled packaging	DQS
Vegetable Stock	**100**	1 kg of stock cooked from scratch, with solid parts removed	0.63	**1.86**	PP Tub with LDPE Lid	4.7
Cane Sugar	**99**	1 kg of sugar	3.07	**3.22**	LDPE Bag	5.6
Beet Sugar	**98**	1 kg of sugar	1.71	**1.86**	LDPE Bag	7.6

Chapter 5

Calculation method

Footprints were taken from the Foodsteps database in December 2022 and are correct as of this date. Footprints are expressed in units of CO_2e, which refers to the fact that other greenhouse gases such as methane (CH_4), have been converted to equivalent units of CO_2, using relative global warming potential factors over a 100-year time period.

For the life cycle assessments of the 100 food items within this report, we have assumed all food items are purchased in local food stores by the end-consumers, stored in line with average shelf life recommendations, and cooked using standard home appliances. We have also made assumptions about the origins of each food item, the cooking appliances used, and how each item is processed, packaged and stored. Table 2 sets out these assumptions in full.

Emissions in the life cycle

Life cycle stage	Activity data
Farm	Emissions arising from land use change (burning and carbon stock), farming, feed, and on-farm processing.
Processing	Emissions arising from the processing and storage of ingredients at processing sites.
Packaging	Emissions arising from raw packaging material acquisition, pre-processing, manufacture of packaging, transport of packaging materials to product systems, and end-of-life after disposal.
Transport	Emissions arising from the transport of ingredients between stages. This includes transport from farm to processor and from processor to retail, and between processors if there are multiple. This also includes distribution storage throughout the life cycle journey, as well as household storage both pre- and post-preparation.
Retail	Emissions arising from retail operations. This includes the impacts of any chilling at retail, and apportioned impacts of the retail facility, such as lighting and air conditioning.
End-Mile	Emissions arising from transport of the food item from its retail location to the location of consumption. This does not include transport of the consumer to the retail location.
Cooking	Emissions arising from use of cooking appliances.
Food Waste	Emissions arising from food disposal throughout the life cycle by anaerobic digestion, composting, incineration, sewer disposal, and landfilling. This also includes emissions from production of food lost throughout the supply chain.

Assumptions used at each stage in the life cycle assessment

Assessment Factor	Assumption made
Origins of each food item and its ingredients	Published life cycle assessments are used to provide impacts for food items, from cradle to retail, which includes Farm, Processing, Packaging, Transport, and Retail. Studies are weighted against each other according to how representative the studied production practices are. Studies with system boundaries larger or smaller than this range are included in the database. • If the system boundary is smaller than cradle-to-retail, then all stages are included, and gaps are filled manually to extend the system boundary to cradle-to-retail. • If the system boundary is larger than cradle-to-retail, then only those cradle-to-retail stages are included, with additional post-retail stages not used to provide impacts in our database. The post-retail stages are better modelled explicitly by Foodsteps, as high variability in these stages means that impacts modelled for specific life cycles in studies are often not widely representative. Life cycle data is sourced in three ways: • Poore and Nemecek (2018) - Data sourced from academic studies on the environmental impacts of food over the life cycle were harmonised in order to be consistent and comparable to one another, and collected in a meta-analysis.
Origins of each food item and its ingredients (cont.)	• Additional studies - These have been manually added to the Foodsteps database by the Foodsteps team. These studies include those collected from Clune (2017)[5], and studies published since 2016 (dictated by gaps in the database) • Studies conducted by Foodsteps - These tend to be LCA studies that we have conducted on specific products, which are then added to the Foodsteps database. (E.g projects with clients). Using these studies, impacts are calculated in three broad ways (i) directly from studies on the food item (ii) indirectly using proxy food items where a direct match cannot be found, and (iii) by combining multiple studies and life cycle stages for complex food items containing more than one ingredient. Foodsteps has modelled environmental impacts for the end-mile of food products (transport from retail to consumption location), the pre-preparation storage of ingredients, the cooking of meals, the post-preparation storage of meals, and the end-of-life of any food waste disposed of. Observations from different source locations are then weighted against each other using import proportions based on UN Comtrade data for the UK, as well as the UK's own production for consumption per commodity, taken from FAOSTAT[6]. Thus, the reported impacts of the commodity consumed in the UK are the average impacts of the commodity. For complex food items (scrambled eggs, sauces, cakes, etc.), this is done at the level of their ingredients.

