# Circularity in food systems

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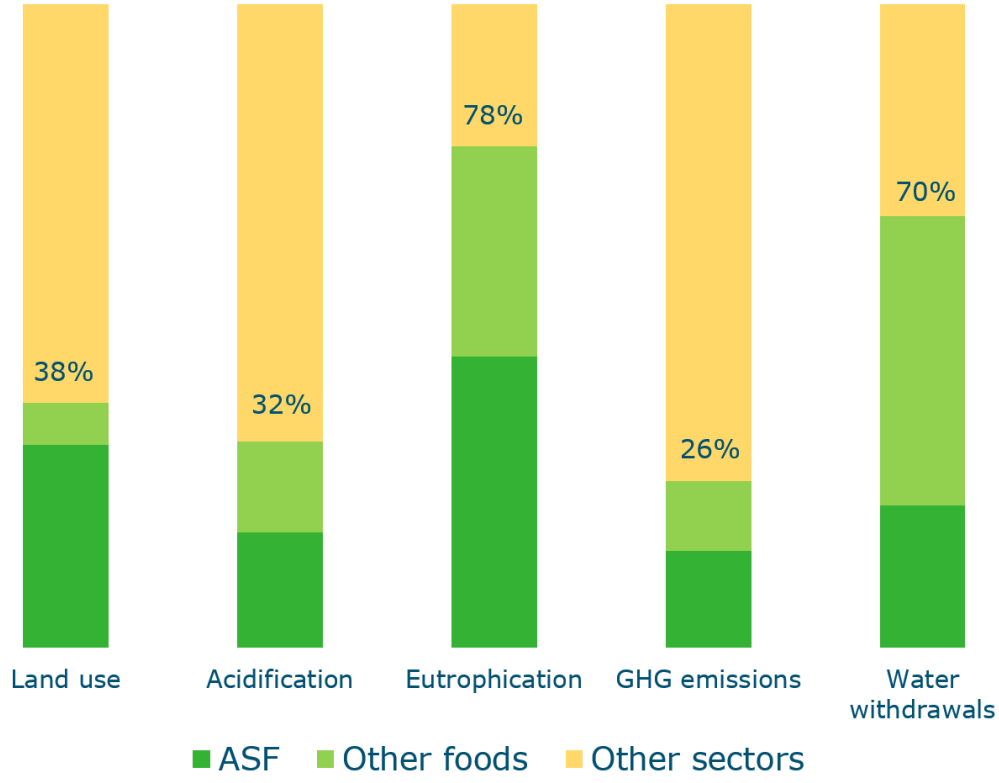
# Resource use and environmental impact of global food system

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*Poore and Nemecek (2018) Science*

