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Comparison of Greenhouse Gas databases using FoodEx2 codes

Parallel thematic session: Resilience, vulnerability, human and planetary health

From: 28 June 2022, 15:10 to 16:25 BST British Summer Time

Christian Reynolds, Jacqueline Tereza da Silva, Josefa Maria Fellegger Garzillo, Angelina Frankowska, Alana Kluczkoński, Diego Rose, Berill Takacs, Victoria Padula de Quadros, Bridget Anna Holmes, Ximena Schmidt Rivera, Sarah Bridle

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Who am I?

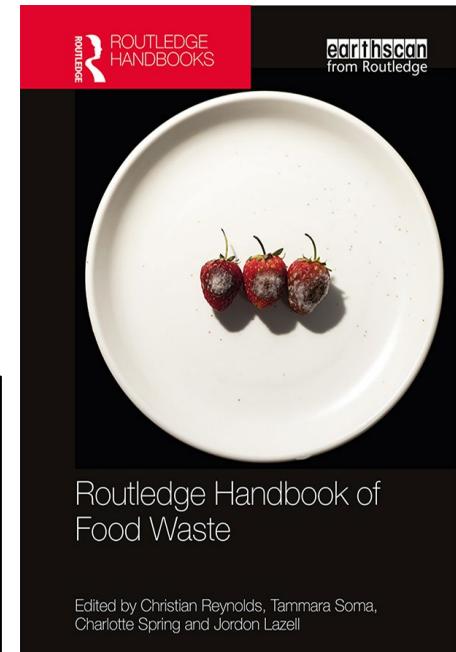
Senior Lecturer at the Centre for Food Policy



The University
Of Sheffield.
Institute for
Sustainable Food.



UK Data Service



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^e, 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 Reynolds¹, Graham W Horgan², Stephen Whybrow¹ and Jennie I Macdiarmid^{1,*}

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

Previously: Food waste politics/history, social sciences approaches

Shameless plug for FLW text book – if you want open access let me know ☺

Part of ongoing research...



PERSPECTIVE
published: 23 February 2021
doi: 10.3389/frai.2020.621577



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

Marieke van Erp^{1,†}, Christian Reynolds^{2,†}, Diana Maynard³, Alain Starke⁴, Rebeca Ibáñez Martín⁵, Frederic Andres⁶, Maria C. A. Leite⁷, Damien Alvarez de Toledo⁶, Ximena Schmidt Rivera⁸, Christoph Trattner⁴, Steven Brewer⁹, Carla Adriano Martins¹⁰, Alana Kluczkovski¹⁰, Angelina Frankowska¹⁰, Sarah Bridle¹⁰, Renata Bertazzi Levy¹¹, Fernanda Rauber¹¹, Jacqueline Tereza da Silva¹⁰ and Ulbe Bosma¹²

<https://doi.org/10.3389/frai.2020.621577>

A pilot method linking greenhouse gas emission databases to the FoodEx2 classification

C.J. Reynolds^{1*}, X. Schmidt Rivera², A. Frankowska¹⁰, A. Kluczkovski¹⁰, J. T. da Silva¹⁰, S. L. Bridle⁷, R. Levy¹¹, F. Rauber¹¹, V.P. Quadros¹, A. Balcerzak¹, R. F. Souza¹, M. Ferroni¹, C. Leckström², B. Koroušć-Seljak¹, Tomež Efimovs^{1,2}

Presenting author: cj.reynolds@efam.eu; 1 Institute and Food Systems Division, Food and Agricultural Organization of the United Nations, Rome, Italy; 2 Research Centre for Food and Nutrition, Council for Agricultural Research and Research, Rome, Italy; 3 Institute of Energy Policy, Brunel University London, London, United Kingdom; 4 Department of Geography, University of Sheffield, Sheffield, United Kingdom; 5 INRAE Research Institute, Montpellier, France; 6 School of Medicine, University of São Paulo, Brazil; 7 School of Physical Advertising, University of Manchester, Manchester, United Kingdom; 8 Computer Systems Department, InforSense Institute, Uppsala, Sweden; 9 Department of Biometrical Data Science and the Center for Population Health Sciences, Vanderbilt University, United States

Introduction
Information related to greenhouse gas emissions (GHGE) embodied in the production and consumption of multiple foods (including meat and dairy) have become more available in recent years, thanks to literature reviews and meta-analysis of life cycle assessment literature. However, there is limited matching of this information to dietary databases. This linkage is needed to investigate the climate change impacts of different dietary patterns, to formulate policies for helping to shift population's eating habits towards healthy and sustainable diets.

