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Recipes that meet the EAT-Lancet: what should we be cooking?

Christian Reynolds,

Hosted by BDA Sustainable Diets Specialist Group

7:30-9:00pm 29 June 2022

Dr Christian Reynolds
Centre for Food Policy, City, University of London
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Centre for Food Policy
Shaping an effective food system

www.city.ac.uk

Who am I? – Christian Reynolds

Senior Lecturer at the Centre for Food Policy

wrap · STFC Food Network+ · N8 AgriFood · The Nutrition Society – Advancing Nutritional Science

University of South Australia · University of Aberdeen · The University Of Sheffield. Institute for Sustainable Food. · UK Data Service

→ City, University of London – Est 1894

Focus: healthy sustainable diets and food consumption (including waste)

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Review

Review: Consumption-stage food waste reduction interventions – What works and how to design better interventions

Christian Reynolds[a,b,*], Liam Goucher[c], Tom Quested[b], Sarah Bromley[b], Sam Gillick[b], Victoria K. Wells[d], David Evans[e], Lenny Koh[c], Annika Carlsson Kanyama[f], Cecilia Katzeff[g], Åsa Svenfelt[f], Peter Jackson[a]

Public Health Nutrition: 22(8), 1503–1517 doi:10.1017/S1368980018003774

Healthy and sustainable diets that meet greenhouse gas emission reduction targets and are affordable for different income groups in the UK

Christian J Reynolds[1], Graham W Horgan[2], Stephen Whybrow[1] and Jennie I Macdiarmid[1,*]

[1]The Rowett Institute University of Aberdeen, Aberdeen AB25 2ZD, UK: [2]Biomathematics & Statistics Scotland, Aberdeen, UK

Previously: Food waste politics/history, social sciences approaches

Cheeky shout out – PhD funding available

City, University of London has multiple funding streams open to Dietitians (and other healthcare professionals) to complete a PhD n food, diet and sustainability – **please do get in touch if you are interested!**

- **UK Food Systems Centre for Doctoral Training (UKFS-CDT)**

https://foodsystems-cdt.ac.uk/

- **HARP PhD Programme**

https://harpphd.org/

Health Advances in Underrepresented Populations and Diseases

- **BARTS Healthcare Professional Clinical Research Training Fellowships**

https://www.bartscharity.org.uk/apply-for-funding/healthcare-professional-clinical-research-training-fellowships/

- **Internal City, University of London Scholarships**

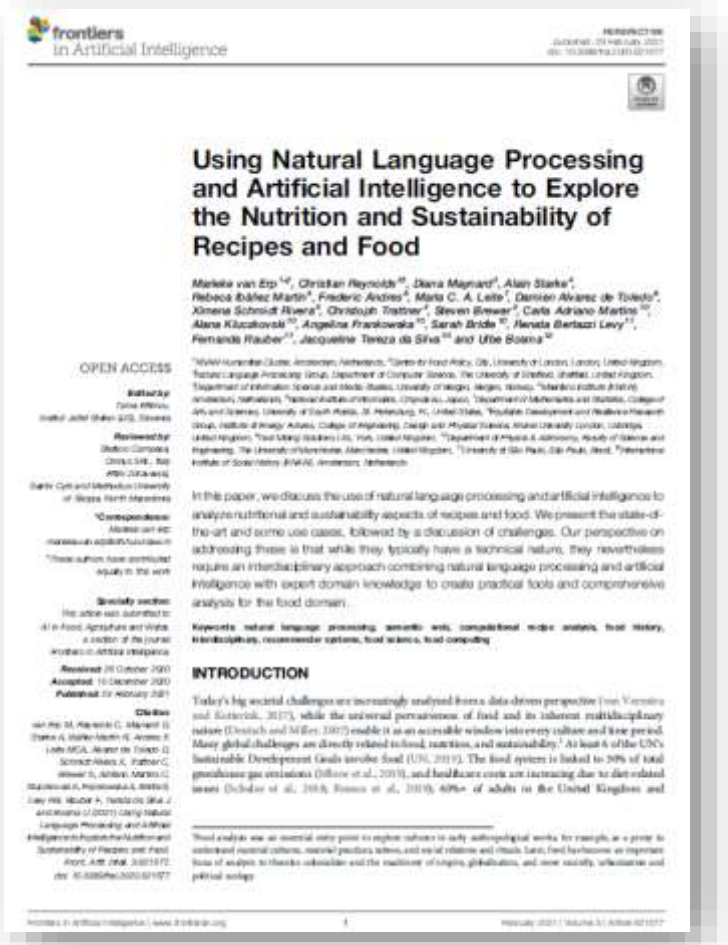
UK FOOD SYSTEMS
CENTRE FOR DOCTORAL TRAINING

HARP

BARTS CHARITY

CITY
UNIVERSITY OF LONDON
EST 1894

This builds on previous NLP and recipe work


frontiers in Artificial Intelligence

Using Natural Language Processing and Artificial Intelligence to Explore the Nutrition and Sustainability of Recipes and Food

OPEN ACCESS

INTRODUCTION

https://dx.doi.org/10.3389%2Ffrai.2020.621577

ScienceDirect

Energy Procedia

1st International Conference on Sustainable Energy and Resource Use in Food Chains, ICSEF 2017, 19-20 April 2017, Berkshire, UK.

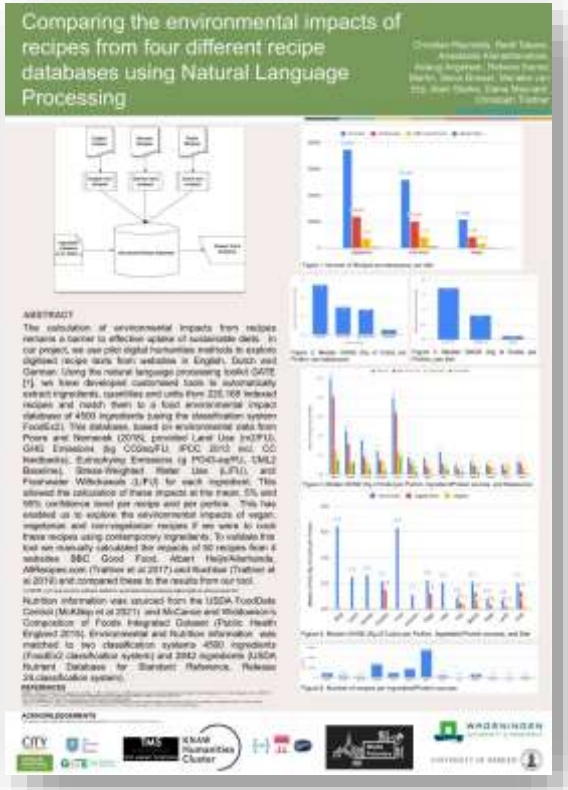
Energy embodied in household cookery: the missing part of a sustainable food system? Part 1: A method to survey and calculate representative recipes

Christian J. Reynolds

Abstract

https://doi.org/10.1016/j.egypro.2017.07.245

LEAP 2021 Poster for the project: Communicating the environmental impact of plant based recipes – funded by the Alpro foundation (2021).


Comparing the environmental impacts of recipes from four different recipe databases using Natural Language Processing

