Towards a circular bio-based society

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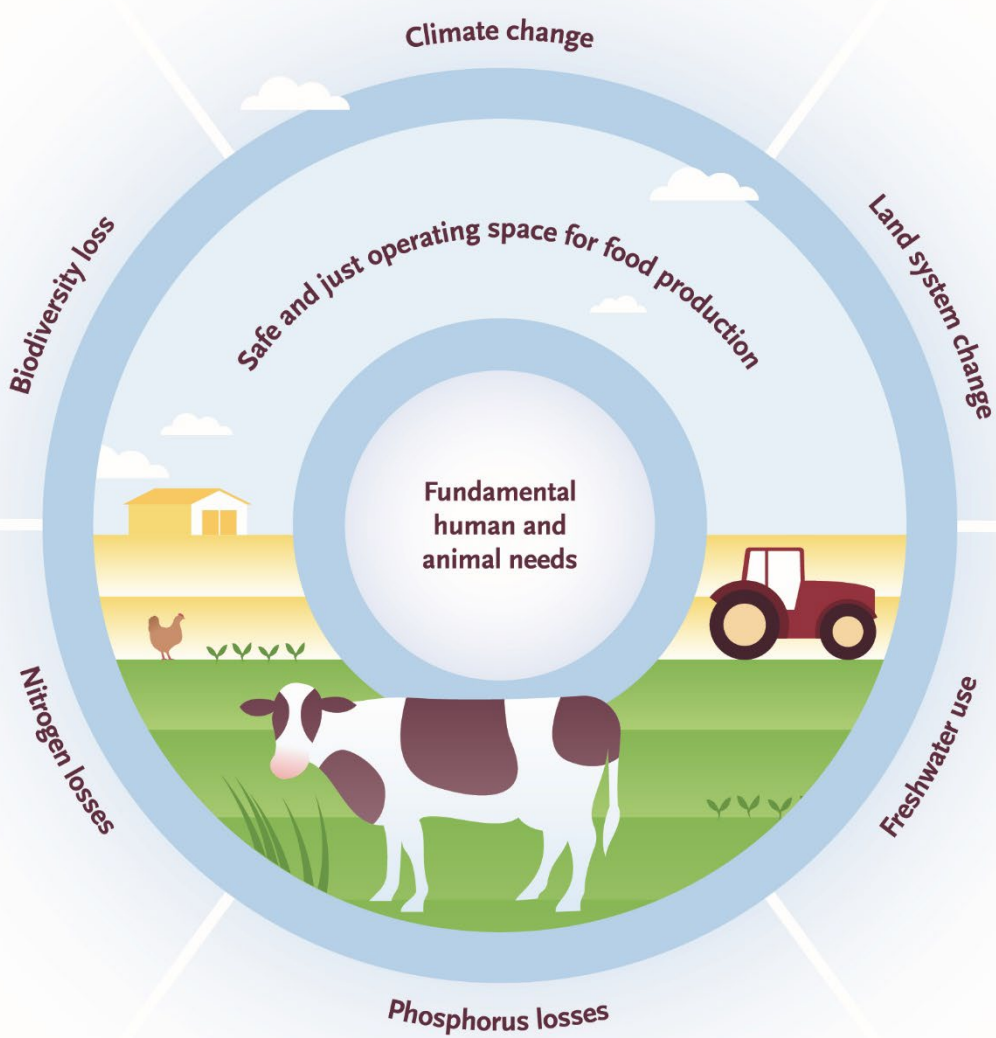
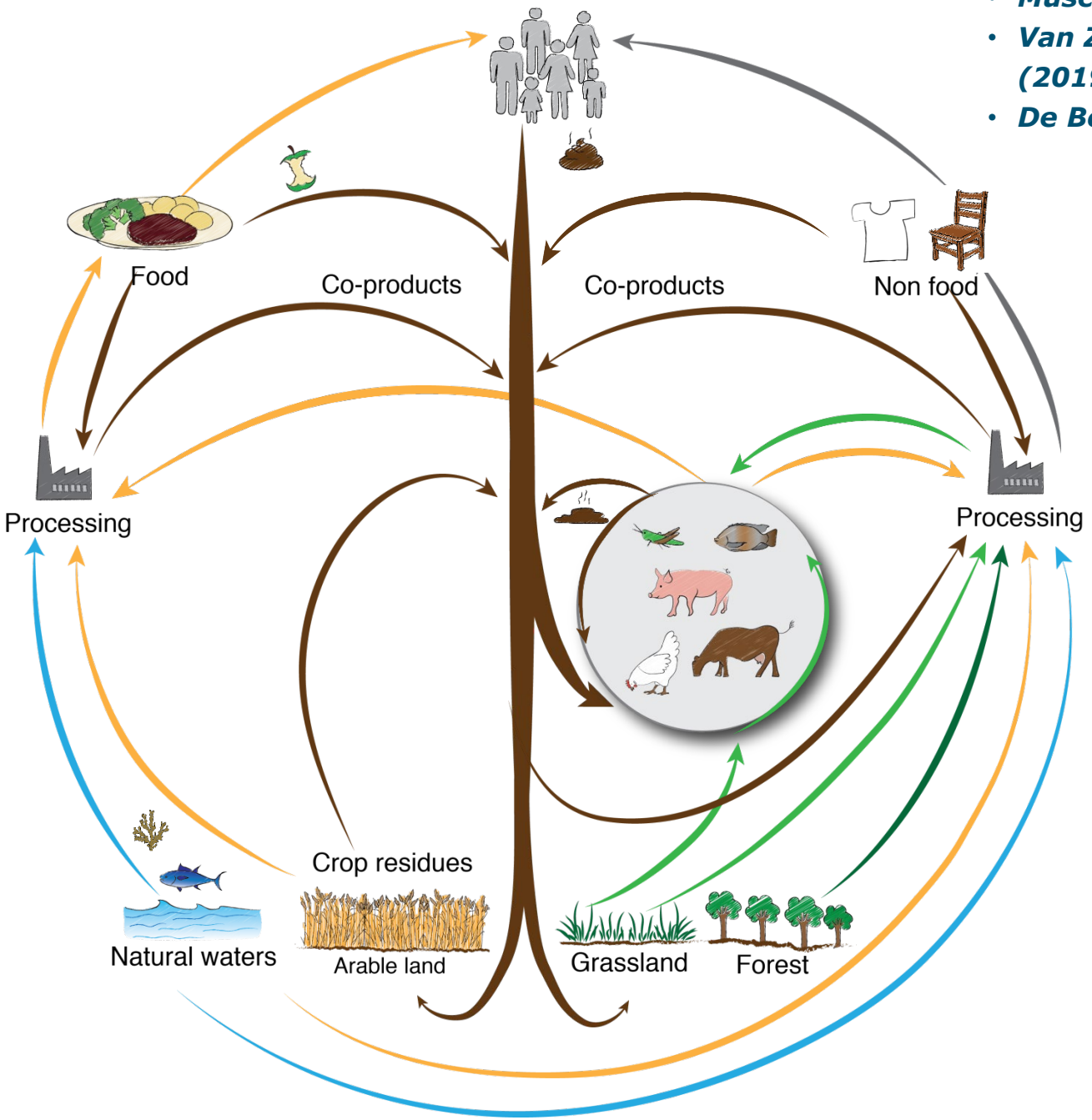
Safe-and-just operating space



