WILHELM WINDISCH - The role of meat in a sustainable environment

Thompson et al. 2023

Featured Article

Ecosystem management using livestock: embracing diversity and respecting ecological principles

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Implications

- Agricultural land is a scarce resource globally and will continue to encounter challenges to sustainably increase food production in the face of global change. Adaptations that make use of livestock should ideally incorporate agroecological principles (e.g., improved circularity), while limiting feed-food competition. However, they should also remain respectful of the diversity of ecosystem contexts, availability of resources, and the various social and economic needs of local populations.
- Herbivores are a natural constituent of the world's ecosystems and have played a key role in the last several million years. As the numbers of wild herbivores have greatly decreased, largely due to human action, the maintenance of such roles depends on the practice of adequate livestock management. This is the ecological basis for sustainable livestock.
- Well-managed animals function as an integral and productive part of agricultural systems. Among other outcomes, they can convert massive quantities of nonedible biomass (inevitably arising from pasture systems and from growing plants into human food), recycle plant nutrients back to the land, sequester carbon, improve soil health, and offer many ecosystem services.
- To optimize both environmental impact and food supply, the broad and underutilized diversity that is inherent to livestock systems should be mobilized instead of being suppressed. This diversity can, for instance, be observed in terms of species and breeds, but also in terms of production methods and management strategies.

Key words: biomass, circularity, ecology, livestock, pasture, sequestration

Introduction

The animal production sector is facing important challenges in the context of global change. This is especially related to population growth, land erosion, a decrease in biodiversity, wastage of water, depletion of resources, disruption of nutrient cycles and eutrophication, and climate change. Even if livestock agriculture has contributed to these problems, as have other forms of human productivity, it can contribute to the solution, provided it operates within an agroecological framework and environmental boundaries, while still respecting primordial principles of diversity (Leroy et al., 2022). The latter relates not only to the biological variety of livestock options as such, but also to the important heterogeneity within ecosystem types, production and management methods, and local needs and resources. Indeed, livestock products and production systems differ, from intensive to extensive, from arctic to tropical, from highly technological to indigenous, or from being a by-product to being the main focus of the system.

Definitions vary, but there are >40 farmed animal species and >7,000 breeds adaptive to specific local needs and context (FAO, 2021). They produce a vast range of foods and services for humans, from diets that are largely inedible for humans. Only a small share of this bounty of diversity is utilized to its

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Featured Article

Challenges for the balanced attribution of livestock's environmental impacts: the art of conveying simple messages around complex realities

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Implications

- Meat production is often listed among the largest contributors to climate change, and is usually associated with biodiversity damage, feed-food competition, and water scarcity. This assumption is largely based on the biogenic methane (CH_4) emissions of the global herd of ruminants and its occupation of land. Environmental assessments of the livestock sector are all too frequently stated in simplistic terms, making use of a myopic selection of metrics, and overlooking underlying heterogeneity and complexities.
- One example of such oversimplification is the comparison of the warming effect of different greenhouse gases (CO_2, CH_4, and N_2O), which are associated with a series of challenges due to their own heterogeneous atmospheric 'behavior'. Whilst useful for certain research questions, standardizations such as the commonly used GWP_{100} hide many complex issues. These issues include considering different emission profiles of production systems (e.g., low-methane porcine vs. high-methane ruminant), the need to factor in CO_2 and CH_4 sinks, the different atmospheric lifetimes of each gas and subsequent atmospheric warming potential, and compensatory background emissions in alternative rewilding scenarios.
- Whilst poorly managed land negatively affects biodiversity, well-managed land strategies, including those pertaining to livestock production, can lead to favorable outcomes (e.g., biodiverse swards that encourage pollination and beneficial microfauna). Similarly, the assessment of water wastage and land use requires contextualized approaches. This highlights the importance of addressing agricultural heterogeneity in systems analysis, including Life Cycle Assessment (LCA).
- To further reflect the food-environment nexus, nutritional LCA (nLCA) incorporates considerations of food, optimizing e.g. nutritional sustenance and reducing, in theory, the amount of food we consume through meal-level assessment - rather than focusing on a single product.
- Being more recent than the wider LCA 'umbrella' (e.g., Life Cycle Cost Analyses), one current drawback of nLCA is that it can be easily manipulated to favour one product over another, whether plant- or animal sourced, by singling out specific nutrients (e.g., fiber or vitamin C vs. vitamin B12 or digestible amino acid balanced protein).
- When considering the value of livestock products against their environmental impact, a holistic assessment is needed using balanced metrics and avoiding tunnel vision. Besides factoring in nutrition

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- Circularity and ecological role
- Careful when using metrics!

