Food systems transformation for climate change mitigation and sustainable development

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Integrated Research on Energy, Environment and Society (IREES)
18.02.25

Have you ever tried to grow/raise plants/animals?

What do plants and animals need to grow/raise, where do they come from, and what plants/animals give in return?

5 Things Plants Need

Water

Light

Air

Space to grow

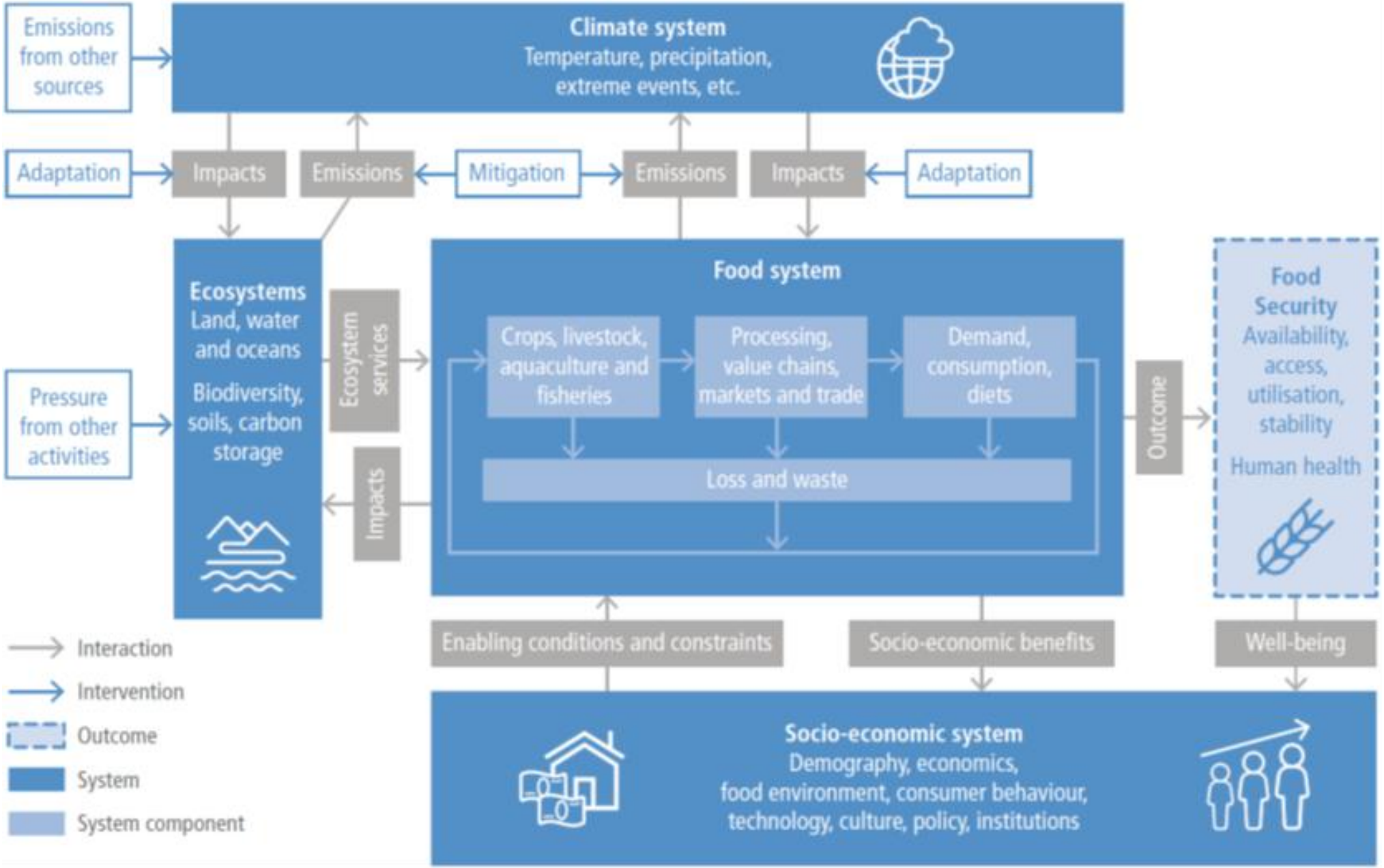
Nutrients

let's talk science

https://letstalkscience.ca/

What is food system?

Describe in around a minute what comes in your mind when you think about a food system.



IPCC 2019 (SRCCL Chapter 5)

Why is the food system broken?

MARCO ANTONIO REZENDE/BRAZIL PHOTOS/LIGHTROCKET/GETTY

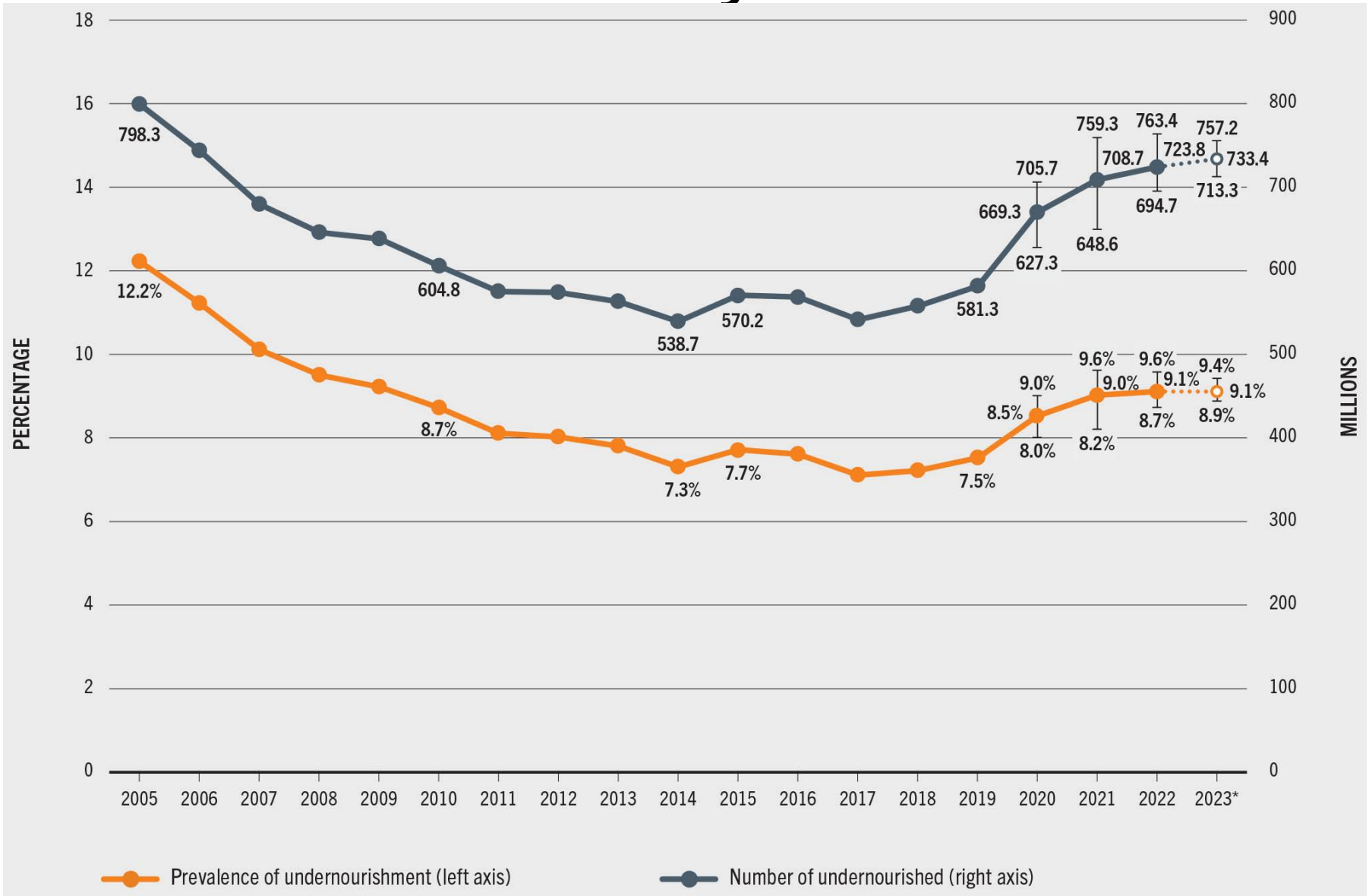
A cattle rancher in Brazil, where pressures to produce more meat collide with the need to reduce deforestation and greenhouse-gas emissions.

Fix the broken food system in three steps

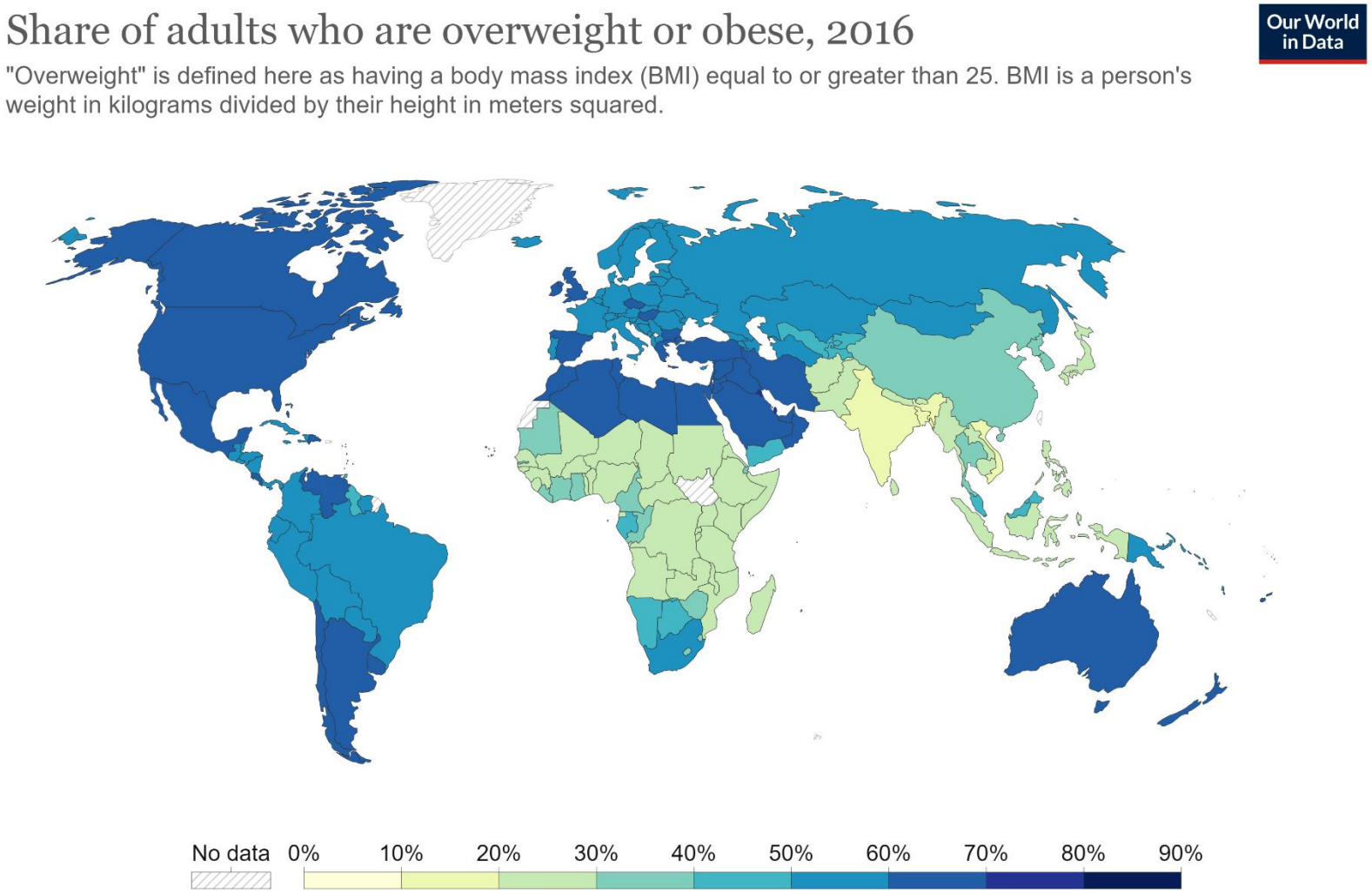
Map, model and manage agriculture, biodiversity, trade and nutrition — and build a global network, urge **Guido Schmidt-Traub**, **Michael Obersteiner** and **Aline Mosnier**.

