Resource-use efficiency of animal-source food: the level of analysis matters

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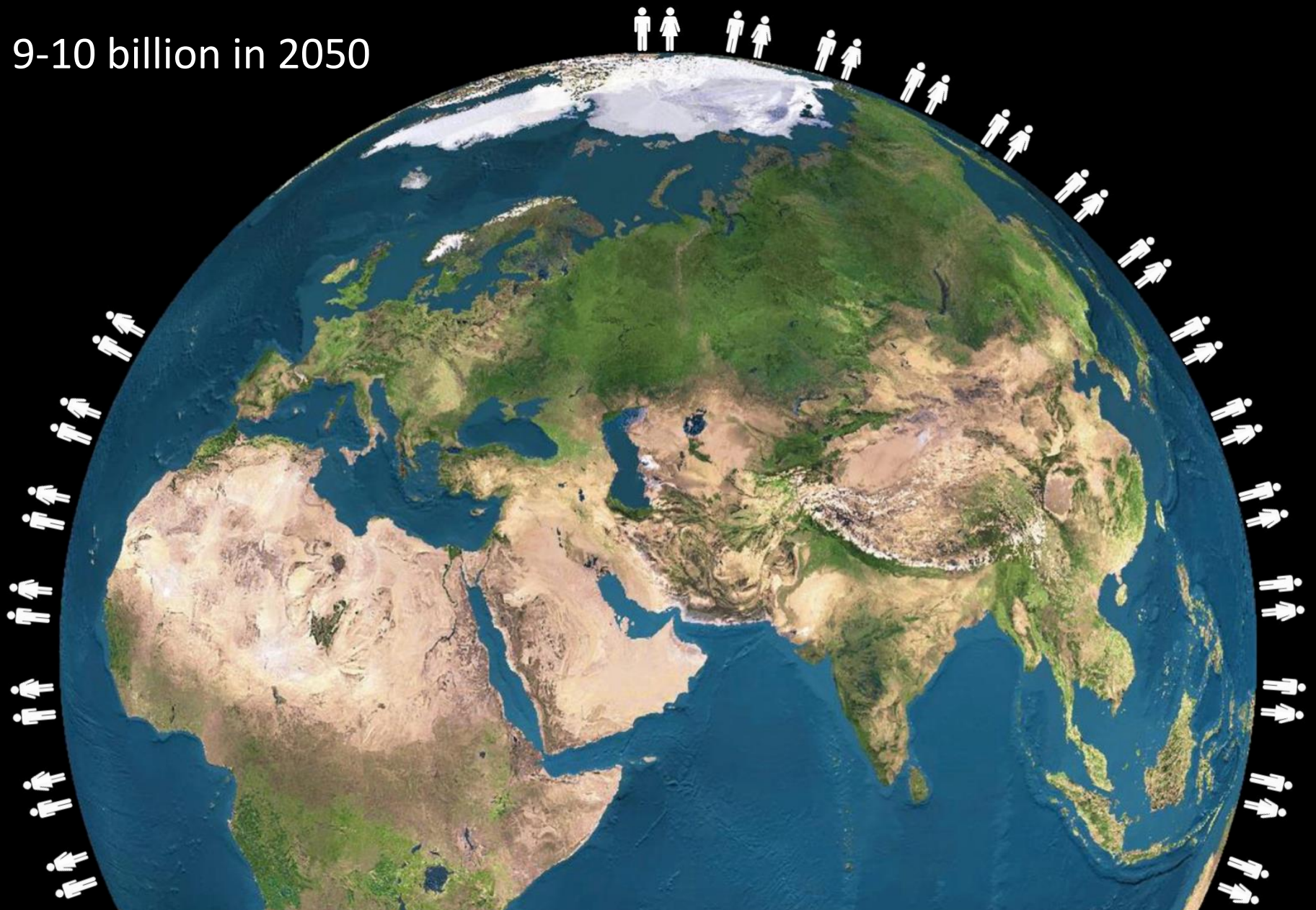
100years
1918 — 2018

We agree on the challenge

9-10 billion in 2050



Animals contribute significantly ...