Prof. Wilhelm Windisch

Meat in sustainable food systems - circularity, ecological context, metrics

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Meat in sustainable food systems – circularity, ecological context, and metrics

W. Windisch
Animal Nutrition
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key statements

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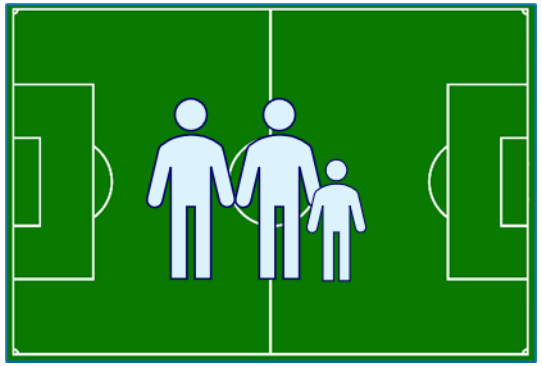
1 **Globally available arable land becomes scarce. In future, food competition by livestock feeding must terminate.**

Globally available arable land becomes scarce

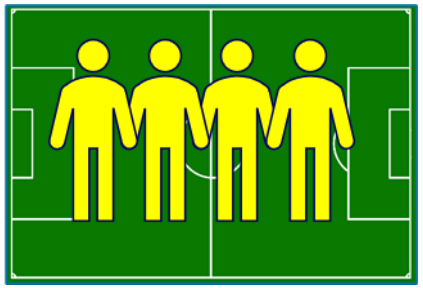
4 bn. humans



3.100m²
per human

1970

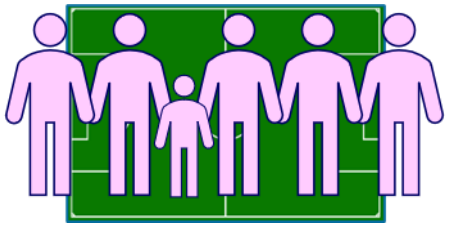
8 bn. humans



1.800m²
per human

2023

10 bn. humans



1.400m²
per human

2050

additional losses of land due to erosion, climate change, …

Turning point in livestock production: food competition by livestock must terminate

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- Currently, 1/3 of global harvest of cereals and corn is fed to agricultural livestock.
- Production of plant-based food will gain top priority.
- Food competition by livestock must terminate.

Must production and consumption of meat terminate as well?

key statements

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2 **Most of agricultural biomass is non-edible.**

Most of agricultural biomass is non-edible

Left image by Elmschrat bearbeitet von VH-Halle - Eigenes Werk, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=11032439
Right image by Simon Koopmann - Eigenes Werk, CC BY-SA 2.0 de, https://commons.wikimedia.org/w/index.php?curid=2547740

Arable land delivers large quantities of non-edible biomass

Crop rotation:
clover, alfalfa, grass, … non edible.

Co-products harvested from the fields:
Straw, leaves, … non edible.

By-products of harvest processing:
bran, pulp, DDGS, extracts, … non-edible.

Image by Elmschrat bearbeitet von VH-Halle - Eigenes Werk, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=11032439

Grassland generates non-edible biomass only

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Absolute grassland – not arable
(too steep, too stony, too cold, too dry, too wet, too far away, flooding zone, …)

Absolute grassland covers large proportions of total agricultural areas:

globally:	>70%
intensive crop regions:	30%

Grazing livestock may create open spaces with high biodiversity: replacement of lost habitats

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In nature, forests are pushed back by herds of large animals (megafauna): bovines, antelopes, equines, sheep, elephants, …
… *our megafauna has been extinguished already during stone age*