# Nitrogen in three contrasting cropping systems

**Mixed farming in Southern Ethiopia**

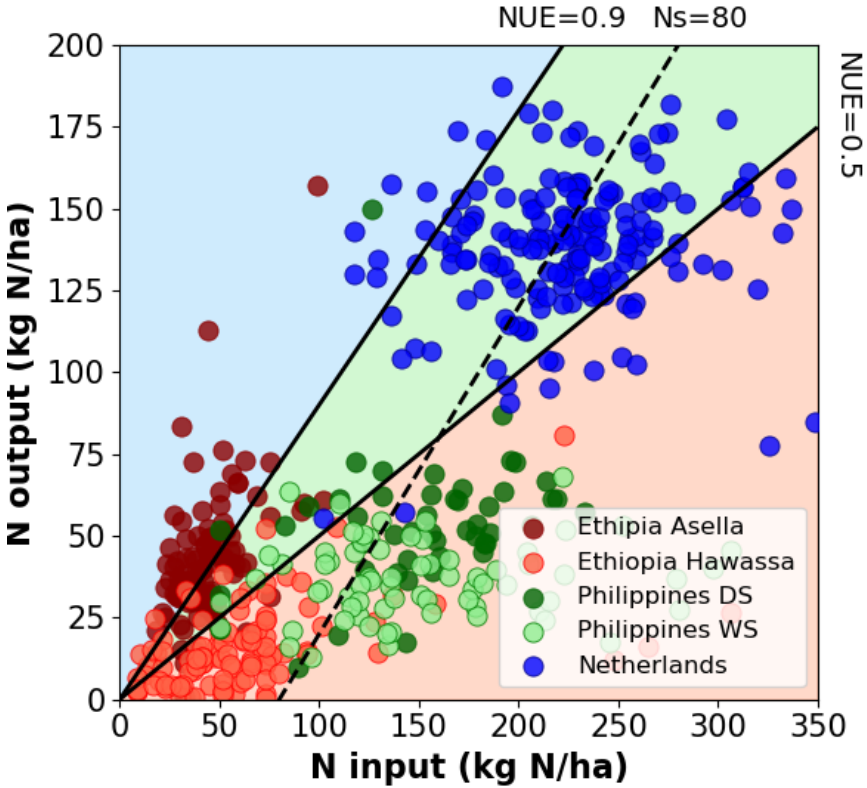
**Main crops**
Maize and wheat

**Rice farming in Central Luzon, Philippines**

**Main crop**
Rice (wet and dry season)

**Arable farming in the Netherlands**

**Main crops**
Wheat, potato, sugar beet

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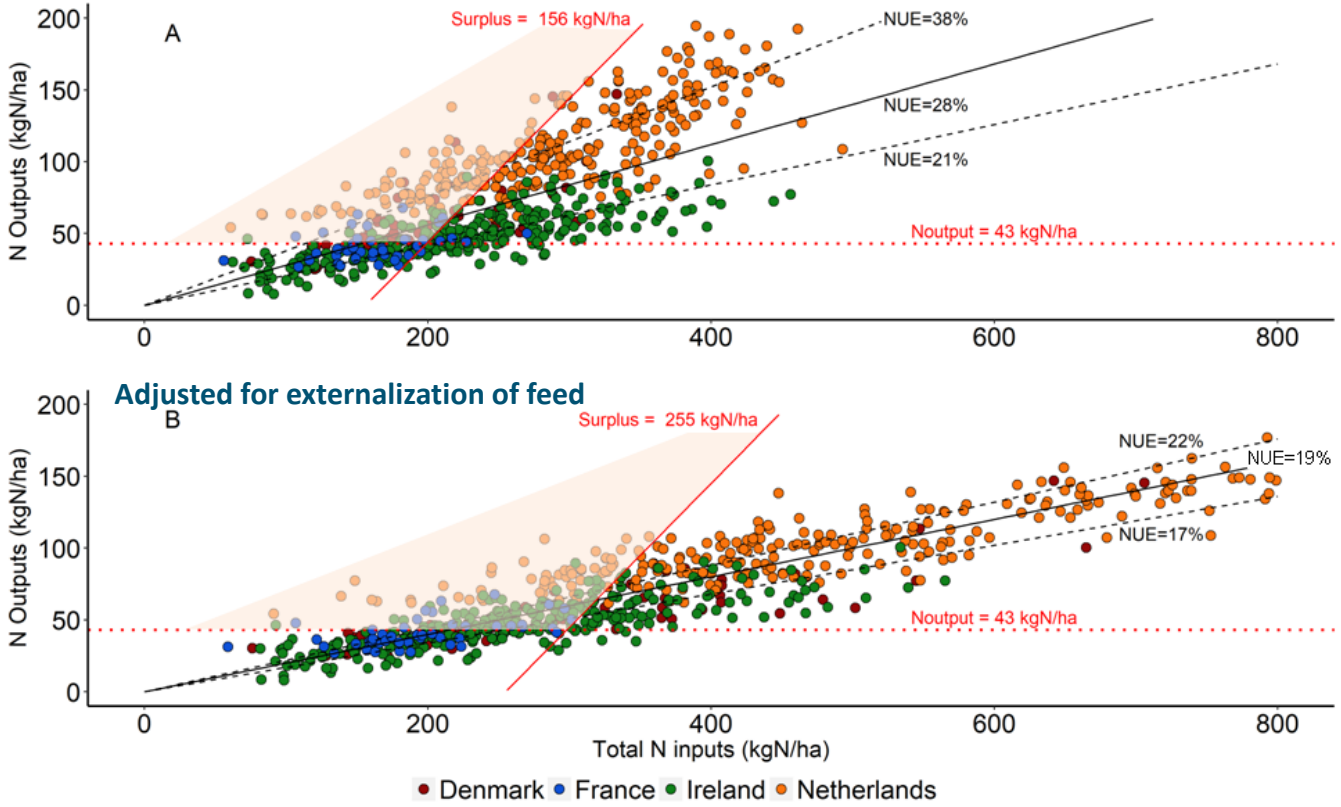
*Silva et al. (in review) Global Food Security*

