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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 Kluczkovski, 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



STFC
Food
Network+



The University
Of Sheffield.
Institute for
Sustainable Food.



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

Contents lists available at ScienceDirect

Food Policy

ELSEVIER 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 Quedsted^b, Sarah Bromley^b, Sam Gillick^b, Victoria K. Wells^d, David Evans^e, Lenny Koh^f, Annika Carlsson Kanyama^g, Cecilia Katzeff^h, Åsa Svenfeltⁱ, Peter Jackson^h

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...



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^{2†}, X. Schmidt Rivera⁸, A. Frankowska¹⁰, A. Kluczkovski¹⁰, J. T. do Silva¹⁰, S. L. Bridle¹⁰, R. Levy¹¹, F. Rauber¹¹, V. P. Quadros¹¹, A. Balcarzak¹⁰, R. F. Souza¹⁰, M. Ferraro¹⁰, C. Leclercq¹⁰, B. Koroušić Seljak⁸, Toma Eftimov¹⁰*

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.

Results
The ranges of GHGE Emissions (kg CO₂e/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 FoodEx1 and Nemecek 2018. This includes L1 categories including 'Composite dishes', 'Products for non-standard diets, food initiatives and food supplements', 'Food products for young population', and 'Water and water-based beverages'.

Linking to EU food consumption databases
The FoodEx2 GHGE values were linked to the EU food consumption databases (Acute Food Consumption Grains [g] in a single day, National Diet and Nutrition Survey - Years 1-3 (2009), and Italian National Food Consumption Survey (INRAN-CAI) 2005-2006). <https://www.euro.who.int/en/communities/topics/food-ex-2>. Below we compare the range of GHGE Emissions for Italian and UK adult diets.

FoodEx2
EFSA has developed a standardised food classification and description system called FoodEx2 (version 2 of the EFSA Food classification and description system for exposure assessment). FoodEx2 consists of descriptions of a large number of individual food items (4400) aggregated into food groups and broader food categories in a hierarchical parent-child relationship (this includes 27 major categories) - see <http://www.onlinelibrary.wiley.com/doi/10.1002/foa.2015.25.1-2015>.

Mapping mapped aggregated GHGE databases to FoodEx2
We manually mapped the aggregated GHGE database (Foome 1 and Nemecek 2018, DOI: 10.1136/ebpub.2018.000116, n=13 foods, GHGE Emissions (kg CO₂e/kg, IPCC 2007) to cover the FoodEx2 classification (n=4400 foods). Matching was carried out at each level of the FoodEx2 hierarchy tree. This was then cross checked using the StandFood tool (DOI: 10.3389/frai.2020.621577).

Acknowledgments
This research was funded through multiple research grants. These include the UKRI GCRF funded project 'Trends in greenhouse gas emissions from Brazilian foods using life cycle assessment (LCA)', the award from the NE Agrifood funded projects 'Greenhouse Gas and Dietary Choices Open-source Toolkit (GGDOT) toolmaker'.

Logos: creaa, NUPENS USP, MANCHESTER, GGDOT, Department of Biomedical Data Science, The University of Manchester, N8 AgriFood, Brunel University.

<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

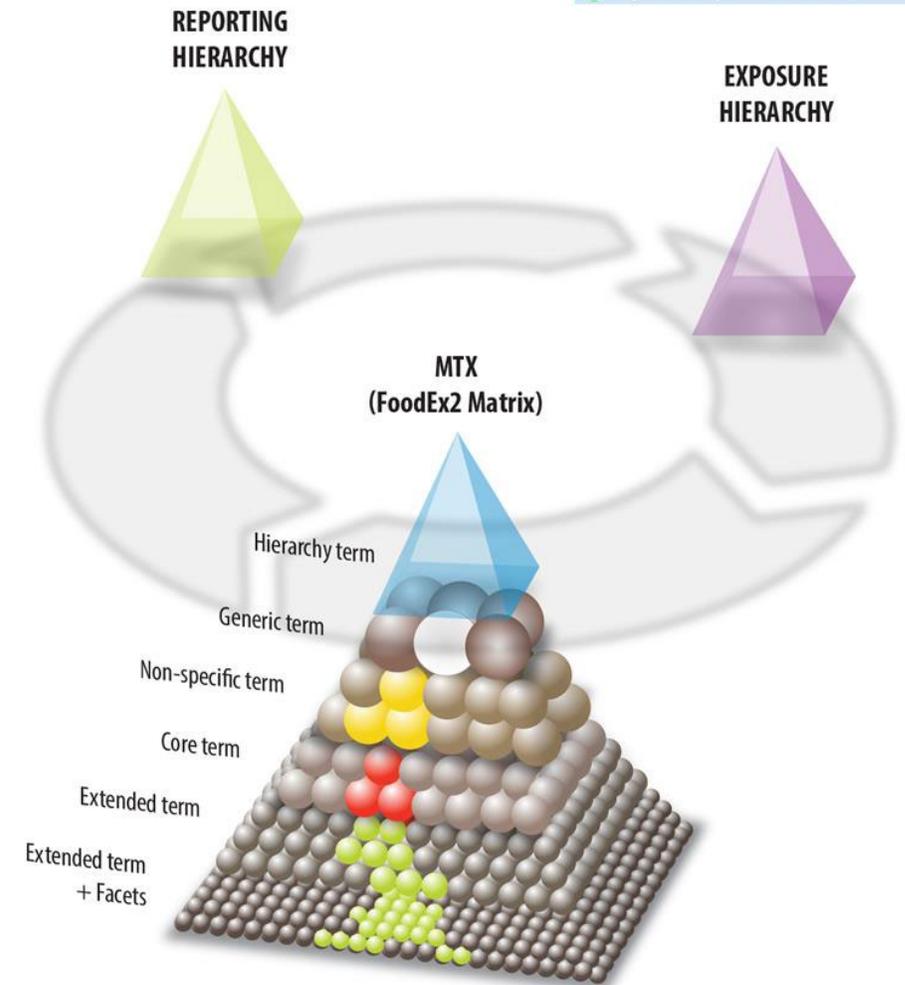
At least 56 food consumption databases have been coded with FoodEx2. see <https://www.globaldietarydatabase.org/>



