Circularity in livestock production: from theory to practice

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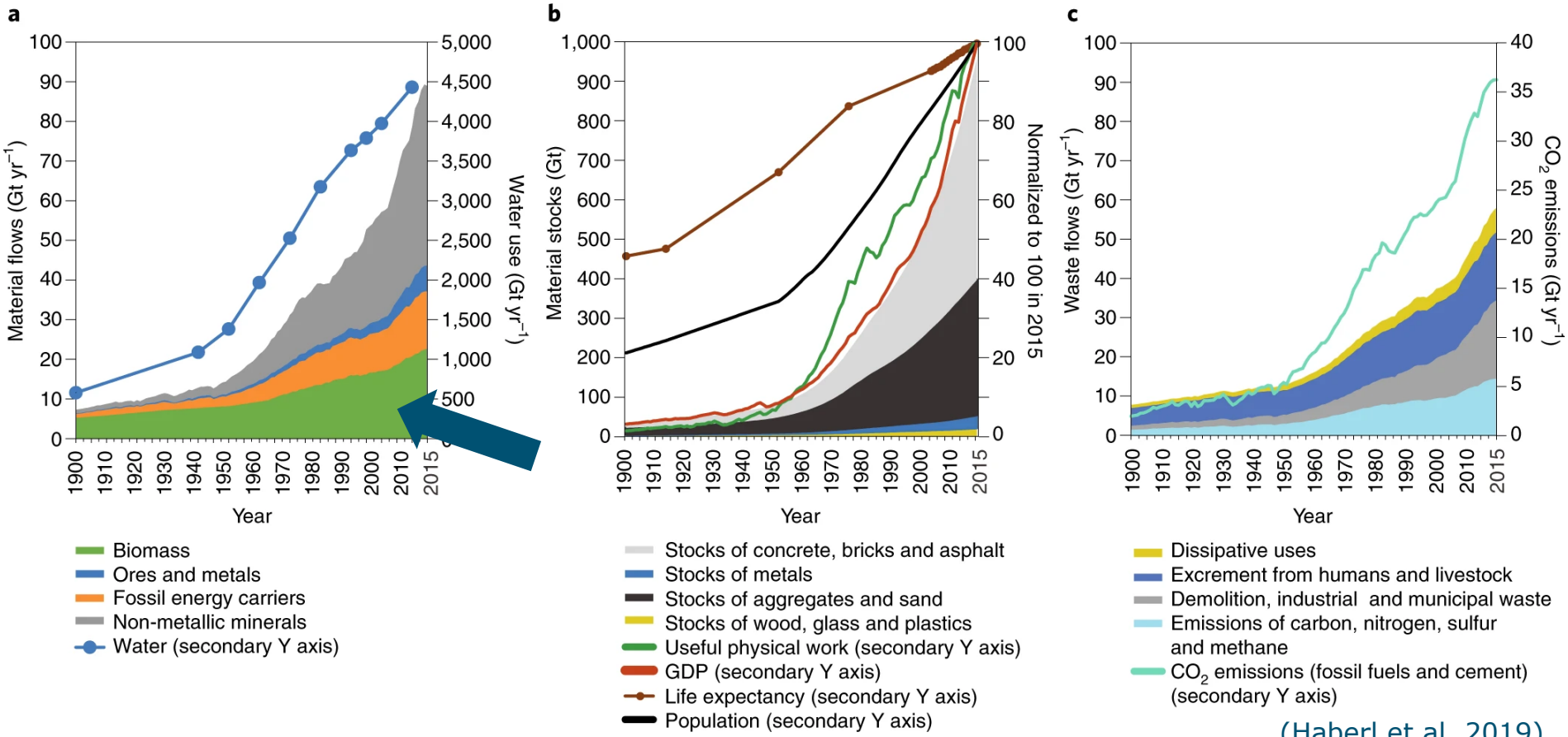
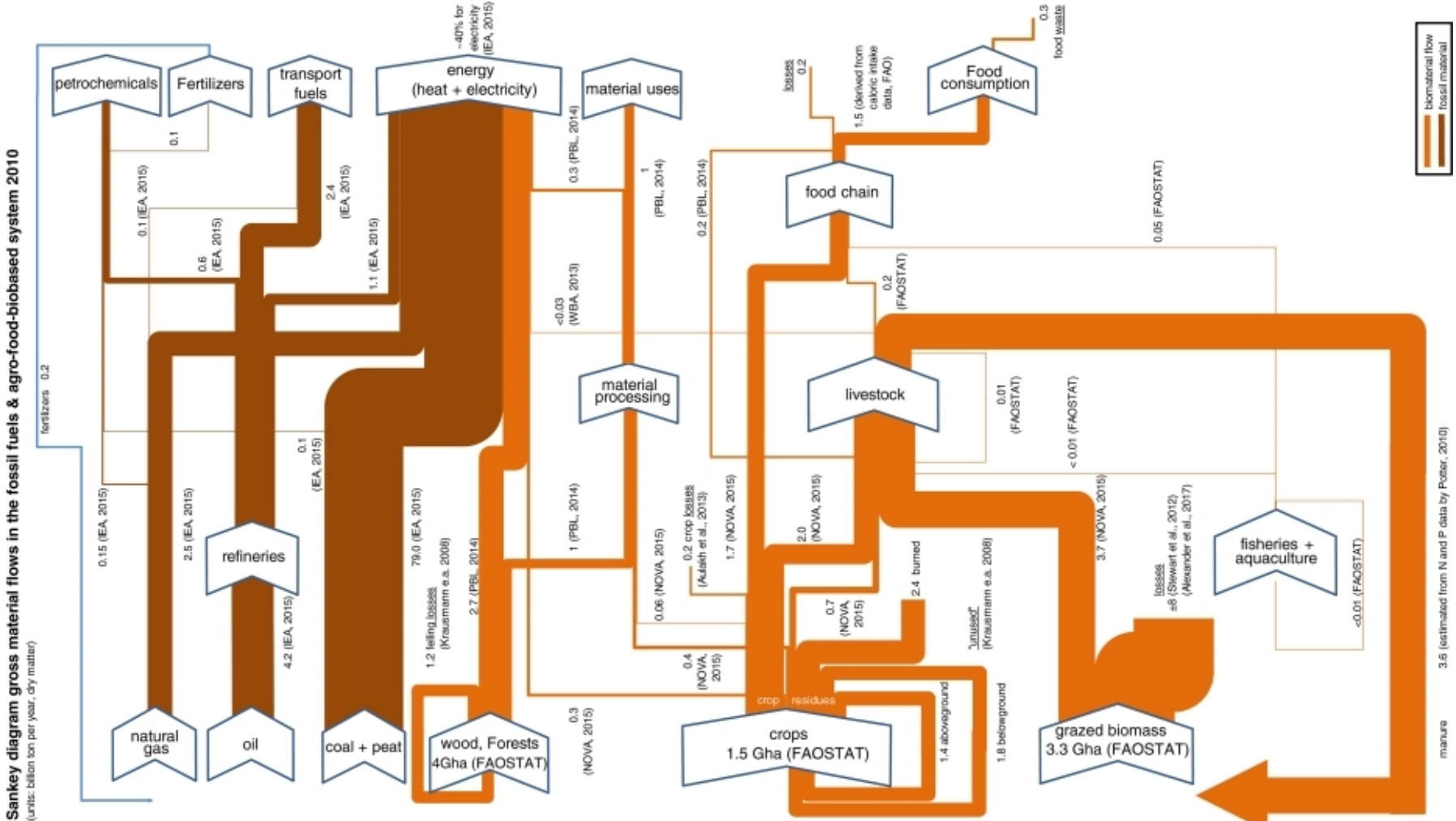
Content