# Nitrogen in four intensive dairy systems



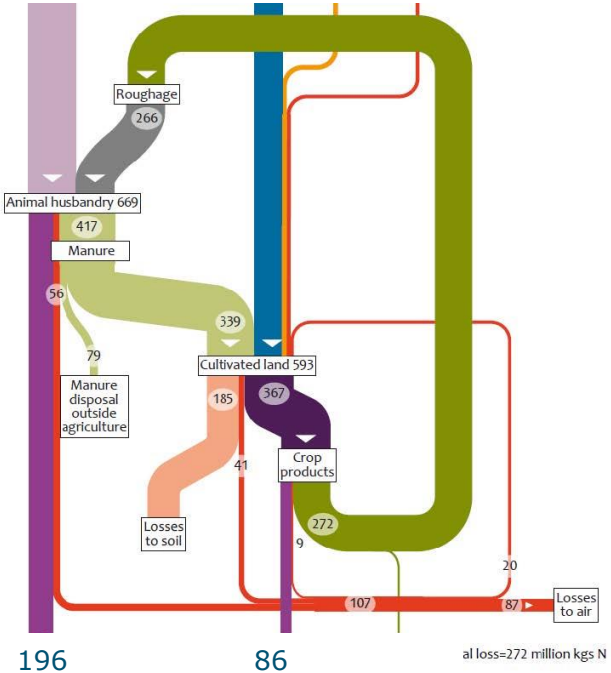

*Quemada et al. (2020) Agricultural Systems*

# Imbalance feed production and livestock in NLs

Nitrogen: million kgs

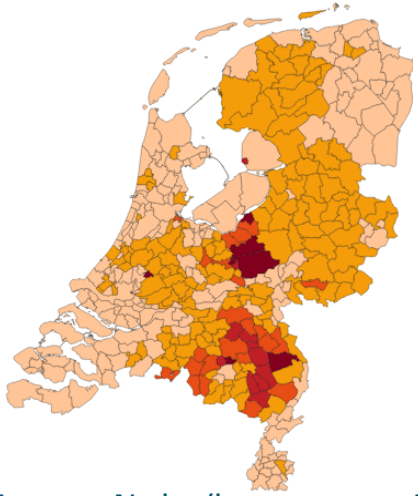
Concentrates 404

Mineral fertilizers 194



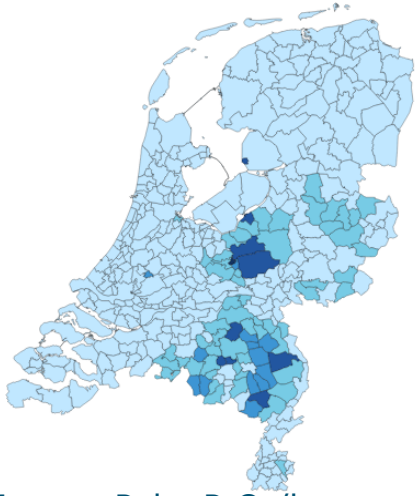

196 In livestock products

86 Sales of crop products



Manure-N, kg/ha

- 0 tot 260 (kg/ha)
- 260 tot 521 (kg/ha)
- 521 tot 781 (kg/ha)
- 781 tot 1 042 (kg/ha)
- meer dan 1 042 (kg/ha)



Manure-P, kg $P_2O_5$/ha

- 0 tot 121 (kg/ha)
- 121 tot 242 (kg/ha)
- 242 tot 362 (kg/ha)
- 362 tot 483 (kg/ha)
- meer dan 483 (kg/ha)

*National Institute for Public Health and the Environment (RIVM), 2016*
*Statline, CBS*

# Key question

How to produce food while respecting the planet?