Linking a dietary database to GHGE is time consuming as well as effortful. These activities are typically not well documented which makes them hard to replicate. Furthermore, as each country has multiple dietary consumption and purchase surveys (which potentially are redesigned between each survey version), there is a potential for coding GHGE to global dietary databases resulting in months of labour. This is a major limitation to speeding up policy making promoting food sustainability, and making information related to global dietary sustainability widely available.

Many global dietary databases are already harmonized to be comparable using the FoodEx2 classification system (www.efsa.europa.eu/en/foodex2_en.html) maintained by EFSA. It is currently used at global level with the support of FAO and WHO. FoodEx2 consists of a vocabulary of foods with assigned codes structured in a hierarchical manner, allowing the classification and description of foods reported in different types of data (e.g., consumption or production method, composition etc.). The linkage of GHGE databases to individual FoodEx2 codes would allow rapid translation to any previously harmonized FoodEx2 food survey.

This poster reports the results of a pilot study that mapped aggregated GHGE databases (Poore J. and Nemecek 2018) to the FoodEx2 classification. An GHGE database of food products was mapped to the FoodEx2 classification system to generate aggregated GHGE values for each FoodEx2 code. These database differences in reported dietary GHGE are compared using different EU food consumption databases. The results suggest that this method allows us to provide rapid global GHGE related to diets comparing multiple GHGE data sources.

FoodEx2
EFSA has developed a standardized food classification and description system called FoodEx2 (version 2 of the EFSA Food classification and descriptive system for exposure assessment). FoodEx2 consists of detailed descriptions of individual food items (n=4000) categorized into food groups and broader food categories in a hierarchical manner. (the “tree” includes 27 “branches” – categories) – see <https://efsajournals.onlinelibrary.wiley.com/doi/10.2901/tp-afsa.2015.EN-004>

A screenshot of the FoodEx2 system showing the tree structure and a detailed description of one food item (apple). The screenshot also shows the “FoodEx2 browser” interface (www.efsa.europa.eu/en/foodex2_en.html). This screenshot shows the “FoodEx2 hierarchy structure with the 27 level 1 “branches” categories.

Mapping mapped aggregated GHGE databases to FoodEx2
We manually mapped the aggregated GHGE database (Poore J. and Nemecek 2018, DOI: 10.1126/science.aax0216, n=43 foods, GHG Emissions (kg CO₂eq/kg, IPCC 2007)) to cover the FoodEx2 classification (n=4000 foods). Matching was carried out at each level of the FoodEx2 hierarchy tree. This was then cross checked using the Standoff tool (DOI: 10.3390/nu9062542).

Results
The ranges of GHG Emissions (kg CO₂eq/kg, IPCC 2007) were mapped to the FoodEx2 codes. Figure below shows the range of possible GHGE values within each L1 hierarchy. Many of the FoodEx2 hierarchies and classifications did not have a direct match in Poore J. and Nemecek 2018. This includes L1 categories including ‘Composite dishes’, ‘Products for non-standard diets, food imitators and food supplements’, ‘Food products for young population’, and ‘Water and water-based beverages’.

Ranges of GHG Emissions (kg CO₂eq/kg, IPCC 2007) for all 4000 items mapped to L1 hierarchy of FoodEx2

Linking to EU food consumption databases
The FoodEx2 GHGE values were linked to the EU food consumption databases (Acute Food Consumption Grams (g) in a single day, National Diet and Nutrition Survey - Years 1-3 (2000), and Italian National Food Consumption Survey INAN-SCAI - Years 05-06 <http://www.eurostat.ec.europa.eu/portal/page/0037>). Below we compare the range of GHG Emissions for the Italian and UK adult diets.