- Ecological principles for a circular bioeconomy
- Analysing circular food systems
- Indicators for circularity at farm level
- A tool to assess circularity of Dutch dairy farms

Global social metabolism

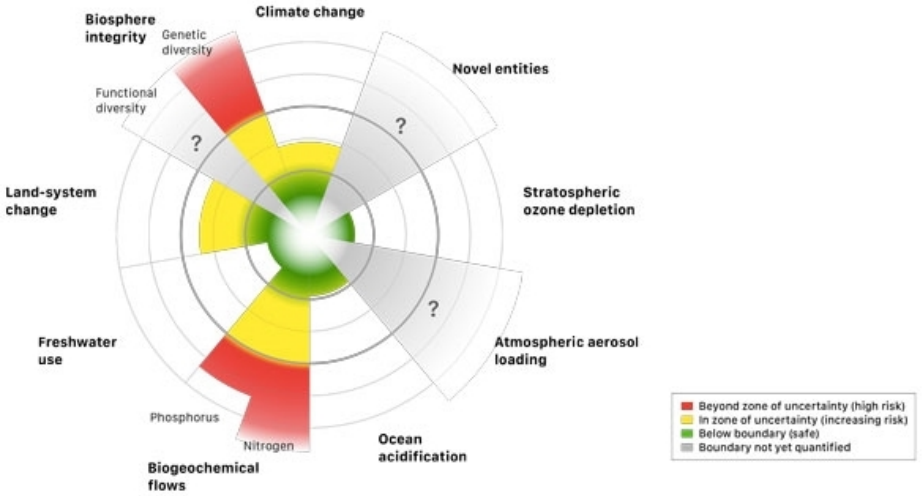


(Haberl et al. 2019)



(Bos & Broeze, 2020)

A healthy planet



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Ecological principles for a circular bioeconomy

1. Safeguard the health of our agroecosystems

(Muscat et al. 2021, Nature Food)

Ecological principles for a circular bioeconomy

1. **Safeguard** the health of our agroecosystems

2. **Avoid** non-essential products, losses & wastes of essential ones

(Muscat et al. 2021, Nature Food)

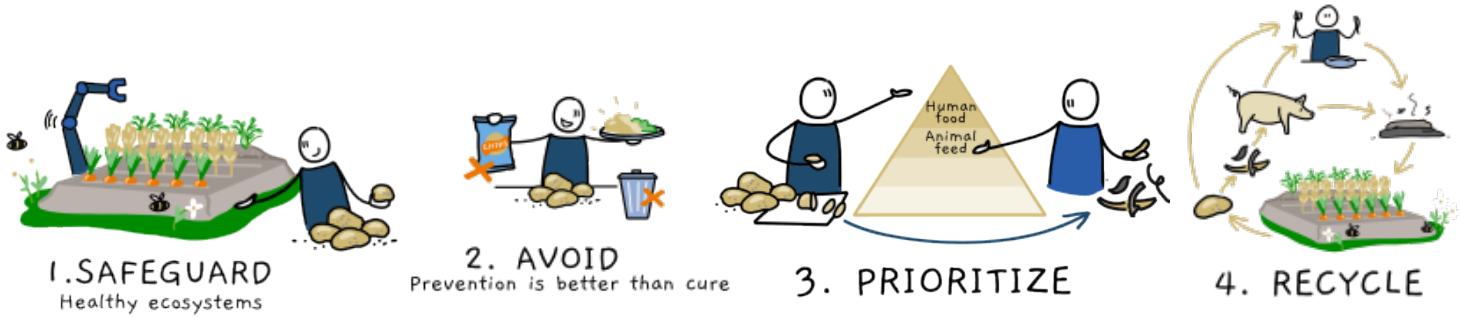
Ecological principles for a circular bioeconomy

1. **Safeguard** the health of our agroecosystems
2. **Avoid** non-essential products, losses & wastes of essential ones
3. **Prioritize** biomass streams for human needs

(Muscat et al. 2021, Nature Food)