Assessment Factor	Assumption made
Packaging	We have included the impacts of final primary packaging only, as this typically forms the majority of the packaging impact for a food item. We have therefore excluded secondary multi-item packaging and tertiary distribution packaging from the calculation. We grouped items together, and assumed that each group is packaged as it might generally be found in a standard supermarket or convenience store. The packaging applied is outlined below. • **LDPE bag (Low-density Polyethylene)** - Fruit & vegetables (except those below), nuts, pulses, seeds, bread, oats, granola, rice, flour & sugar • **Loose, no packaging** - Pumpkins, potatoes, sweet potatoes, apples, pineapples, garlic and citrus fruits • **PE (Polyethylene) tray with a PE film lid** - Meat, fish, cheese, jelly, olives, strawberries, tomatoes & tofu • **Glass jars with aluminium lids** - Sauces & condiments • **LDPE Squeeze Tube** - Tomato puree • **PET (Polyethylene terephthalate) bottle with a PP (Polypropylene) lid** - Milks & fruit juices • **Glass bottles with aluminium lids** - Alcoholic drinks and cooking oils • **PP tubs with a LDPE lid** - Butter, margarine, cream, ice cream, yoghurts & vegetable stock • **PP wrapping** - Biscuits, chocolate • **PP tubs** - Cakes, falafels, onion bhajis • **Aluminium tin** - Baked beans, chopped tomatoes, custard & mushy peas • **Cardboard boxes lined with PE wax** - Frozen items (fish fingers, plant-based burgers and sausages, breaded chicken goujons) • **Cardboard box** - Eggs • In the case of scrambled eggs, the packaging impact here relates to the impacts of packaging its constituent ingredients (eggs and butter).

Assessment Factor	Assumption made
Packaging (cont.)	We have assumed that the materials used in the packaging of these items contain no recycled content. For end-user packaging recycling rates, we have used DEFRA's 2020 statistics for packaging waste[7] for each material, as set out in the 'UK Statistics on waste' gov.uk publication. For all non-recycled packaging, we have used a weighted average of the proportion of waste sent to landfill or combustion in 2020 from statistics published by each of the 4 UK governments.
Storage time	We have assumed an average home storage length for refrigerated items before consumption based on a range of typical shelf lives for refrigerated and frozen items. • **3 days** - Meat, fish, dairy fruit, fruit juices & vegetables (excluding root vegetables) • **7 days** - Sauces & Condiments • **14 days** - Frozen items (fish fingers, plant-based burgers and sausages, breaded chicken goujons)
Storage method	We have assumed all refrigerated and frozen items are stored in standard household electrical fridge/freezer appliances with power sourced from a UK national grid mix of renewable and non-renewable energy.