Open grasslands in African wilderness

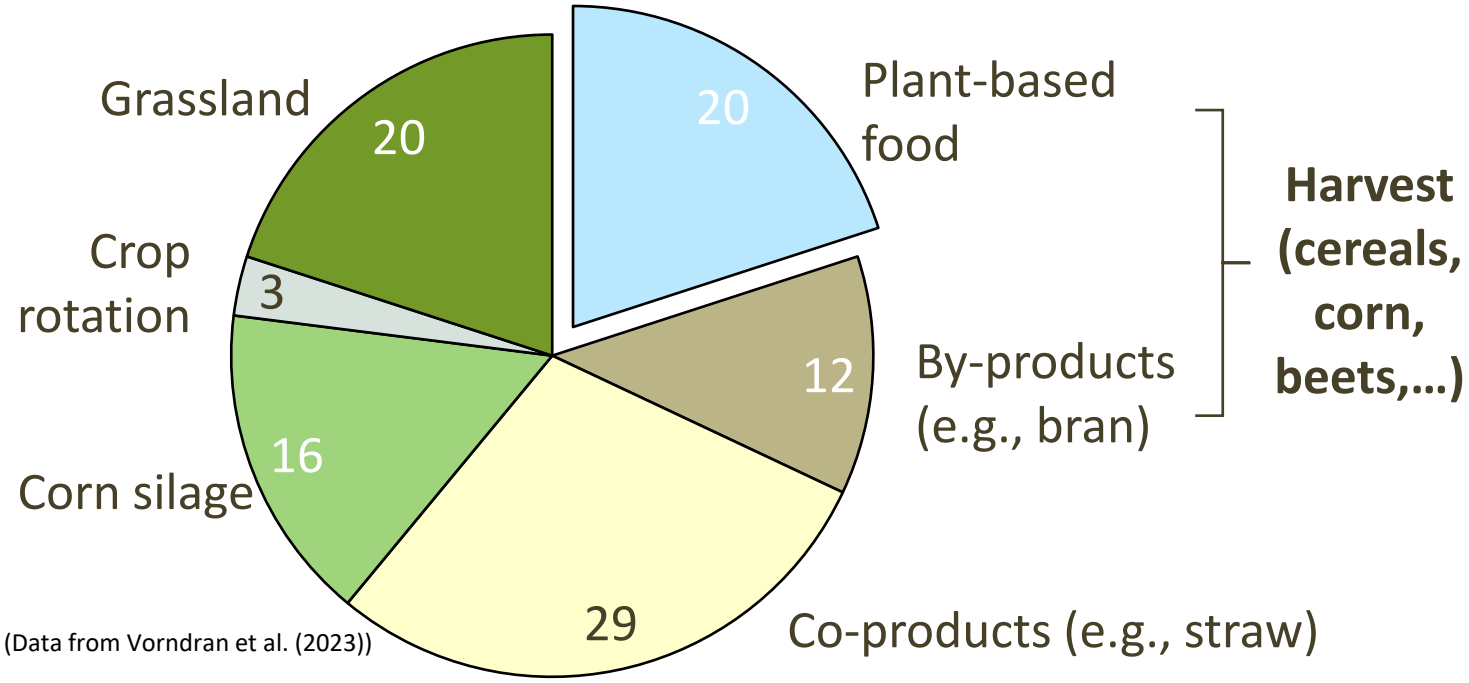
Open grasslands created by sheep in former forest/shrub areas, full of biodiversity (South Germany)

Source of left image: Pablo Manzano, own work, by curtesy
Right image by Ortrun Humpert (Schäferei Humpert) – own work, by curtesy

Most of agricultural biomass is non-edible

E.g., Germany: Distribution (%) of biomass harvested in total (120 Mio MT DM/year) (%)

(Assumption: entire harvest is used for production of vegan food)



(Data from Vorndran et al. (2023))

1kg of vegan food generates at least 3 to 5kg of non-edible biomass.

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3

Livestock may double the ‘harvest’ of food from a given area without food competition.

How to treat the non-edible biomass?

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1kg of vegan food generates at least 3 to 5kg of non-edible biomass

Plant nutrients (N, P, …) bound in non-edible biomass must return to the soils:

- **directly back to the soil (rotting):**
  uncontrolled degradation, high emissions, low fertilizing efficiency, low plant harvests.
- **fermentation to biogas (CH_4), using residues:**
  residues may be stored and applied in a targeted way, high fertilizing efficiency
  high plant harvest.
- **feeding to livestock, using dung:** win-win-situation
  dung may be stored and applied in a targeted way, high fertilizing efficiency,
  high plant harvest, …. **plus extra amounts of high-quality human food.**

High-quality food from circularity of non-edible biomass

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1kg of vegan food generates at least 3 to 5kg of non-edible biomass

e.g., bread
100g protein
3000kcal

net gain from
non-edible biomass:
½ kg meat or 3 kg milk

e.g., meat
100g protein
1500kcal

Livestock rises the yield of human food from the same limited agricultural area by at least 50%
– without food competition –