A screenshot of the FoodEx2 system showing the tree structure and a detailed description of one food item (apple). The screenshot also shows the “FoodEx2 browser” interface (www.efsa.europa.eu/en/foodex2_en.html). This screenshot shows the “FoodEx2 hierarchy structure with the 27 level 1 “branches” categories.

Comparison adult day consumption of Italian and UK adult diets (apple, FoodEx2 consumption in kg/day linked to FoodEx2)

Acknowledgments
This research was funded through multiple research grants. These include the STFC GOF funded project “Food in greenhouse gas emissions from different foods using食譜” (ST/T000088/2012), this arose from the Food in Global Health project, “Nutrition and dietetic choices OpenSource Toolkit” (N4Food).

<http://dx.doi.org/10.13140/RG.2.2.15990.34889>

The problem: lack of comparable GHGE data

- Multiple Greenhouse Gas Emissions (GHGE) databases exist (Each describes the impacts of different agricultural production systems around the world).
- There is a growing need to capture the environmental impacts of dietary choices.
- Direct matching of GHGE databases to dietary databases is very time consuming.
- However, there are standards for comparing dietary databases – one of these is FoodEx2.

Can a harmonised dietary classification system be used to compare/allocate GHGE impacts to food categories?

In this presentation, we aim to assess the reliability of the linking a GHGE database to FoodEx2, by comparing it to similar databases.

What is FoodEx2?

- A comprehensive food classification and description system
- A common language
- Developed and maintained by EFSA

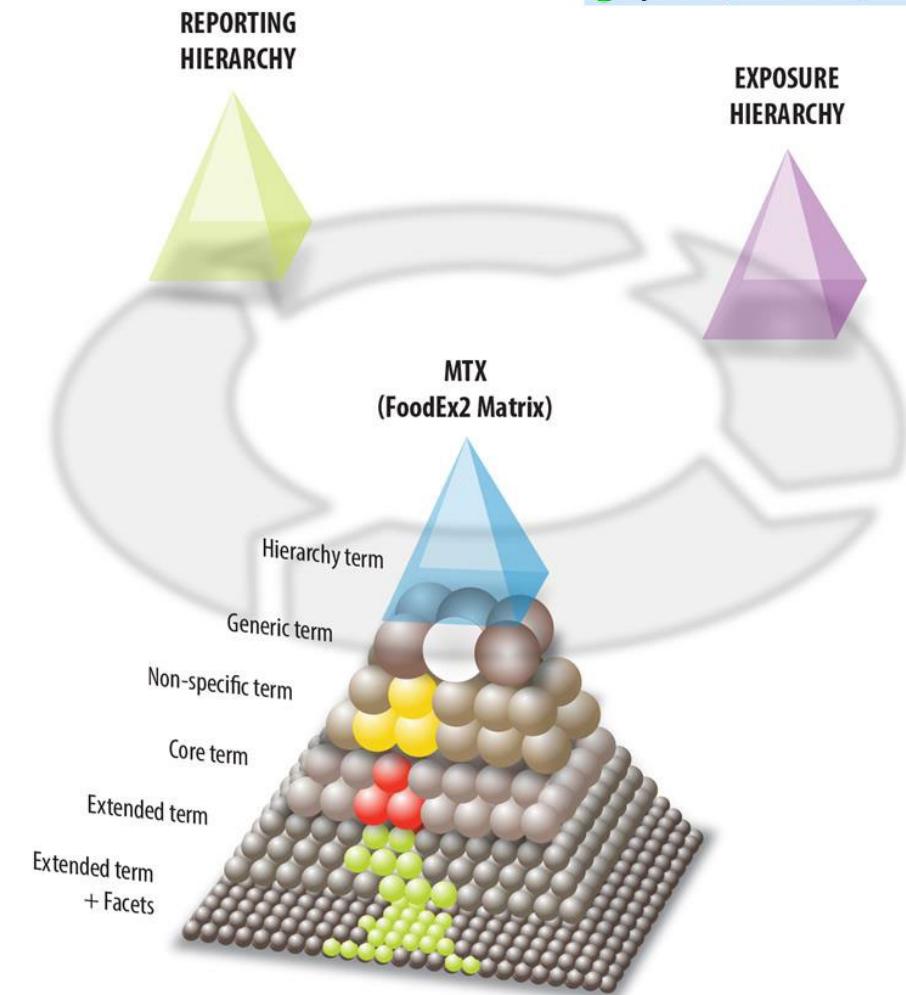
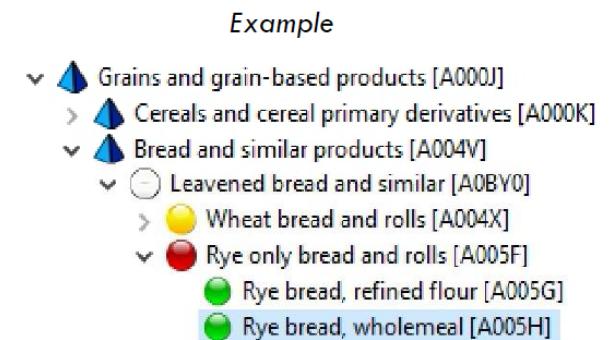
- Clearly defined
- Hierarchical structure
- A food fits in one group only
- For every food there is a group