- ***Muscat et al. (2021) Nature Food***
- ***Van Zanten, Van Ittersum, De Boer (2019) Global Food Security***
- ***De Boer and Van Ittersum (2018)***



Key ecological principles

1. **Safeguard** the health of our agroecosystems
2. **Avoid** non-essential products, losses & wastes of essential ones
3. **Prioritize use** of biomass
4. **Recycle** inevitable & unavoidable biomass streams
5. **Use renewable energy** wisely

Muscat et al. (2021) Nature Food

1. Safeguard

Regeneration and conservation of healthy ecosystems

Diversify
at all levels

Conservation
e.g. zero deforestation

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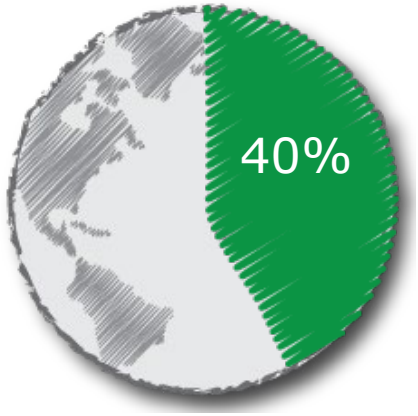
2. Avoid

Avoid comes before prioritize/recycle to prevent upstream production processes and associated impacts

3. Prioritize principle

Use biomass and production resources most effectively – human needs framework



Global arable land

Mottet et al. (2017)

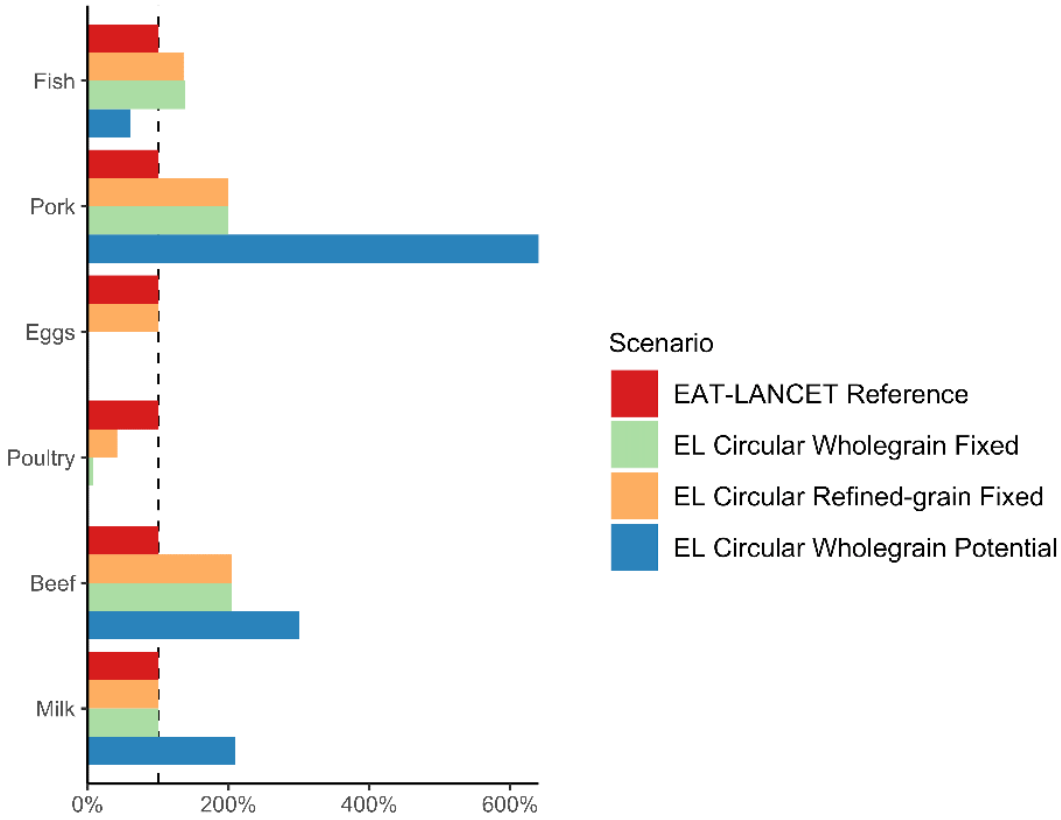
4. Recycle principle

Recycle co-products back into the system if they are inevitable or unavoidable

?

