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Cookbook analysis and other methods to assess the Environmental Impact of Sustainable and Vegetarian recipes (video presentation)

Centre for Food Policy

Shaping an effective food system

Presented at Designing Regenerative Food Cultures: An online workshop discussing food culture, green transition and sustainability
4 Dec 2023 2:00 PM – 4:00 PM CET

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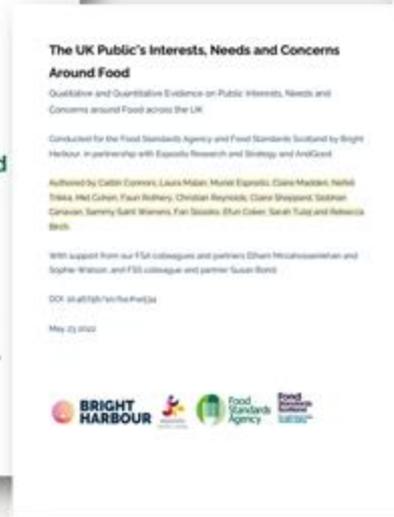
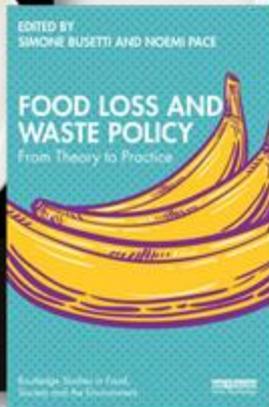
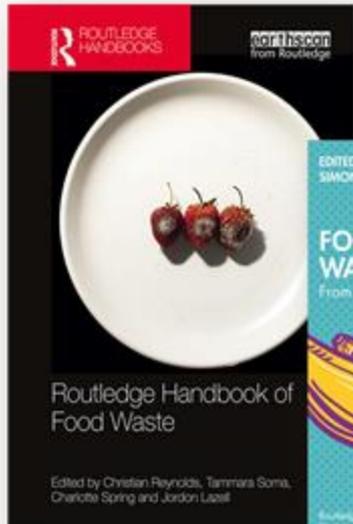
ISGSS | International Society for
Gastronomic Sciences and Studies

This research and the GATE NLP tool have been developed with a [research grant](#) from the [alpro foundation](#)

Who am I?

Reader at the Centre for Food Policy.

- Focus on sustainable food systems and food waste.
- Supporting the FSA/Defra through research projects. Scottish food systems research (ZWScotland). Household Simulation modelling (WRAP). Local food strategy development.
- Nutrition Society Food Systems theme lead. IFST Sustainability working group.
- Recent publications



What is regenerative and sustainable cooking?

Two approaches to look at answering this question.

- Bibliographic analysis of historic cookbooks
- Recipe analysis using NLP

A Leap of Faith: Regenerative Agriculture as a Contested Worldview Rather Than as a Practice Change Issue

by  Camille Page *  and  Bradd Witt 

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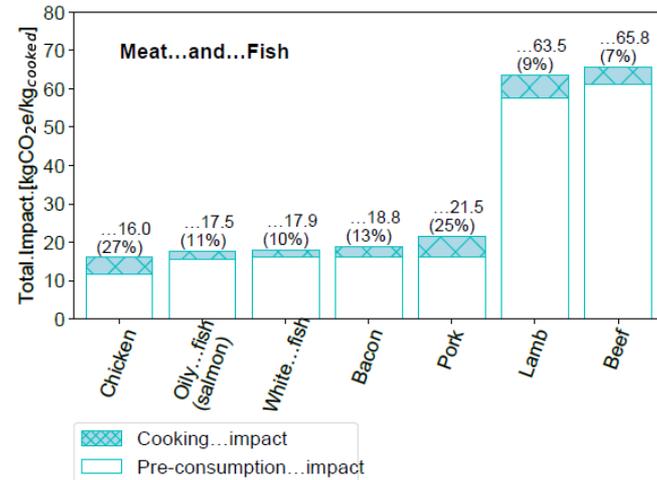
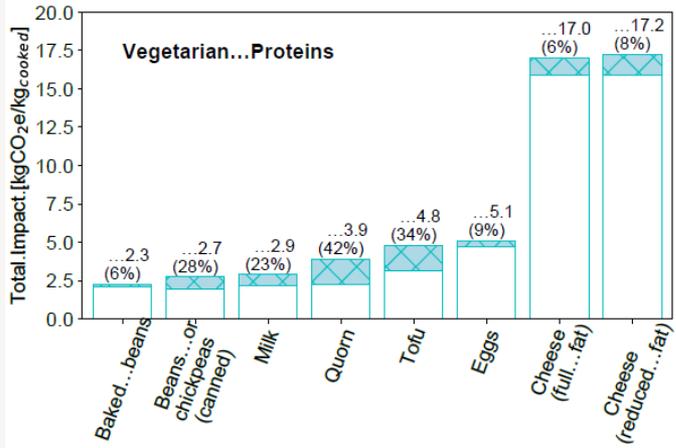
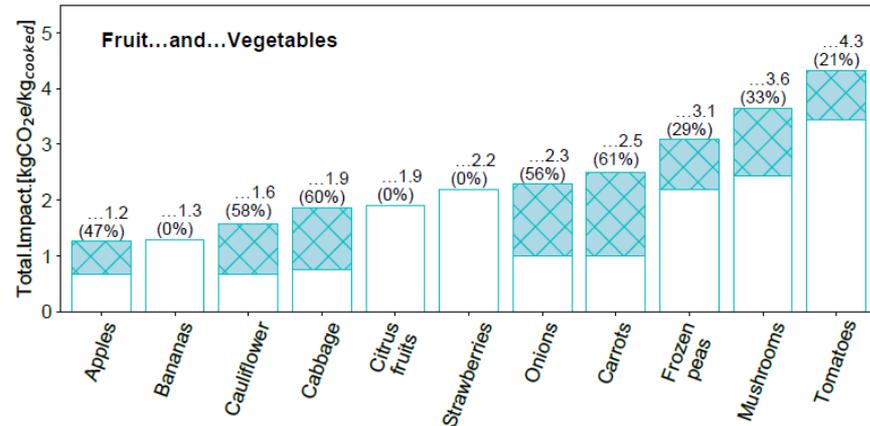
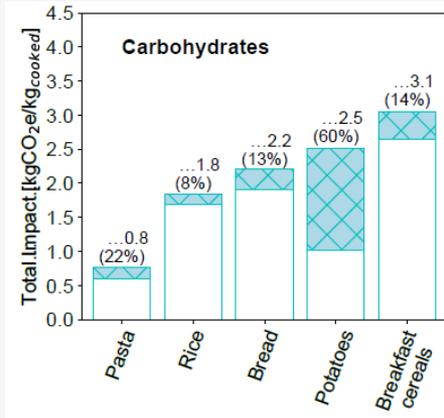
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Published: 10 November 2022

