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Agroecology

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One Health Summer School, University of Bern

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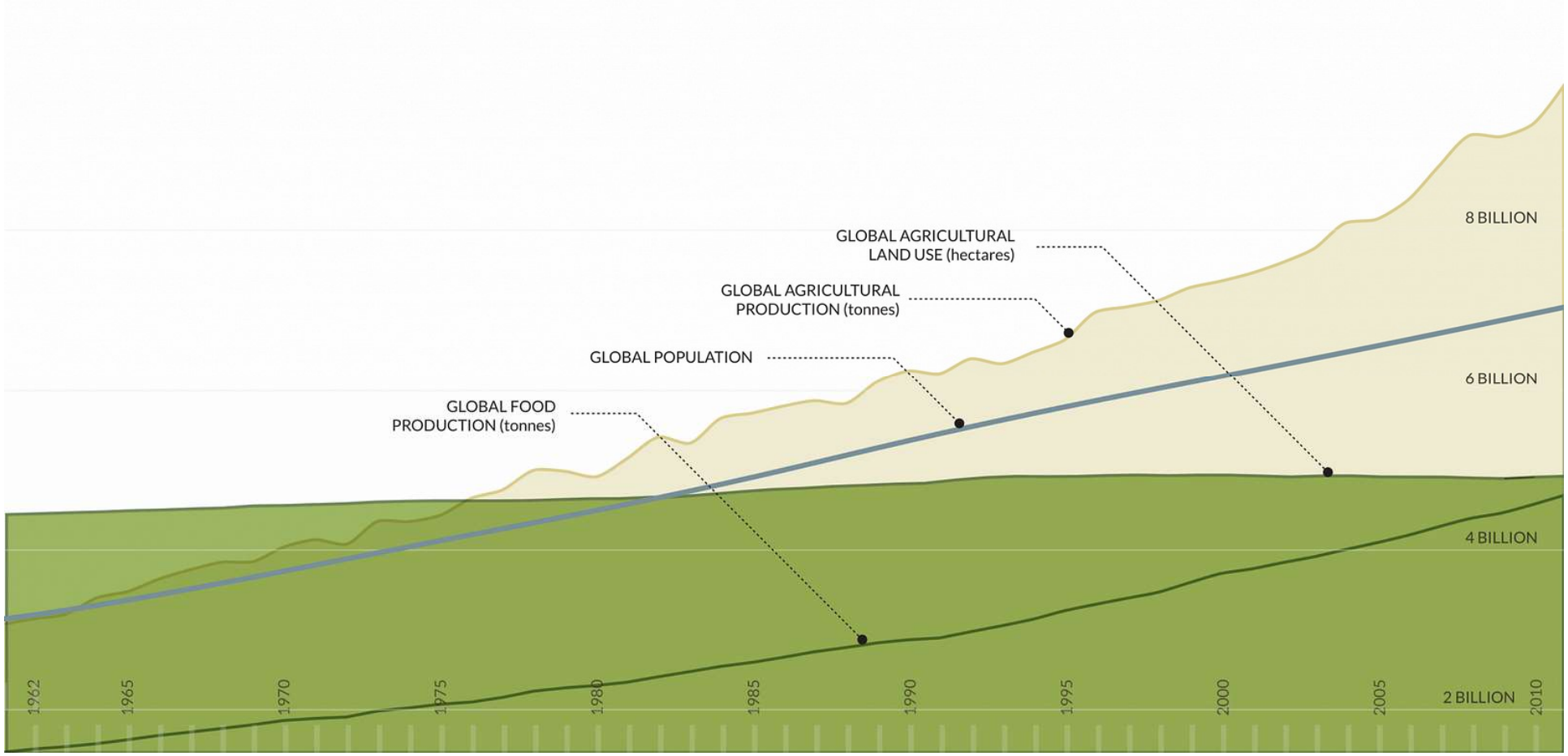
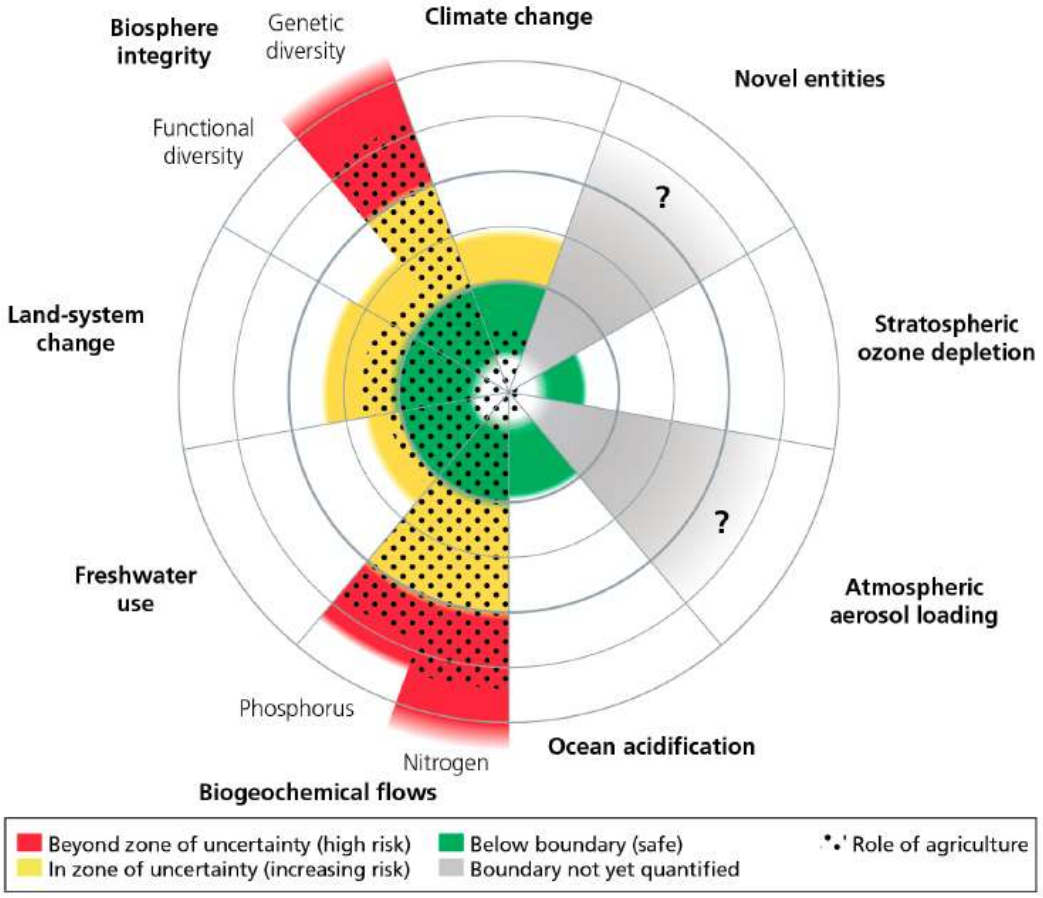
Food system challenges: past, present, future



