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CLIMATE IMPACT RESEARCH

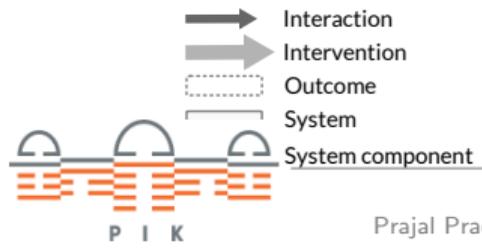
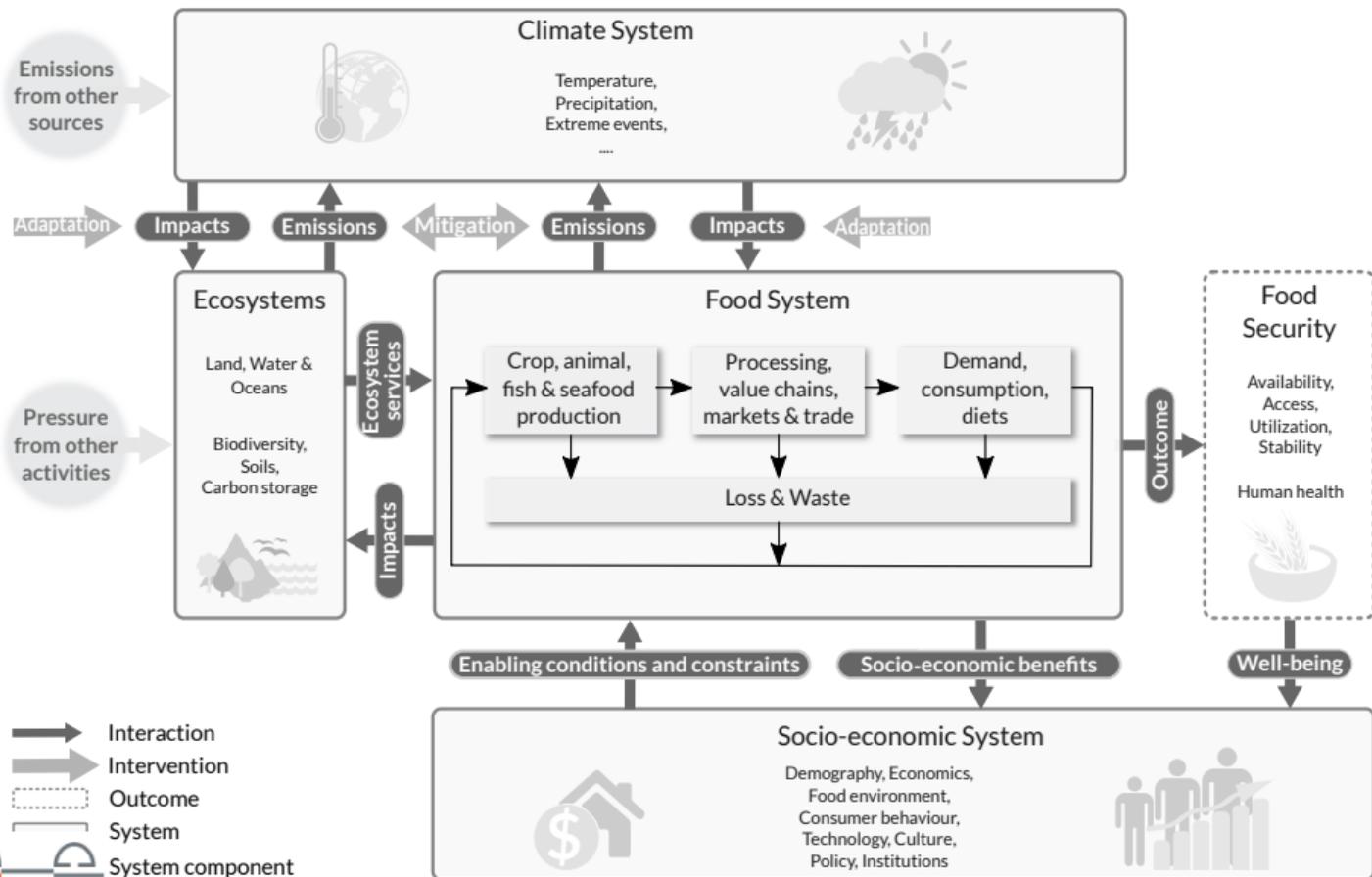
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Food systems transformation for climate change mitigation and sustainable development

Prajal Pradhan

Climate Change Challenges and Responses

5th March 2023, Asian Institute of Technology



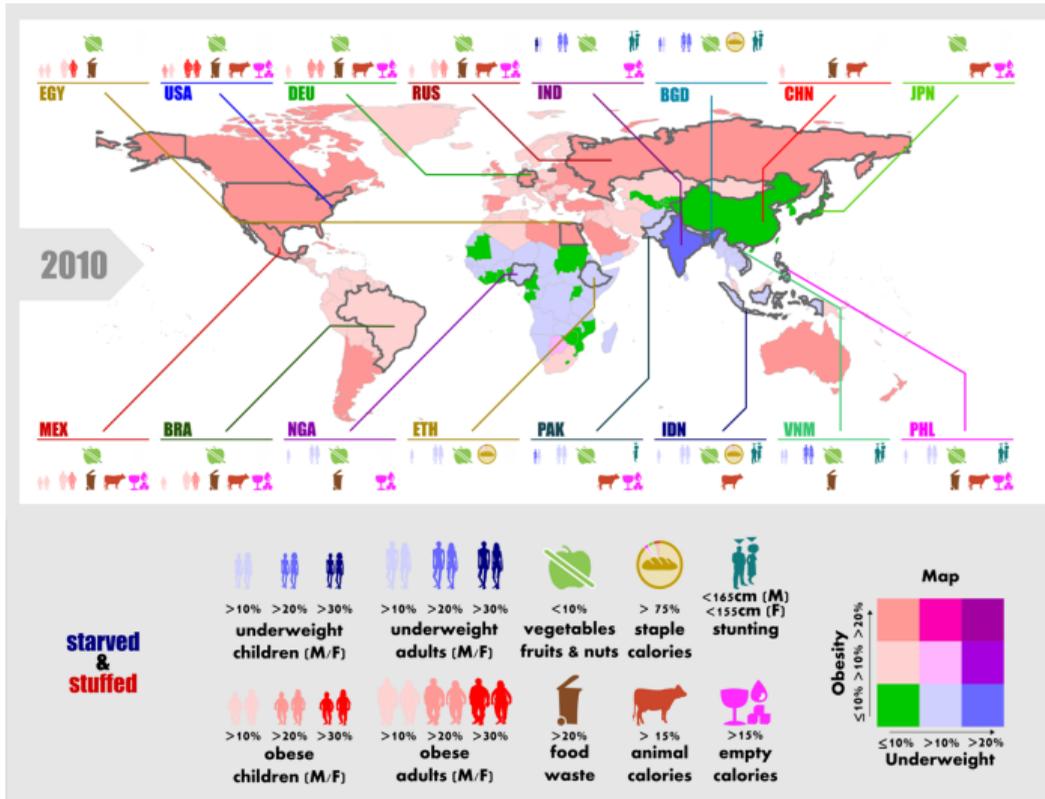


A cattle rancher in Brazil, where pressures to produce more meat collide with the need to reduce deforestation and greenhouse-gas emissions.