Multiple studies already

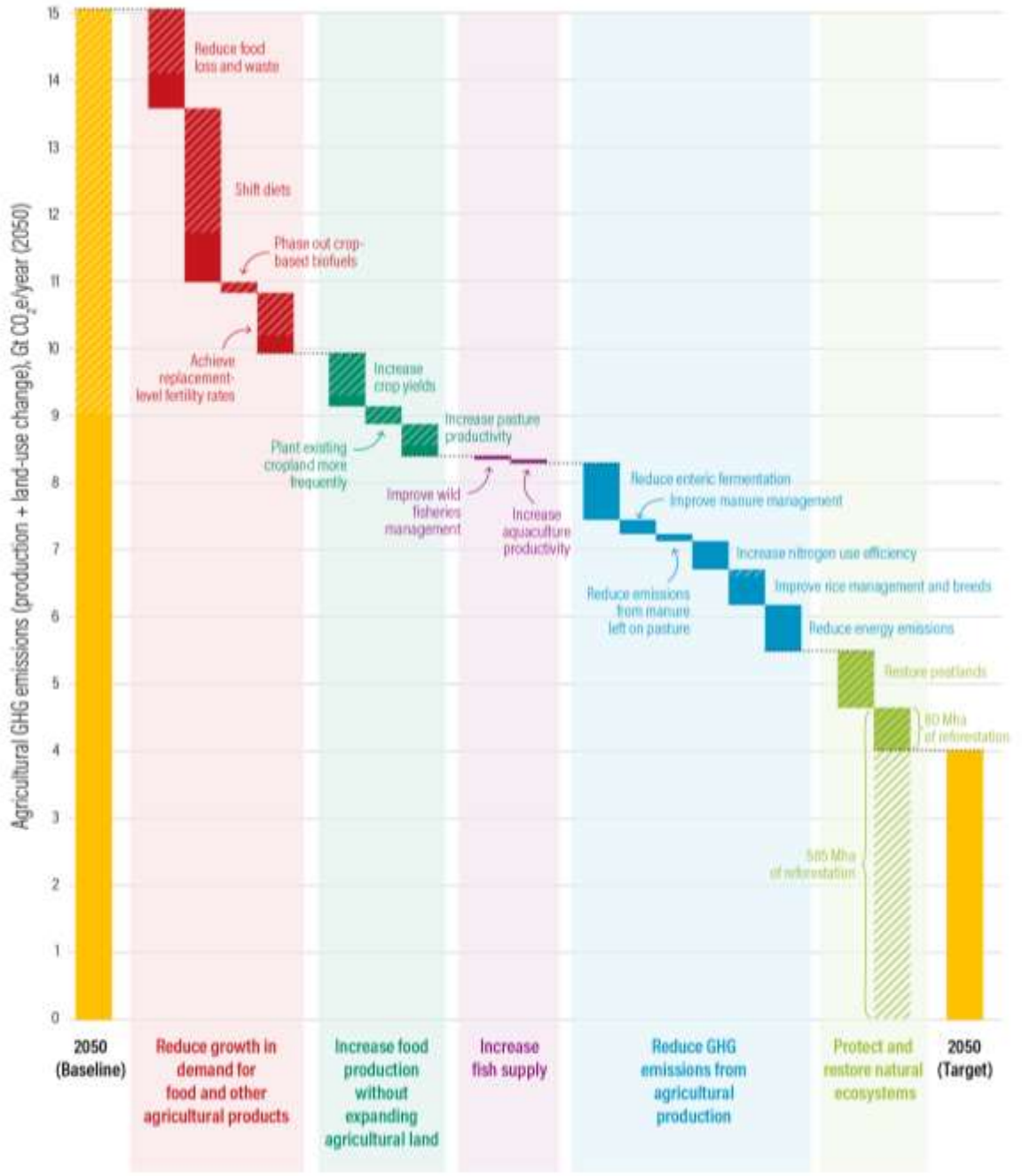
- Nutritional and health studies (Reinivuo et al., 2009; Trattner et al., 2017)
- Computational linguistics (Jurafsky, 2015),
- Computational gastronomy (Jain et al.,2015)
- Online shopping recommendations (Aiello et al., 2019)
- Semantic web (Haussmann et al., 2019)

This is still a young field of investigation!

The emissions reduction challenge – A warming food system

The two biggest reductions we can make to agricultural GHGE to achieve a **2°C** warming target (4 Gt/year) or **1.5°C** warming target (0 Gt/year) are through:

1. **Shifting to sustainable diets**
2. Reducing Food Loss and Waste



Note: Solid areas represent agricultural production emissions. Hatched areas represent emissions from land-use change.
Source: GlobAgri-WRR model.

Source WRI, [World Resources Report: Creating a Sustainable Food Future]

Sustainable diets and The EAT–Lancet report

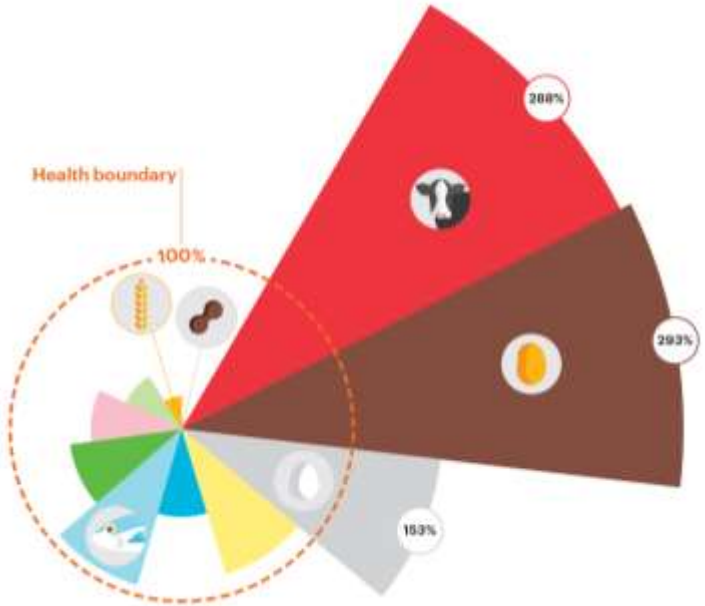
Published in 2019

Setting Scientific Targets for Healthy Diets and Sustainable Food Production

↑ consumption of fruit (100 -300g/day) & vegetables (200-600g/day)

↓consumption of animal products

Per day requirements: 2500 kcal, and protein 56g, for a max of 1780g of CO2e

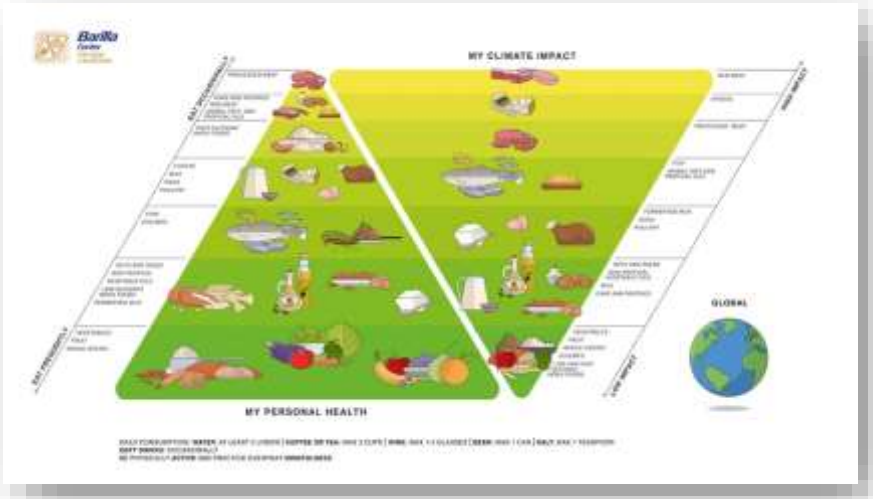


	Macronutrient intake grams per day (possible range)	Caloric intake kcal per day
Whole grains Rice, wheat, corn and other	232	811
Tubers or starchy vegetables Potatoes and cassava	50 (0–100)	39
Vegetables All vegetables	300 (200–600)	78
Fruits All fruits	200 (100–300)	126
Dairy foods Whole milk or equivalents	250 (0–500)	153
Protein sources Beef, lamb and pork	14 (0–28)	30
Chicken and other poultry	29 (0–58)	62
Eggs	13 (0–25)	19
Fish	28 (0–100)	40
Legumes	75 (0–100)	284
Nuts	50 (0–75)	291
Added fats Unsaturated oils	40 (20–80)	354
Saturated oils	11.8 (0–11.8)	96
Added sugars All sugars	31 (0–31)	120

The EAT–Lancet report - A Critique

- Lack of consideration of local and traditional diets, food ways or systems of production.
- Limited suggestions on how to implement the ‘global healthy sustainable diet’ (only photos).
- Minimal discussion of cooking and real life examples (e.g. no recipes)

- Current sustainable dietary guidance is given as ingredients
- We have only just started to see translation into sustainable gastronomy – see Barilla foundation reports (2021)



We need sustainable recipes tools and data

- **Public engagement/communication need**

#1 ask I get is …

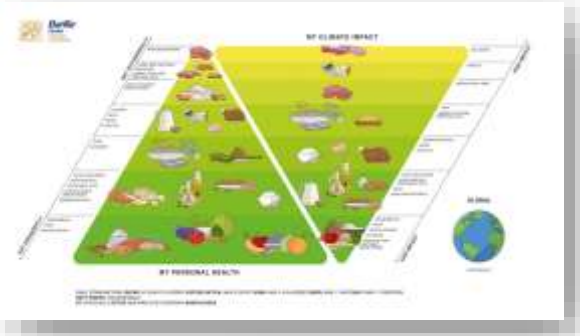
TAKE A BITE OUT OF CLIMATE CHANGE

“how/what can I cook sustainably this at home?”

“what are the impacts of this recipe?”

We need this information to empower citizens!

