The carbon emissions content of your food choices: Did an NUS classroom intervention make a difference?

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LRF IPUR event @ NUS Sustainability Connect

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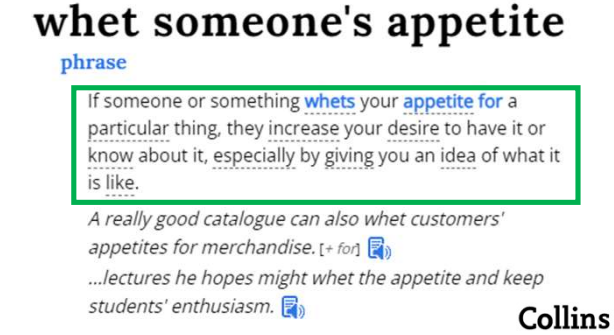
This talk reflects the speaker's views, not necessarily those of LRF IPUR or of NUS

To whet our appetite



whet someone's appetite

phrase

If someone or something whets your appetite for a particular thing, they increase your desire to have it or know about it, especially by giving you an idea of what it is like.

A really good catalogue can also whet customers' appetites for merchandise. [+ for]

...lectures he hopes might whet the appetite and keep students' enthusiasm.

Collins

- **Hunger for knowledge and individual climate action**
- Four questions on direct and indirect atmospheric emissions
  - 1 rain tree as it grows captures how many kg of CO_2e each week?
  - 10 km ride in a mid-size petrol car adds how many kg of CO_2e?
  - Relative to 10-km car ride, 1 kg of beef adds how many kg of CO_2e?
  - Relative to 1 kg of beef, 1 kg of chicken adds how many kg of CO_2e?
- www.pollev.com/salvo

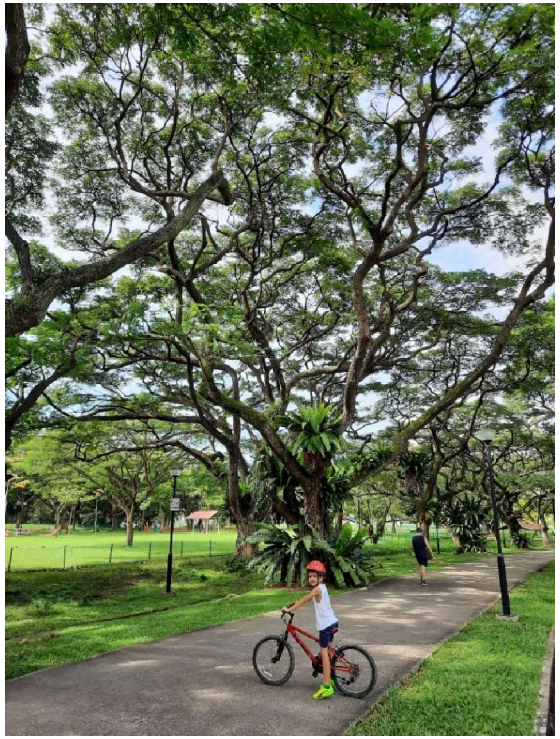
Carbon labeling and education

- Examples of personal carbon emissions (lifecycle)
  - Urban travel: A 10-km ride in a mid-size petrol car (Saudi oil)
    - 2 kg CO_2e **$0.40 climate damage @ the Social Cost of Carbon (~$200 per ton of CO_2e)**
  - Residential utilities: 10 kWh (a 3-room HDB flat's daily use) (Indonesian gas)
    - 5 kg CO_2e **$0.90 climate damage**
  - Animal protein: 1 kg bone-free beef **(the edible version of coal)**
    - 25 kg CO_2e **$5 climate damage**
  - Air travel: Economy-class roundtrip Singapore to London **(now in tons!)**
    - 3,000 kg CO_2e **$600 climate damage**
  - And in the business cabin?
    - 9,000 kg CO_2e **$1,800 climate damage**

The glamour of a high-carbon consumption lifestyle:
Penelope Cruz, Brand Ambassador for Emirates Business Class

Varying personal attitudes

- Why should I do something when Taylor Swift flies in her private jet?
- It's businesses that pollute, I am just an individual consumer
  - Consumers, through their demands, pull every supply chain
- I'll plant a tree
- I'll buy a carbon offset
  - Verifiability, additionality, and permanence?
  - Priced as low as 1/40th the **SCC**
- I'll substitute to lower-carbon substitutes…
  - …where not too inconvenient/value not too high (v)
  - …with the help of incentives ($v - p$)



A raintree and low-carbon consumption

A plug-in to important IPUR work

IS INDIVIDUAL ACTION IMPORTANT?

Any individual's carbon emissions make up a tiny part of national, let alone global emissions. It may feel like there is no point in trying to reduce your own emissions when governments, firms and other people aren't taking action.

Don't get discouraged! Here are 4 reasons why it is worth taking individual action:

Pave the way.

Each step you take helps to make climate action more familiar to others, gradually changing what people think of as normal.

Live in harmony with your values.

For people who treasure the environment, it is natural to make lifestyle choices that help to protect the earth.

Signal to governments and firms that people want change.

Decision-makers hold back from making major changes on the grounds that the public will not support them. Changing consumption and behaviours voluntarily sends a powerful signal to public and private decision-makers.

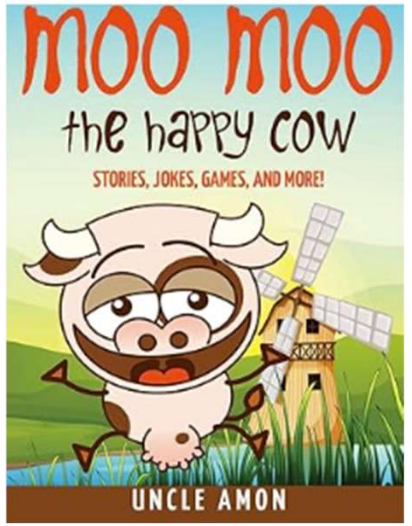
Small actions add up.