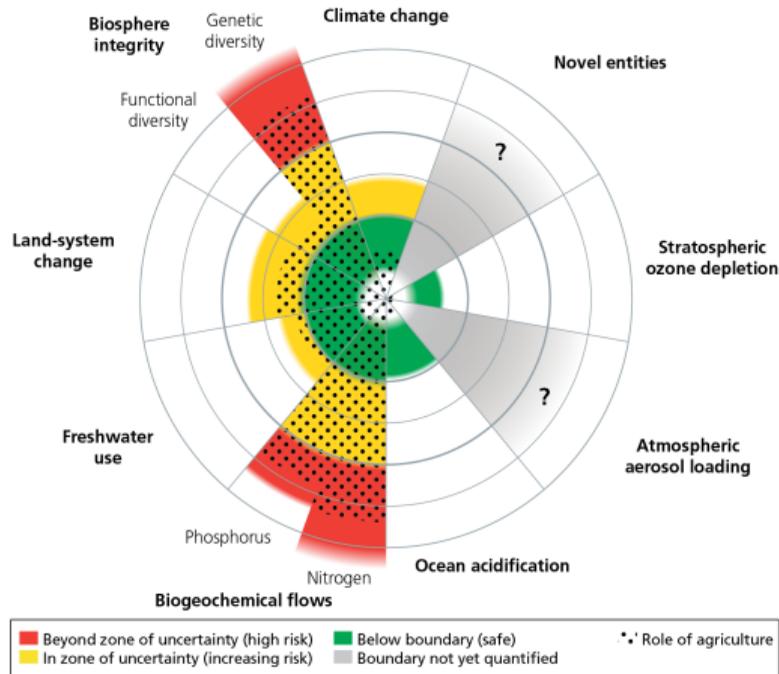
Fix the broken food system in three steps

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

Food security status



Environmental implications



Campbell et al. 2017 (*Ecology & Society*)

Table 1 | Comparison of 2007–2016 mean values and standard deviations of emissions from AFOLU⁶ and global food system⁵ emissions by component, including food loss and waste

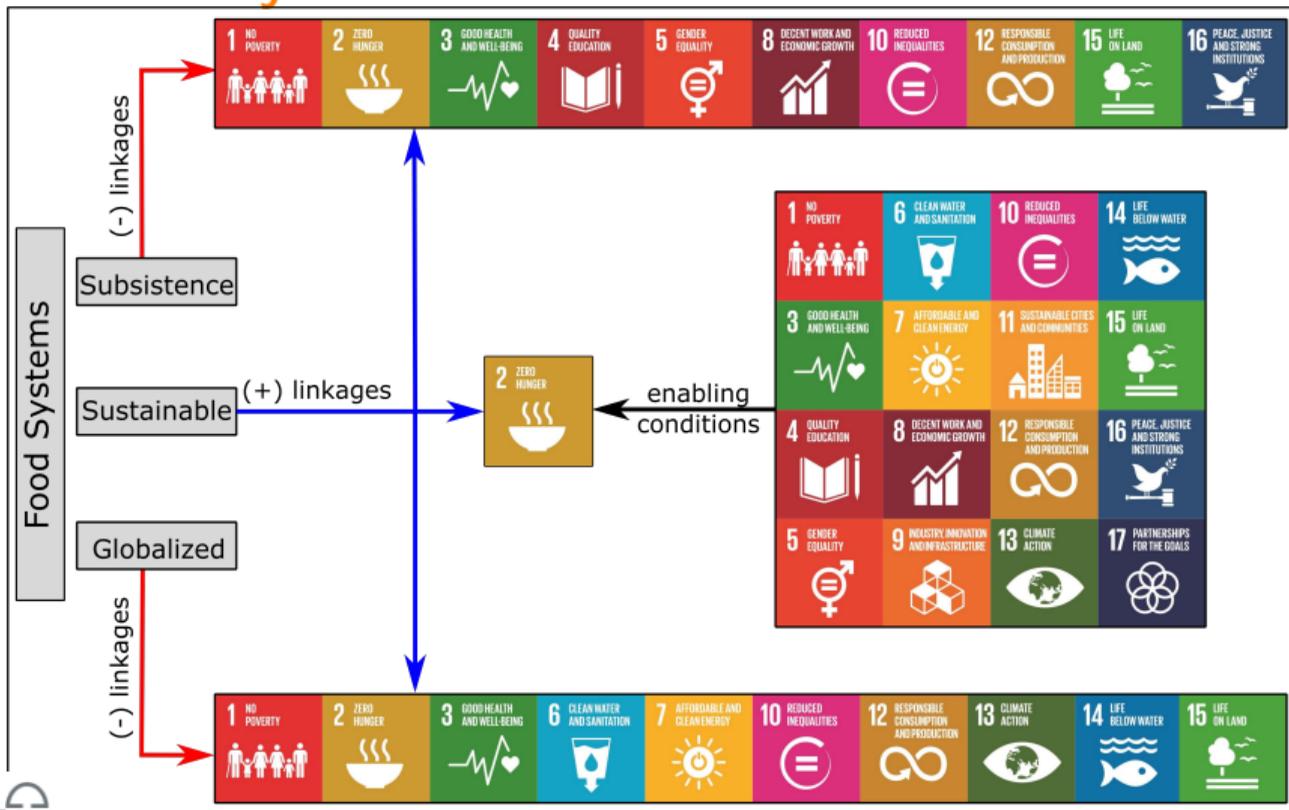
Components	AFOLU		Food system	
	Emissions (GtCO ₂ e yr ⁻¹) ^a	Percentage of anthropogenic GHG emissions (%) ^b	Emissions (GtCO ₂ e yr ⁻¹) ^a	Percentage of anthropogenic GHG emissions (%) ^b
Agriculture	6.2 ± 1.4 ^{18,19}	9–14	6.2 ± 1.4 ^{18,19}	9–14
FOLU ^c	5.8 ± 2.6 ⁶	6–16	4.9 ± 2.5 ¹⁸	5–14
Pre- to post-production	-	-	2.6–5.2 ^{7,8}	5–10 ^d
Total	12.0 ± 2.9	17–29	10.8–19.1	21–37

^aMean and 95% confidence interval, using GWP values of the IPCC AR5 with no climate feedback (GWP-CH₄ = 28; GWP-N₂O = 265).
^bComputed using a total emissions value for the period 2007–2016 of 52 GtCO₂e per year⁶. ^cFood-related FOLU for food system columns.
^dRounded to nearest fifth percentile due to assessed uncertainty in estimates.