People do not think in **ingredients**, they think in **recipes**



- **Industry need**

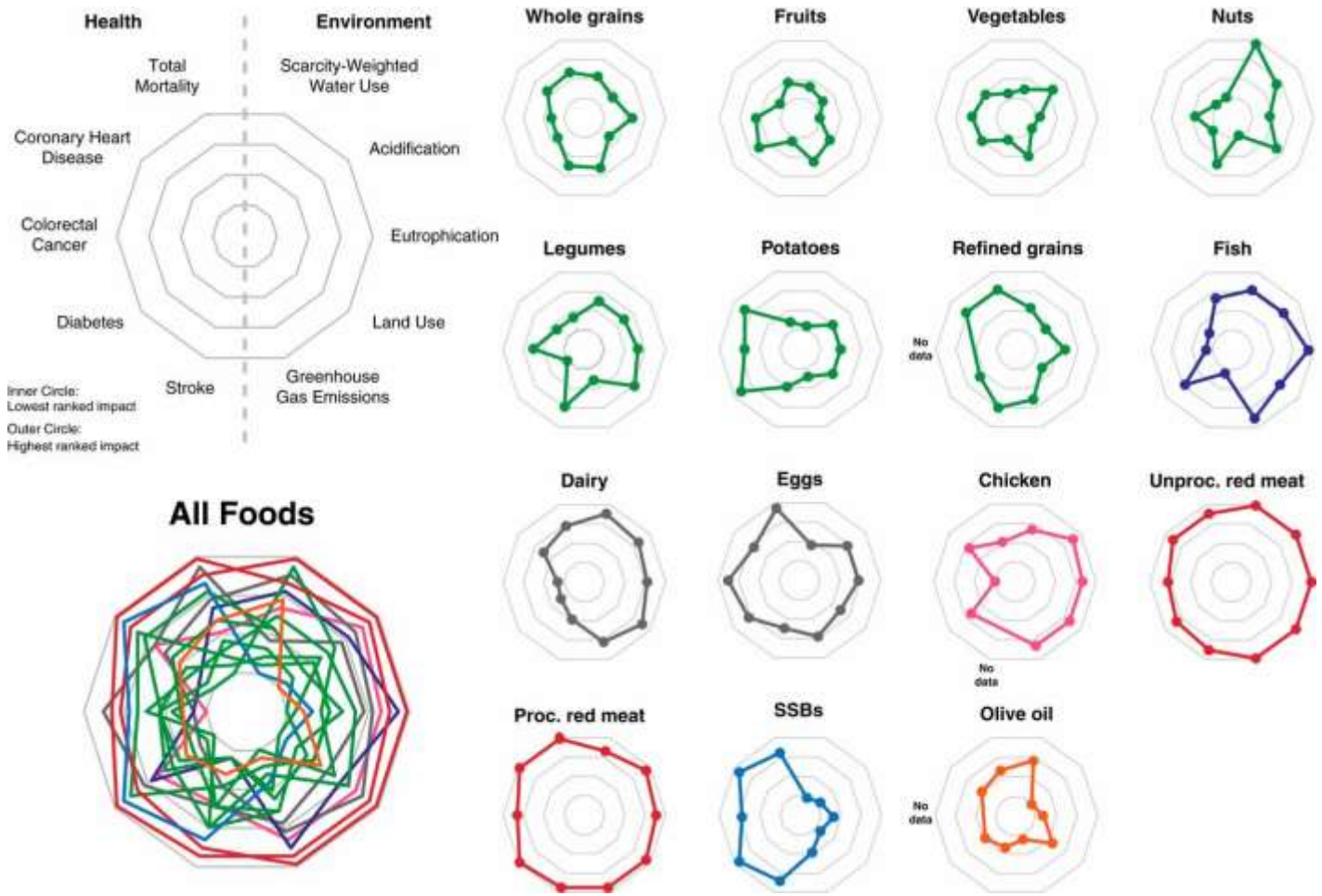
Need for communication around sustainable menu development and recipe design.

- **Policy need**

Need for data / visualisations of nutrition and food education, pack and portion advice etc.

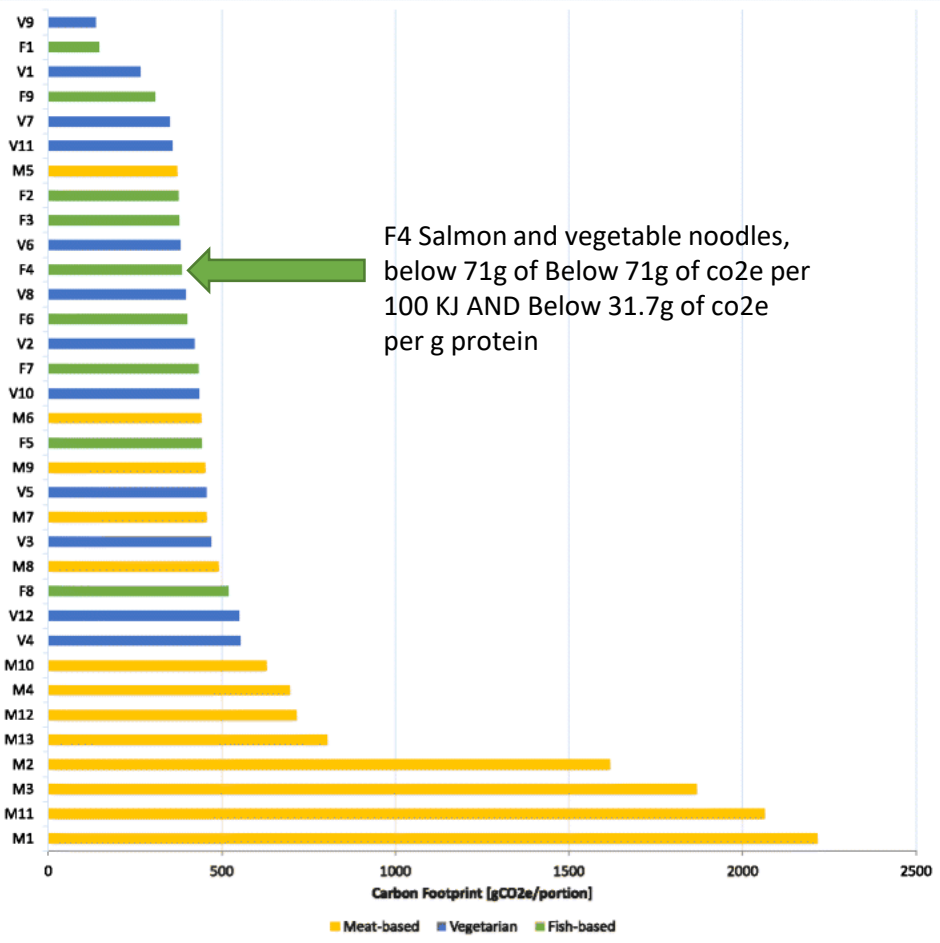
Are there recipes that meet or are within the **Eat-Lancet** ?

Each ingredient has different health and environmental impacts – so what about recipes (and complex ingredients)?



https://doi.org/10.1073/pnas.1906908116

Do other studies have EAT-Lancet compatible meals ?



F4 Salmon and vegetable noodles, below 71g of Below 71g of co2e per 100 KJ AND Below 31.7g of co2e per g protein

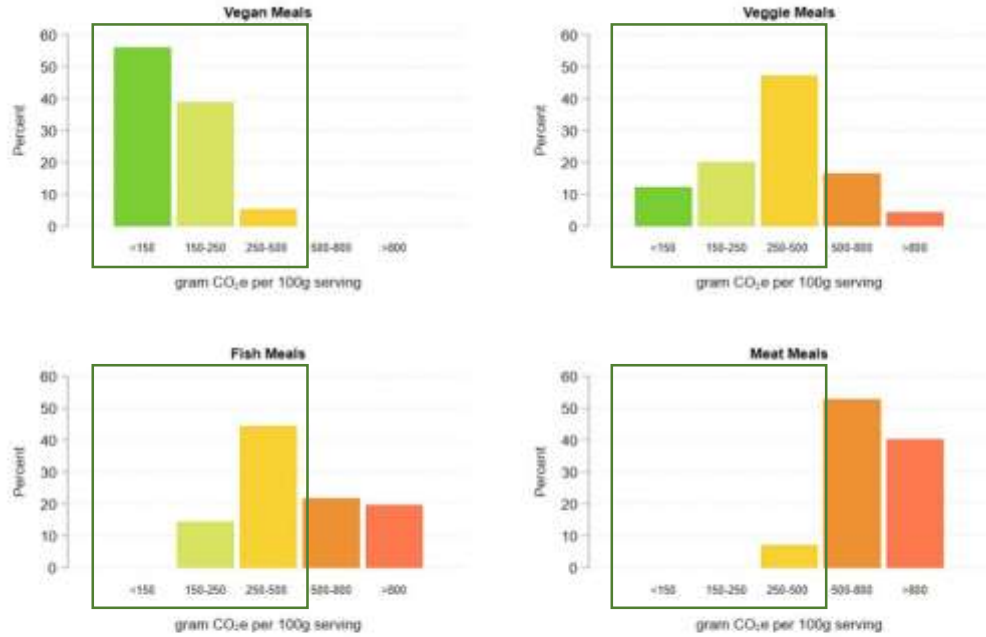


Figure A2: **Frequency distribution of vegan, vegetarian, fish and meat meals across label categories**