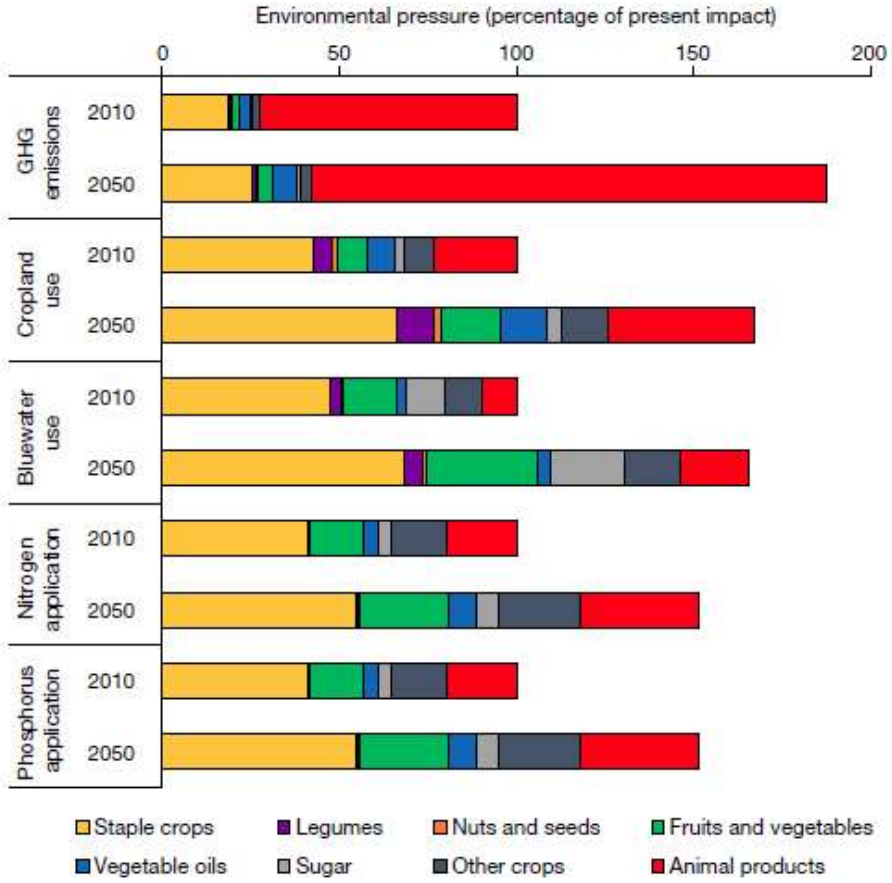
Source: FAO 2015, FAOSTAT

Contribution of agriculture to the planetary boundaries

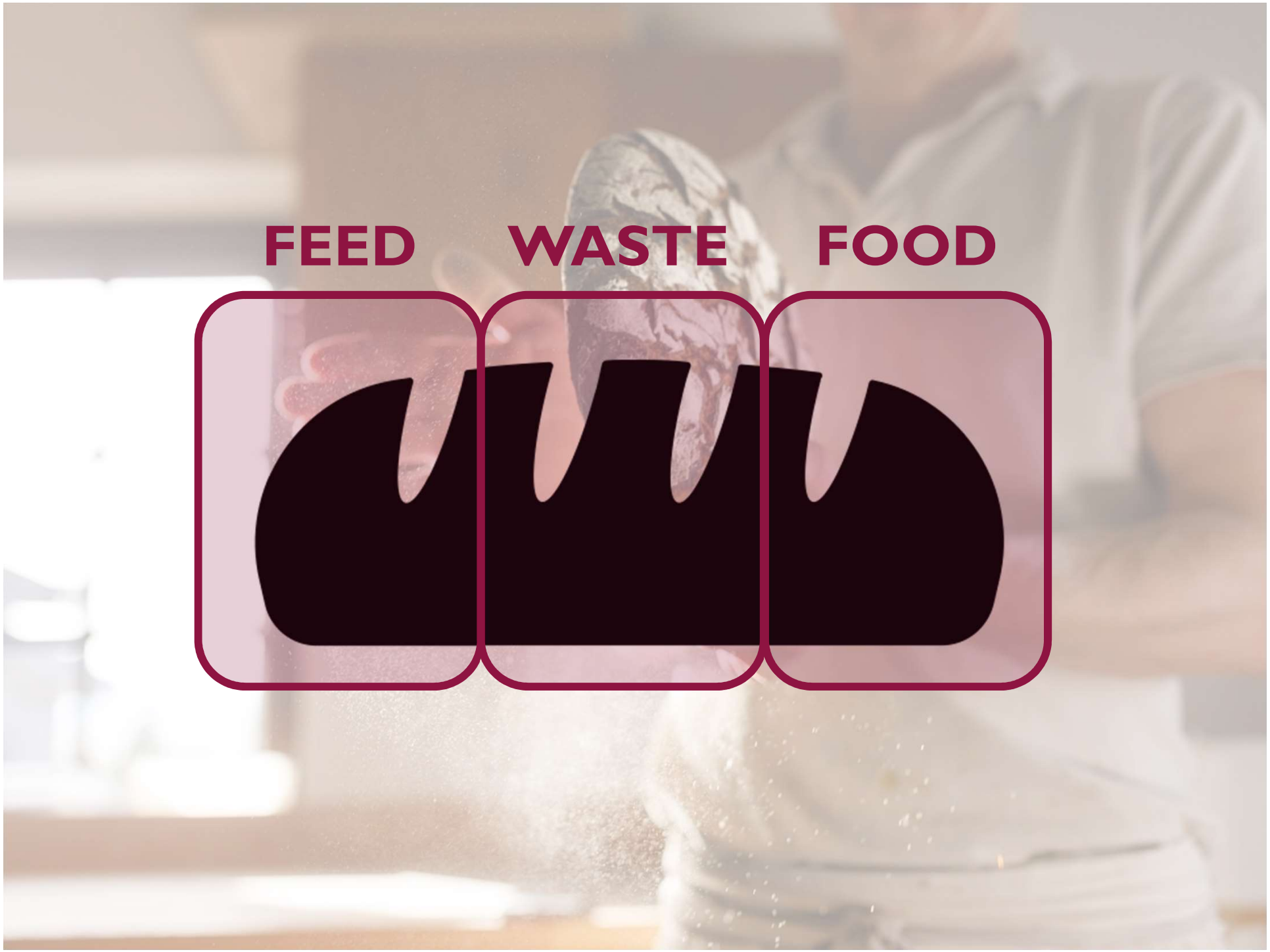


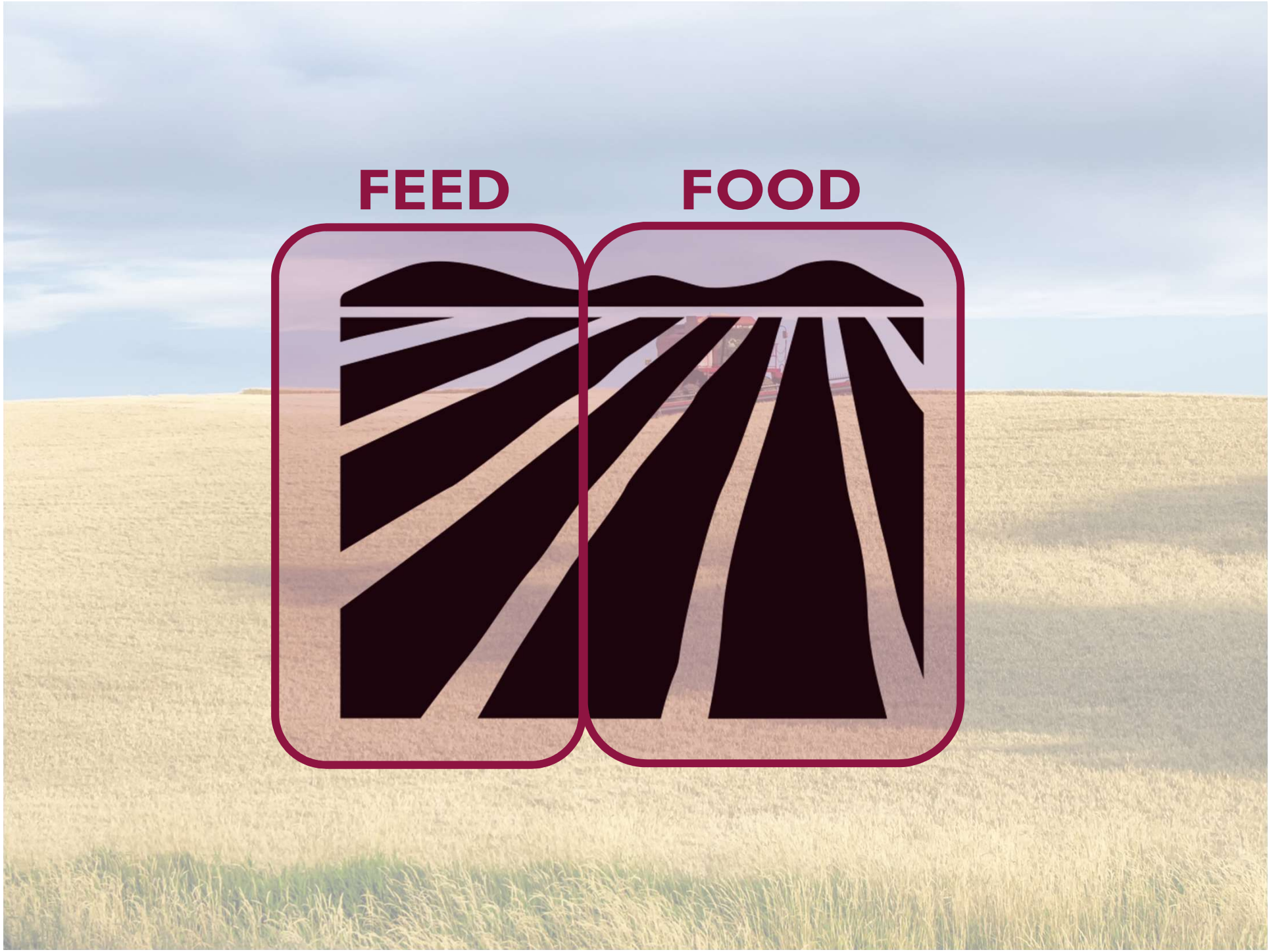
Source: Campbell et al., 2017, *Ecology and Society*

