The health, nutritional, and environmental aspects of sustainable diets – findings from the EAT-Lancet Commission on Healthy Diets from Sustainable Food Systems

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Environmental impacts of the food system

The current food system is environmentally unsustainable:

- major driver of climate change (25% of GHG emissions, Vermeulen et al, 2012);
- major driver of land-use change and biodiversity loss (40% of the Earth's surface, Ramankutty et al, 2008; Houghton et al, 2012);
- major user of freshwater resources (70% of global freshwater withdrawals (WWAP, 2012);
- major polluter of terrestrial and aquatic systems through fertilizer runoff (Vitousek et al, 1997) ($\rightarrow$ dead zones in coastal oceans, Diaz and Rosenberg, 2008)

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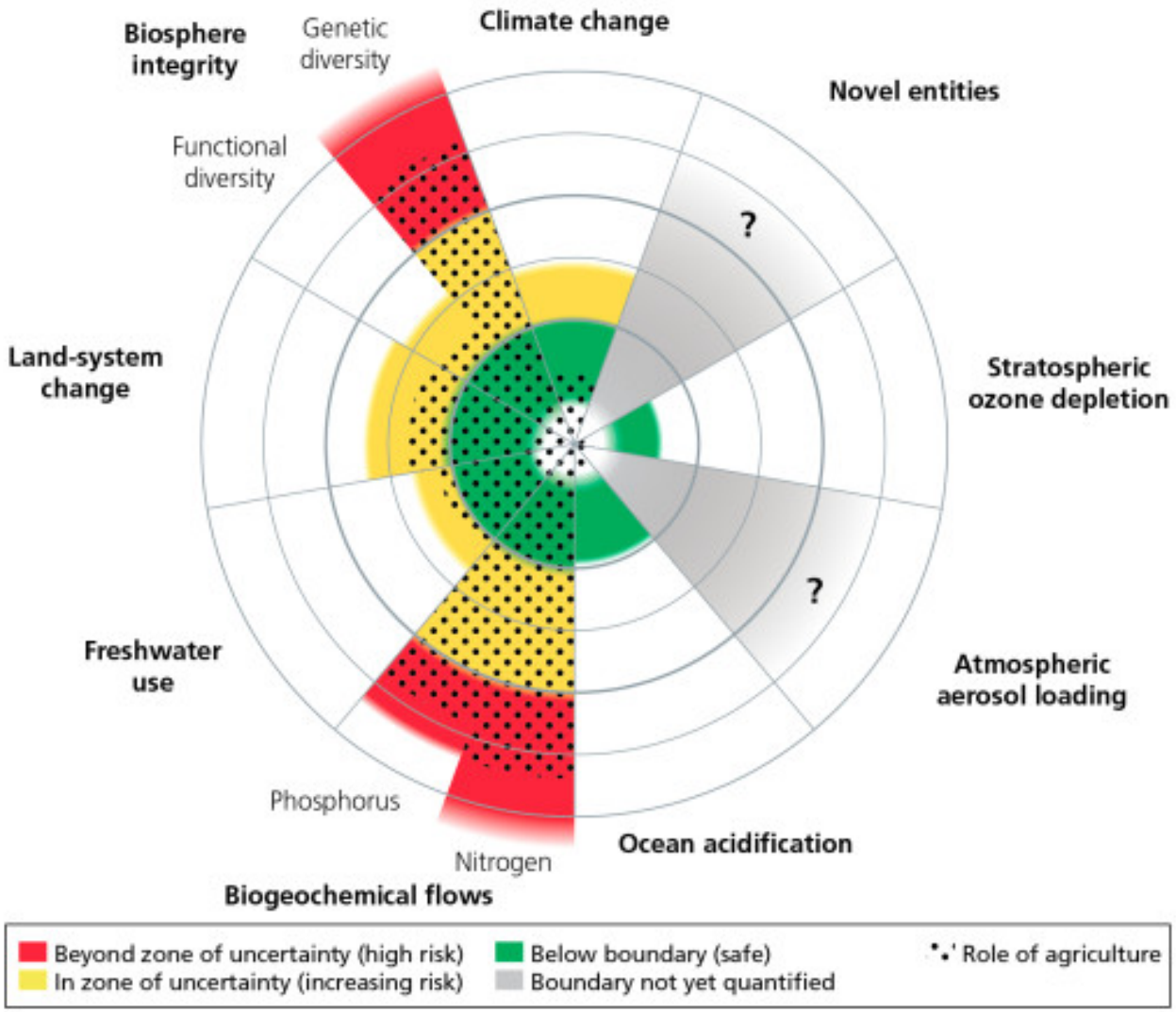
$\rightarrow$ major driver of planetary impacts

Planetary boundaries



Steffan et al (2015), Campbell et al (2017)

Planetary boundaries

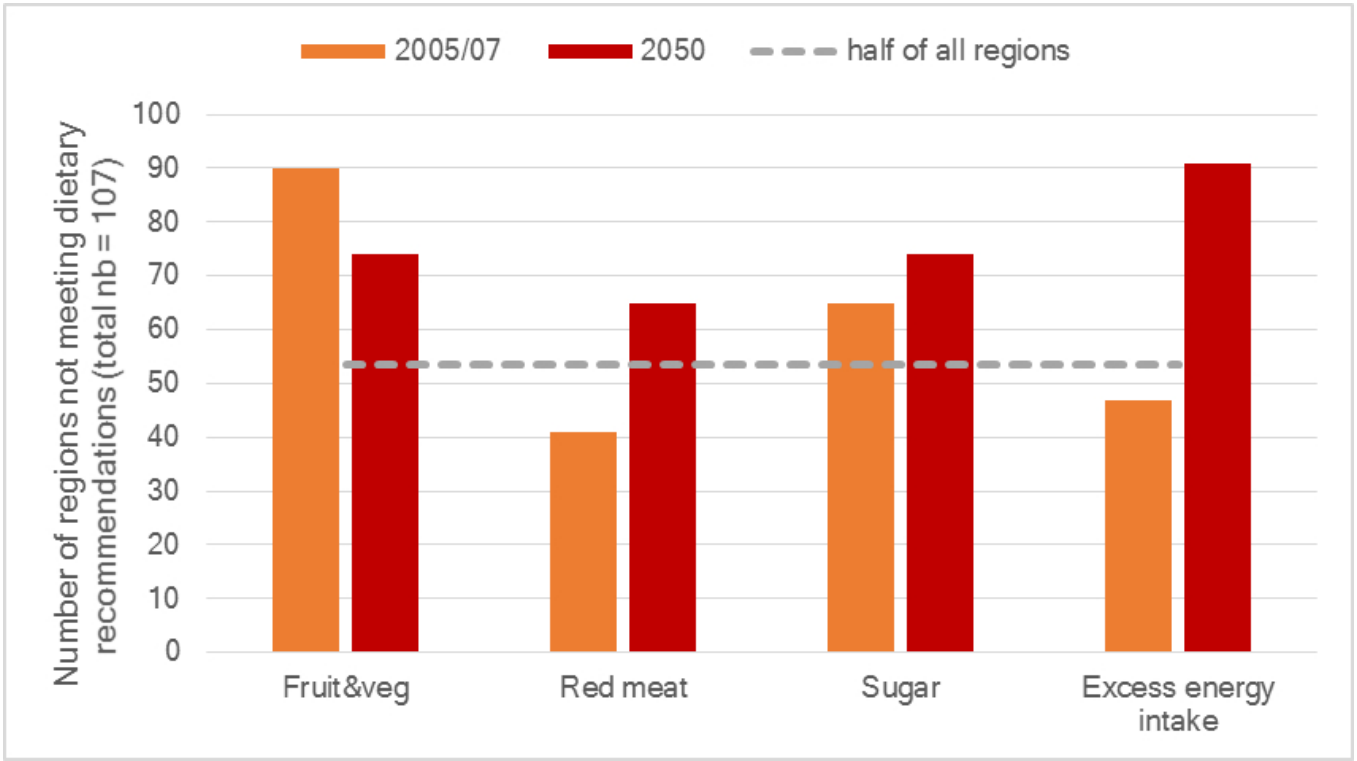
Concept:

- Define a safe operating space for humanity (Rockström et al, 2009);
- Transgressing put ecosystems at risk of being destabilised and losing regulating functions on which populations depend

Health impacts of the food system

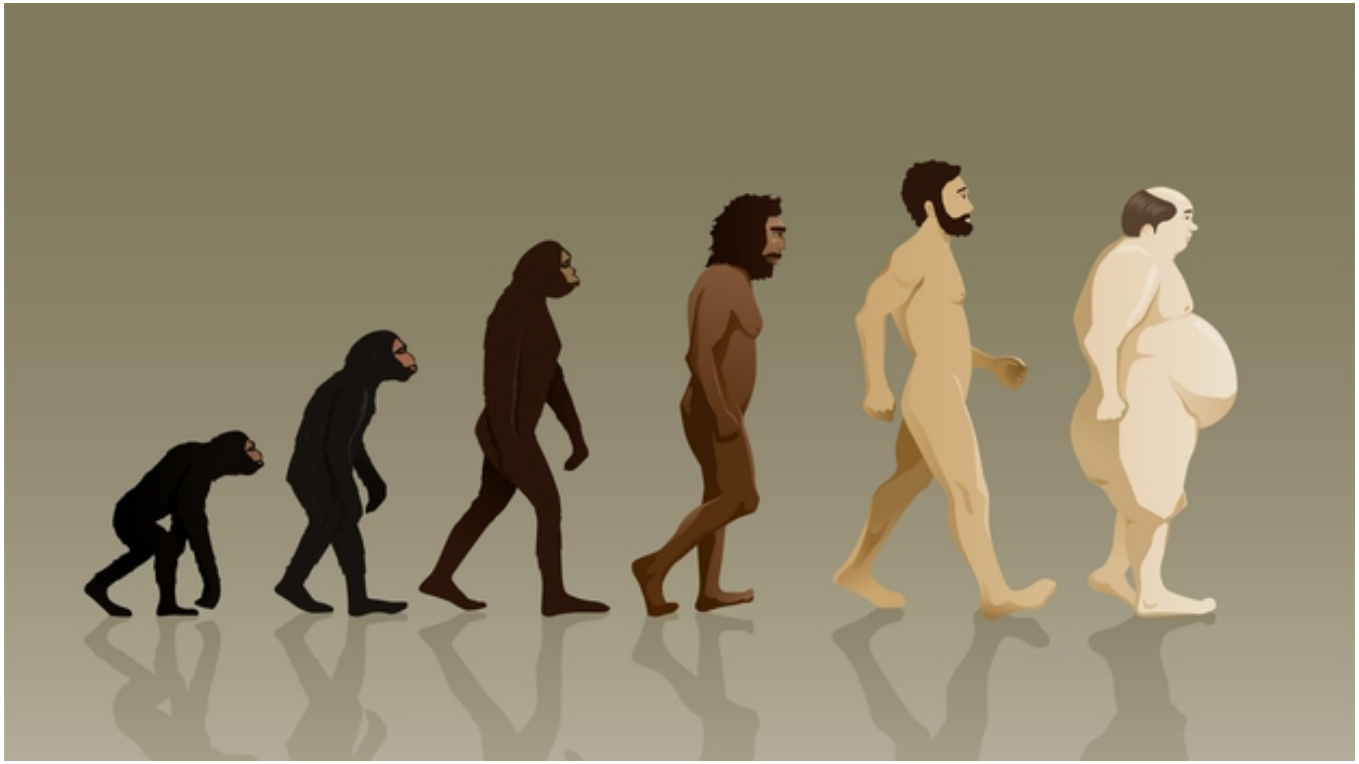
Current diets are not healthy:

- Less than half of all countries meet or are projected to meet dietary guidelines on red meat, fruits and vegetables, sugar, and total energy intake (Micha et al, 2015; Springmann et al, 2016).



Health impacts of the food system

- Global prevalence of overweight increased over a third, and obesity rates doubled over last 30 years (Stevens et al, 2012).



Health impacts of the food system

- Dietary risks are leading risk factors globally and in most regions (GBD, 2013):

	Global	High-income Asia Pacific	Western Europe	Australasia	High-income North America	Central Europe	Southern Latin America	Eastern Europe	East Asia	Tropical Latin America	Central Latin America	Southeast Asia	Central Asia	Andean Latin America	North Africa and Middle East	Caribbean	South Asia	Oceania	Southern Sub-Saharan Africa	Eastern Sub-Saharan Africa	Central Sub-Saharan Africa	Western Sub-Saharan Africa
Dietary risks	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	3	4	4
High blood pressure	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	5	1	1	3	3
Smoking	3	3	3	3	2	3	4	4	3	3	5	3	3	4	4	3	4	4	6	8	9	9
Household air pollution	4	23	24	24	24	10	14	13	5	11	9	4	9	8	13	7	3	6	8	2	2	2
High fasting plasma glucose	5	6	7	6	6	7	6	8	6	5	4	5	6	5	6	4	5	1	5	6	7	7
High body-mass index	6	7	4	4	4	4	3	5	9	4	3	9	4	3	3	5	12	3	3	10	15	10
Ambient PM pollution	7	5	8	11	8	8	11	9	4	12	10	7	7	13	7	11	6	16	15	12	12	8
Physical inactivity	8	4	5	5	5	5	5	6	7	7	7	6	5	7	5	6	7	7	7	9	8	11
Alcohol use	9	8	9	8	9	9	8	3	8	6	6	8	10	6	10	8	9	8	4	5	6	5
High total cholesterol	10	9	6	7	7	6	7	7	10	8	8	10	8	9	8	9	11	9	12	17	19	19
Childhood underweight	11	22	21	19	20	20	20	21	21	19	14	14	15	16	14	14	10	10	10	4	1	1
Occupational risks	12	11	11	10	12	12	10	12	11	10	12	11	12	11	11	15	8	11	13	13	17	15
Lead	13	10	10	9	11	11	9	10	12	9	11	12	11	10	9	10	14	13	11	16	18	18
Suboptimal breastfeeding	14	25	24	24	24	25	18	25	18	14	13	13	13	12	12	13	13	12	9	7	5	6
Sanitation	15	19	19	18	22	23	21	20	22	21	23	18	25	20	21	18	15	15	17	11	10	12
Low bone mineral density	16	12	12	12	13	13	13	17	13	15	17	15	22	19	18	16	18	22	22	21	23	20
Intimate partner violence	17	13	16	15	16	16	16	14	15	16	18	17	16	17	16	17	16	17	16	20	20	21
Drug use	18	14	14	13	10	15	12	11	17	13	16	16	14	14	15	19	24	19	14	22	21	22
Ozone	19	17	15	23	15	17	25	18	14	23	21	25	19	25	17	24	17	25	23	24	22	23
Vitamin A deficiency	20	24	23	22	23	24	24	24	25	25	25	22	23	22	24	22	19	21	18	14	13	13
Iron deficiency	21	18	18	16	18	19	15	19	20	17	15	21	21	15	22	12	20	14	19	19	16	14
Unimproved water	22	20	20	21	19	22	22	23	24	24	24	20	24	23	19	20	22	18	21	15	11	16
Zinc deficiency	23	21	22	20	21	21	23	22	23	22	20	19	17	18	23	21	23	20	20	18	14	17
Radon	24	16	13	17	14	14	17	15	16	18	19	23	18	24	20	25	25	24	25	25	25	25
Childhood sexual abuse	25	15	17	14	17	18	19	16	19	20	22	24	20	21	25	23	21	23	24	23	24	24

EAT-Lancet Commission

Goal of the **EAT-Lancet Commission on Healthy Diets from Sustainable Food Systems**:

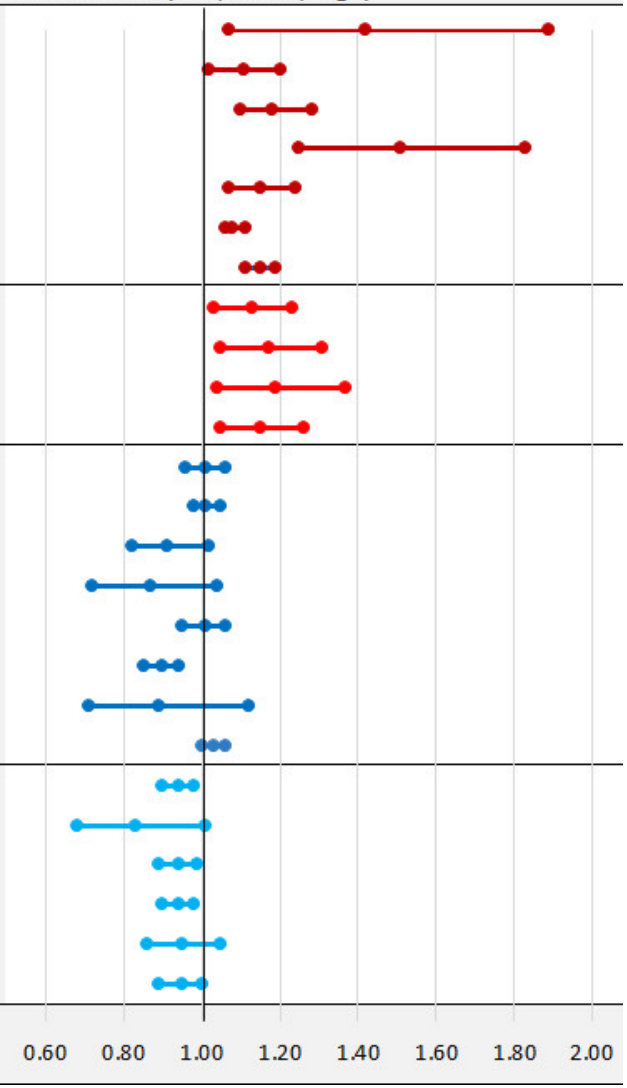
- Achieve a sustainable food system that can deliver healthy diets for a growing population.

Approach:

- Group of 19 commissioners and 18 co-authors from 16 countries and various fields, including human health, agriculture, political science and environmental sustainability.
- Define a healthy reference diet
- Define planetary boundaries of the food system
- Analyse diets and food system changes to stay within planetary boundaries
- Outline strategies to achieve healthy diets from sustainable food systems by 2050.

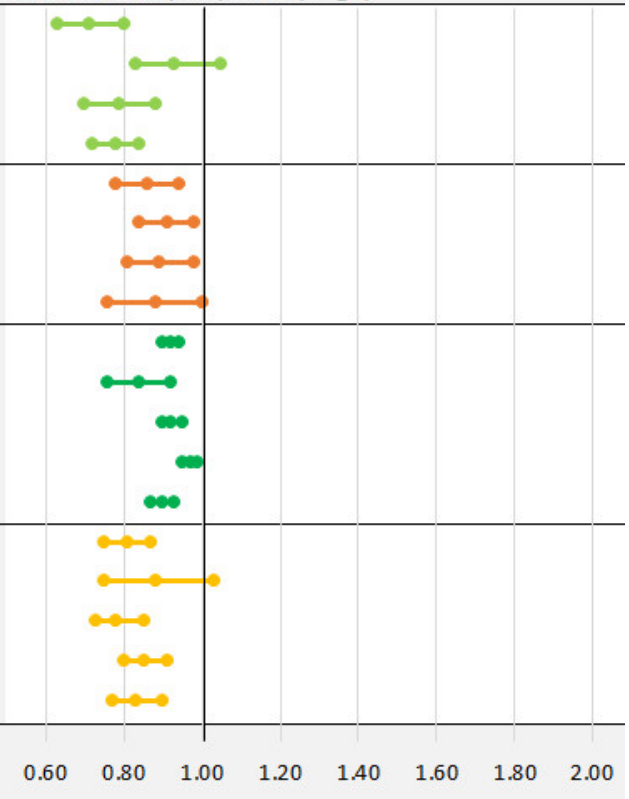
Evidence base for devising healthy diets: relative risks

Food group	Reference	Endpoint	Unit
Processed meat	Micha et al (2012)	CHD	50 g/d
	Chen et al (2013)	Stroke	50 g/d
	Chan et al (2011)	Colorectal cancer	50 g/d
	Feskens et al (2013)	Type 2 diabetes	50 g/d
	Wang et al (2016)	CVD mortality	50 g/d
	Wang et al (2016)	Cancer mortality	50 g/d
	Wang et al (2016)	All-cause mortality	50 g/d
Red meat	Chen et al (2013)	Stroke	100 g/d
	Chan et al (2011)	Colorectal cancer	100 g/d
	Feskens et al (2013)	Type 2 diabetes	100 g/d
	Abete et al (2014)	CVD mortality	100 g/d
Dairy	Mullie et al (2016)	All-cause mortality	200 mL/d
	Mullie et al (2016)	CHD	200 mL/d
	Mullie et al (2016)	Stroke	200 mL/d
	Aune et al (2013)	Type 2 diabetes	200 g/d
	Aune et al (2013)	Type 2 diabetes (adj, red meat intake)	200 g/d
	Aune et al (2012)	Colorectal cancer	200 g/d
	Aune et al (2012)	Colorectal cancer (adj, red meat intake)	200 g/d
	Aune et al (2015)	Prostate cancer	200 g/d
Seafood	Zheng et al (2012)	CHD mortality	15 g/d
	Zheng et al (2012)	CHD mortality	> 71 g/d
	Larsson and Orsini (2011)	Stroke	43 g/d
	Zhao et al (2016)	All-cause mortality	high vs low
	Zhao et al (2016)	All-cause mortality (adj, red meat intake)	high vs low
	Zhao et al (2016)	All-cause mortality (adj, fruit and veg intake	high vs low



Healthy diets

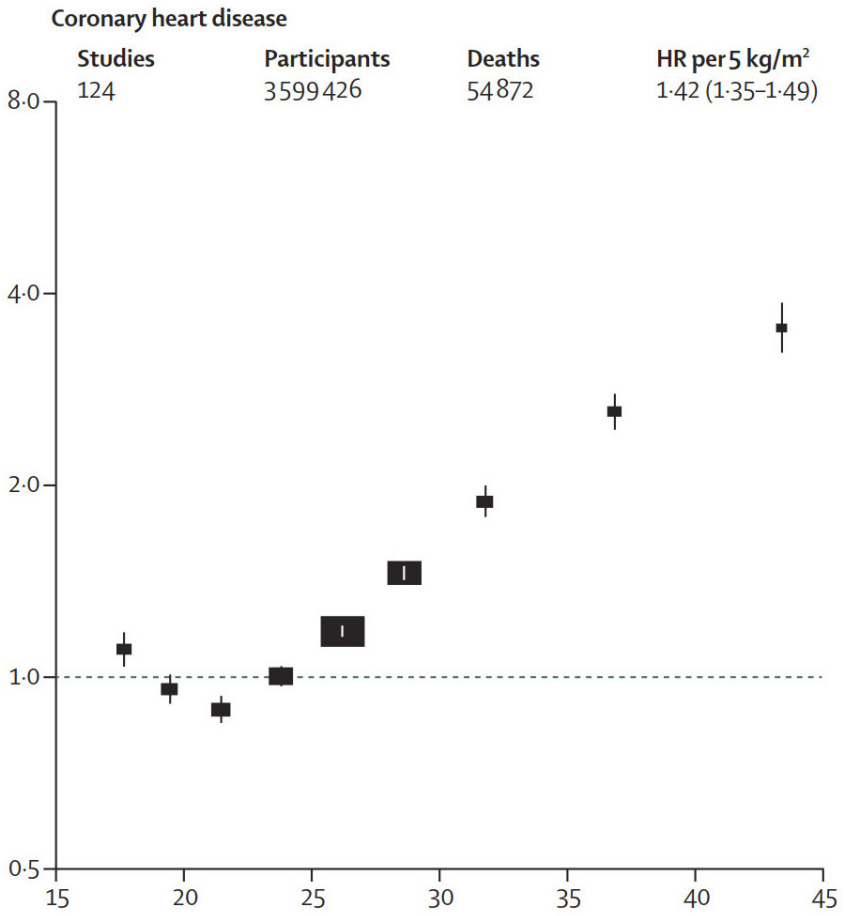
Food group	Reference	Endpoint	Unit
Nuts	Aune et al (2016)	CHD	28 g/d
	Aune et al (2016)	Stroke	28 g/d
	Aune et al (2016)	CVD	28 g/d
	Aune et al (2016)	All-cause mortality	28 g/d
Legumes	Afshin et al (2014)	CHD	57 g/d
	Zhu et al (2015)	Colorectal cancer	high vs low
	Zhu et al (2015)	Colorectal cancer (adj, red meat intake)	high vs low
	Zhu et al (2015)	Colorectal cancer (adj, fruit and veg intake)	high vs low
Fruit and vegetables	Aune et al (2017)	CHD	200g/d
	Aune et al (2017)	Stroke	200g/d
	Aune et al (2017)	CVD	200g/d
	Aune et al (2017)	Cancer	200g/d
	Aune et al (2017)	All-cause mortality	200g/d
Whole grains	Aune et al (2016)	CHD	90 g/d
	Aune et al (2016)	Stroke	90 g/d
	Aune et al (2016)	CVD	90 g/d
	Aune et al (2016)	Cancer mortality	90 g/d
	Aune et al (2016)	All-cause mortality	90 g/d