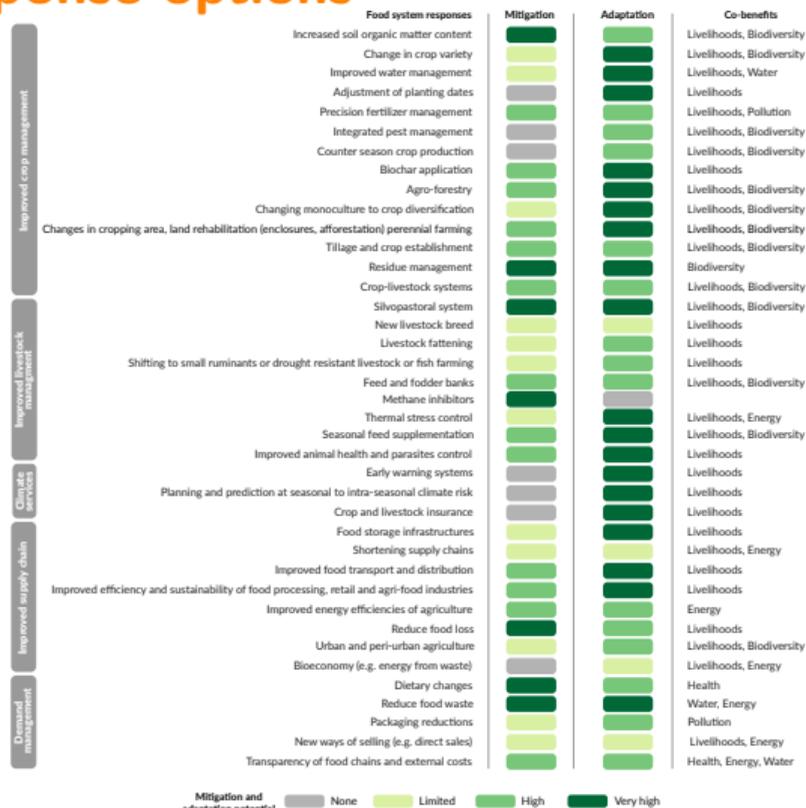
Rosenzweig et al. 2020 (*Nature Food*)



Sustainable food systems and SDGs

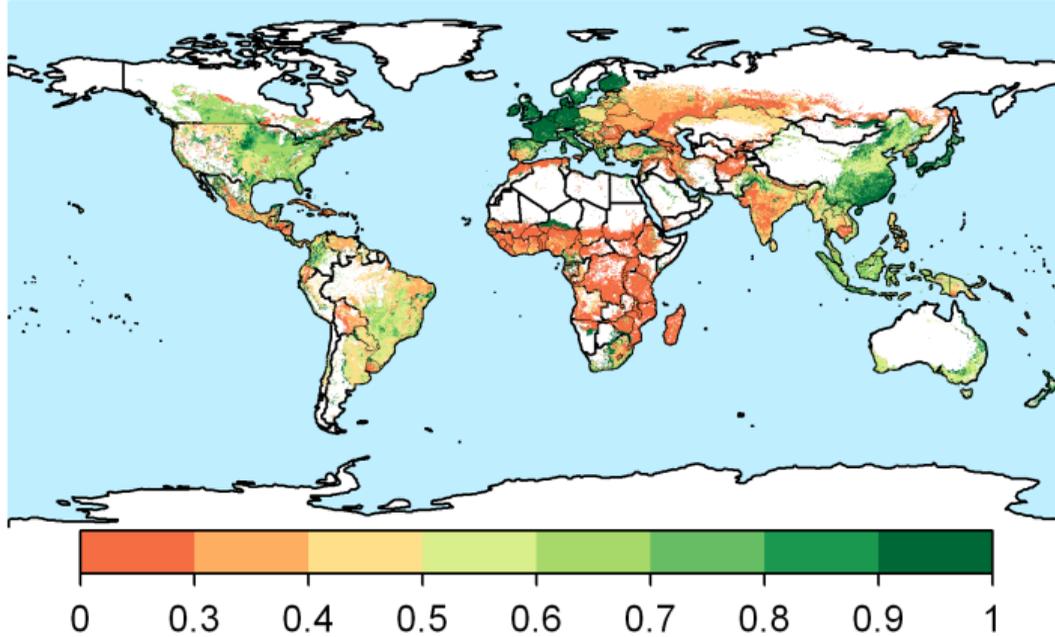


Food systems response options

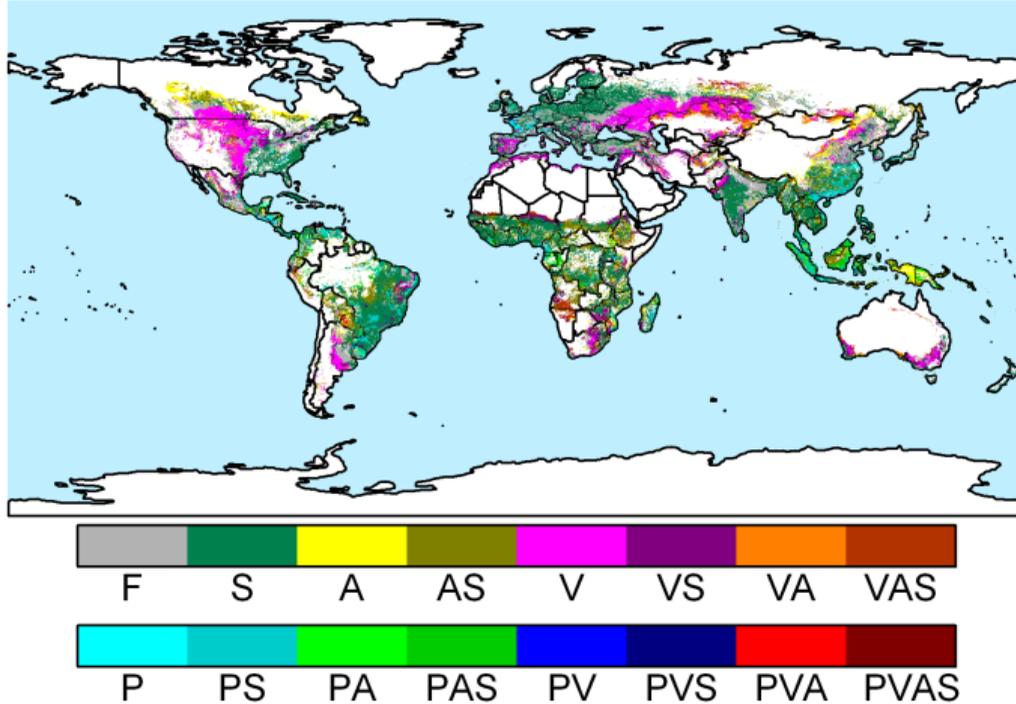


Crop production gaps

Most regions in Africa, South Asia, and Eastern Europe are lag behind in attaining their potential crop calorie production.



Required strategies to close yield gaps



inputs and management required additional to fertilizer application (F): management of soil quality (S), market accessibility (A), climatic yield variability (V), and pests, diseases, and weeds (P)