15% climate change

70% agricultural land

18% acidification

44% eutrophication

Gerber et al. 2013; Poore and Nemecel 2018

Resource-use efficiency

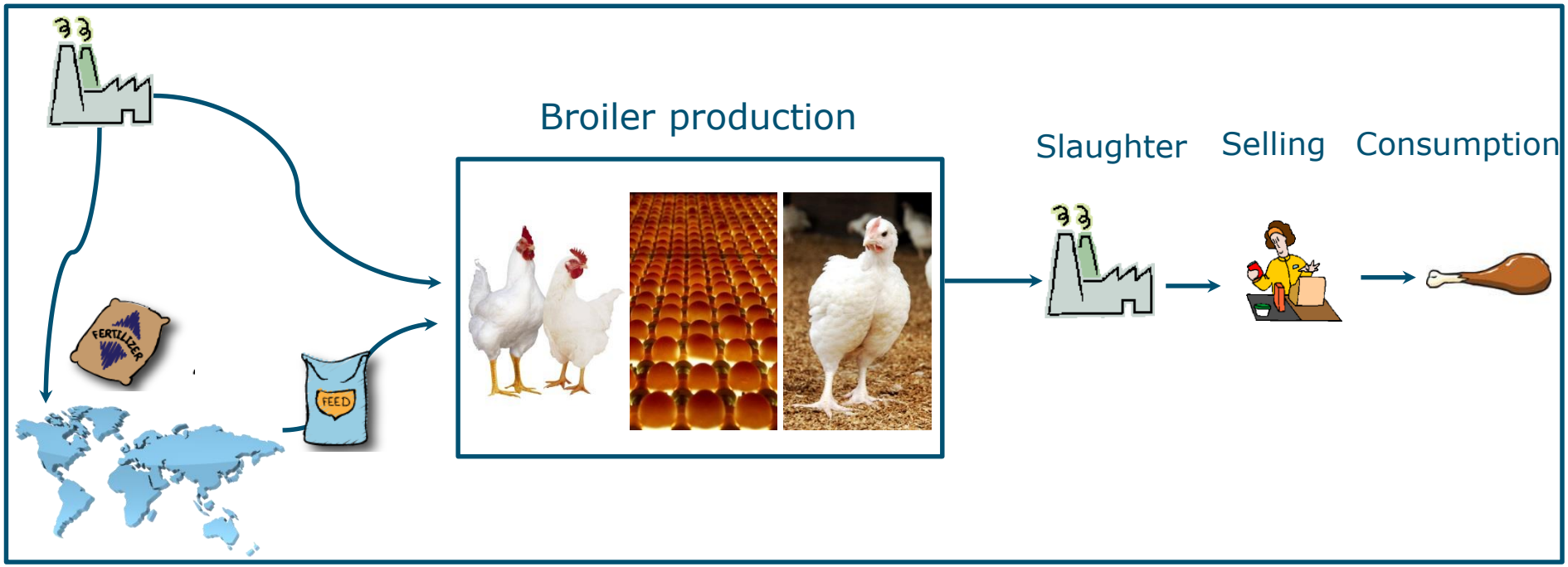
use of resources or emissions

output

Choice of your system boundary affects your conclusion – solution pathway

Example: land-use efficiency

Reduce natural resource use per unit of ASF



METRIC

$$\frac{\text{resource use in chain}}{\text{unit of ASF}}$$

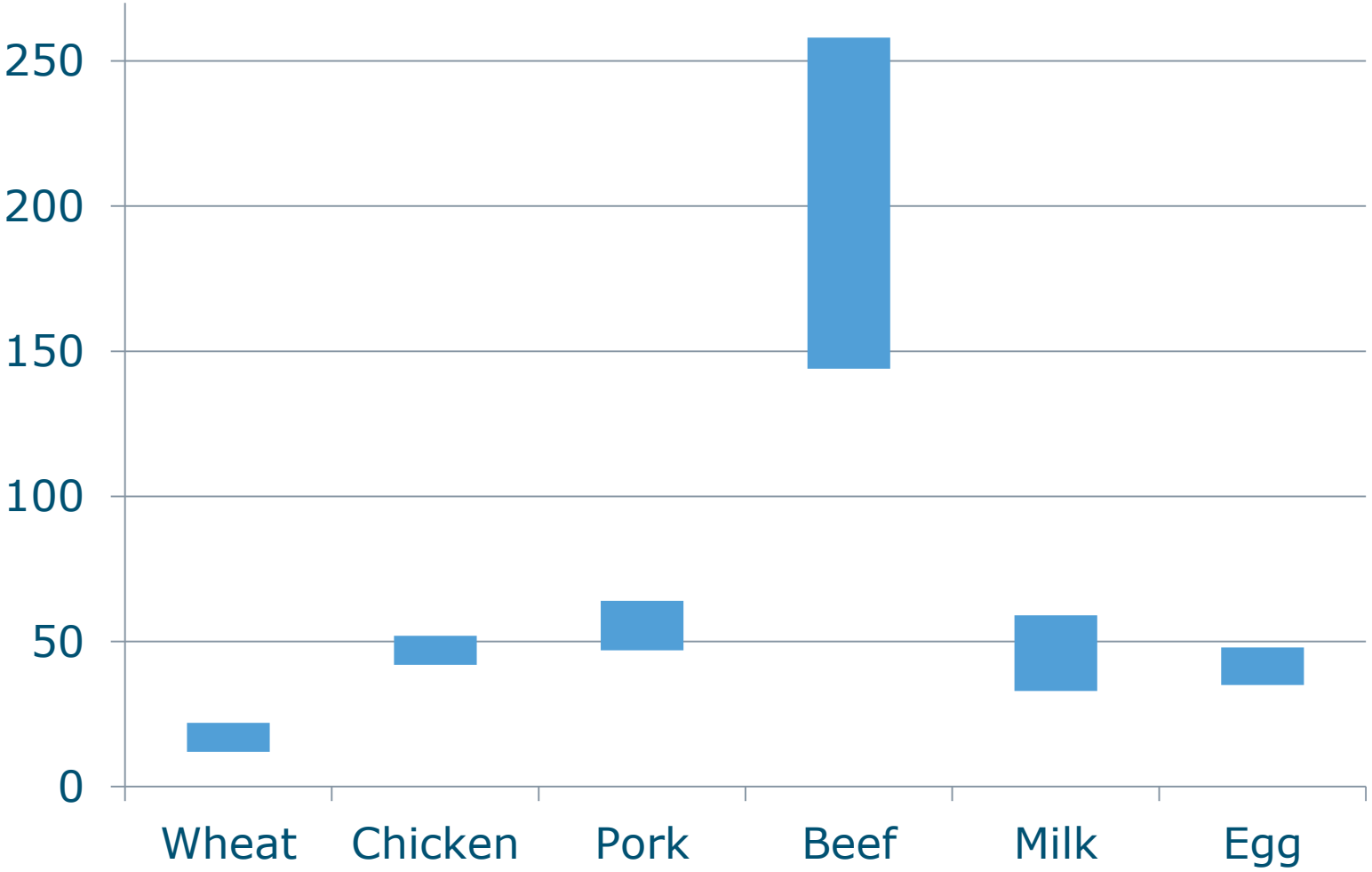
Production narrative
- produce (more) with less -

- Higher crop yields per unit of land/energy/P - Nature 2011
- Improving feed efficiency - PNAS 2008
- Improving life-time productivity - PNAS 2008
- Use fast-growing broilers – Poultry Science 2012
- From grass-based to mixed ruminant systems - PNAS 2014

Sustainable intensification of crop and animal production

Consume less, better or no ASF
- consumption narrative -

- life cycle perspective: m^2 per kg edible protein -



De Vries and De Boer (2010)

Consume less, better or no ASF
- consumption narrative -

METRIC

Annual consumption per person × Footprint per product

kg milk	m^2 per kg milk
kg pork	m^2 kg pork
kg cod	m^2 kg cod
kg potatoes	m^2 kg potatoes
kg beans	m^2 kg beans
....	....