Changing individual purchasing habits and behaviours makes it easier and cheaper for every sector to reduce emissions.

Why food choices matter

- Global food system today
  - ~25% GHG emissions
  - ~50% habitable land
  - Exacerbates the **twin climate and biodiversity challenges**
  - Growing meat consumption
  - Protein transition is an imperative, just like the energy transition
- **Co-benefits** beyond sustainability
  - Human health
  - Animal welfare
  - Food security
  - Zoonotic disease risk

Are we being honest about ‘fellow’ sentient mammals?



Climate-health co-benefits of dietary choices

PNAS

Analysis and valuation of the health and climate change cobenefits of dietary change

Marco Springmann[a,b,1], H. Charles J. Godfray[a,c], Mike Rayner[a,b], and Peter Scarborough[a,b]

[a]Oxford Martin Programme on the Future of Food, Department of Zoology, University of Oxford, Oxford OX1 3PS, United Kingdom; [b]British Heart Foundation Centre on Population Approaches for Non-Communicable Disease Prevention, Nuffield Department of Population Health, University of Oxford, Headington, Oxford OX3 7LF, United Kingdom; and [c]Department of Zoology, University of Oxford, Oxford OX1 3PS, United Kingdom

Edited by David Tilman, University of Minnesota, St. Paul, MN, and approved February 9, 2016 (received for review November 22, 2015)

What we eat greatly influences our personal health and the environment we all share. Recent analyses have highlighted the likely dual health and environmental benefits of reducing the fraction of animal-sourced foods in our diets. Here, we couple for the first time, to our knowledge, a region-specific global health model based on dietary and weight-related risk factors with emissions accounting and economic valuation modules to quantify the linked health and environmental consequences of dietary changes. We find that the impacts of dietary changes toward less meat and more plant-based diets vary greatly among regions. The largest absolute environmental and health benefits result from diet shifts in developing countries whereas Western high-income and middle-income countries gain most in per capita terms. Transitioning toward more plant-based diets that are in line with standard dietary guidelines could reduce global mortality by 6–10% and food-related greenhouse gas emissions by 29–70% compared with a reference scenario in 2050. We find that the monetized

Climate-health co-benefits of dietary choices

Global diets link environmental sustainability and human health

David Tilman[1,2] & Michael Clark[1]

Diets link environmental and human health. Rising incomes and urbanization are driving a global dietary transition in which traditional diets are replaced by diets higher in refined sugars, refined fats, oils and meats. By 2050 these dietary trends, if unchecked, would be a major contributor to an estimated 80 per cent increase in global agricultural greenhouse gas emissions from food production and to global land clearing. Moreover, these dietary shifts are greatly increasing the incidence of type II diabetes, coronary heart disease and other chronic non-communicable diseases that lower global life expectancies. Alternative diets that offer substantial health benefits could, if widely adopted, reduce global agricultural greenhouse gas emissions, reduce land clearing and resultant species extinctions, and help prevent such diet-related chronic non-communicable diseases. The implementation of dietary solutions to the tightly linked diet-environment-health trilemma is a global challenge, and opportunity, of great environmental and public health importance.

[1]Department of Ecology, Evolution and Behavior, University of Minnesota, St Paul, Minnesota 55108, USA. [2]Bren School of Environmental Science and Management, University of California Santa Barbara, California 93106, USA.

Bezos Centre for Sustainable Protein at NUS

“Since 1970, the human population has doubled, while the population of all other vertebrates has halved.” Sir Andrew Steer, Bezos Earth Fund, at the recent launch

“3/4 of all agricultural lands (a land mass the size of China + India times two, plus Indonesia) is used to grow feed for animals or graze them, while they only deliver 1/3 of our protein supply.” Mirte Gosker, Good Food Institute

A multi-disciplinary team to address a whole-of-society challenge

What the rest of this talk is about

- Present work with NUS students
- **Integrates** teaching and research
- Carbon education and consumption choices
  - With a focus on protein foods
  - With highly varying lifecycle emissions intensities

Class and the university as a living lab

- Different NUS student-partners in multiple roles
  - NSWS RAs surveying the public's carbon-health literacy of protein foods
  - Students studying the literacy survey data in their course assignments
  - Students' own literacy tested after vs. before taking an environmental course
  - Students' own food orders after vs. before taking the course (as part of a revealed preference experiment)

Carbon-health literacy of protein foods

- Food and **planetary health**

Consider the concept of a **carbon footprint**. This is the total amount of **planet-warming gases** (including carbon dioxide and methane) that are **emitted** to produce a product we consume, in Singapore.

Take **food**, for example. This includes emissions at the farm all the way to our table, also known as **farm to table**.

It is measured in kg of carbon dioxide equivalents (**kg CO2e**).

To help you, one rain tree as it grows **captures 4.7 kg of CO2e each week**. 

Question I. Where in the scale would you estimate the **carbon footprint** of the following foods (bone free if meat)?

What is the **carbon footprint** of these foods? **Average in Singapore**	<0.1 kg CO2e	0.1-0.5 kg CO2e	0.5-1 kg CO2e	1-5 kg CO2e	5-10 kg CO2e	10-20 kg CO2e	>20 kg CO2e
1 kg of beef	O	O	O	O	O	O	O
1 kg of chicken	O	O	O	O	O	O	O
1 kg of chickpeas	O	O	O	O	O	O	O
1 kg of fish	O	O	O	O	O	O	O
1 kg of kidney beans	O	O	O	O	O	O	O
1 kg of mutton	O	O	O	O	O	O	O
1 kg of pinto beans	O	O	O	O	O	O	O
1 kg of pork	O	O	O	O	O	O	O
1 kg of shrimp	O	O	O	O	O	O	O

7-point Likert scale (qualitative and quantitative)

Different versions were implemented to control for framing (order, tree/no tree equivalent)

Carbon literacy of other familiar products

- Frequently consumed energy-intensive products for comparability

The carbon footprint concept also applies to other products.

