POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

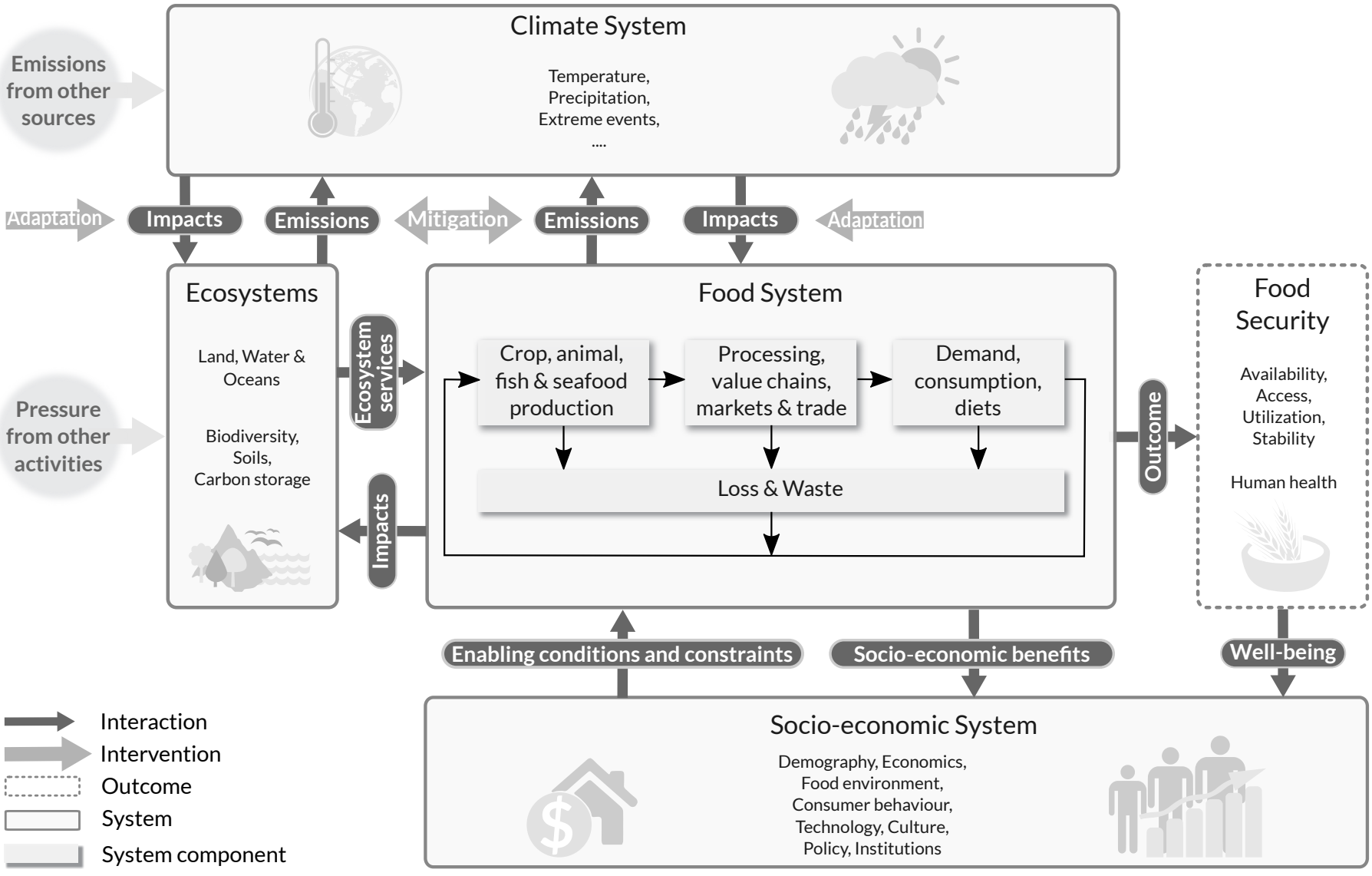
Needs for food systems transformation for climate change mitigation and sustainable development

Prajal Pradhan

Climate Change Challenges and Responses

15th February 2022, Asian Institute of Technology

Food systems



IPCC 2019 (*SRCCL Chapter 5*)

Food system is broken

MARCO ANTONIO REZENDE/BRAZIL PHOTOS/LIGHTROCKET/GETTY

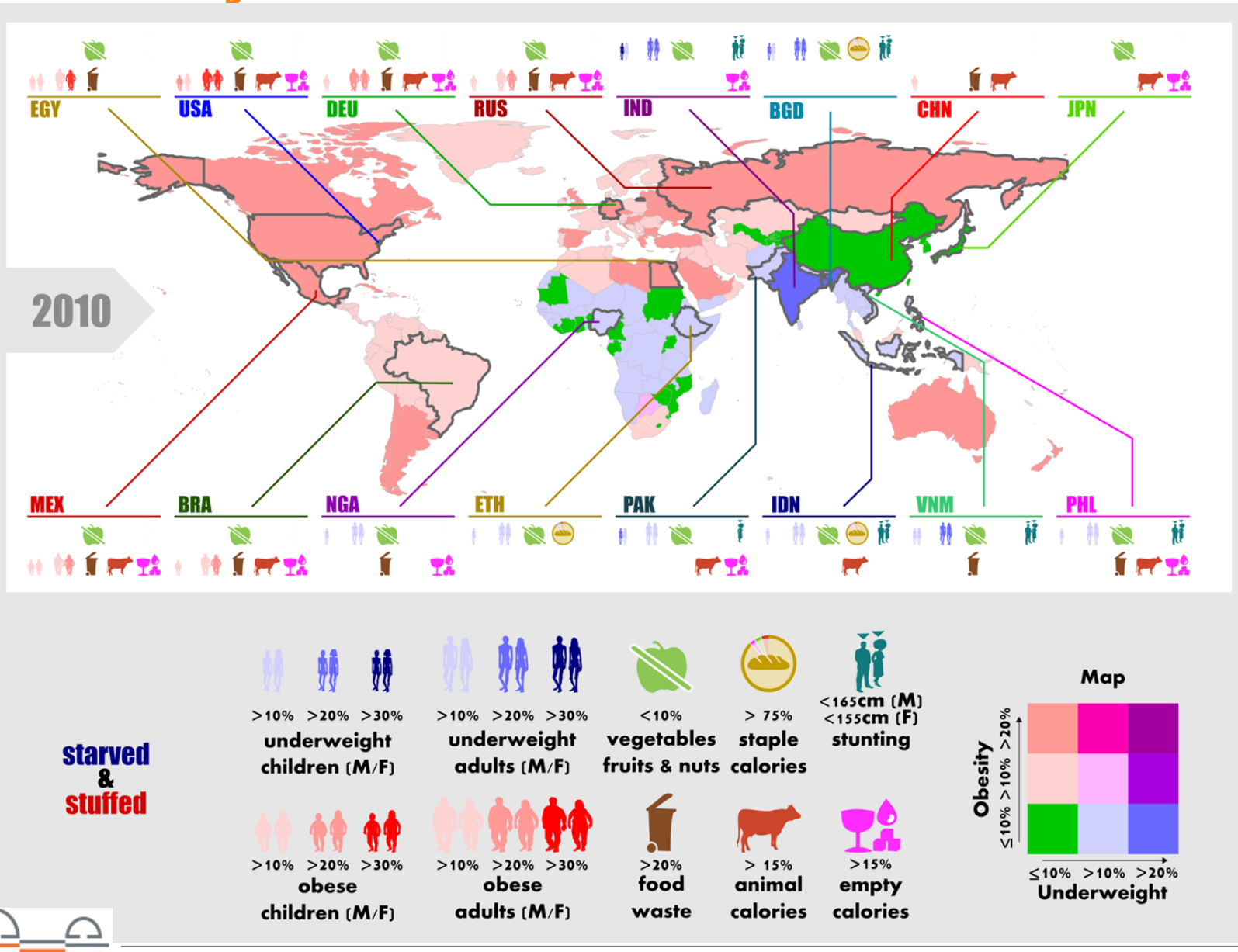
A cattle rancher in Brazil, where pressures to produce more meat collide with the need to reduce deforestation and greenhouse-gas emissions.

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**.

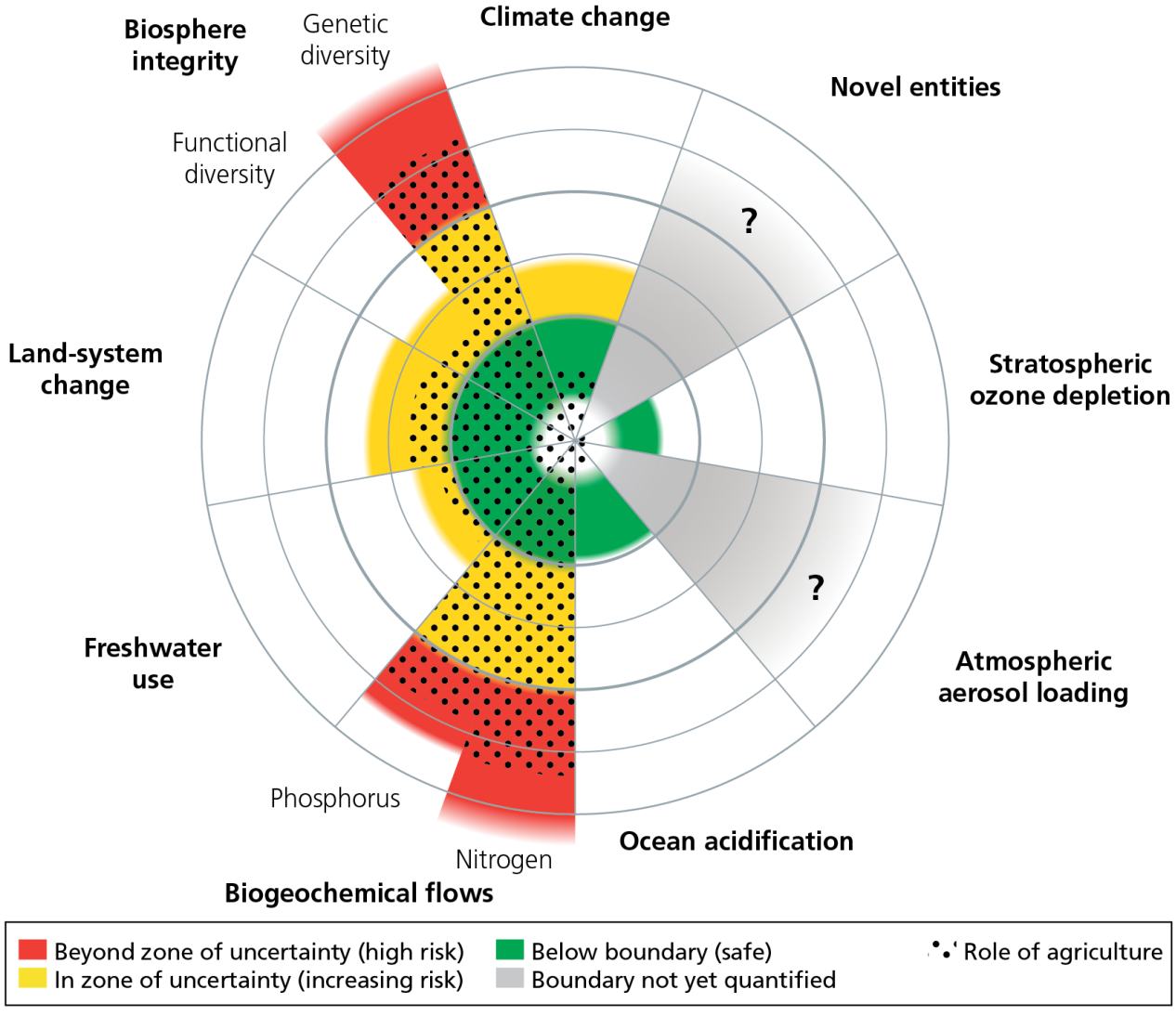
Schmidt-Traub et al. 2019 (*Nature*)