Environmental impacts of our food system

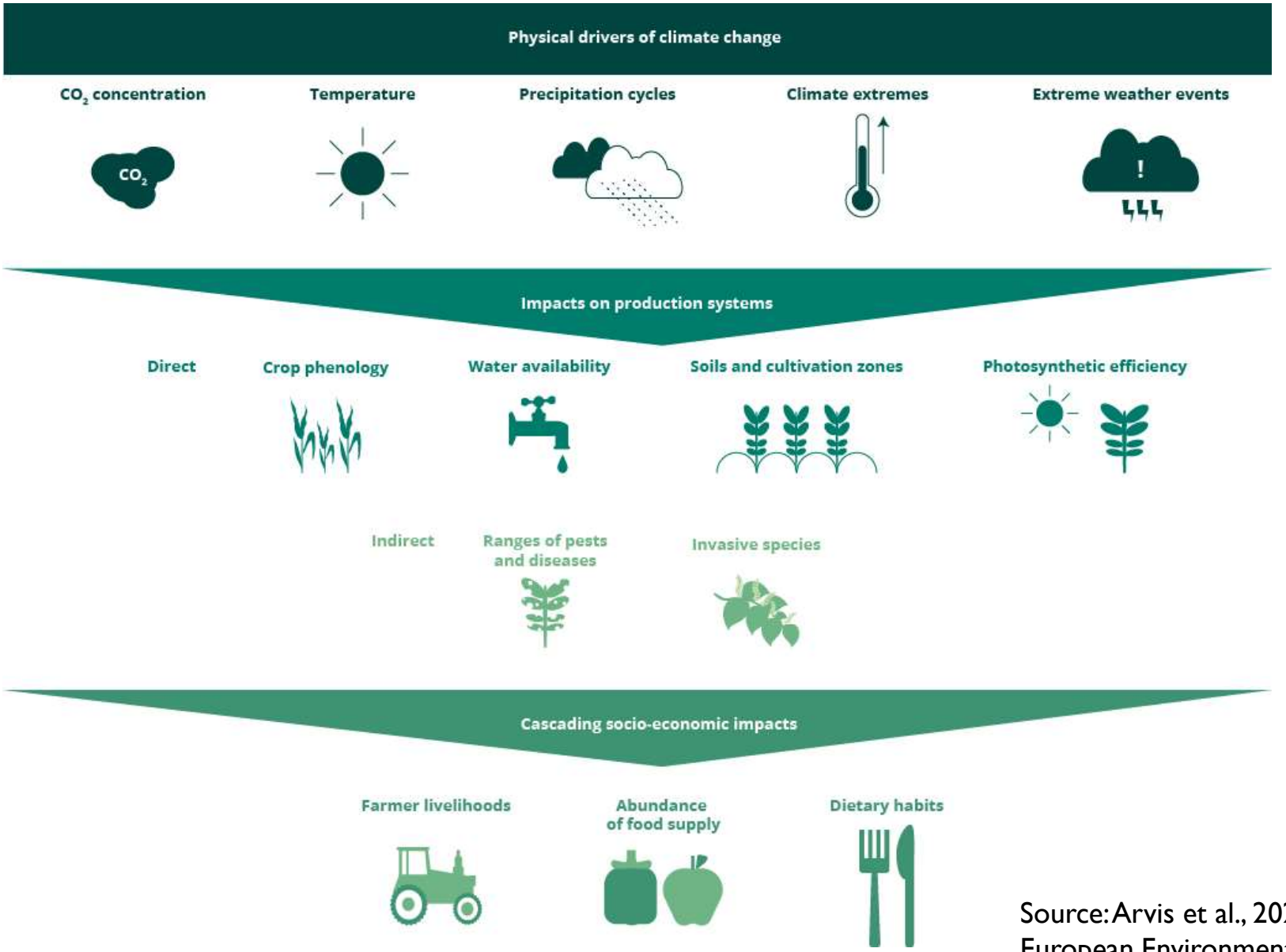


Source: Springmann et al., 2018, *Nature*


FEED
WASTE
FOOD

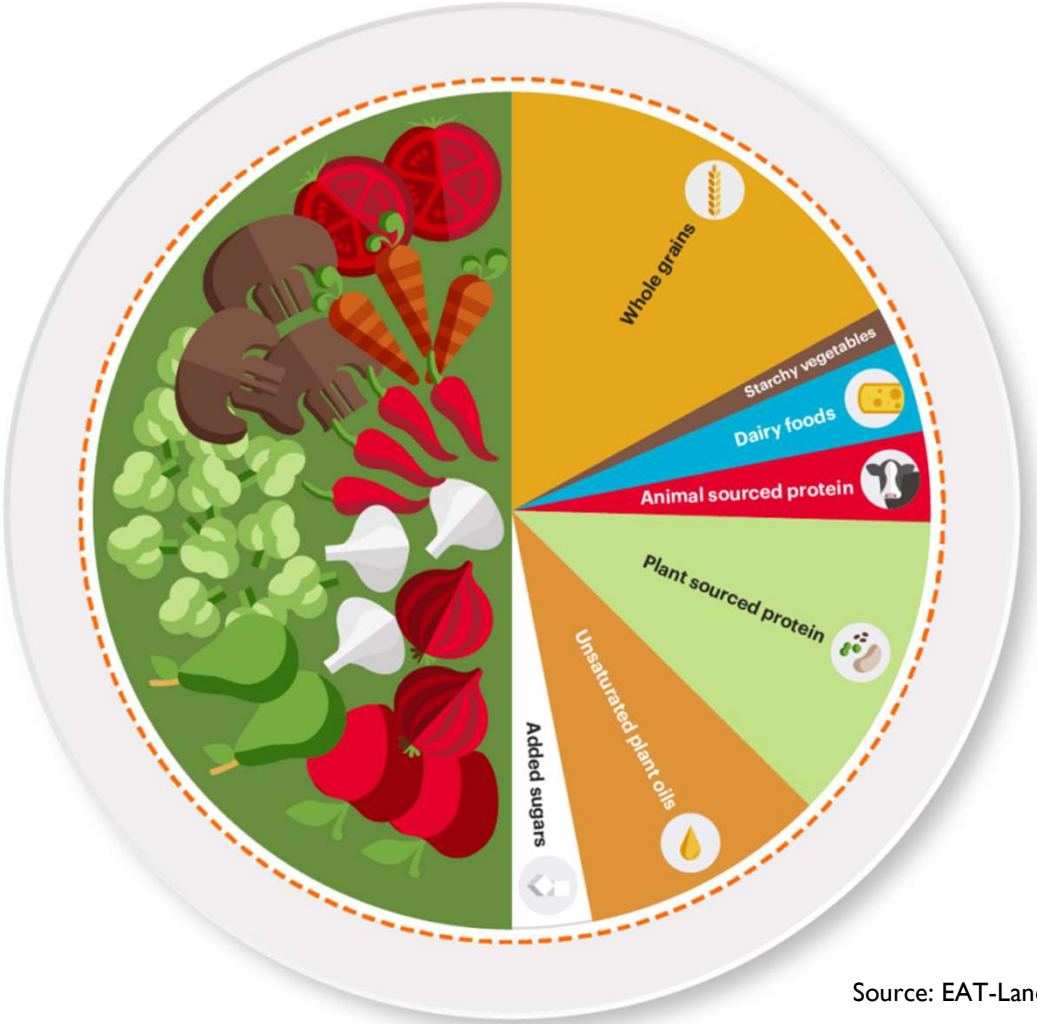

FEED
FOOD

Climate change and agriculture



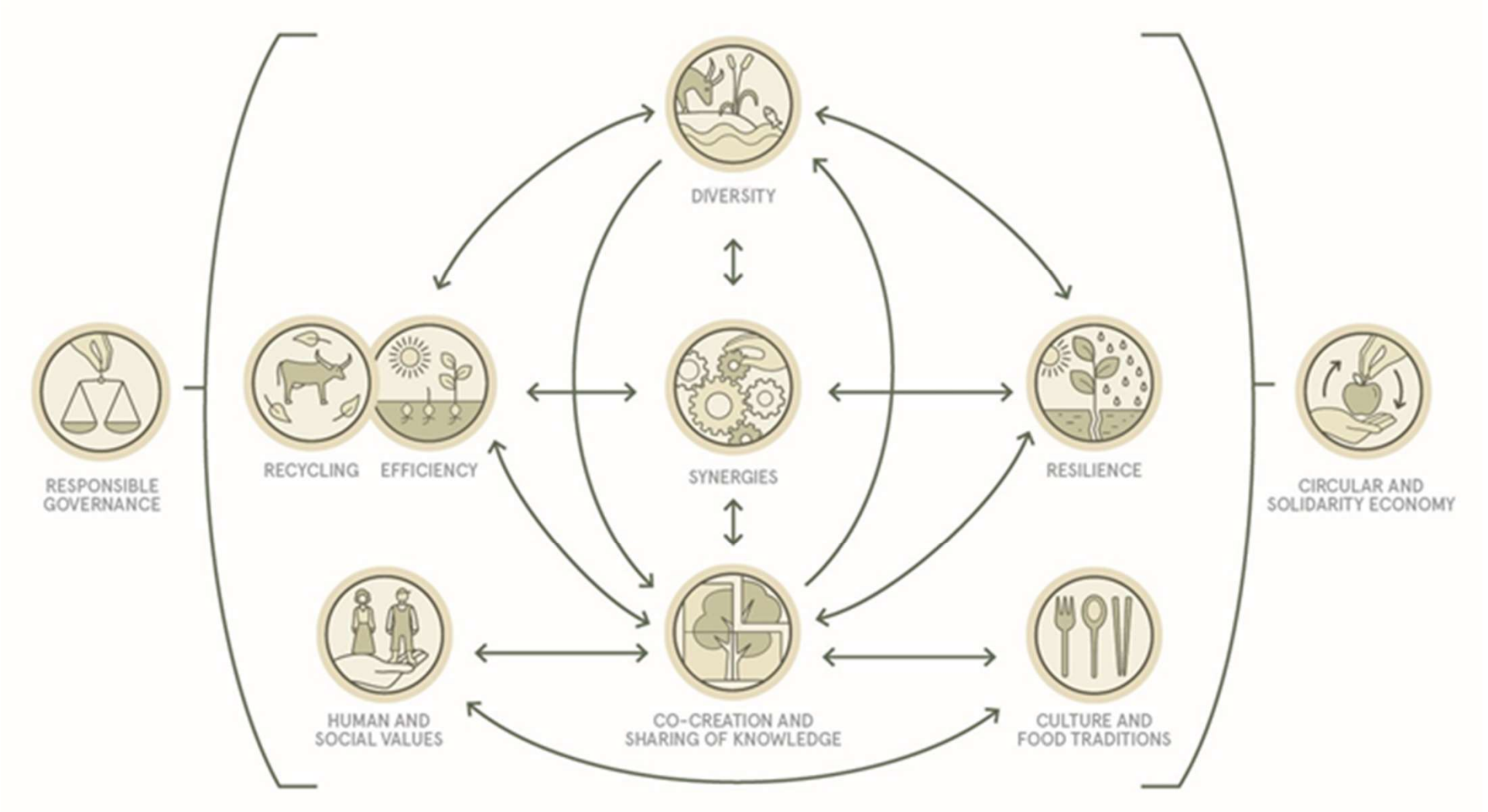
Source: Arvis et al., 2020, European Environment Agency