Diets, health, and climate change

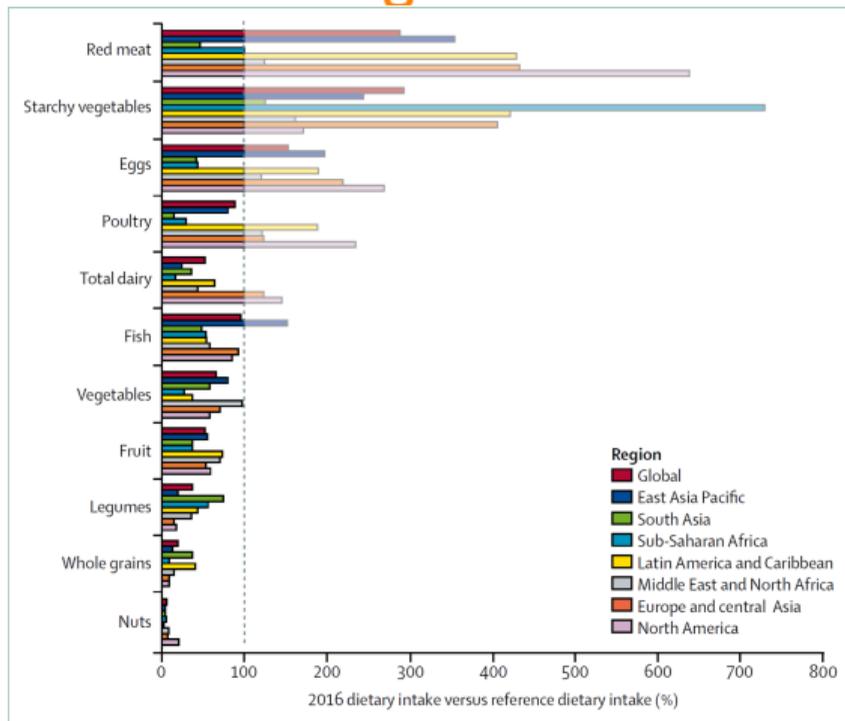
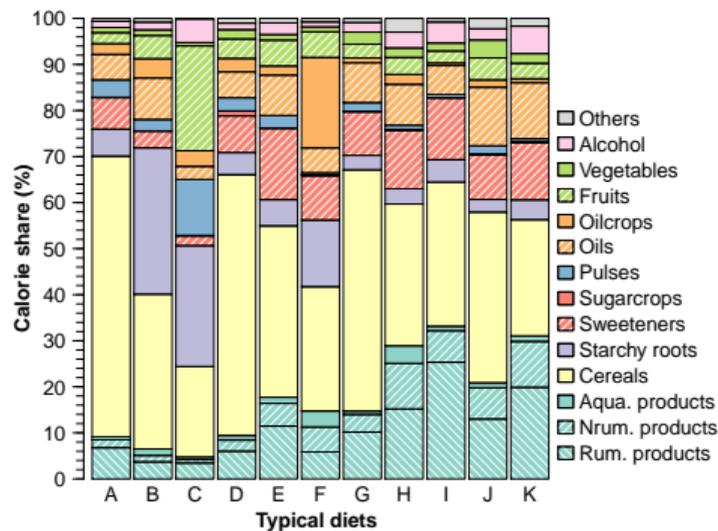
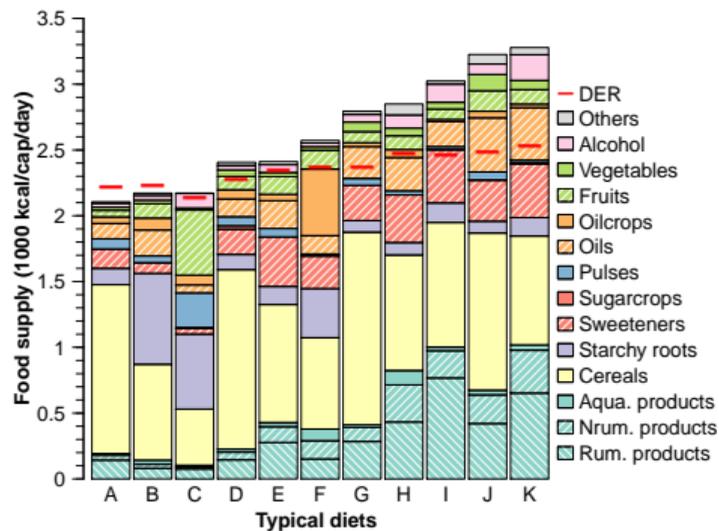


Figure 1: Diet gap between dietary patterns in 2016 and reference diet intakes of food

Data on 2016 intakes are from the Global Burden of Disease database.¹⁰⁰ The dotted line represents intakes in reference diet (table 1).

Diets, health, and climate change

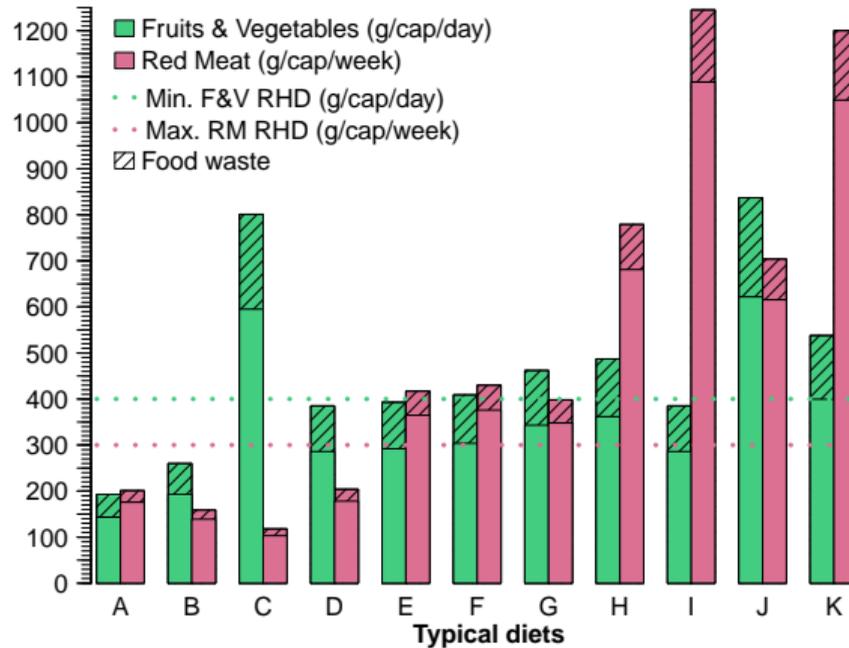


Typical diets across the world between 1961–2013:
 an update from Pradhan et al. 2013 (Plos One).



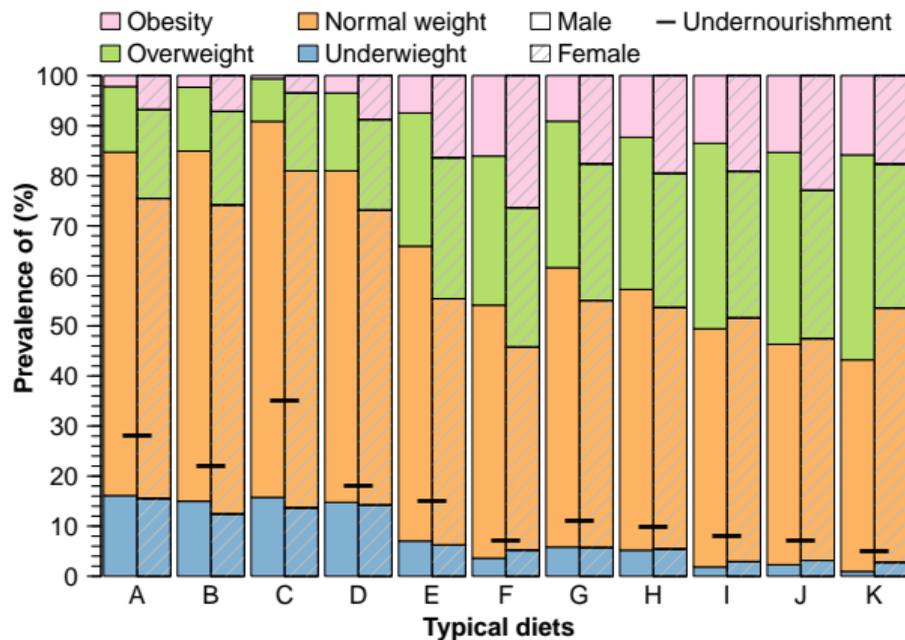
Recommended healthy diets

Most diets contain either higher than recommended amount of red meat or lower than advised value of fruits and vegetables.