Take **petrol**, which most of Singapore's cars run on. Petrol's carbon footprint includes emissions all the way from the oil well to driving the car, also known as **well to wheels**.

Take **electricity**, which in Singapore comes mainly from burning natural gas. Electricity's carbon footprint includes emissions all the way from the **gas field to the plug**.

Question I cont'd. Where in the scale would you estimate the **carbon footprint** of these products? (assume you have AC)

What is the **carbon footprint** of these products? **Average in Singapore**	<0.1 kg CO2e	0.1-0.5 kg CO2e	0.5-1 kg CO2e	1-5 kg CO2e	5-10 kg CO2e	10-20 kg CO2e	>20 kg CO2e
10 km ride in a petrol car (mid-size) 	O	O	O	O	O	O	O
4 hours of AirCon in your bedroom on an average Singapore **afternoon** 	O	O	O	O	O	O	O
8 hours of AirCon in your bedroom on an average Singapore **evening** 	O	O	O	O	O	O	O

Health literacy of protein foods

- Food and **personal health**

Question II. Consider the **healthiness** of the following foods.

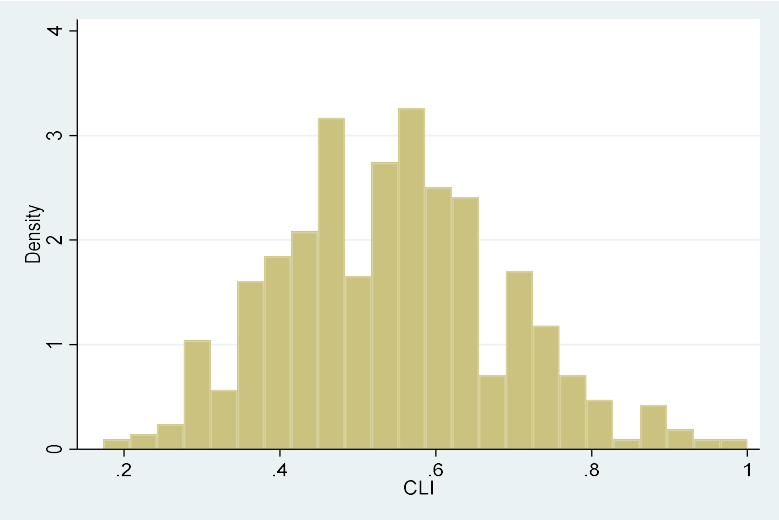
What are the **good protein** and **bad cholesterol (LDL)** contents of these foods?	**Protein** content (kg in 1 kg food)			**Cholesterol** content (grams in 1 kg food)		
	Low protein <0.05 kg	Medium protein 0.05-0.15 kg	High protein >0.15 kg	Low cholesterol <0.25 g	Medium cholesterol 0.25-1 g	High cholesterol >1 g
1 kg of beef 	O	O	O	O	O	O
1 kg of chicken 	O	O	O	O	O	O
1 kg of chickpeas 	O	O	O	O	O	O
1 kg of fish 	O	O	O	O	O	O
1 kg of kidney beans 	O	O	O	O	O	O
1 kg of mutton 	O	O	O	O	O	O
1 kg of pinto beans 	O	O	O	O	O	O
1 kg of pork 	O	O	O	O	O	O
1 kg of shrimp 	O	O	O	O	O	O

Towards a Carbon Literacy Index (CLI)

- Examples of how each (anonymous) respondent is **graded**
  - Absolute level for each food & energy-intensive product (includes partial credit)
  - Relative levels within and across product type
    - Beef or mutton selected as the most carbon-intensive food
    - Kidney beans, pinto beans, or chickpeas as the least carbon-intensive food
    - Chicken as 2-3 units less carbon-intensive than beef
    - 10-km petrol car ride equal or 1 unit above 4-hour afternoon AC
    - 4-hour afternoon AC equal or 1 unit above 8-hour evening AC
    - 10-km petrol car ride 2-3 units below 1 kg of beef

Carbon literacy index exhibits large variance

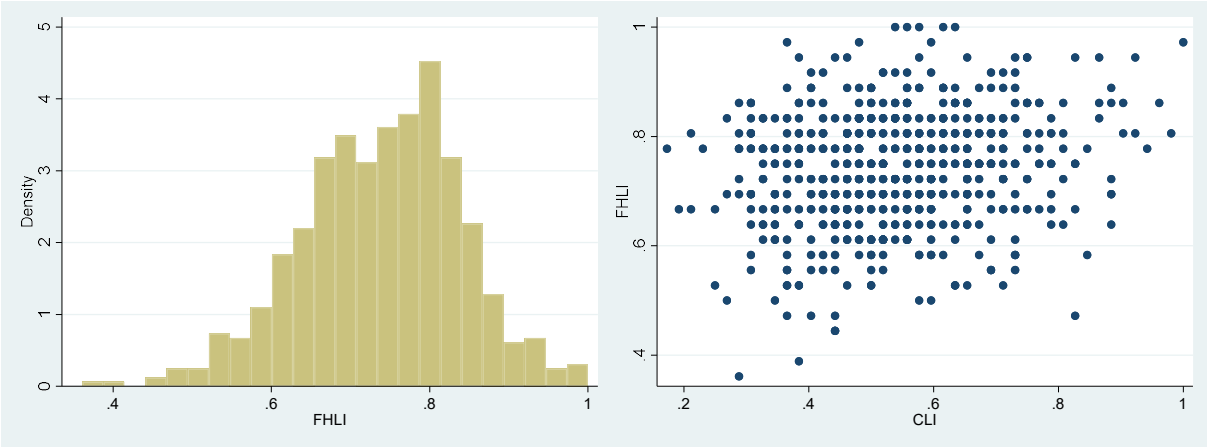
- Knowledge gap 1: **Beef vs. car rides**
  - Emissions from animal proteins are understated relative to those from driving.
- Knowledge gap 2: **Beef vs. chicken vs. beans**
  - Respondents understate the variation in emissions across protein foods, in part driven by understating beef emissions