Schmidt-Traub et al. 2019 (Nature)

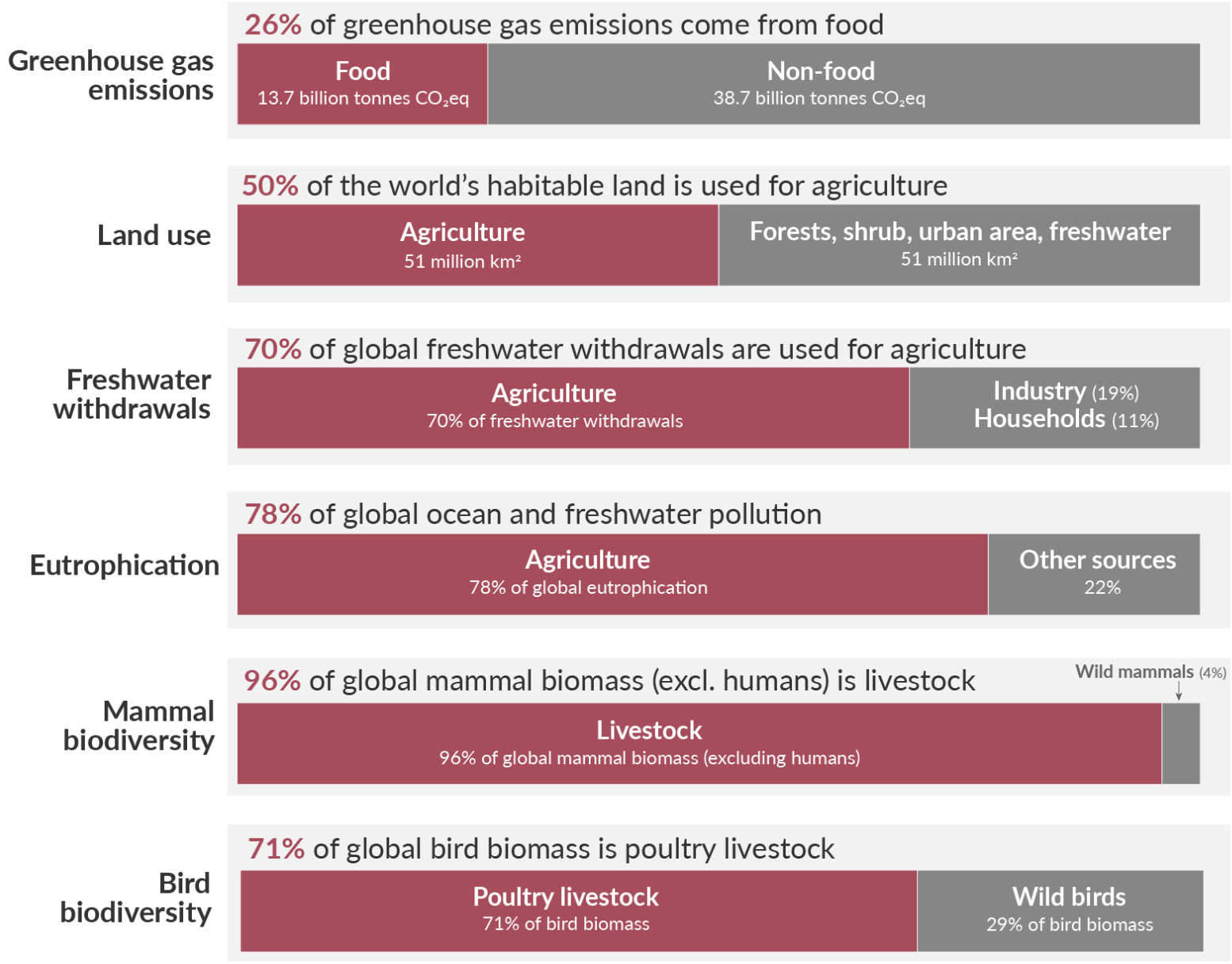
State of Food Security and Nutrition 2023



The triple burden of malnutrition

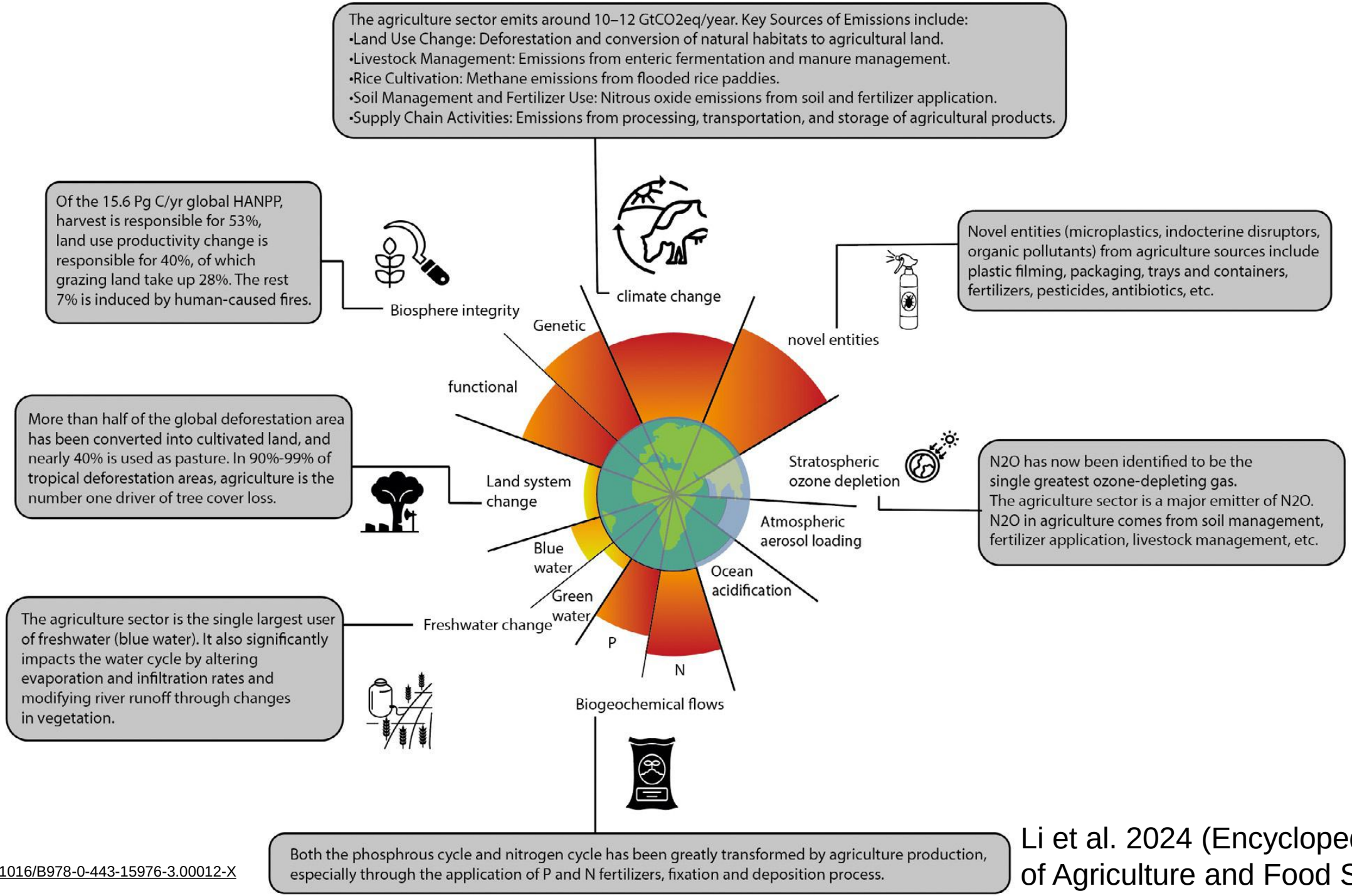


Our food systems have huge environmental impacts.



Data sources: Poore & Nemecek (2018); UN FAO; UN AQUASTAT; Bar-On et al. (2018).
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Date published: November 2022.



https://doi.org/10.1016/B978-0-443-15976-3.00012-X

Li et al. 2024 (Encyclopedia of Agriculture and Food Systems)

Food system and climate change

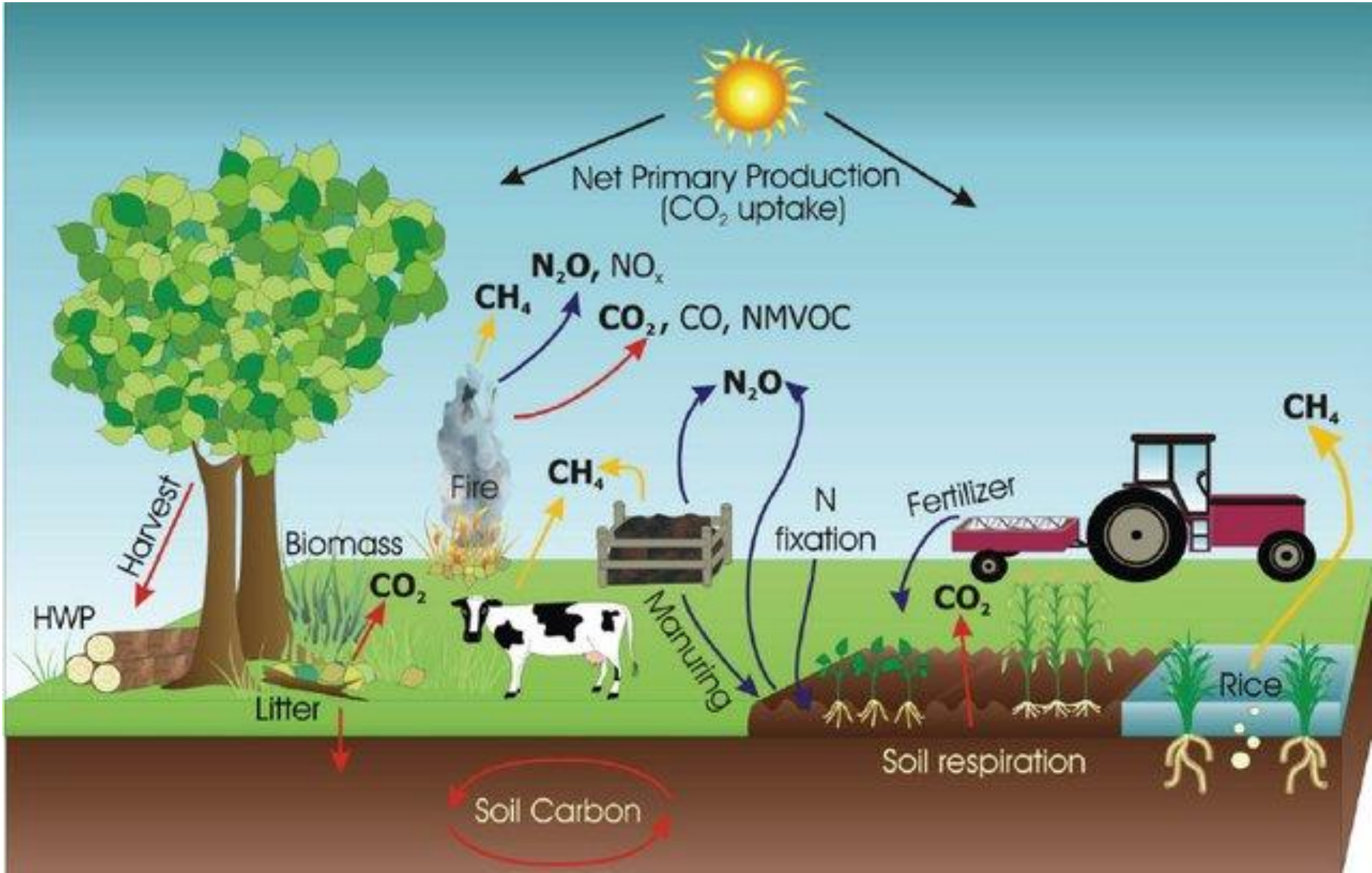
Prajal Pradhan

[illegible]

What are the sources of greenhouse gas emissions in food system?