Left image by Peggy Greb, USDA ARS - This image was released by the Agricultural Research Service, the research agency of the United States Department of Agriculture, with the ID k9566-1 (next)., Gemeinfrei, https://commons.wikimedia.org/w/index.php?curid=266310
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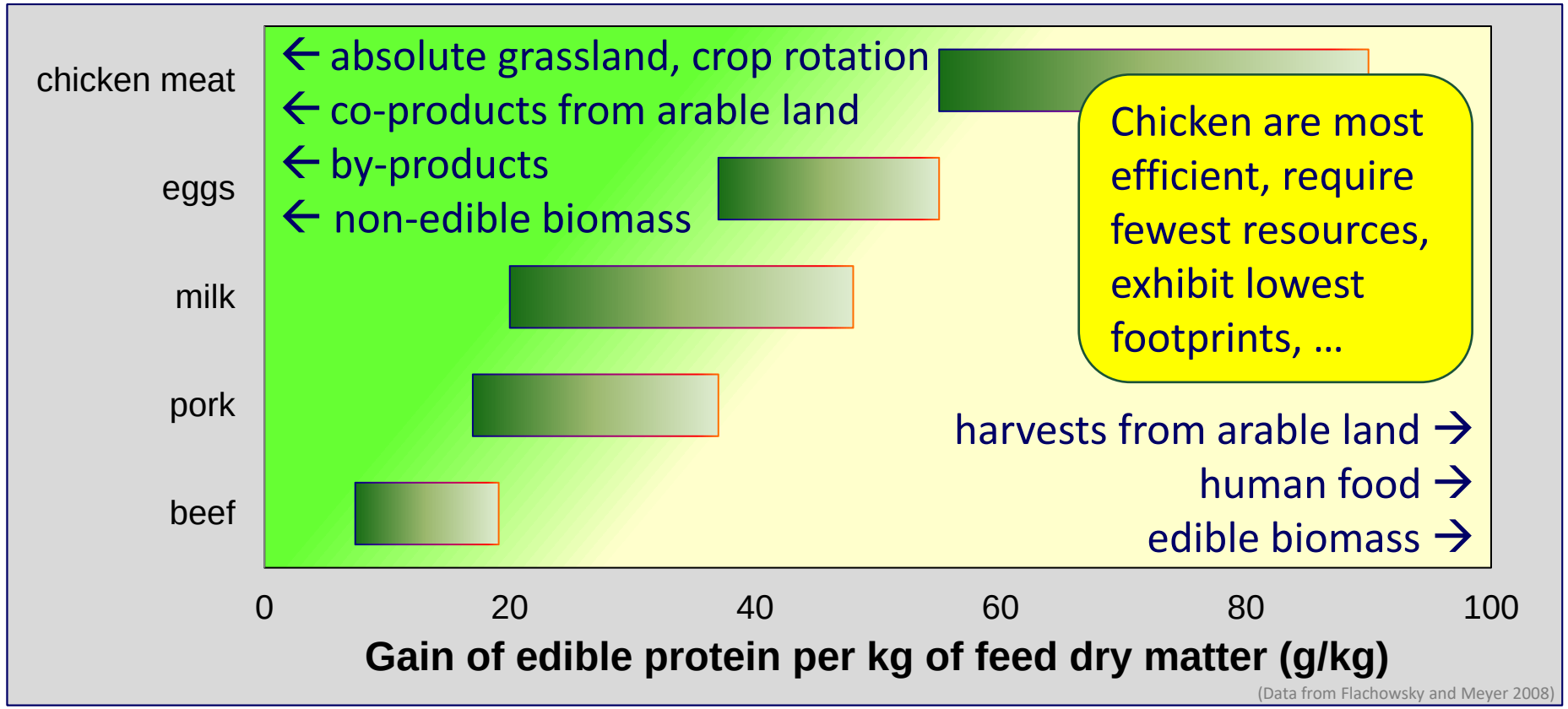
Circularity highlights the relevance of ruminants to utilize non-edible biomass.

Current feed efficiency and low footprints: chicken > swine > ruminants



At present, high feed efficiency and low footprints are realized by food competition to humans.

…

… something on its way out!

Termination of food competition highlights the future relevance of ruminants

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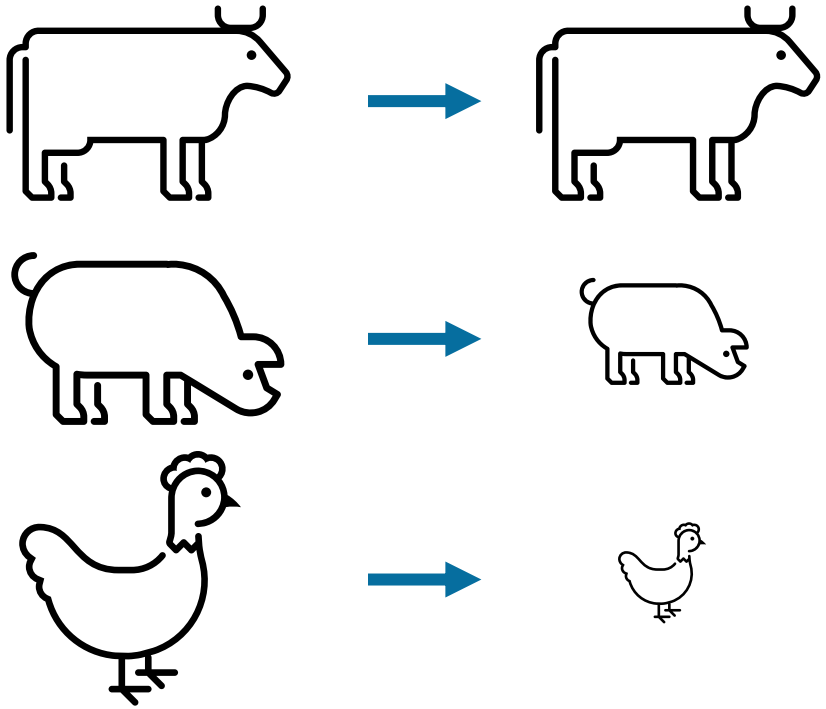
1kg of vegan food generates at least 3 to 5kg of non-edible biomass