<https://doi.org/10.3390/su142214803>



How we cook matters! Up to 61% of GHGE impacts



Cooking...impact
 Pre-consumption...impact

BRIEF COMMUNICATION

<https://doi.org/10.1038/s43016-020-00200-w>

[Check for updates](#)

Impacts of home cooking methods and appliances on the GHG emissions of food

Angelina Frankowska¹, Ximena Schmidt Rivera¹, Sarah Bridle¹, Alana Marielle Rodrigues Galvão Klaczinski^{2,3}, Jacqueline Tenza da Silva^{1,4}, Carla Adriano Martins, Fernanda Rauber⁵, Renata Bertazzi Levy⁶, Joanne Cook⁶ and Christian Reynolds^{1,4}

Food is widely acknowledged as a major contributor to climate change but estimates of food-related greenhouse gas (GHG) emissions frequently consider supply chain stages only up to the farm gate or regional distribution areas. Here we estimate GHG emissions associated with different cooking methods and appliances in the UK. Data on current cooking practices were collected through a survey with 10,000 UK respondents. Our results reveal that home cooking accounts for as much as 61% of total emissions associated with specific foods, and that this can be substantially reduced through alternative, readily available cooking practices.

The contribution of home cooking to climate change is rarely assessed because data on household cooking practices are scarce. Yet understanding climate change impacts of different food items from cradle to grave is vital for effectively reducing greenhouse gas (GHG) emissions.

Whilst whole life cycles of food products are seldom assessed, foods are estimated to contribute up to 37% of global GHG emissions¹. Most studies estimate the climate change impact of food only up to the retail/purchase stage of the food supply chain, thus excluding consumers (here defined as food preparation and cooking). However, the preparation of meat and vegetables can contribute up to 30% and half of total product emissions, respectively, when recipe recommendations of mass cooking methods are followed². Cooking food from scratch at home can result in lower overall GHG emissions than consuming ready-made meals³.

Previous studies have indicated that GHG emissions from home cooking can be reduced by consuming cooking times and appliance use. Such a reduction can reach 60% in the case of pork and the equivalent of 0.33% less energy use in the case of meat loaf and ‘hardcore pudding’⁴. However, little is known about actual cooking practices for different foods or households. Previously recorded cooking practices adopted by consumers enabled models to be used to reduce GHG emissions due to unsustainable cooking⁵, but are not representative of general consumer practices across the population.

In this article we assess the impact of home cooking based on actual cooking practices and preferences rather than solely on recipe recommendations. We first report the results of a UK-wide survey conducted to collect data on cooking practices considering various foods, appliances and cooking times. Then, we compare fresh and cooking methods with respect to their GHG emissions and estimate the contribution of cooking to total product ‘cradle to gate’ impact on

climate change. Based on these results, we identify the least and most sustainable cooking techniques as well as opportunities to reduce their GHG impacts. Unavailable cooking practices such as prolonged heating of up to the point of overcooking, as well as not using energy efficient appliances, are found to increase GHG emissions unconsciously. Addressing these issues can help reduce emissions. The contribution of cooking to climate change and how unsustainable cooking practices can counteract the problem.

Cooking practices in the UK
 Our survey revealed that on average cooking accounts for 46.1% of the total GHG emissions impact for a given food (Fig. 1a). In the particular case of vegetables, protein sources, cereals, cauliflower and onions, cooking accounts for up to 61% of their total emissions. In the case of meat and fish, it represents 9–27% of their total emissions.

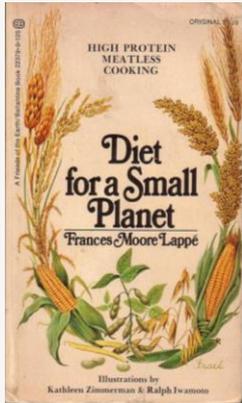
Considering foods that are ready-to-eat, the cooking of bread contributes 13% of the total emissions released (Fig. 1). The oven-toasted or proofed breads, such as rolls and buns, cooking accounts for up to 47% of their GHGs. Cooking canned baked beans, which are ready to eat from frozen storage, also represents 47% of their total emissions. Cooking other types of canned pulses (beans or chickpeas) accounts for 23% of their total emissions.