FoodEx2
efsa

Example

- ▼ ▲ Grains and grain-based products [A000J]
 - > ▲ Cereals and cereal primary derivatives [A000K]
 - ▼ ▲ Bread and similar products [A004V]
 - ▼ ○ Leavened bread and similar [A0BY0]
 - > ● Wheat bread and rolls [A004X]
 - ▼ ● Rye only bread and rolls [A005F]
 - Rye bread, refined flour [A005G]
 - Rye bread, wholemeal [A005H]



Example of FoodEx2 coding

Organic yoghurt, cow milk, semi skimmed, with cereals and raspberries

Facets

● Corn flakes: **A00DD**
(Processed maize-based flakes)

● Raspberries: **A01EP**
(Raspberries (red and yellow))

● Instant oats: **A00DJ**
(Oat rolled grains, instant)

● **FoodEx2 core term** Yoghurt, cow milk, flavoured: **A02NH**
(Yoghurt, cow milk, flavoured)

Organic production: **A07SE**
(Organic production)

Fat related qualitative information: **A077G**
(Semi-skimmed)

In a cup: **A07NT** (Cup/pot)
Made from glass: **A07PF** (Glass)

FoodEx2 code string : **A02NH#F04.A00DD\$F04.A00DJ\$F04.A01EP\$F10.A077G\$F21.A07SE\$F18.A07NT\$F19.A07PF**