A product footprint approach

Produce
with less impact

Eat
with less impact

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# Example animal-source food

## Produce with less impact

- Herd productivity
- Nutrient-dense feed

## Eat with less impact

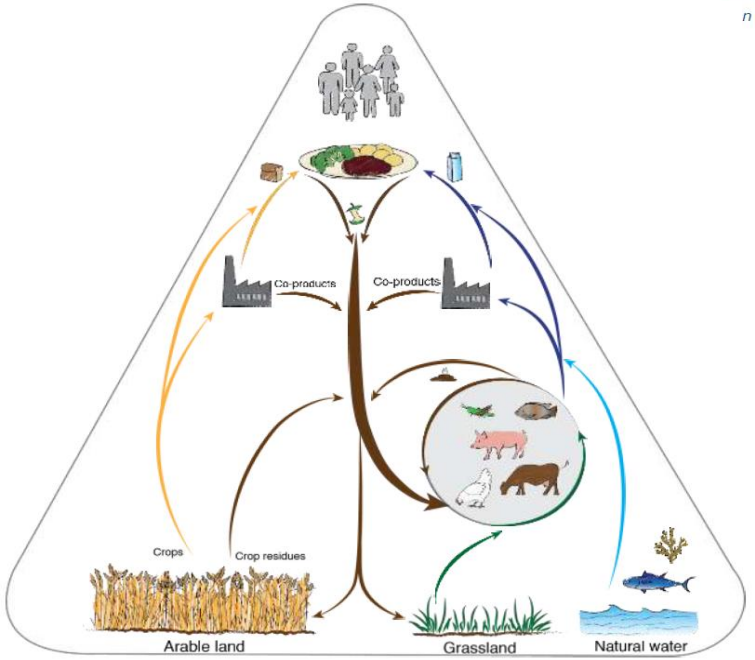
- Eat chicken and no beef
- Go vegan
- By-products & Grass?

Feed-food competition

A footprint approach does NOT address feed-food competition or interlinkages in the food system

# Guiding principles for Circular Food Systems

1. Use land as efficiently as possible
    - *Produce plant biomass for food*
2. Avoid waste, and by-products should be recycled back into the system
    - *With a proper prioritisation*
3. Use animals for conversion of human inedible biomass into food
    - *Consequences for consumption*




*De Boer & Van Ittersum (2018) Mansholt lecture, WUR*

*Van Zanten et al. (2019) Global Food Security*

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# 1. Use land for food production

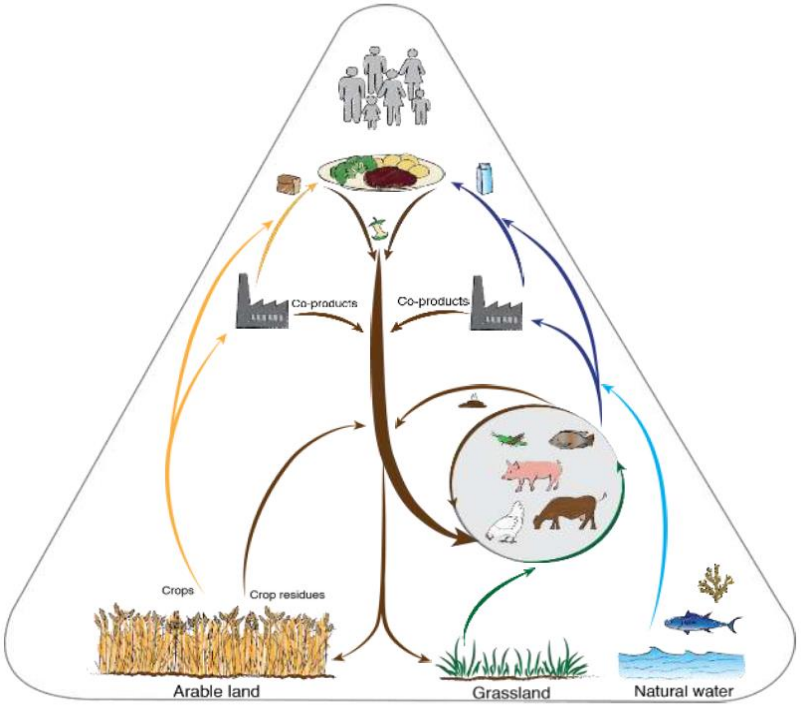
- Focus on quantity *and* quality of yield *and* residues
- Fertilisation:
    - First re-use all organic sources
    - P: finite but not readily lost:

      - work towards closed system
    - N: infinite but losses (incl. GHGs) inevitable:

      - compensate with legumes (extra land) or

      - mineral fertilisers produced with renewables
- Managing weeds, pests and diseases?