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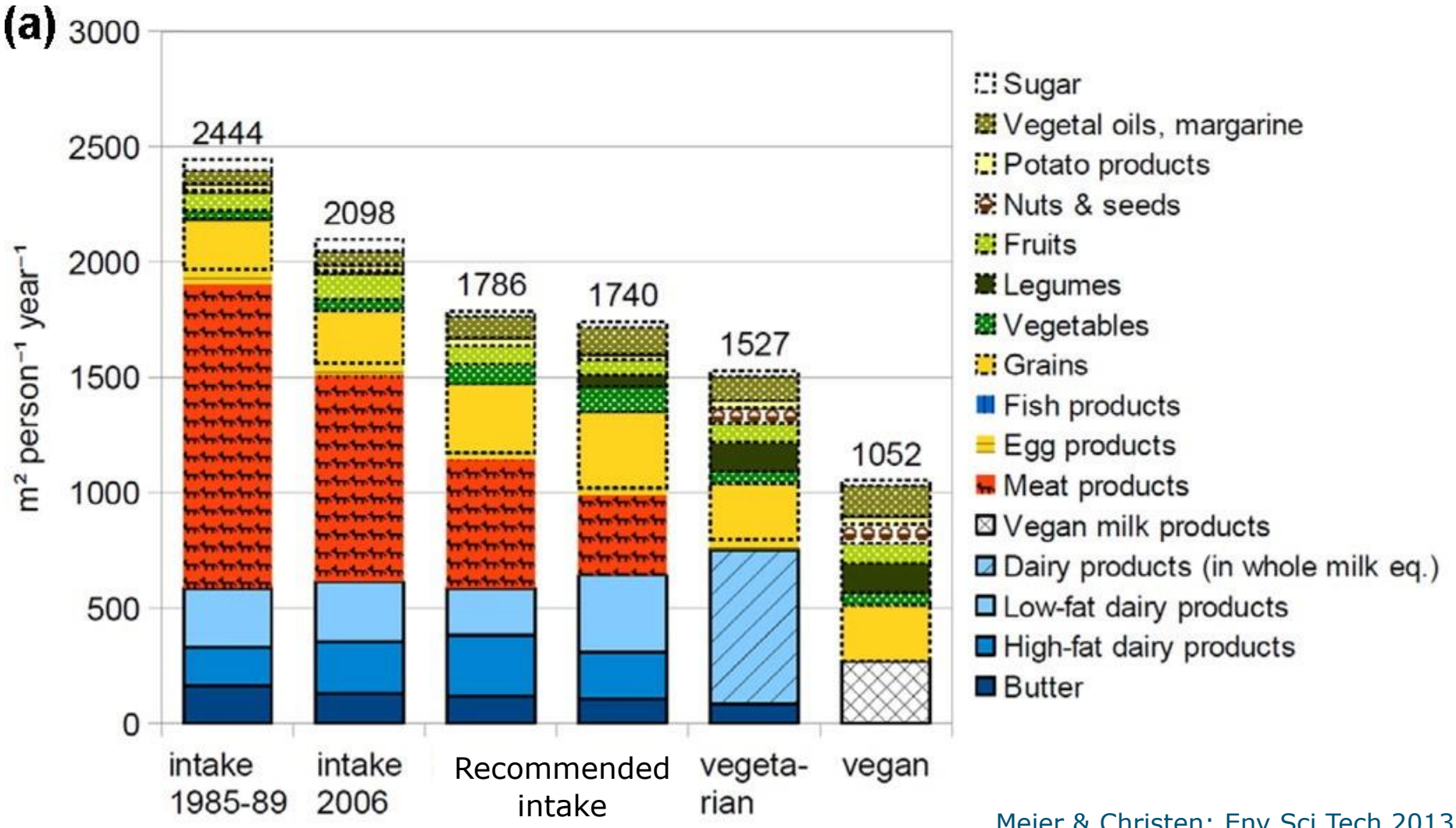
Consume less, no or better ASF
- consumption narrative -



Meier & Christen; Env Sci Tech 2013

Solutions
- consumption narrative -

- Become vegetarian or vegan
- Replace “red meat” by “white meat” or “fish”

