



City Research Online

City St George's, University of London

Citation: Reynolds, C. (2024). Mapping Food Waste Solutions. Paper presented at the Love Food Hate Waste webinar, 16 Jan 2024, Online.

This is the presentation version of the paper.

This version of the publication may differ from the final published version. To cite this item please consult the publisher's version.

Permanent repository link: <https://openaccess.city.ac.uk/id/eprint/32828/>

Copyright and Reuse: Copyright and Moral Rights remain with the author(s) and/or copyright holders. Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge, unless otherwise indicated, provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way. For full details of reuse please refer to [City Research Online policy](#).



Mapping Food Waste Solutions

**Centre for
Food Policy**

Shaping an effective food system

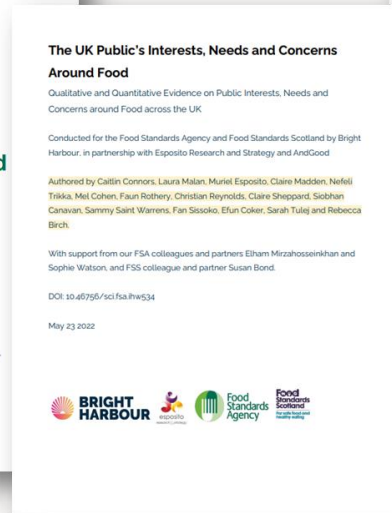
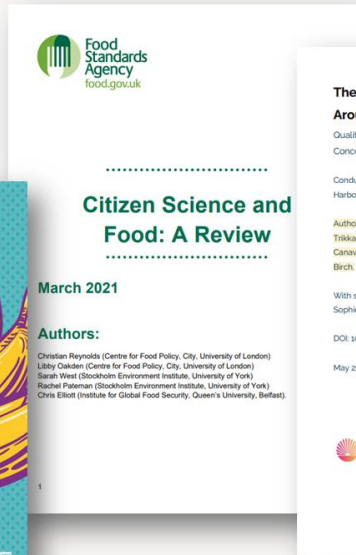
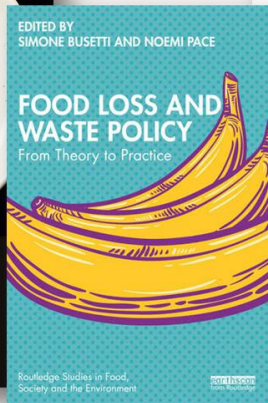
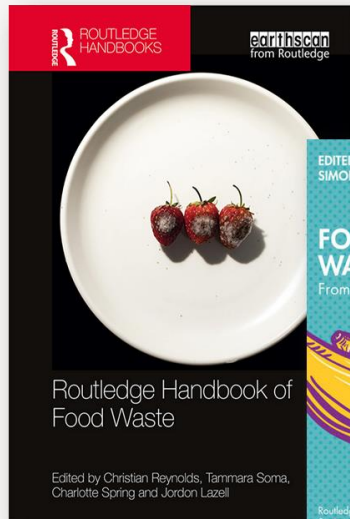
Love Food Hate Waste webinar Tue 16/01/2024 06:00 - 07:15am (UK)

Dr Christian Reynolds
Centre for Food Policy,
City, University of London
[@sartorialfoodie](#) [@FoodPolicyCity](#)
christian.reynolds@city.ac.uk

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



Shout out my other research: The Household simulation model

<https://blogs.city.ac.uk/householdfoodsimulation/>

HOUSEHOLD FOOD SIMULATION

The Household Simulation Model: A decision making tool for building more sustainable food systems.



FOOD AND PACKAGING TRADE-OFFS

RESEARCH ON NEW PACKAGING SYSTEMS
REUSABILITY AND REFILLABILITY



PACK SIZE

ALIGNMENT WITH CONSUMPTION NEEDS
PACKAGING LIGHTWEIGHTING



SHELF-LIFE EXTENSION

PACKAGING TECHNOLOGIES EXTENDING SHELF LIFE OF
PRODUCTS



STORAGE PRACTICES

EDUCATE CONSUMERS ABOUT THE BENEFITS OF MAXIMISING
PRODUCT SHELF LIFE THROUGH APPROPRIATE STORAGE
PRACTICES



COMBINATION OF INTERVENTIONS

SINGLE INTERVENTIONS MAY HAVE LIMITED IMPACTS



Today is a work in progress and part of wider research on FLW policy solutions.

- All input warmly received. (Feedback, questions, your thoughts.)
- Who should I be talking to?

Dr Christian Reynolds
Centre for Food Policy, City, University of London
@sartorialfoodie @FoodPolicyCity
christian.reynolds@city.ac.uk

In 2019 I presented this... and published this...



N8 AgriFood

What can local authorities do to reduce food waste?
What can we learn from ten years of food waste interventions.

Public Policy Exchange, London, 13 February 2019

Dr Christian Reynolds
Knowledge Exchange Research Fellow (N8 AgriFood project)
Department of Geography, University of Sheffield
[@sartorialfoodie](#)



N8



HEALTHY EDUCATION FOR THE FUTURE



SheFF
The University of Sheffield
Sustainable Food Futures



Food Policy
Volume 83, February 2019, Pages 7-27



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](#)^h, [Peter Jackson](#)^a

Show more ▾

+ Add to Mendeley  Share  Cite

<https://doi.org/10.1016/j.foodpol.2019.01.009> [Get rights and content](#) ▸

A Local Authority representative in the audience asked
"So what can we do to reduce food waste if we follow WRAP guidance already..."
For five years, I have been trying to answer!
So what do we know in 2024?

We know that FLW is a climate issue.

- Responses to FLW need to think about climate change

6% of global greenhouse gas emissions come from food losses and waste

Our World in Data

Emissions from food that is never eaten accounts for 6% of total emissions



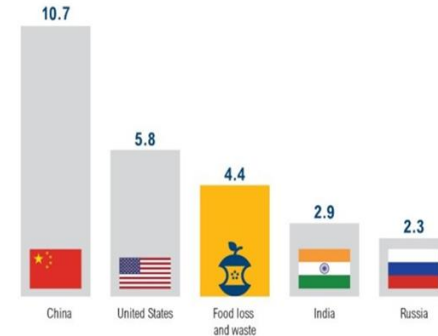
Note: One-quarter of food emissions comes from food that is never eaten: 15% of food emissions from food lost in supply chains; and 9% from consumer waste.

