Technische Universität München

The myth of animal feed being unsustainable

W. Windisch
Chair of Animal Nutrition
TUM School of Life Sciences
Technical University of Munich

The myth of animal feed being unsustainable

Technische Universität München

The role of livestock in utilizing agricultural biomass

Trade off between emissions, efficiency, and food competition

Where to go?

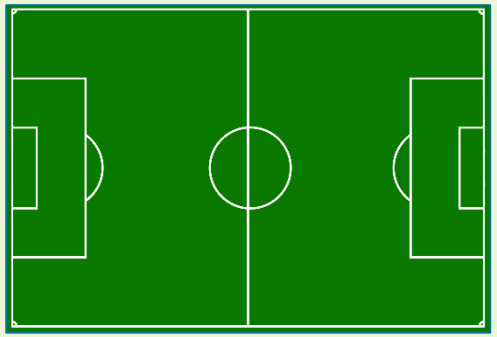
The availability of agricultural area is severely shrinking

Technische Universität München

Globally available agricultural area (m²/person)

Year 1970	3800
Year 2020	2400
Year 2050	1500

(Germany, now ca. 2300 m²/person)



How many persons must feed a soccer ground (7400m²) per year

now	3 persons
by year 2050	> 5 persons

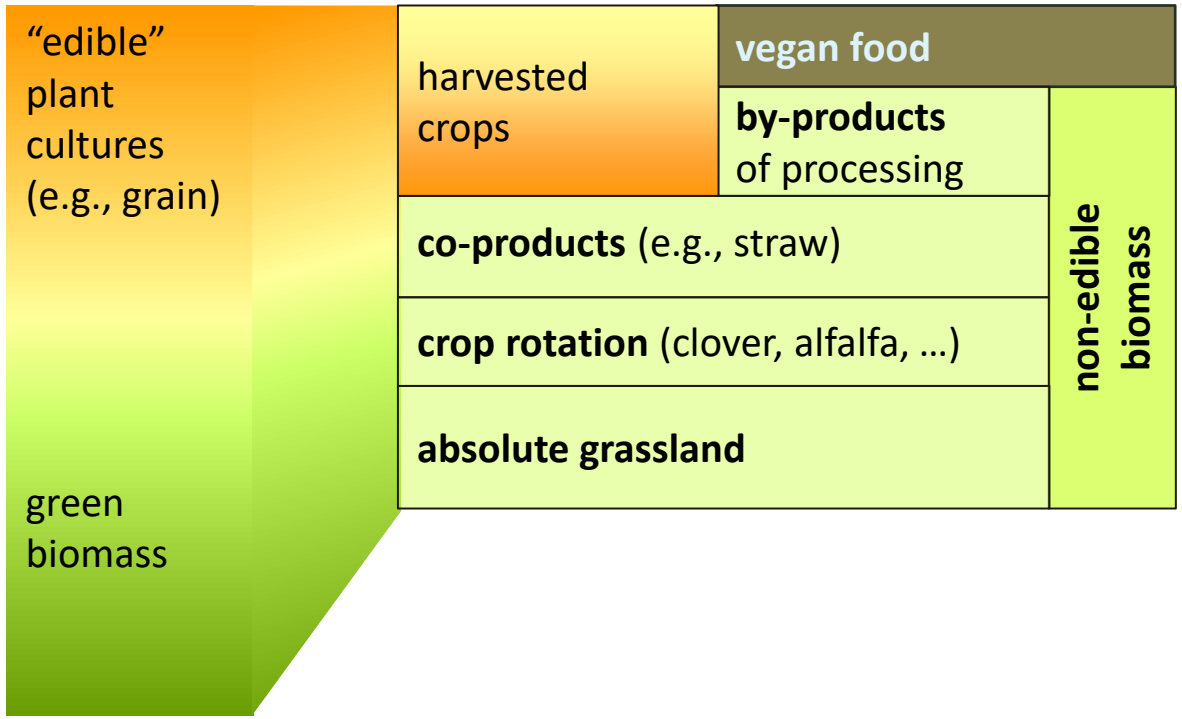
Von Simon Koopmann - Eigenes Werk, CC BY-SA 2.0 de, https://commons.wikimedia.org/w/index.php?curid=2547740

How much of visible biomass is **edible** at all?