  Lower footprint per kg protein & kcal

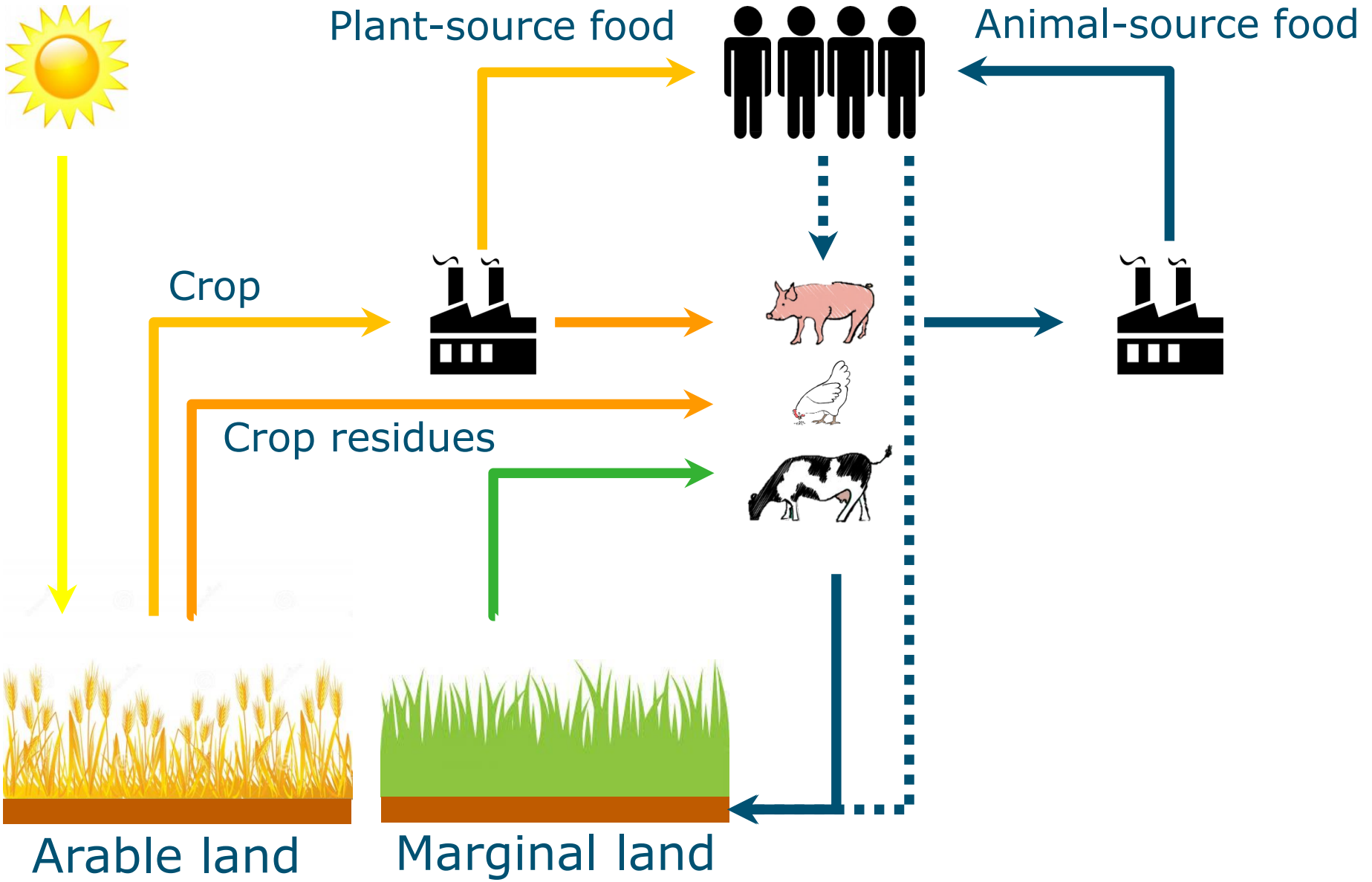
Footprint studies ignore ....

- “product-packages“

  no milk without meat, no sugar without beet-pulp

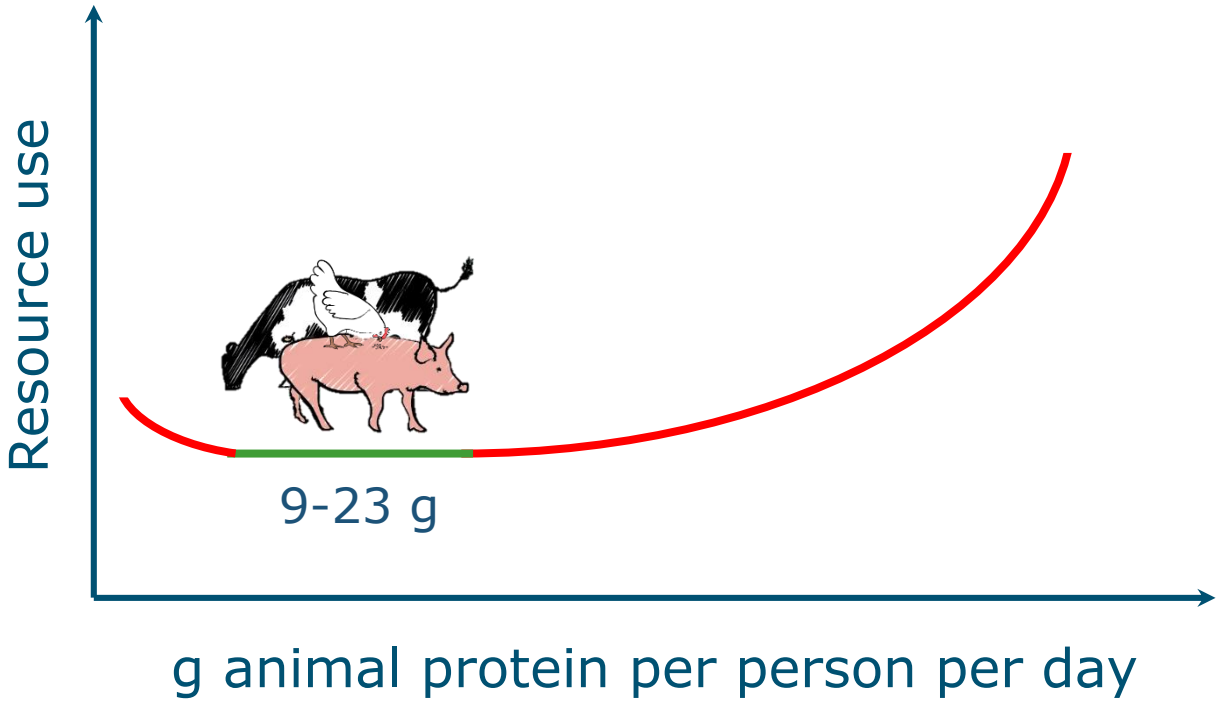
- “feed-food” competition

Concept of circular narrative



Animals are essential for food production
- circular narrative -

Animals value leftovers & grass resources



Feeding maximum amount of people

resource use

Van Kernebeek et al. (2016); Van Zanten et al. (2018)