Springmann et al, 2019, *Environmental Nutrition, 1st Edition, Chapter 14*

Healthy body weight:

The Global BMI Mortality Collaboration (2016), WHO (2004)

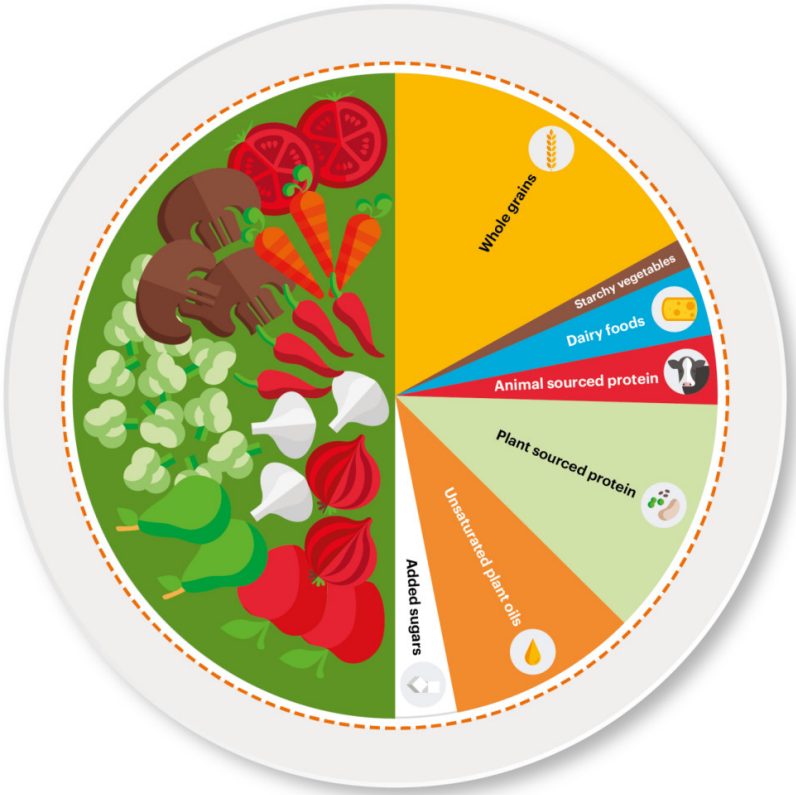


Age	Female	Male	Average
0-4	1200	1200	1200
5-9	1520	1600	1560
10-14	1920	2120	2020
15-19	2040	2760	2400
20-24	2200	2800	2500
25-29	2000	2600	2300
30-34	2000	2600	2300
35-39	2000	2600	2300
40-44	2000	2600	2300
45-49	2000	2400	2200
50-54	1800	2400	2100
55-59	1800	2400	2100
60-64	1800	2400	2000
65-69	1800	2200	2000
70-74	1800	2200	2000
75-79	1800	2200	2000
80-84	1800	2200	2000
85-89	1800	2200	2000
90-94	1800	2200	2000
95-99	1800	2200	2000
100+	1800	2200	2000

Healthy diets

Predominantly **plant-based** dietary patterns (flexitarian, pescatarian, vegetarian, vegan):

	Macronutrient intake grams per day (possible range)	Caloric intake kcal per day
Whole grains		
Rice, wheat, corn and other	232	811
Tubers or starchy vegetables		
Potatoes and cassava	50 (0–100)	39
Vegetables		
All vegetables	300 (200–600)	78
Fruits		
All fruits	200 (100–300)	126
Dairy foods		
Whole milk or equivalents	250 (0–500)	153
Protein sources		
Beef, lamb and pork	14 (0–28)	30
Chicken and other poultry	29 (0–58)	62
Eggs	13 (0–25)	19
Fish	28 (0–100)	40
Legumes	75 (0–100)	284
Nuts	50 (0–75)	291
Added fats		
Unsaturated oils	40 (20–80)	354
Saturated oils	11.8 (0-11.8)	96
Added sugars		
All sugars	31 (0–31)	120



Healthy diets

Consumption changes (%) to reach flexitarian diets in 2030:

Food groups	World	HIC	UMC	LMC	LIC
red meat	-82	-90	-83	-78	-57
sugar	-48	-56	-68	-39	-15
white meat	-38	-59	-52	-6	-7
milk&eggs	-32	-55	-31	-17	-8
staples	-28	8	-16	-36	-33
fish	50	20	98	46	106
vegetables	55	50	92	35	247
fruits	59	24	24	72	117
legumes	249	485	198	240	187
nuts	280	336	294	248	335

Healthy diets

Analysis of diets:

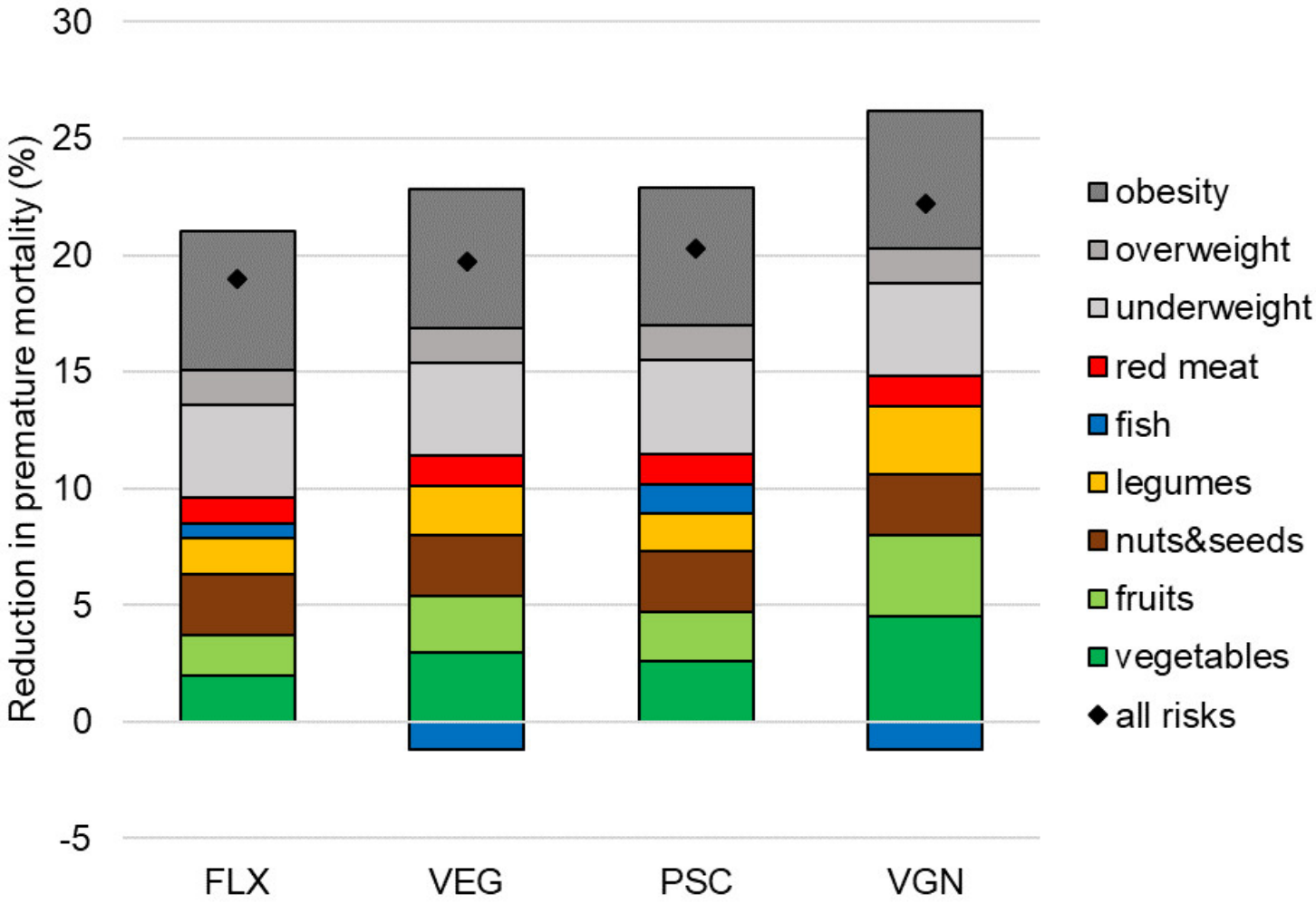
- Nutritional analysis: nutritional content of food groups for 24 nutrients based on GENuS dataset (Smith et al, 2016) and USDA (B5, B12); comparison to WHO recommendations;
- Mortality analysis: comparative risk assessment with 9 dietary and weight-related risk factors and 5 disease endpoints based on Oxford Global Health model (Springmann et al, 2016a,b);
- Environmental analysis: country-specific footprints for GHG emissions, cropland use, freshwater use, nitrogen application, phosphorus application (Springmann et al, 2018a).
- Food-systems analysis: combined analysis of improvements in technologies and management, reductions in food loss and waste, and dietary changes to more plant-based diets (Springmann et al, 2018b).

Nutritional analysis

Nutrient	unit	rec	Diet scenario				
			BMK	FLX	PSC	VEG	VGN
calories	kcal	2084	2146	2084	2084	2084	2084
protein	g	>52	68.4	70.6	72.5	65.0	64.7
carbohydrates	g	<391	324	274	278	289	304
fat	g		68.9	81.8	78.1	77.3	71.3
saturatedFA	g	<23	22.5	19.7	17.5	17.2	13.4
monounsatFA	g		26.7	31.4	28.1	27.7	26.1
polyunsatFA	g	>14	16.7	27.7	27.2	27.4	27.6
vitaminC	mg	>42	86.9	148	163	171	196
vitaminA	µg	>544	482	627	679	694	703
folate	µg	>364	280	553	577	644	733
calcium	mg	>520	556	621	660	630	489
iron	mg	>17	16.4	18.8	19.3	19.5	21.1
zinc	mg	>6.1	10.8	10.4	10.4	10.2	10.3
potassium	mg	>3247	2506	3383	3555	3634	3952
fiber	g	>29	26.0	35.5	36.6	39.9	44.6
copper	mg	>0.8	1.6	2.3	2.3	2.5	2.7
phosphorus	mg	>757	1312	1379	1429	1366	1337
thiamin	mg	>1.1	1.3	1.5	1.5	1.5	1.6
riboflavin	mg	>1.1	0.9	0.9	1.0	0.9	0.9
niacin	mg	>14	18.7	17.5	17.4	16.0	16.8
vitaminB6	mg	>1.2	6.1	6.1	6.2	6.1	2.3
magnesium	mg	>205	436	527	543	561	596
pantothenate	mg	>4.7	5.7	5.4	5.4	5.3	4.9
vitaminB12	µg	>2.2	3.0	2.4	3.7	0.8	0.0

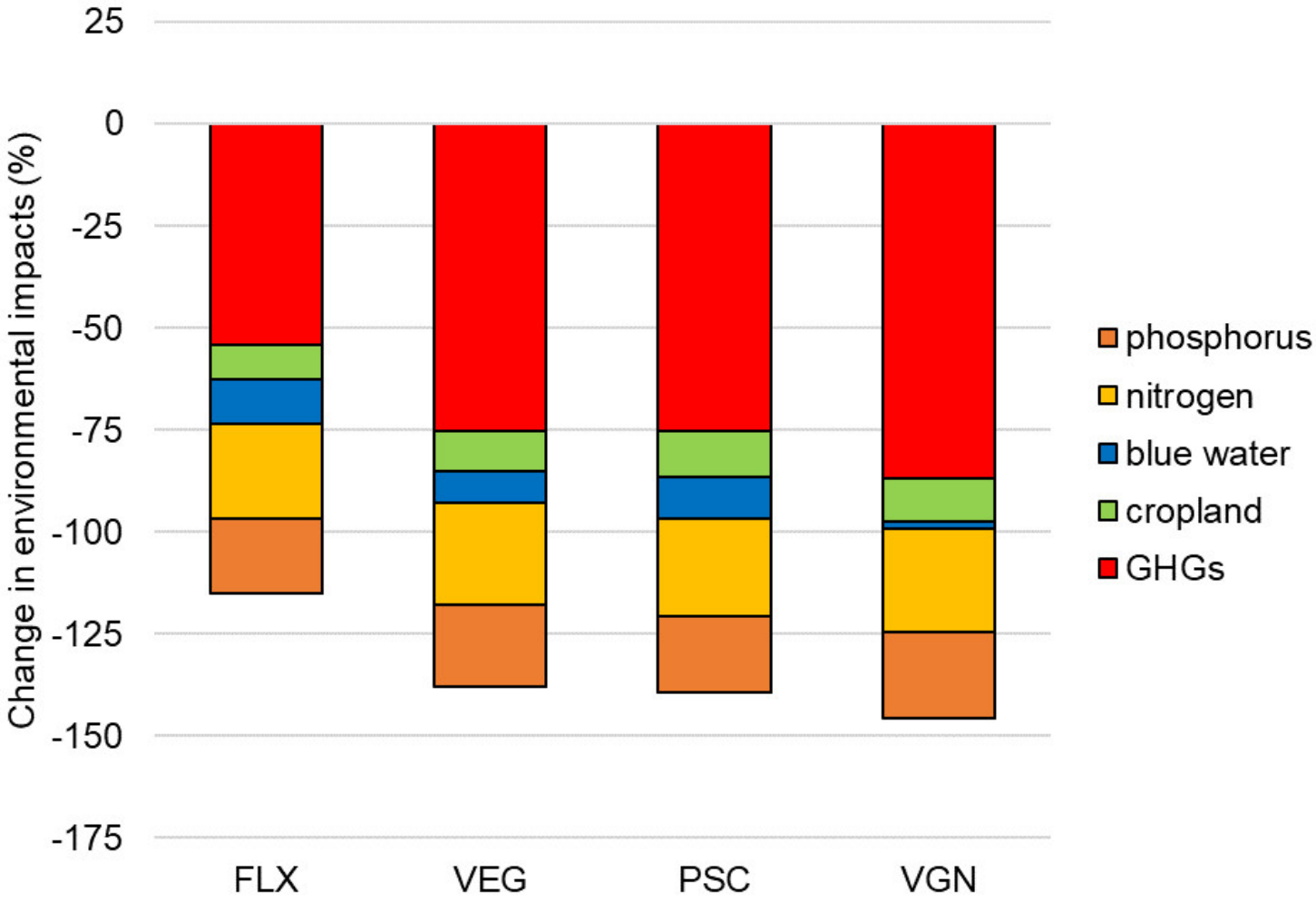
Springmann et al, *Lancet Planetary Health* 2018