N = 614, 2022-2023
Carbon Literacy Index (CLI), out of 1
NUS and NTU campus communities
Environmental students: Undergraduates and policy officers
General population: Malls, parks, food courts

Opportunity to sell health co-benefit

- Knowledge gap 3: Many respondents **misperceive plant proteins as low on protein**
- Knowledge gap 4: Responses vary widely for fish and shrimp, which is perceived by many as low cholesterol and low carbon



Food-Health Literacy index (FHLI) and its correlation with CLI
Pairwise correlation index of 0.19 is significant at the 1% level

Who is more carbon literate?

- Environmental students ($N = 175$) vs. General Population ($N = 119$)
  - CHLI 0.58 vs. 0.52, equality rejects w/ p-value $= 0.001$
- Environmental students ($N = 175$) vs. Campus Community ($N = 320$)
  - CHLI 0.58 vs. 0.53, equality rejects w/ p-value < 0.001
- General Population and Campus Community are indistinguishable
- Highly educated ($N = 546$) vs. less educated ($N = 68$)
  - CHLI 0.55 vs. 0.48, equality rejects w/ p-value < 0.001
- ~40 students after vs. before taking an environmental course
  - CHLI 0.68 vs. 0.55, equality rejects w/ p-value < 0.001

Who is more food-health literate? (similar patterns)

- Environmental students ($N = 175$) vs. General Population ($N = 119$)
  - CHLI 0.76 vs. 0.72, equality rejects w/ p-value $= 0.005$
- Environmental students ($N = 175$) vs. Campus Community ($N = 320$)
  - CHLI 0.76 vs. 0.74, equality rejects w/ p-value $= 0.01$
- General Population and Campus Community are indistinguishable
- Highly educated ($N = 546$) vs. less educated ($N = 68$)
  - CHLI 0.75 vs. 0.70, equality rejects w/ p-value $= 0.001$
- ~40 students after vs. before taking an environmental course
  - CHLI 0.79 vs. 0.76, equality cannot reject (p-value $= 0.15$)

How to educate without raising eco-anxiety?

- Survey climate change beliefs and attitudes (9 statements)
- ~40 students after vs. before taking an environmental course (Jan-Apr)
- *Animals and plants have as much right as humans to exist*
  - % agreeing after vs. before: 88% vs. 75%, equality rejects w/ p-value $= 0.10$
- *I feel **anxious** about what global warming and rising sea levels will do to us*
  - % agreeing after vs. before: 95% vs. 78%, equality rejects w/ p-value $= 0.02$
- *Actions to reduce our impact on the environment are very important for Singapore's **consumers** to consider*
  - % agreeing after vs. before: 98% vs. 93%
  - Equality cannot reject because baseline is already very high!

Over to shopping: Open data

- To serve as a proof of concept: Does education alone nudge?
- Jan to May 2023: 111 students in Environ. Econ. (mostly non economists)
  - Key themes: Carbon education, personal carbon tracking, and pricing
- Jun 2023: I recruited a control group of students
- June to July: I invited students to share their downloadable 180-day consumption history… the participation rate was 70%

Consumer product	Retailers (platforms with digital transactions)	Transactions shared (5 Jan to 20 Jun 2023)
Food	Grabfood, Foodpanda, Deliveroo	669 orders (15% ruminant meat, 17% no animal meat)
Public transport	SimplyGo	17,974 rides
Private car use	Grab, Gojek, TADA, CDG Zig	1,176 rides
Air conditioning	EVS (living on campus, room with AC)	104 purchases (only 14 students)

10:21 4G 90

9 May 2023 at 14:04

Booking ID A-4TJJ3PIWWEJE

McDonald's - Bedok Mall
Delivered • GF-909

311 New Upper Changi Road, 01-10/11, Bedok, 4673...
Home

Order Summary

1x	Dbl Quarter Pounder® with Cheese Meal	11.95
1x	Big Mac® Meal	10.05

More details

Subtotal	S$22.00
Service fees	5.20
Green Programme	0.10
Up to $3 OFF Del Fee, min $15	-3.00
Total	**S$24.30**

You've earned 145 GrabRewards points

Contact Grab

Order #o0bn-yfpd
Delivered on 20 Mar, 18:24

Order from
Ru Yi Chicken Rice

Delivered to
Singapore, Miltonia Cl, 334

2x	**Chicken Rice 鸡饭** Breast meat, white chicken	S$ 6.60
3x	**Braised Egg 卤蛋**	S$ 2.70
1x	**Chicken 鸡**	S$ 14.70

Subtotal	S$ 24.00
Delivery fee	S$ 2.19
Rider's tip	S$ 0.00
Total (incl. GST where applicable)	S$ 26.19