Ruminants become fundamental pillars for conversion of non-edible biomass.

Swine will receive less valuable feedstuffs (less productivity).

Chicken feeding is limited by scarce amounts of high-quality components from non-edible biomass.

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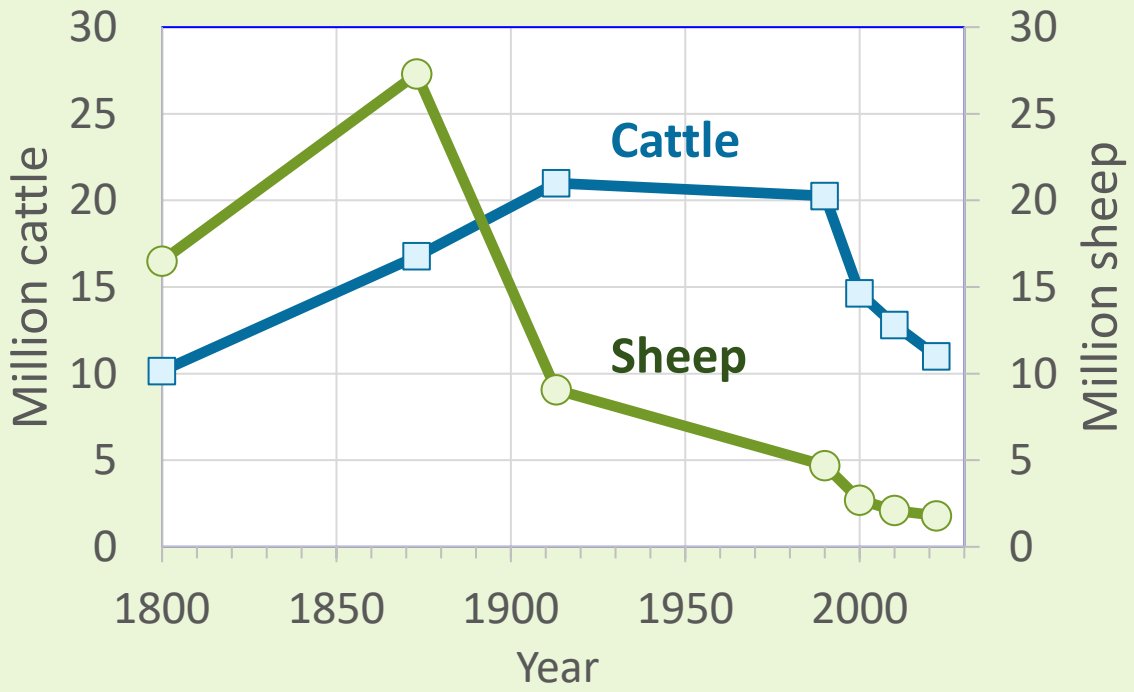
Ruminants balanced at circularity do not pose CH_4 problems on climate.

Methane homework already done?