Cooking meat accounts for the highest overall emissions across the various foods in the UK. This is due to the long cooking times (combined with energy wastage), which constitute the most energy among the different appliance types (Fig. 2a). Supplementary Fig. 2 (Supplementary Tables 1 and 2) shows which food and beef cause the highest total GHG emissions by far, cooking impacts are mostly less than 11% of total GHG emissions. Compared with the pre-cooking stage (168 kgCO₂e per kg cooked), cooking-related emissions (up to 4 kgCO₂e per kg cooked) are negligible. This suggests that reducing the consumption of lamb and beef is more important than changing the cooking methods. Reducing emissions with pulses provides a rich protein source that generates lower GHG emissions. For instance, frozen and canned pulses reduce emissions by up to 79 times and 10-fold compared with beef/lamb and pork/chicken meat, respectively, per kilogram of cooked food (Fig. 1). Pulses also perform better in terms of protein content, reducing GHG emissions by about 40% compared with chicken and beef, and by up to 16-fold compared with beef/lamb (Supplementary Fig. 2). Furthermore, apart from mushrooms GHG emissions that beef is

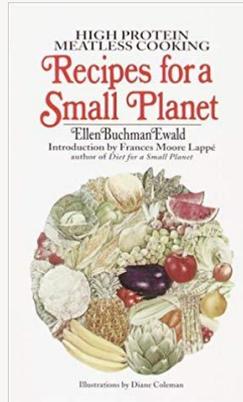
Is there such a thing as a sustainable cookbook?

Earliest English language “modern” “cookbook” rather than book on food?

1971 (Diet for a Small Planet) -> 1973 (Recipes For A Small Planet)



1971 0 recipes
1992 152 recipes
2022 85 recipes

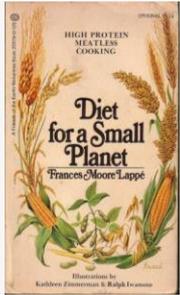


1973 202 recipes

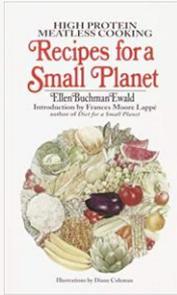
- Shifting of diet towards environmental vegetarianism (not carbon focused)
- Lentil and nuts – focused
- Large geography of cuisine styles: middle eastern, Indian, Brazilian, Mexican, Greek, Italian and ‘oriental’.
- Oven (and other high energy use methods) used.

A timeline of sustainable cookbooks

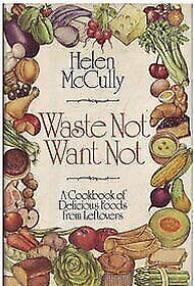
I searched <https://www.eatyourbooks.com/>* to find **278 cookbooks** that had titles including “sustainable”, “eco”, “planet”, “climate”, “carbon”, “waste”, and “flexitarian” 1973-2022



1971/2021
30 editions



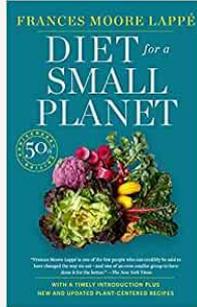
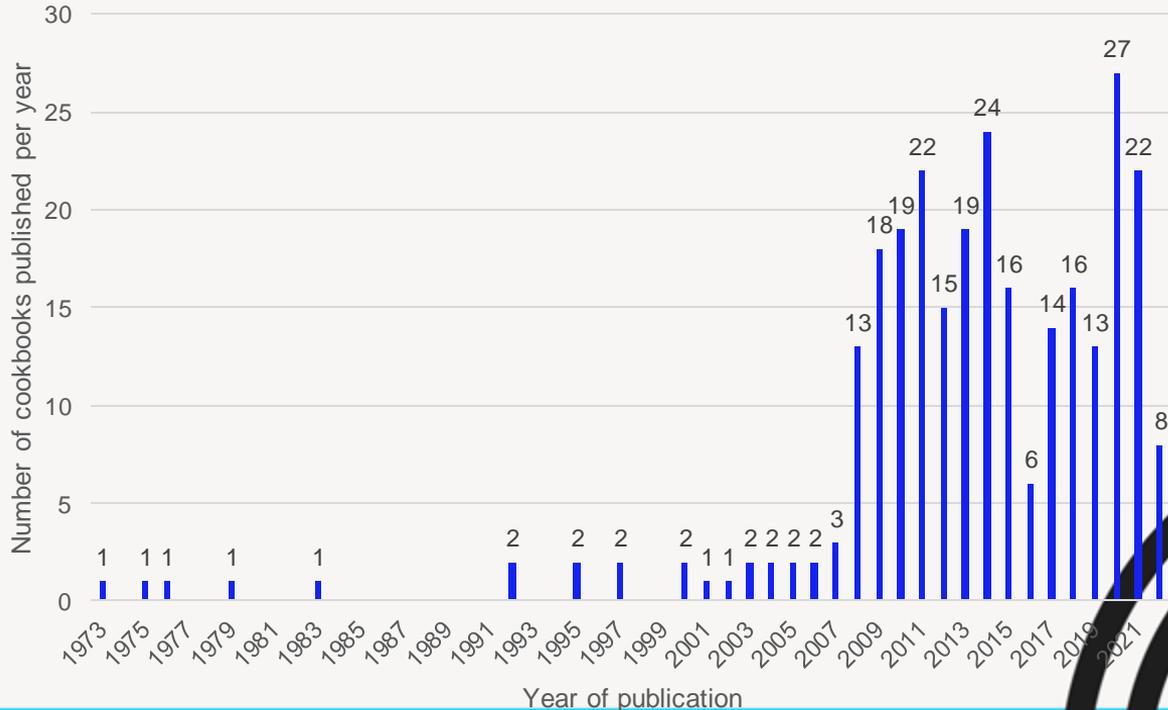
1973/1985