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

Agriculture produces biomass, that is **non-edible** for the most part

Agriculture produces mainly **non-edible** biomass



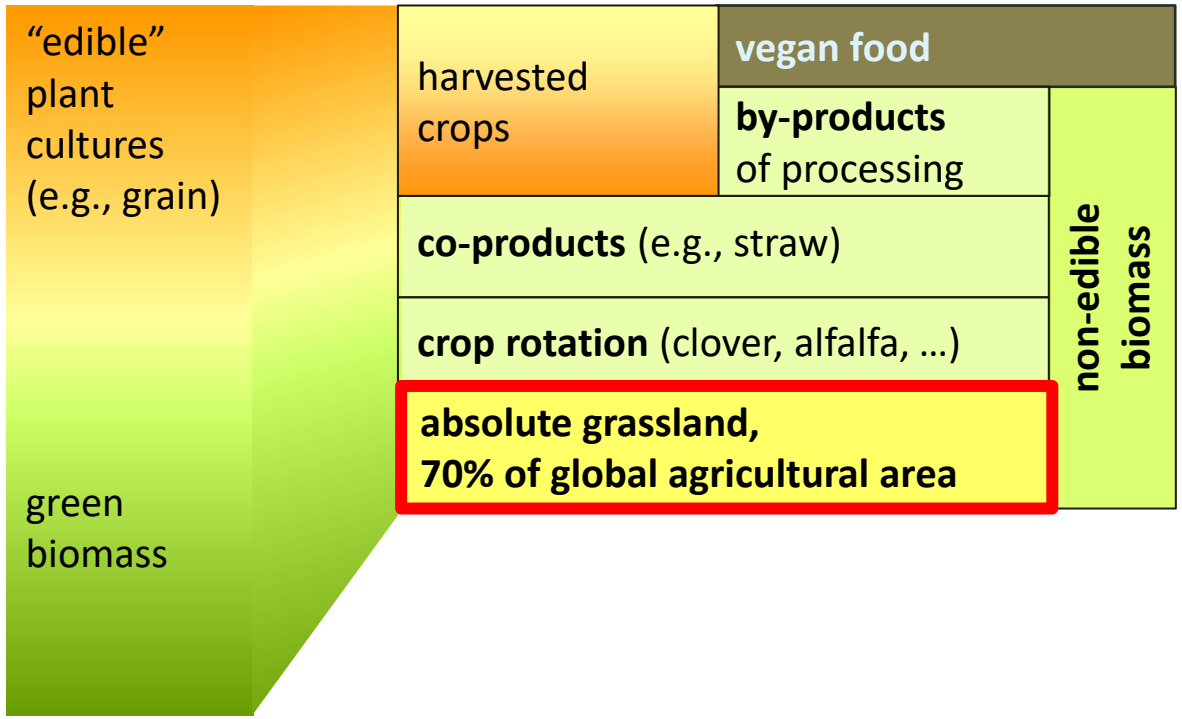
Absolute grasslands cannot be converted into arable land producing vegan food because of

- climate (too humid/dry, short vegetation period, …)
- topography (too steep, periodically flooded, …)
- conversion would release dramatic amounts of CO_2

Absolute grassland covers major proportions of total agricultural areas, e.g.,

>70%	global agricultural area
40 – 70%	Alpine regions
ca. 30%	Central European areas with intensive plant production

Make responsible use of grassland!