Food security status



Bodisky et al. 2020 (*Scientific Reports*)

Environmental implications



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

Greenhouse gas emissions

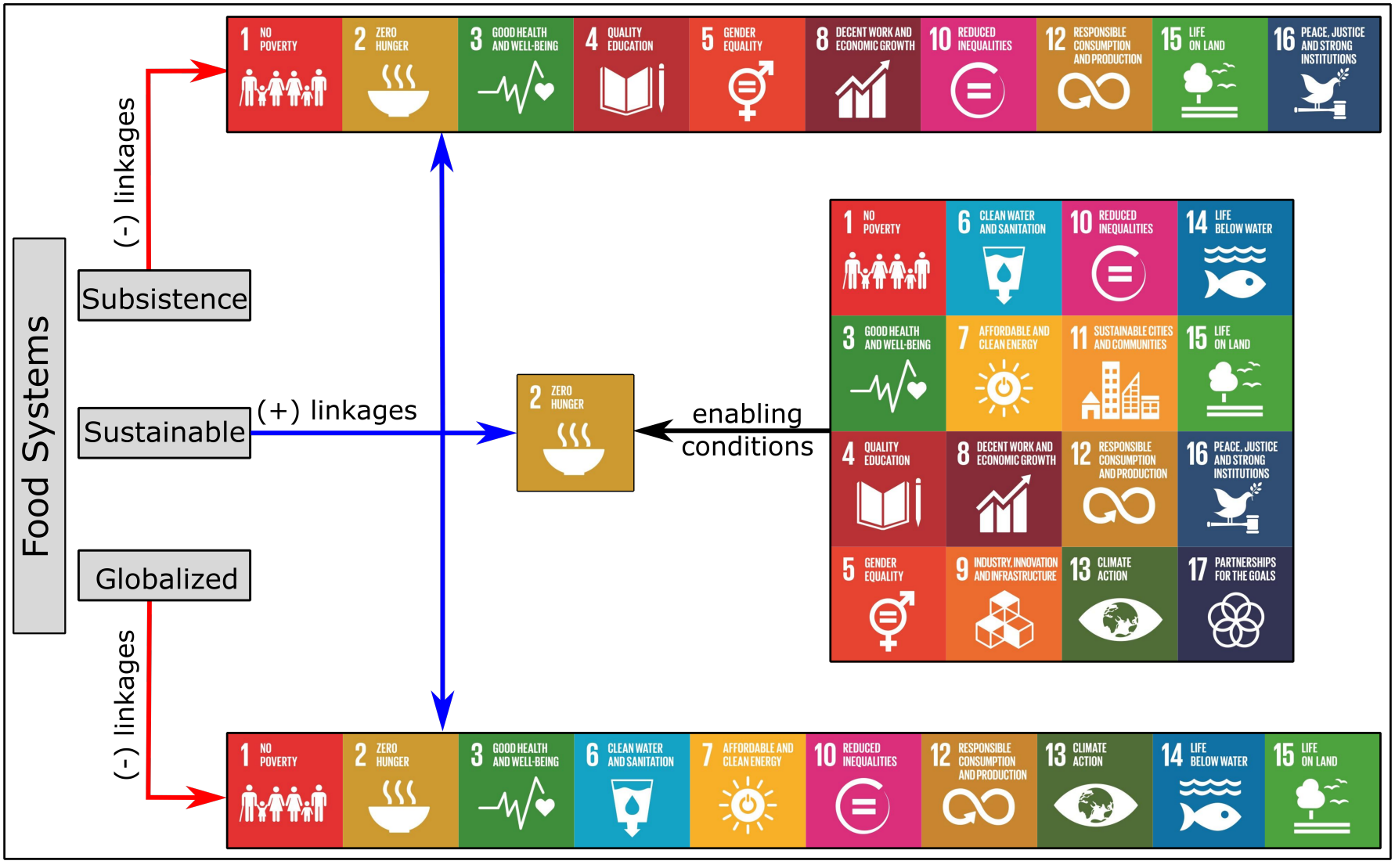
Table 1 | Comparison of 2007–2016 mean values and standard deviations of emissions from AFOLU[6] and global food system[5] emissions by component, including food loss and waste

	AFOLU		Food system	
Components	**Emissions ($GtCO_2e\ yr^{-1}$)[a]**	**Percentage of anthropogenic GHG emissions (%)[b]**	**Emissions ($GtCO_2e\ yr^{-1}$)[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

[a]Mean and 95% confidence interval, using GWP values of the IPCC AR5 with no climate feedback (GWP-CH_4 = 28; GWP-N_2O = 265). [b]Computed using a total emissions value for the period 2007–2016 of 52 $GtCO_2e$ per year[6]. [c]Food-related FOLU for food system columns. [d]Rounded to nearest fifth percentile due to assesse[d] uncertainty in estimates.

Rosenzweig et al. 2020 (*Nature Food*)

Sustainable food systems and SDGs



(Pradhan et al. 2021, Rural 2021)

Climate change mitigation potentials

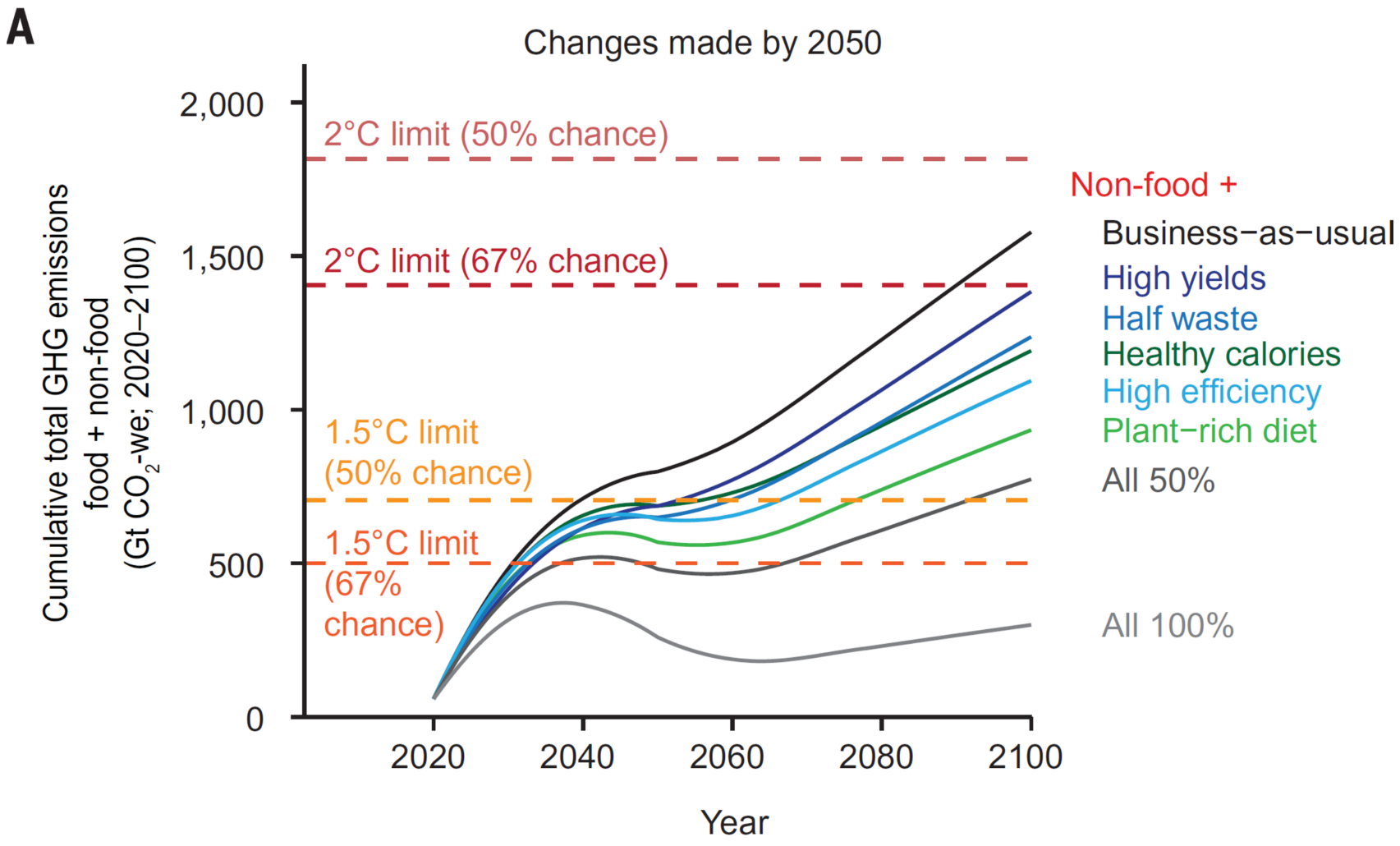
Table 2 | Food system supply-side and demand-side technical and economic mitigation potentials[5]

Mitigation potential	Supply side ($GtCO_2e\ yr^{-1}$)	Demand side ($GtCO_2e\ yr^{-1}$)
Technical	2.3–9.6	0.7–8.0
Economic	1.5–4.0[a]	1.8–3.4[b]

[a]By 2030 at prices ranging from 20–100 USD per tCO_2e. [b]By 2050 at prices ranging from 20–100 USD per tCO_2e.