The role of animals

Analysis for European Union + UK

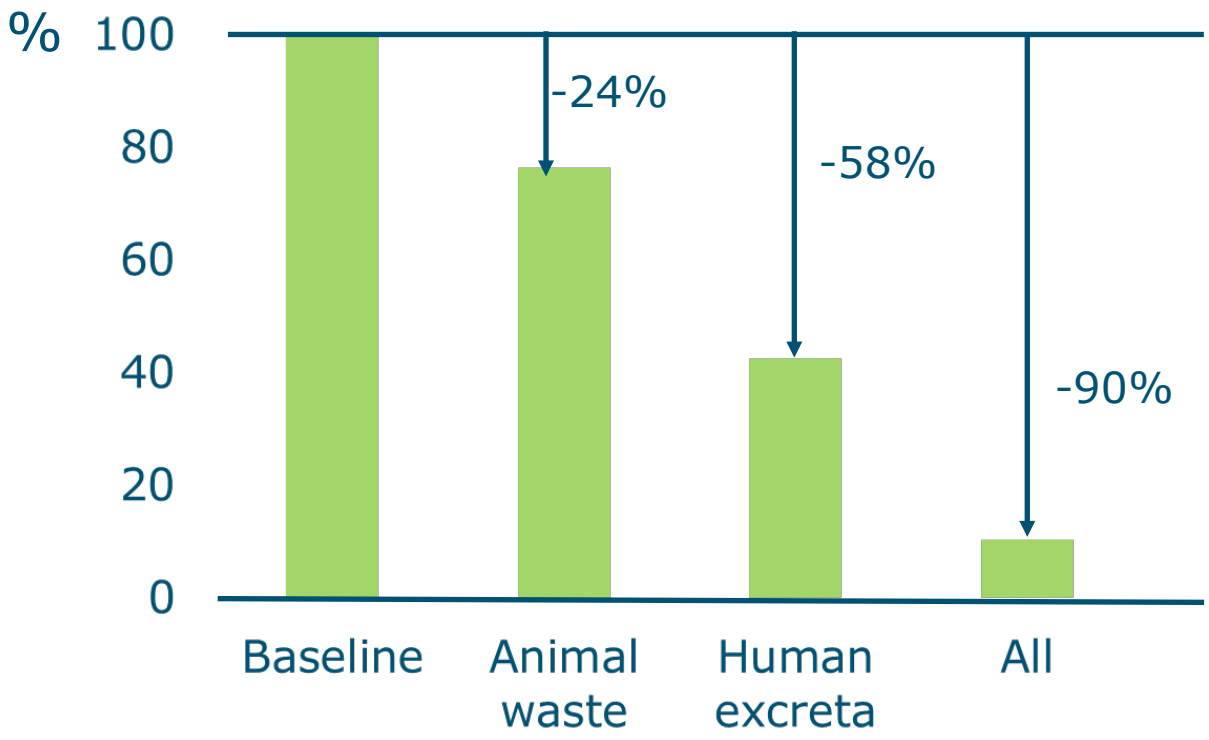


Circularity scenarios can meet:

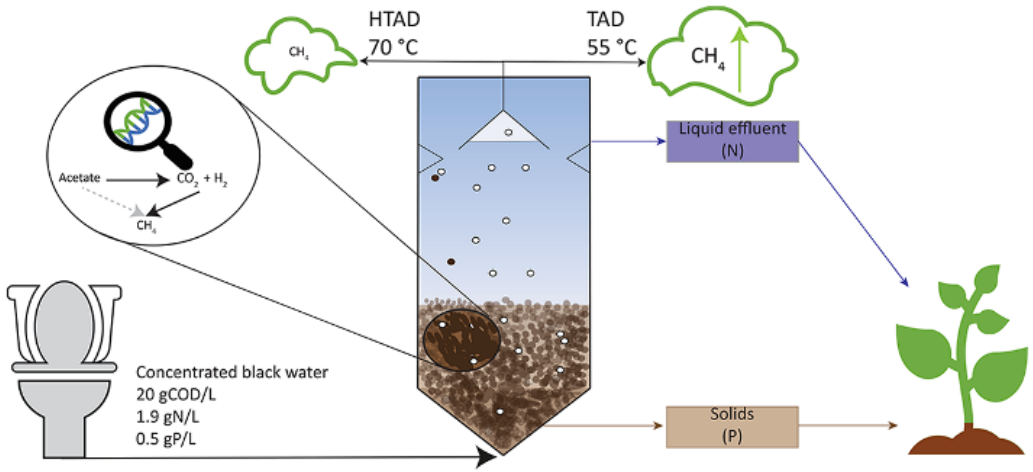
- Recommended animal protein levels EAT-LANCET diet
- But not the precise dietary guidelines EAT-LANCET diet