1975



1976

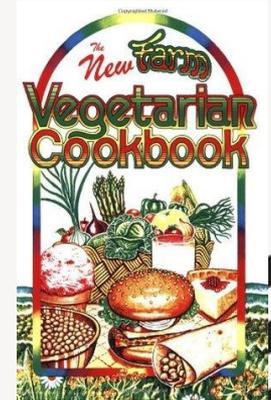
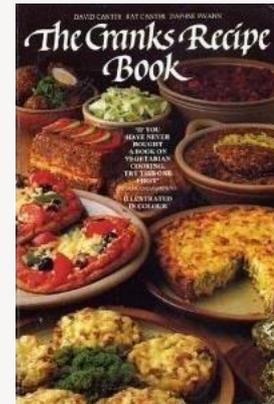
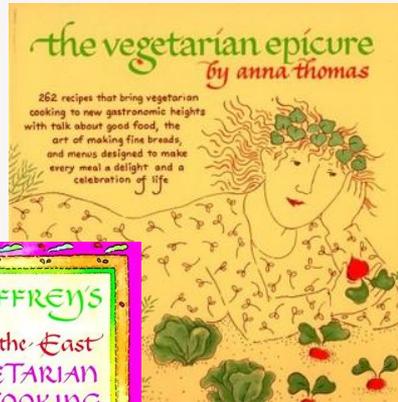
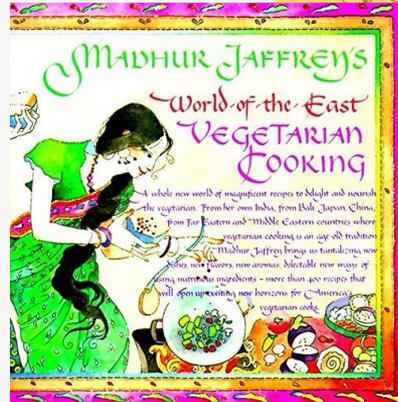
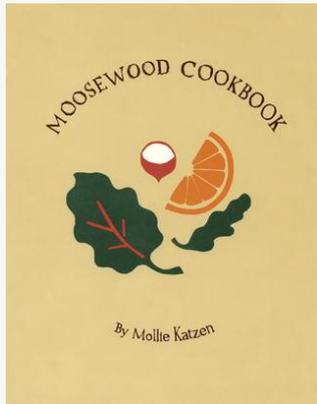


2021

* <https://www.eatyourbooks.com/> has n=160,943 books in its database (oldest book 1833), vegetarian n=5,428 (oldest book 1950), vegan n=1,433

This did not include other “classics”

A limitation of this survey was that it missed many classic books that might also be considered sustainable such as vegetarian or vegan cookbooks that do not mention “sustainability” etc. in their title (but do in the text). This method also misses non English language cookbooks.



Context for sustainability and climate change

2007, the IPCC and U.S. Vice-President Al Gore were jointly awarded the Nobel Peace Prize

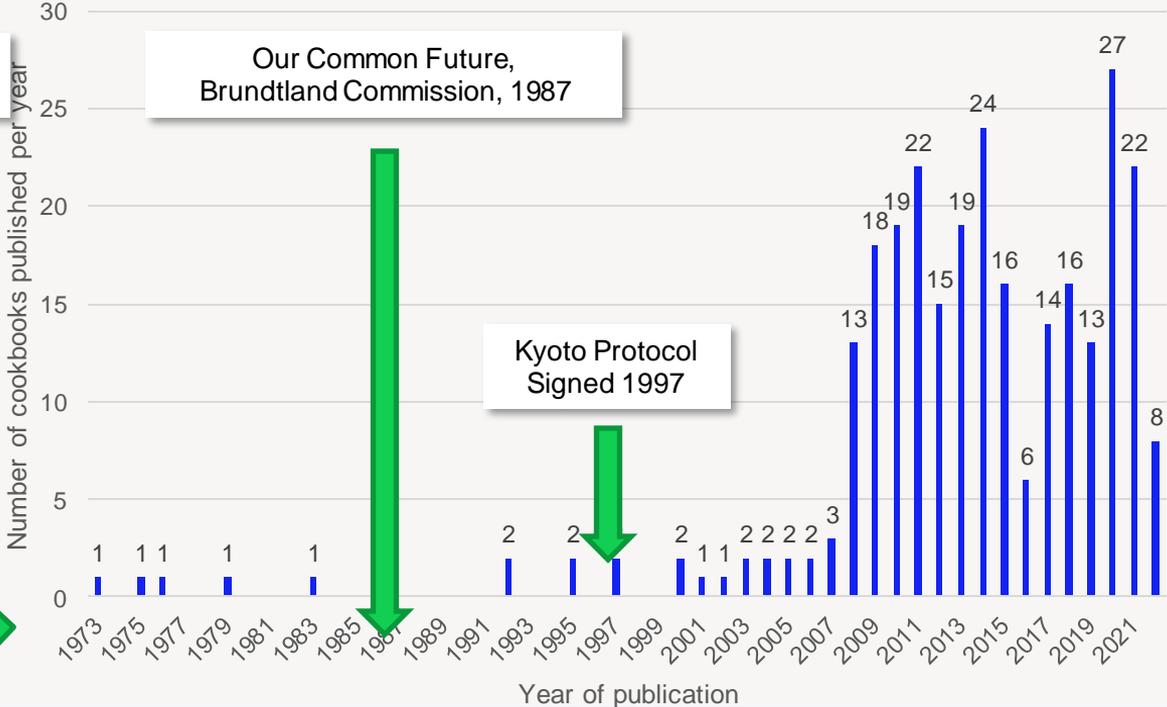
Intergovernmental
Panel on Climate
Change
1st report 1992