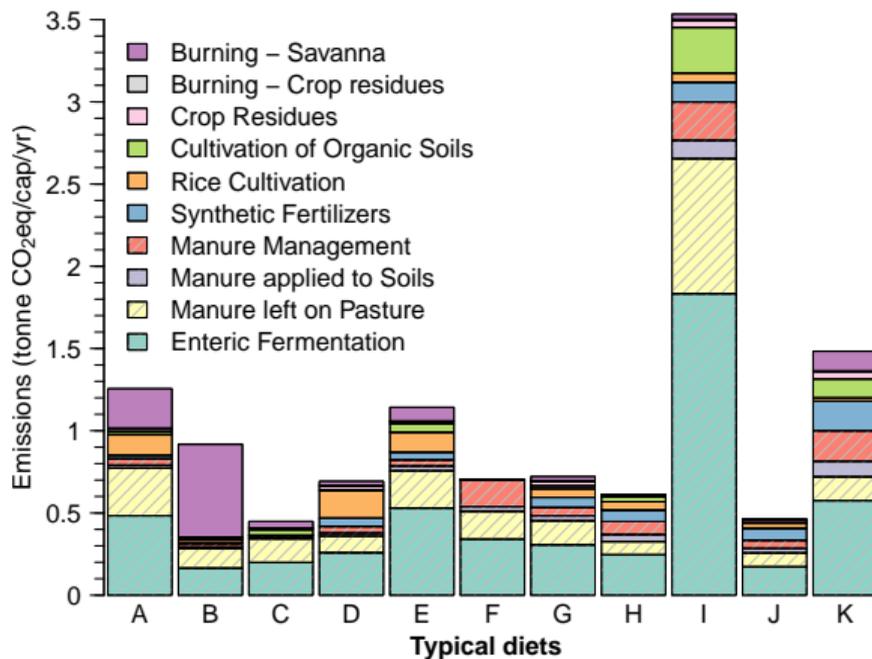
Diets and body mass index (BMI)

Prevalence of BMIs varies with diets for both male and female population. A larger share of female than male is suffering from obesity.



Diets and Emissions

The production phase agricultural GHG emissions associated with the diets do not provide a clear relation with the calorie supply.



Spatial distribution of diets

The share of global population consuming the low-energy diets (A–C) decreased from



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)



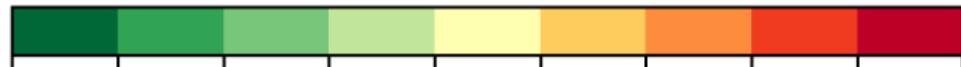
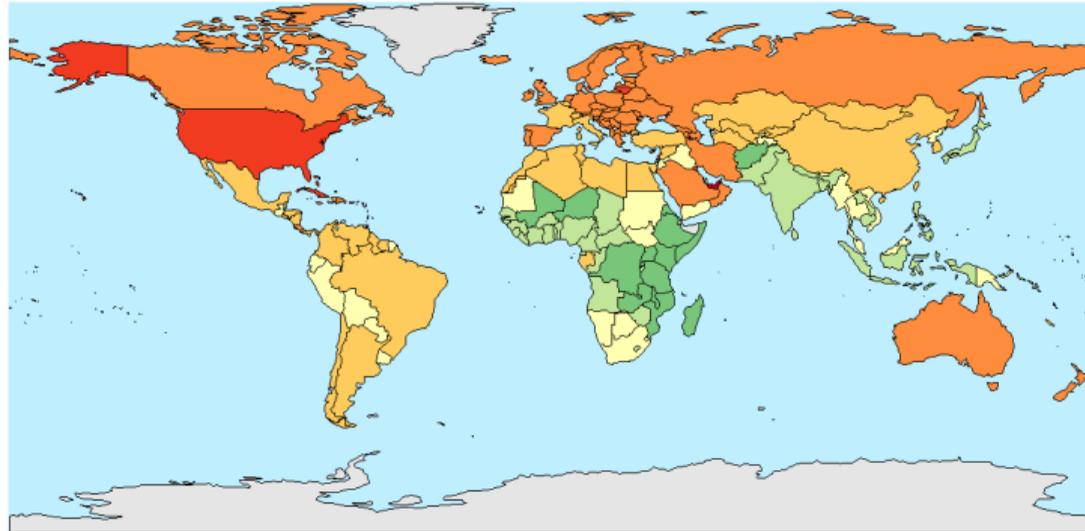
Food loss and waste

- **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 – food decreased during **production, post-harvest, and processing**
- food waste – **food discarded at consumer level**



Food energy requirements

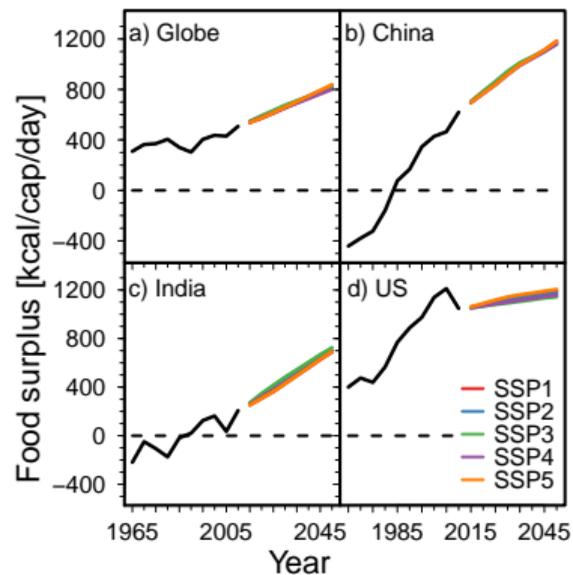
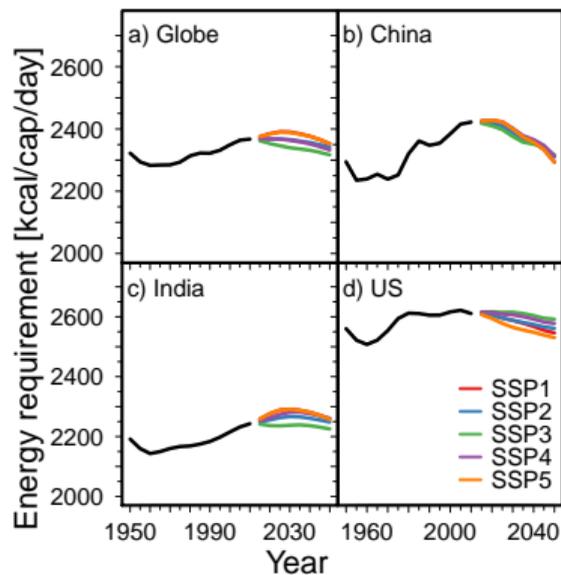
Country with **heavy body weights** or **larger share of adult population** requires larger food energy.