21 Food groups in total for 4558 FoodEx2 codes

At least 56 food consumption databases have been coded with FoodEx2. see <https://www.globaldietarydatabase.org/>



FoodEx2
efsa



Example of FoodEx2 coding



Source: https://www.hapih.hr/wp-content/uploads/2019/11/loannidou_FoodEx-2-klasifikacija-hrane.pdf

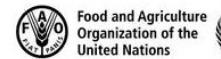
FoodEx2 is linked to many global dietary datasets

33 countries via FAO/WHO GIFT <https://www.fao.org/gift-individual-food-consumption/en/>

21 countries via The EFSA Comprehensive European Food Consumption Database <https://www.efsa.europa.eu/en/data-report/food-consumption-data#the-efsa-comprehensive-european-food-consumption-database>

407 data sets via <https://www.globaldietarydatabase.org/>

FAO/WHO GIFT | Global Individual Food consumption data Tool



A screenshot of the FAO/WHO GIFT website. At the top, there is a navigation bar with links for Home, Overview, Data and indicators, Inventory of surveys, Resources, and Methodology. Below the navigation bar is a large image of a meal in a blue bowl. To the right of the image, the text "FAO/WHO GIFT" is displayed in large white letters. At the bottom of the screenshot, there is a banner with the text "FAO/WHO GIFT: Better data, better policies, better diets" and "Providing tailored answers for health, nutrition and agriculture policies.".

FoodEx2 offers an opportunity to link many datasets to environmental impacts in a quick and comparable manner.