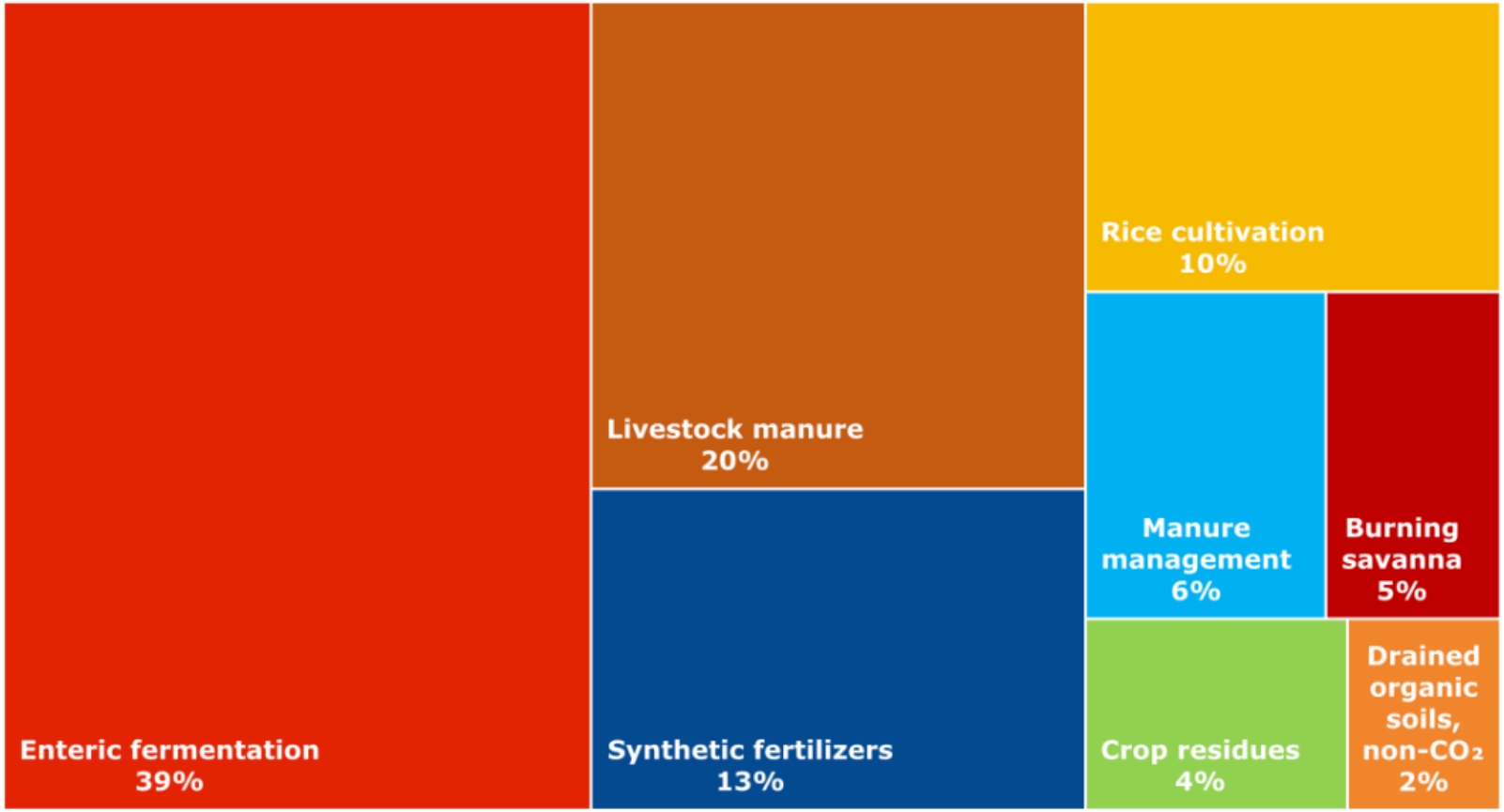
Which are the main GHG gases the food system emits?

Food system emissions

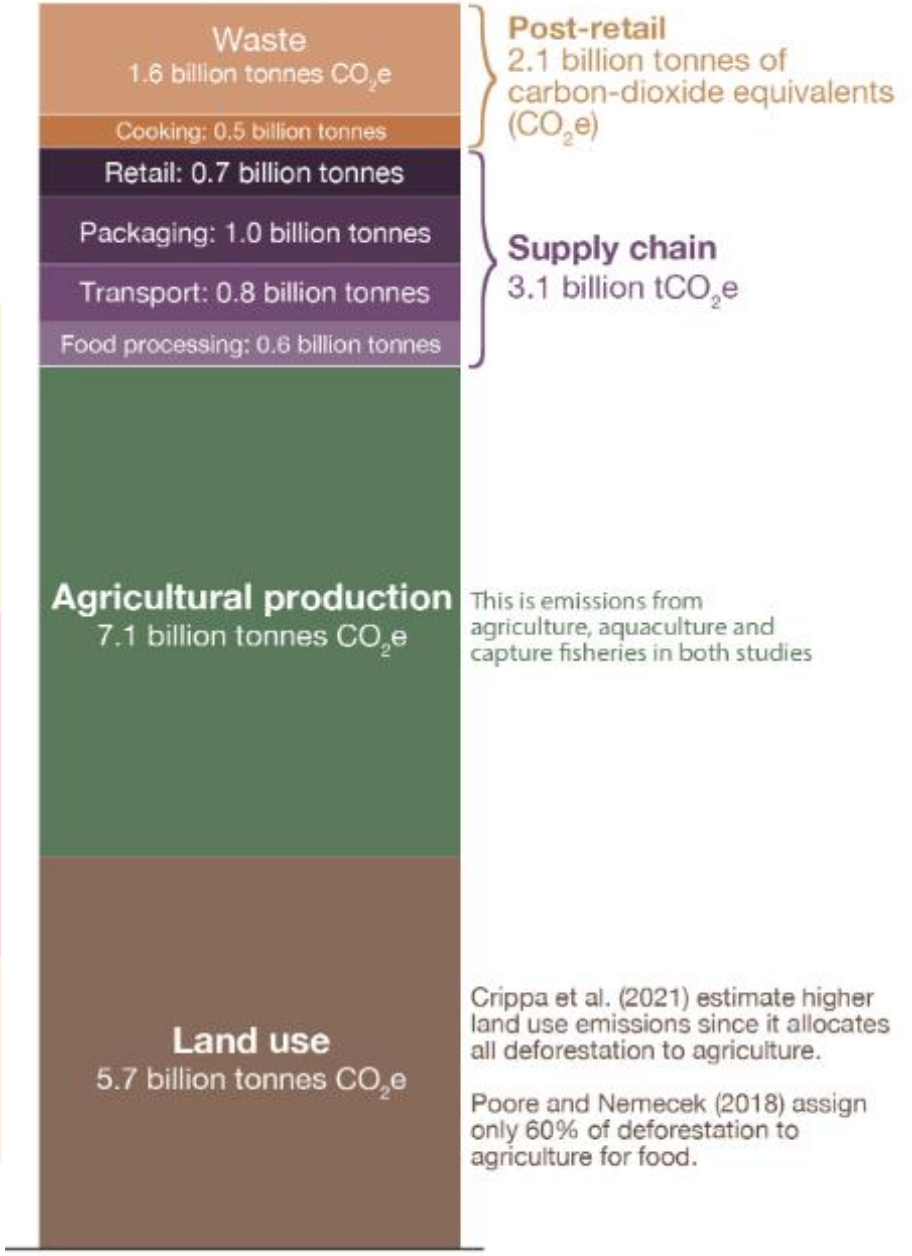


OECD Food, Agriculture and Fisheries Papers No. 89

Food system emissions

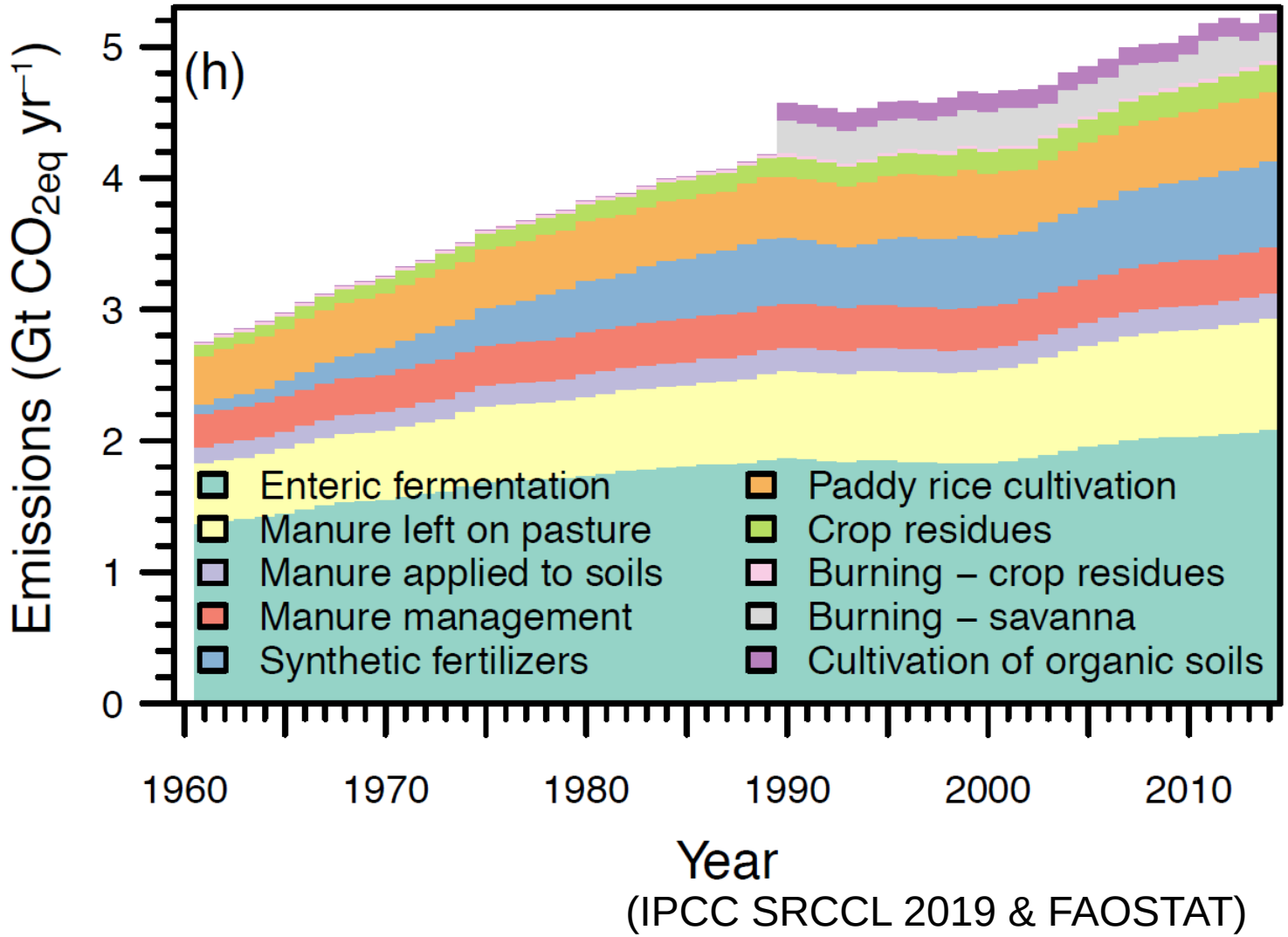


Source: FAOSTAT 2020.