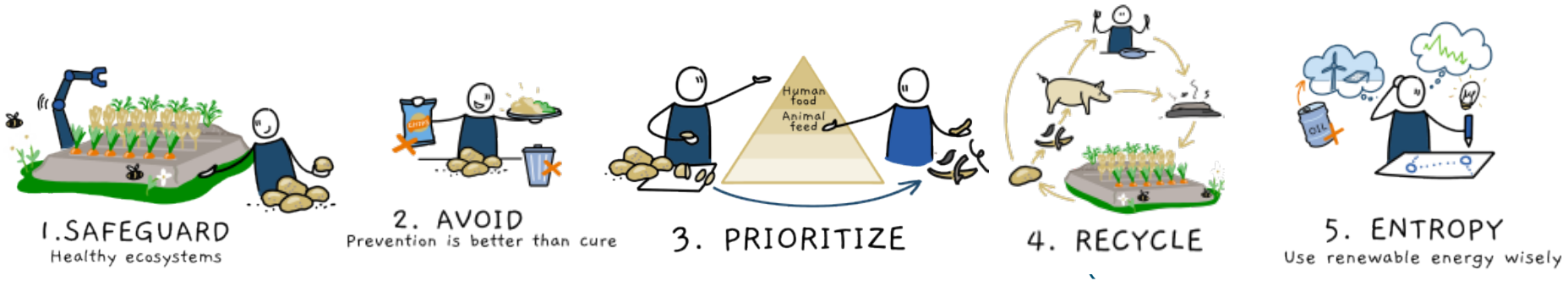
Ecological principles for a circular bioeconomy

1. **Safeguard** the health of our agroecosystems
2. **Avoid** non-essential products, losses & wastes of essential ones
3. **Prioritize** biomass streams for human needs
4. **Recycle** inevitable & unavoidable biomass streams



Ecological principles for a circular bioeconomy

1. **Safeguard** the health of our agroecosystems
2. **Avoid** non-essential products, losses & wastes of essential ones
3. **Prioritize** biomass streams for human needs
4. **Recycle** inevitable & unavoidable biomass streams
5. **Entropy** reduce energy use and use renewables wisely



Circularity is …

- … effective use of available resources (land, biomass, water, nutrients, etc.)
- … not a goal in itself but a means to stay within the planetary boundaries
- … not nessarily local production
- … required to safeguard the regenerative capacity of our planet for the future

Analysing circular food systems

- Food system models
  - FOODSOM
- Farm-level indicators
- Circular agriculture initiatives

Journal of Cleaner Production 219 (2019) 485–496

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Upcycling food leftovers and grass resources through livestock: Impact of livestock system and productivity

O. van Hal [a, *], I.J.M. de Boer [a], A. Muller [b], S. de Vries [c], K.-H. Erb [d], C. Schader [b], W.J.J. Gerrits [c], H.H.E. van Zanten [a]

Science of the Total Environment 899 (2023) 165540

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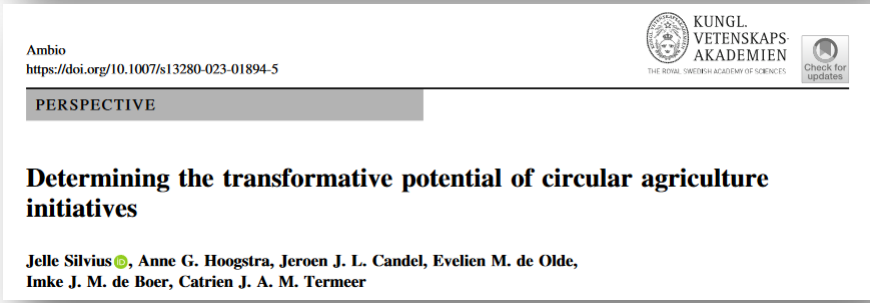
Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Recoupling livestock and feed production in the Netherlands to reduce environmental impacts