Note: Vegan N = 152, Veggie N = 140, Fish N = 84, Meat N = 199

De Laurentiis et al (2018) n=34 recipes total
Below 31.7g of co2e per g protein n=24 recipe
Below 71g of co2e per 100 KJ n= 1 recipe
https://doi.org/10.1007/s11367-018-1460-x

Lohmann et al (2022) n=575 recipes total
Below ~390g of co2e per 100g. 20 meat ,and 45 fish, 136 vegan and 110 vegetarian
https://doi.org/10.1016/j.jeem.2022.102693

There are (now) many Tools and Apps

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.

EINPRESSWIRE

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.

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.

EDAMAM

Food. Data. Health

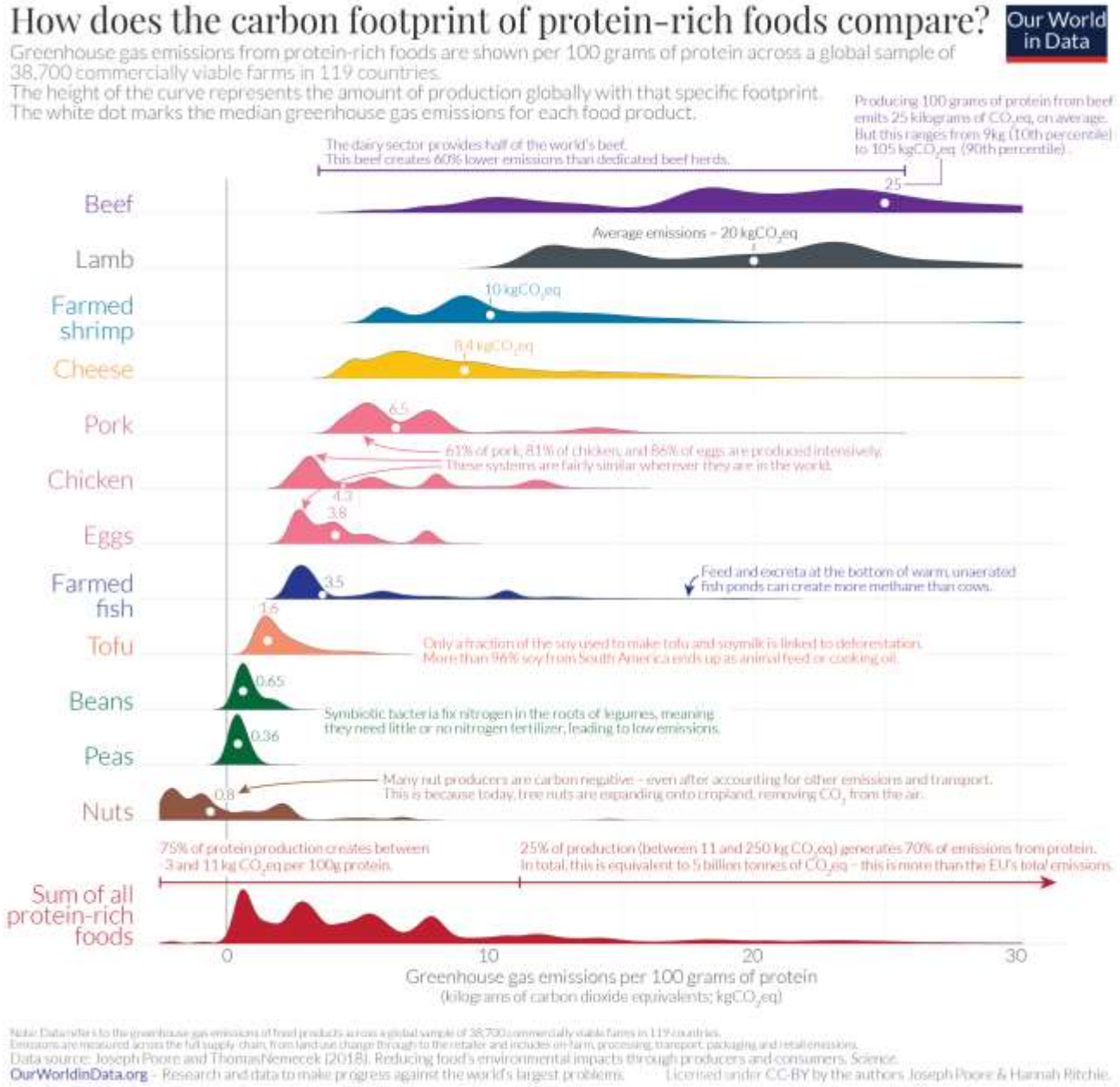
The advantage of Poore and Nemecek (2018)

The Poore and Nemeck (2018) database provides 5% and 95% confidence intervals as well as **mean global impacts**

43 food categories meta-analysis comparing various types of food production systems.

Impact can vary 50-fold among producers of the same product, creating substantial mitigation opportunities

Note EAT-Lancet requires 56g of Protein for 1780 g CO2e / person / day
So ~0.31 g CO2e per 100g of Protein on average.



Matching P&N (2018) to FoodEx2/USDA

43 food categories matched to 4558 FoodEx2 code (Kg of Co2e per 100g)

All products were matched by hand, using the closest raw product; if it was a product with multiple ingredients, we took the largest ingredient by weight. GHGE Values corrected for hydration and processing.

N	O	P	Q
L7_Foo	L7_FoodEx2_desc	level	Category
A000J	Grains and grain-based products	1	Wheat & Rye (Bread)
A000K	Cereals and cereal primary derivatives	2	Wheat & Rye (Bread)
A000L	Cereal grains (and cereal-like grains)	3	Wheat & Rye (Bread)
A001X	Mixture of grains	4	Wheat & Rye (Bread)
A0D9Y	Barley and similar-	4	Barley (Beer)
A000P	Barley grains	5	Barley (Beer)
A002K	Barley grain, pearled	6	Barley (Beer)

N	O	P	Q
L7_Foo	L7_FoodEx2_desc	level	Category
A00ZT	Potatoes	4	Potatoes
A011P	Potato boiled	5	Potatoes
A011R	Potato baked	5	Potatoes
A00ZX	Main-crop potatoes	5	Potatoes
A00ZV	New potatoes	5	Potatoes
A0DPM	Andigena	4	Potatoes
A00ZY	Tropical root and tuber vegetables	3	Cassava
A04JX	Cassava roots and similar-	4	Cassava
A00ZZ	Cassava roots	5	Cassava

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)

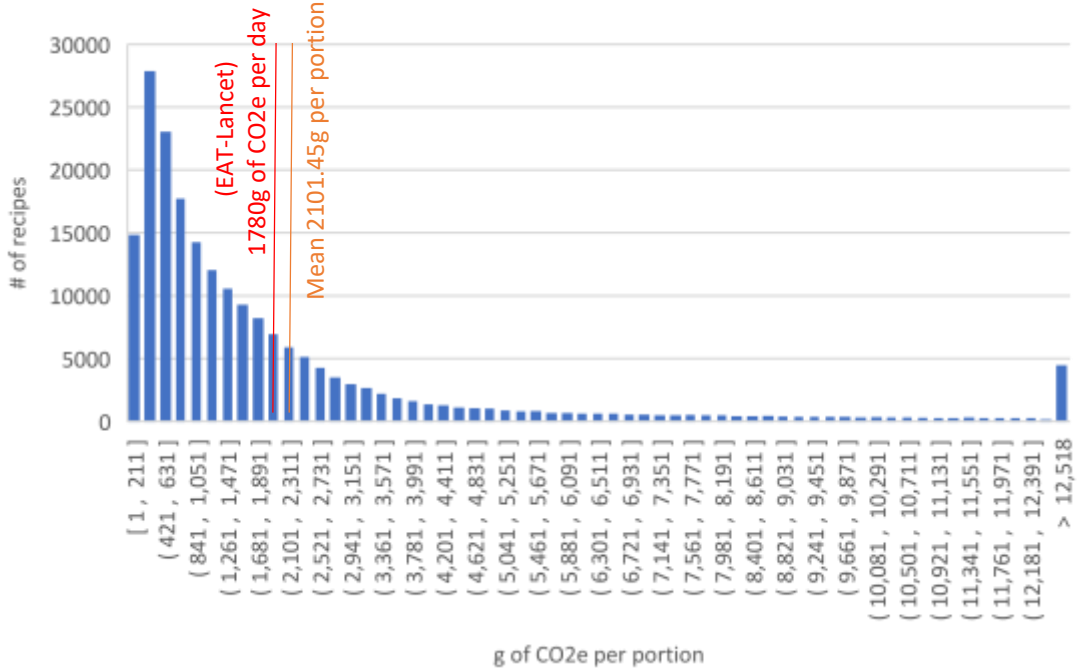
Information provided in grams of CO2e per **portion**, per **Kcal**, per g of **protein**