Intergovernmental
Panel on Climate
Change
4th report 2007

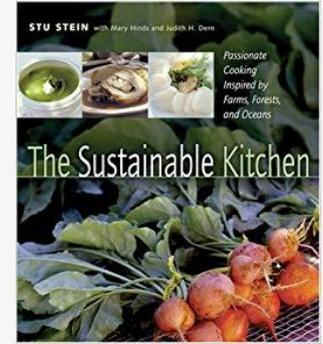
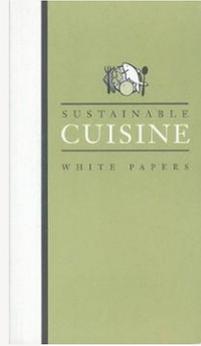
Limits to growth,
Club of Rome, 1972

Our Common Future,
Brundtland Commission, 1987

Kyoto Protocol
Signed 1997



2000-2007



15 titles including...

2000 Planet Organic: Organic Cookbook by Eric Treuille and Renee Elliot

2000 Sustainable Cuisine: White Papers by Earth Pledge

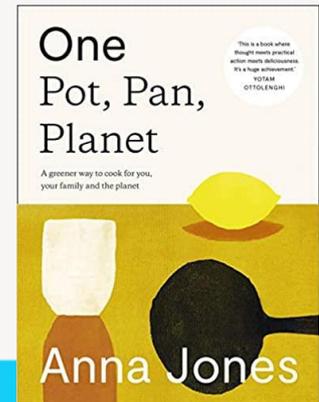
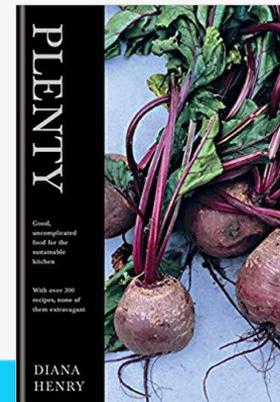
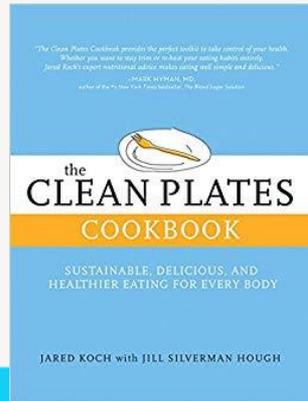
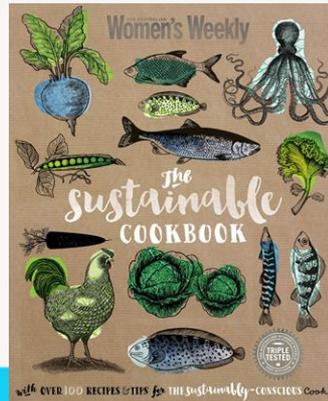
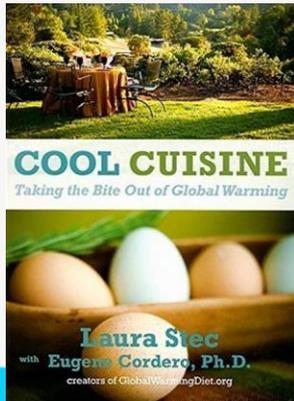
2004 The Sustainable Kitchen: Passionate Cooking Inspired by Farms, Forests and Oceans

- 'Local' and small scale (supporting CSA) Understand ingredients (and their complex production processes and histories).
- Highlighted sustainable food is more than low environmental impact, needed to sustain heritage and community economies.
- No mention of cooking impacts
- Contains beef, lamb etc.



2008-2022

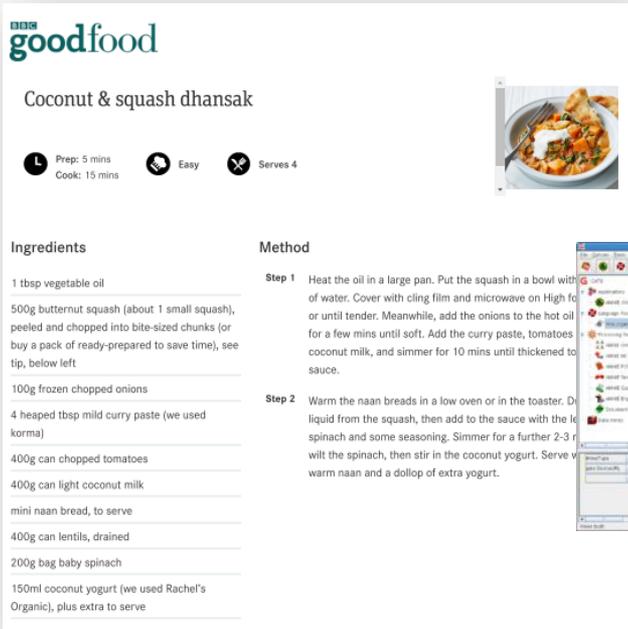
- 252 books, average of 16 published per year!
- Majority omnivorous recipes (containing beef or lamb), Become more plant based as time goes on...
- Rise and fall of sustainable seafood.
- Some read like “wellness” books.
- None of the books give the amount of carbon embodied in their recipes.
- All ask the reader to change behaviour: using leftovers, shopping organic, buying local, mindful eating, and eating seasonally.
- Books mention cooking impacts, but still use oven recipes and use beef/lamb.