Assessment Factor	Assumption made
Cooking method	Our assumptions around how each food item will be cooked in the household, after they have been purchased, have been made to ensure consistency across similar food groups and are presented below. All items that aren't listed below are assumed not to be cooked. • **Hob, 210 minutes** - Salt beef • **Hob, 120 minutes** - Vegetable stock, from scratch • **Hob, 25 minutes** - Lentils • **Hob, 20 minutes** - Artichoke hearts, chopped tomatoes, potatoes, pumpkins & sweet potatoes • **Hob, 15 minutes** - Pork sausages & rice • **Hob, 12 minutes** - Meat (excluding pre-cooked meats) & plant-based sausages and burgers • **Hob, 10 minutes** - Carrots • **Hob, 7 minutes** - Garlic & onions • **Hob, 6.5 minutes** - Peppers, eggs & scrambled eggs • **Hob, 6 minutes** - Fish & tofu • **Hob, 5 minutes** - Cabbages • **Hob, 4 minutes** - Bacon • **Hob, 3.5 minutes** - Broccoli • **Hob, 3 minutes** - Peas • **Hob, 2 minutes** - Prawns • **Microwave, 2.5 minutes** - Baked beans & oats • **Microwave, 2 minutes** - Custard • **Microwave, 1.5 minutes** - Mushy peas • **Oven, 20 minutes** - Chicken goujons • **Oven, 15 minutes** - Fish fingers & onion bhajis • **Oven, 10 minutes** - Falafels • **Oven, 7 minutes** - Yorkshire puddings For food items that are cooked before they reach the supermarket shelves (e.g. onion bhajis), an average cooking time before reaching the supermarket shelves has been assumed and is included within the carbon impact of the food item, but is not included within the above list.

Assessment Factor	Assumption made
Cooking appliance energy source	For any appliances that could have their power sourced from either electric or gas (oven and hob), cooking impacts are calculated using a weighted average of electric and gas impacts. This weighted average is based on UK cooking appliance statistics[8]. For all other appliances, electric power sourcing and non-renewable energy sourcing has been assumed.
End-mile transportation	For all end-mile transport, ie. from supermarket to household, we used data from the Foodsteps end-mile model. This takes into account a range of inputs to calculate a UK-average end-mile emissions factor of kg CO_2e per kg of food, such as: • Proportion of journey modes selected when shopping at both supermarkets[9] and convenience stores[10] • Journey distances to shops[11 12 13] • Split between shop type[14] • Food consumption volume per person per week[15] • Emissions factors per tonne.km (1 tonne.km is 1 tonne of goods transported 1 kilometre) for a range of transport modes[16]

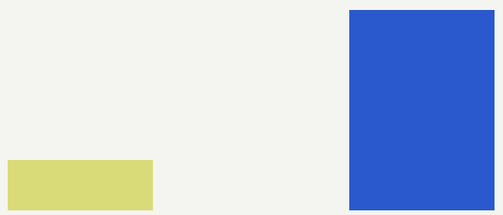
100 food items selection

We wanted to share impact data related to the average eating habits of the UK population. To achieve this we chose 100 items from a selection of main food groups identified in the annual UK National Dietary and Nutritional Survey (NDNS)[17].

This also ensured we captured a good range of food items from across the 5 main groups set out in the Eatwell Guide[18] (Fruits & Vegetables, Starchy foods, Milk & Dairy foods, Proteins, and Fats), which explains how different foods and drinks can contribute towards a healthy balanced diet.

We began by allocating a number of food items to each NDNS main food group roughly in line with the percentage of grams consumed in each group for the average UK adult aged 19 years and above. We then selected food items for each NDNS main food group based on how high they ranked within the Foodsteps database.

Food items in the Foodsteps database were ranked on a weighted average (20:80) of two different criteria:



20%
Cumulative **weight** across all recipes stored in the database

80%
Cumulative **kg CO_2e** across all recipes stored in the database

Adjustments to the number of food items used from each NDNS main food group were then made to diversify further the range of food items analysed, facilitate interesting comparisons between similar items, and incorporate more of our favourite foods. This led to the final 100 items that you see in this report.

Chapter 6

Data quality scoring

The footprints are based on the best available data. However the availability of this varies by food item.

In an industry first, for each impact we have determined a Foodsteps Data Quality Score (DQS) which shows how much confidence we have in each final impact figure computed. The DQS is a metric that provides an immediate summary of the relevance and quality of data underpinning Foodsteps' impact estimates. It is an indicator of how strong the foundation of data is that supports our understanding across several dimensions.