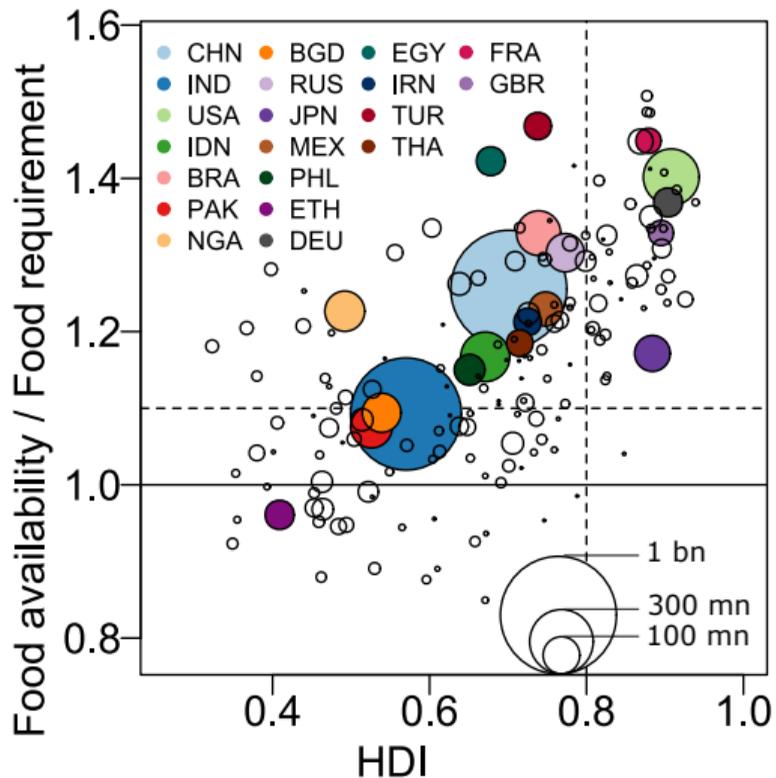
1800 2000 2100 2200 2300 2400 2500 2600 2700 2800

Country scale food energy requirements for 2010 considering moderate PAL in kcal/cap/d
(Hiç et al. 2016, ES & T)

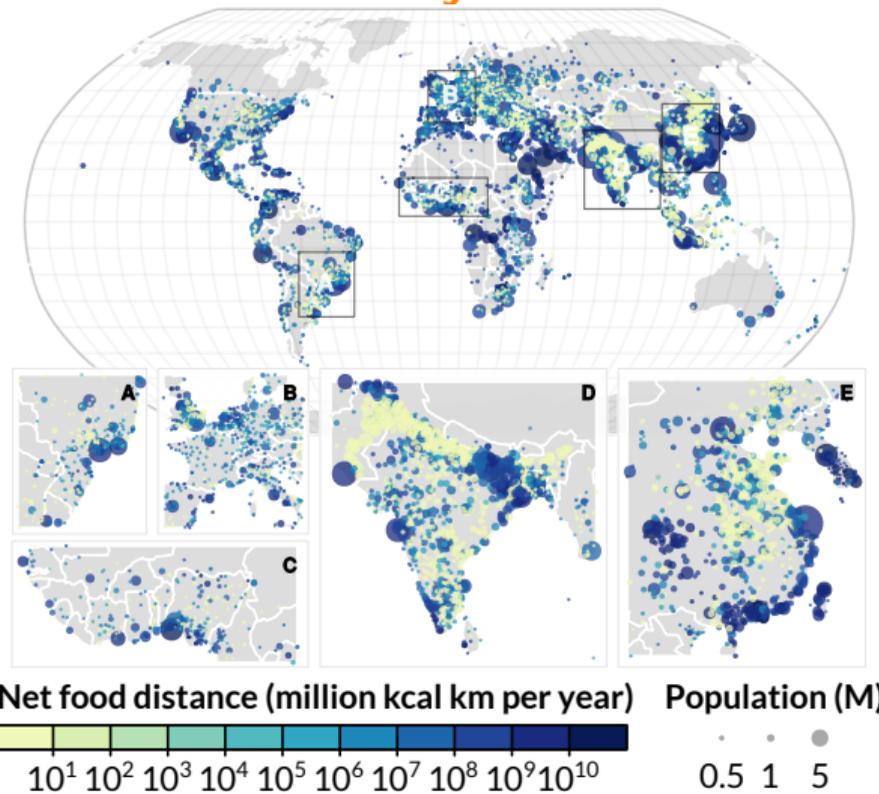
Food requirements and waste



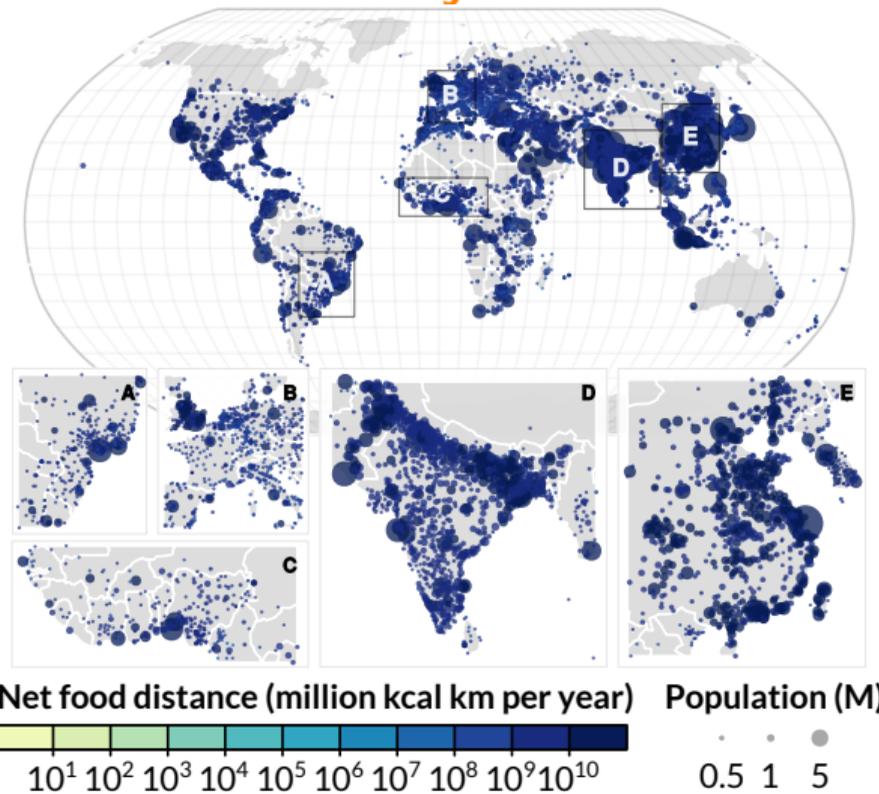
Human development index and food waste (2010)



Regionalized vs Globalized food systems



Regionalized vs Globalized food systems



Emissions under different food systems (2010)

Food systems	Baseline	FW	CYG	FW & CYG	FG
Regionalized	0.150	0.103	0.089	0.061	0.287
Globalized	1.872	1.748	1.869	1.745	1.738

FW: food waste reduction by 50%

CYP: closing crop yield gaps by 50%

FW-CYP: combination of FW and CYP

FG: eight food groups

Global food transport emissions in 2010 is 0.8 GT CO_{2eq}/yr

Regionalization of urban food systems by consuming **local and regional** food can **halve the emissions** due to food transport

CLIMATE CHANGE

Food transport emissions matter

Trade enables food access and is therefore key to achieving global food security. However, greenhouse gas emissions associated with food transport are many times higher than what was indicated by previous estimates.