Recipe analysis using NLP

We can now use Natural Language Processing to conduct analysis of how recipes from different sustainable cookbooks rate in terms of quantified sustainability impacts – e.g. Carbon footprint (kg of Co2e), water footprint etc.

However, our project's tool currently can only calculate the impacts of recipes from websites.



bbc goodfood

Coconut & squash dhansak

Prep: 5 mins
Cook: 15 mins
Easy
Serves 4



Ingredients

- 1 tbsp vegetable oil
- 500g butternut squash (about 1 small squash), peeled and chopped into bite-sized chunks (or buy a pack of ready-prepared to save time), see tip, below left
- 100g frozen chopped onions
- 4 heaped tbsp mild curry paste (we used korma)
- 400g can chopped tomatoes
- 400g can light coconut milk
- mini naan bread, to serve
- 400g can lentils, drained
- 200g bag baby spinach
- 150ml coconut yogurt (we used Rachel's Organic), plus extra to serve

Method

Step 1 Heat the oil in a large pan. Put the squash in a bowl with water. Cover with cling film and microwave on High for or until tender. Meanwhile, add the onions to the hot oil for a few mins until soft. Add the curry paste, tomatoes coconut milk, and simmer for 10 mins until thickened to sauce.

Step 2 Warm the naan breads in a low oven or in the toaster. Drizzle liquid from the squash, then add to the sauce with the spinach and some seasoning. Simmer for a further 2-3 mins until the spinach, then stir in the coconut yogurt. Serve with warm naan and a dollop of extra yogurt.



What recipe would you like to process?

URL

Please be aware that some pages may be slow to process, especially if they contain multiple recipes.

Recipe for 'Coconut & squash dhansak recipe | BBC Good Food'

Ingredients	150ml coconut, butternut squash, coconut milk, lentils, onions, spinach, tomatoes, vegetable oil
GHGE	1.74 kg CO2eq (-1.76 kg CO2eq to 12.4400015 kg CO2eq)
GHGE per Portion	0.435 kg CO2eq (-0.444 kg CO2eq to 3.1100004 kg CO2eq)
Eutrophying Emissions	17.84 g PO43-eq (4.84 g PO43-eq to 52.99 g PO43-eq)
Eutrophying Emissions per Portion	4.46 g PO43-eq (1.21 g PO43-eq to 13.2475 g PO43-eq)
Acidifying Emissions	39.66 g SO2eq (14.56 g SO2eq to 98.56 g SO2eq)
Acidifying Emissions per Portion	9.915 g SO2eq (3.64 g SO2eq to 24.64 g SO2eq)
Freshwater Withdrawals	2555.65 L (52.63 L to 7625.27 L)
Freshwater Withdrawals per Portion	638.9125 L (13.1675 L to 1906.3175 L)
Stress Weighted Water Use	135247.9 L (742.7 L to 474483.5 L)
Stress Weighted Water Use per Portion	33811.977 L (185.675 L to 118620.98 L)

THIS TOOL HAS BEEN DEVELOPED WITH A RESEARCH GRANT FROM THE ALPRO FOUNDATION

Generic Meals and carbon labels

Edamam, a provider of nutrition data and semantic solutions for businesses in the food, health, and wellness sectors (<https://developer.edamam.com>)

- Integrated a food environmental impact database of 2,842 ingredients (using the classification system of the USDA Nutrient Database for Standard Reference, Release 24). This food environmental impact database was based on environmental data from Poore and Nemecek (2018) and was supplied by City.
- For some items which are not part of USDA food list Edamam used in-house nutrition experts to map them to USDA items.
- Edamam has labeled about **5 million recipes in the English language web** with CO2 labels ranking from A+ (best) to G (worst) and is making those searchable via its Recipe Search API.

Edamam's Generic meals are a database of **180,000+** recipes that encompass more than 90% of what restaurants offer/commonly cooked at home.

- Similar recipes are clustered based on titles after removing certain non essential words from the title. These recipes represent the initial generic meal set.
- Compare recipes based on nutrition and content and remove any outliers. From the rest of the recipes Edamam build a combined recipes for which they also create a distribution of labels and nutrition among the recipe population. CO2e is one of the values which is part of this calculation.
- Edamam matched the CO2e data and carbon labels to the Generic meals database.

EIN PRESSWIRE

Edamam Partners with City University of London to Provide CO2 Imprint of Recipes and Meals

Edamam leverages research by City University and its proprietary algorithms to calculate CO2 impact of 5 million recipes and 70,000 most commonly eaten meals.



EDAMAM

Food. Data. Health

Results: YES! Eat-Lancet compatible recipes!