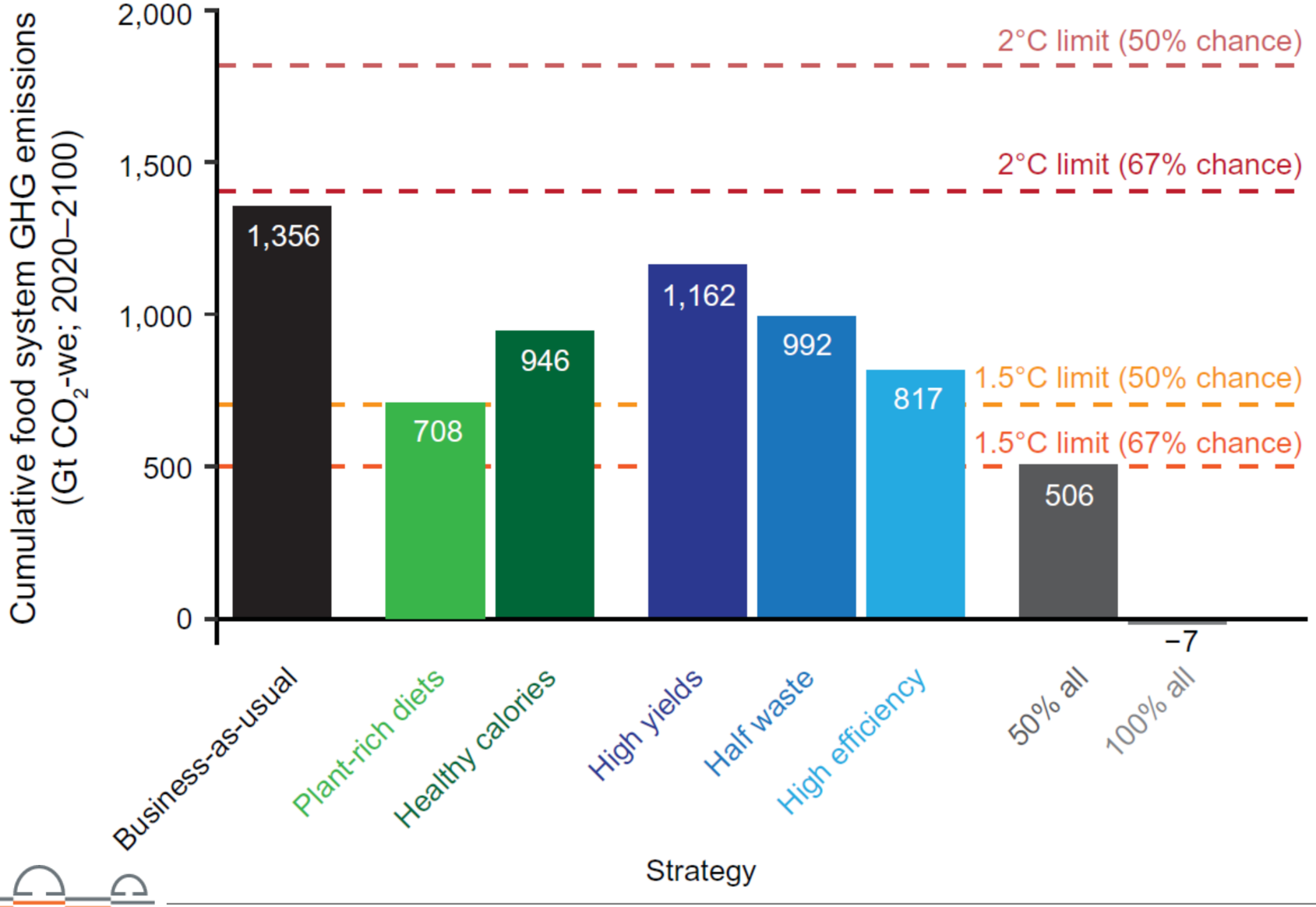
Rosenzweig et al. 2020 (*Nature Food*)

Importance of reducing food system emissions



Clark et al. 2020 (*Science*)

Measures to mitigate food system emissions

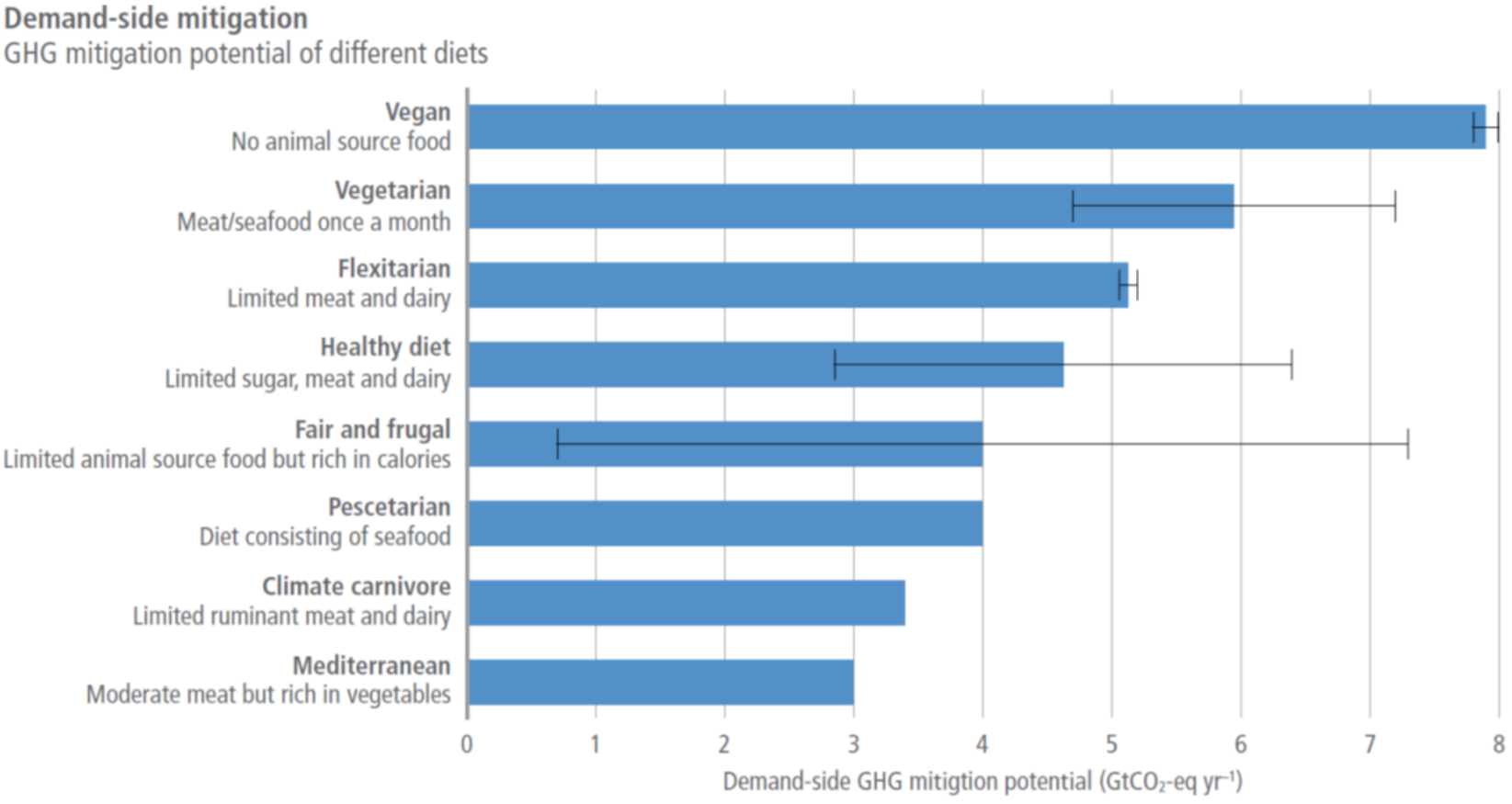


Clark et al. 2020 (*Science*)

Mitigation synergies and co-benefits

Rosenzweig et al. 2020 (*Nature Food*)

Demand-side mitigation: dietary changes



IPCC 2019 (*SRCCL*, *Chapter 5*)

Diets, health, and climate change

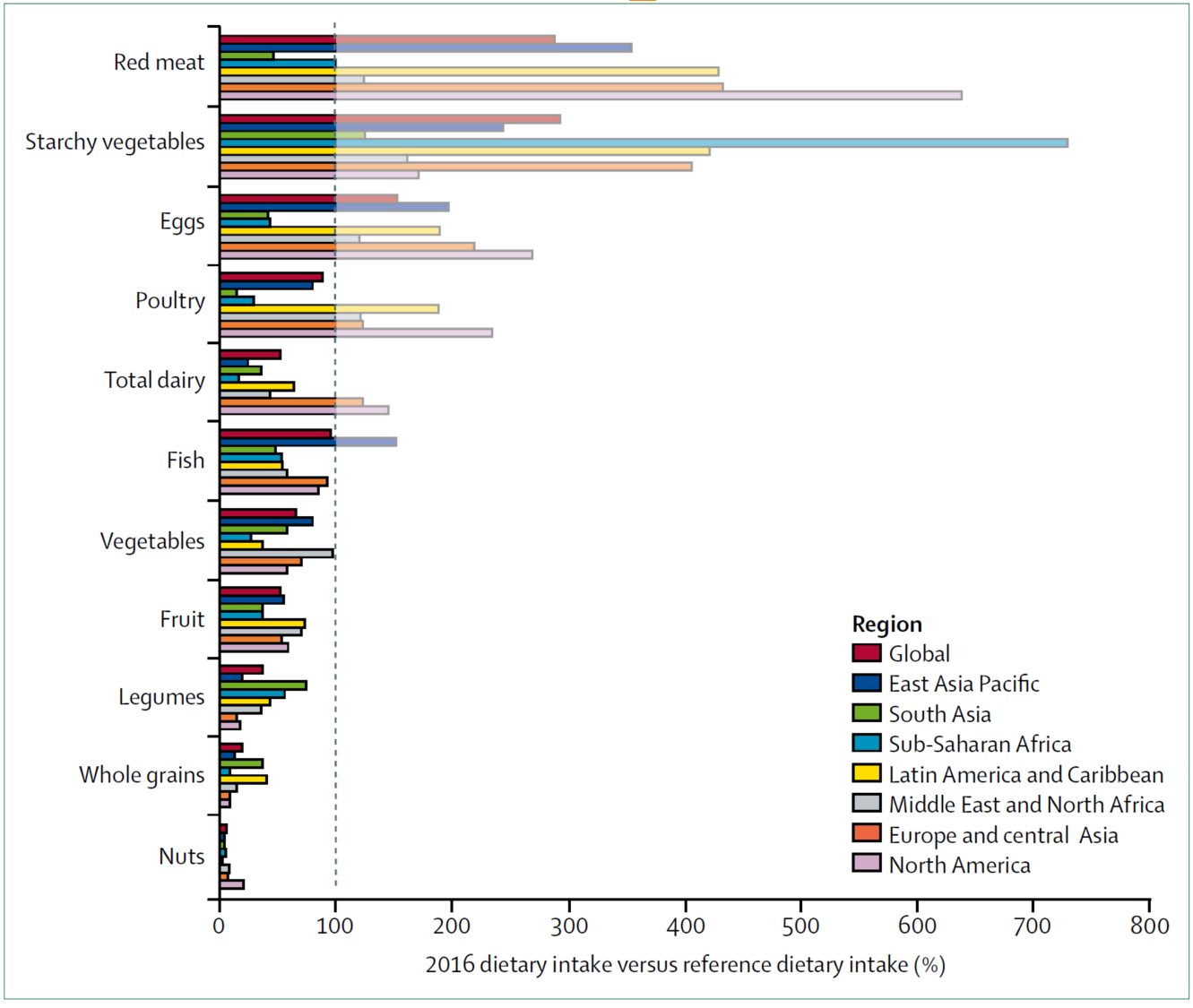
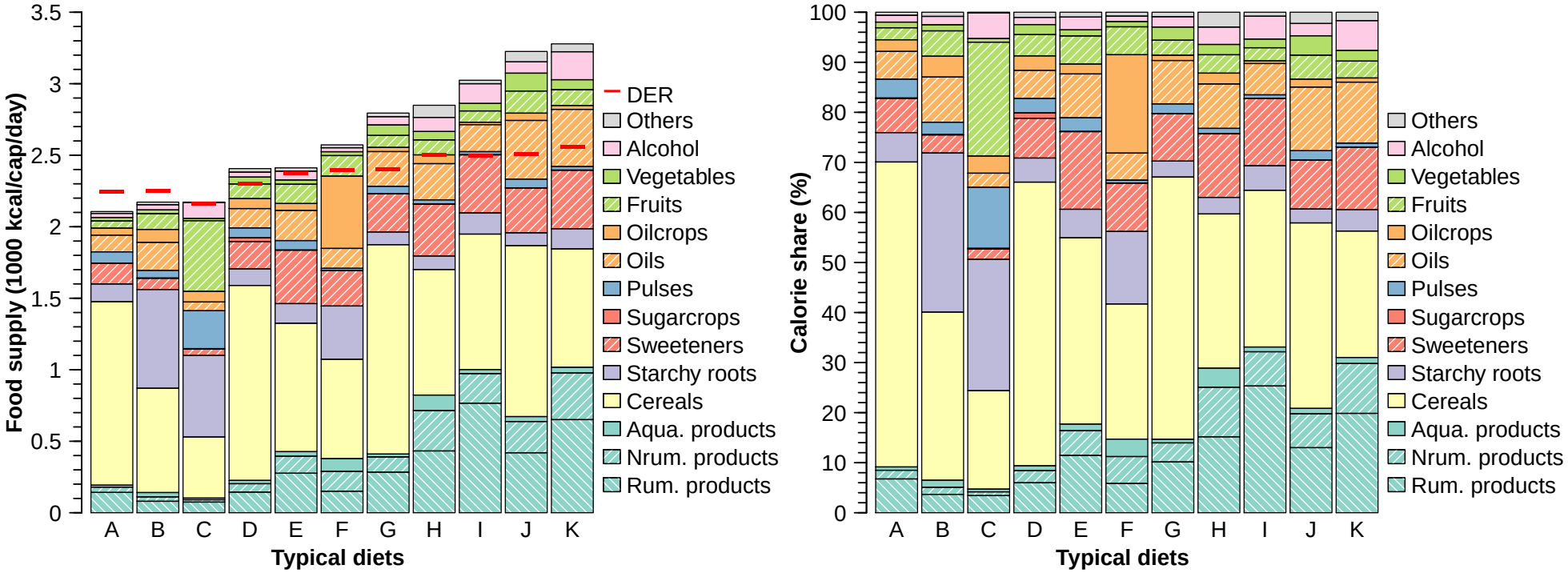