Solutions
- circular narrative -

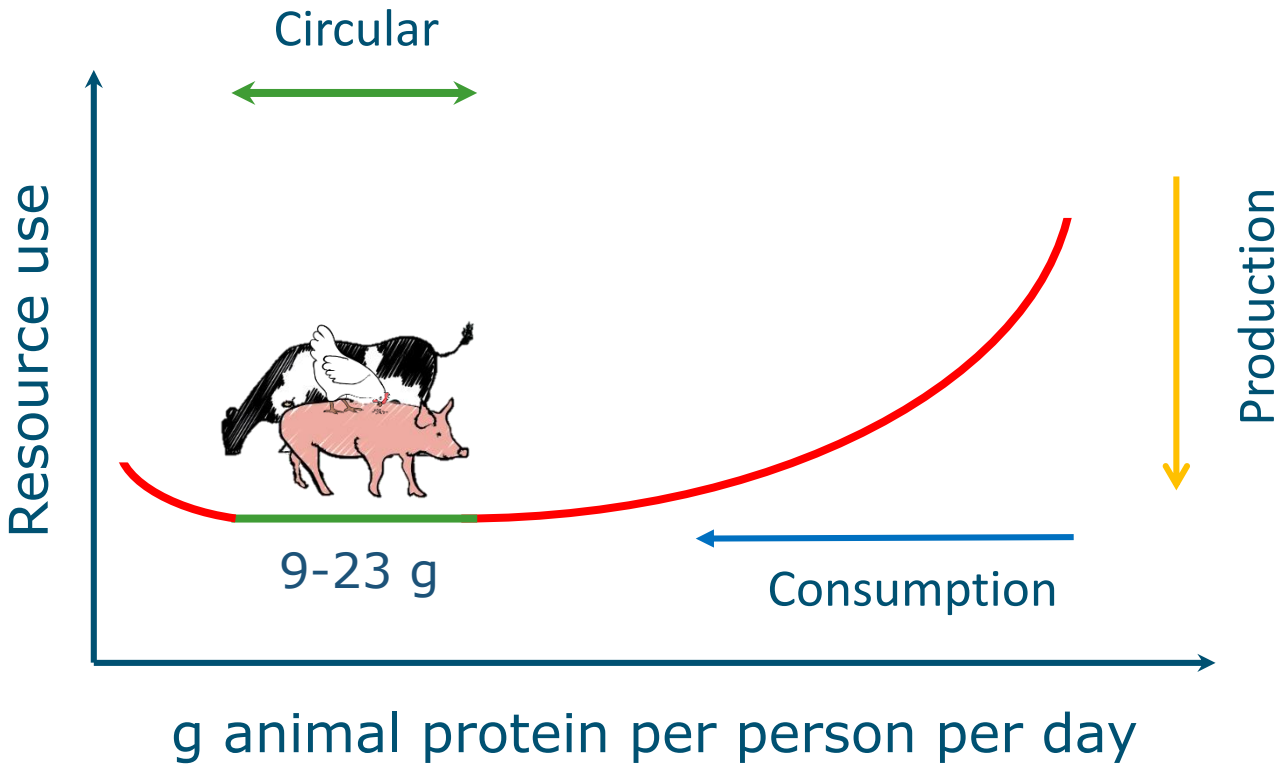
- Use biomass at highest utility
- Improve utilization of leftovers & grass resources (GR)

  - food-feed crops, fungi, use of food waste

  - breeding: animals efficiently convert leftovers & GR

  - role of fish, insects?
- Value animal and human excreta as fertilizer
- Prevent losses in the food chain
- Moderate consumption of ASF

Unarticulated assumptions



Van Kernebeek et al. (2016); Van Zanten et al. (2016)

Efficiency of milk producing cows

	Grain & silage based system (EU), Holstein cows	Elephant-grass based systems (UG), Ankole beef-oriented cow
		
kg DM intake/kg ECM	0.6	2.3
(IFCN, 2016)		
kg HEP/kg HEP milk	0.3	0

Water efficiency beef – Uruguay (l/kg)

Ran et al. (2017)

Evaluation of benefits and costs

Metrics affect solution pathways

Cacophony of solutions

Different numbers & articles

Miscommunication

Inaction

Questions

- What do we want?
- Where to go from here?
- **No-regret solutions**:
  - Prevent food losses along the chain
  - Nose-to-tail eating
  - Precision farming: fertilization, irrigation, feeding
  - Improve animal health
  - Value animal and human excreta as fertilizer
  - Moderate population growth?

Thank you for your attention

THXS!

Energy and protein conversion ratios

feed potentially edible for humans / animal product

Product	Energy (MJ/MJ)	Protein (kg CP/kg)
Milk	0.47	0.71
Upland Beef	1.9	0.92
Cereal Beef	6.2	3.0
Pork	6.3	2.6
Chicken	3.3	2.1
Egg	3.6	2.3

Sustainable ratio < 1.0

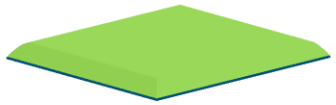
- Increasing share of co-products that are not edible for humans
- Increasing efficiency of "grass use" in livestock production

Wilkinson 2011

Land use ratio

Van Zanten at al. (2016)

Area feed cultivation



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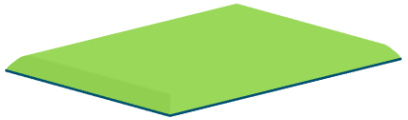


=

1 kg HDP
animal-source food (ASF)