196,005 recipes with 100% ingredients matched to CO2e data. Mean 2101.45g of CO2e per portion, (SD 3472.02g)

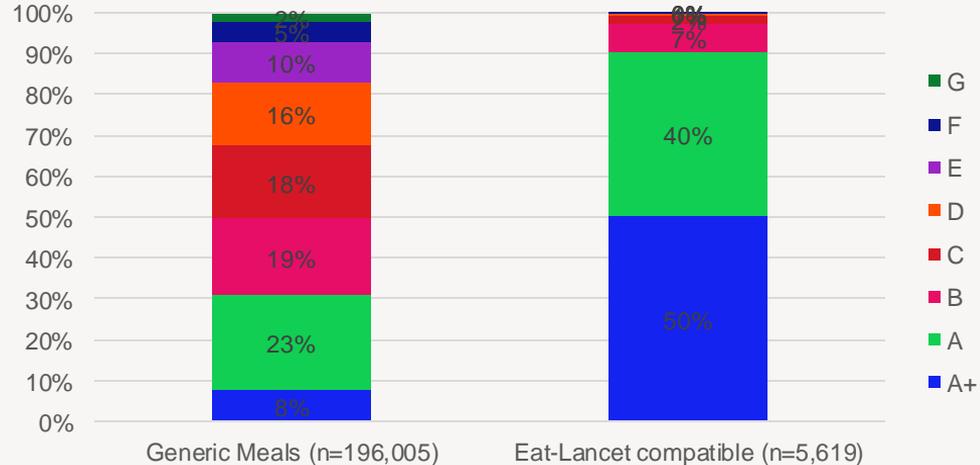
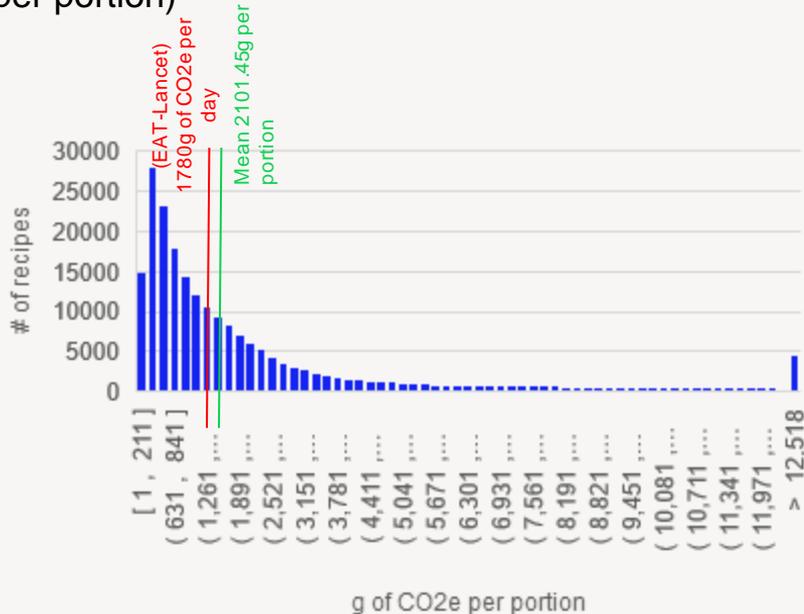
Information provided in grams of CO2e per **portion**, per **Kcal**, per g of **protein**

Eat-Lancet recipes: Assume consumption of this recipe is scaled to meet 2500 kcal, and protein 56g, is the scaled recipe below 1780g of CO2e.

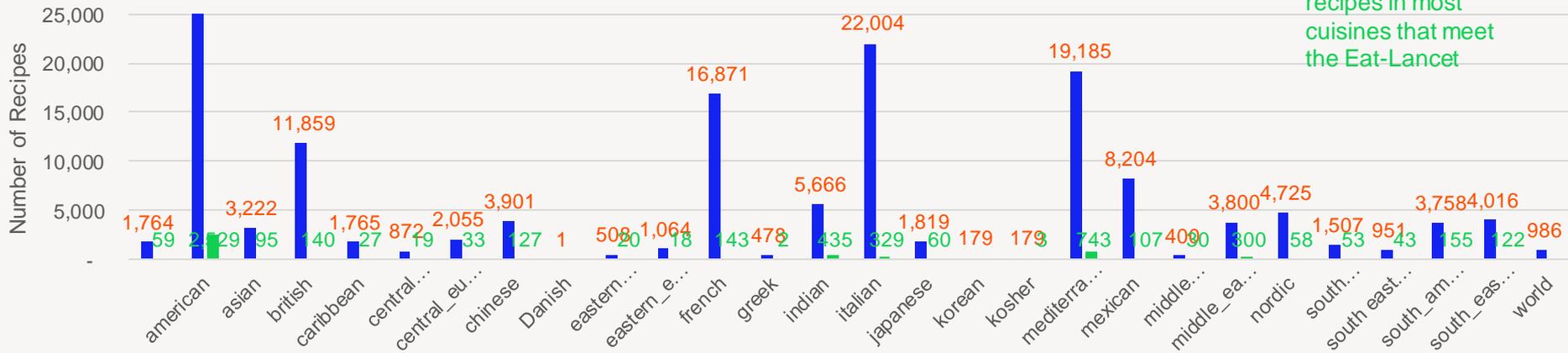
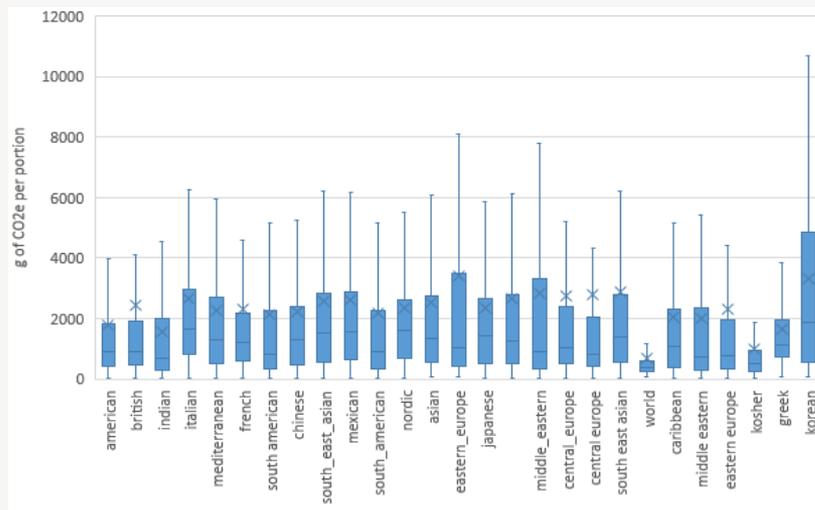
Below 31.7g of co2e per g protein n=10,434