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

[OurWorldinData.org](https://ourworldindata.org) - Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Hannah Ritchie.

If Food Loss and Waste Were its own Country, it Would Be the Third-Largest Greenhouse Gas Emitter



GT CO₂e (2011/12)*

* Figures reflect all six anthropogenic greenhouse gas emissions, including those from land use, land-use change, and forestry (LULUCF). Country data is for 2012 while the food loss and waste data is for 2011 (the most recent data available). To avoid double counting, the food loss and waste emissions figure should not be added to the country figures.

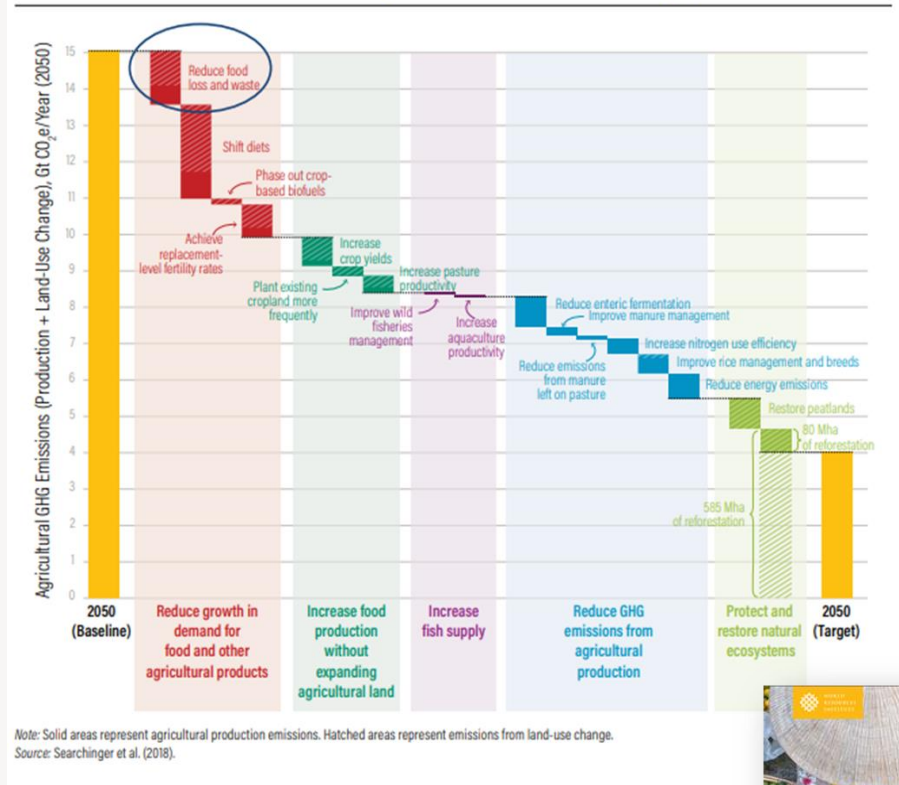
Source: CAIT, 2015; FAO, 2016. Food waste footprint & climate change. Rome: FAO.



FLW reduction is one of the biggest actions we can take to reduce global GHGE

- 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

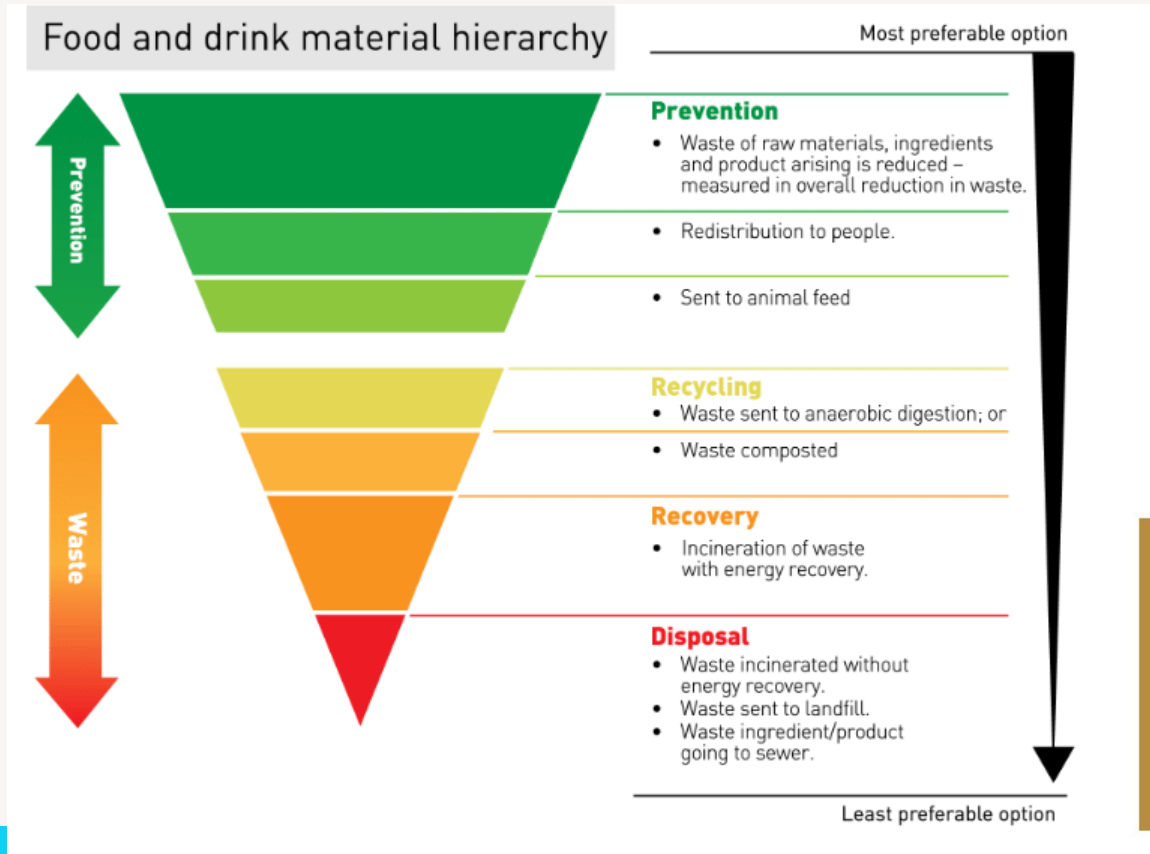
Figure I.2 | Reducing Food Loss and Waste Can Play an Important Role in Eliminating the Projected 15 Gt of Greenhouse Gas Emissions from Agriculture and Land-Use in 2050 (CO₂ equivalent)