Crippa et al. (2021)
17.9 billion tonnes CO_2e from food*
That's 34% of global GHG emissions
(*some non-food agricultural products included)

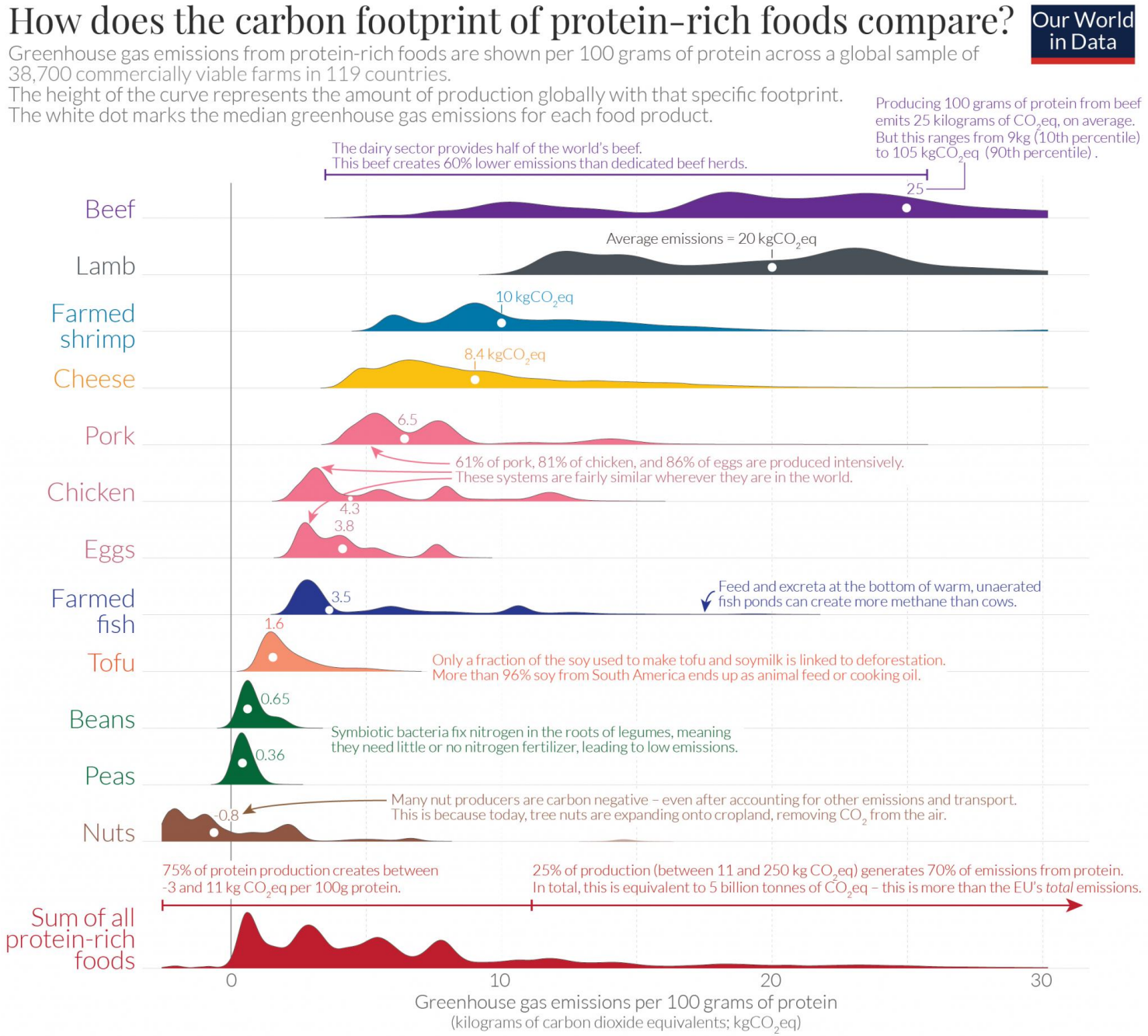
NGHGI Sector		Activity	GHG Emitted CH_4	GHG Emitted N_2O	GHG Emitted CO_2	FAO	
AFOLU	LULUCF	Forest Conversion to Other Land Uses and Burning Biomass	x	x	x	LAND USE CHANGE	FOOD SYSTEM
		Peat Fires	x		x		
		Drained Organic Soils	x		x		
	AGRICULTURE	Burning - Crop residues	x	x		FARM GATE	
		Burning - Savanna	x	x			
		Crop Residues		x			
		Drained Organic Soils		x			
		Enteric Fermentation	x				
		Manure Management	x	x			
		Manure Applied to Soils		x			
		Manure Left on Pasture		x			
		Rice Cultivation	x				
		Synthetic Fertilizers		x			
ENERGY AND IPPU		On-farm Energy Use	x	x	x	AGRICULTURAL LAND	
		Food Transport	x	x	x	PRE AND POST PRODUCTION	
		Processing	x	x	x		
		Packaging	x	x	x		
		Refrigeration	x	x	x		
		Retail	x	x	x		
		Cooking	x	x	x		
		Fertilizer manufacturing and other pre-production	x	x	x		
WASTE		Solid Food Waste	x				
		Incineration			x		
		Industrial Wastewater	x	x			
		Domestic Wastewater	x	x			



(IPCC SRCCL 2019 & FAOSTAT)

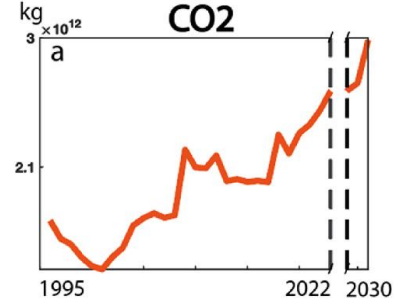
Agriculture, forestry and other land uses (AFOLU)
National GHG inventory (NGHGI)
land use, land use change and forestry (LULUCF)
Industrial Processes and Product Use (IPPU)
(Tubiello et al. 2021, ERL)

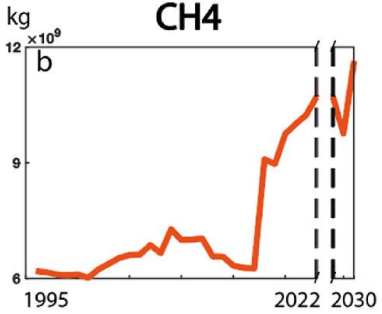
Animal-source foods emit more GHG than plant-based ones.

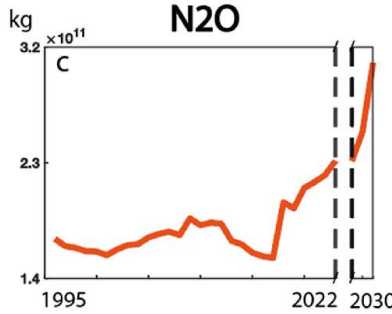


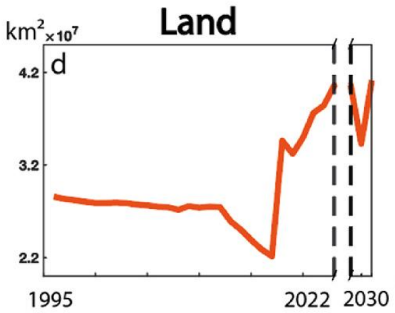
Note: Data refers to the greenhouse gas emissions of food products across a global sample of 38,700 commercially viable farms in 119 countries.
Emissions are measured across the full supply-chain, from land use change through to the retailer and includes on-farm, processing, transport, packaging and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

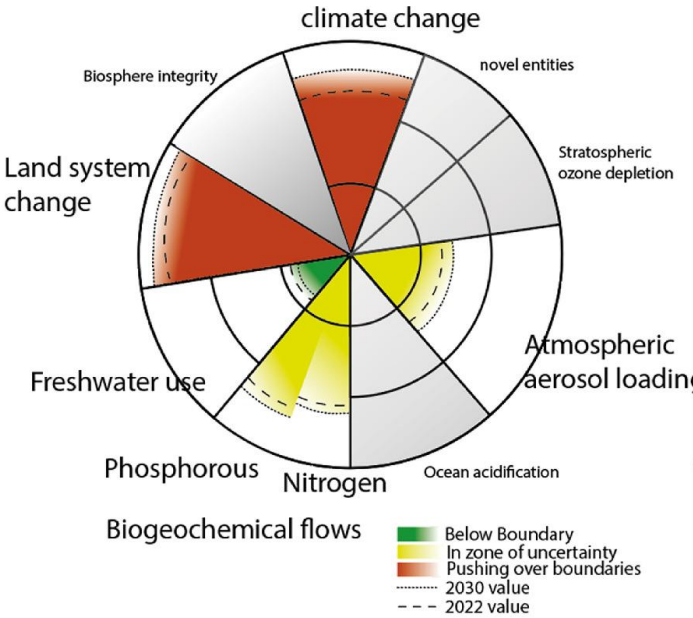
The livestock sector can threaten planetary boundaries.