Chronic-disease analysis



Springmann et al, *Lancet Planetary Health* 2018

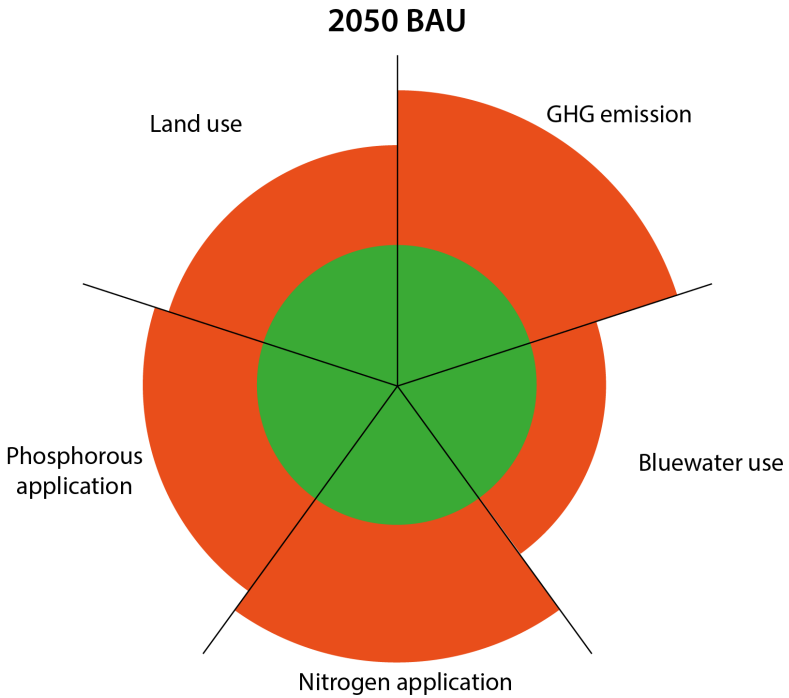
Environmental analysis

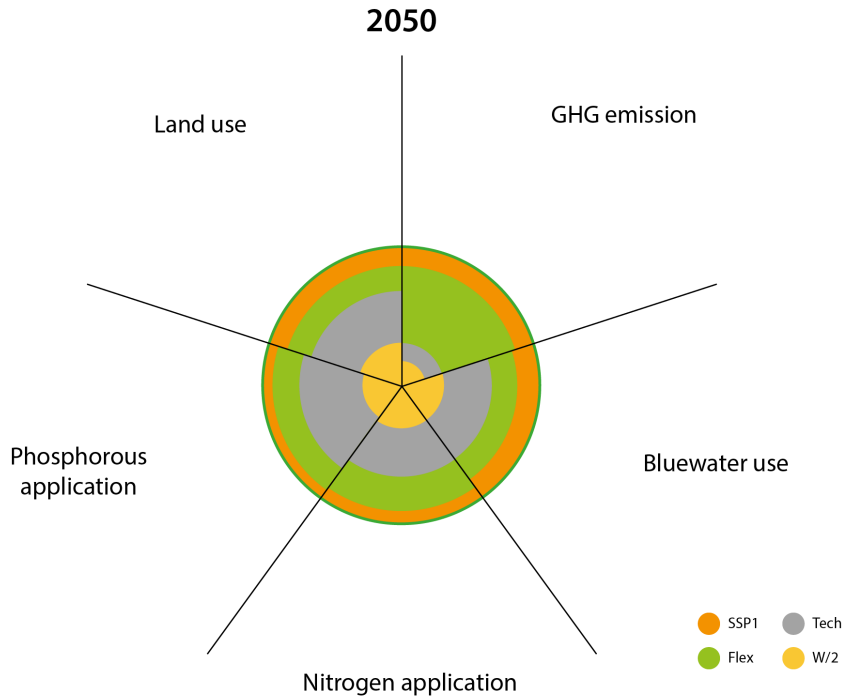


Springmann et al, *Lancet Planetary Health* 2018

Food-systems analysis

Technological and dietary changes are needed to stay within **planetary boundaries** of the food system:

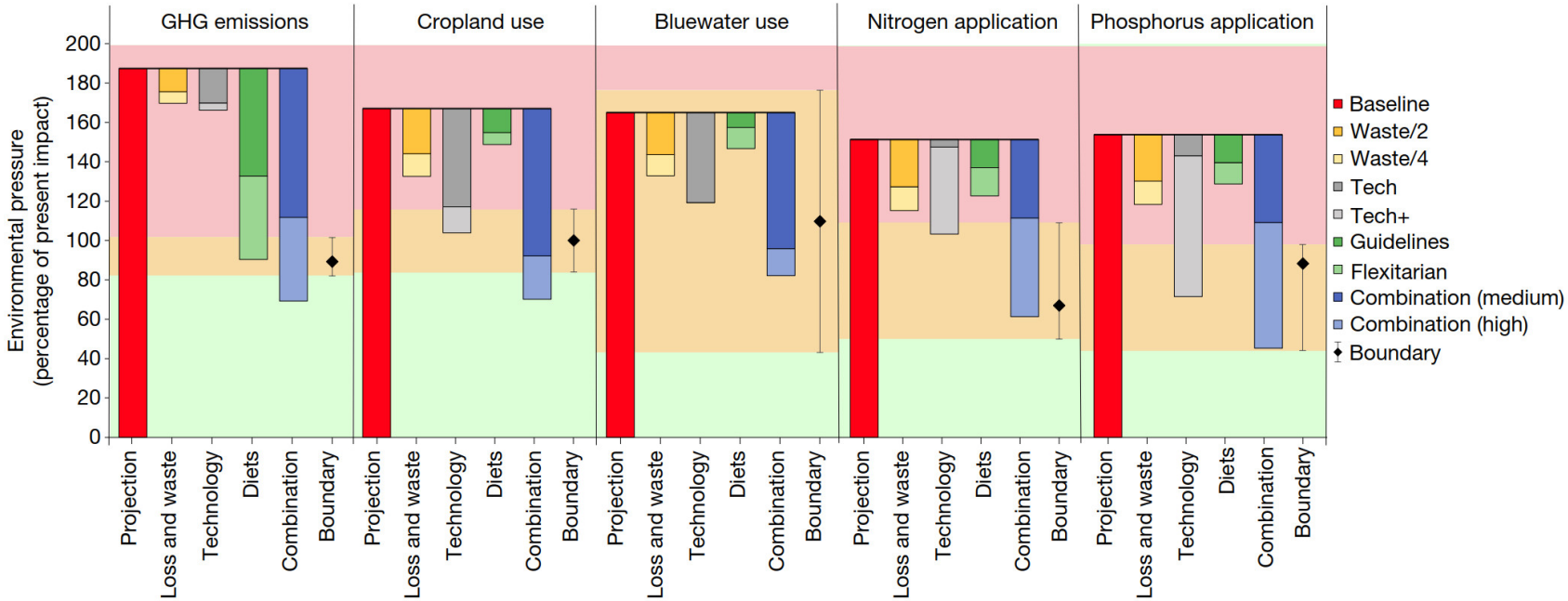




Springmann et al, *Nature* 2018

Food-systems analysis

Zoom in $\rightarrow$ ambition of food-system changes, environmental domains, range of planetary boundaries:



Planetary boundaries

Relationship of planetary boundaries and policy goals (**SDGs**):