Planetary Health Diet



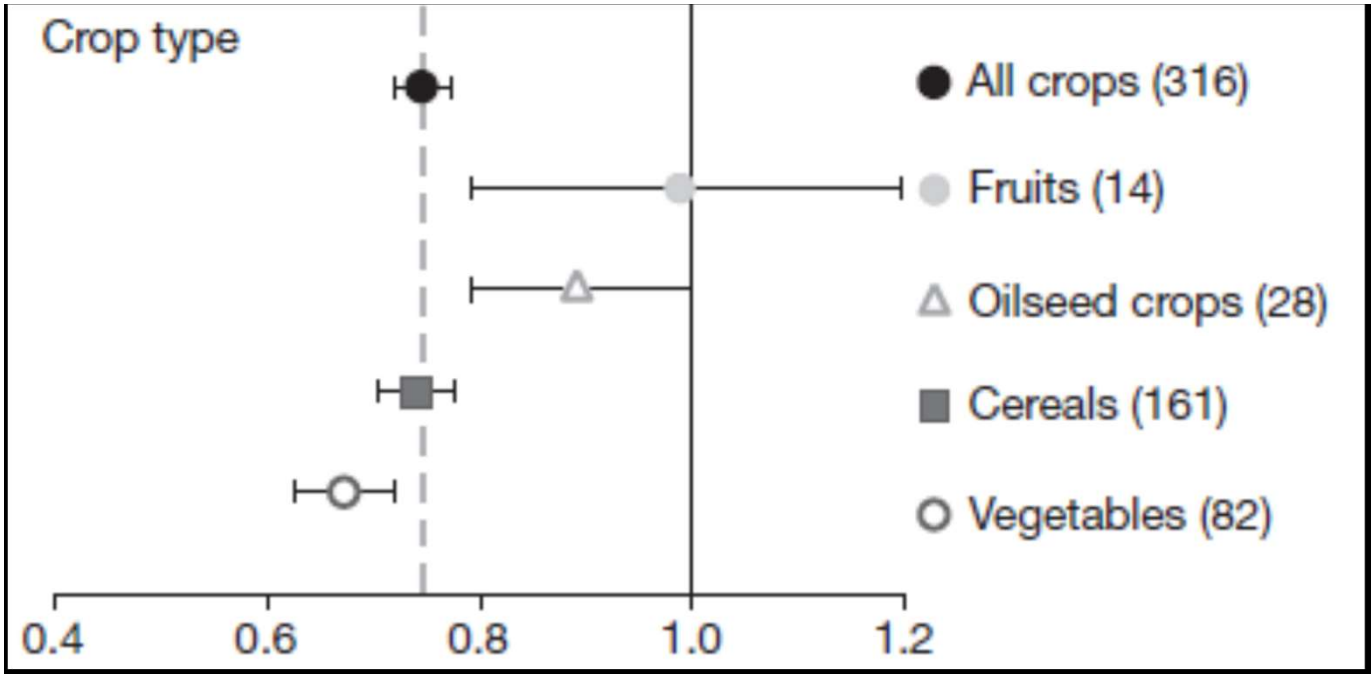
Source: EAT-Lancet report: Planetary Health Diet