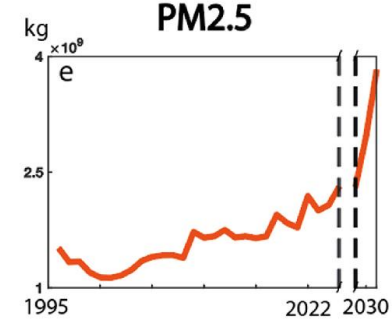


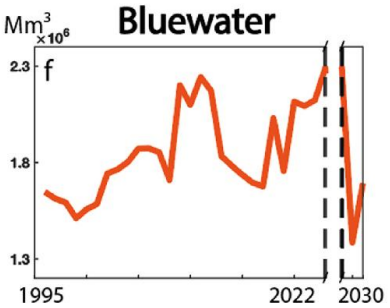


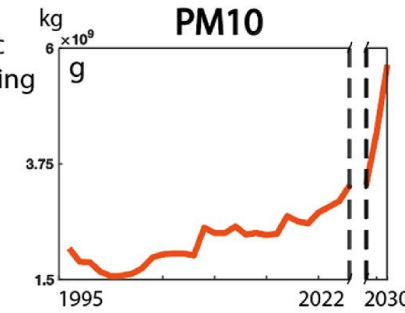


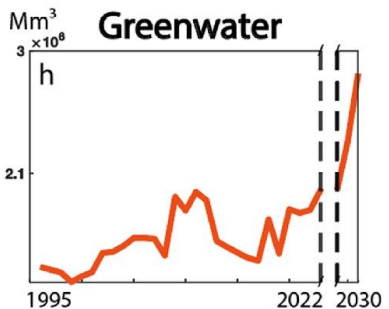


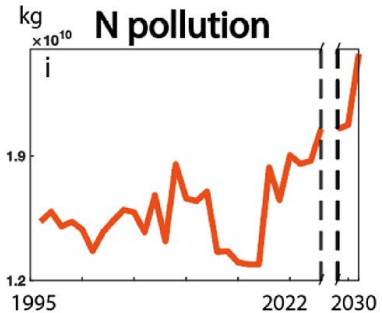


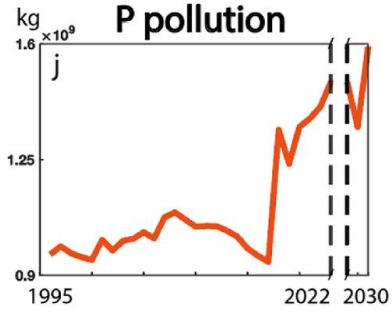






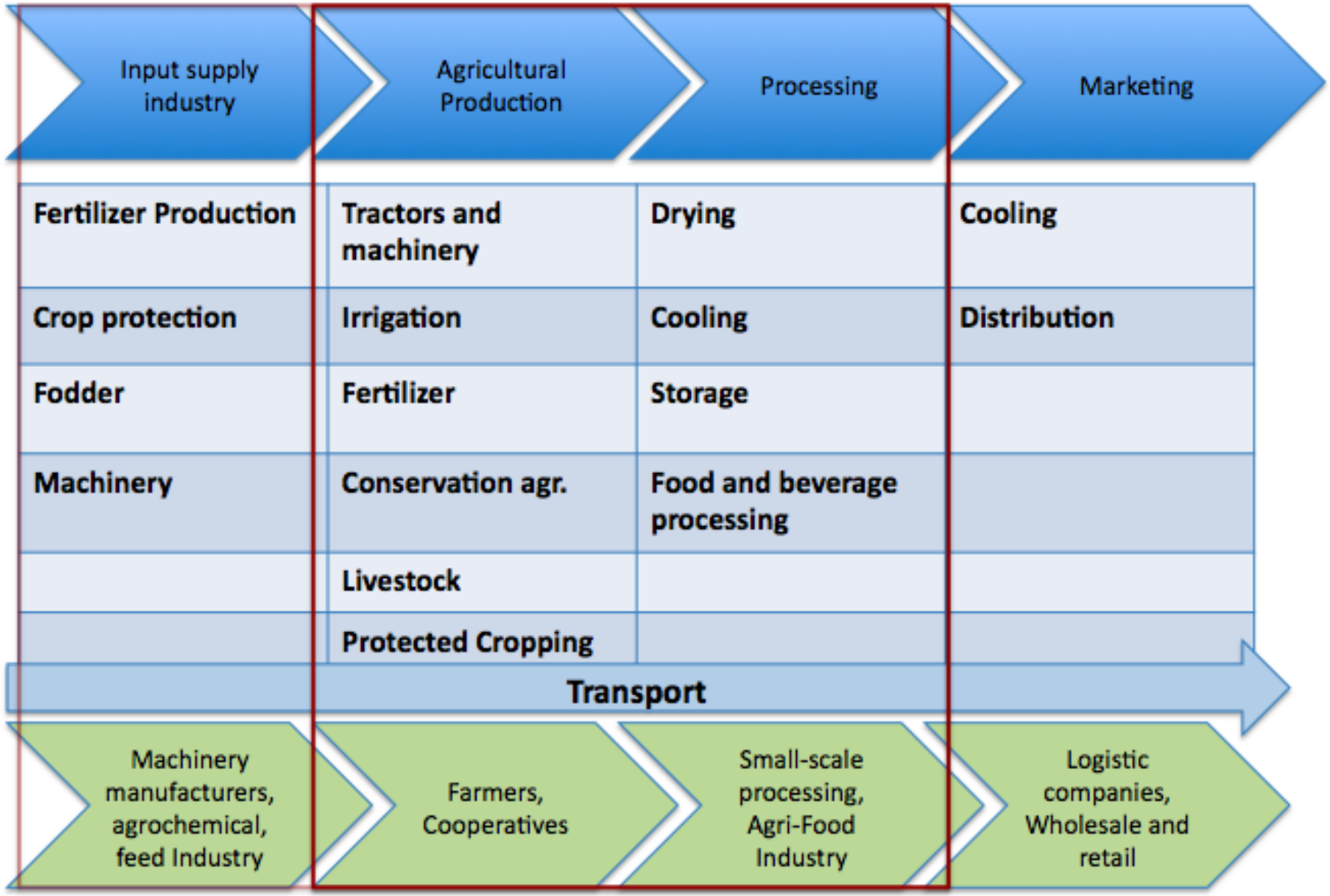






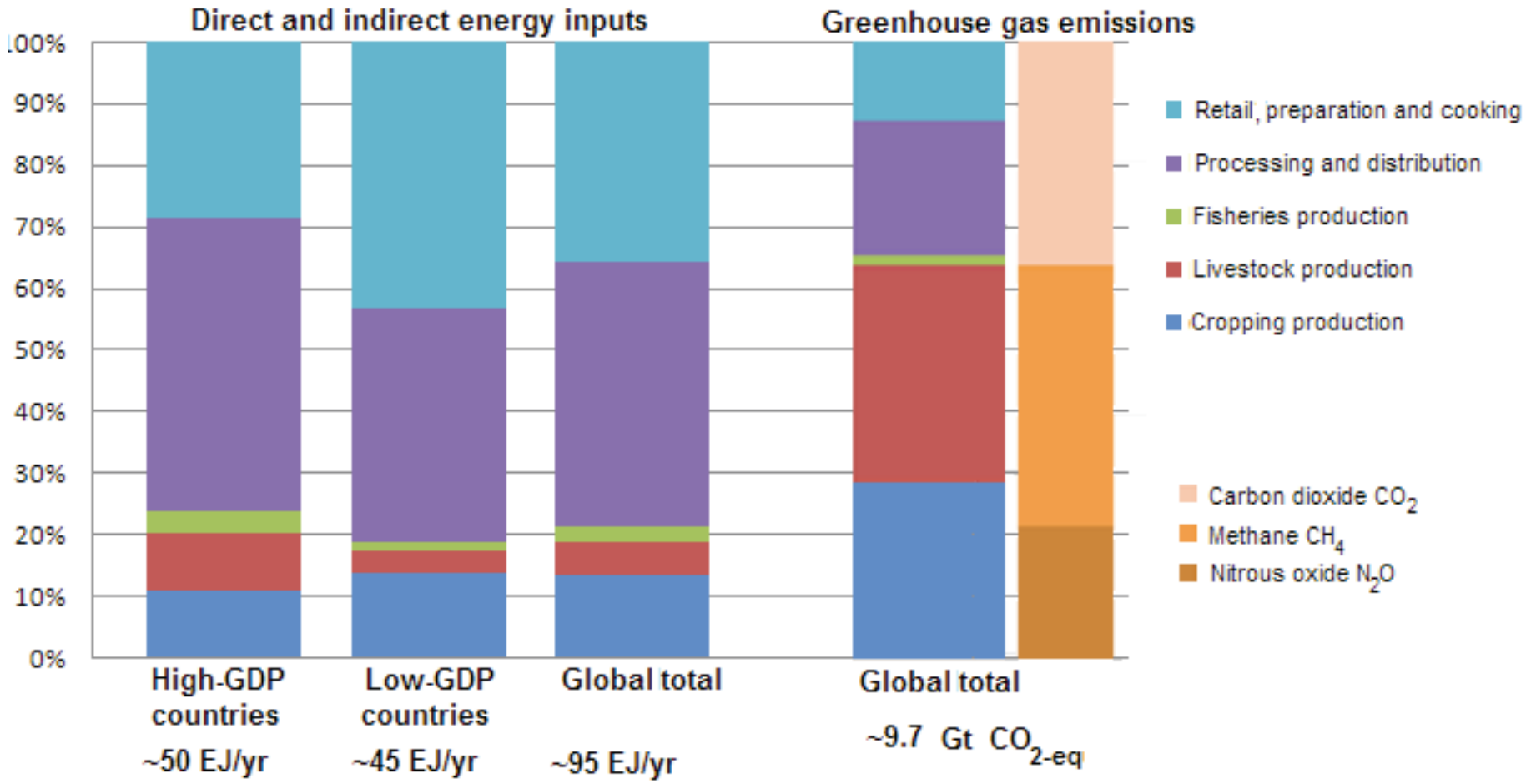
Energy for food

Energy consumption within the food supply chain



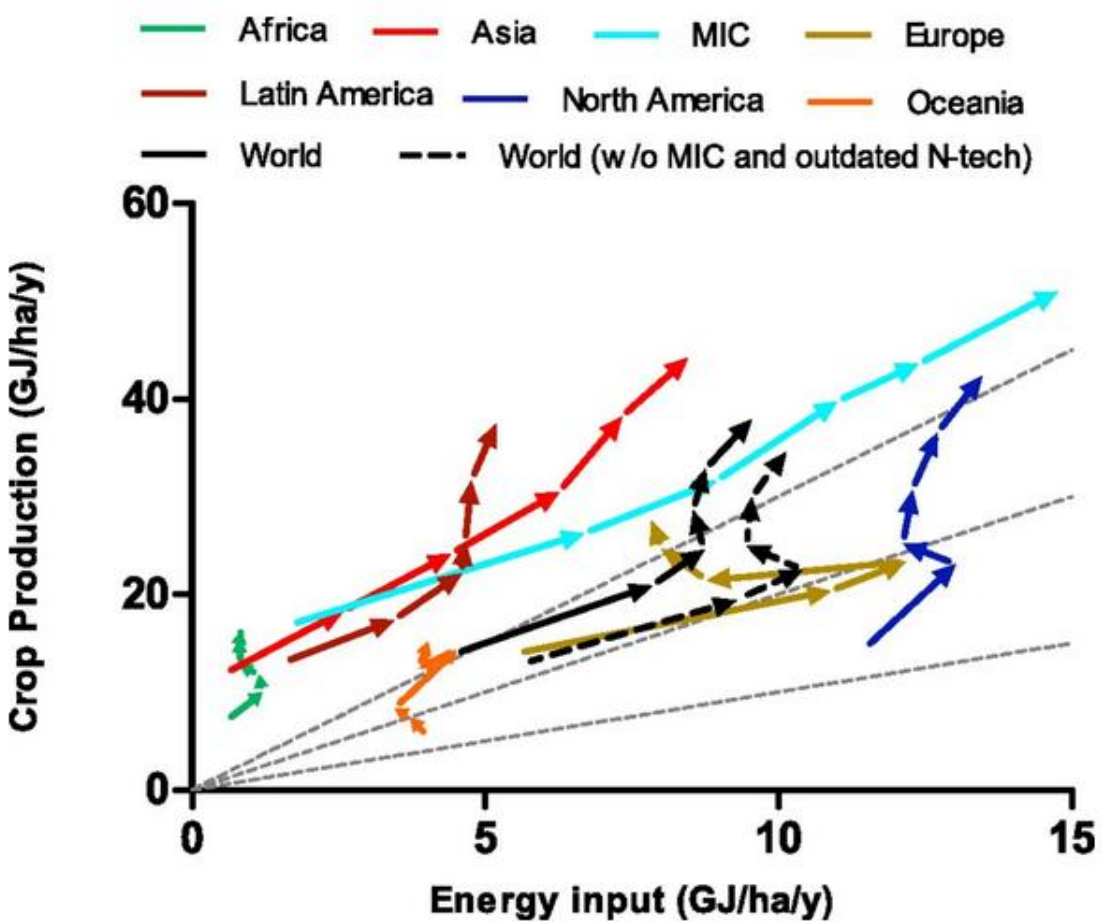
https://energypedia.info

Food consumes about 30% of global energy



FAO, 2011: “Energy-smart” food for people and climate – Issue Paper: http://www.fao.org/docrep/014/i2454e/i2454e00.pdf