Figure 1: **Diet gap between dietary patterns in 2016 and reference diet intakes of food**
Data on 2016 intakes are from the Global Burden of Disease database.[130] The dotted line represents intakes in reference diet (table 1).

Willett et al 2019 (*Lancet*)

Diets, health, and climate change

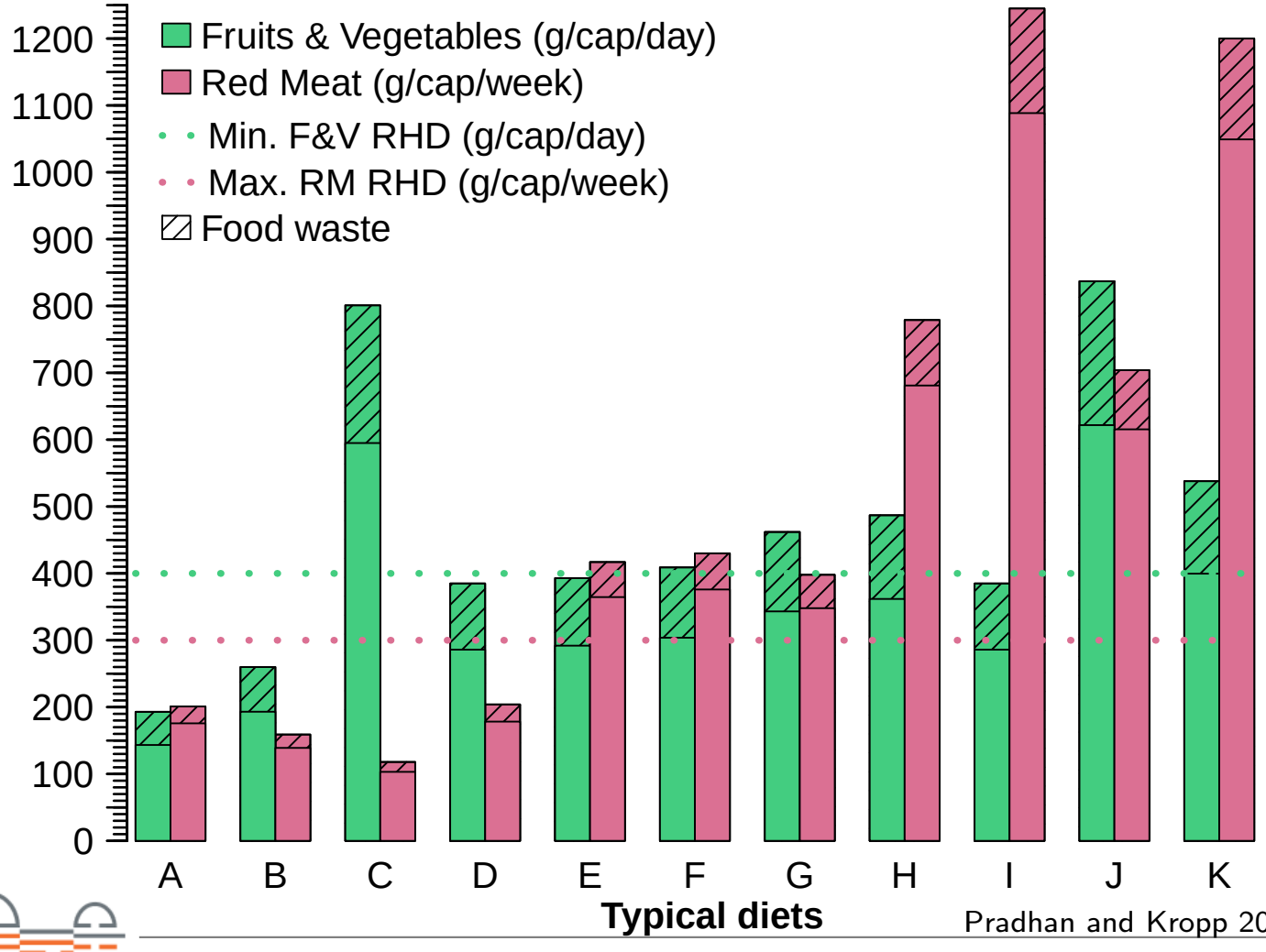


Typical diets across the world between 1961–2013:
an update from Pradhan et al. 2013 (Plos One).

Pradhan and Kropp 2020 (*Sustainability*)

Recommended healthy diets

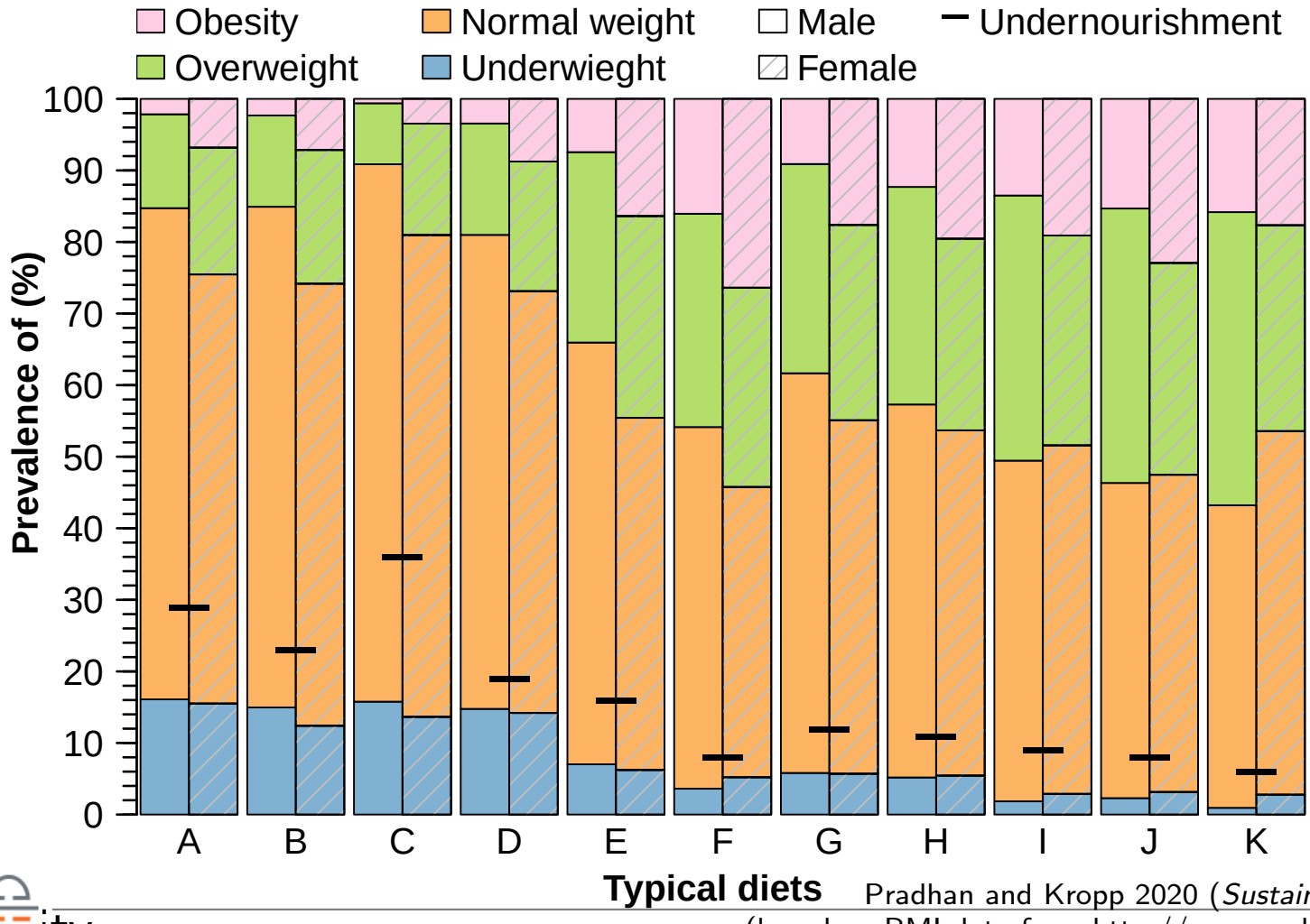
Most diets contain either higher than recommended amount of red meat or lower than advised value of fruits and vegetables.