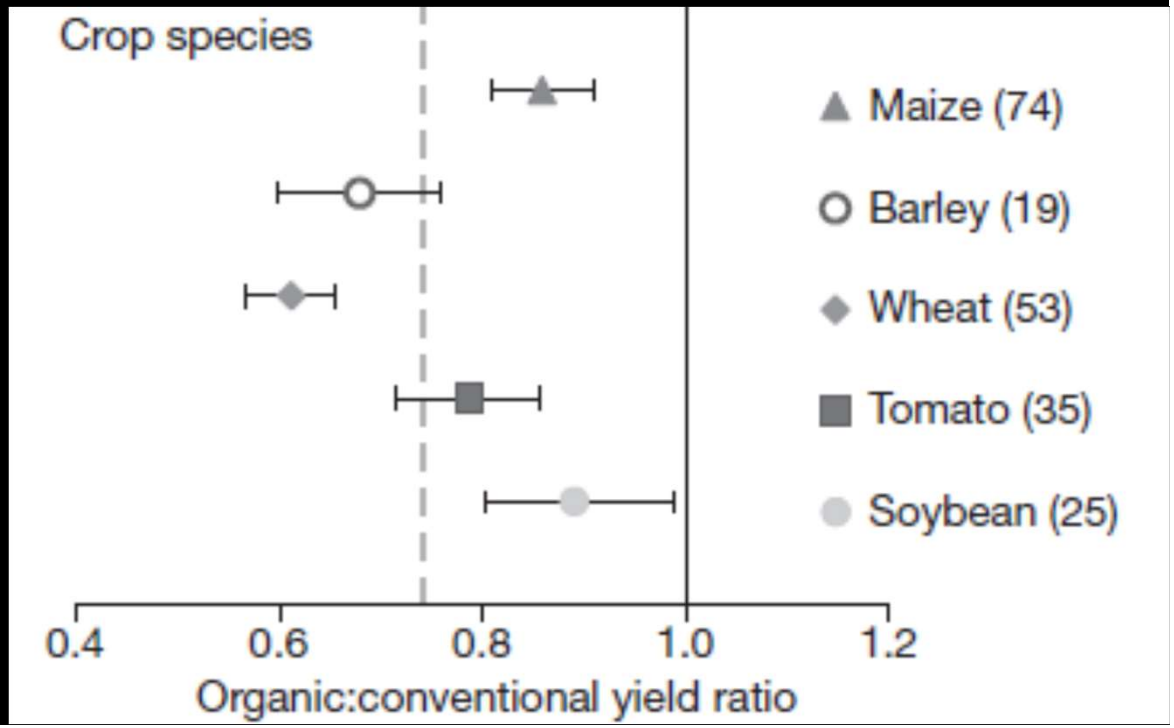
10 elements of agroeoclogy



FAO 2018

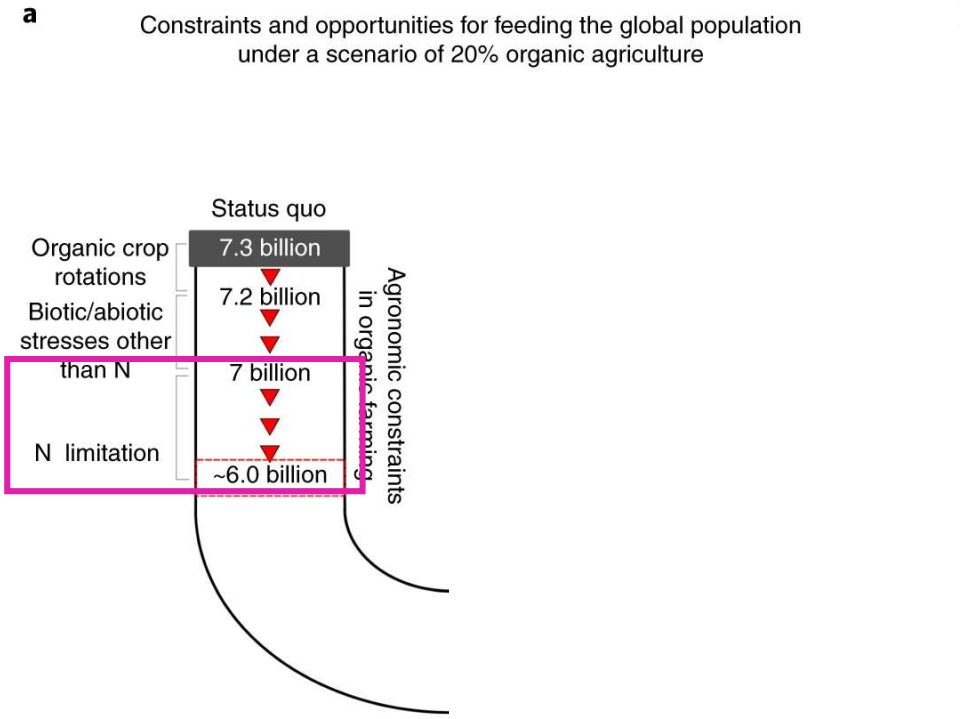
Yields





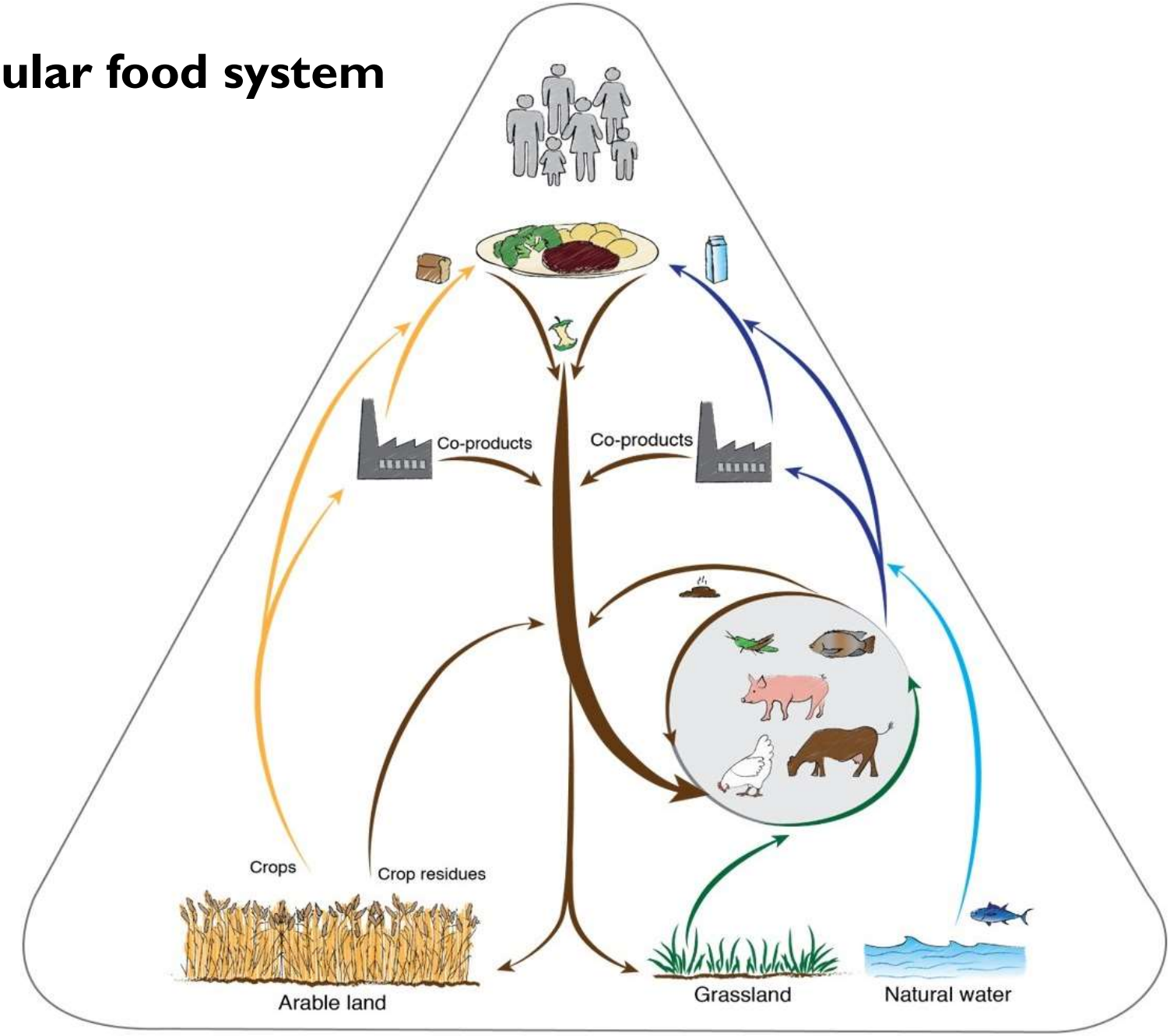
Seufert et al. 2012

Nutrient supply



Barbieri et al. 2021

Circular food system



Van Zanten et al., 2019

Plant protection

The use of broad-spectrum insecticides against larvae of cabbage moth (*Mamestra brassicae*) has negative effects on aphid parasitoids. As a result, severe aphid infestations may build up, necessitating further insecticide applications.

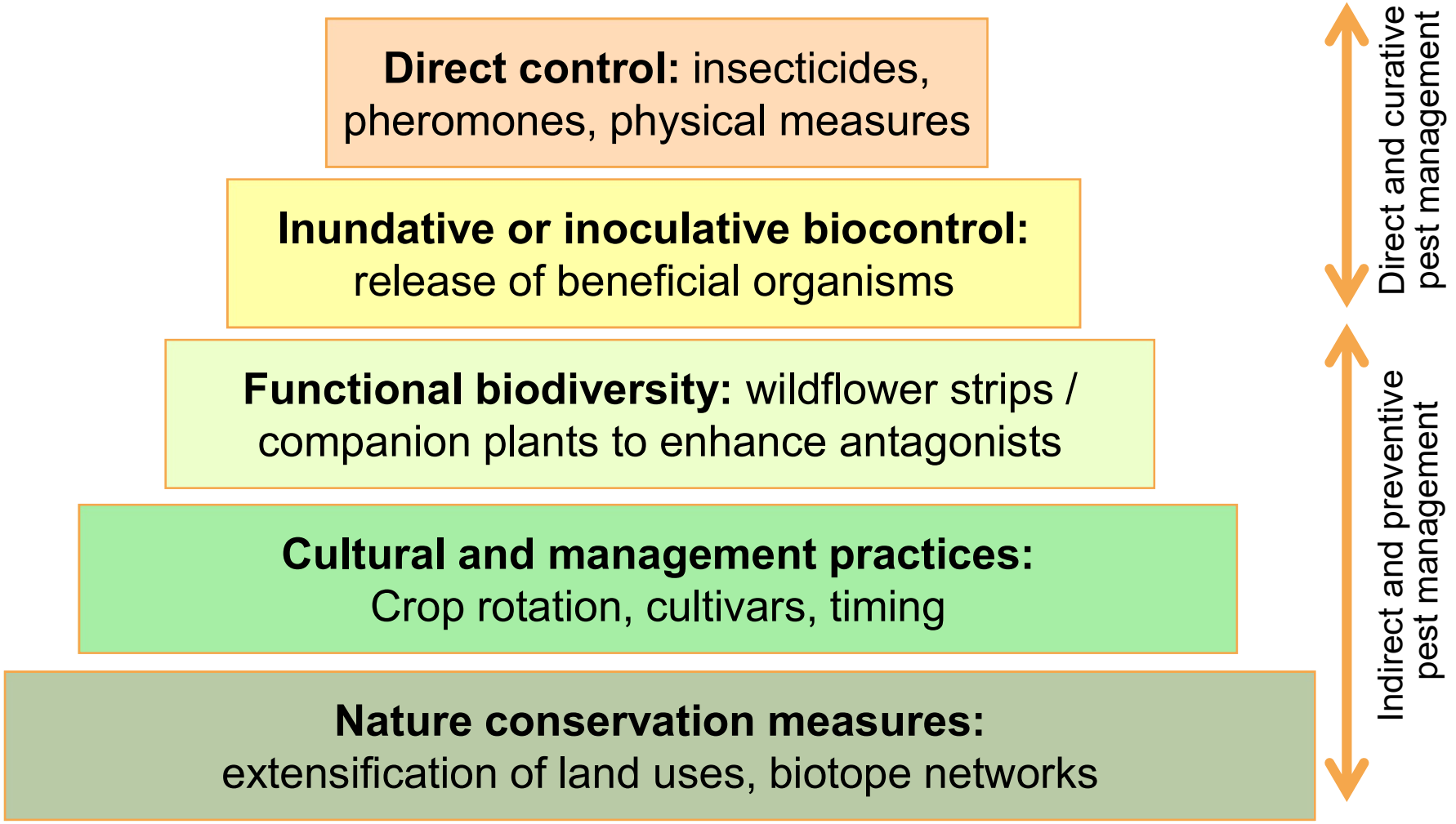
→ main problem of conventional farming: all problems are considered separately; the view of the whole system is missing



Plant protection strategy in organic farming

- Systems approach
- Inclusion of ecosystem services
- Focus on preventive measures
- Selective measures
- Biocontrol
- Physical control measures (nets)