Benjamin van Selm [a,b,*], Renske Hijbeek [b], Martin K. van Ittersum [b], Ollie van Hal [a], Corina E. van Middelaar [a], Imke J.M. de Boer [a]



Ambio
https://doi.org/10.1007/s13280-023-01894-5

KUNGL. VETENSKAPS AKADEMIEN

PERSPECTIVE

Determining the transformative potential of circular agriculture initiatives

Jelle Silvius, Anne G. Hoogstra, Jeroen J. L. Candel, Evelien M. de Olde, Imke J. M. de Boer, Catrien J. A. M. Termeer

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Analysing circular food systems

- LCA studies tend to result in 2 recommendations
  - To produce with lower GHG per kg product, increase yield, by improving feed quality
  - To consume with lower GHG, shift to products with lower impact (e.g. chicken), also require higher feed quality

- Improvement on product level ≠ improvement on food system level
  - ➢ Analysing circularity requires a food systems lens

Indicators for circularity (models)

- To express the effective use of resources
  - Edible Protein Conversion Ratio (Wilkinson, 2011)
    - efficiency of producing Human Digestible Protein (HDP)
  - Land Use Ratio (LUR) (van Zanten et al. 2016)
    - potential HDP from crops grown on land used to produce the livestock feed against the HDP in the livestock produce

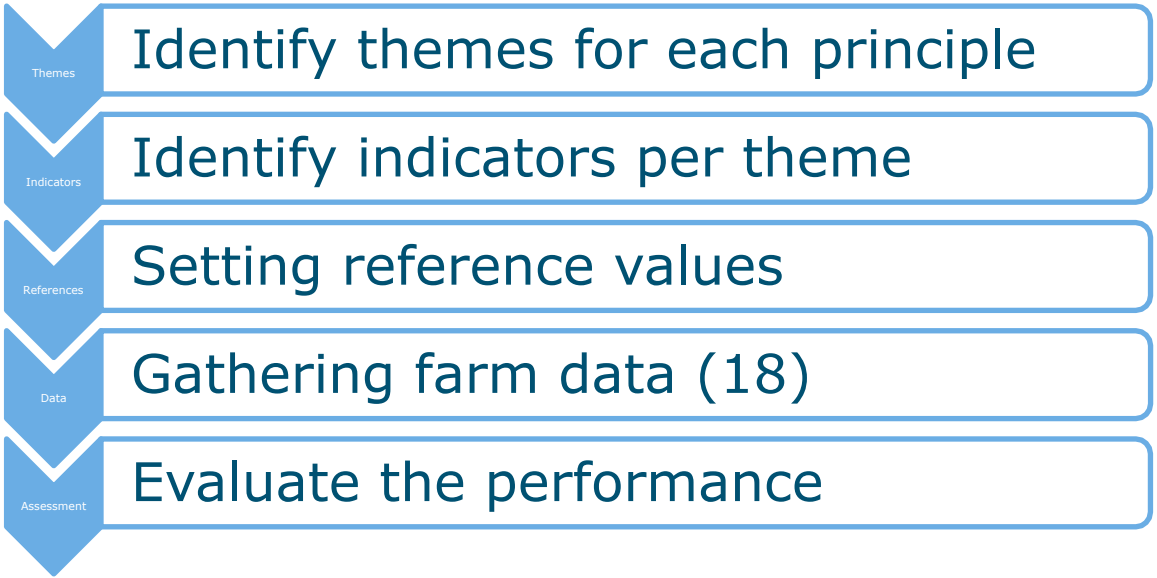
Indicators for circularity (farms)

- Vision Ministry of Agriculture, Nature and Food Quality (2017)
- The Netherlands a leader in circular agriculture by 2030

➢ Projects to evaluate circular agriculture in farming practice

➢ What is effective use of land, water, manure, energy... (perspectives, contexts)