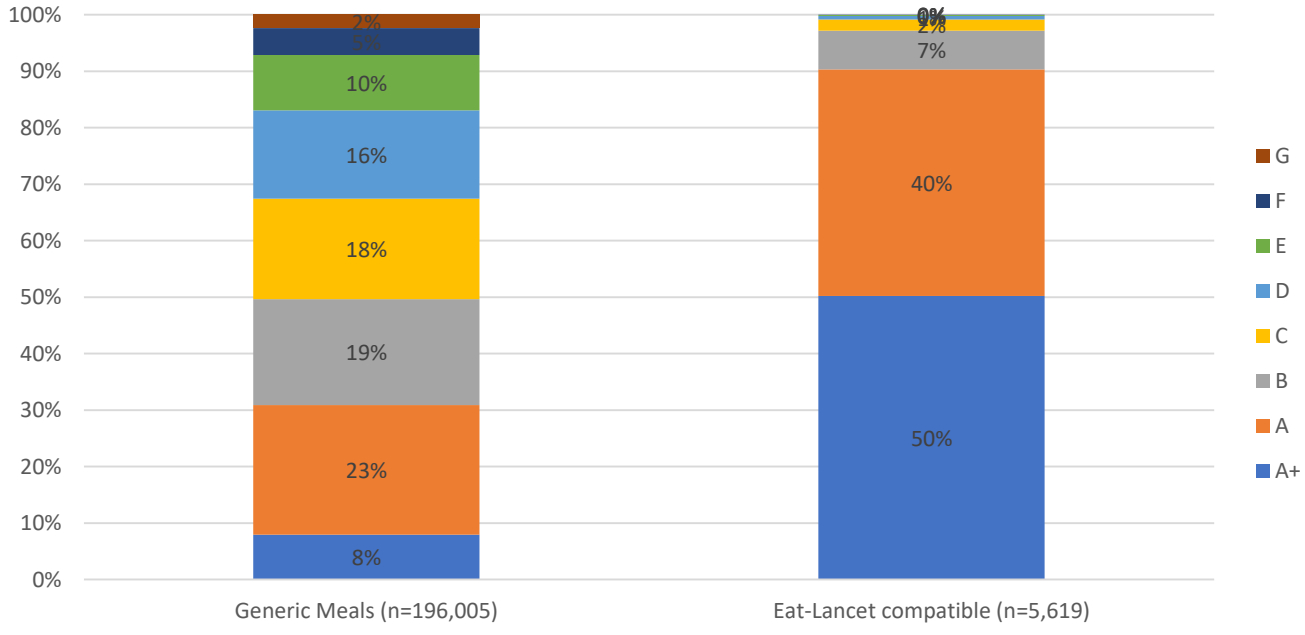
Eat-Lancet recipes: Assume consumption of this recipe is scaled to meet 2500 kcal, and protein 56g, is the scaled recipe below 1780g of CO2e.

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

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

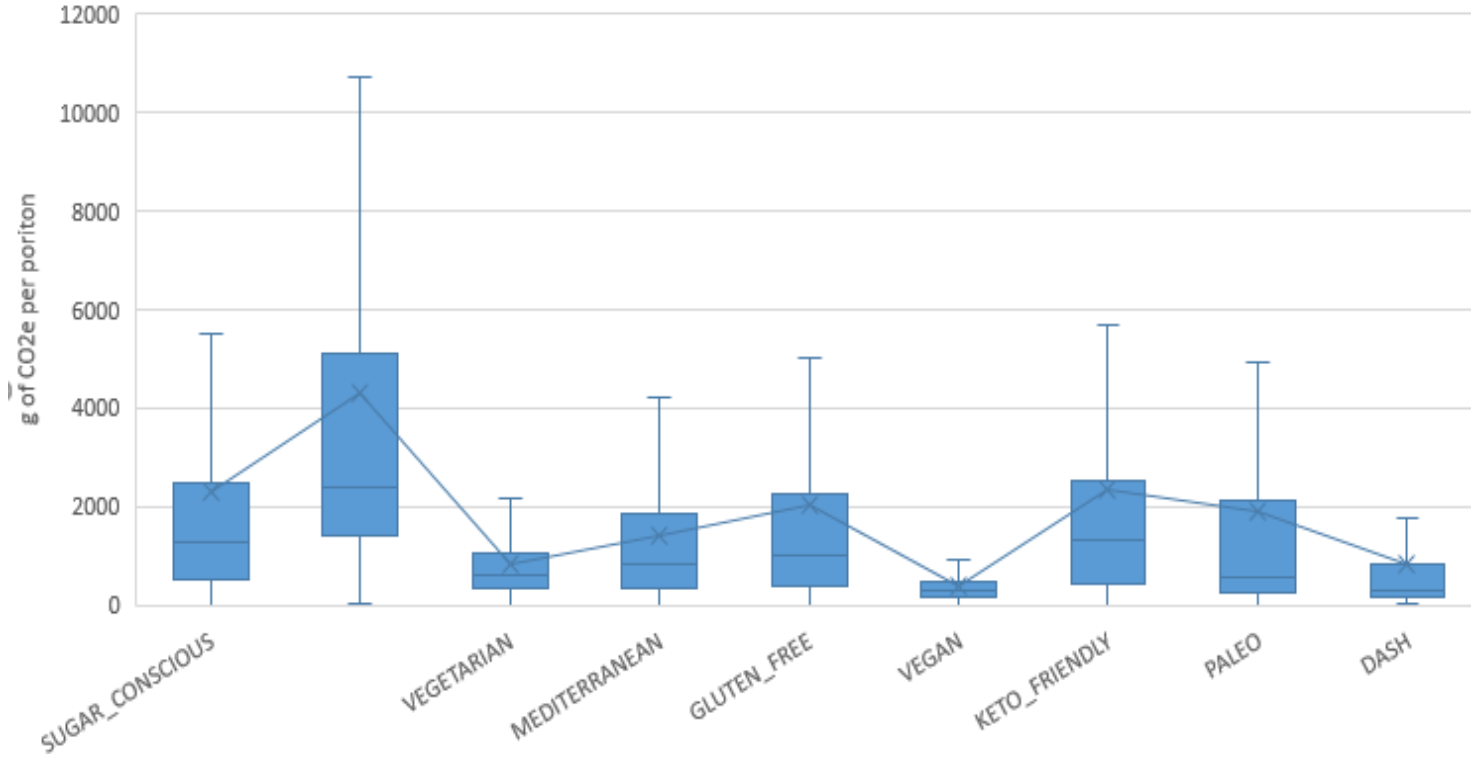
5,619 recipes met both criteria! (2.8%) Mean 180.87g of CO2e per portion, (SD 117.20g, max 1240g of CO2e per portion)





Different ways to cut the data… Health/Diet

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



	SUGAR CONSCIOUS	No Classification	VEGETARIAN	MEDITERRANEAN	GLUTEN_FREE	VEGAN	KETO FRIENDLY	PALEO	DASH
Count	49,690	29,031	111,263	37,869	81,000	24,651	22,372	11,270	7,086
Avg. g CO2e per portion	2,313.34	4,320.09	833.55	1,417.64	2,013.42	402.28	2,349.80	1,881.94	816.31

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.