We report this to help users understand how good the data is behind each impact score. This transparency is vital in helping build trust as well as an understanding of the heterogeneity of environmental data. There's great data out there on some food items, and not so much for other food items.

How is it calculated?

All DQS scores and subcomponent scores are on a scale from 0 to 10. The higher the DQS, the more confident we are that the data underlying our impact estimates reflect a food's true emissions.

The DQS is composed of six distinct subcomponents, weighted according to their relative importance in determining how 'good' a piece of data is. The subcomponents are more precise when diagnosing our understanding of the data. The six subcomponents are as follows:

1. Methodological

Foodsteps calculates impact estimates for different food items using various methods, depending on the food type and available data. If we can directly match the food item to our database, it gets a higher score than if we need to match it to a proxy item.

2. Geographic

Assesses how well the sourcing profile matches the data tied to production and consumption regions. In the case of the 100 food items, this therefore measures how well tuned our data is to UK consumption.

3. Recency

Assesses how recent the data supporting an estimate is.

4. Source Reliability

Assesses the rigour of sources and studies used to generate impact estimates directly.

5. Impact Estimate Dispersion

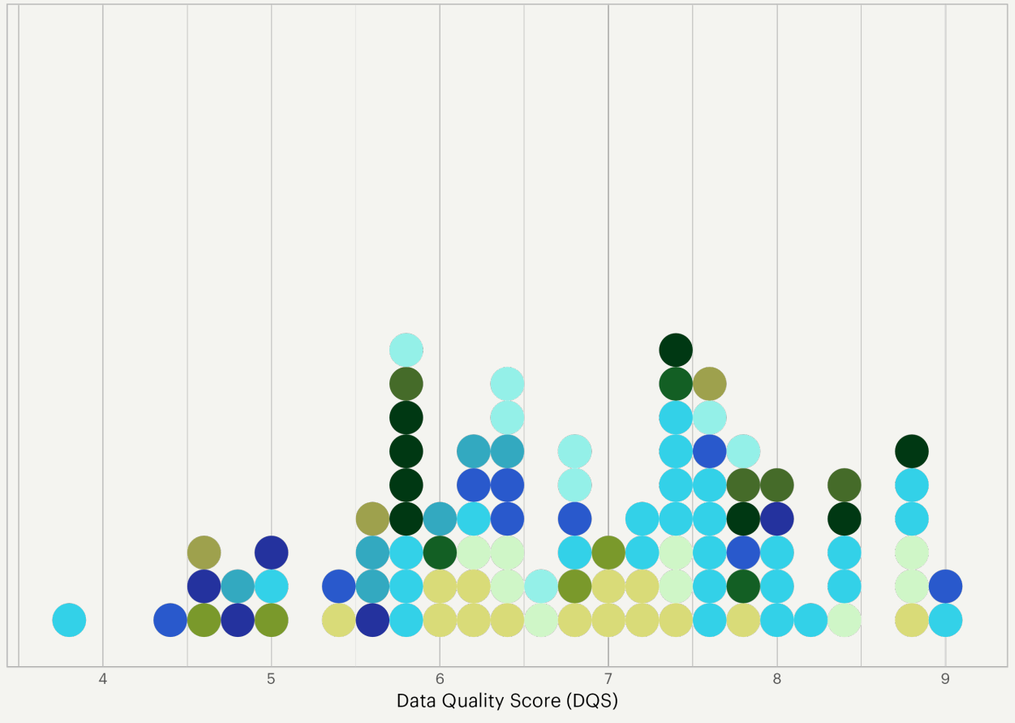
How much agreement and variation we see within our data points supporting the calculation.

6. Completeness

Whether we are lacking specificity or coverage in our underlying data supporting the impact estimates.

The final DQS is a weighted average of the six subcomponents according to their relative importance and can be seen in the following scatter graph.