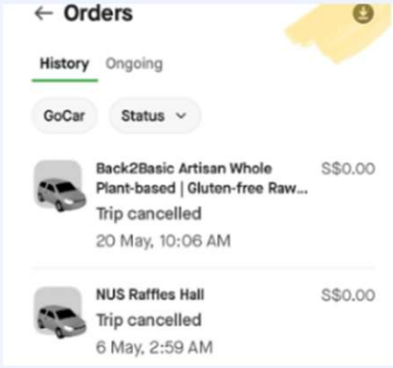
Paid with

credit card S$ 26.19

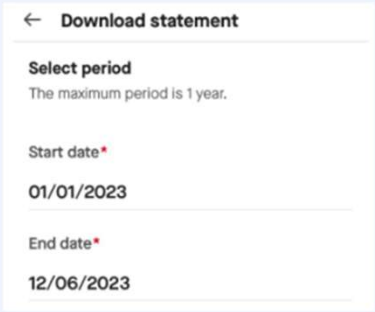
Select items to reorder

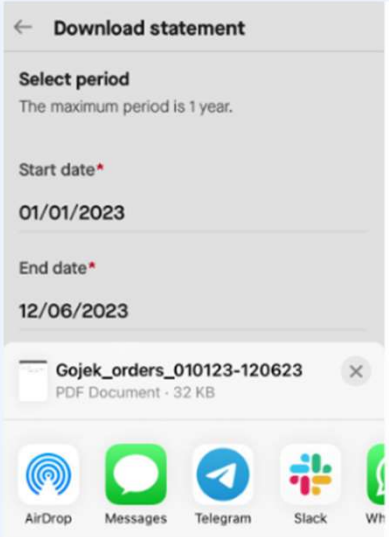
How to download travel history from Gojek

01 **My Profile -> My Orders**



02 **Click on the icon in the top right corner and input Start date: 1 Jan 2023 and End date: 20 June 2023**





03 **Click DOWNLOAD and share the PDF via WhatsApp/Telegram**

A best-case scenario? (Occidental College)

nature food

Brief Communication

https://doi.org/10.1038/s43016-023-00712-1

Low-cost climate-change informational intervention reduces meat consumption among students for 3 years

Received: 8 September 2022

Accepted: 7 February 2023

Published online: 02 March 2023

Check for updates

Andrew J. Jalil[1], Joshua Tasoff[2] & Arturo Vargas Bustamante[3]

Evidence on the impact of information campaigns on meat consumption patterns is limited. Here, using a dataset of more than 100,000 meal selections over 3 years, we examine the long-term effects of an informational intervention designed to increase awareness about the role of meat consumption in climate change. Students randomized to the treatment group reduced their meat consumption by 5.6 percentage points with no signs of reversal over 3 years. Calculations indicate a high return on investment even under conservative assumptions (-US$14 per metric ton CO_2eq). Our findings show that informational interventions can be cost effective and generate long-lasting shifts towards more sustainable food options.

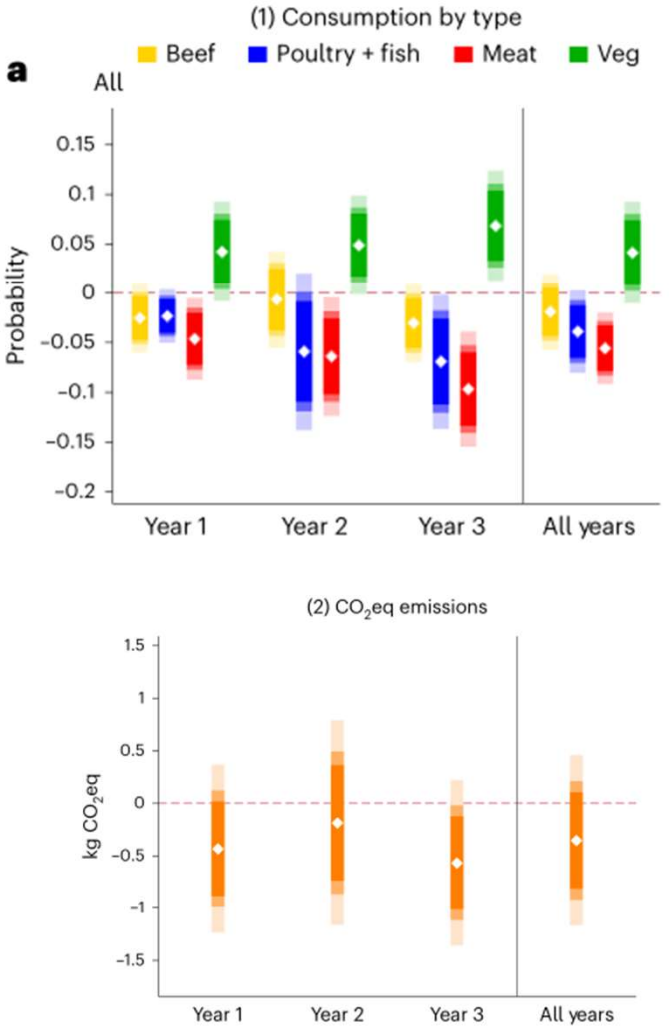


Fig. 1 | Long-term treatment effects on diet and CO_2eq. a–c, Diamonds represent logit average marginal treatment effects for column 1 and ordinary least squares treatment effects for column 2. All regressions control for individual, date and hour fixed effects. The sample size consists of 103,375 meal purchases across 213 students over 3 years (years 1, 2 and 3 correspond to the 2017–2018, 2018–2019 and 2019–2020 academic years, respectively, and 'all