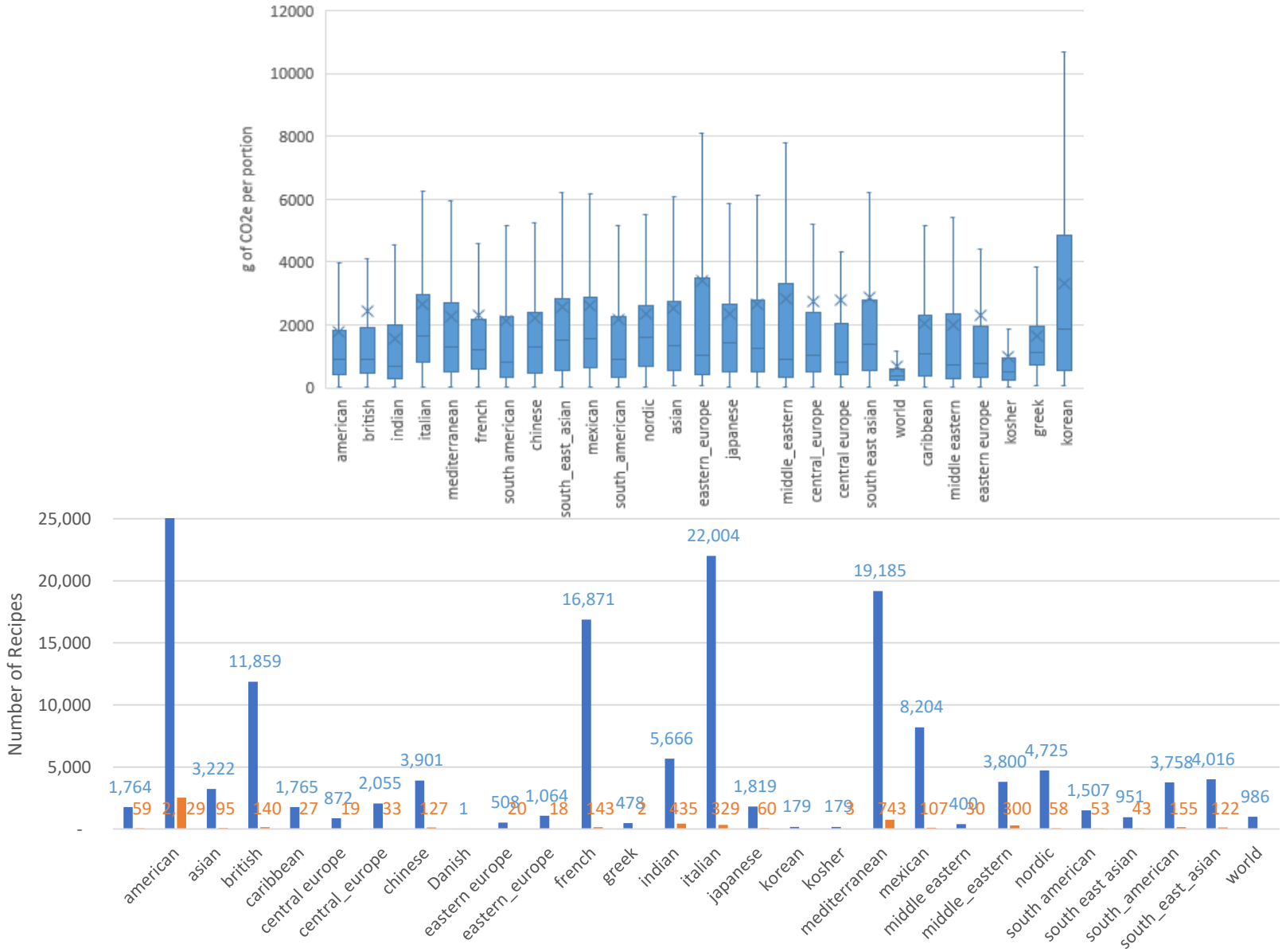
DASH= Dietary Approaches to Stop Hypertension, includes foods that are rich in potassium, calcium and magnesium. Limits foods that are high in sodium, saturated fat and added sugars.

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.

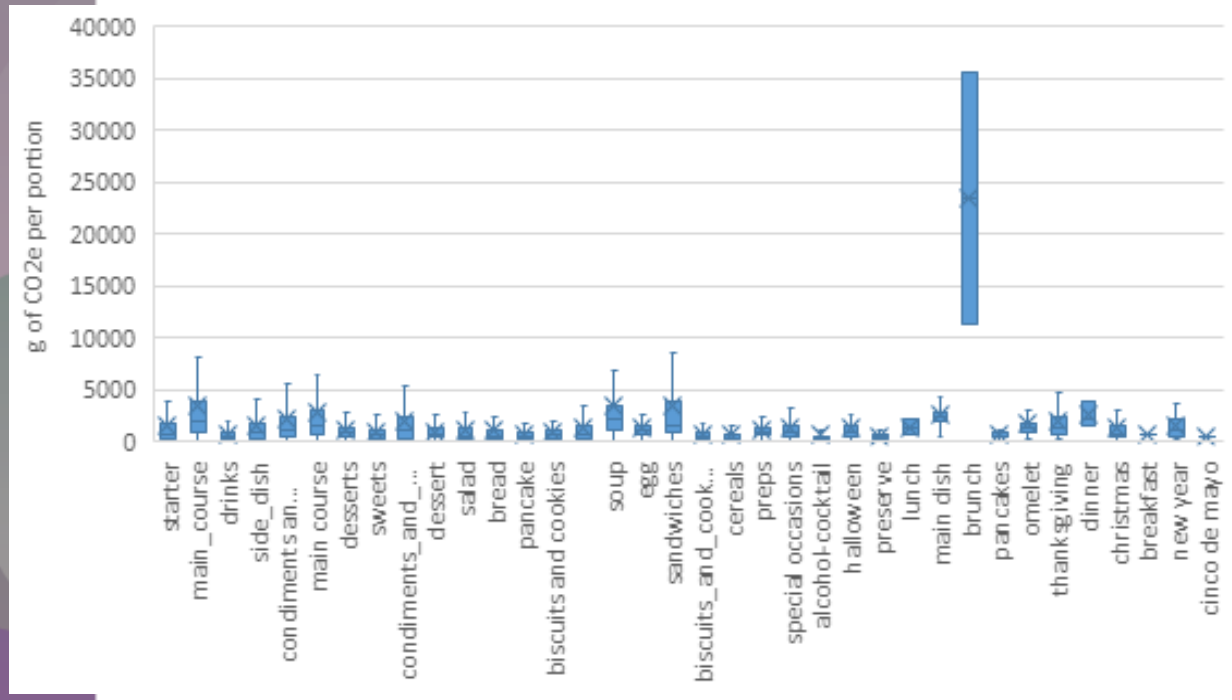
(note to self at least 100 variant recipes for hummus)

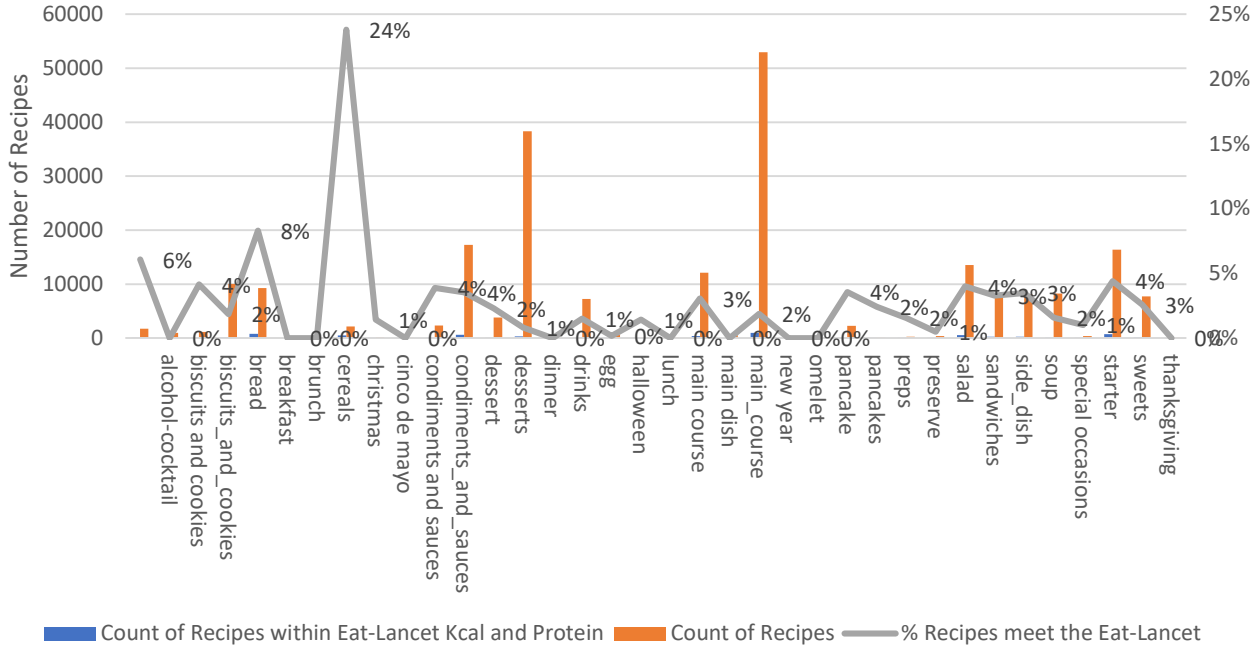
Different ways to cut the data… Cuisine type