Many reasons / drivers for FLW

Primary Production	Processing and Manufacturing	Distribution and Wholesale	Retail	Food Service/ Institutions	Household
Spillage	Spillage	Cosmetic or physical damage	Product recall	Product recall	Product recall
Cosmetic or physical damage	Trimming during processing	Spoilage	Food prepared improperly	Food prepared improperly	Food prepared improperly
Damage from pests or animals	Rejected from market	Past sell-by date	Food cooked but not eaten	Food cooked but not eaten	Food cooked but not eaten
Not harvested		Rejected from market	Cosmetic damage	Cosmetic damage	Cosmetic Damage
Unable to sell due to quantity or size		Unable to reach market	Spoilage	Spoilage	Spoilage
Unable to reach market			Past sell-by date		Past sell-by or use-by date

Food loss and waste solutions are within a hierarchy



All interventions and policy solutions prevent, divert (recover or recycle), or reduce food loss and waste.

We need a combination of solutions to achieve Sustainable Development Goal 12.3.

TARGET 12-3

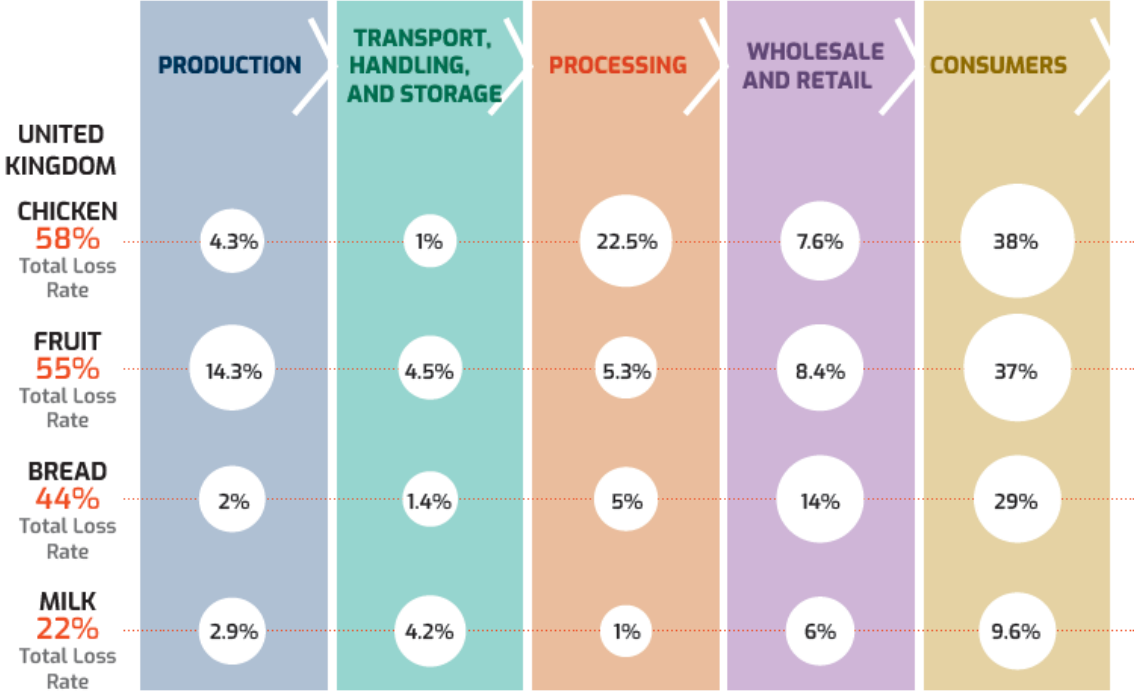
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

50%

HALVE GLOBAL PER CAPITA FOOD WASTE

Action needed at different points in the supply chain, for diff. products/countries...

FIGURE 14: Rates of loss and waste at each stage of the supply chain – UK, Rwanda, Vietnam



Many Actors needed to reduce FLW

Figure 4.2 | Key Actors for Reducing Food Loss and Waste (Not Exhaustive)



2019 - Review: Consumption-stage food waste reduction interventions

- 17 applied interventions that claim to have achieved food waste reductions.
- 13 quantified food waste reductions.
 - Plate size interventions resulted in up to **57%** food waste reduction.
 - Changing nutritional guidelines in schools reduced vegetable waste by up to **28%**.
 - Information campaigns had up to **28%** food waste reduction.
- Lots of gaps and missing data.



A growing reviewed evidence base.

- Zhang et al 2023 <https://doi.org/10.1016/j.foodpol.2023.102480>
 - Overall effect of nudges on food waste reduction is a 0.38 SD
 - Effectiveness of nudges can be reinforced when applied in public (vs. private) settings
- Casonato et al 2023 <https://doi.org/10.1016/j.spc.2023.08.002> ,
 - Nudges rated as ++ effective,
 - School education programmes ++ effective
 - Food management skills ++ effective
 - Training + effective
 - Site based posters and awareness campaigns + effective
 - National food waste campaigns +/- effective
- Tian et al 2022 <https://doi.org/10.1088/1748-9326/ac72b6>
 - Behavioural interventions have a moderate effect ($\beta = 0.22$) on food waste reduction,
 - Education programs having the most significant impact
 - Informational feedback having the least.
- Stöckli et al. 2018 <https://doi.org/10.1016/j.resconrec.2018.03.029>
 - Informational interventions: the most commonly used intervention type BUT evidence indicates that this intervention type is relatively ineffective,
 - A lack of evidence of the effectiveness of anti-consumer-food-waste interventions.