Van Selm et al. (2022) Nature Food

Recycling – example phosphorus requirements



Van Kernebeek et al. (2018), Animal



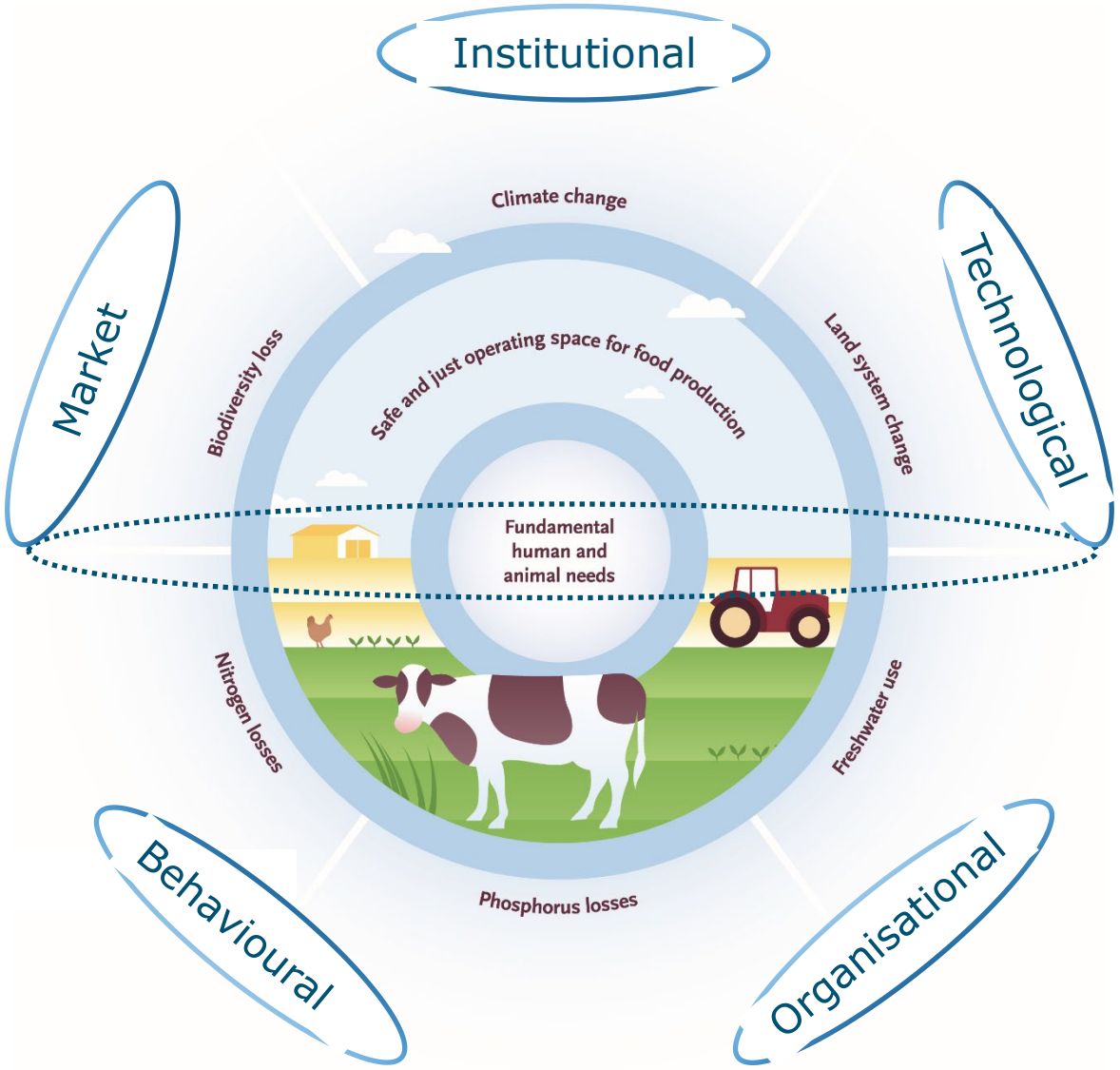
Thermophilic anaerobic digestion of concentrated BW