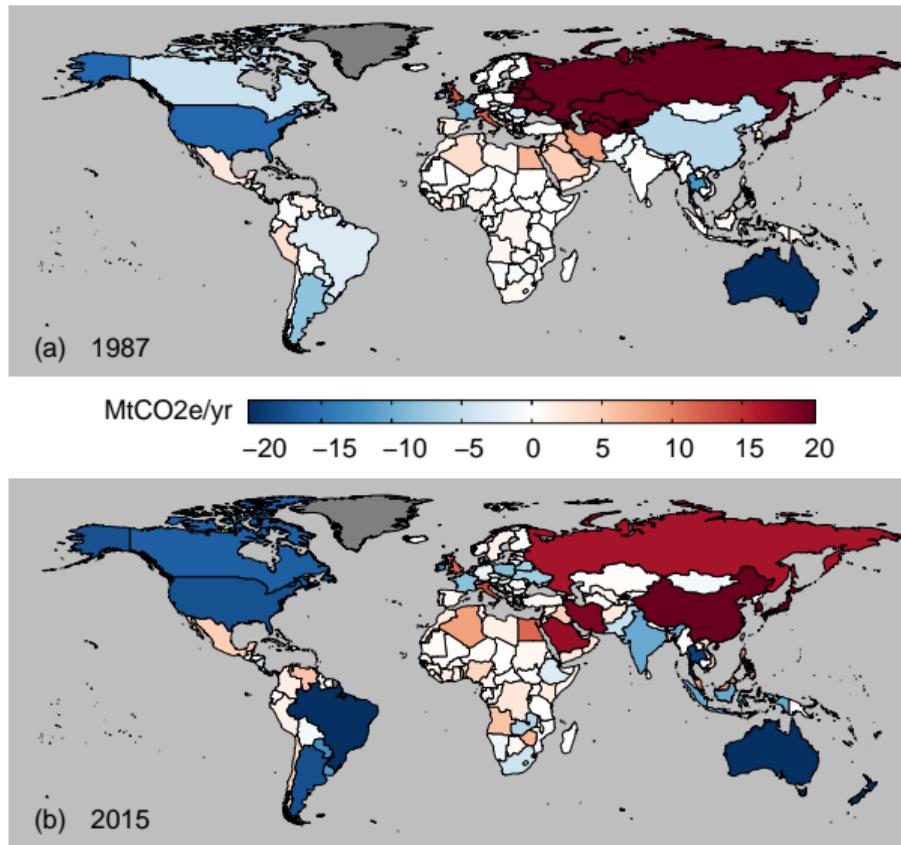
Prajal Pradhan

Without reducing greenhouse gas (GHG) emissions from food systems, it would not be possible to limit global warming to well below 2 °C, even if fossil fuel emissions were immediately stopped¹. Food systems contributed around 21–37% of global anthropogenic GHG emissions for the period 2007–2016 (ref. 2). Response options are available to reduce these emissions at various stages of food systems, from pre-production to post-consumption^{3,4}. One of these stages is food trade and transport, which plays a crucial role in increased global food distribution and accessibility⁵. However, the mitigation potential of food transport emissions, for example, by reducing food miles, is debated. 'Food miles' is the distance food is transported to reach its consumers. Food transport emissions due to food miles have so far been considered a small share of the food systems emissions⁶.

Writing in Nature Food 1 and



Differences between trade-adjusted agricultural emissions and production-based emissions.



Urban and Peri-urban agriculture

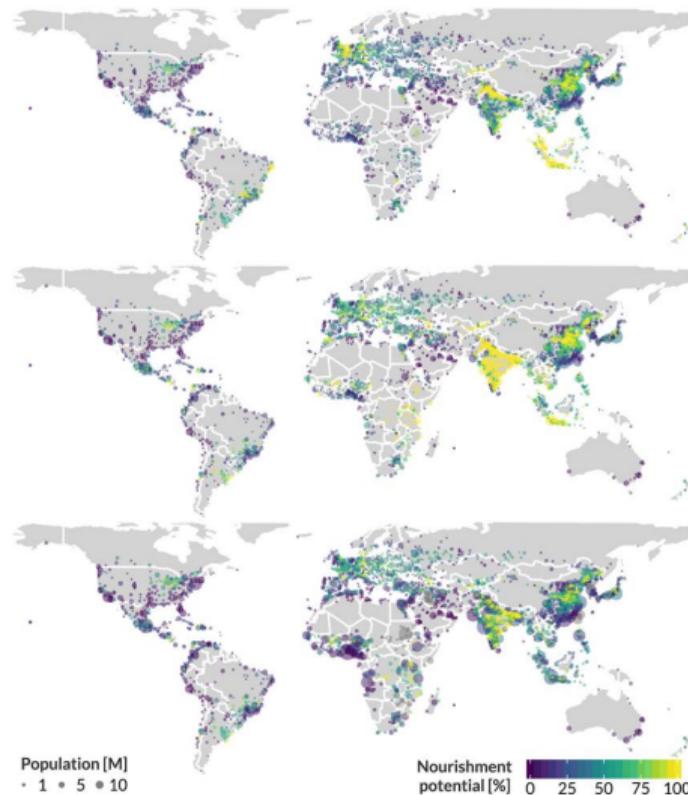
	Pop.	Share
2010	1.09	30.6
2010 CYG	1.26	35.3
2050 CC	1.40	22.1

Pop.: population in billion

Share: Share of the urban population
(%)