Pradhan and Kropp 2020 (*Sustainability*)

Diets and body mas index (BMI)

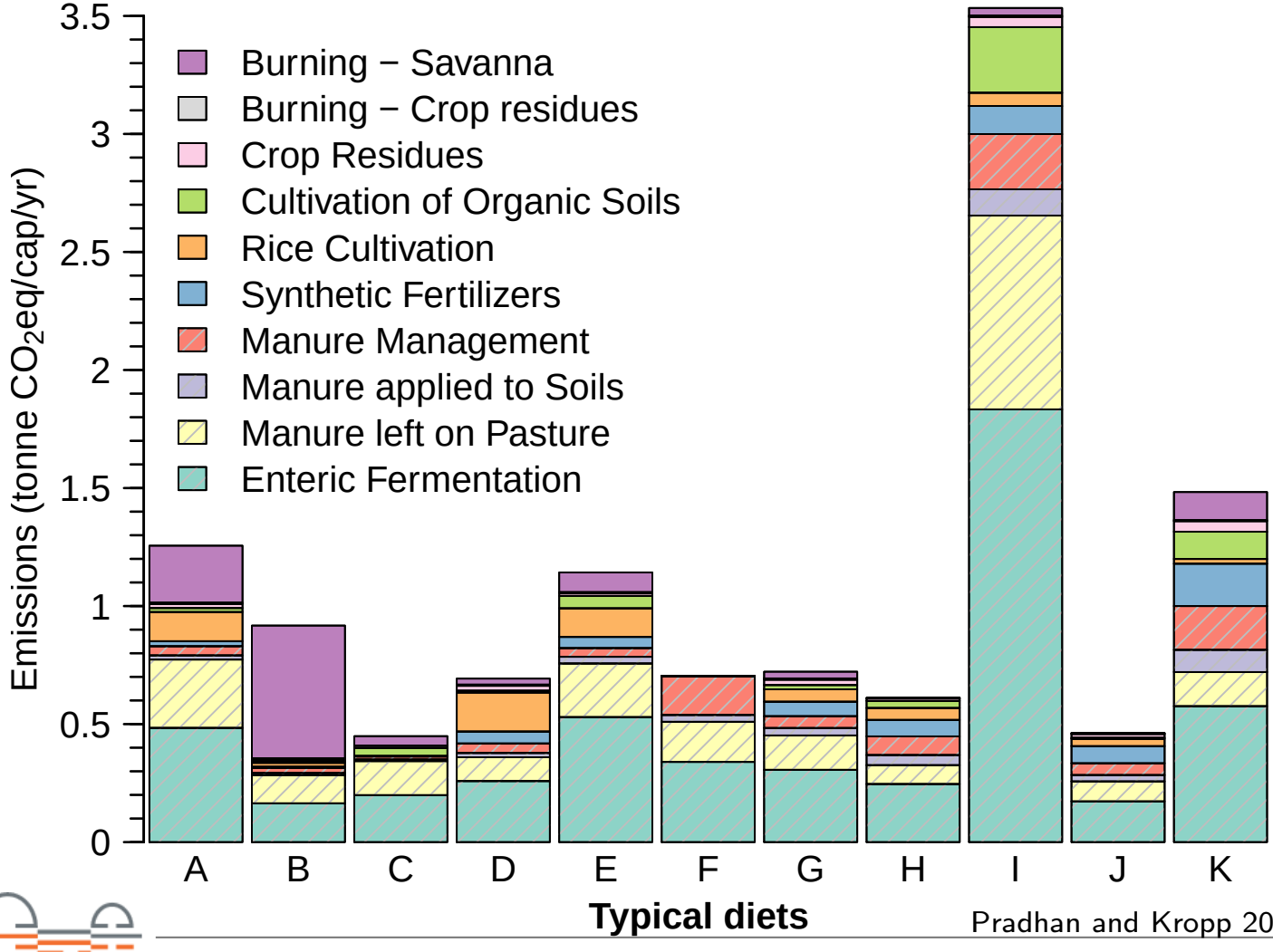
Prevalence of BMIs varies with diets for both male and female population. A larger share of female than male is suffering from



Pradhan and Kropp 2020 (*Sustainability*)
(based on BMI data from http://www.ncdrisc.org)

Diets and Emissions

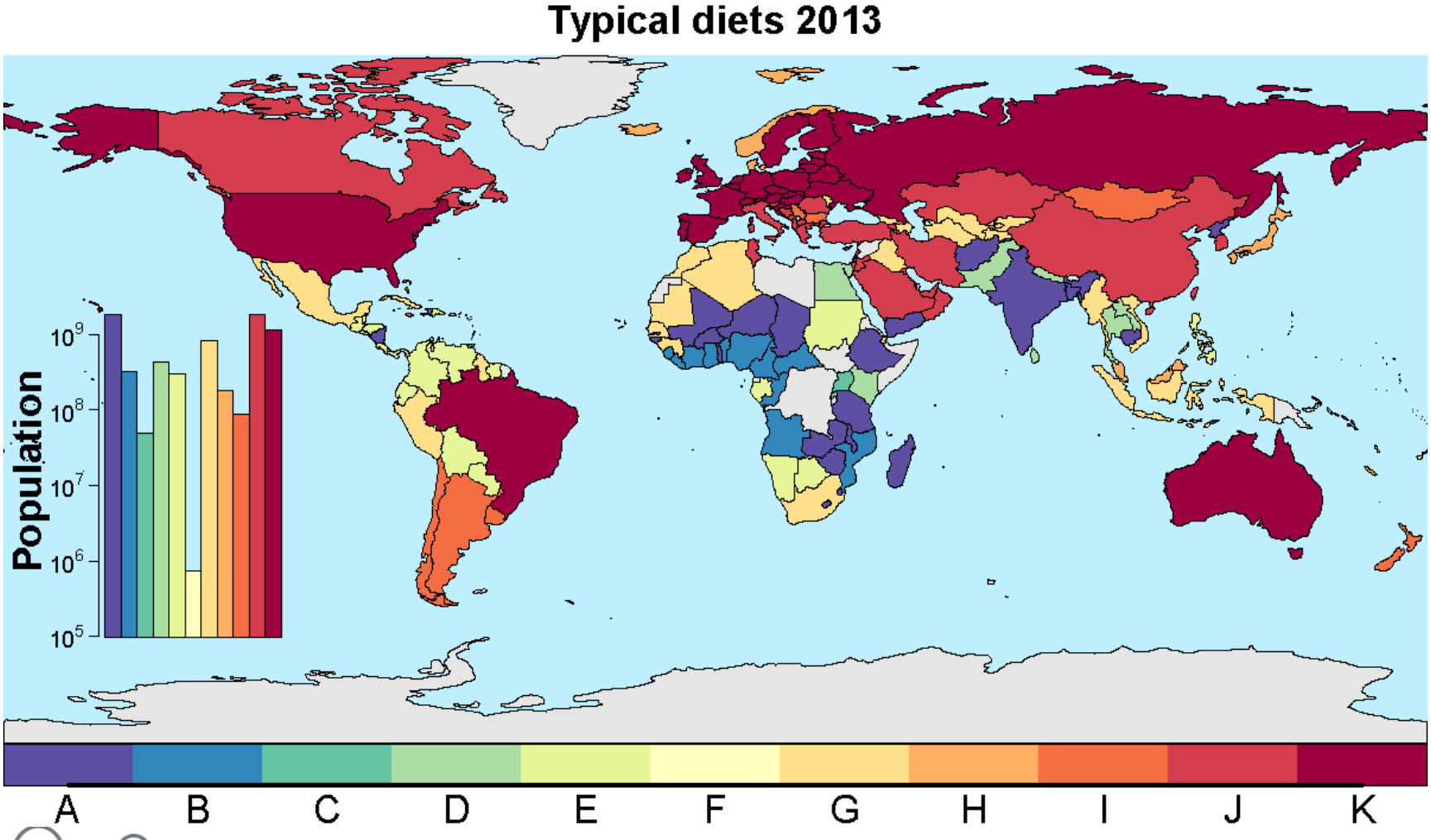
The production phase agricultural GHG emissions associated with the diets do not provide a clear relation with the calorie supply.



Pradhan and Kropp 2020 (*Sustainability*)

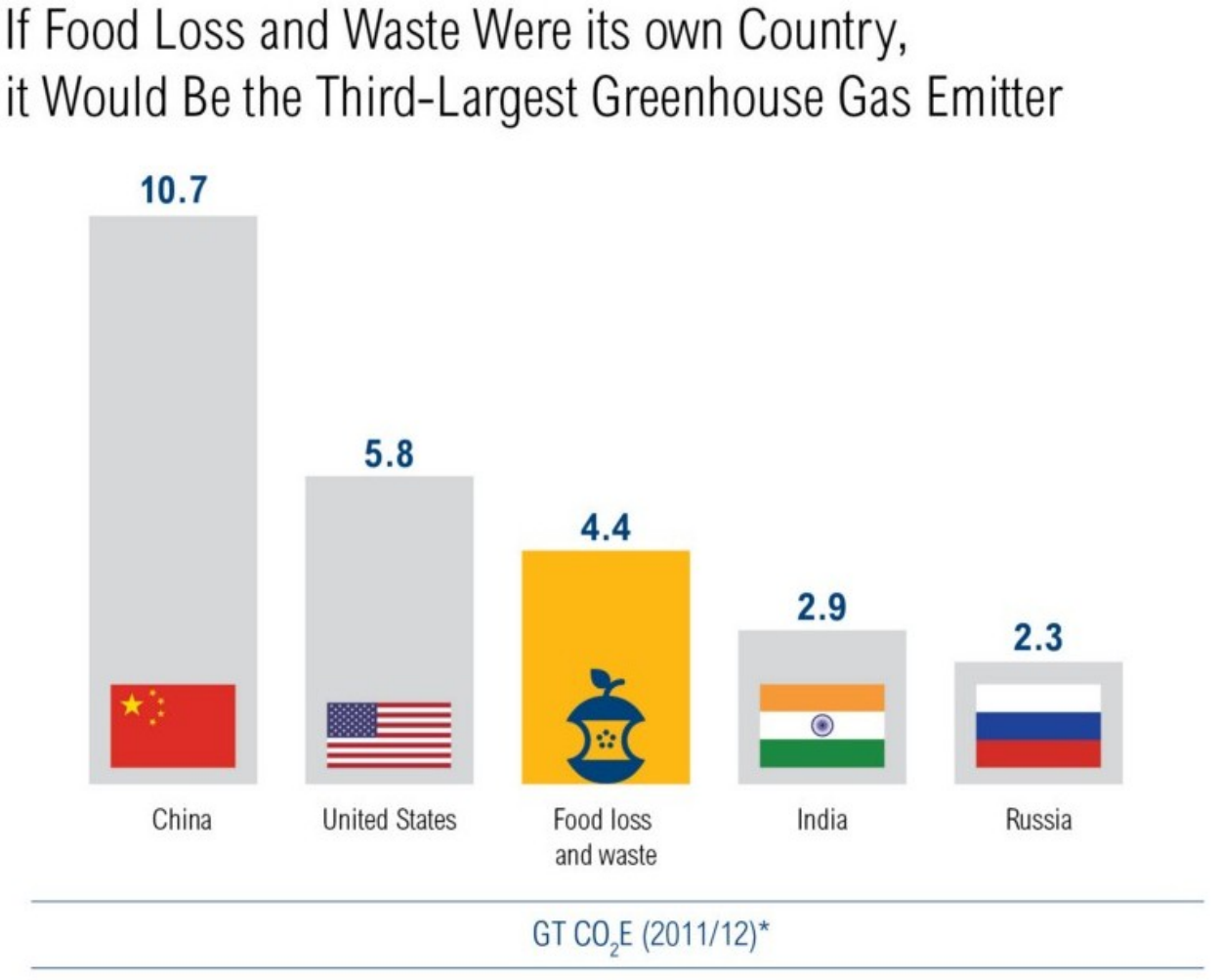
Spatial distribution of diets

The share of global population consuming the low-energy diets (A–C) decreased from 61% to 31%.



Pradhan and Kropp 2020 (*Sustainability*)

Food loss and waste emissions



* 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. 2015. *Food wastage footprint & climate change*. Rome: FAO.