Van Herpen et al 2023

- *Reducing food waste by simply measuring it: insights from interventions to reduce household food waste* <https://doi.org/10.1108/BFJ-02-2023-0092>
 - Interventions on cooking planning and purchasing planning
 - 166 days data period. Results show that the interventions did not significantly reduce food waste, but **measuring food waste alone resulted in a decrease over time.**
- *Convenient tools and social norms: Measuring the effectiveness of an intervention to reduce household food waste* <https://doi.org/10.1016/j.jclepro.2023.139604>
 - A **tool kit for food management (measuring cup, stickers, etc)** diminished food waste. **Decreases self-reported food waste by 39.2%** (e1) and 23.0% (e 2)
 - Effects on waste-preventing behaviours were stronger w/ added social norm messages.
 - In this study, effects of using self-reported food measurement appeared minimal.
- *Does Cash Really Mean Trash? An Empirical Investigation into the Effect of Retailer Price Promotions on Household Food Waste* <https://doi.org/10.1093/jcr/ucad018>
 - **Retailer price promotions (eg “buy one, get one”)** do not cause food waste
 - Households that take advantage of multi-unit deals waste less food (self selection)
 - Promotion-induced overbuying leads to concerns about food waste

Many types of FLW Solution



	Waste reduction potential	Savings per tonne of waste reduced		
		Climate	Water	Costs
Products, processing and food waste solutions				
Animal feed from insects	■	●	●	●
Processed food waste to chicken feed	■	●	●	●
Dairy waste to animal feed	■	●	●	●
Processing technology to improve shelf life	■	◆	■	◆
Standardised date labelling	◆	■	■	■
Better information for longer shelf life	◆	■	■	■
Fibre products from food waste	◆	●	◆	●
New food products from processing waste	●	●	●	●
Nutrient extraction from processing waste	●	●	●	●
Packaging size and design adjustments	●	■	■	■
Relax produce specifications at retail	●	●	●	◆
Efficient business operations and supply chain solutions				
Waste tracking and analytics	■	◆	■	■
Improved cold chain management	■	◆	◆	■
Whole crop purchase contracts	◆	●	●	●
Centralised and 'dark' commercial kitchens	◆	◆	■	■
Manufacturing line optimisation	●	●	●	●

	Waste reduction potential	Savings per tonne of waste reduced		
		Climate	Water	Costs
Education and behaviour change solutions				
Household behaviour change programs	■	■	■	■
Hospitality and food service solutions	◆	■	■	■
Waste audits at hospitality and institutions	◆	■	■	■
Food rescue, recovery and redistribution solutions				
Business-to-consumer platforms	■	◆	■	■
Increase food rescue across supply chain	■	◆	■	◆
Secondary resellers	◆	◆	●	◆
Legislating food rescue at retail	◆	■	●	■
Sustainable catering guidelines and procurement	●	■	■	■
Online platform for surplus products	●	◆	●	◆

■ High impact ◆ Medium impact ● Low impact



The Path to Half (Victoria, Au) 25 Solutions

ReFED (USA) 73 Solutions

Australian food waste strategy 41 Solutions

Recommendations for Action in Food Waste Prevention (EU Platform on Food Losses and Food Waste) 47 Solutions



Welsh FW Route map 13 Solution

Figure 4: Estimated savings in 2030 by intervention

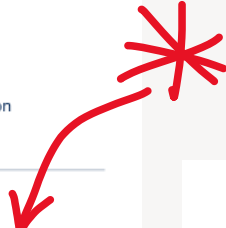
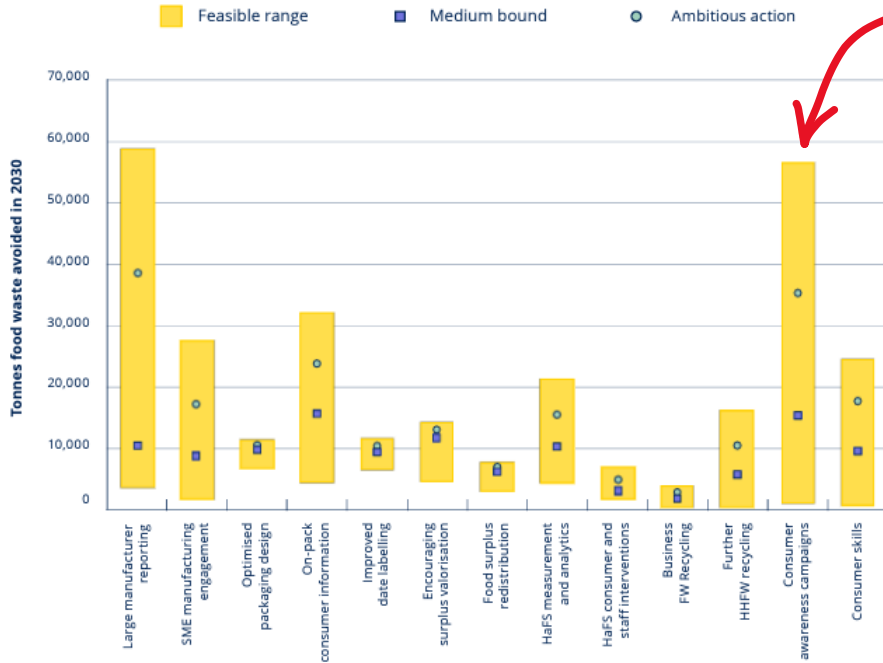
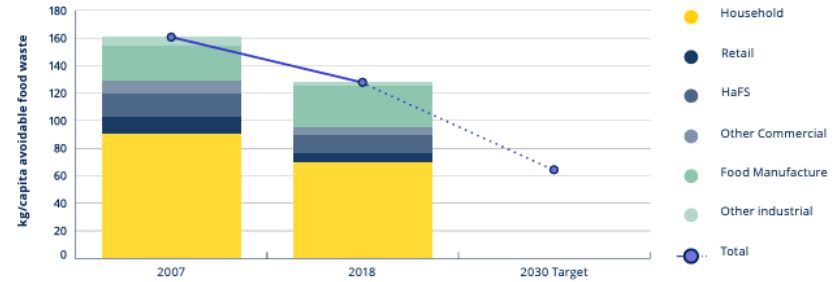