Planetary boundary	Motivation	Method	Global targets	Comment
Climate change	Further increasing GHG emissions increase climate-related risks to ecosystems and cultures, e.g. from sea-level rise and increased occurrence of extreme weather events, such as heat waves, extreme precipitation, and coastal flooding [82].	Food-related GHG emissions in line with limiting global warming to below 2 degrees Celsius [63] with uncertainty derived from a model comparison of integrated assessment models [58].	**Paris Climate Agreement**	The Paris Agreement's long-term goal is to keep the increase in global average temperature to well below 2 °C above pre-industrial levels; and to limit the increase to 1.5 °C, since this would substantially reduce the risks and effects of climate change. Reflected in **SDG 13** and in the plenatary boundary for climate change.
Land-system change	Further increasing the amount of agricultural land through deforestation could impact the functioning of ecosystems [3], release large amounts of carbon dioxide [1], and diminish habitat for wild species and thereby pose major threats to biodiversity [4].	Analysis of conservation levels for each forest biome in line with preserving ecosystem integrity, scaled up to a global value [12] and related to cropland use [33,39].	**Aichi Biodiversity Targets**	Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced. Related to **SDG 15** and planetary boundary for land-system change.
Freshwater use	Further depletion and overexploitation of groundwater resources impairs natural streamflow, wetlands and related ecosystems, and can lead to land subsidence and salt-water intrusion in deltaic areas [6] and, eventually, to cascading impacts on the global hydrological cycle [77].	Basin-level assessments of the environmental flow requirements of river systems [12,20] scaled to agricultural bluewater use [5,33].	**SDG target on water withdrawals**	**SDG 6.4**: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity. In line with planetary boundary for freshwater use.
Bio-geochemical flows	Agricultural runoff from overapplication of fertilizers leads to eutrophication, an increase in chemical nutrients in the water [7,9], which in turn can lead to excessive blooms of algae that deplete underwater oxygen levels resulting in so-called dead zones in coastal oceans [8].	Analysis of eutrophication risk based on nitrogen and phosphorus pollution estimates of agricultural runoff and ecological thresholds [19], with an upper value in line with re-balancing of application between over and under-applying regions [32].	**SDG target on nutrient pollution**	**SDG 14.1**: By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution
Healthy diets	Levels of malnutrition are increasing, in particular overweight, obesity, and dietary risks. All people should have access to healthy and nutritious diets.	Review of literature on healthy eating and construction of general food-based dietary guidelines in line with healthy diets.	**NCD Agenda**	**SDG 3.4**: the target is to "reduce by one third premature mortality from NCDs through prevention and treatment, and promote mental health and wellbeing", which builds on the World Health Organization (WHO) "25x25" NCD target.

Discussion

Improvements in technologies and management:

- What is needed:
  - Close yield gaps to 75%
  - Rebalance fertilizer application and increase use-efficiency (N) and recycling (P)
  - Increase basin efficiency, storage capacity, rainwater utilization
  - Increase feed conversion efficiency and manure management, and adapt agro-ecological practices for irrigation and cropping
- Policy implications:
  - Investments in public infrastructure
  - Farm-level incentives/support to adopt best available technologies
  - Better environmental regulation (eg water use and quality)

Reductions in food loss and waste:

- What is needed:
  - Reduce food loss and waste by at least half
- Policy implications:
  - *Loss*: investments in agricultural infrastructure, technological skills, storage, transport and distribution
  - *Waste*: Closed-loop supply chains, packaging, labelling and awareness campaigns

Discussion

Improvements in socio-economic development:

- What is needed:
  - Pathway with higher income and lower population growth would be beneficial
- Policy implications:
  - Investments in education, especially for women
  - Improved access to general and reproductive health services

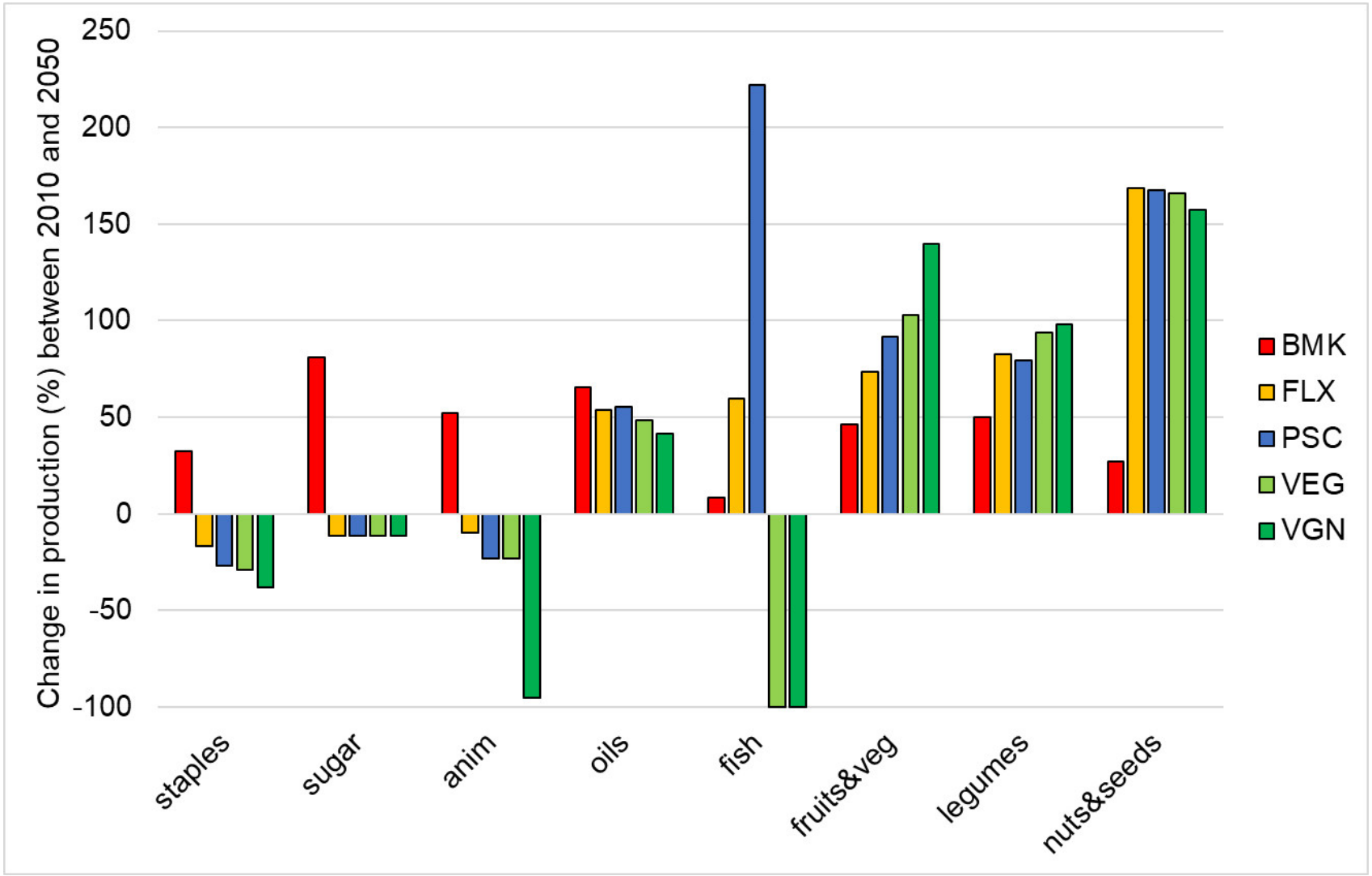
Discussion

Improvements in diets:

- What is needed:
  - Limit red meat consumption to less than one serving per week
  - Limit white meat to less than half a portion a day, and dairy to less than one serving per day
  - Limit sugar and total energy intake in line with recommendations
  - Eat more than five portions of fruits and veg
- Policy implications:
  - Multicomponent approaches essential
  - Media and education campaigns; labelling and consumer information;
  - Fiscal measures, such as taxation, subsidies, and other economic incentives;
  - School and workplace approaches; local environmental changes;
  - Update national dietary guidelines
  - Make agricultural policies health-sensitive