WORLD RESOURCES INSTITUTE

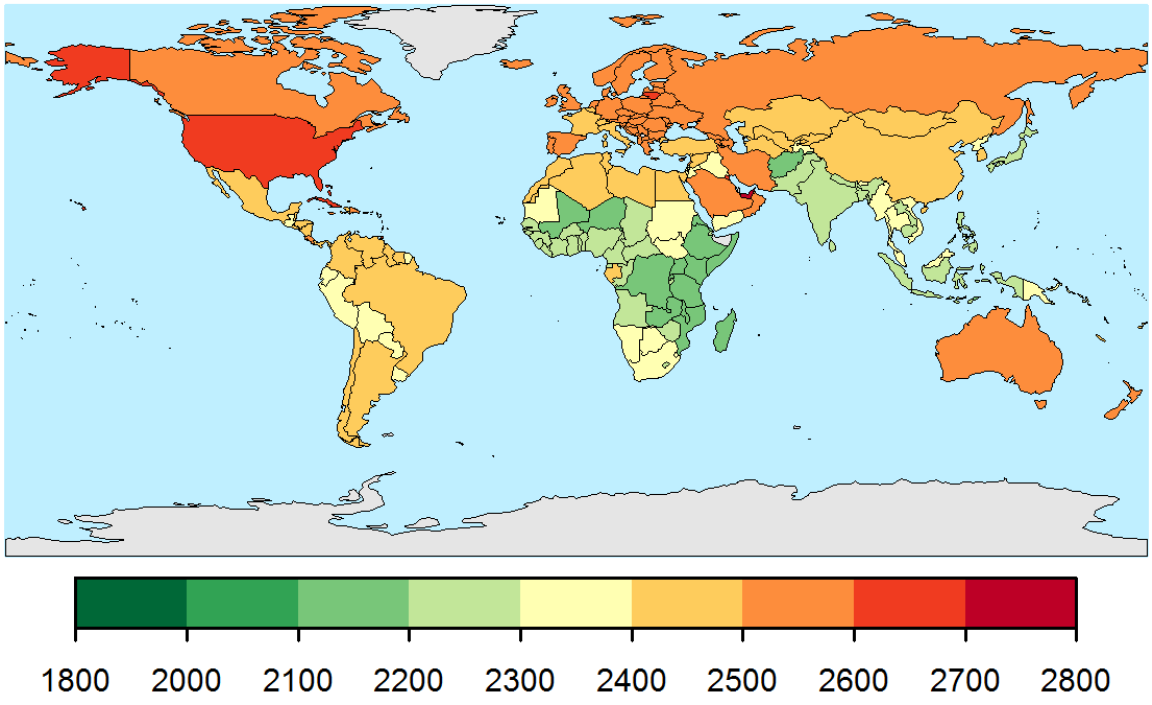
Food loss and waste

- **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

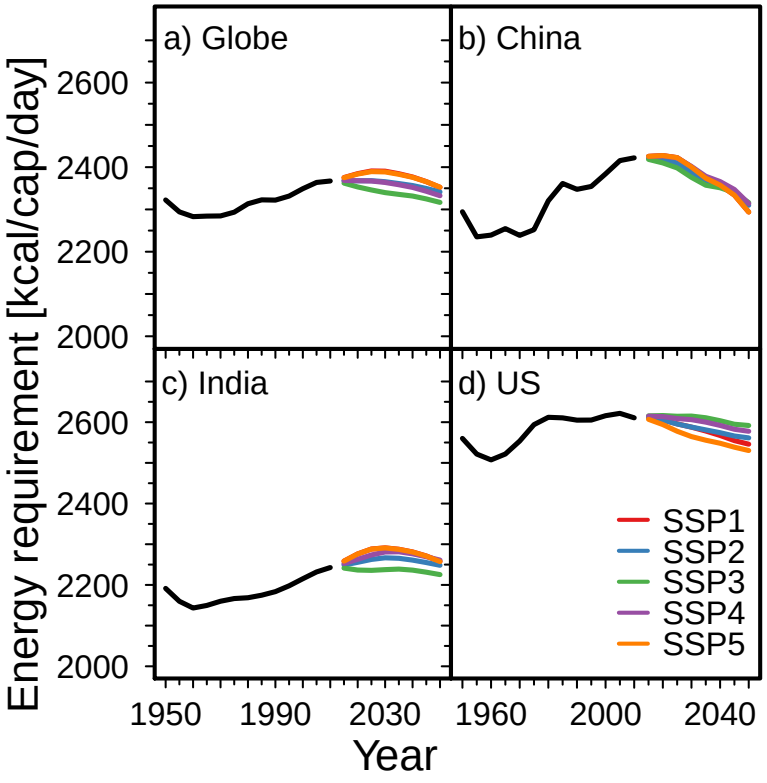


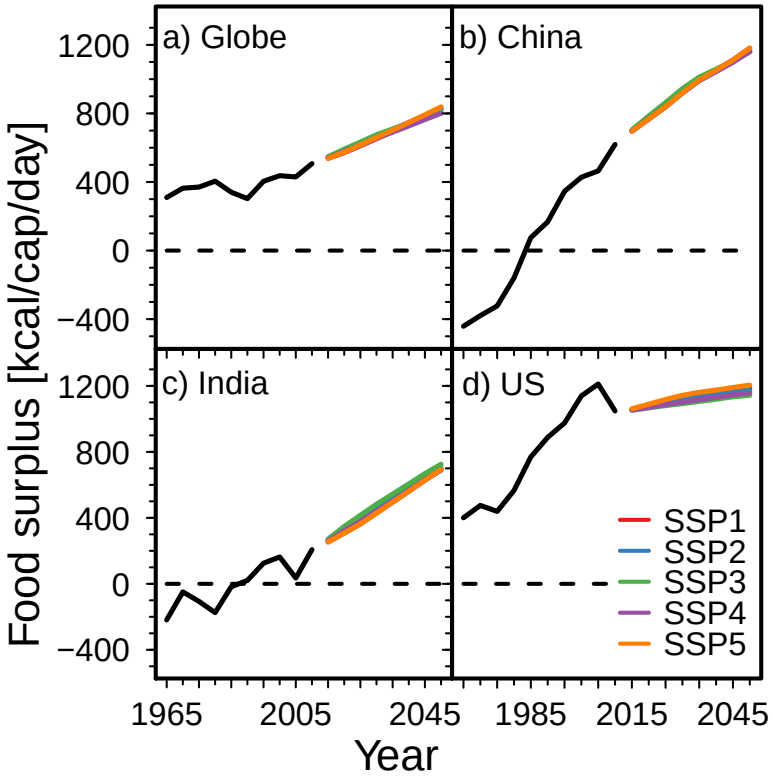
Country scale food energy requirements for 2010 considering moderate PAL in kcal/cap/d

- country with **heavy body weights** required larger food energy (e.g. United States, Australia, etc.)
- counties with **larger share of adult population** compare to younger population require larger food energy (e.g. China)

(Hiç et al. 2016, ES & T)

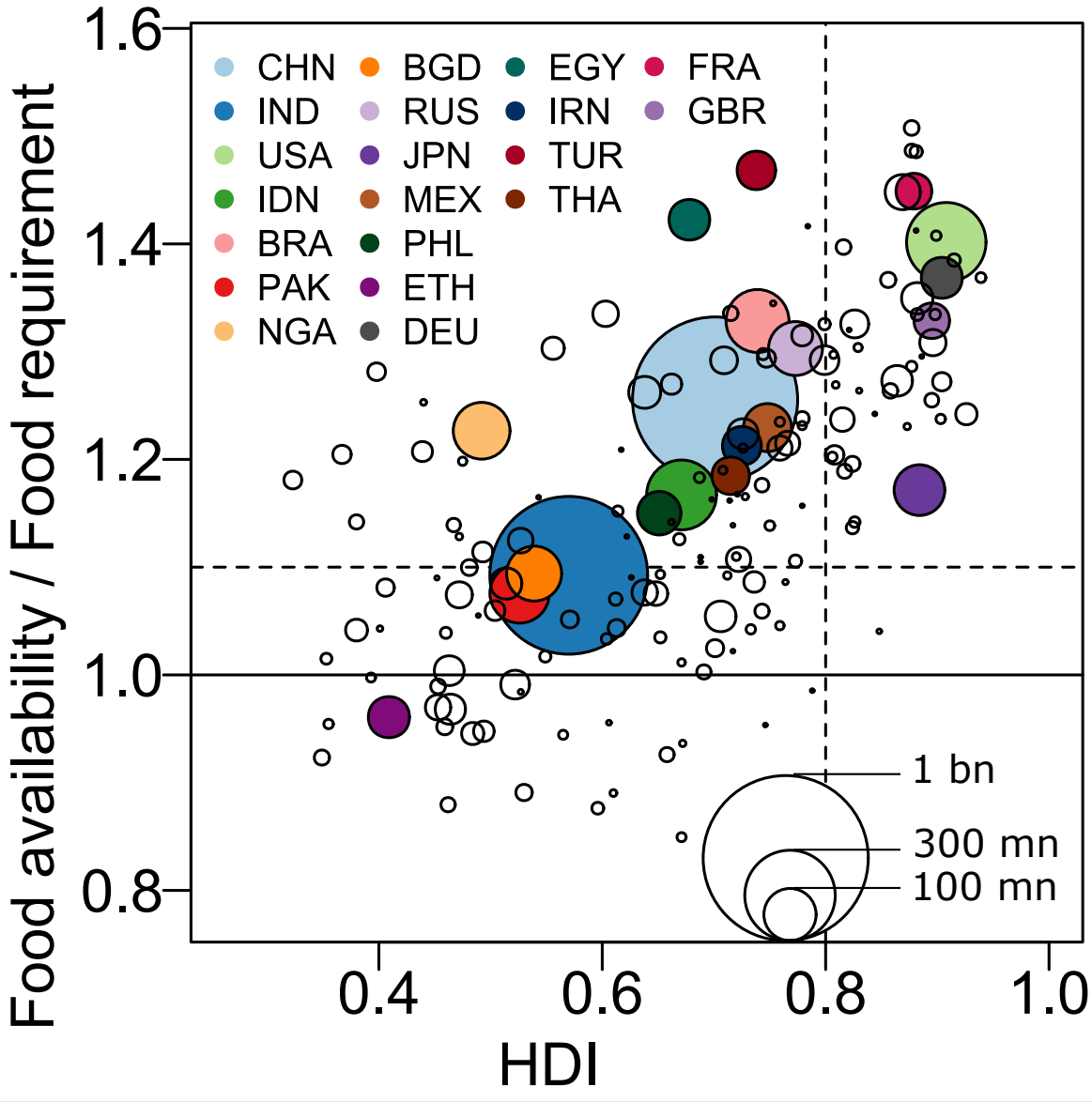
Food requirements and waste





(Hiç et al. 2016, ES & T)