Energy use for food varies



(Pellegrini and Fernández 2018, PNAS)

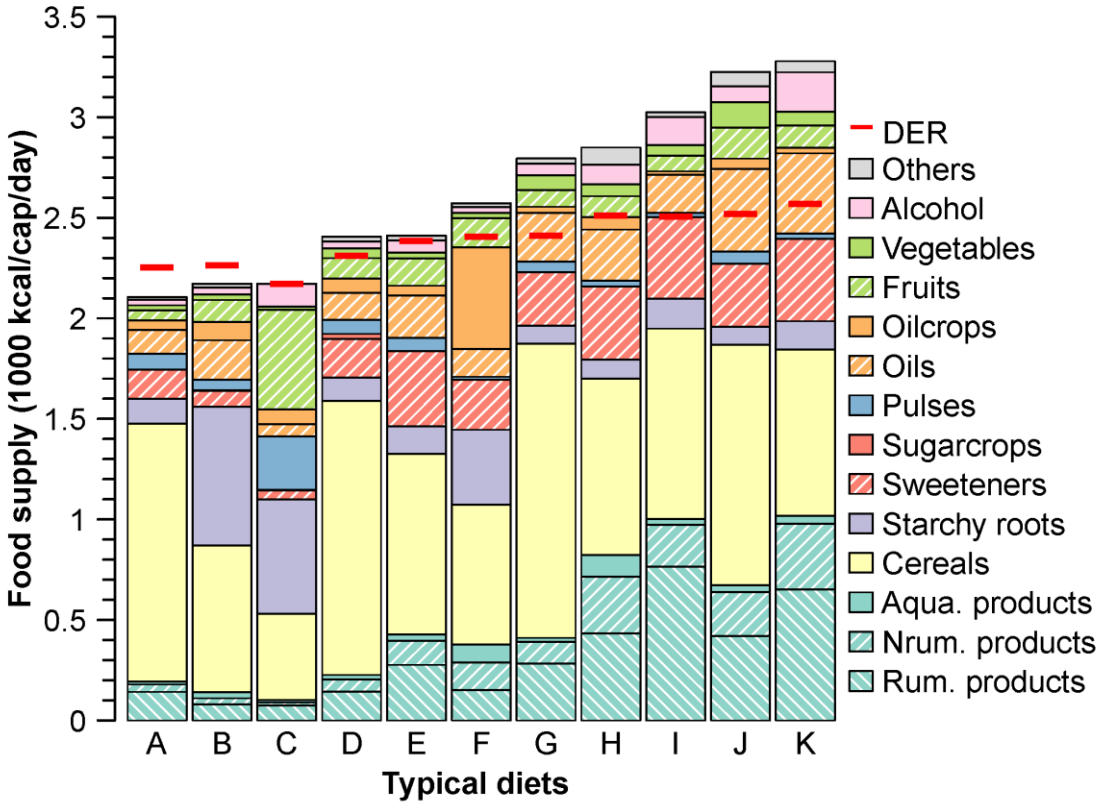
Total primary energy use (PEU)	PEU[a] GJ/t	
	UK	non-UK
Tomatoes (loose classic), Spain		
Pre-farm gate total	34.1	4.4
Transport to the UK	NA	3.6
Total	36.2	9.6
Strawberries, Spain		
Pre-farm gate total	12.9	8.3
Transport to the UK	NA	3.0
Total	14.6	13.3
Early potatoes, Israel		
Pre-farm gate total	1.5	1.9
Transport to the UK	NA	8.6
Total	2.8	10.5
Apples, New Zealand		
Pre-farm gate total	2.1	1.2
Transport to the UK	NA	7.5
Total	5.1	11.2
Lamb, New Zealand		
Pre-farm gate total	17.9	12.2
Transport to the UK	NA	7.5
Total	30.7	37.0
Poultry, Brazil		
Pre-farm gate total	15.9	12.2
Transport to the UK	NA	4.1
Total	21.1	24.7
Beef, Brazil		
Pre-farm gate total	41.3	7.8
Transport to the UK	NA	4.0
Total	44.4	17.1

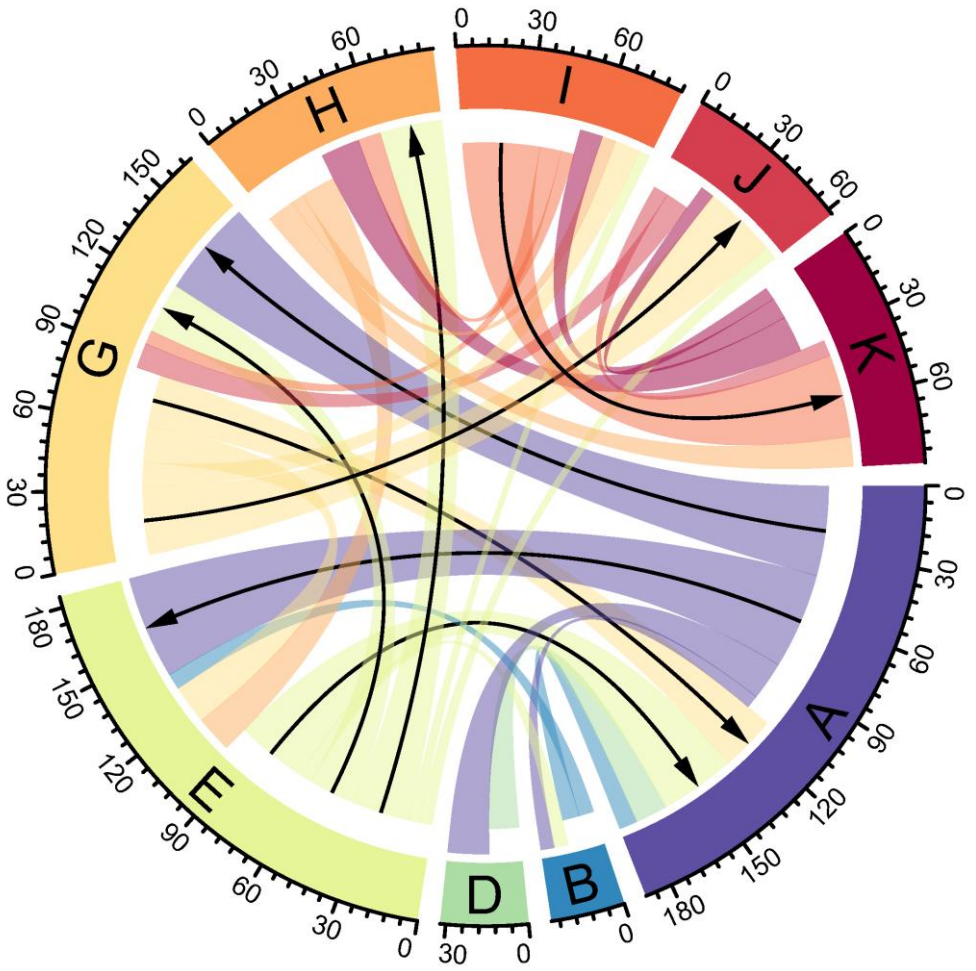
(Webb et al. 2013)

How have our diets changed in last decades?

Reflect on the food you have during childhood and now.

Dietary changes





(Pradhan and Kropp 2020, Sustainability)

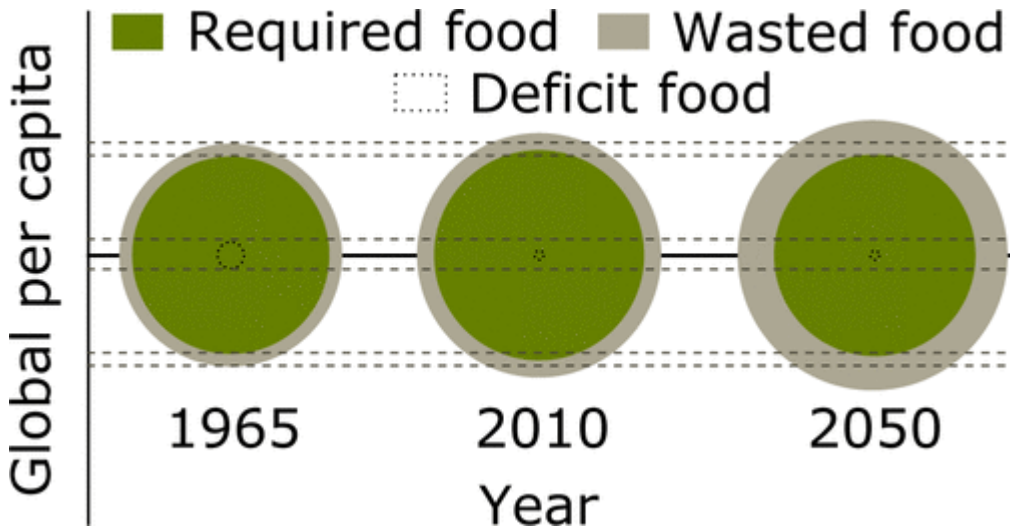
Was there food left today after your lunch?

Reflect on how much food do we waste or loss.