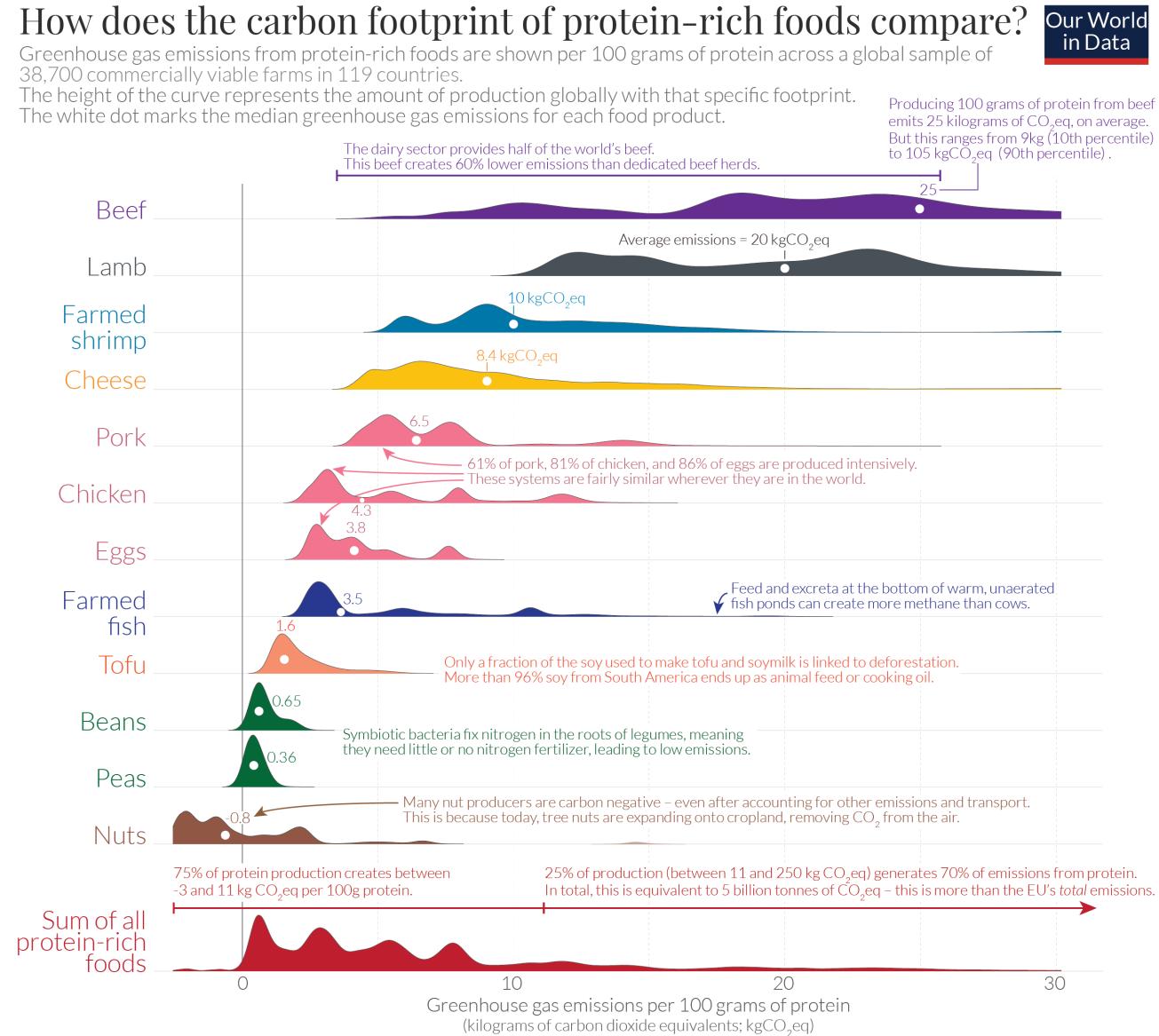


The advantage of Poore and Nemecek (2018)

The Poore and Nemecek (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: Data refers to the greenhouse gas emissions of food products across a global sample of 38,700 commercially viable farms in 119 countries. Emissions are measured across the full supply-chain, from land use change through to the retailer and includes on-farm, processing, transport, packaging and retail emissions.

Data source: Joseph Poore and Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. *Science*.

OurWorldInData.org – Research and data to make progress against the world's largest problems. Licensed under CC-BY by the authors Joseph Poore & Hannah Ritchie.

Matching P&N (2018) to FoodEx2

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
A000J	Grains and grain-based products	1	Potatoes
A000K	Cereals and cereal primary derivatives	2	Potato boiled
A000L	Cereal grains (and cereal-like grains)	3	Potato baked
A001X	Mixture of grains	4	Main-crop potatoes
A0D9Y	Barley and similar-	4	New potatoes
A000P	Barley grains	5	Andigena
A002K	Barley grain, pearled	6	Tropical root and tuber vegetables
			Cassava
			Cassava roots
			4 Potatoes
			5 Potatoes
			4 Potatoes
			3 Cassava
			4 Cassava
			5 Cassava

GHGE Databases matched to FoodEx2

Reducing food's environmental impacts through producers and consumers

J. POORE  AND T. NEMECEK 

SCIENCE • 1 Jun 2018 • Vol 360, Issue 6392 • pp. 987-992 • DOI: 10.1126/science.aaq0216

<https://doi.org/10.1126/science.aaq0216>

Data Article

SHARP-Indicators Database towards a public database for environmental sustainability

Elly Mertens , Gerdine Kaptijn , Anneleen Kuijsten , Hannah van Zanten , Johanna M. Geleijnse , Pieter van 't Veer 

<https://doi.org/10.1016/j.dib.2019.104617>

Carbon footprint of self-selected US diets: nutritional, demographic, and behavioral correlates