Moerman, van Eeekert and Buisman, 2022

5. Energy Principle

Renewable energy sources, minimise energy use

Systems change



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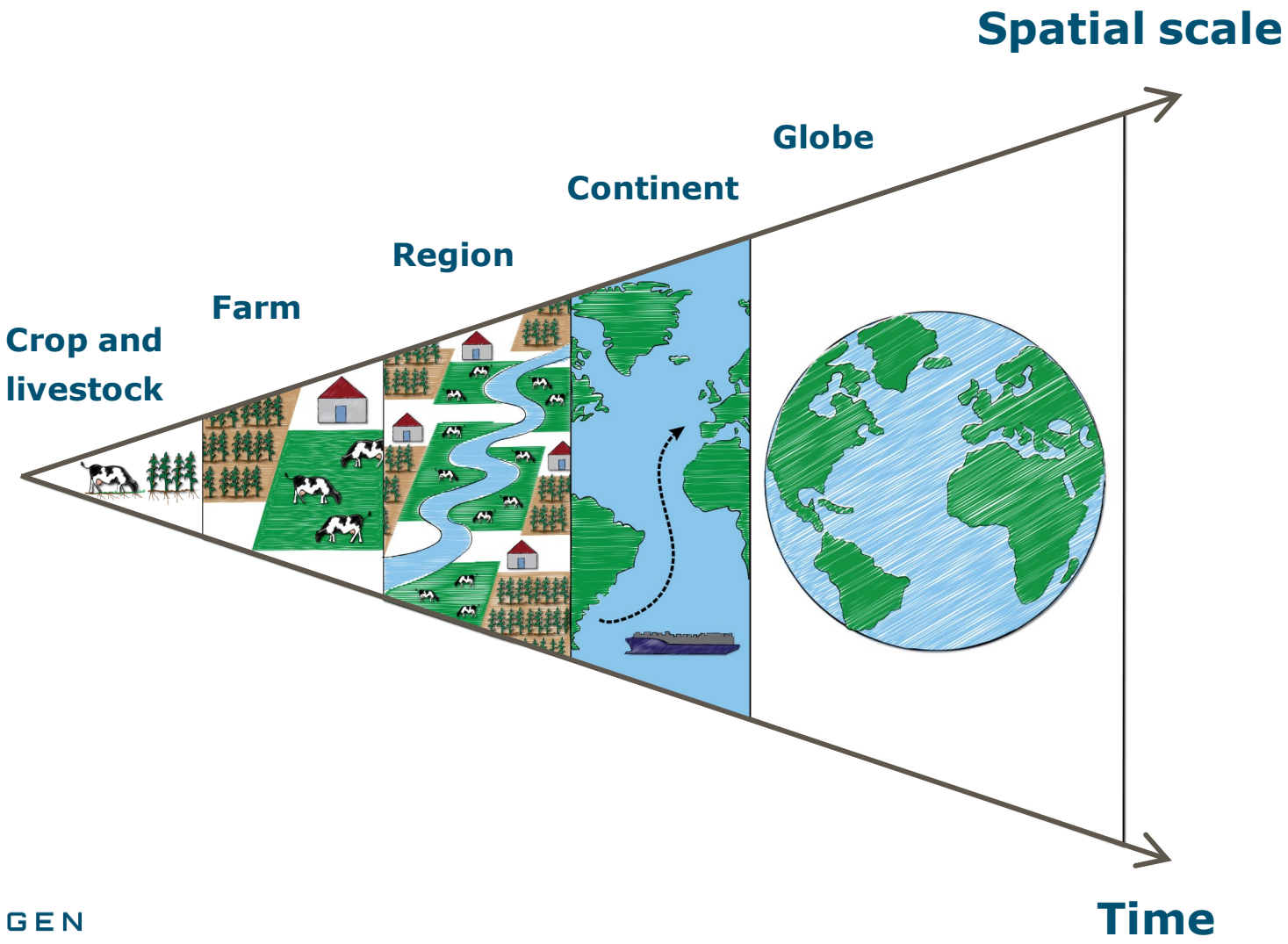
Circularity at which level?