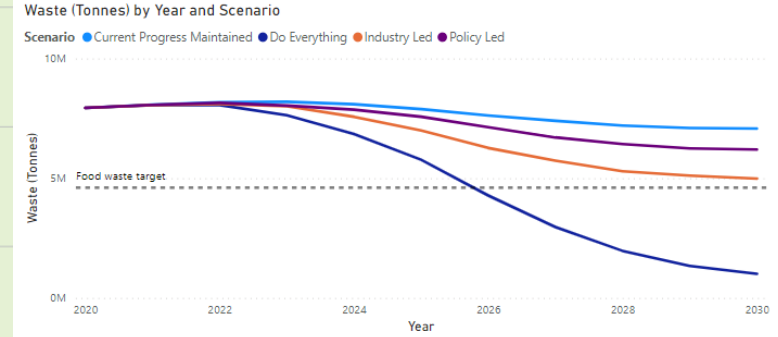
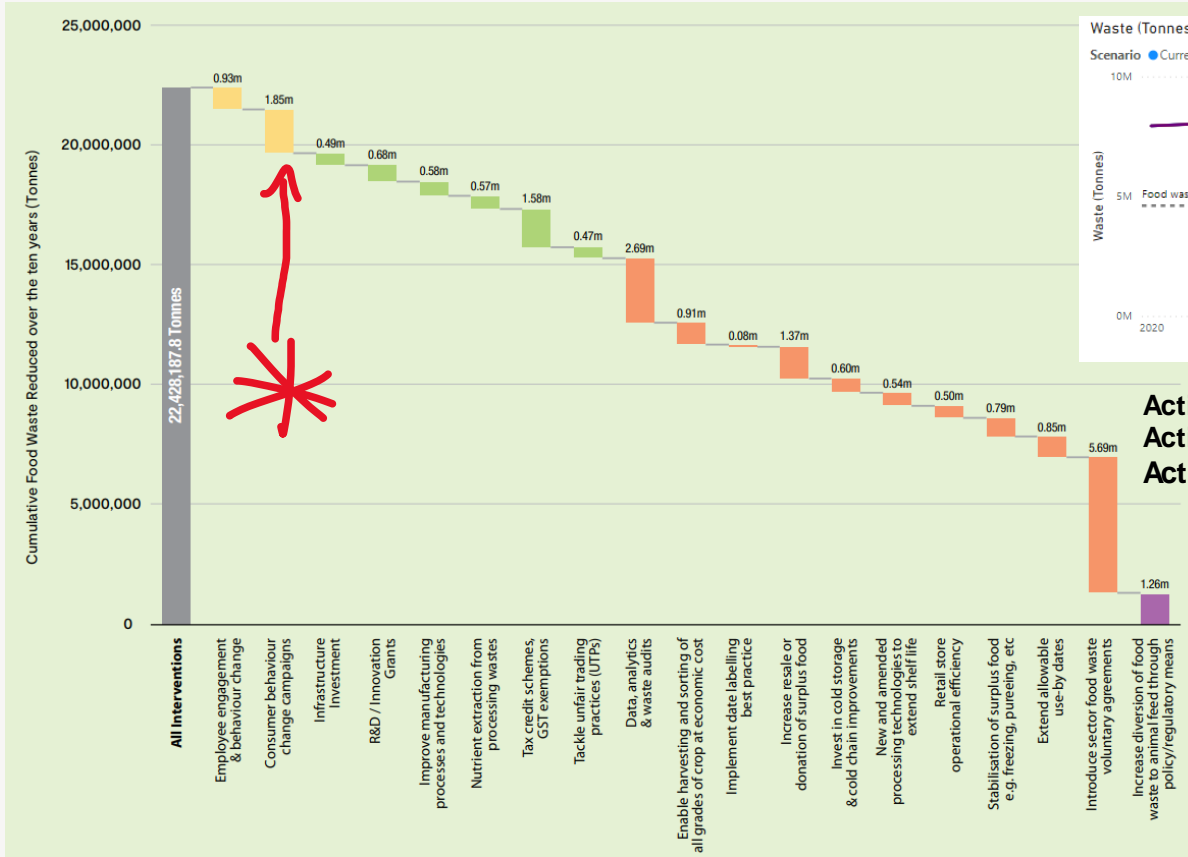
Figure 1: Progress to food waste target



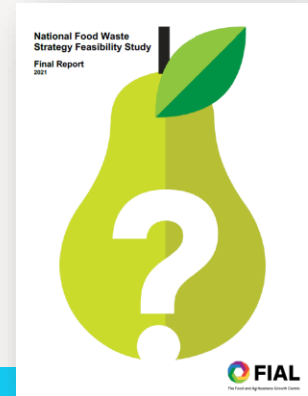
Actions impact on different parts of the food system
 Actions reduce different amounts of waste
 Actions happen over different periods of time