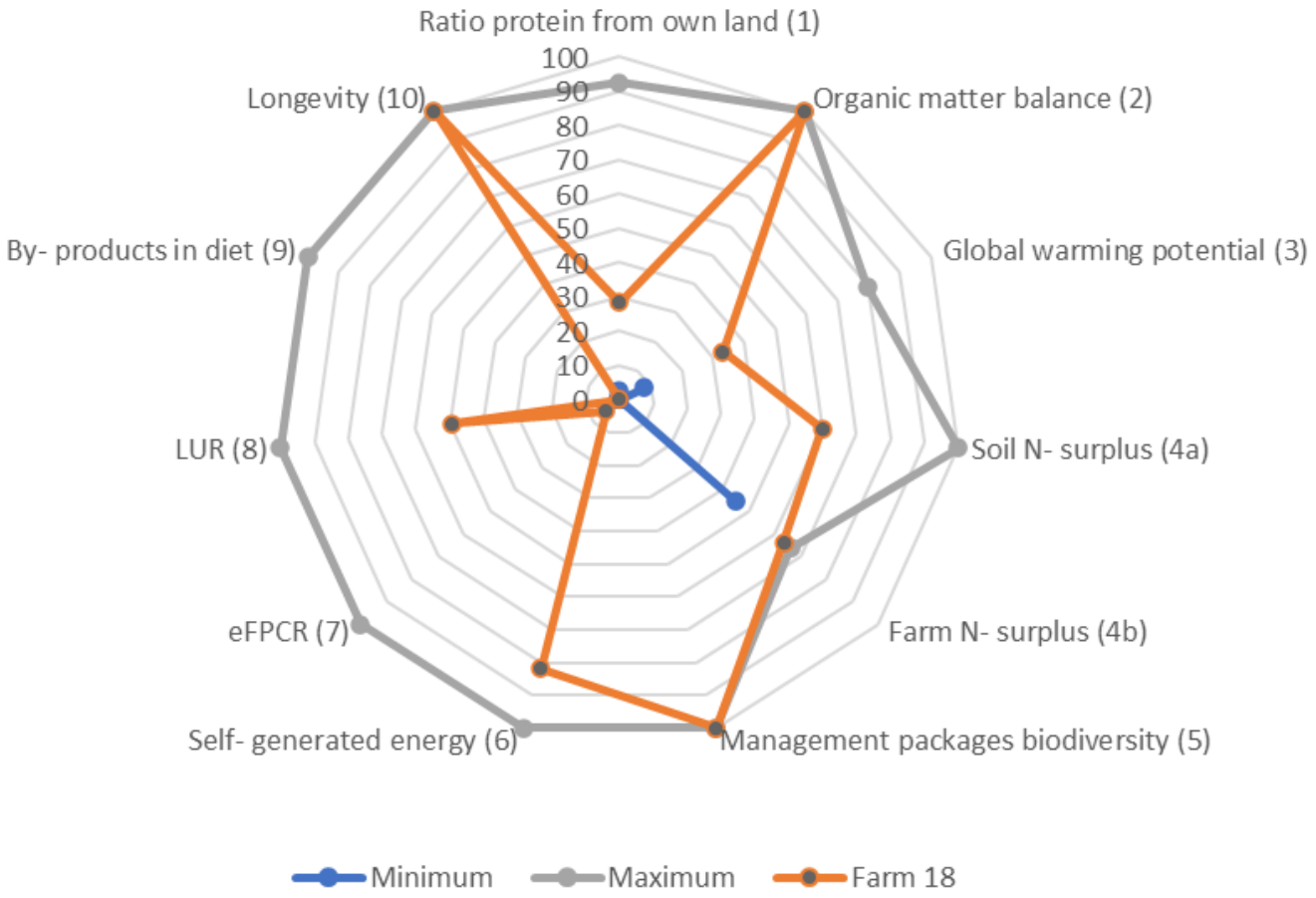
A tool to assess circularity in dairy farms