→ kg HDP food crop

+

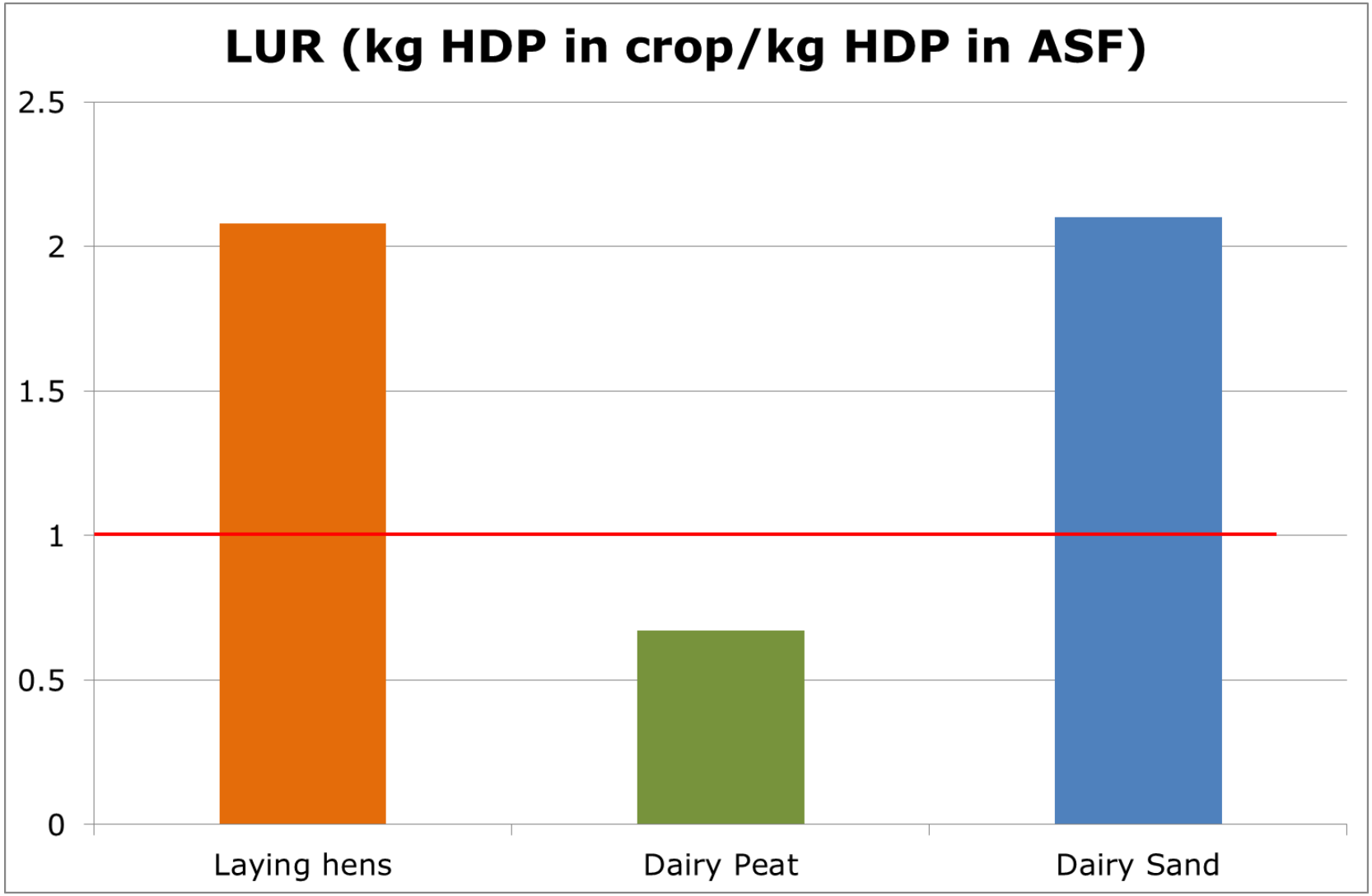
→ kg HDP food crop

+

→ kg HDP food crop

$$\frac{\sum \text{HDP food crops}}{\text{HDP in one kg ASF}}$$

Land use ratio

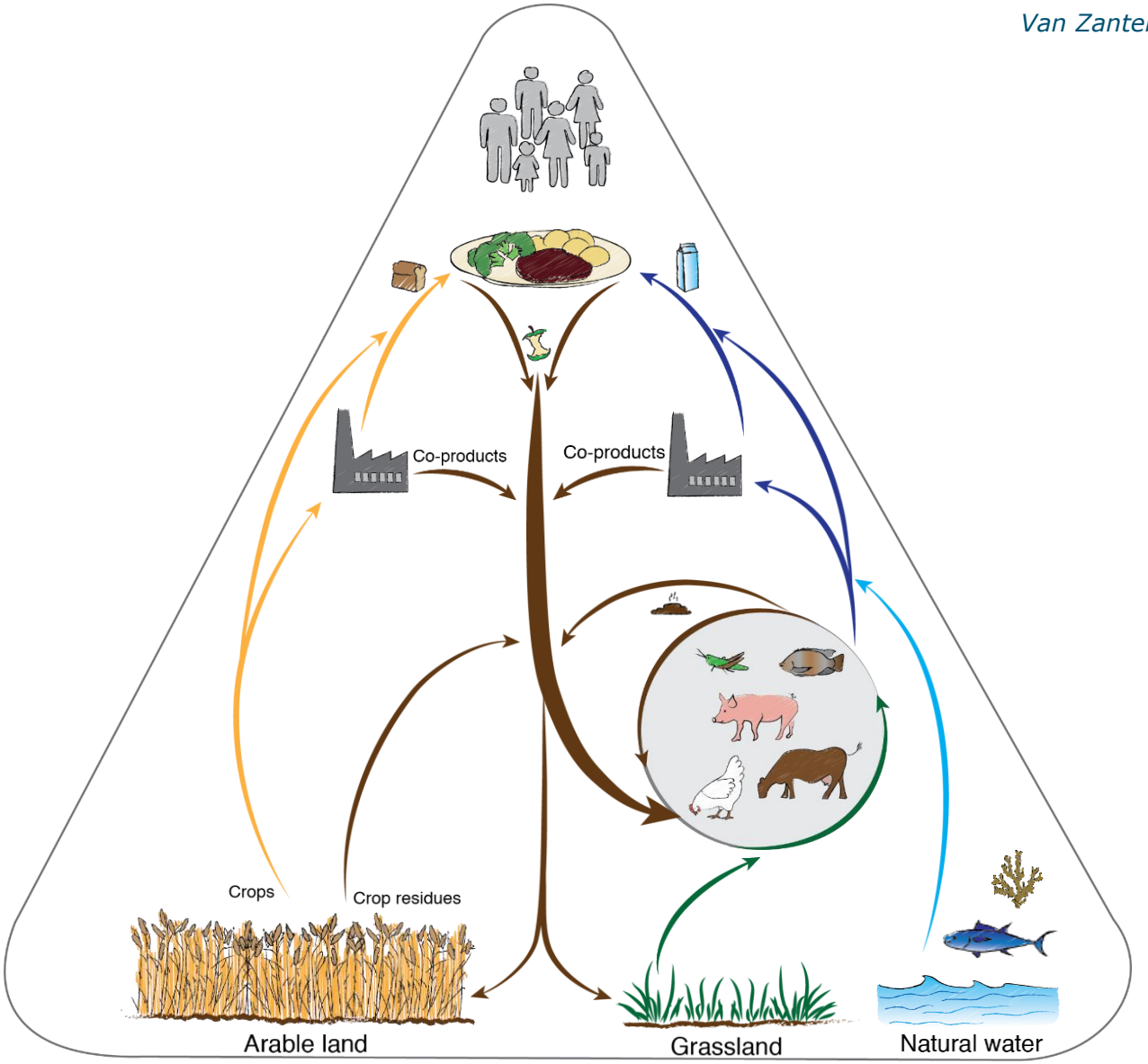


Van Zanten et al. (2016)

Planetary boundaries absolute

Animal production 3.0

Van Zanten and De Boer (2018)



Acknowledge benefits and costs

- Macro- and micronutrients

- Manure
- Draught power
- Income

- Employment
- Social status

- C-sequestration
- Maintaining landscape
- ……

- Climate change
- Major user natural resources