CYG: closing crop yield gaps

CC: Climate change RCP 8.5

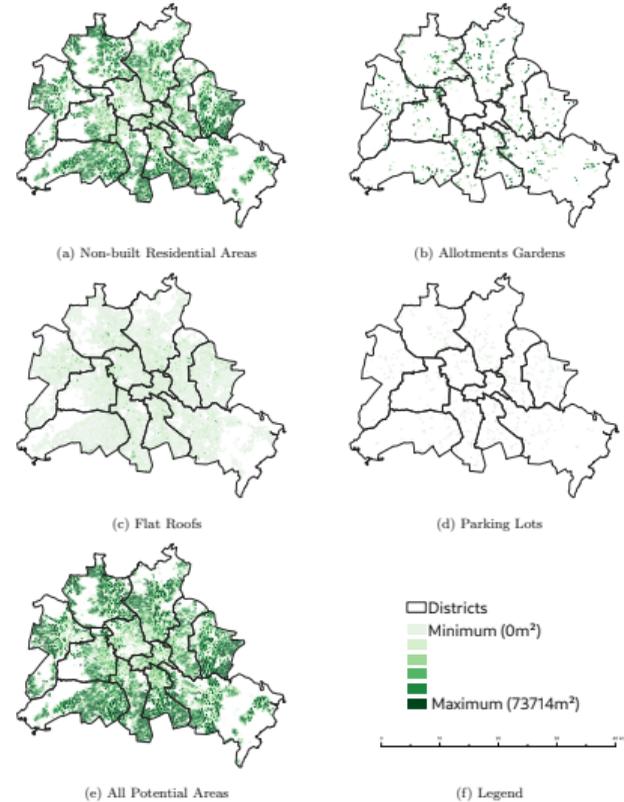


Urban agriculture in Berlin

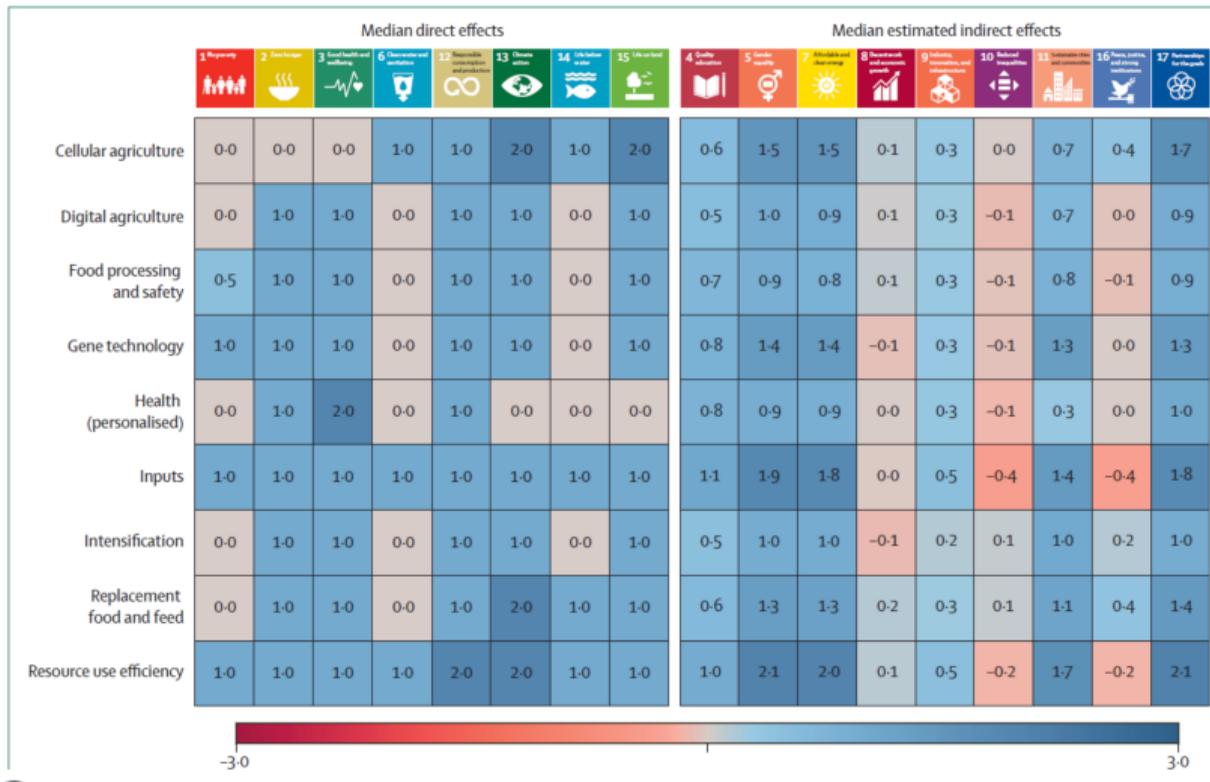
Table 2

Potential vegetable production under different usages of potential areas (scenarios A–C) and yields (scenarios 1–3). The production is given in tons/year, and the self-sufficiency is as a percentage of Berlin's vegetable consumption.

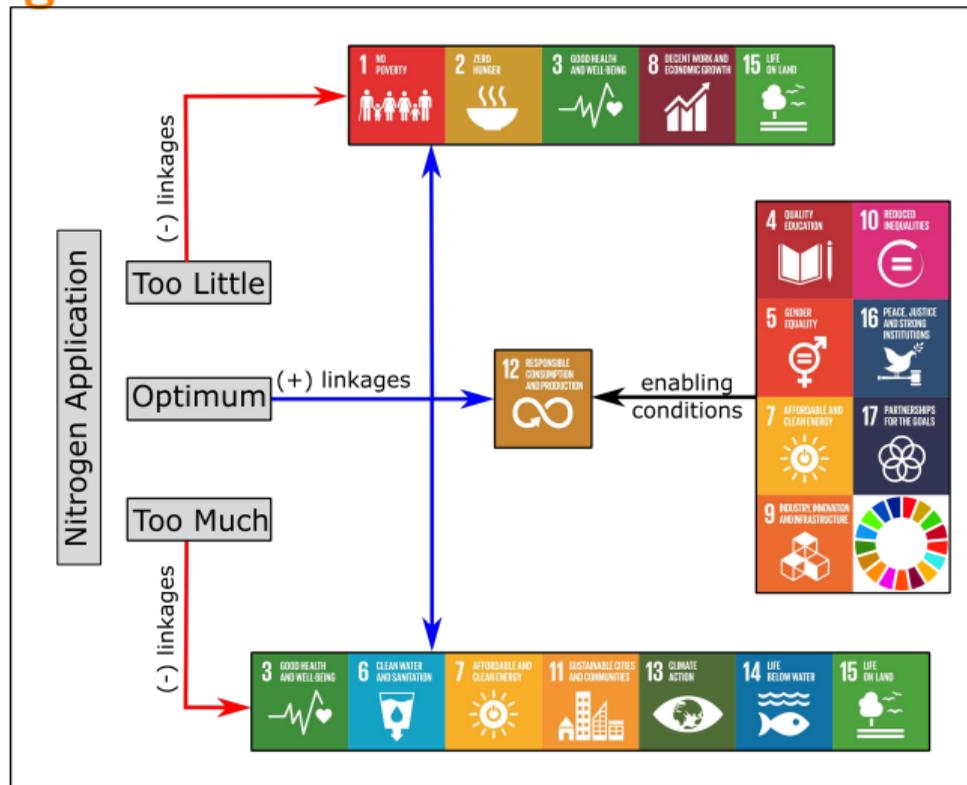
	Scenario A	Scenario B	Scenario C
Scenario 1	18 779 5%	37 557 10%	56 905 16%
Scenario 2	49 756 14%	99 513 28%	150 777 42%
Scenario 3	97 868 27%	195 736 54%	296 570 82%



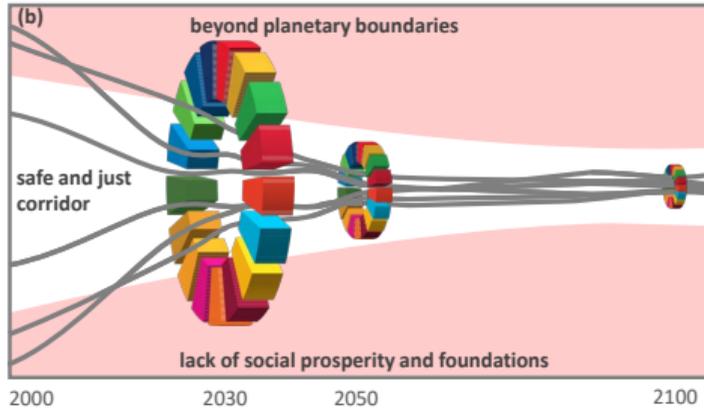
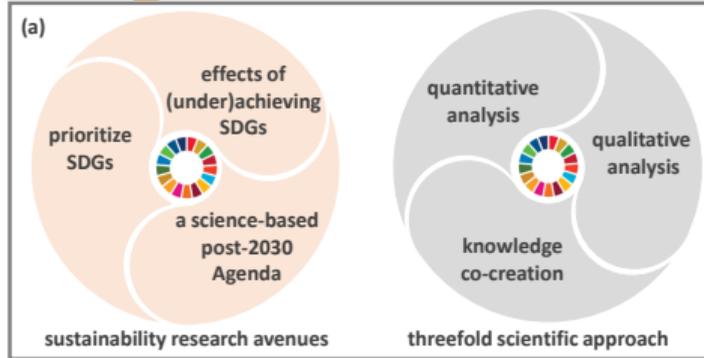
Food system innovations and SDGs



Optimum Nitrogen crucial for SDGs and vice versa



Rescue SDGs from failing



Summary

- currently food systems are broken
- response options are available throughout the food systems, from production to consumption, to fix the broken food systems
- food systems transformation provide multifold **social, economic and environmental benefits**





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Thank You...



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