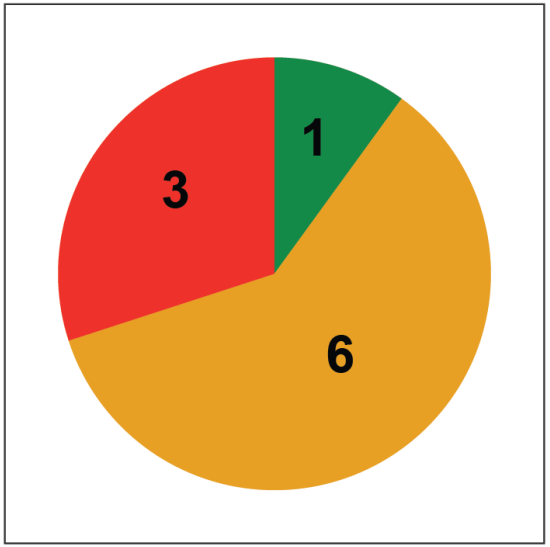
# 2. Recycling by-products: prioritize!



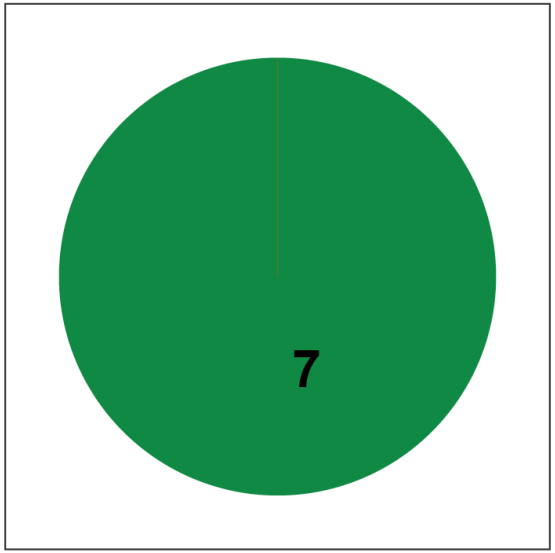

1. Maintain soil quality: application to field
2. Feed for livestock, fish or insects
3. Renewables: energy, fertilizers or other materials
4. Soil carbon sequestration

# Soil organic matter - mean yield effects are NPK effects

A. Mean yield effect of increasing SOM - N, P, K effects excluded




B. Mean yield effect of increasing SOM - N, P, K effects cannot be ruled out





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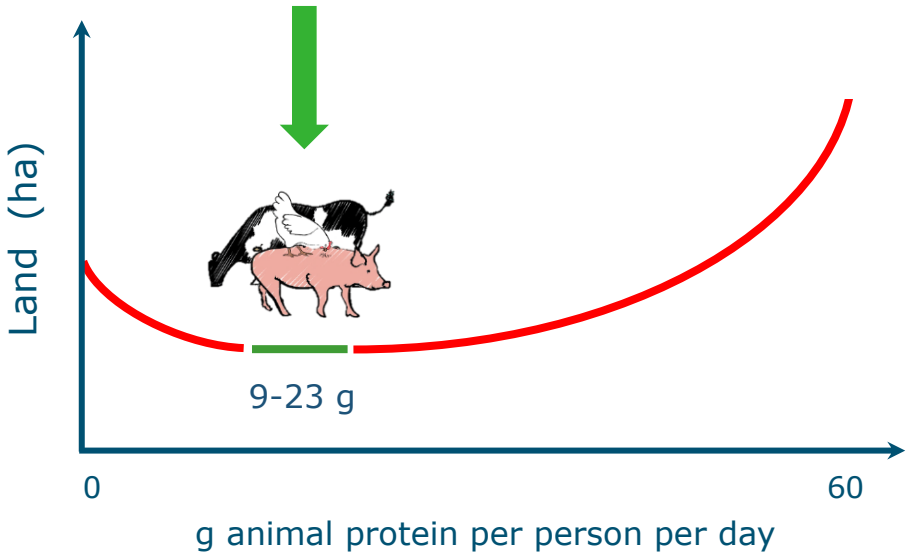
*Renske Hijbeek, Martin van Ittersum, Hein ten Berge, Andy Whitmore (2018) IFS Proceedings*