- Biodiversity loss
- Acidification
- Eutrophication

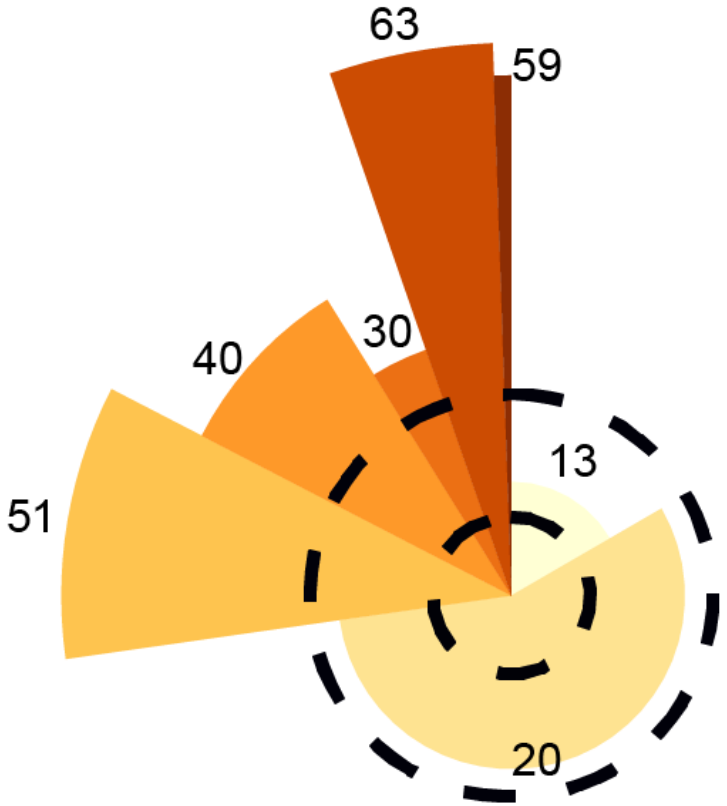
- Zoonoses
- Antibiotic resistance
- Dust/odour

- Welfare concerns
- ……

Such animals

- nutrient-dense food
- fertilizer
- other ecosystem services

Boundary for sustainable ASF consumption



Region

- Africa
- Asia
- Europe
- Latin America & Caribbean
- Middle East
- North America
- Oceania
- Default livestock min and max values

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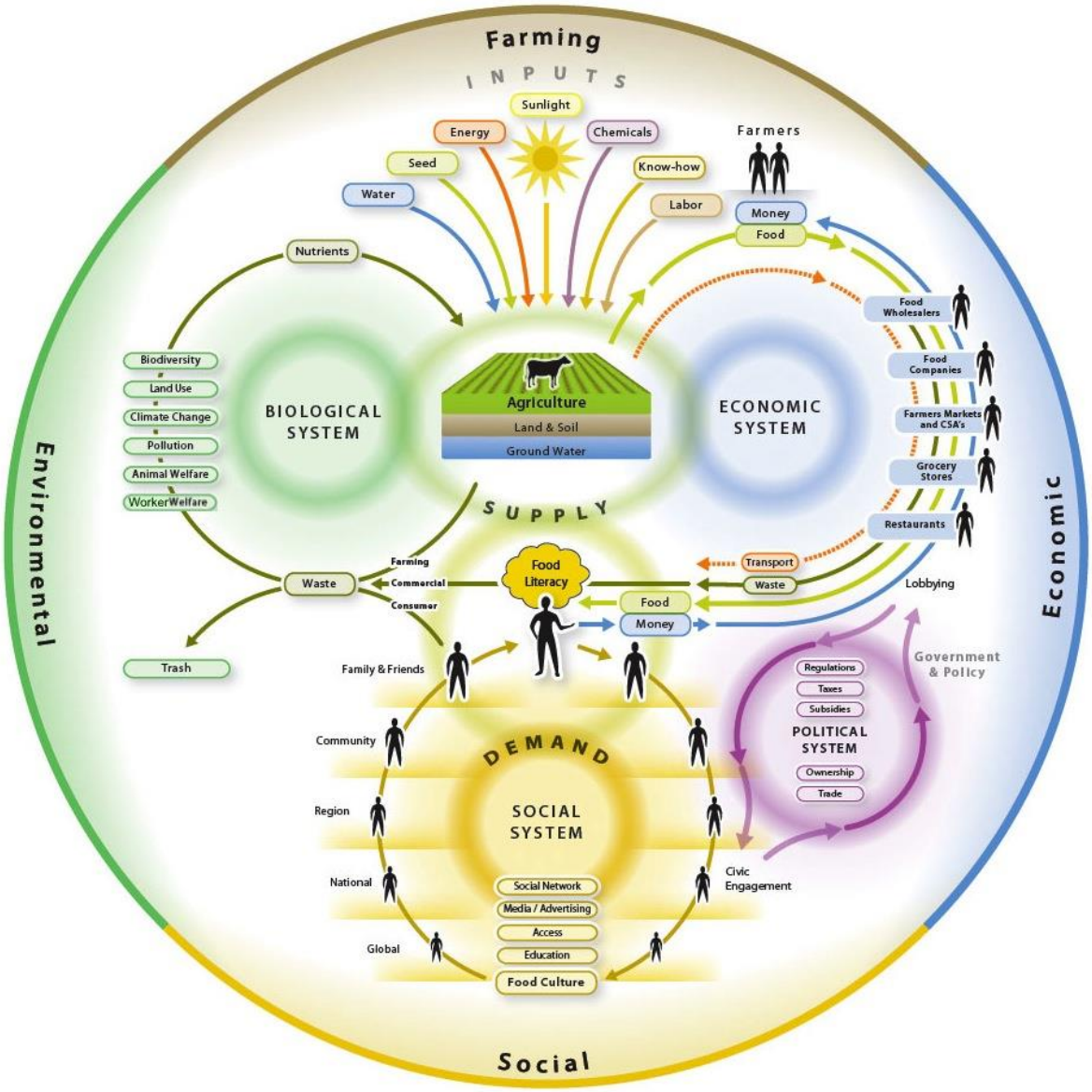
Van Zanten et al. (2018) Global Change Biology