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

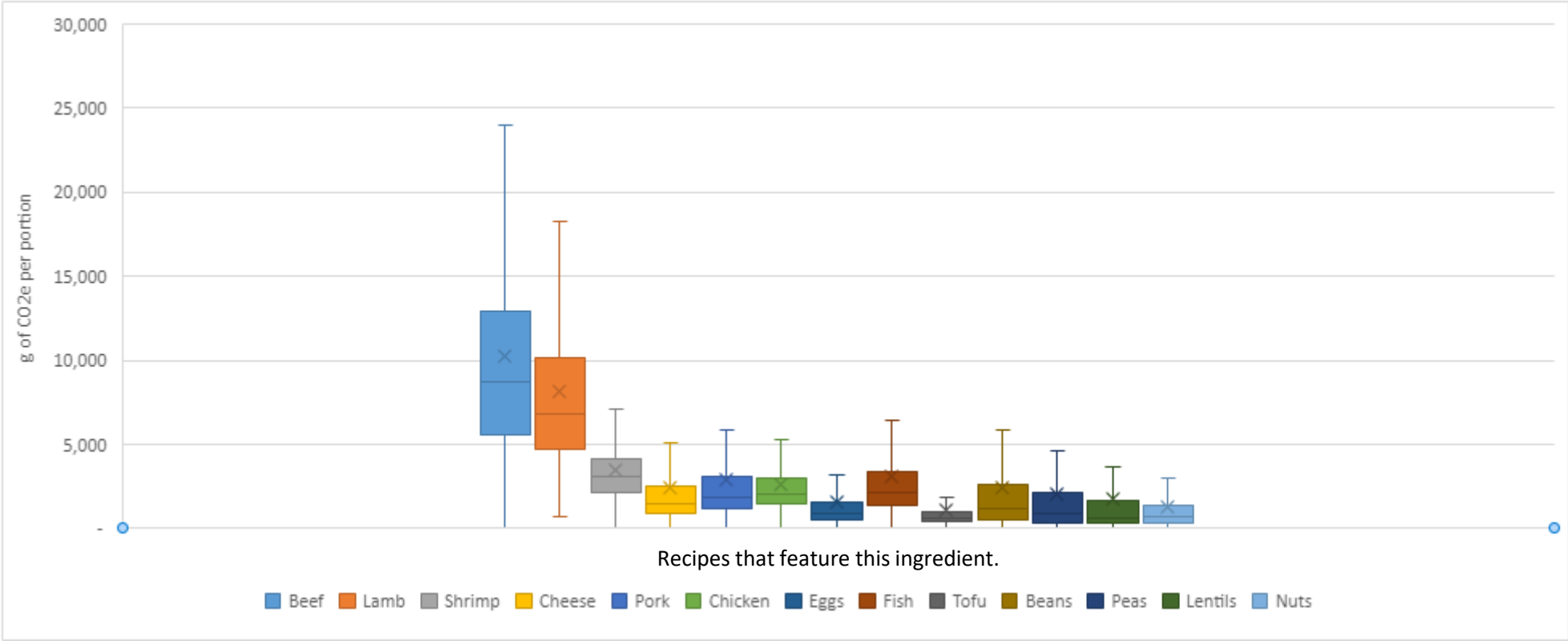
Different ways to cut the data… Dish type





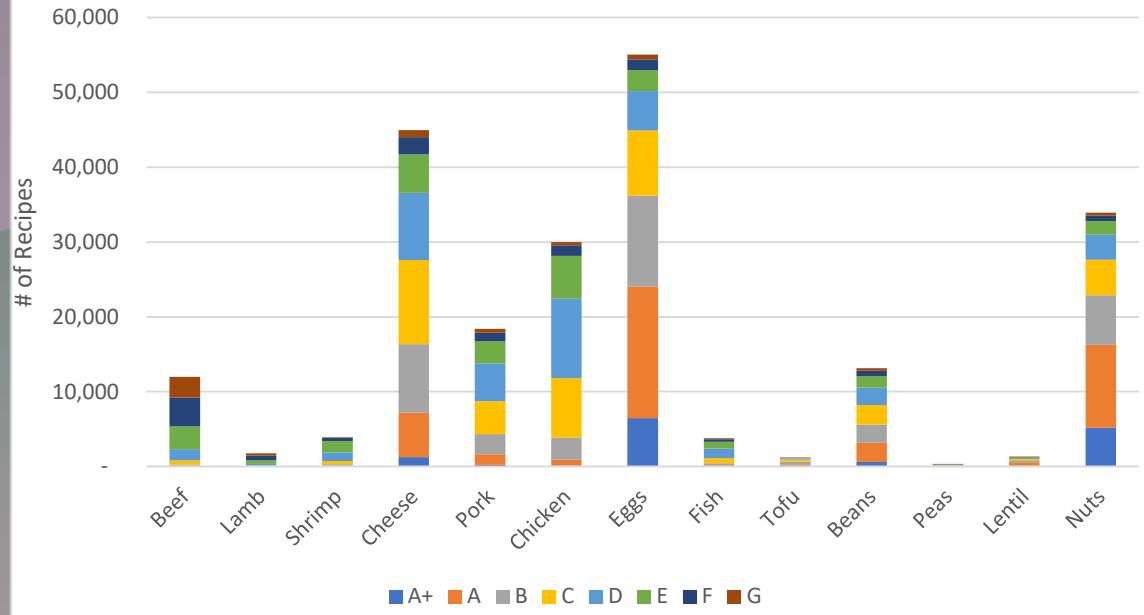
There are a % of recipes that meet the Eat-Lancet – Dish types vary in footprint, but a problem with sample size/tagging

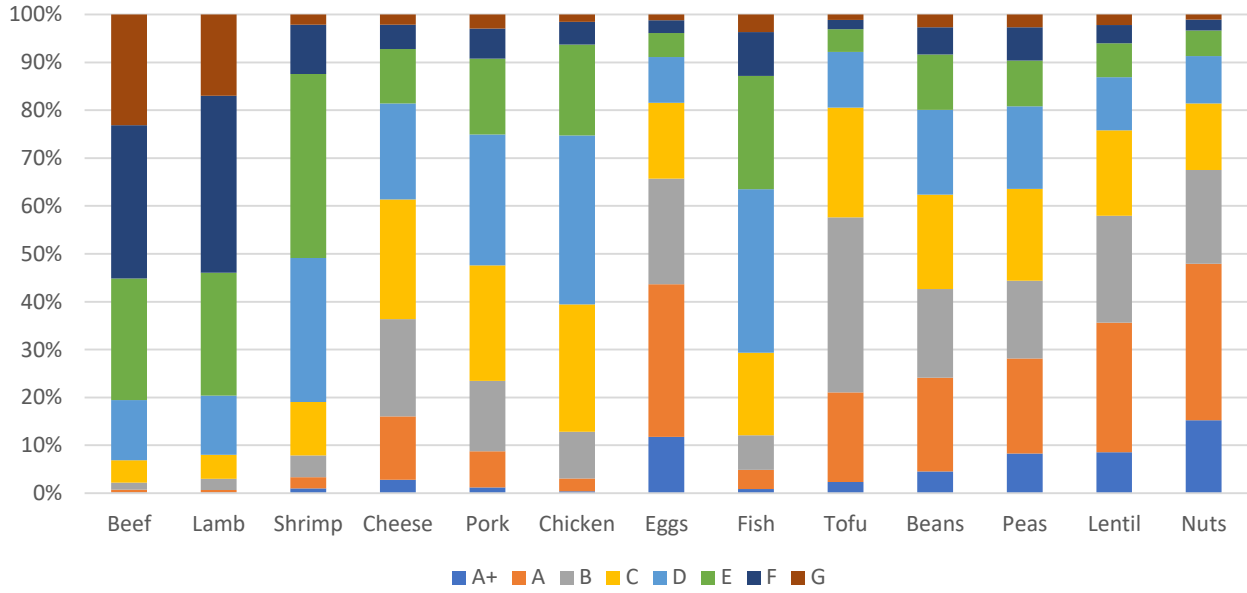
Different ways to cut the data… Ingredients



	Beef	Lamb	Shrimp	Cheese	Pork	Chicken	Eggs	Fish	Tofu	Beans	Peas	Lentil	Nuts
Mean g of CO2e per portion	10,265.96	8,139.05	3,448.71	2,388.032	2,890.13	2890.13	1,552.63	3,086.02	1,054.26	2,473.38	2,057.60	1,742.12	1,289.52
Count	11,984	1,776	3,890	44,959	18,411	18,411	55,074	3,795	1,168	13,157	302	1,312	33,835
# of Eat-Lancet	0	0	4	48	17	14	542	8	12	608	31	206	1802
% Eat-Lancet	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	1.0%	0.2%	1.0%	4.6%	10.3%	15.7%	5.3%

Different ways to cut the data… Ingredients





Different carbon label spreads across ingredient types, but also the number of recipes matters!