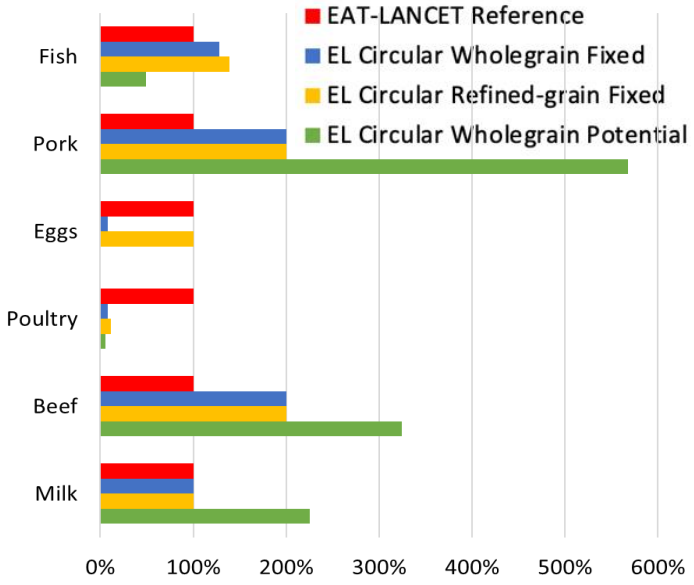
*Hijbeek et al. (2017) Plant and Soil*

# 3. The role of animals

Unlock inedible, low opportunity cost biomass




Analysis for European Union



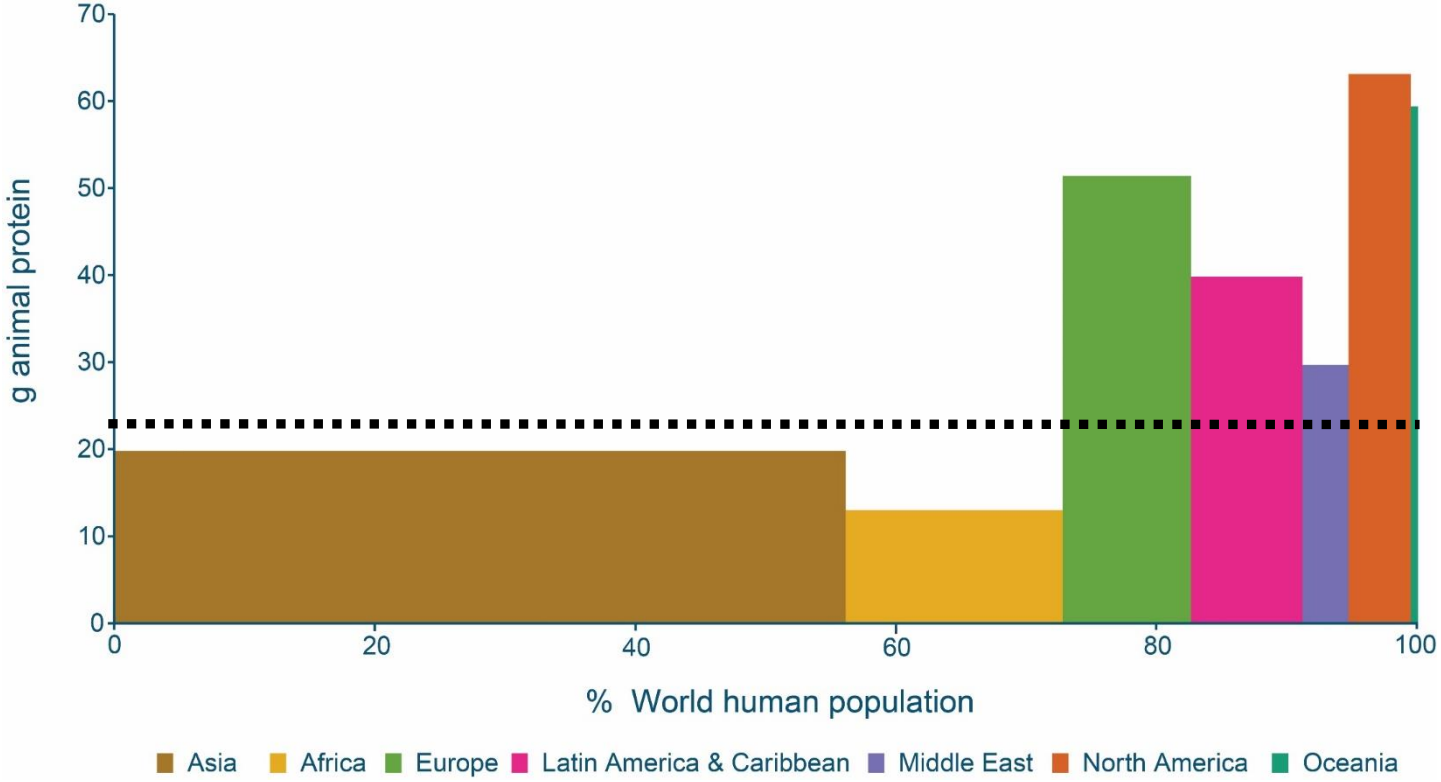

Circularity scenarios can meet:

- Recommended animal protein levels EAT-LANCET diet
- But not the precise dietary guidelines EAT-LANCET diet

*Van Zanten et al. (2018) Global Change Biology*

*Van Selm et al. (2021) In review*

# Animal protein available for consumption

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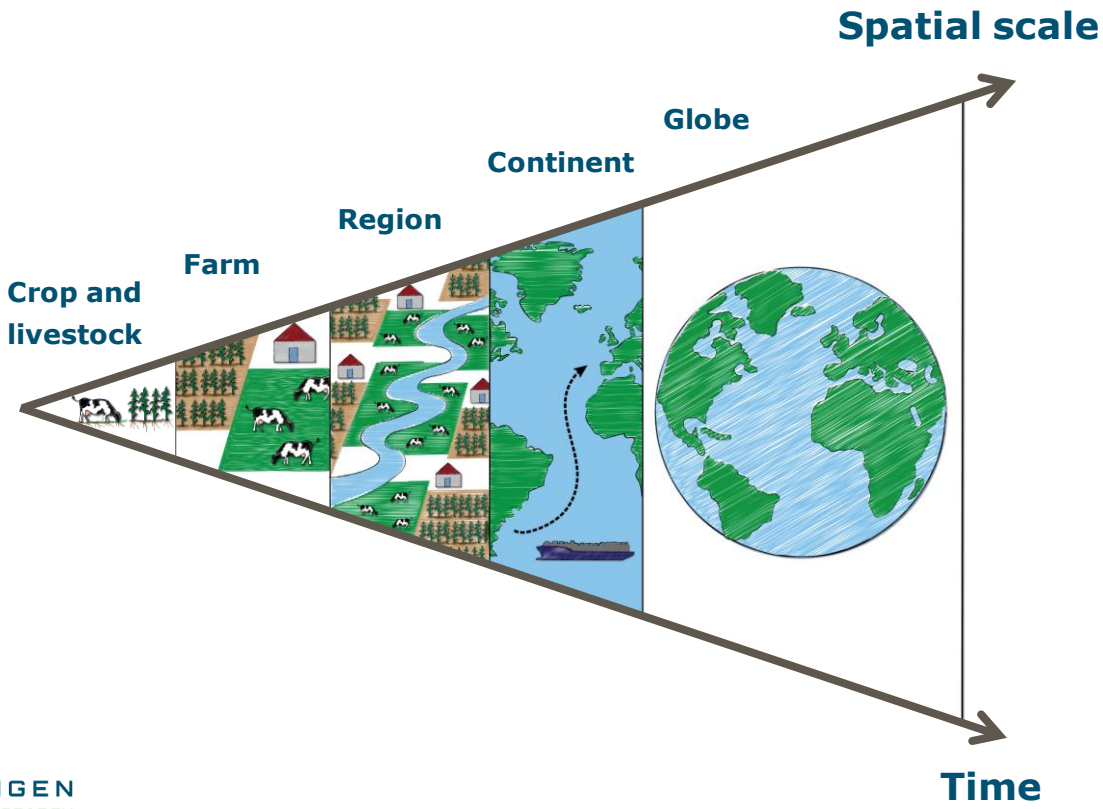
*Van Zanten et al. (2018) Global Change Biology*

# Circularity at which level?



# Conclusions

- Rethink our food system – circularity with three guiding principles:

- Use (good) land efficiently: biomass for food
- Avoid waste, and re-use by-products with a prioritisation
- Use animals to upgrade ‘low-opportunity cost biomass’

- Reduce consumption of animal-source food in high-income countries

- Monitoring and Level of implementation are key research questions
- ..... just as barriers and incentives ....

# Future harvest

Thank you for your attention!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