Donald Rose , Martin C Heller, Amelia M Willits-Smith, Robert J Meyer

The American Journal of Clinical Nutrition, Volume 109, Issue 3, March 2019, Pages 526–534, <https://doi.org/10.1093/ajcn/nqy327>

<https://doi.org/10.1093/ajcn/nqy327>

Footprints of foods and culinary preparations consumed in Brazil
Josefa Maria Fellegger Garzillo, Priscila Pereira Machado, Maria Laura da Costa Louzada, Renata Bertazzi Levy, Carlos Augusto Monteiro,
<https://doi.org/10.11606/9788588848405>

“City”

43 food categories matched to 4558 FoodEx2 code
matched by authors

“SHARP”

945 food categories matched to FoodEx2

“Rose/Heller”

608 food categories

357 categories linked to FICD to National Health and Nutrition Examination Survey (NHANES), this resulted in 608 linked to FoodEx2 (using Global Dietary Database concordance).

“Garzillo”

329 food categories

linked to the Brazilian Food Consumption Survey which was matched to FoodEx2

(All databases normalised to kg of Co2e per 100g)

Correlations

Database	n	Spearman correlation	p-value
Sharp	945	0.699	< 0.001
Rose/Heller	608	0.572	< 0.001
Garzillo	329	0.610	< 0.001