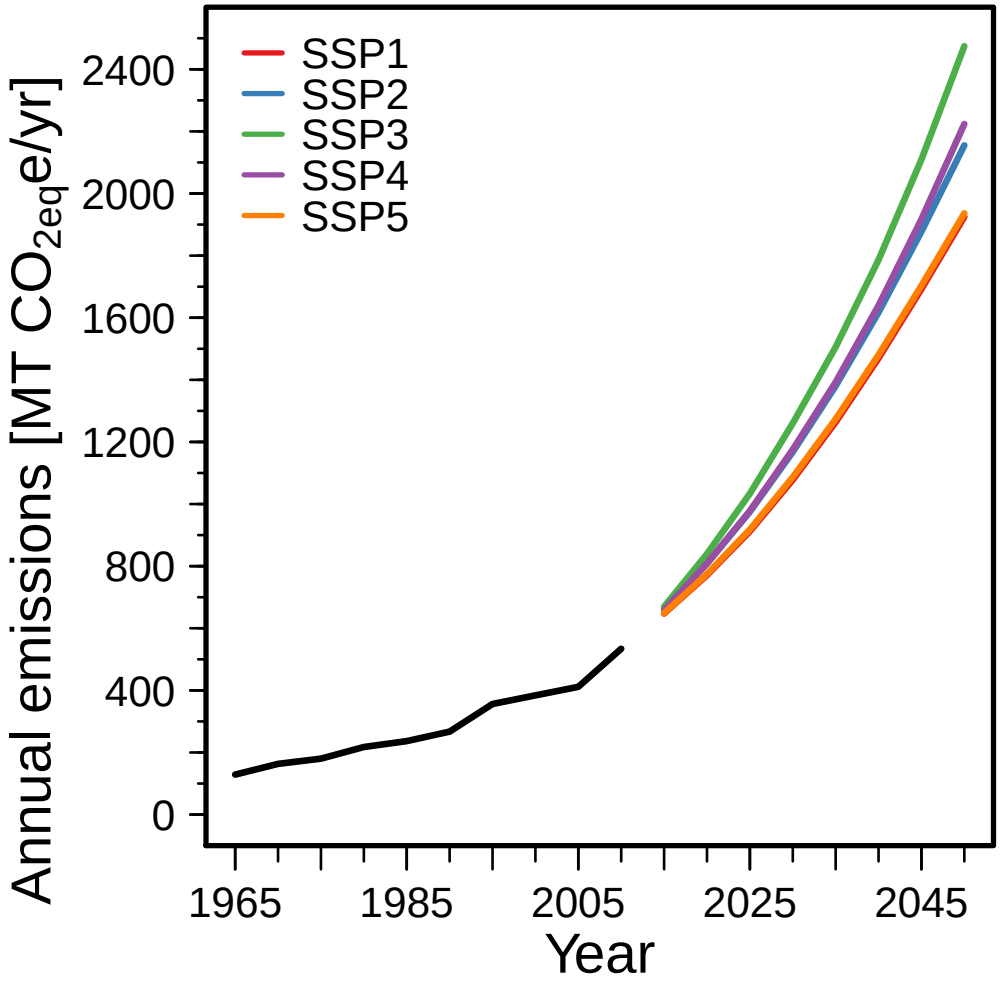
Human development index and food waste (2010)



(Hiç et al. 2016, ES & T)

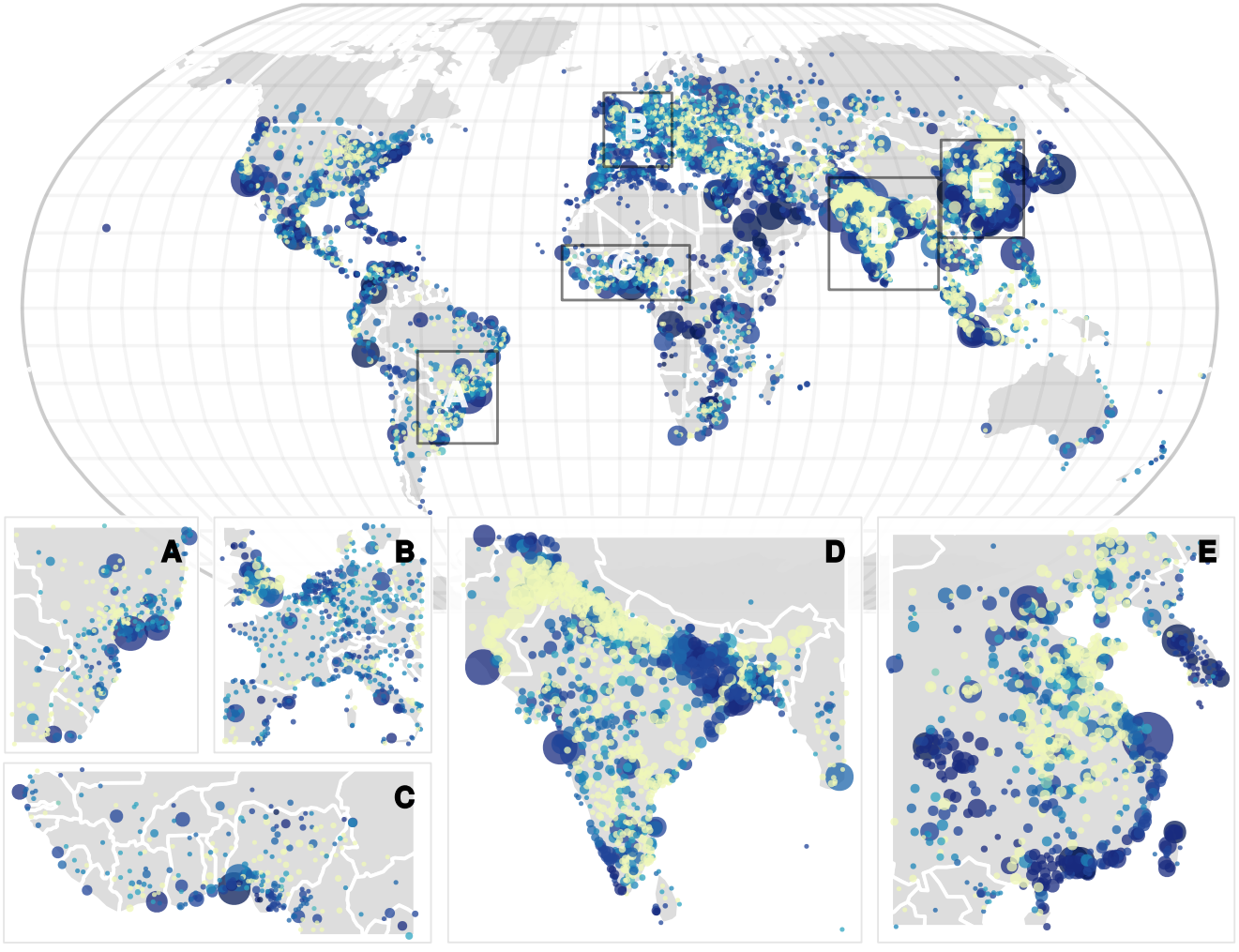
Reducing food waste

- emissions increased from 130 Mt $CO_{2eq.}$/yr to 530 Mt $CO_{2eq.}$/yr between 1965 and 2010
- may increase tremendously to 1.9–2.5 Gt $CO_{2eq.}$/yr by 2050



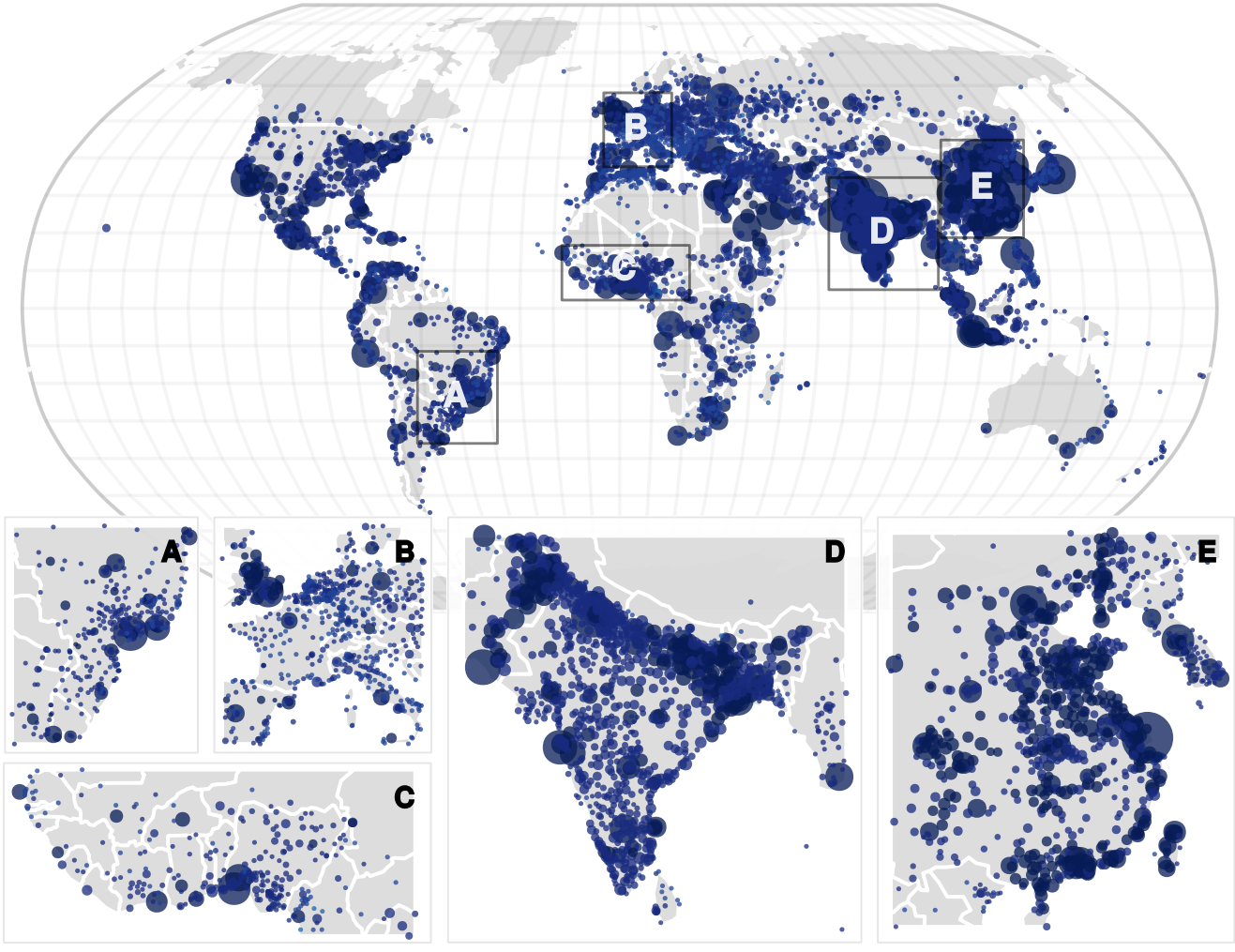
(Hiç et al. 2016, ES & T)

Regionalized vs Globalized food systems



Pradhan et al. 2020 (*ES&T*)

Regionalized vs Globalized food systems



Pradhan et al. 2020 (*ES&T*)

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

Food system innovations

(Herrero et al. 2020, Nature Food)