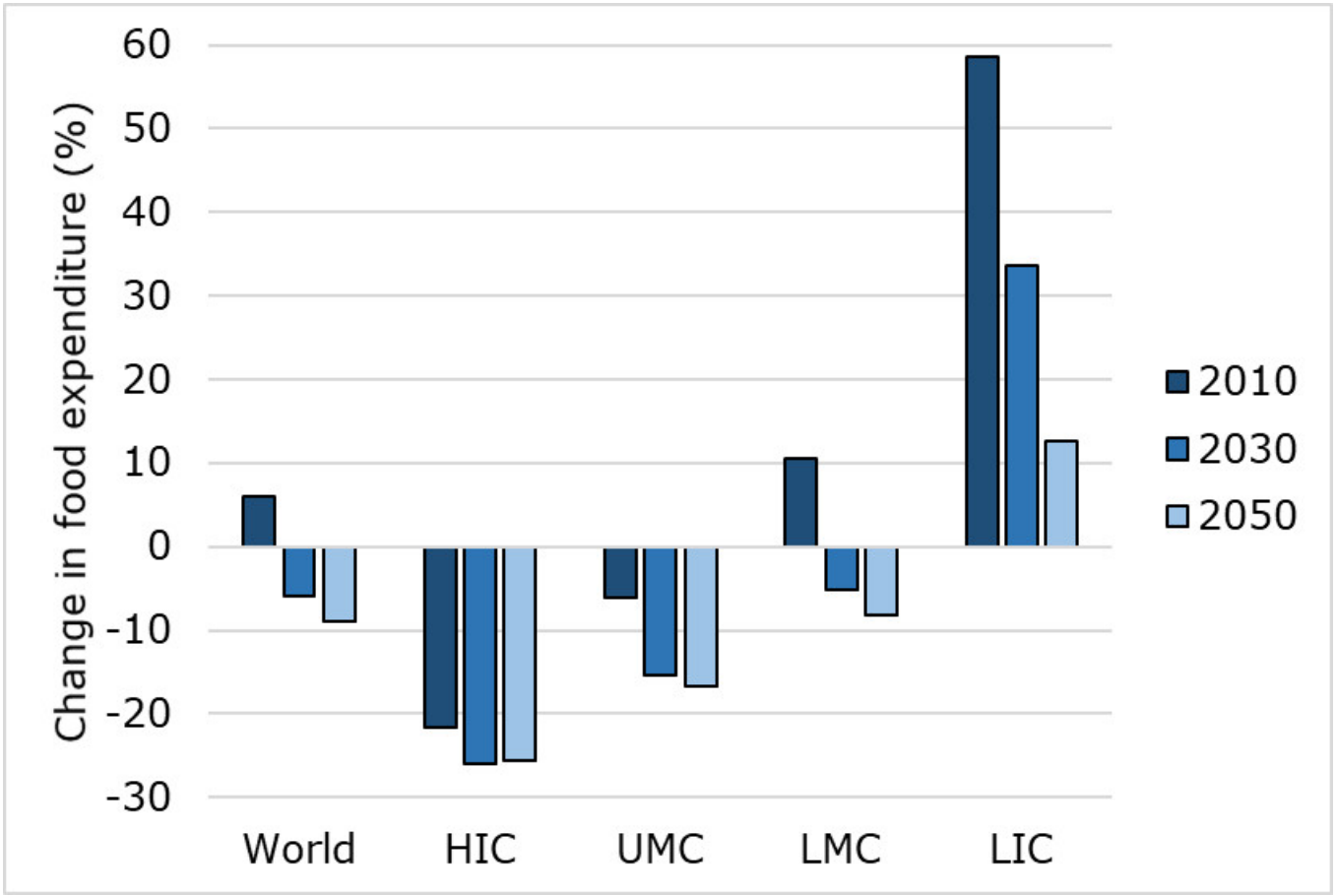
Implications for agriculture

Large-scale transition to more plant-based foods (in addition to improvements in technology and management):



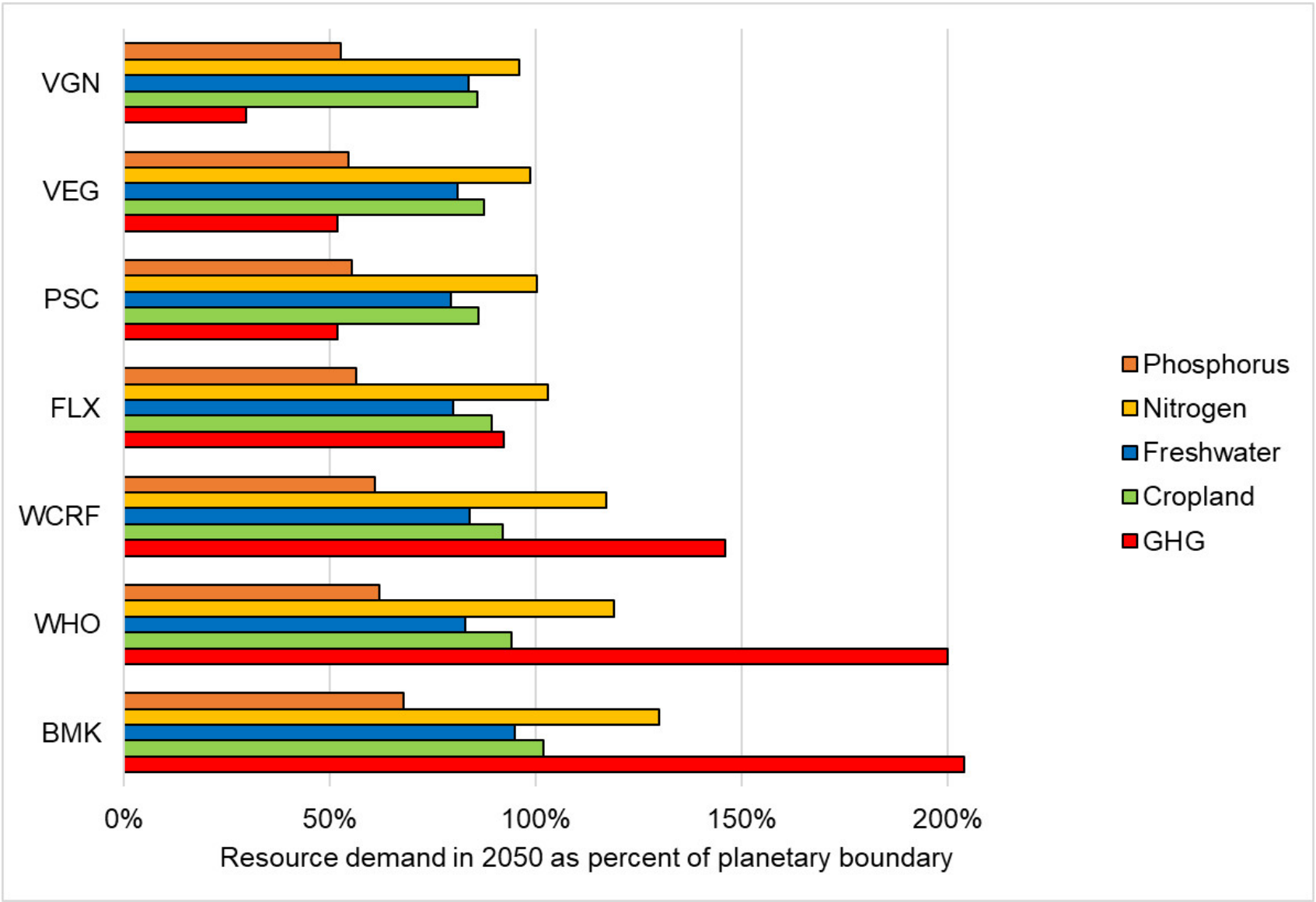
Implications for development aid

Changes in food expenditure due to dietary change:



Implications for dietary guidelines

Current dietary guidelines (WHO, WCRF) are not sustainable:



Conclusion

Healthy diets and sustainable food systems are achievable, but it will require:

- Synergistic combination of improvements in technologies and management, reductions in food loss and waste, and dietary changes towards healthier, more plant-based diets;
- Strong regulation and right incentives are required;
- Combining measures with attention to local contexts important for defining region-specific sustainable-development pathways;
- The country-specific data and suite of scenarios produced for the report and associated studies can be a starting point.

Literature

Country-level results available in:

- Willett et al, 2019, Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems, *The Lancet* 392:10270, 447-492.
- Springmann et al, 2018, Options for keeping the food system within environmental limits, *Nature* 562, 519-525.
- Springmann et al, 2018, Health and nutritional aspects of sustainable diet strategies and their association with environmental impacts: a global modelling analysis with country-level detail, *Lancet Planetary Health* 2, e451-e461.

Thank you

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