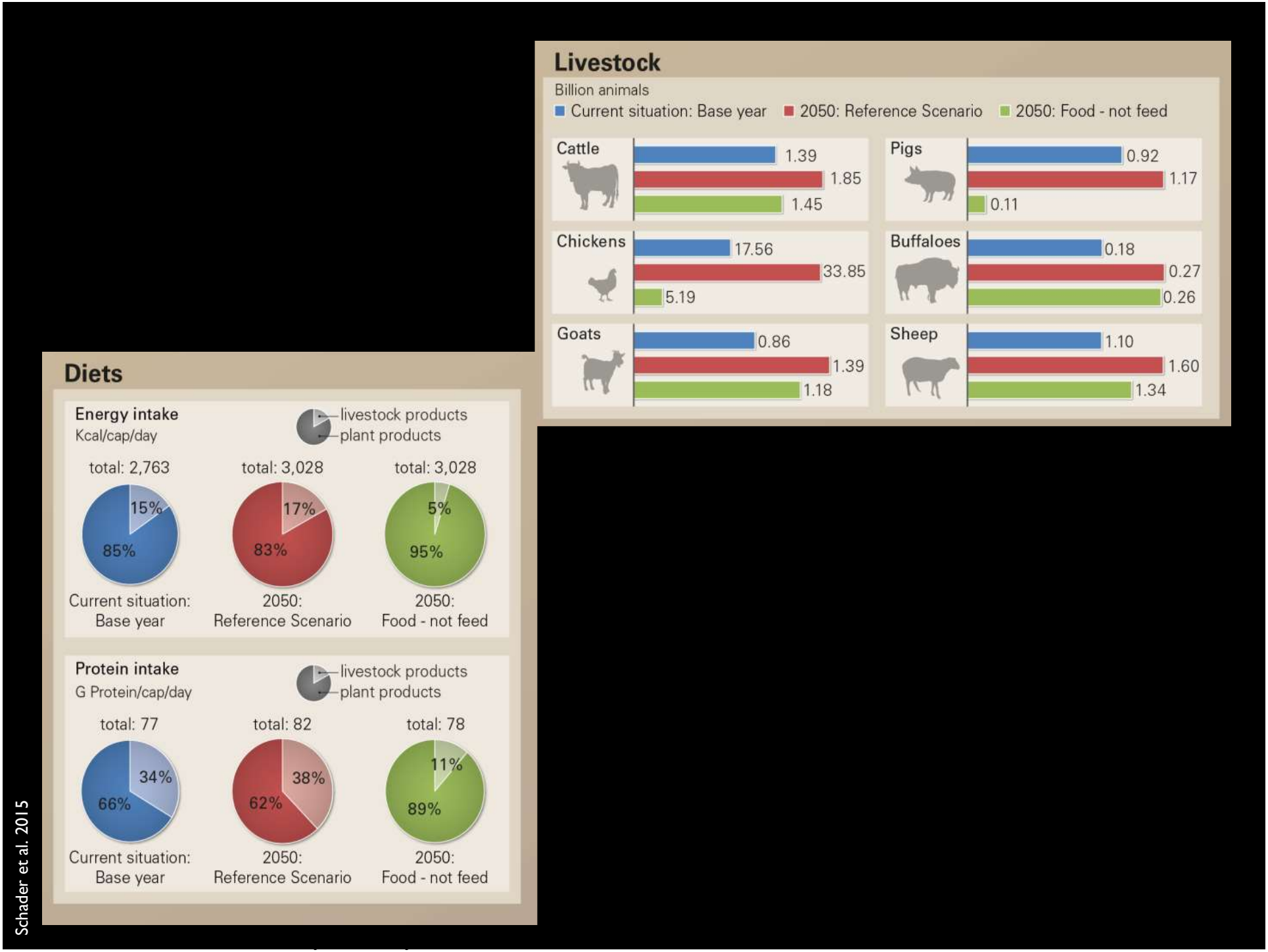
Plant protection strategy in organic farming



Example: Biocontrol

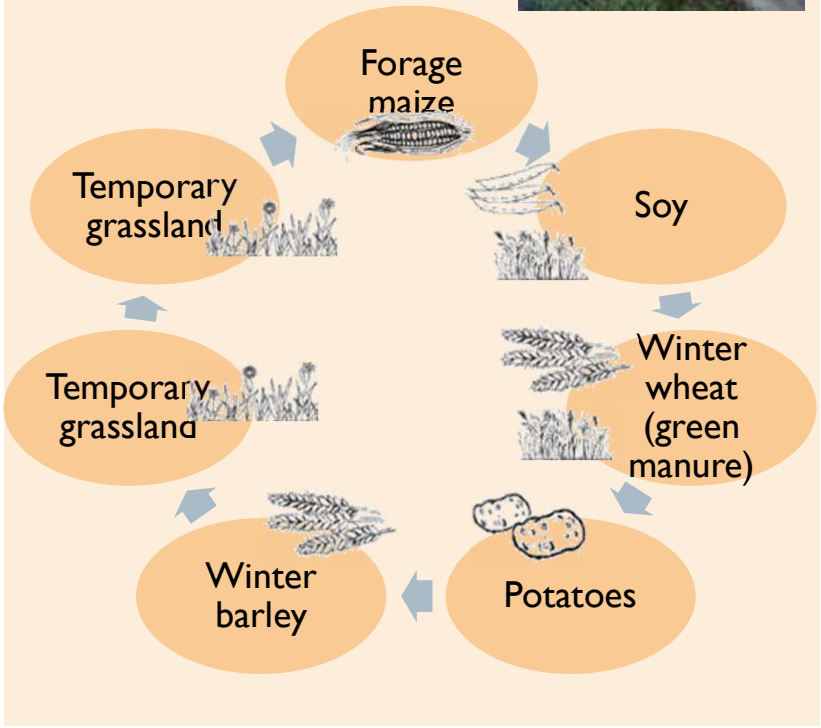
- The use of spinosad against codling moth kills parasitoids of the woolly apple aphid
- Mass propagation of the woolly apple aphid cannot be controlled by organic insecticides

- Use of selective granulose viruses against codling moth is more reasonable

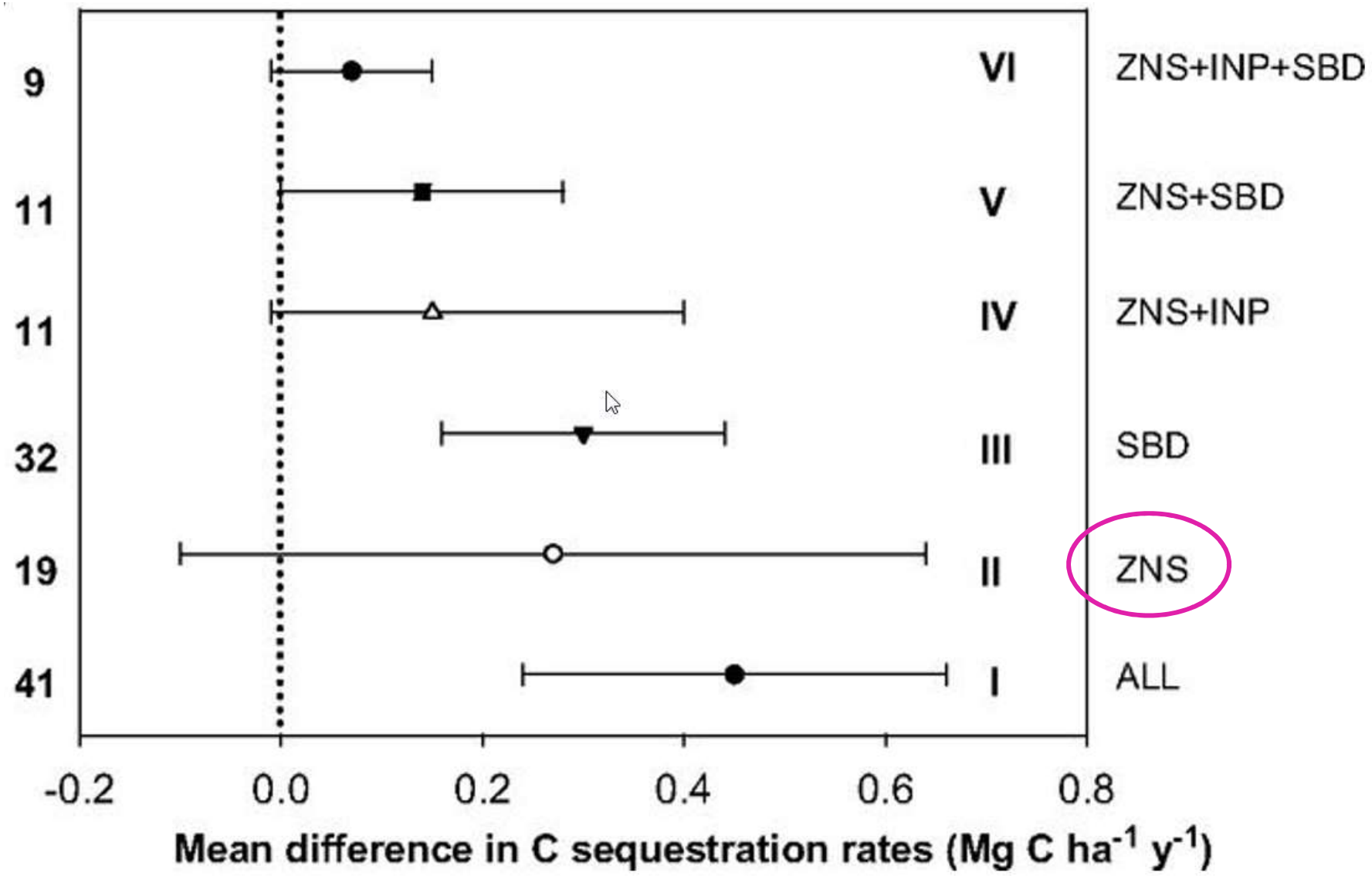

Livestock
Billion animals
Current situation: Base year
2050: Reference Scenario
2050: Food - not feed
Cattle
1.39
1.85
1.45
Pigs
0.92
1.17
0.11
Chickens
17.56
33.85
5.19
Buffaloes
0.18
0.27
0.26
Goats
0.86
1.39
1.18
Sheep
1.10
1.60
1.34
Diets
Energy intake
Kcal/cap/day
livestock products
plant products
total: 2,763
15%
85%
Current situation:
Base year
total: 3,028
17%
83%
2050:
Reference Scenario
total: 3,028
5%
95%
2050:
Food - not feed
Protein intake
G Protein/cap/day
livestock products
plant products
total: 77
34%
66%
Current situation:
Base year
total: 82
38%
62%
2050:
Reference Scenario
total: 78
11%
89%
2050:
Food - not feed
Schader et al. 2015