Metrics to measure progress

Some examples

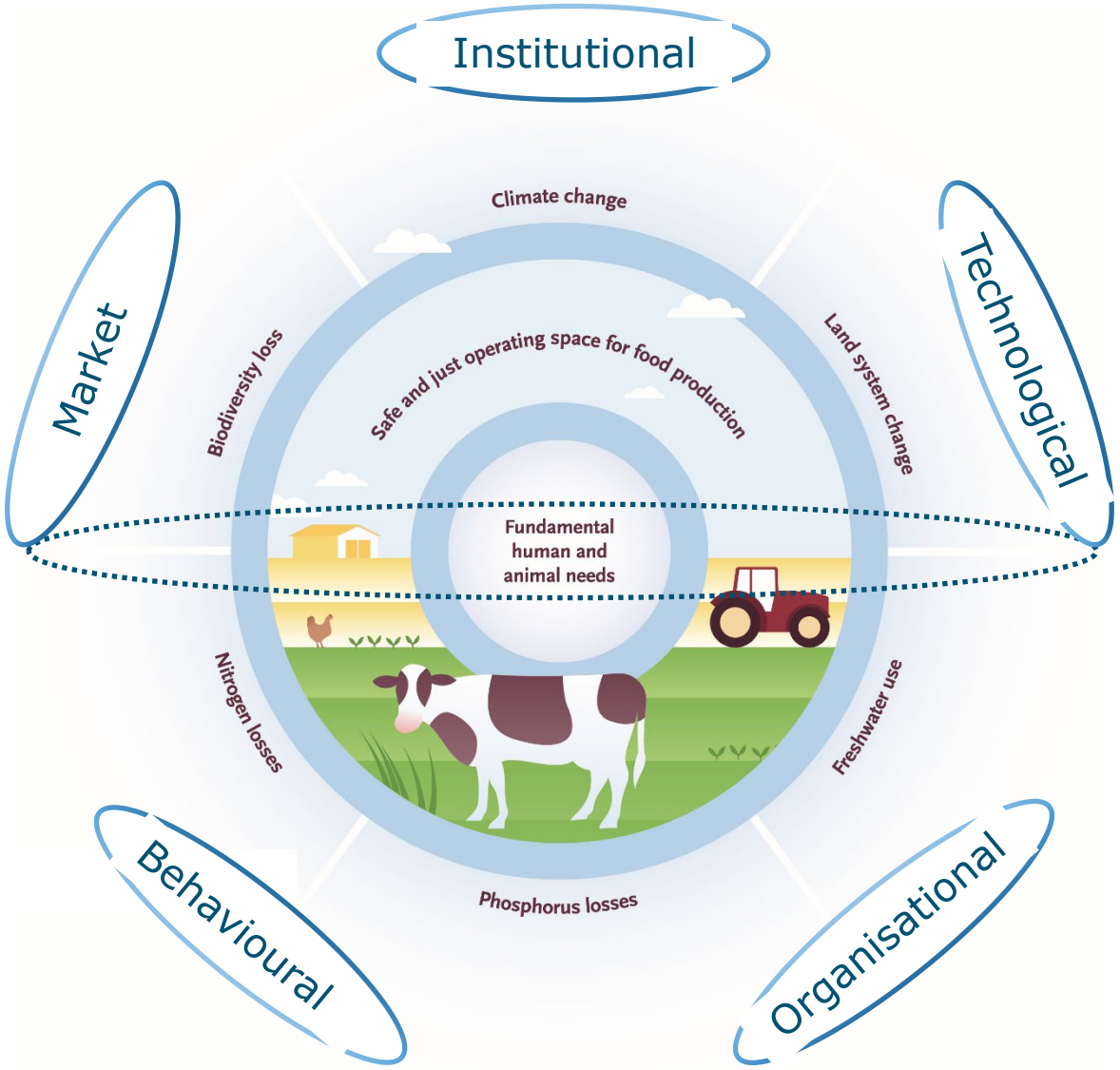
- Use cycle count: how many times a nutrient, after entering the system, is used (animal consumption, crop uptake, human consumption) in a full cycle
- Finn cycling index: nutrients cycling in ecological systems (no output)
- Figge circularity indicator: material recycling in industrial processes

But:

- Cycling without production will not help us
- We also need production efficiency and balance indicators
- Output=input and Balance = 0 does not express circularity

Ten Berge et al, in preparation

Systems change



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Future harvest

Thank you for your attention!

Acknowledgement: Imke de Boer

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