Role of animals is limited by

- Availability and nutritional quality of leftovers & grass resources
- Efficiency with which animals utilize these resources

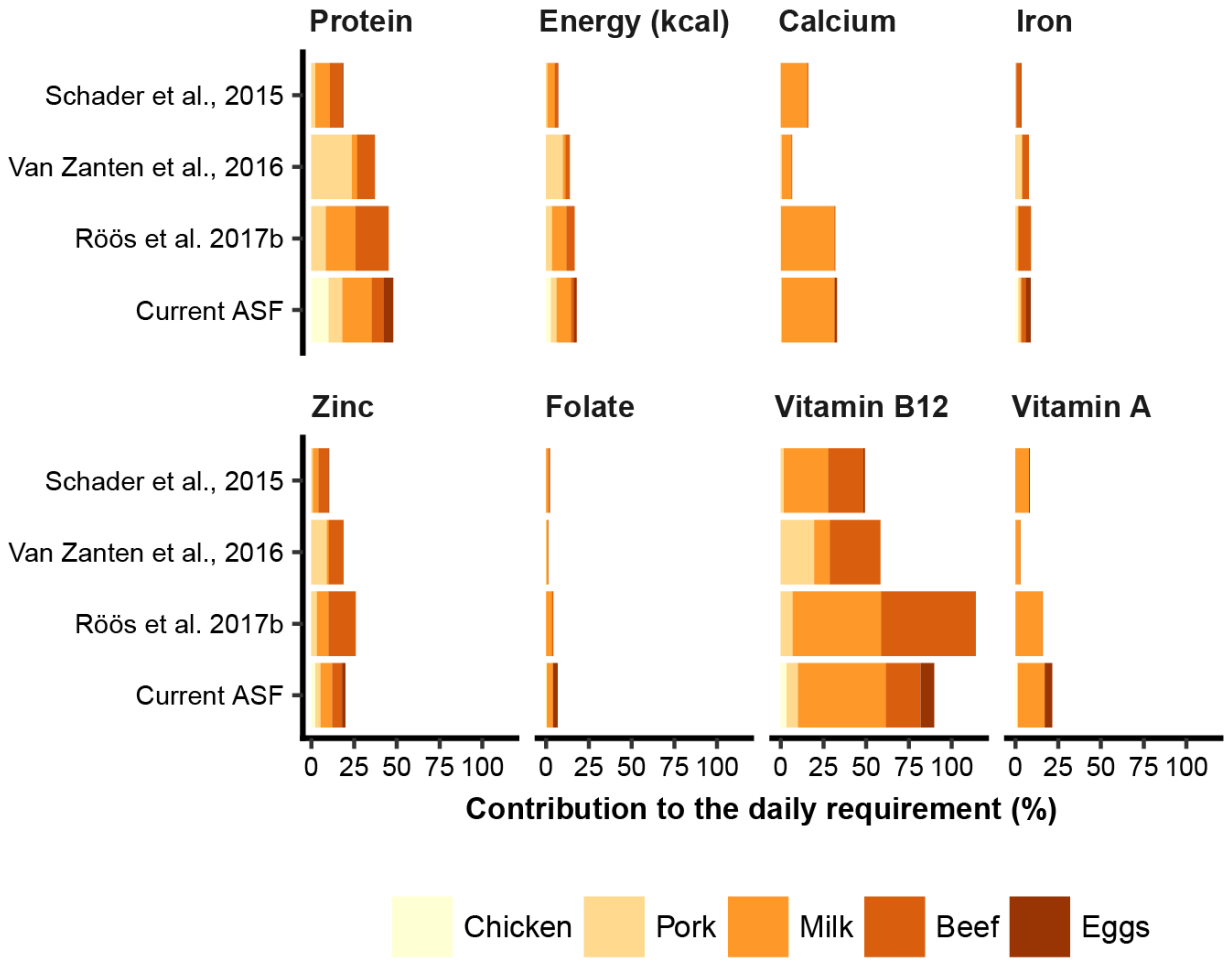
Importance of systems thinking



How?

- Built a common future about the role of animals – including all stakeholders
- Develop holistic plans
  climate change, biodiversity, human health, animal welfare, economic viability
- Develop new metrics
- Stimulate show-cases
- Overcome institutional and societal barriers

Its not only about proteins



Van Zanten et al. (2018) Global Change Biology