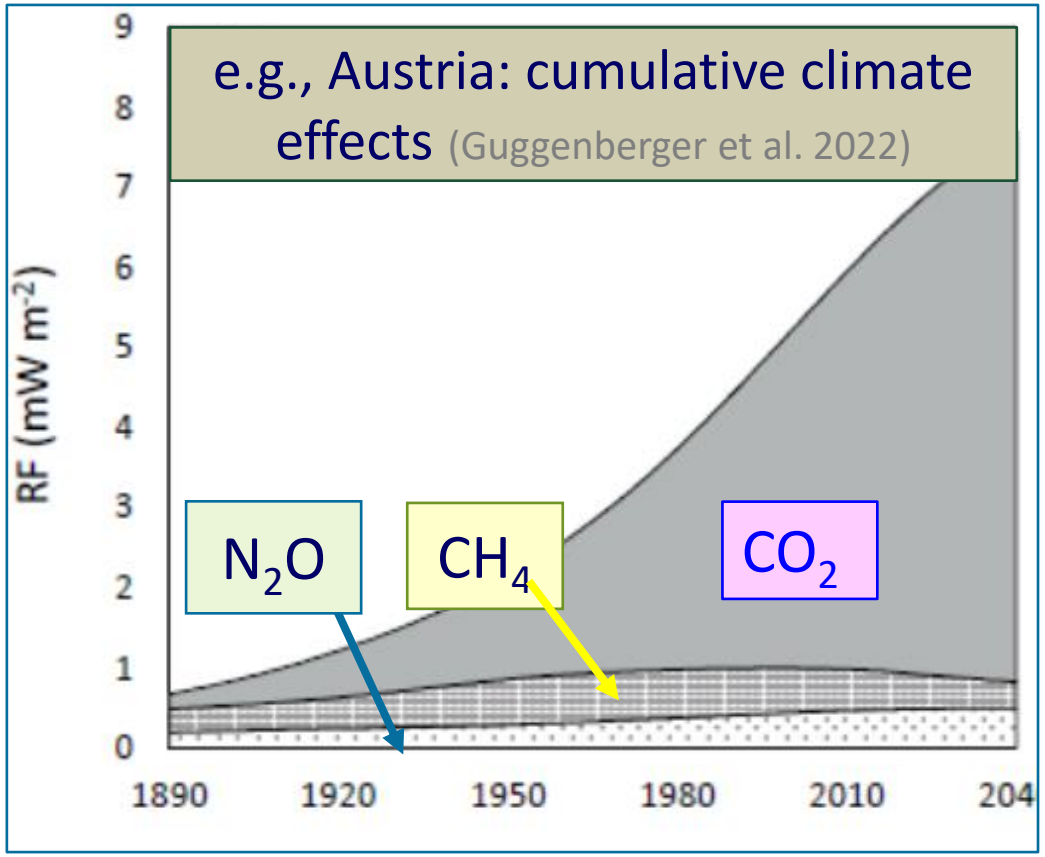
(Data from Schulze, 2014; bmel-statistik.de)

Current situation in Germany, Austria, …

- Less head counts of ruminants than in preindustrial times.
- Less CH_4 emission from ruminants than in preindustrial times (Kuhla and Viereck, 2022).

Further reductions of methane emissions are true savings above ‘climate homework’.

climate-killer-cow is a misleading narrative



CO_2 is a weak but extremely stable GHG.
It accumulates, once released from fossil sources.

CH_4 is a strong GHG but quickly degraded (exponential decay, 8 years half-life time).

At constant ruminant production, CH_4 emissions are in steady state with degradation. They do not additionally heat up the atmosphere.

Climate effects of changes in ruminant production depend on the direction of change:

→ reduction: small effect, short term
→ increase: large effect, long term

Ruminants balanced at circularity do not pose CH_4 problems

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- Standard CO_2 equivalents largely ignore the physics of atmospheric CH_4.
- Standard CO_2 equivalents severely **overestimate** the CH_4 impact of ruminants at constant production intensity, but **underestimate** it at rising intensity.
- The CH_4 climate impact of ruminant livestock is largely irrelevant, once the intensity of production remains balanced at circularity.

Standard CO_2 equivalents are legal standard, cannot be changed so far…

Possible way out: balancing (reducing) ruminant production intensity at the level of circularity, further minimizing CH_4 emissions through feeding strategies.

key statements

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6

Circularity on base of livestock minimizes the impact of total food production on environment and climate.