Impact of 100 food items compared to DQS score



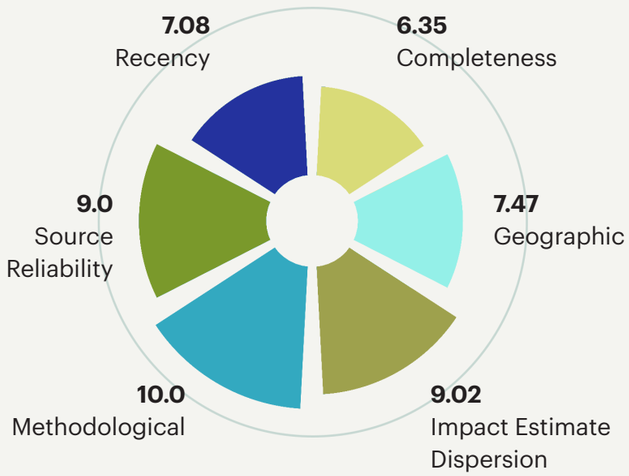
Comparison between the DQS scores for two recipe's subcomponents

When visualising the relationship between the impact of an item and our DQS, we see priority areas for collecting more data to support our estimates.

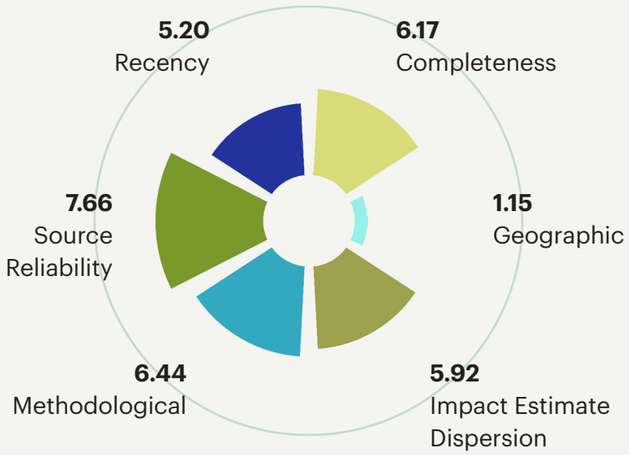
For example, salt beef has the highest impact of the 100 food items, but needs to be more understood in our database. The Foodsteps team is constantly working to build up our database, and tools like DQS help direct our work.

The radial figures below show how Foodsteps evaluates our impact estimates and where they may fall short. Our understanding of salt beef tends to come from reliable studies that are not specifically tied to UK consumption sources. Salt beef is a complex recipe, meaning its ingredients (beef, onions, herbs, and spices) come from across the globe. The large number of possible origins across the ingredients results in more possible source locations that we don't have studied impacts for. This leads to a lower geographical data quality score. Our understanding of potatoes is much more precise as these are a one-source food item that can be traced to where they were grown - oftentimes here in the UK.

Potatoes
DQS: 9.01



Salt Beef
DQS: 5.72



Chapter 7

References

1 Frankowska, A., Schmidt Rivera, X., Bridle, S.L., Kluczkovski, A., da Silva, J., Martins, C., Rauber, F., Levy, R.B., Cook, J. and Reynolds, C., 2020. How home cooking methods and appliances affect the GHG emissions of food. Nature Food, 1, pp.787-791. [cited 2023 February 01]. Available from: https://openaccess.city.ac.uk/id/eprint/25224/8/AuthorAcceptedversion13122020withAppendix.pdf

2 United Kingdom. Department for Business, Energy & Industrial Strategy. Energy Price Guarantee. [Internet]. London; 2022. [cited 2022 Dec 20]. Available from: https://www.gov.uk/government/publications/energy-bills-support/energy-bills-support-factsheet-8-september-2022#:~:text=Average%20standing%20charges%20for%20customers,customer%20paying%20by%20direct%20debit.