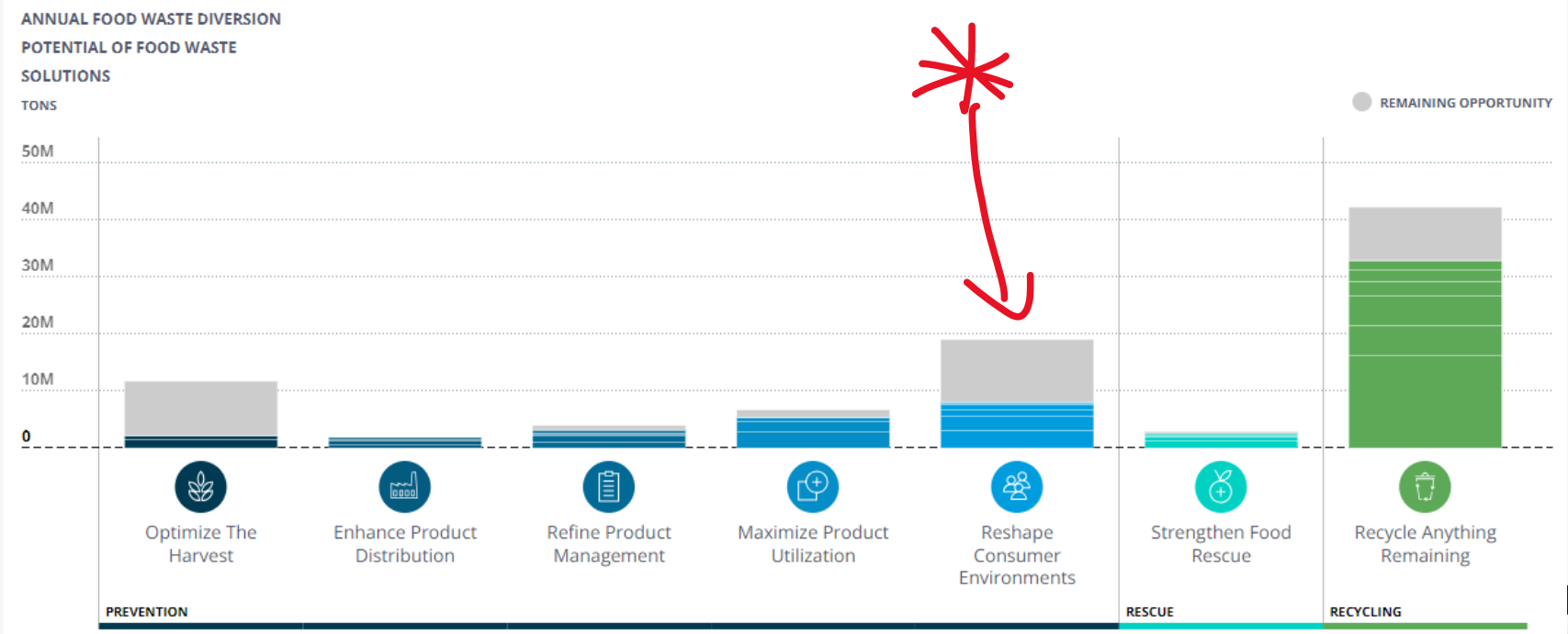
Australian FLW strategy 41 Solution



**Actions impact on different parts of the food system
 Actions reduce different amounts of waste
 Actions happen over different periods of time**



ReFed Solutions Database USA 73 Solutions



Actions impact on different parts of the food system
Actions reduce different amounts of waste
Actions happen over different periods of time



ReFED
Roadmap to 2030: Reducing
U.S. Food Waste by 50% and
the ReFED Insights Engine
At-A-Glance





**We have a growing number of
lists of actions across multiple
countries...**



**But we don't have a review of
effectiveness of these actions!**

Objective: Create an evidence base for Actions

- "Imperfect" review of the literature, using 25 Academic articles, NGO reports and policy documents.
- Looking for the suggested actions to reduce and divert FLW
- Recording tonnages and % of diversion
- Mapping these actions to
 - 1) 89 Keywords
 - 2) 11 categories from the Food Systems Transformation Solution-Bank



25 sources (8 quantified documents) –109 quantified actions, 713 actions total

Source	Quantified Actions	Total Actions
A meta-analysis on the effectiveness of food-waste reducing nudges (2023)		25
A National Strategy to Reduce Food Waste at the Consumer Level (2020, National Academy of Sciences)		12
Assessment of food waste prevention actions - European Commission (2019)	29	43
Call for Testing Interventions to Prevent Consumer Food Waste (University of Bern)		4
Case studies on household food waste reduction interventions Fight Food Waste Cooperative Research Centre (2023)	4	6
Changing the rules of the game: Impact and feasibility of policy and regulatory measures on the prevention and reduction of food waste (2020)		32
European Citizens' Panel on Food Waste Final recommendations		23
FIAL (2021). Appendix 2: National food loss and waste reduction: Review of international best practice and interventions,	1	40
Food Loss and Waste Sector Guidelines (Greece)		4
Food Loss and Waste Sector Guidelines (Turkey)	1	5
HALVING FOOD LOSS AND WASTE IN THE EU BY 2030:THE MAJOR STEPS NEEDED TO ACCELERATE PROGRESS		6
Mitigating climate change via food consumption and food waste: A systematic map of behavioral interventions (Reisch 2021)		19
New paradigms on how to achieve zero food waste in future cities – Optimizing food use by waste prevention and valorization (2015)		65
No time to waste: assessing the performance of food waste prevention actions (Laurentiis 2020)		1
Recommendations for Action in Food Waste Prevention (EU Platform on Food Losses and Food Waste)		47
REDUCING CONSUMER FOOD WASTE USING GREEN AND DIGITAL TECHNOLOGIES (UNEP DTU partnership)		53
Reducing food loss and waste (World Resources Institute)		107
Reducing Food Loss and Waste along the Food Value Chain in APEC during and postCOVID-19 Pandemic (March 2022)		16
ReFED: A Roadmap to reduce US Food Waste by 20% (March 2016)	28	28
Review: Consumption-stage food waste reduction interventions – What works and how to design better interventions (Reynolds 2019)	8	17
Setting the scene for an EU initiative on food waste reduction targets (European Commission 2023)		25
Sustainable Materials Management of Food in the APEC Region: A Review of Public Policies That Support Reducing Food Loss and Waste (2022)		82
The Path to half: Solutions to halve Victoria's Food Waste by 2030 (2020)	25	25
Welsh Food Waste Routemap (WRAP 2023)	13	21
What a waste! Evidence of consumer food waste prevention and its effectiveness Cecilia Casonato (2023)		7
Grand Total	109	713

Different rates of effectiveness for different actions. Different levels of quantified evidence base.

Category (primary)	Average of Average diversion or reduction potential %	Total mentions	Number of quantified studies
Certification and standards	5%	8	3
Direct food provision		43	13*
Economic/financial	7%	36	1
Framework policies	10%	47	3
Governance/organisation	17%	50	5
Information/communication	13%	206	29
Market intervention		11	0
Not sure	7%	17	2
Regulatory	13%	125	28
Technology/innovation	26%	167	25

* Not all data provided as a % so these could not be included.