Feeding non-edible biomass to livestock is the most smart pathway of circularity

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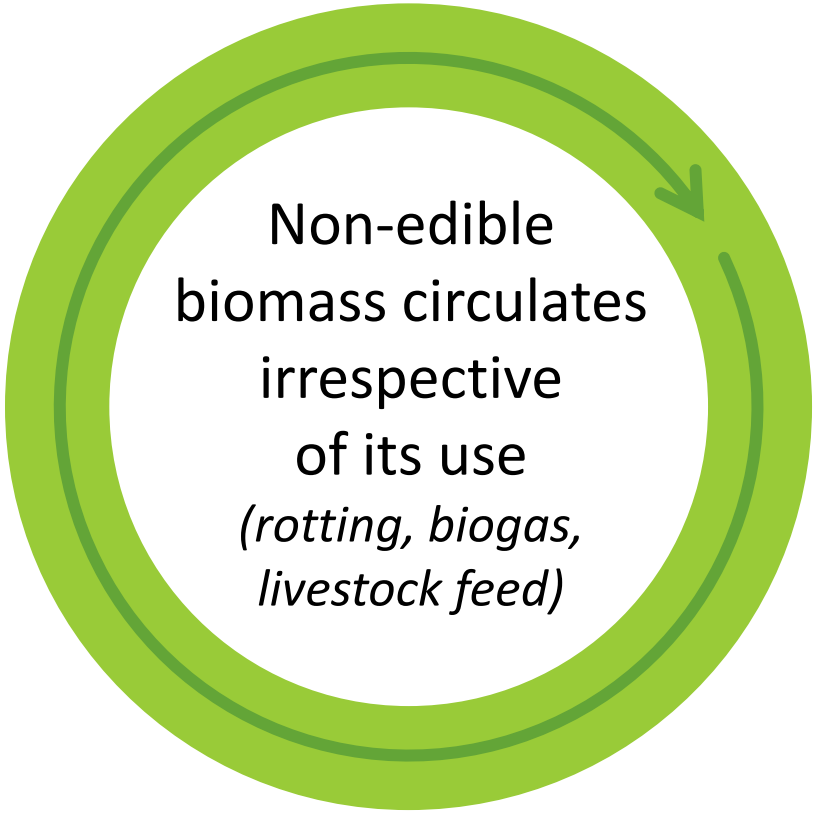
1kg of vegan food generates at least 3 to 5kg of non-edible biomass



Abstinence from feeding non-edible biomass:

- does not relief environment or climate
  (most of emissions occurre already during production of vegan food, ruminant CH_4 is largely irrelevant)
- destroys food delivered „for free“.
- intensifies vegan production
  → rising consumption of resources (e.g. land).
  → rising emissions per unit of nutrients.

The minimum impact is achieved <u>with</u> livestock

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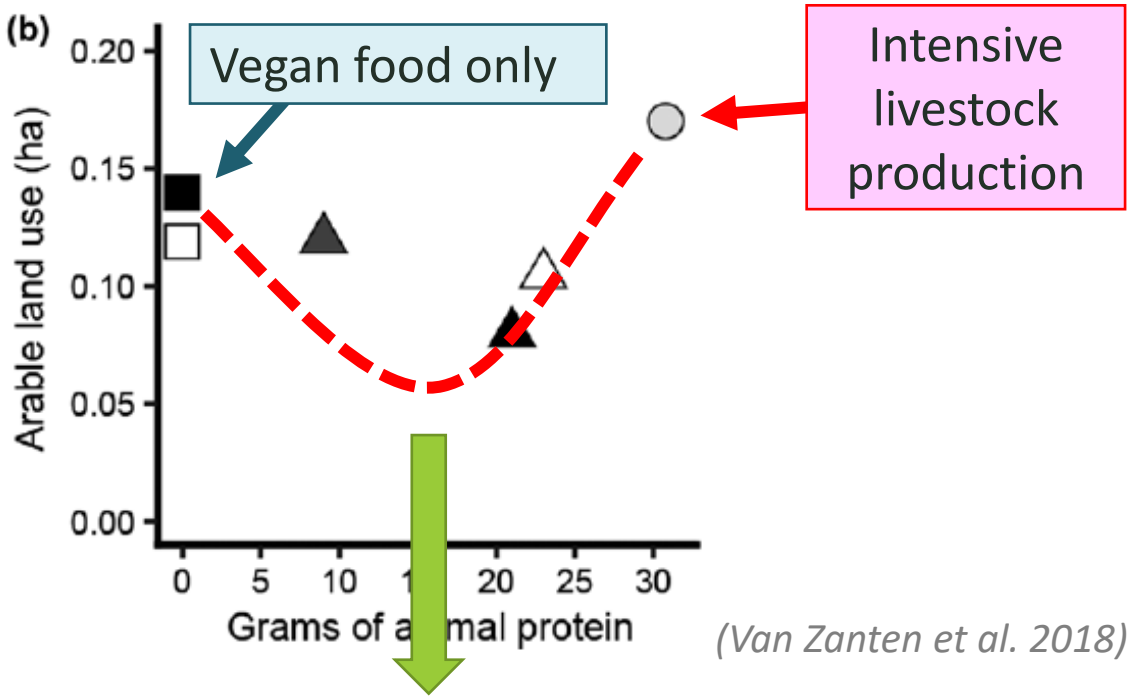
1kg of vegan food generates at least 3 to 5kg of non-edible biomass



(Van Zanten et al. 2018)

Circularity = minimum impact

- Current livestock production is out of balance.
- ‘Vegan agriculture’ would be out of balance, too.
- Circularity with livestock denotes the minimum impact of total food production (vegan + animal) from a given area of land.