Table 1. Correlation between “City” database to other databases

Visualisation of matches

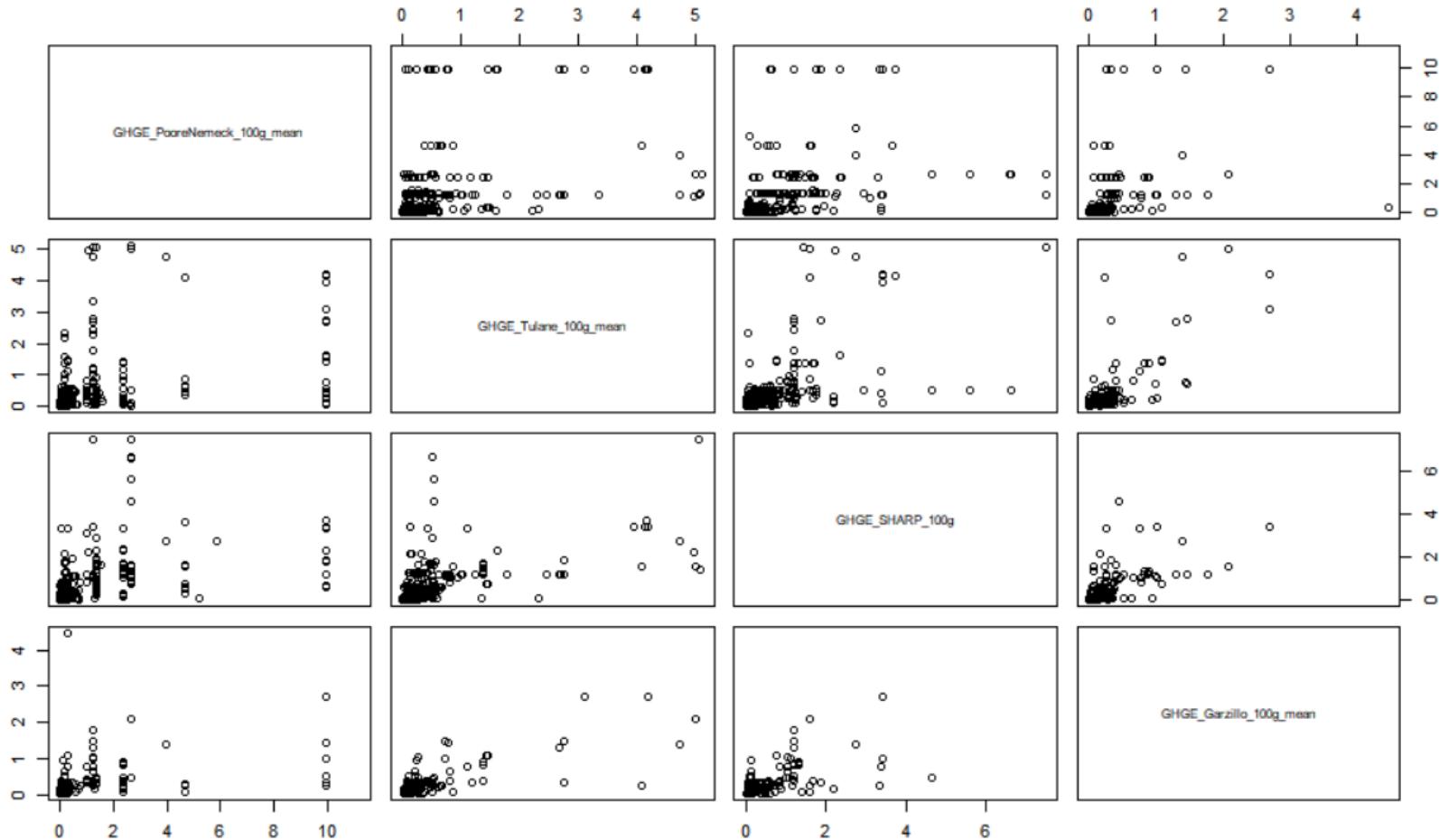


Figure 1. Scatterplot displaying the relationship between GHGE from multiples sources (Reynolds/Takacs, Rose/Heller, Sharp, Garzillo)

Differences in “City” and SHARP

Of the 945 food items with GHGE in “City” and SHARP, 50% (n = 476) were ranked in the same quintile. The kappa statistics was 0.536 (p < 0.001).

Of the 469 food items not ranked into the same quintiles,

44% (n=206) were within p5 and p95 confidence interval values of City

31% (n=144) were lower than the p5 confidence interval values of City

25% (n= 119) were higher than p95 confidence interval values of City.

The food items with the biggest differences between mean values for “City” and SHARP are wheat and rye; fish and seafood; pig meat; fruits; nuts and pulses.

These food items will be further investigated in the next update of the data, aiming to increase reliability to estimate GHGE from food consumption.

So what does this mean practically?



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Beef bourguignon

By Barney Desmazery

★★★★★ 62 ratings Rate 47 comments

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L Prep: 45 mins Easy Serves 6
Cook: 3 hrs and 30 mins
Plus overnight marinating

The secret to this rich beef casserole is to use all wine and no stock. Our ultimate beef bourguignon recipe is an instant comforting classic, full of satisfying flavours.



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Bangers and mash with onion gravy

By Barney Desmazery

★★★★★ 17 ratings Rate 7 comments

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L Prep: 20 mins More effort Cook: 50 mins Serves 4

Make sausages and mash with love and you're in for a real treat. We've perfected this recipe to make it the very best it can be



Nutrition: Per serving

SHARP 62.76kg of Co2e (Beef is 87% of the footprint)
City 166.58kg of Co2e (Beef is 95% of the footprint)

(Sausages is 62% of the footprint)
(Sausages is 77% of the footprint)



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Broccoli salad

By Liberty Mendez

★★★★★ 17 ratings Rate 5 comments

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L Prep: 10 mins Easy Serves 2
Cook: 3 mins plus cooling

Enjoy this crunchy, vegan broccoli salad for lunch or as a side. It's sweet, sharp and full of different textures and colours

SHARP 0.95kg of Co2e (Broccoli is 30% of the footprint)
City 1.07kg of Co2e (Broccoli is 14% of the footprint)



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Classic Victoria sandwich recipe

By Barney Desmazery

★★★★★ 995 ratings Rate 852 comments

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L Prep: 40 mins Easy Cuts into 10 slices
Cook: 20 mins plus cooling

The perfect party cake, a Victoria sponge is a traditional bake everyone will love.
Makes an easy wedding cake, too

SHARP 11.34kg of Co2e (Butter is 88% of the footprint)
City 3.77kg of Co2e (Butter is 24% of the footprint)

Many thanks to all the co-authors

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<https://www.city.ac.uk/prospective-students/courses/postgraduate/food-policy>

Parallel thematic session: Resilience, vulnerability, human and planetary health

From: 28 June 2022, 15:10 to 16:25 BST British Summer Time

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