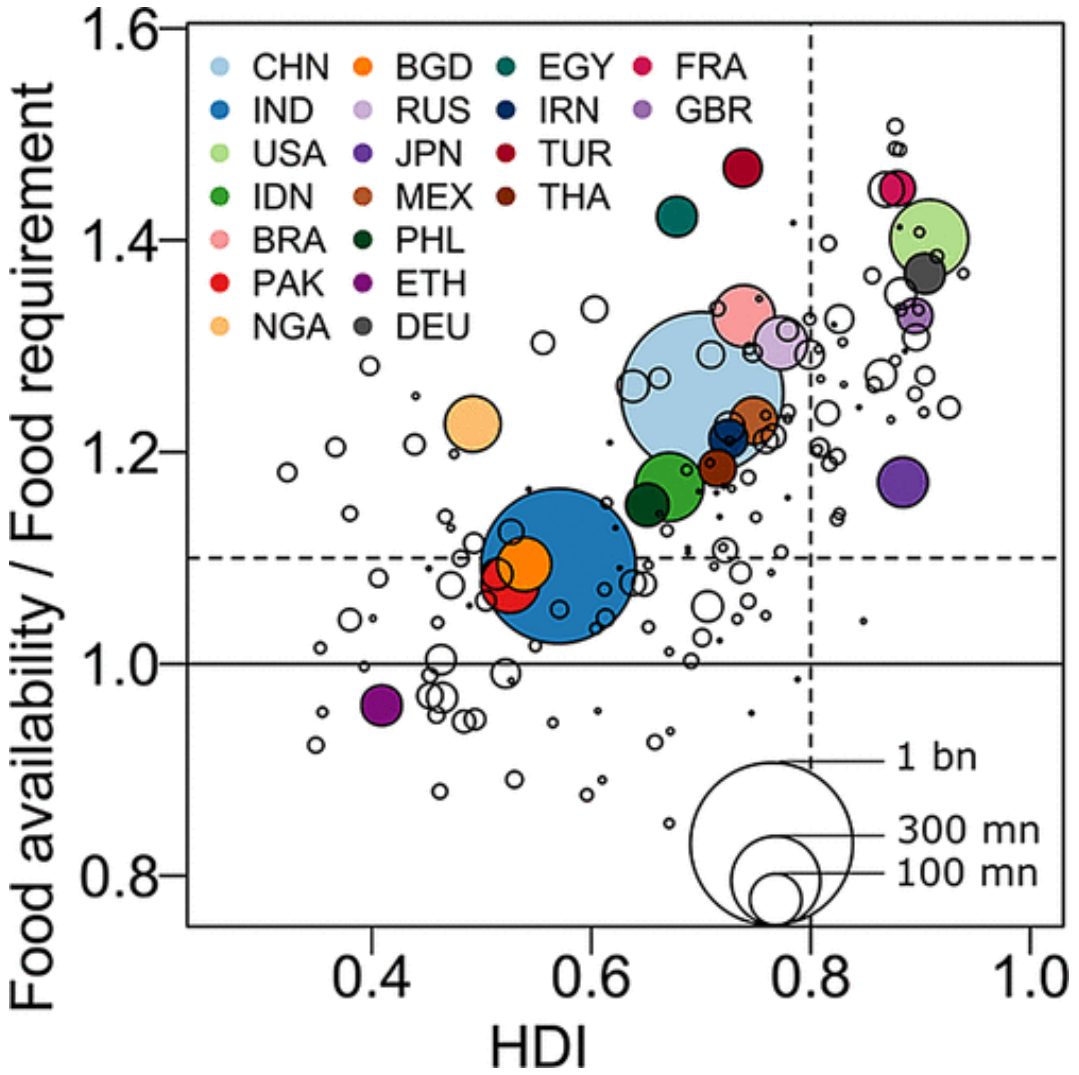
Food loss and waste

- 30%- 40% of food is lost and wasted in both developing and developed countries (Godfray et al. 2010)
- food is lost and wasted across various stages of the food supply chain (FAO 2011)
- food loss is food decreased during production, post-harvest, and processing
- food waste is food discarded at the consumer level

The more developed we are, the more food we waste.



(Hic et al. 2016, ES&T)



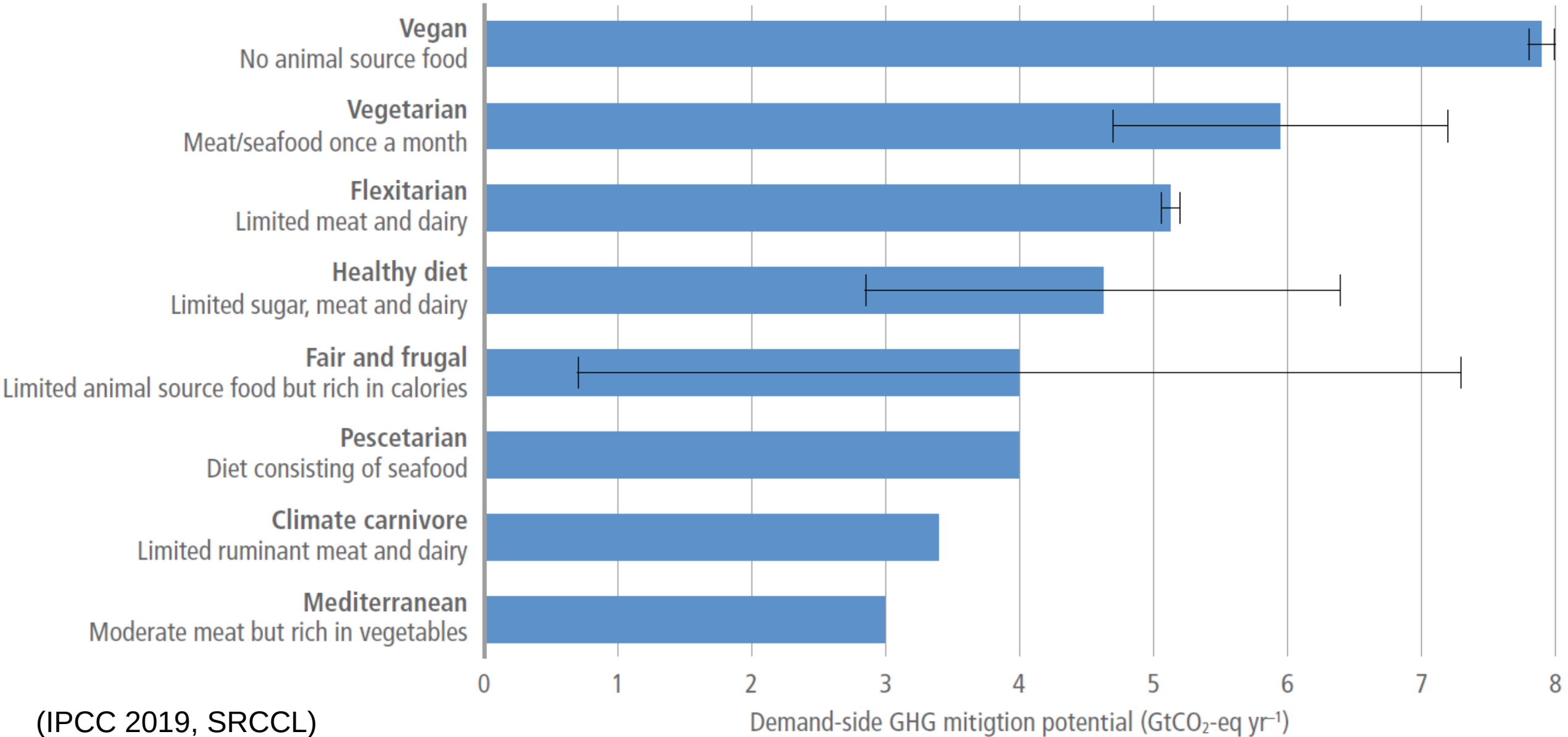
How can we transform our food systems?

Options are available to transform food systems with mitigation, adaptation, and other co-benefits.

(Rosenzweig et al. 2020, Nature Food)

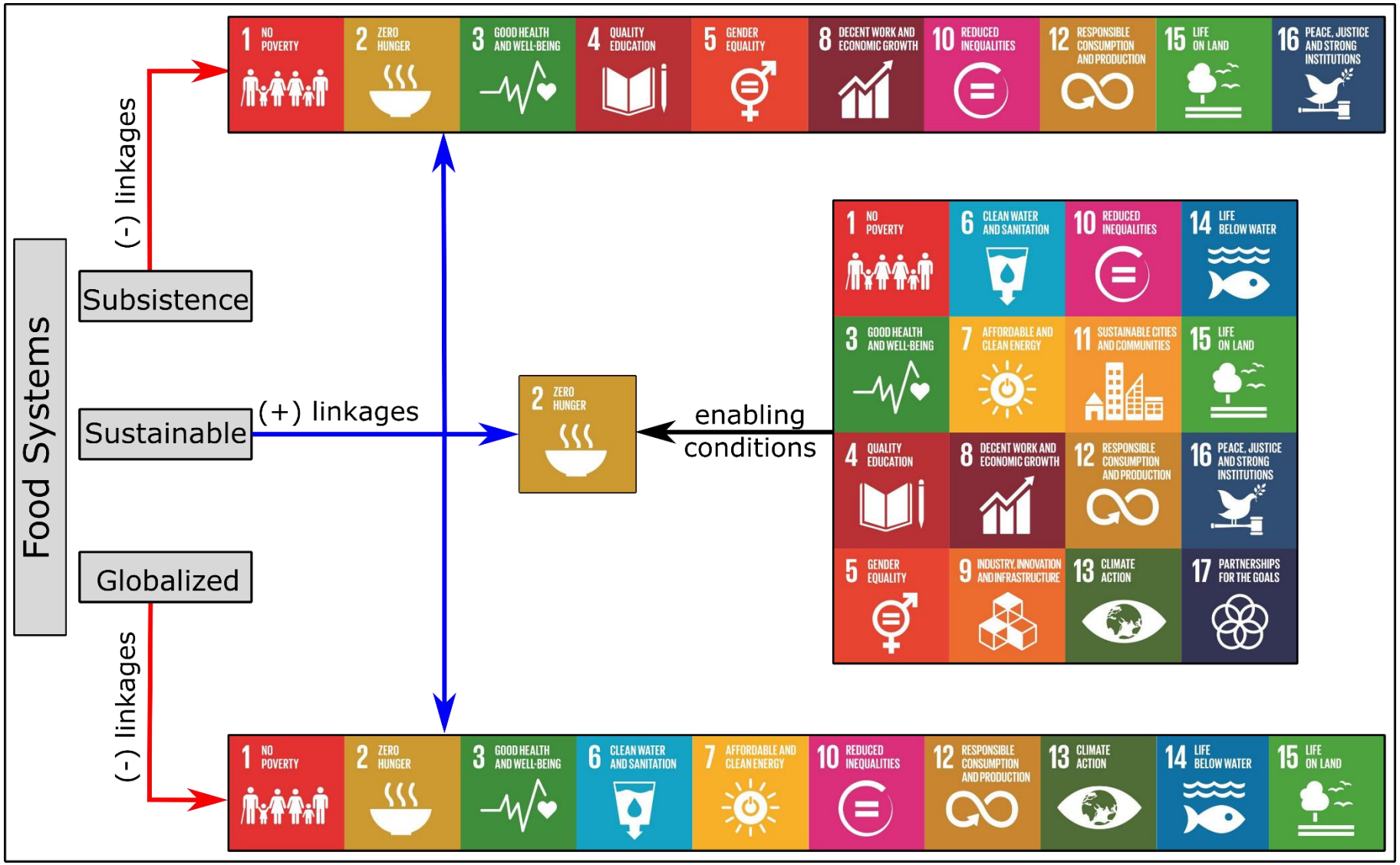
Demand-side mitigation

GHG mitigation potential of different diets



(IPCC 2019, SRCCL)