key statements

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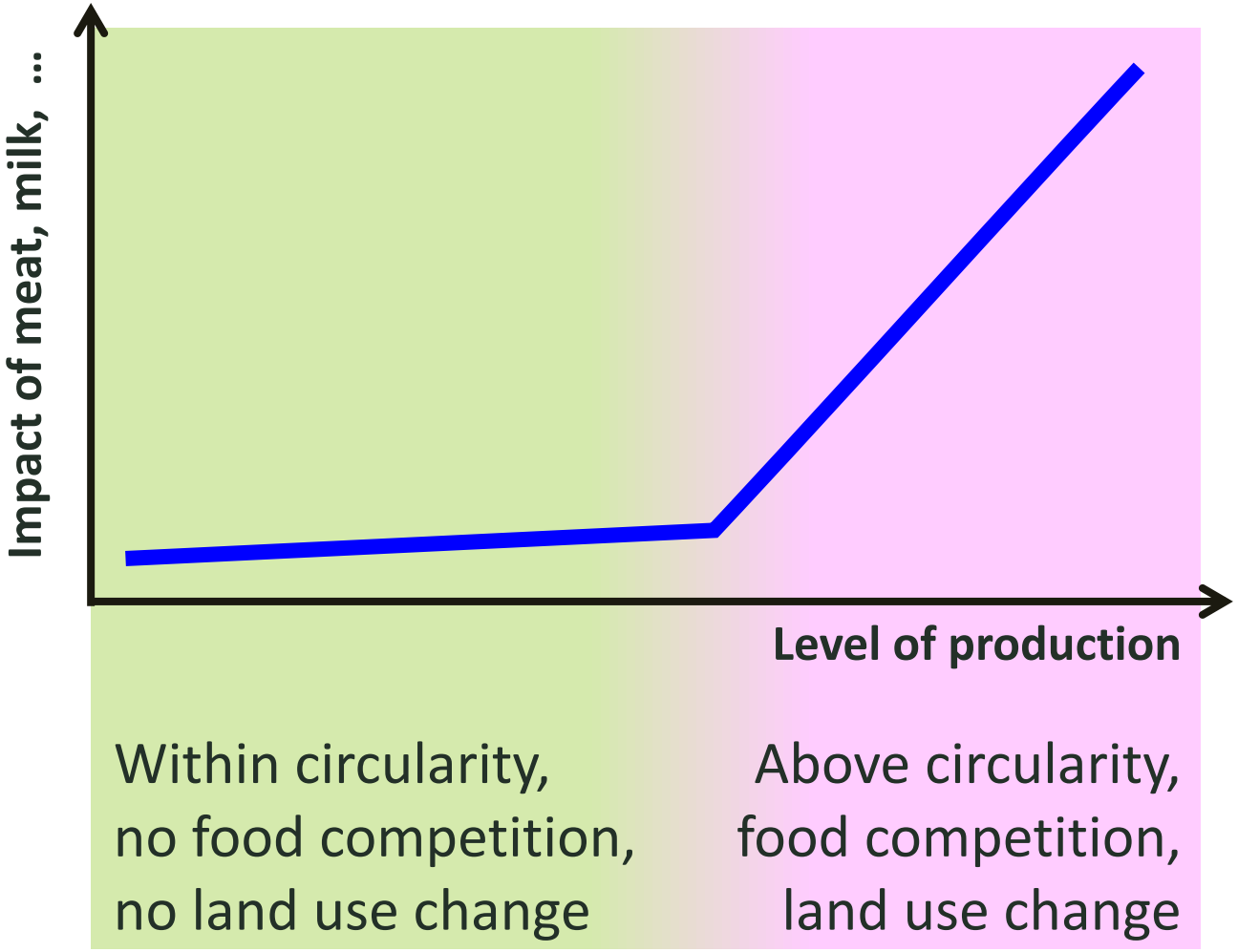
7

Footprints of meat, milk, eggs exhibit two levels:

- **low footprints at circularity**
- **high footprints above circularity**

Footprints of meat, milk, eggs exhibit two levels



- Low footprints at circularity, high footprints above circularity.
- Universal footprints are misleading.

key statements - overview

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1-7

Food competition by livestock must terminate.

Livestock in balance with circularity of non-edible biomass minimizes footprints of overall food production …

… but limits also production of meat, milk,…

Shifting livestock production towards circularity is a change in paradigm

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- reduced quantity of feed
- reduced quality of feed
- less animal head counts
- less emissions

} less beef, less milk, significantly less pork, severe drop in chicken meat and egg production

- The non-edible biomass becomes the limiting factor of livestock production.
- The feed efficiency of non-edible biomass must be maximized (low input – high output).
- Less emissions and less meat, milk, eggs, …are resulting from circularity (not vice versa).

Conclusion

There is no sustainable agriculture without livestock.

Meat production in balance with circularity supports environment and climate.