Food system innovations

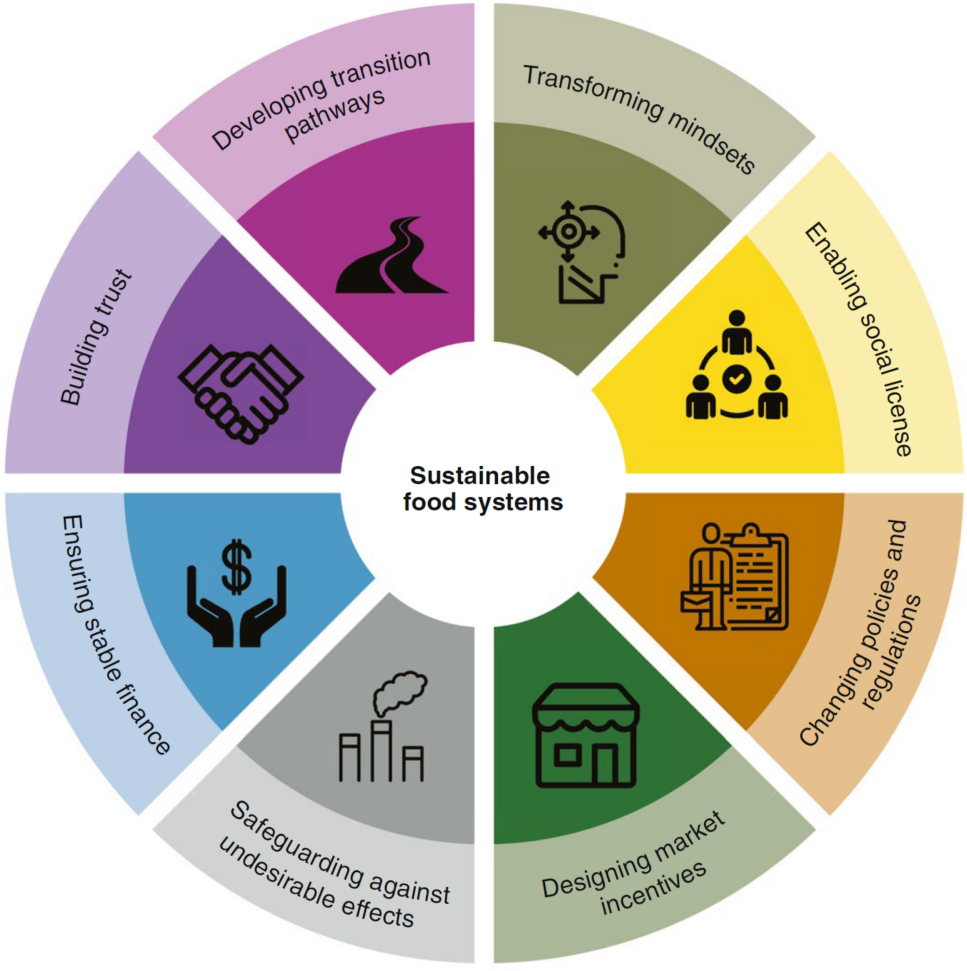
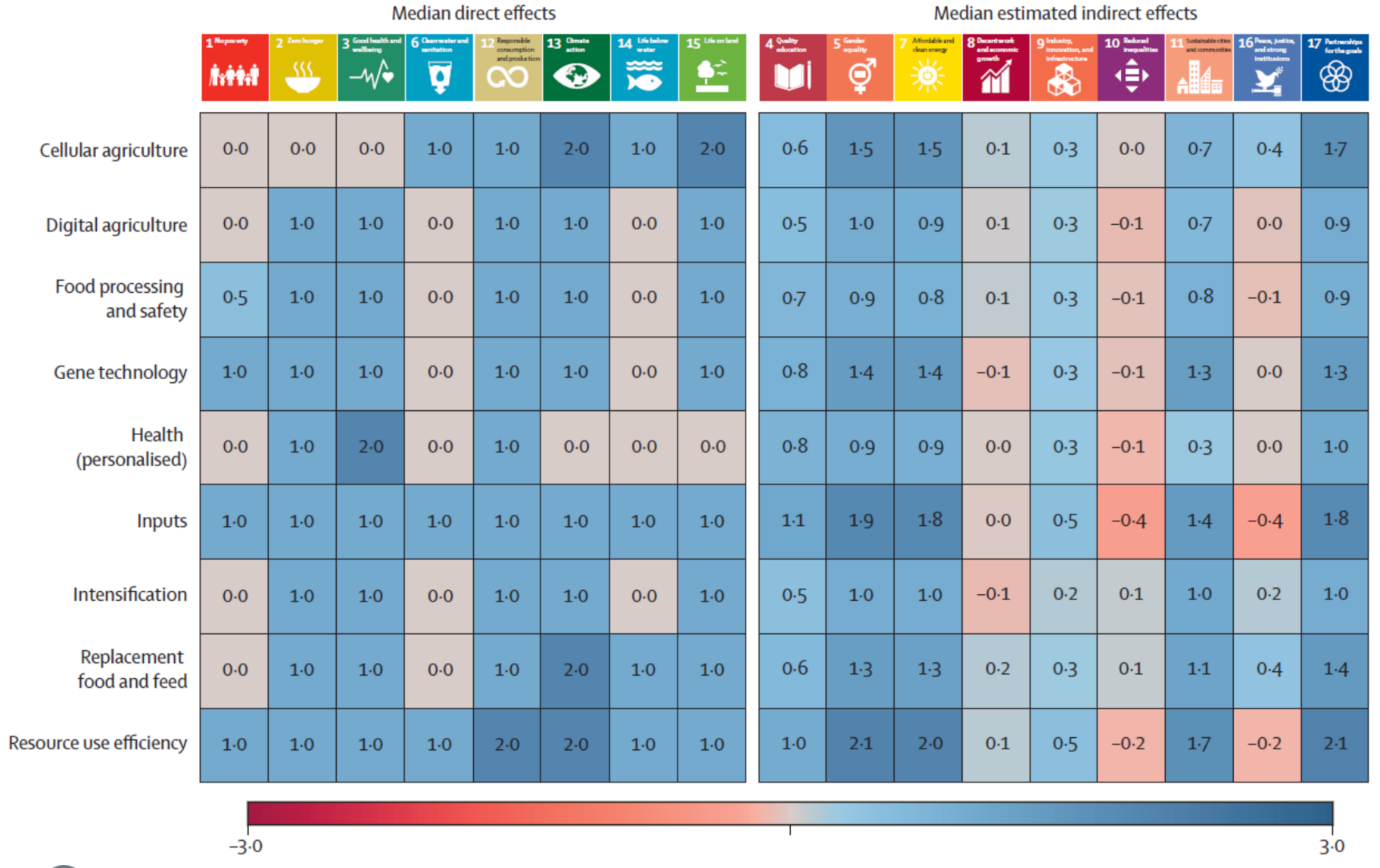


Fig. 3 | Essential elements for accelerating the systemic transformation of food systems. These accelerators help achieve healthy and sustainable diets, productive agrifood systems and improved waste management—three outcomes necessary to attain sustainable food systems.

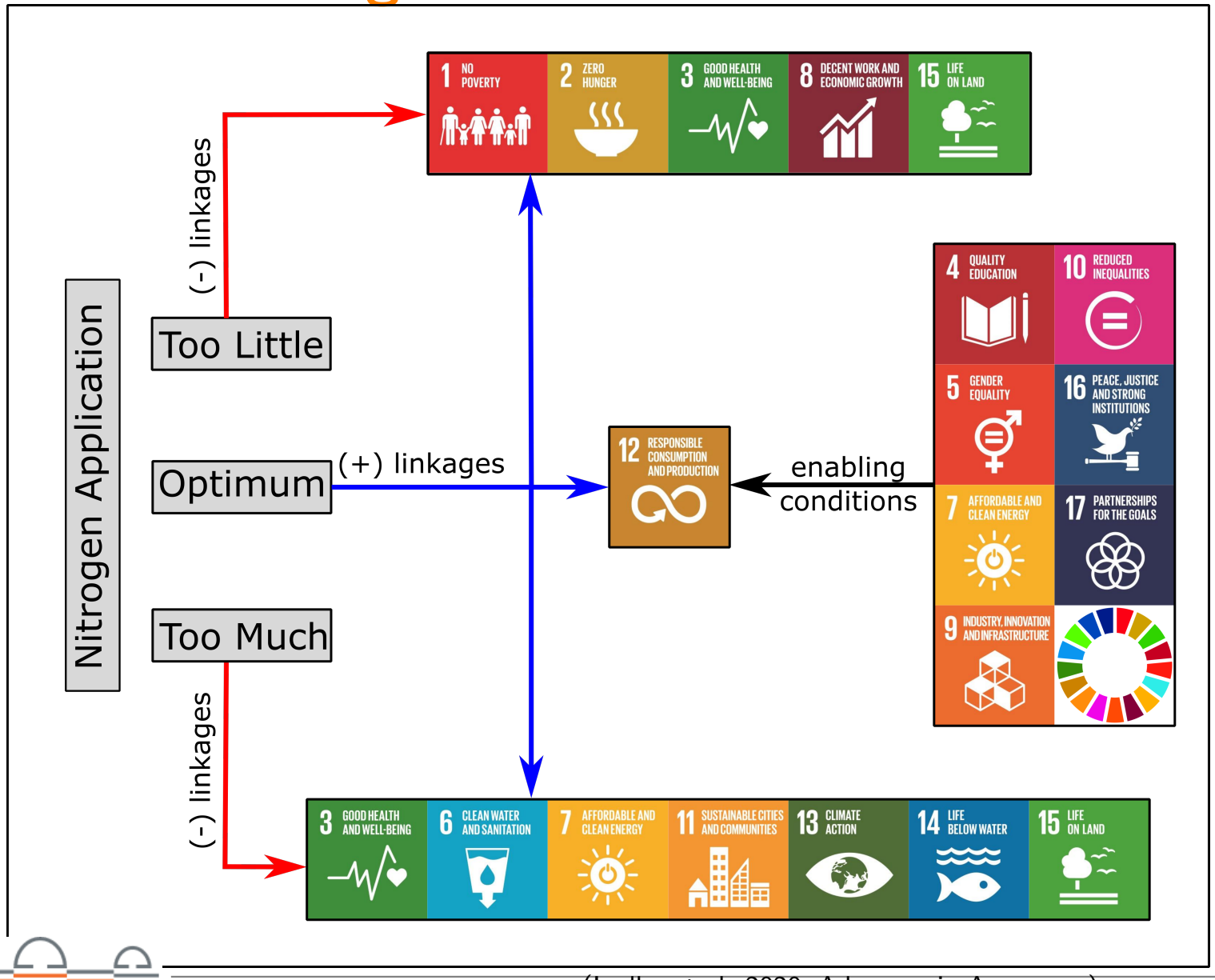
(Herrero et al. 2020, Nature Food)

Food system innovations



(Herrero et al. 2021, The Lancet Planetary Health)

Optimum Nitrogen crucial for SDGs and vice versa



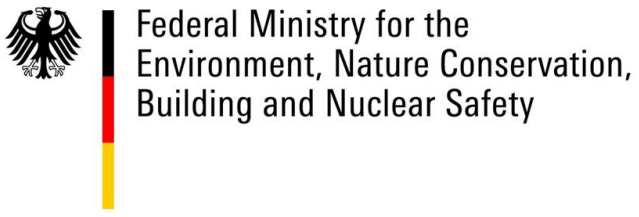
(Ladha et al. 2020, Advances in Agronomy)

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**

Thank You...

Supported by



pradhan@pik-potsdam.de
@prajdhan