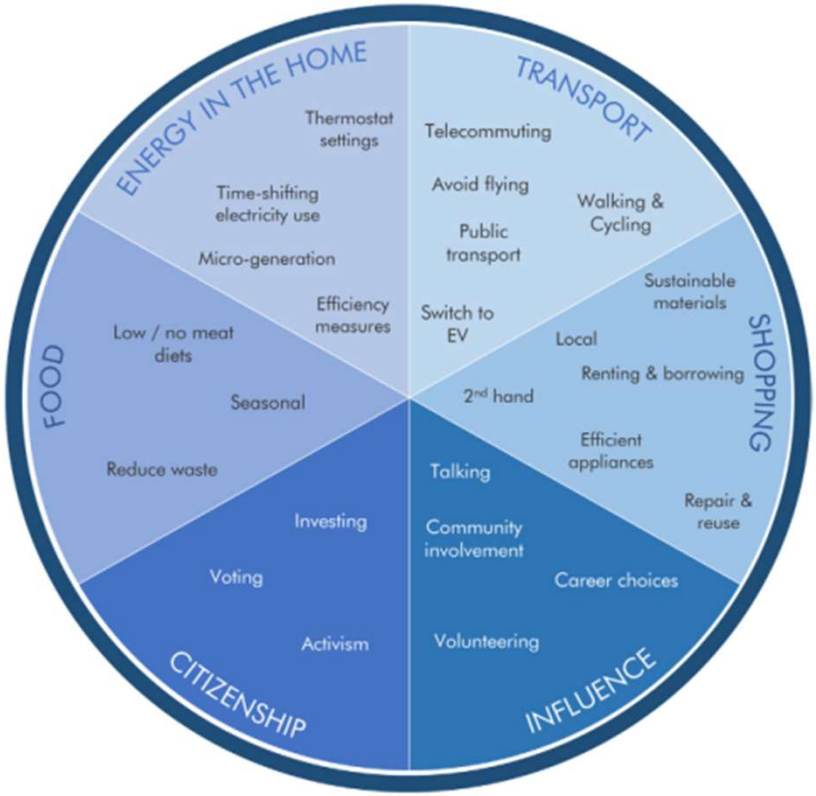
Results of the intervention on platform orders

- Food-delivery orders
  - Prop. of orders w/ ruminants: 0.187 (environmental students) vs. 0.091 (non-environm.), equality rejects w/ p-value < 0.001. **Difference is stable over time!**
  - Prop. of orders w/o animal meat is indistinguishable across the two groups
- Car-hail rides vs. public transport
  - Prop. of rides in cars: 0.070 (environmental students) vs. 0.055 (non-environm.), equality rejects w/ p-value < 0.001. **Difference is stable over time!**
- Limitations
  - Short run
  - Limited, incomplete data on consumption
- Intention-action gap

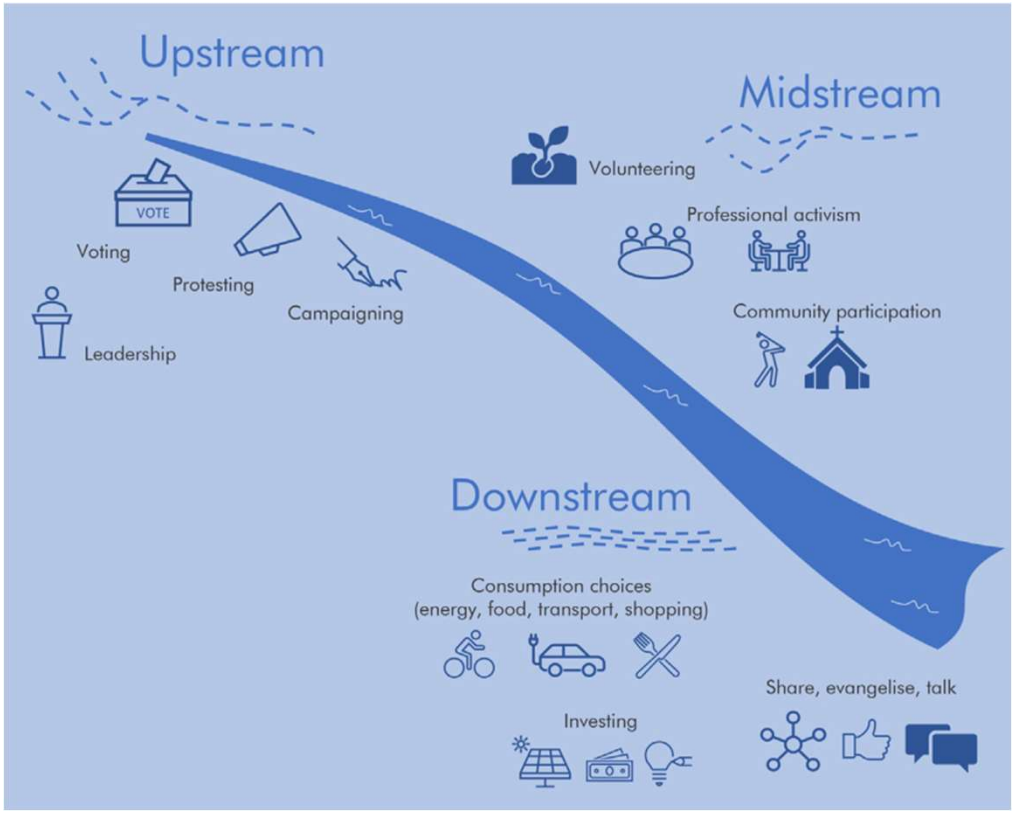
A takeaway note

- Consumers in the short run
  - *Behavioral nudges are a very small step towards deep decarbonization. In contrast, the more expensive scalable technologies have a much greater potential for substantial emissions reductions.* Gillingham and Stock (2018)
  - *Most of these studies find intervention effects of a few percentage points on emissions, but these effects tend to decrease over time*. Imai et al. (2022), on information provision and labeling studies of consumer behavior
- Climate-literate citizens in the long run
  - Link between education, accountability, and support for costly decarbonization
  - Would policymakers (in rich countries) then be more daring?
  - Public understanding of climate risk is key, in spite of heightened eco-anxiety
  - Leverage co-benefits, which may be more local

“A (GREAT) review of the multiple roles individuals play”



“The six domains of choice for climate action” (Hampton and Whitmarsh, 2023)



“The riverine ecology of choice for climate action. A combination of upstream, midstream, and downstream interventions is needed to enable and scale choices for climate action.” (Hampton and Whitmarsh, 2023)

Appendix (not to be shown for lack of time)

Food-carbon literacy in a general population

General Population, $N = 119$

Where in the scale would you estimate the **carbon footprint** (kg CO2e) of these foods (bone free if meat)?