Below 71g of co2e per 100 KJ =8,015

5,619 recipes met both criteria! (2.8%) Mean 180.87g of CO2e per portion, (SD 117.20g, max 1240g of CO2e per portion)



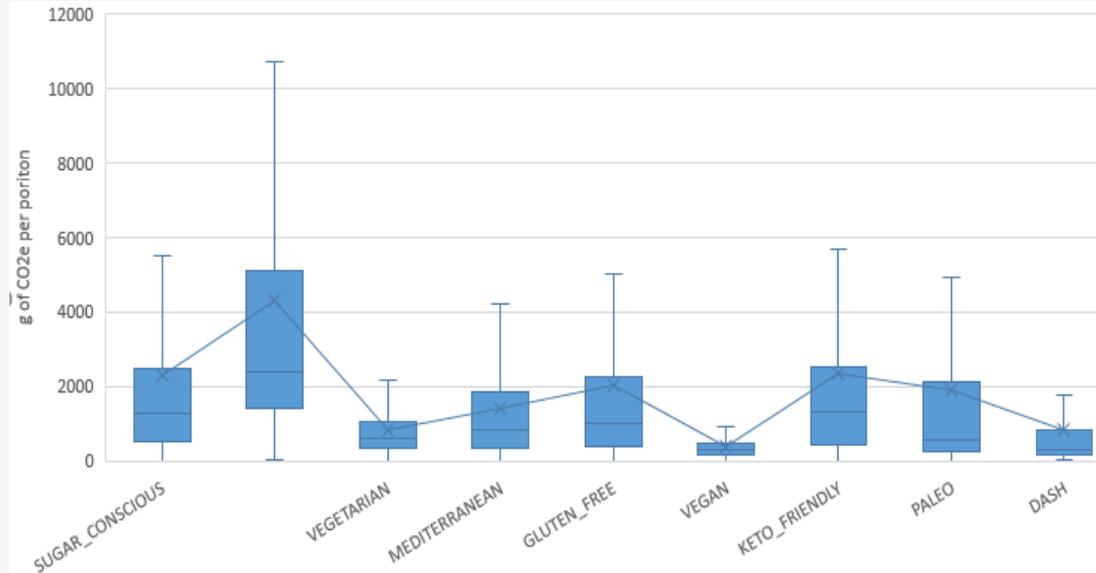
Different ways to cut the data... Cuisine type



There are a % of recipes in most cuisines that meet the Eat-Lancet

Different ways to cut the data... Health/Diet

Metadata presented for Meal type, Health/Diet type, Cuisine type, Dish type, and Ingredients per recipe



Different carbon impact spreads across Diet choice types, but also the number of recipes matters!

DASH, Vegan, and Vegetarian recipes had the lowest mean, median and IQR of any specific health/diet type.

DASH= Dietary Approaches to Stop Hypertension, includes foods that are rich in potassium, calcium and magnesium. Limits foods that are high in sodium, saturated fat and added sugars.



Examples of DASH, Vegan, and Vegetarian recipes that meet Eat-Lancet

- Sweet Potato Flat Breads (44g of Co2e per portion)
- Curly Kale With Caramelized Onions (46g of Co2e per portion)
- Alfresco Friday Hummus (49g of Co2e per portion)
- Oatmeal Raisin Cookie Larabars (69g of Co2e per portion)
- Pasta With Lentil Soup Sauce (137g of Co2e per portion)
- Lentil And Spinach Salad With Onion, Cumin And Garlic (145g of Co2e per portion)
- Falafel Veggie Burgers (173g of Co2e per portion)
- Farro Salad With Winter Fruit, Pistachios And Ginger (175g of Co2e per portion)
- Kale, Quinoa And Roasted Pumpkin Pilaf (226g of Co2e per portion)
- Spicy Portabella Couscous (237g of Co2e per portion)
- ...
- Cumin And Coriander Chickpea Salad (568g of Co2e per portion) etc.

- (note to self at least 100 variant recipes for hummus)



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<https://www.city.ac.uk/about/schools/health-sciences/research/centre-for-food-policy>

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Undergraduate degree

Food Policy MSc/PGDip/PGCert/MSc

Distance Learning

Postgraduate taught degree

PhD/MPhil Food Policy

Postgraduate research degree

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