Crop rotations

Mixed farm
(arable)

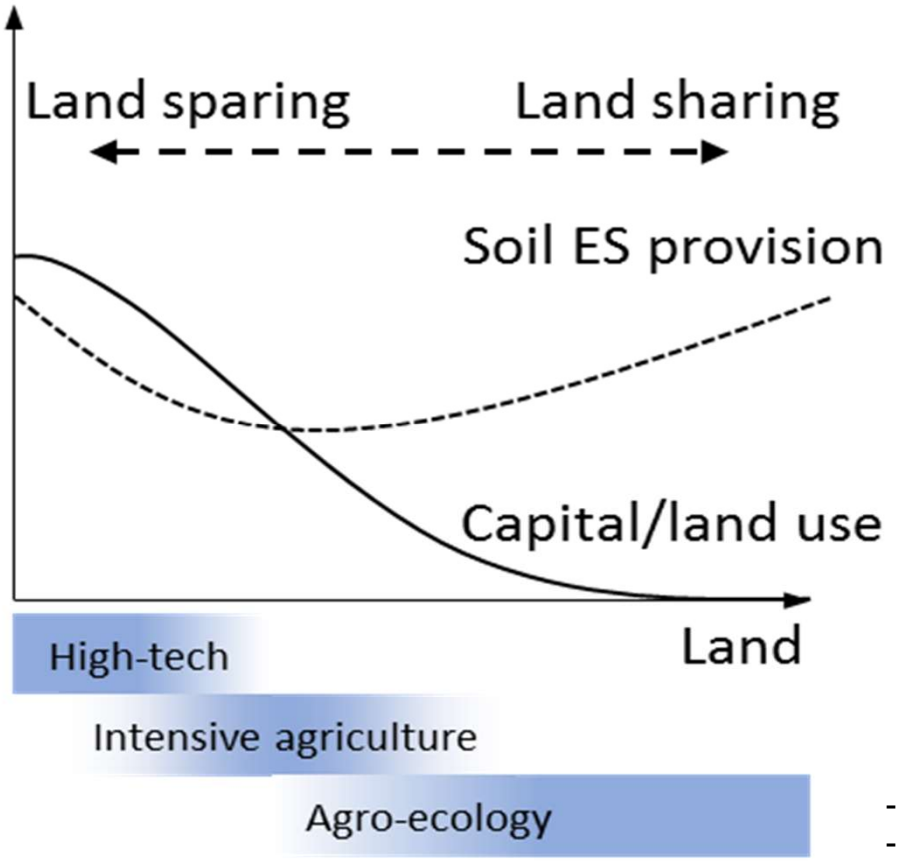


Soil carbon



Gattinger et al. 2012

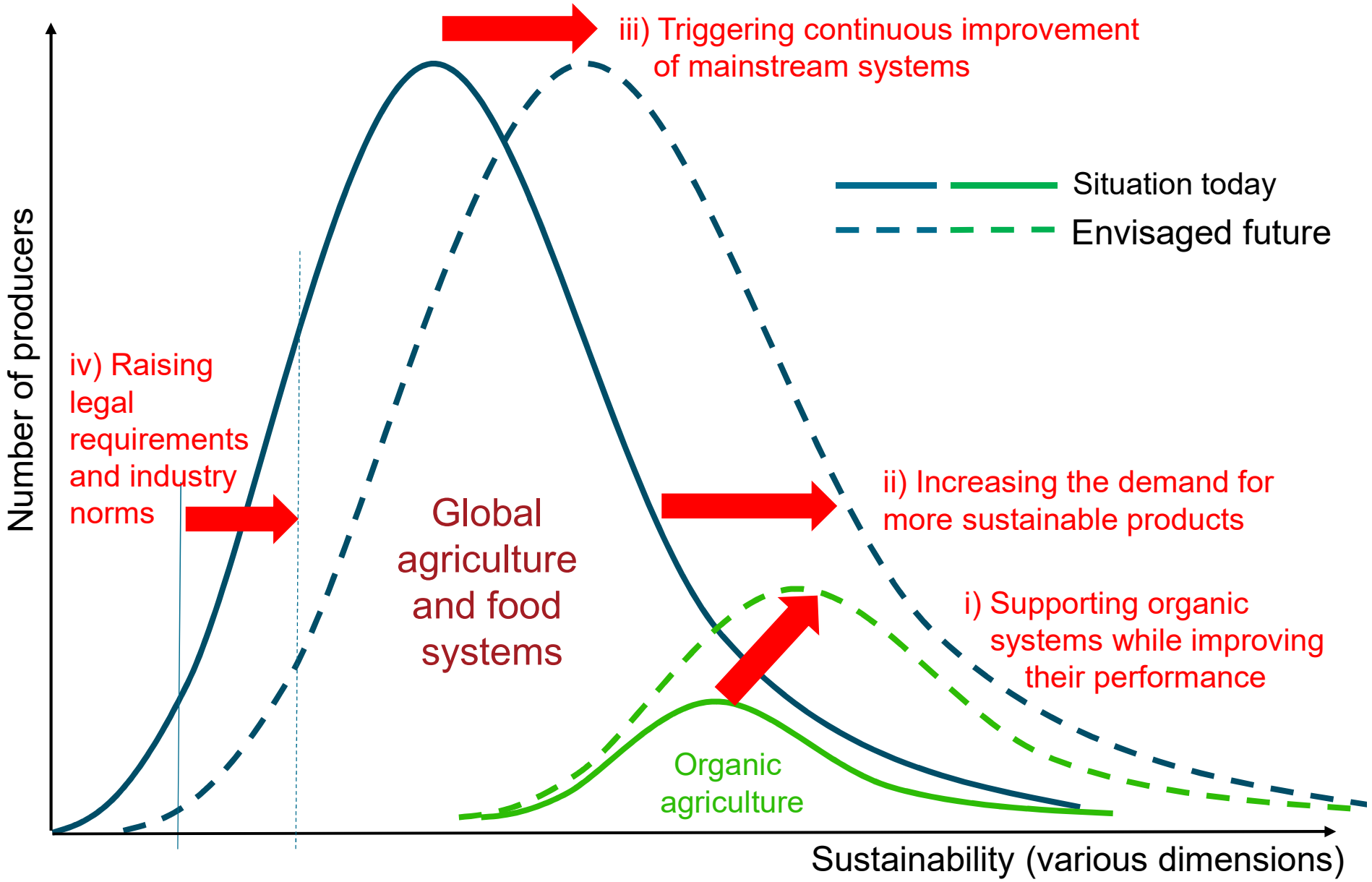
Agroecology – naturalness - examples



- Organic agriculture
- Agroforestry
- Permaculture
- …

Muller et al, 2017

Policy levers driving sustainability in global agriculture



Eyhorn et al. 2019

Agroecology and human health

How to measure impacts on human health of different food choices?

Are food products from agroecological production systems healthier?

Dietary indices: Alternate Healthy Eating Index

Component	Criteria for minimum score (0)	Criteria for maximum score (10)	AHEI-2010 in women	AHEI-2010 in men
Vegetables,[2] *servings/d*	0	≥5	5.4 ± 2.4	5.6 ± 2.6
Fruit,[3] *servings/d*	0	≥4	3.4 ± 2.4	3.7 ± 2.6
Whole grains,[4] *g/d*	0		1.8 ± 1.7	2.4 ± 2.0
Women		75		
Men		90		
Sugar-sweetened beverages and fruit juice,[5] *servings/d*	≥1	0	3.0 ± 3.6	2.6 ± 3.5
Nuts and legumes,[6] *servings/d*	0	≥1	2.7 ± 2.5	4.1 ± 3.2
Red/processed meat,[7] *servings/d*	≥1.5	0	3.5 ± 3.1	3.1 ± 3.0
trans Fat,[8] *% of energy*	≥4	≤0.5	6.0 ± 1.7	7.8 ± 1.4
Long-chain (n-3) fats (EPA + DHA),[9] *mg/d*	0	250	6.2 ± 3.2	7.6 ± 3.1
PUFA,[10] *% of energy*	≤2	≥10	5.6 ± 2.0	4.7 ± 1.8
Sodium,[11] *mg/d*	Highest decile	Lowest decile	5.0 ± 3.2	5.0 ± 3.2
Alcohol,[12] d*rinks/d*			5.1 ± 3.1	5.8 ± 3.3
Women	≥2.5	0.5–1.5		
Men	≥3.5	0.5–2.0		
Total	0	110	47.6 ± 10.8	52.4 ± 11.5