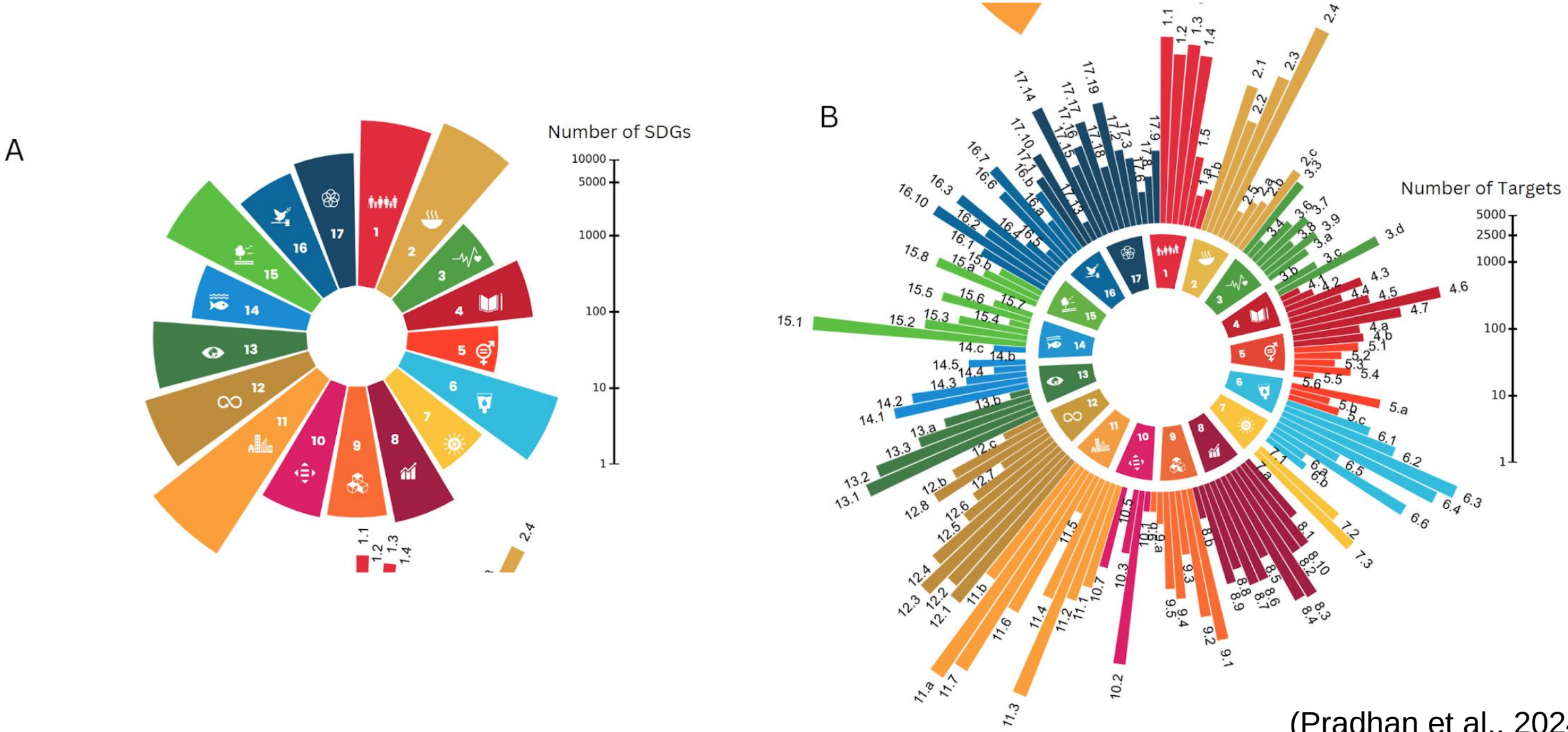
Sustainable food systems and SDGs



Pradhan et al. 2021 (Rural 2021)

Urban agriculture matters for sustainable development

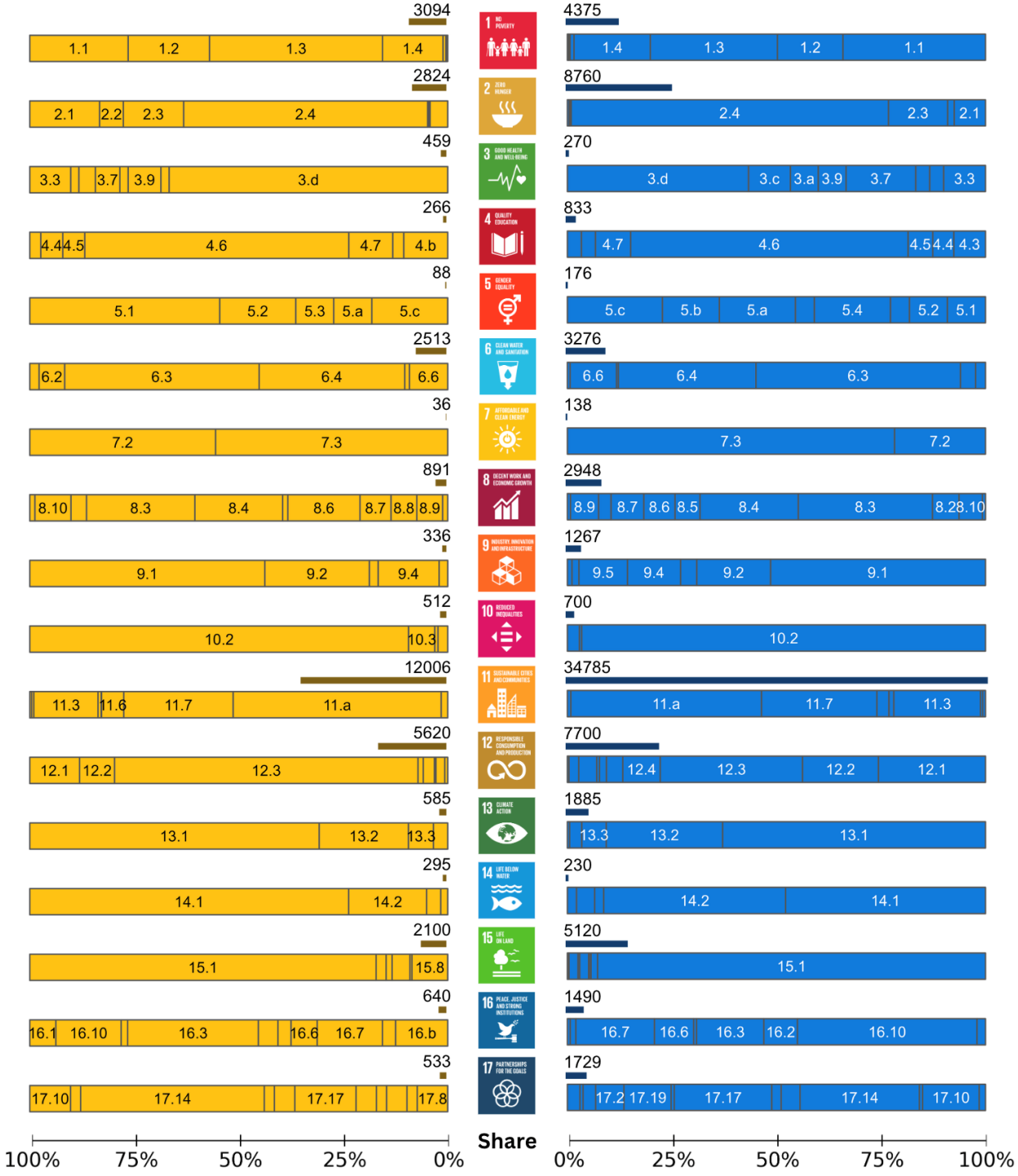
SDGs and urban agriculture

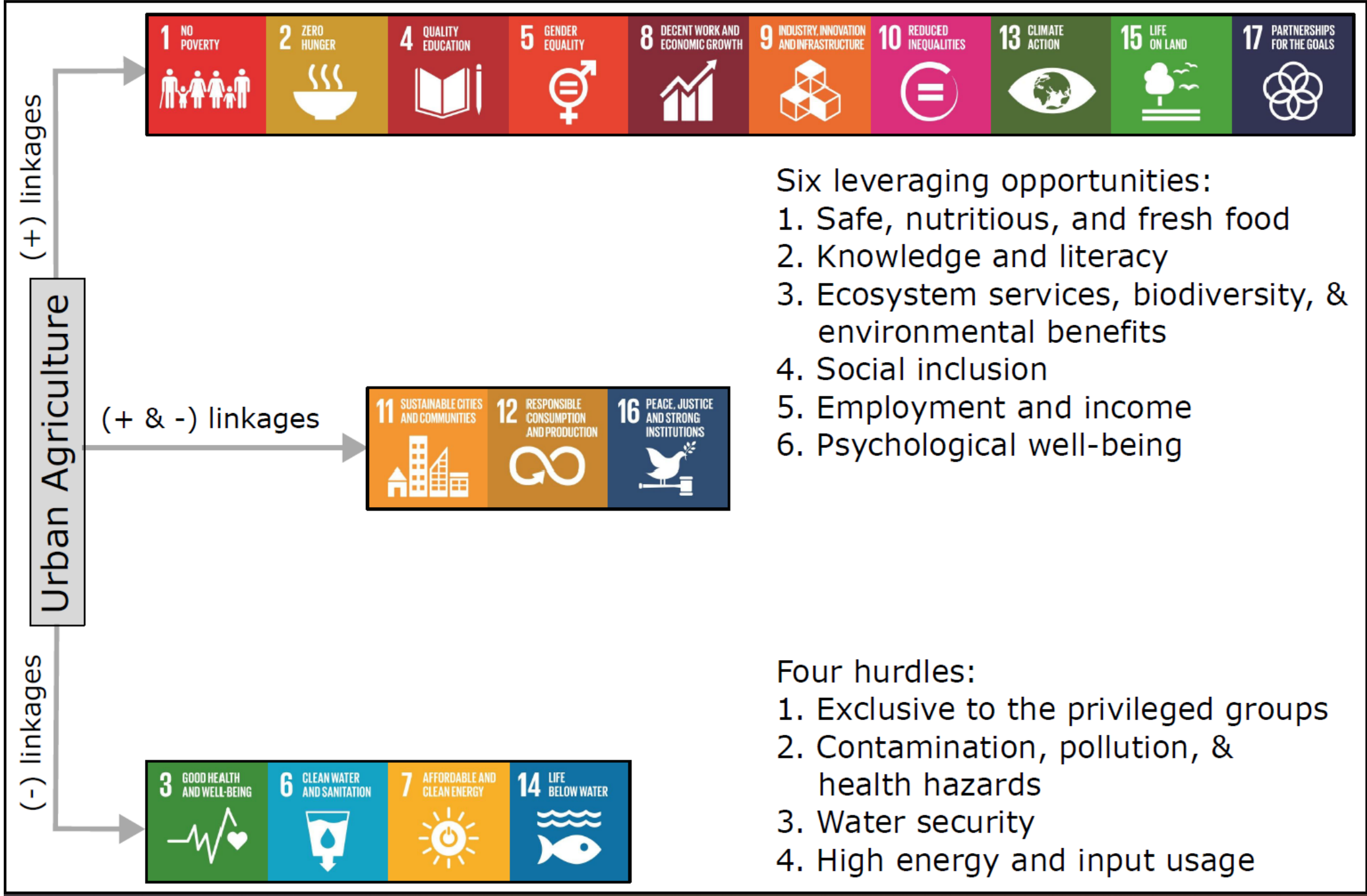


(Pradhan et al., 2024)

Sentiment analysis

› More positive than negative sentiment




Urban Agriculture
(+) linkages
1 NO POVERTY
2 ZERO HUNGER
4 QUALITY EDUCATION
5 GENDER EQUALITY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
13 CLIMATE ACTION
15 LIFE ON LAND
17 PARTNERSHIPS FOR THE GOALS
(+ & -) linkages
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
(-) linkages
3 GOOD HEALTH AND WELL-BEING
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
14 LIFE BELOW WATER
Six leveraging opportunities:
1. Safe, nutritious, and fresh food
2. Knowledge and literacy
3. Ecosystem services, biodiversity, & environmental benefits
4. Social inclusion
5. Employment and income
6. Psychological well-being
Four hurdles:
1. Exclusive to the privileged groups
2. Contamination, pollution, & health hazards
3. Water security
4. High energy and input usage

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Article

Urban agriculture matters for sustainable development

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Recap

- Concept of food system
- Environmental impacts from the food system
- Greenhouse gas emissions from the food system
- Response options for the food system transformation

Thank you very much!

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