Share of respondents selecting each alternative (in %, "close" to LCA in blue, "far" in red)

What is the **carbon footprint** of these foods? **Average in SG**	**Science /policy**[1]	<0.1 kg CO2e	0.1-0.5 kg CO2e	0.5-1 kg CO2e	1-5 kg CO2e	5-10 kg CO2e	10-20 kg CO2e	>20 kg CO2e
1 kg of kidney beans	**0.4**	31%	37%	15%	14%	3%	0%	1%
1 kg of pinto beans	**0.7**	29%	35%	24%	8%	2%	1%	1%
1 kg of chickpeas	**0.8**	34%	34%	20%	8%	3%	1%	0%
1 kg of fish	**3.5/ 6.3**	14%	24%	29%	18%	11%	4%	0%
1 kg of chicken	**3.7/ 3.5**	7%	20%	22%	32%	13%	3%	3%
1 kg of pork	**5.8/ 12.0**	3%	7%	18%	26%	32%	12%	3%
1 kg of shrimp	**7.8/ 6.3**	13%	21%	32%	20%	10%	4%	0%
1 kg of mutton	**25.6/ 16.4**	3%	3%	19%	28%	29%	16%	3%
1 kg of beef	**26.6/ 24.4**	4%	4%	12%	22%	24%	24%	10%

Opportunity:
Ruminants perceived to be significantly lower than actual (including relative to driving)

Food-health literacy in a general population

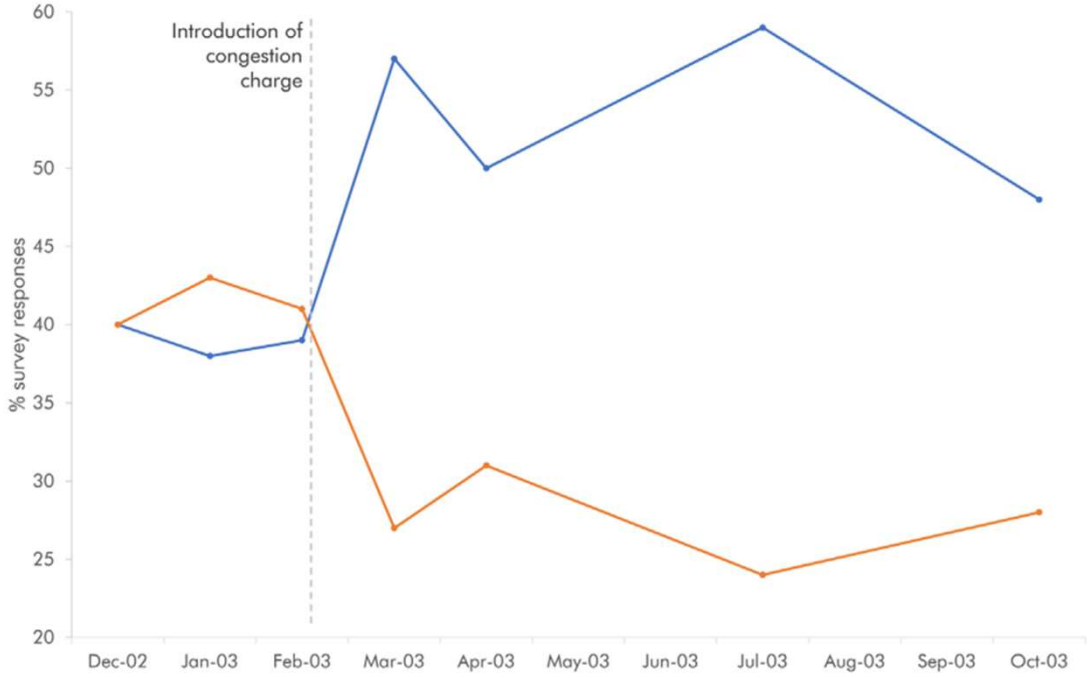
Opportunity: Health co-benefits that may be more 'local' to the individual than climate is

Consider the **healthiness** of the following foods.

Share of respondents selecting each alternative (in %, "close" to LCA in blue, "far" in red)

What are the **good protein** and **bad cholesterol (LDL)** contents of these foods?	**Protein** content (kg in 1 kg food)				**Cholesterol** content (grams in 1 kg food)			
	Science /policy[3]	Low protein <0.05 kg	Medium protein 0.05-0.15 kg	High protein >0.15 kg	**Science /policy**	Low cholesterol <0.25 g	Medium cholesterol 0.25-1 g	High cholesterol >1 g
1 kg of kidney beans	**0.24**	28%	40%	32%	**0**	85%	11%	4%
1 kg of pinto beans	**0.21**	28%	48%	24%	**0**	82%	16%	3%
1 kg of chickpeas	**0.21**	27%	39%	34%	**0**	87%	10%	3%
1 kg of fish	**0.23**	13%	45%	42%	**0.84**	68%	30%	2%
1 kg of chicken	**0.31**	3%	38%	60%	**1.04**	30%	64%	6%
1 kg of pork	**0.27**	8%	53%	38%	**0.80**	2%	40%	58%
1 kg of shrimp	**0.24**	24%	54%	22%	**1.89**	24%	29%	47%
1 kg of mutton	**0.27**	3%	36%	62%	**0.87**	2%	35%	63%
1 kg of beef	**0.28**	1%	25%	74%	**0.85**	2%	38%	61%

Education and incentives



Wishful thinking?
Or our best hope for a sustainable future of collective action?