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/>

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

FAO/WHO GIFT | Global Individual Food consumption data Tool



Food and Agriculture Organization of the United Nations



World Health Organization



Global Dietary
D A T A B A S E

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

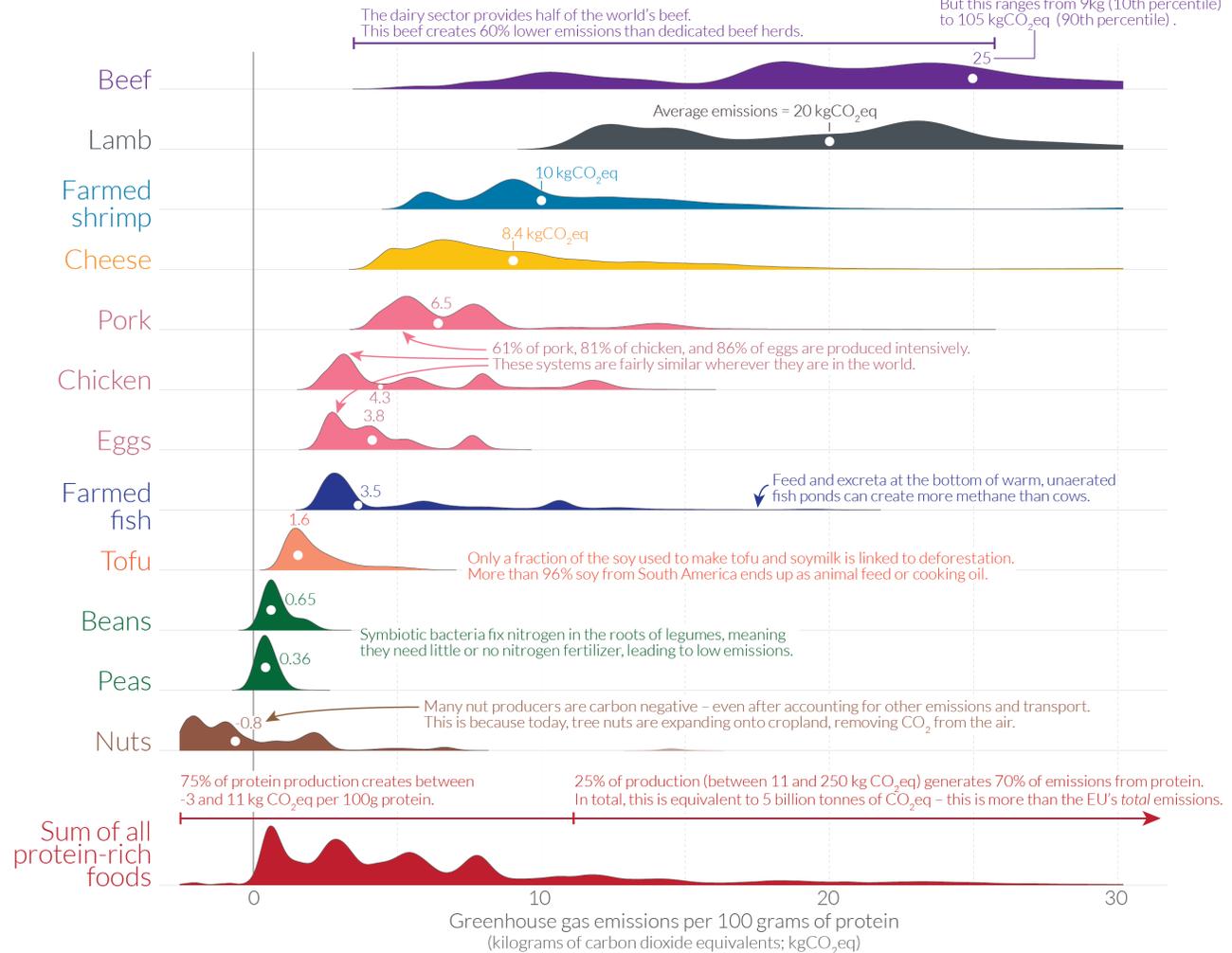
How does the carbon footprint of protein-rich foods compare?

Our World in Data

Greenhouse gas emissions from protein-rich foods are shown per 100 grams of protein across a global sample of 38,700 commercially viable farms in 119 countries.

The height of the curve represents the amount of production globally with that specific footprint. The white dot marks the median greenhouse gas emissions for each food product.

Producing 100 grams of protein from beef emits 25 kilograms of CO₂eq, on average. But this ranges from 9kg (10th percentile) to 105 kgCO₂eq (90th percentile).



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
A000P	Potatoes and similar-	3	Potatoes
A002T	Potatoes	4	Potatoes
A011P	Potato boiled	5	Potatoes
A011R	Potato baked	5	Potatoes
A002X	Main-crop potatoes	5	Potatoes
A002V	New potatoes	5	Potatoes
A0DPM	Andigena	4	Potatoes
A002Y	Tropical root and tuber vegetables	3	Cassava
A04JX	Cassava roots and similar-	4	Cassava
A002Z	Cassava roots	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.aag0216

<https://doi.org/10.1126/science.aag0216>

Data Article

SHARP-Indicators Database towards a public database for environmental sustainability

Elly Mertens ^{a, 2} , Gerdine Kaptijn ^a, Anneleen Kuijsten ^{a, b}, Hannah van Zanten ^c, Johanna M. Geleijnse ^{a, b}, Pieter van 't Veer ^{a, b} 