Different rates of effectiveness throughout the supply chain

Average diversion or reduction potential %

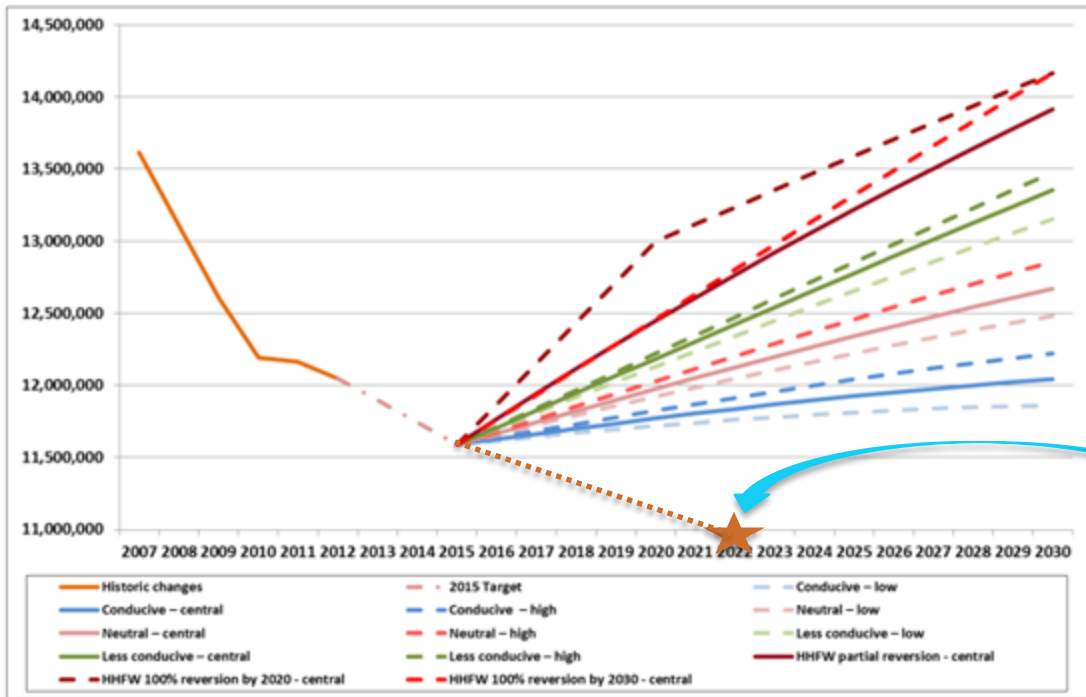
	On farm/Primary Production	Supply chains Wholesale Manufacturing	Grocery/Retail	Out-of-home	Institutional	Informal	Local government	Consumers & Citizens
Certification and standards	5%							
Direct food provision								
Economic financial	7%			7%				
Framework policies	10%	10%	10%	10%	10%			
Governance organisation		25%	25%	17%	17%	25%		
Information communication				5%	10%			14%
Market intervention								
Regulatory	18%	12%	14%	20%	17%	23%	33%	18%
Technology innovation	17%	28%	31%	27%	24%	24%		32%
Average % per supply chain stage	15%	20%	22%	21%	19%	23%	33%	19%

So what works?

		Average diversion or reduction potential %	Min diversion or reduction potential %	Max diversion or reduction potential %	# of quantified studies
Regulatory	Advisory Guidelines	3%	3%	3%	1
	Food-Related Laws	16%	3%	28%	2
	Food-Related Rules	33%	12%	54%	2
	Industry Voluntary Agreements	20%	20%	20%	1
	Labelling	5%	5%	5%	1
	Self-Regulation	11%	1%	30%	12
Technology & innovation	Distribution of Food Surplus	21%	1%	50%	7
	Financing of Innovation	58%	25%	90%	2
	Research Activities on Food System	33%	25%	50%	3
Information & communication	Consumer Information Campaigns	10%	2%	18%	3
	Digital content	7%	6%	8%	2
	Labelling	5%	5%	5%	1
	Skills, Knowledge Training	16%	15%	16%	2
Governance & organisation	Mapping, Measuring and Monitoring	17%	9%	25%	3
Certification and standards	Standards – Food Safety, Quality, Composition	5%	1%	8%	3

A reminder: Reduction is not enough

Figure 4 – Estimates of UK food waste (tonnes), incorporating different scenarios for total food waste (three different economic scenarios – 'conductive', 'neutral' and 'less conducive'), under different rates of population growth (low, central and high). Note for the 'reversion' scenario, and the household fraction of the total, 'low' = partial reversion, 'medium' = 100% reversion by 2030 and 'high' = 100% reversion by 2020).



We need a combination of solutions that prevent, divert (recover or recycle), or reduce food loss and waste to achieve Sustainable Development Goal 12.3.

Where we are in 2022/23

Table E51: Summary of UK food waste arisings (kg per capita per year) for the Courtald 2030 baseline year (2007, 2018, and 2021), including changes over time.

	Food waste (kg / capita / year)			Change 2018 to 2021		Change 2007 to 2021	
	2007	2018	2021	kg / capita / year	%	kg / capita / year	%
Household ¹	90.9	66.5	75.5	+9.0	+13.5%	-15.5	-17.0%
Supply chain	50.7	43.6	40.2	-2.8	-6.5%	-10.5	-20.7%
Factual	-	-4.7	-9.8 ²	-3.5	-8.3%	-1.2	-26.0%
Manufacture	31.0 ³	22.7	20.6	-2.1	-9.2%	-10.4	-33.6%
HotS ⁴	15.0 ⁵	16.5	16.2	-0.4	-2.2%	+1.2	+7.7%
Total	141.7	109.5	115.7	+6.2	+5.6%	-26.0	-18.3%

Parry A (2014) UK food waste – Historical changes and how amounts might be influenced in the future. Banbury,

<https://wrap.org.uk/resources/guide/uk-food-waste-historical-changes-and-how-amounts-might-be-influenced-in-the-future#download-file>



**So what does this mean for
National and local government Policy?**

Multiple Actions need policy coherence

Food policy coherence

The alignment of policies that affect the food system with the aim of achieving health, environmental, social and economic goals, to ensure that policies designed to improve one food system outcome do not undermine others.

Food policy incoherence creates problems and misses opportunities.