"Support for London's congestion charge grew following its introduction" (Hampton and Whitmarsh, 2023)

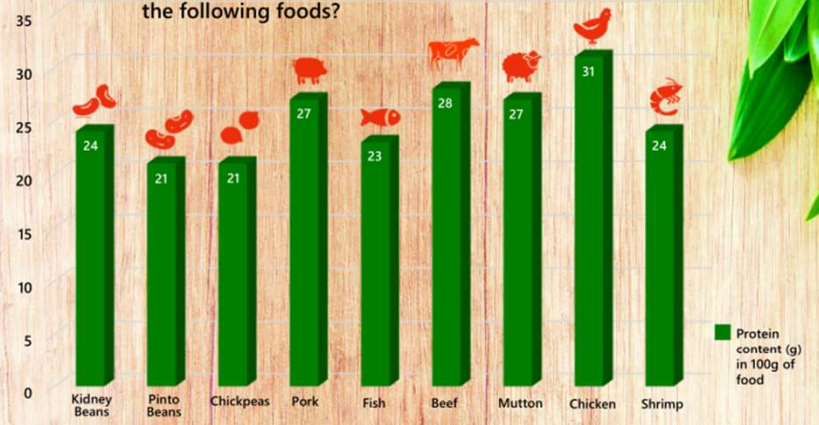
Carbon label at a less granular level

- Focus on specific foods: Protein-rich foods
- Highlight connection between planetary and personal health
  - By informing co-benefit, or making salient, more shoppers/diners may care
  - Feels more local, where the shopper can make a difference to his/her loved ones
- Can overlay with personalized messaging and rewards
- Does fintech (and retailers generally) have a role to play in carbon education?
  - Retailers pipe my data to my platform of choice
  - Attributes I may care about, e.g., My Protein, Our Carbon
  - Tech4Good

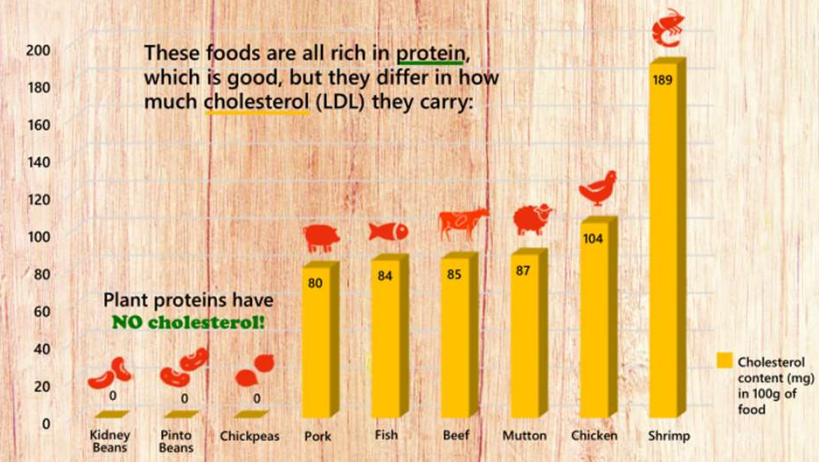
DO YOUR BIT.

For the health of your family and of our planet.

Have you ever thought about the protein content in 100g of the following foods?



These foods are all rich in protein, which is good, but they differ in how much cholesterol (LDL) they carry:



Source: Retailer XXX - National University of Singapore - Health Education working group

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BE HEALTH CONSCIOUS.

For your family and for our planet.

Did you know that by making good choices for your health, you can also protect our climate?

Agriculture is responsible for 25% of planet-warming carbon emissions.

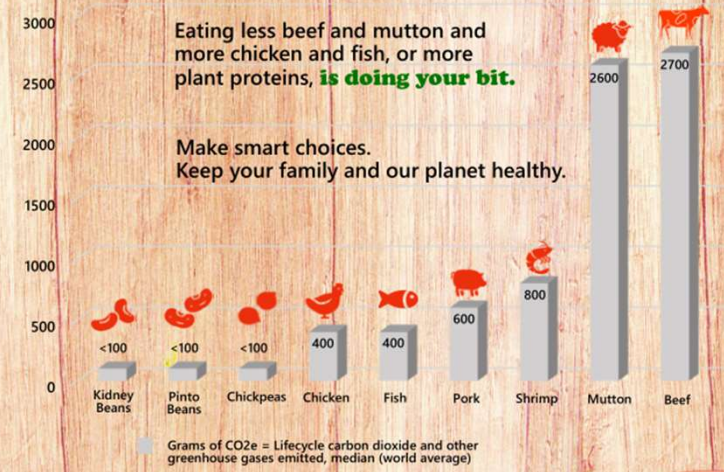
Food accounts for about 25% of a household's carbon footprint.

A carbon footprint is the total amount of planet-warming gases (including carbon dioxide and methane) that are generated to produce a good.

A higher carbon footprint makes our planet hotter, drier, and less healthy.

Because they are ruminants, cattle and sheep produce methane during digestion. Methane is a potent planet-warming gas. This is why beef and mutton have a large carbon footprint.

When you serve 100g of each of these protein foods, how much do you add to our planet's warming potential?



Eating less beef and mutton and more chicken and fish, or more plant proteins, **is doing your bit.**

Make smart choices.
Keep your family and our planet healthy.

Source: Retailer XXX - National University of Singapore - Health Education working group

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