Source: Chiuve et al., 2012, The Journal of Nutrition

Benefits for human health

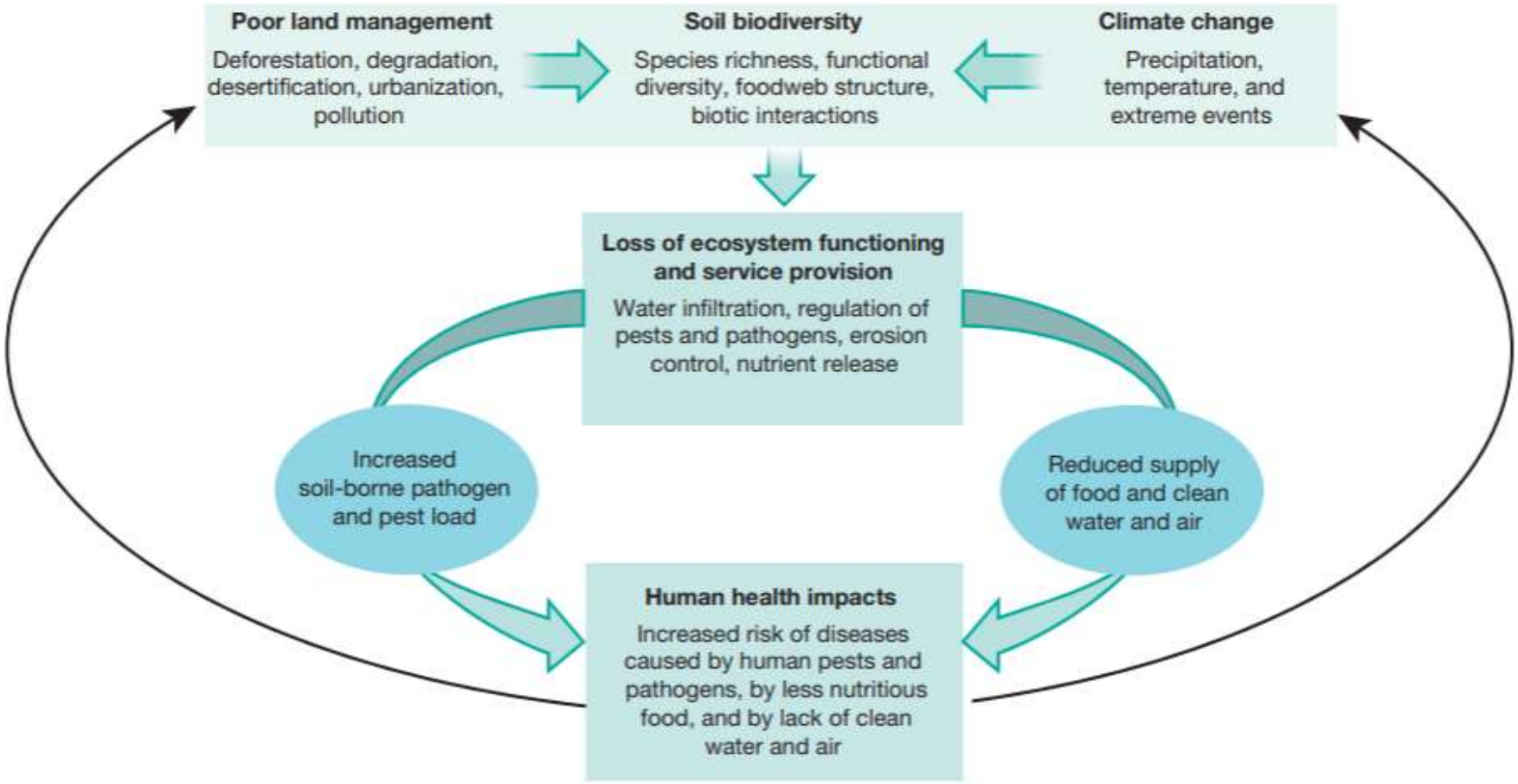
Some evidence on organic food products and

- Nutritional value (higher)
- Exposure to antibiotic resistant bacteria (lower)
- Pesticide residues (lower)

Foods	Chemicals studied	Results	Reference
apple	phenolic compounds	higher contents of phenolic substances in the organic apple pulp compared with apple cultivars of integrated production	Veberic et al., 2005
Golden delicious apple	phosphorous, fibres, phenolic compounds, flavonoids	higher contents for Golden delicious apples cultivated in organic system compared to the ones cultivated in conventional systems	Stoian, 2011
eggplants	phenolic compounds	lower content for organic Blackbell cultivar compared to conventional one; higher content for organic Millionaire cultivar compared to conventional one	Luthria et al., 2010
tomatoes	Vitamin C, carotenoids, phenolic content	higher content for organic tomatoes compared to conventional ones, when expressed as fresh matter; when expressed in dry matter, no difference was found in carotenoid content, whereas the concentrations of vitamin C and polyphenols remained higher in purees made out of organic tomatoes	Caris-Veyrat et al., 2004
frozen corn	Vitamin C	higher content in organic corn compared to conventional one	Asami, Hong, Barrett, & Mitchell, 2003
milk	CLA, ω-3 fatty acids	higher content in organic milk compared to conventional milk	Mie, 2016
meat	saturated fat, ω-3 fatty acids	similar content of saturated fat in organic and conventional meat; higher content of ω-3 fatty acids in organic meat compared to conventional one	Średnicka-Tober et al., 2016

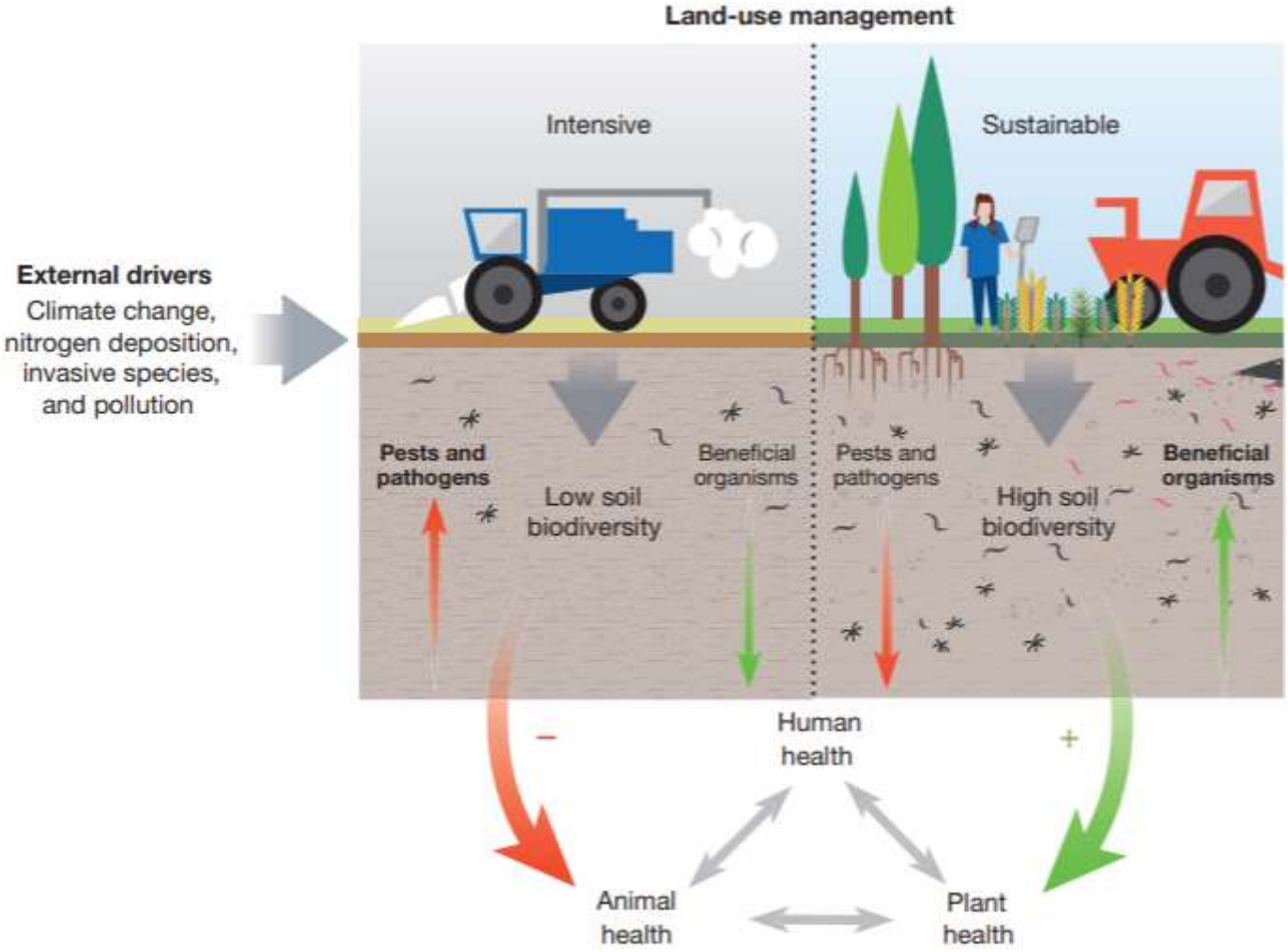
Source: Popa et al., 2019, Trends in Food Science & Technology

Agroecology, soil biodiversity and human health



Source: Wall et al., 2015, Nature

Land-use management, soil biodiversity and human health



Source: Wall et al., 2015, Nature

Conclusions

Key for sustainable agriculture and healthy food systems are:

- «No nutrients are for free»
  - Solutions on how to fertilize the production

- «Simplification does not pay off»
  - Good management of the relevant ecosystem processes

- «Sustainable food production is not possible without healthy and sustainable food consumption»
  - Holistic approaches are needed to manage closely interlinked production and consumption aspects

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