<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

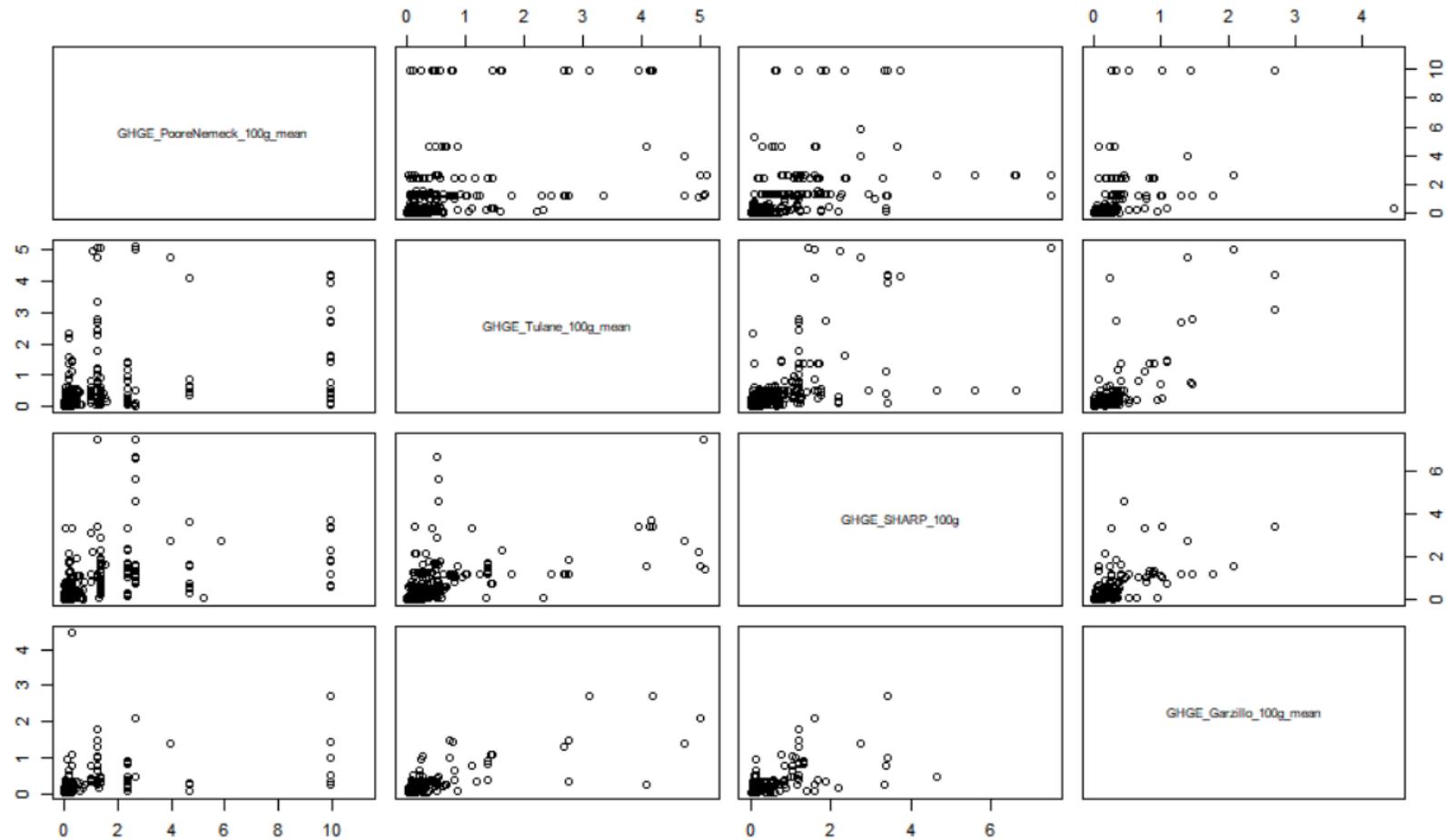


Figure 1. Scatterplot displaying the relationship between GHGE from multiples sources (Reynolds/Takacs, Rose/Heller, Sharp, Garzillo)

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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Ingredient, dish, keyword... 

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Beef bourguignon
By [Barney Desmazery](#)
★★★★★ 62 ratings [Rate](#) [47 comments](#)
[Magazine subscription – your first 5 issues for only £5!](#)
⌚ 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.

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

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Ingredient, dish, keyword... 

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Bangers and mash with onion gravy
By [Barney Desmazery](#)
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⌚ Prep: 20 mins ⚙️ More effort 🍴 Serves 4
⌚ Cook: 50 mins
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 8.77kg of Co2e (Sausages is 62% of the footprint)
City 7.11kg of Co2e (Sausages is 77% of the footprint)

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Ingredient, dish, keyword... 

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Broccoli salad
By [Liberty Mendez](#)
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[Magazine subscription – your first 5 issues for only £5!](#)
⌚ 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

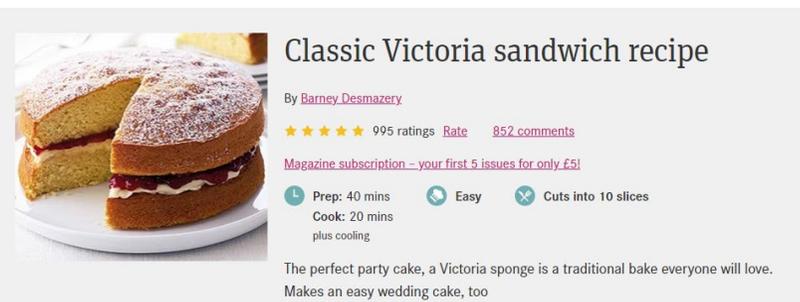
SHARP 0.95kg of Co2e (Broccoli is 30% of the footprint)
City 1.07kg of Co2e (Broccoli is 14% of the footprint)

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Ingredient, dish, keyword... 

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Home > Recipes > Classic Victoria sandwich recipe



Classic Victoria sandwich recipe
By [Barney Desmazery](#)
★★★★★ 995 ratings [Rate](#) [852 comments](#)
[Magazine subscription – your first 5 issues for only £5!](#)
⌚ 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

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