3 World Wildlife Fund. Sugar and the Environment. [Internet]. 2005. [36] Available from: https://wwfint.awsassets.panda.org/downloads/sugarandtheenvironment_fidq.pdf

4 Poore, J. and Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. Science, 360(6392), pp.987-992.

5 Clune, S., Crossin, E. and Verghese, K., 2017. Systematic review of greenhouse gas emissions for different fresh food categories. Journal of Cleaner Production, 140, pp.766-783.

6 United Kingdom. Department for Business, Energy & Industrial Strategy. Greenhouse gas reporting: conversion factors 2022 [Internet]. London; 2022. [cited 2022 Jul 01]. Available from: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022

7 Italy. Food and Agriculture Organization of the United Nations. Crops and Livestock products - Trade Data [Internet]. Italy; 2020. [2021 March 15]. Available from: https://www.fao.org/faostat/en/#data/TCL

8 United Kingdom. Department for Business, Energy & Industrial Strategy. Energy Follow Up Survey - Report 1: Summary of Findings [Internet]. London; 2011. [cited 2021 Feb 19]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/274769/1_Summary_Report.pdf

9 United Kingdom. Department for Transport. National Travel Survey 2015 - Why people travel: Shopping [Internet]. London; 2015. [cited 2021 March 15]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/604103/why-people-travel-shopping-2015.pdf

10 United Kingdom. Transportation and Planning Journal Volume 36, Issue 8 (2013). An exploration of shoppers travel mode choice in visiting convenience stores in the UK [Internet]. London; 2013. [cited 2021 March 15]. Available from: https://www.researchgate.net/publication/263042449_An_exploration_of_shoppers_travel_mode_choice_in_visiting_convenience_stores_in_the_UK

11 United Kingdom. Association of Convenience Stores. The Local Shop Report 2018 [Internet]. United Kingdom; 2018. [cited 2021 March 15]. Available from: https://www.acs.org.uk/sites/default/files/local_shop_report_2018.pdf

12 United Kingdom. Future Publishing Limited. How Tesco uses sat nav to deliver your shopping [Internet]. United Kingdom; 2007. [cited 2021 March 15]. Available from: https://www.itpro.co.uk/114898/how-tesco-uses-sat-nav-to-deliver-your-shopping

13 United Kingdom. The Future Foundation. The Future Foundation on food miles [Internet]. United Kingdom; 2011. [cited 2021 March 15]. Available from: https://www.tabledebates.org/research-library/future-foundation-food-miles

14 United States. American Journal of Preventive Medicine Volume 49 Issue 6 (2015). Supermarket Choice, Shopping Behavior, Socioeconomic Status, and Food Purchases [Internet]. United States; 2016. [cited 2021 March 15]. Available from: https://www.sciencedirect.com/science/article/pii/S0749379715002044

15 United Kingdom. Department for Business, Energy & Industrial Strategy. Greenhouse gas reporting: conversion factors 2022 [Internet]. London; 2022. [cited 2022 Jul 01]. Available from: https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022

16 United States. The Lancet. Affordability of the EAT–Lancet reference diet: a global analysis [Internet]. United States; 2019. [cited 2021 March 15]. Available from: https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(19)30447-4/fulltext

17 United Kingdom. Public Health England. National Diet and Nutrition Survey Rolling programme Years 9 to 11 (2016/2017 to 2018/2019). [Internet]. London; 2020. [cited 2022 Aug 15]. Available from: https://www.gov.uk/government/statistics/ndns-results-from-years-9-to-11-2016-to-2017-and-2018-to-2019

18 National Health Service. The Eatwell Guide. [Internet]. London; 2022. [cited 2022 Oct 01]. Available from: https://www.nhs.uk/live-well/eat-well/food-guidelines-and-food-labels/the-eatwell-guide/

Food businesses need the right information to understand the impact their food has on the environment — so they can make better choices around their food items and recipes. That's where Foodsteps comes in. We provide environmental impact assessments for food, accessible insights, suggested actions and messaging that turn your food sales into climate actions.

www.foodsteps.earth

Foodsteps®