Health (social) policy
goal = to prevent disease and treat and manage ill-health in the population

Environmental policy
goal = less deforestation, water pollution, greenhouse gases

Economic policy
Goal = growth and competitiveness for income generations and jobs

Policy incoherence



Economic policy or economic policy instruments not fit for purpose in reinforcing environmental and health policy goals

Policy made in different spaces



Multiple government departments linked to FLW reduction... (but not enough?)



- Defra
- BEIS (2021) => Department for Business and Trade (DBT), the Department for Energy Security and Net Zero (DESNZ)
- FCDO (overseas funding)
- Are they all talking?
- Who is leading?
- Multiple behavior change campaigns on different issues.

Complexity! 34 Local Govt. policy areas linked to food.

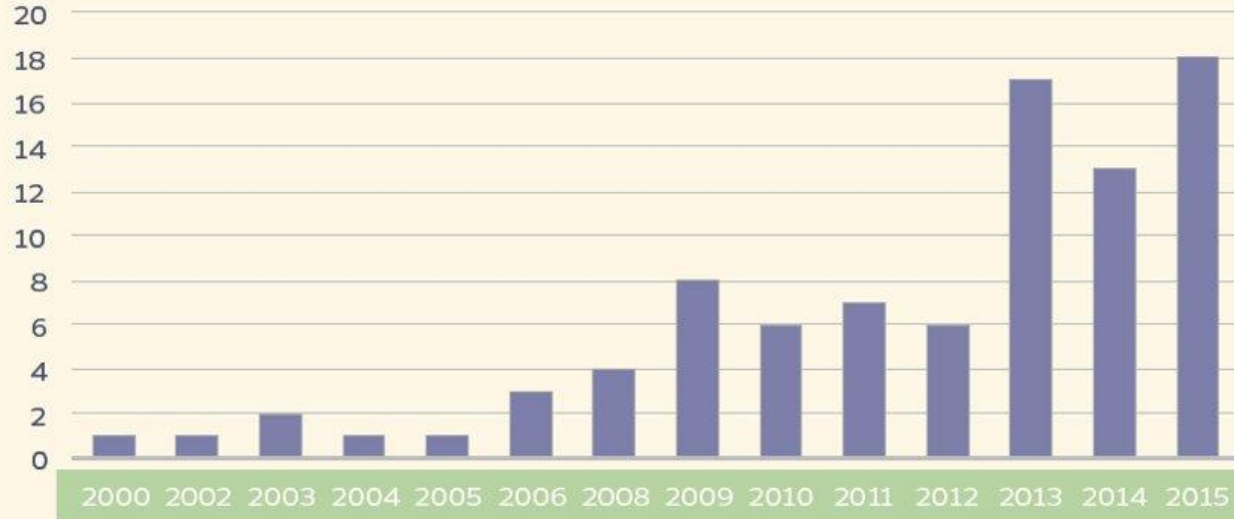
Access to safe drinking water
Accessible healthy food retail
Affordable housing
Agrobiodiversity and wild foods
Animal husbandry
Breastfeeding
Dedicated food system policy/strategy
Dietary guidelines for external settings
Education on/enforce food safety regulations
Education/events on food system issues
Encourage existing retailers/caterers to sell healthy, sustainable and affordable food
Encourage opening of new fresh food outlets; discourage unhealthy outlets

Food losses and food waste

Food production on LG land
Food related job creation
Food supply and food system resilience
Healthy eating by LG staff
Healthy/sustainable LG food procurement policies

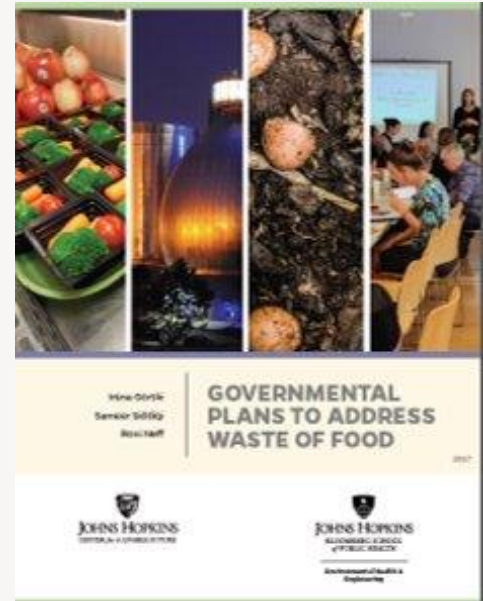
Home and community gardening
Local food initiatives for economic development
Local food producers
Local, sustainable food processing
Modify housing/property designs to ensure adequate food storage/preparation areas
Nutrition in vulnerable populations
Partner with sport clubs to provide healthy choices
Pregnancy dietary advice
Public food markets and distributors
Restrict unhealthy food advertising; increase healthy food promotion
Restrict unhealthy food in vending machines under LG control
Strengthen food chain connections/distribution
Sustainable local food production
Sustainable water management in food production
Traditional food cultures
Use economic measures to encourage affordability/consumption of healthier foods; discourage less healthy foods

Write Food Waste into the next LA strategic plan



of LA globally with Food Waste plan

<https://clf.jhsph.edu/sites/default/files/2019-01/governmental-plans-to-address-waste-of-food.pdf>





Today is a work in progress and part of wider research on FLW policy solutions.

- All input warmly received. (Feedback, questions, your thoughts.)
- Who should I be talking to?
- Do you have evidence of impact in public documents?

Dr Christian Reynolds
Centre for Food Policy, City, University of London
@sartorialfoodie @FoodPolicyCity
christian.reynolds@city.ac.uk

End of presentation

School of Health & Psychological Sciences

City, University of London
Northampton Square
London
EC1V 0HB
United Kingdom

T: +44 (0)20 7040 5060

E: christian.reynolds@city.ac.uk
[@sartorialfoodie](https://www.instagram.com/sartorialfoodie)

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

The Centre for Food Policy, City,
University of London offers the following
courses

Nutrition and Food Policy BSc (Hons)

Undergraduate degree

Food Policy MSc/PGDip/PGCert/MSc

Distance Learning

Postgraduate taught degree

PhD/MPhil Food Policy

Postgraduate research degree

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