A tool to assess circularity in dairy farms

Theme	Indicator	Unit
Land use	Ratio protein from own land	%
Soil	Organic matter balance	%
Air	Global warming potential	CO2-eq in kg per kg milk
	Soil + farm N-surplus	Kg per ha + kg per L milk
Biodiversity	Management packages landscape elements (OTWTPP)	%
Finite resources	Self-generated energy	%
Feed-food competition	Edible feed protein conversion rate (eFPCR)	Kg HDP in milk per kg HDP feed input
	Land use ratio (LUR)	Kg HDP per ha produced per kg HDP in 1 kg product
By-products	By-product in ration	%
Animals' abilities	Dairy cow longevity	Age in years

No.	KPI	Reference values		Unit	Based on
		0 points	100 points		
1	Ratio protein from own land	37	76	%	ANCA (2018)
2	Organic matter balance	5	1	%	Van Eekeren et al. (2015)
3	Global warming potential	1453	898	CO2-eq in kg per kg milk	ANCA (2018)
4a	Soil N-surplus	287	60	Kg N per ha	ANCA (2018)
4b	Farm N-surplus	26.7	6.6	Kg N per tons of milk	ANCA (2018)
5	Management packages landscape elements	5	1	%	Authors & OTWTPP
6	Self-generated energy	5	1	%	Authors
7	eFPCR	0.98	2.48	Kg HEP in milk per kg HEP feed input	Authors
8	LUR	1.46	0.81	Kg HDP per ha produced per kg HDP in 1 kg product	Authors
9	By-products in diet	5	1	%	Authors
10	Longevity	5	6	Age in years	Authors


Ratio protein from own land (1)
Organic matter balance (2)
Global warming potential (3)
Soil N- surplus (4a)
Farm N- surplus (4b)
Management packages biodiversity (5)
Self- generated energy (6)
eFPCR (7)
LUR (8)
By- products in diet (9)
Longevity (10)
100
90
80
70
60
50
40
30
20
10
0
Minimum
Maximum
Farm 18

A tool to assess circularity in dairy farms

- Quick tool as starting point for discussion
- Reference values need to be more context specific
- Water use is missing
- Farm level can be limiting (e.g. crop-livestock collaboration)

Discussion

- Need for dynamic models across scales
- Defining what is human edible / by-product
- Access to data on origin of feed ingredients

- Circularity mainly addresses planetary boundaries but also requires social foundation – essential rights for humans and animals (Raworth, 2017)
    - Rethinking value and prosperity

Discussion

Do the interlinkages between resource use and socioeconomic performance require more radical transformation of our food system?

Table 1 | Principles by which growth and post-growth metabolisms operate arranged by category

	Economic principles	Social–ecological principles	Allocative principles	Institutional principles	Relational principles
Growth metabolism	Efficiency	Extraction	Accumulation	Private ownership	Control
Post-growth metabolism	Sufficiency	Regeneration	Distribution	Commons	Care

nature sustainability

PERSPECTIVE

https://doi.org/10.1038/s41893-022-00933-5

Check for updates

Sustainable agrifood systems for a post-growth world

Steven R. McGreevy[1,2,3,30], Christoph D. D. Rupprecht[4,30], Daniel Niles[3,30], Arnim Wiek[5,30], Michael Carolan[6], Giorgos Kallis[7,8], Kanang Kantamaturapoj[9], Astrid Mangnus[10], Petr Jehlička[11], Oliver Taherzadeh[12], Marlyne Sahakian[13], Ilan Chabay[14], Ashley Colby[15], Jose-Luis Vivero-Pol[16], Rajat Chaudhuri[17], Maximilian Spiegelberg[2], Mai Kobayashi[18], Bálint Balázs[19], Kazuaki Tsuchiya[20], Clara Nicholls[21], Keiko Tanaka[22], Joost Vervoort[10], Motoki Akitsu[23], Hein Mallee[24], Kazuhiko Ota[25], Rika Shinkai[3], Ashlesha Khadse[26], Norie Tamura[27], Ken-ichi Abe[3], Miguel Altieri[28], Yo-Ichiro Sato[24] and Masashi Tachikawa[29]

Thanks!

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