This means there are some border line recipes in all cases.

To consider… the underlying GHGE data *may* not be accurate

Multiple Greenhouse Gas Emissions (GHGE) databases exist (Each describes the impacts of different agricultural production systems around the world).

Our use of Poore and Nemeck (2018) is not the only ingredient level data out there.

Each database makes assumptions.

To validate our results we compared Poore and Nemeck (2018) to other databases all matched to FoodEx2 classification system.

For SHARP (n=945)
44% (n=206) within p5 and p95 confidence interval values of City
31% (n=144) lower than the p5 confidence interval values of City
25% (n= 119) higher than p95 confidence interval values of City.

Database	**n**	**Spearman correlation**	**p-value**
Sharp https://doi.org/10.1016/j.dib.2019.104617	945	0.699	< 0.001
Rose/Heller https://doi.org/10.1093/ajcn/nqy327	608	0.572	< 0.001
Garzillo https://doi.org/10.11606/9788588848405	329	0.610	< 0.001

So what does this mean practically?

SHARP 62.76kg of Co2e (Beef is 87% of the footprint)

City 166.58kg of Co2e (Beef is 95% of the footprint)

SHARP 8.77kg of Co2e (Sausages is 62% of the footprint)

City 7.11kg of Co2e (Sausages is 77% of the footprint)

SHARP 0.95kg of Co2e (Broccoli is 30% of the footprint)

City 1.07kg of Co2e (Broccoli is 14% of the footprint)

SHARP 11.34kg of Co2e (Butter is 88% of the footprint)

City 3.77kg of Co2e (Butter is 24% of the footprint)

How recipes could be changed to reduce their environmental impacts

Modifying fruit, vegetable, fat and animal protein contents.

Option 1

Halve the amounts of animal protein and fat (and or switch to plant based)

– the biggest difference we found was a ~50% **decrease** in footprint

SHARP 62.76kg of Co2e (Beef is 87% of the footprint)

City 166.58kg of Co2e (Beef is 95% of the footprint)

Option 2

Double the amount of fruits and vegetables

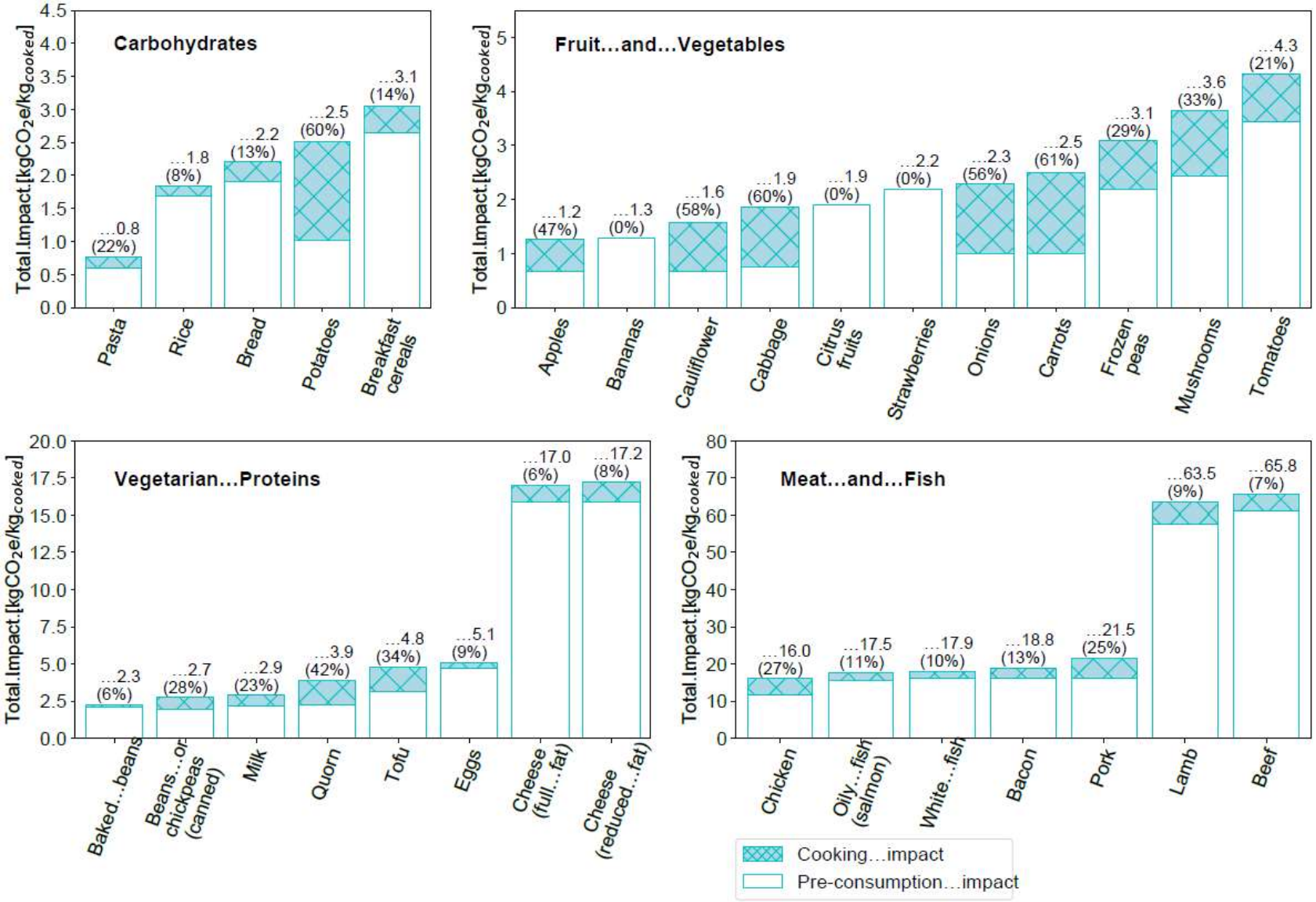
– the biggest difference we found was a ~25% **increase** in footprint

SHARP 0.95kg of Co2e (Broccoli is 30% of the footprint)

City 1.07kg of Co2e (Broccoli is 14% of the footprint)

Final thought - How we cook matters!

Up to 61% of GHGE impacts



BRIEF COMMUNICATION

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

Angelina Frankowska, Ximena Schmidt Rivera, Sarah Bridle, Alana Marielle Rodrigues, Galdino Kluczkovski, Jacqueline Tereza da Silva, Carla Adriano Martins, Fernanda Rauber, Renata Bertazzi Levy, Joanne Cook and Christian Reynolds

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Key take-away's

- We have a database for CO2e of ~200,000 commonly cooked recipes in the English language (web)
  - Information provided in grams of CO2e per **portion**, per **Kcal**, per g of **protein** and **carbon labels**
  - This database, and API can easily be used on menus, cookbooks etc.
- Recipes from different cuisines, dishes, health/diets, and protein sources all can **NOW** be cooked to meet the Kcal and Protein requirements set out by the EAT-Lancet.
- DASH, Vegan, and Vegetarian recipes had the lowest mean, median and IQR of any specific health/diet type.
- We need to think about how carbon/eco labels convey complexity when compared to specific diet requirements (e.g Eat-Lancet).
- Halving animal protein and fat and **double** the amount of fruits and vegetables – both strategies that can work

- This is all very much a work in progress, I would love to hear your thoughts and feedback.

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Aprifel – French Recipes

Looking at French Recipes and environmental impacts.

Scrape of the CuisineAZ website.

Selected 50 recipes to compare “by hand” calculation and using NLP tools.

- Beef (and other animal products) biggest impacts in recipes that use this (90% of carbon footprint)
- For some vegetarian recipes the biggest impacts are from Butter, Cheese or eggs (60%+ for one ingredients) (Butter can be less than 5% of weight but 60%+ of impacts)
- A recipe mostly composed by plant-based product, CO2 emissions of the ingredients are quite balanced (max 15% per ingredient)

How do we communicate this complexity with the French public, chefs etc?