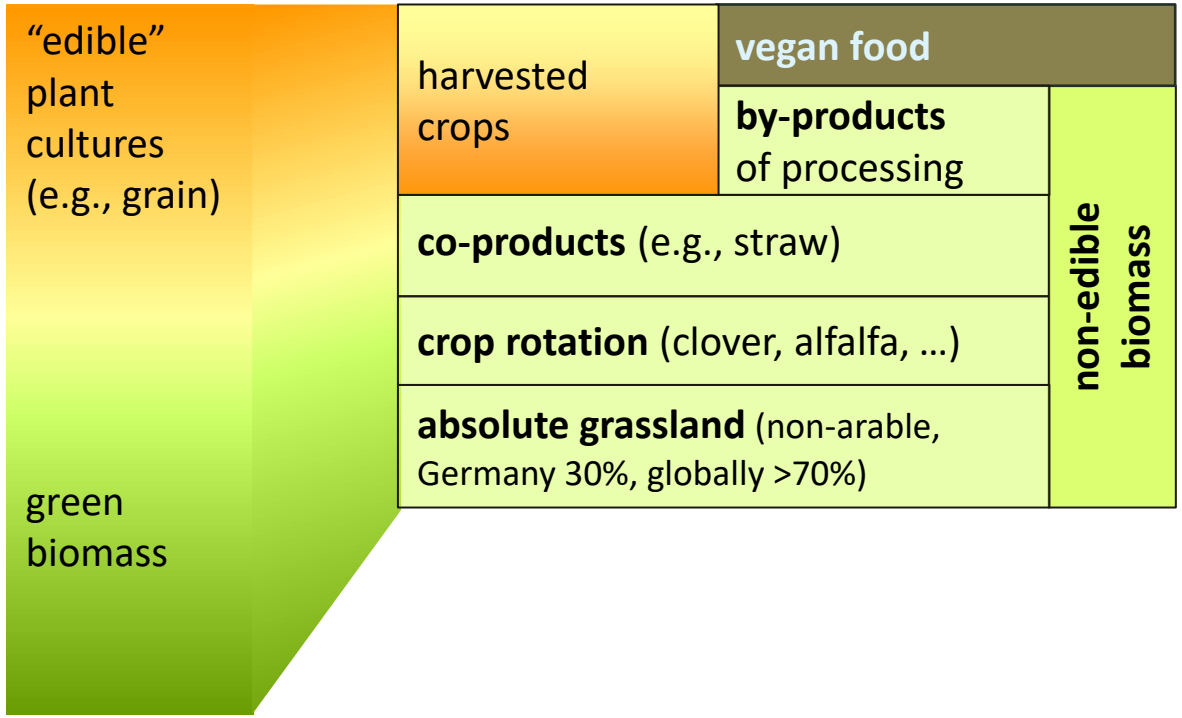


On a global scale,
only the penalty area is arable land!

Penalty area (arable land):
production of vegan food comes first!

Play ground (absolute grassland):
make best use of non-edible biomass!

Agriculture produces mainly **non-edible** biomass

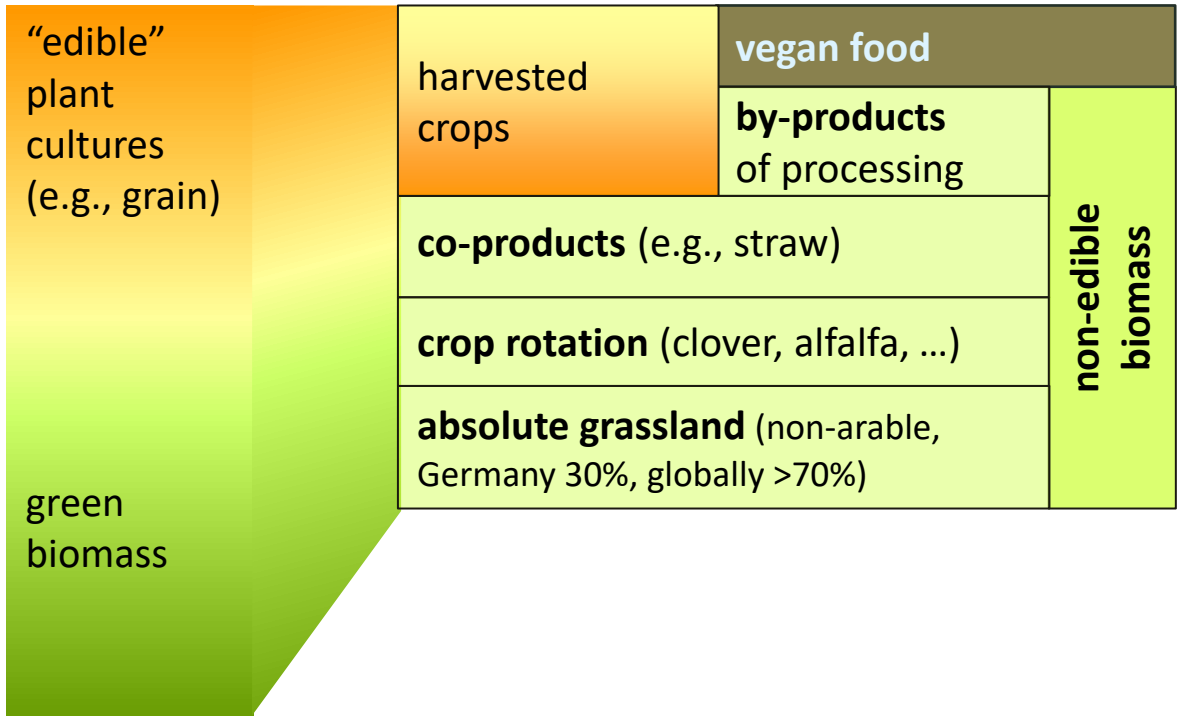


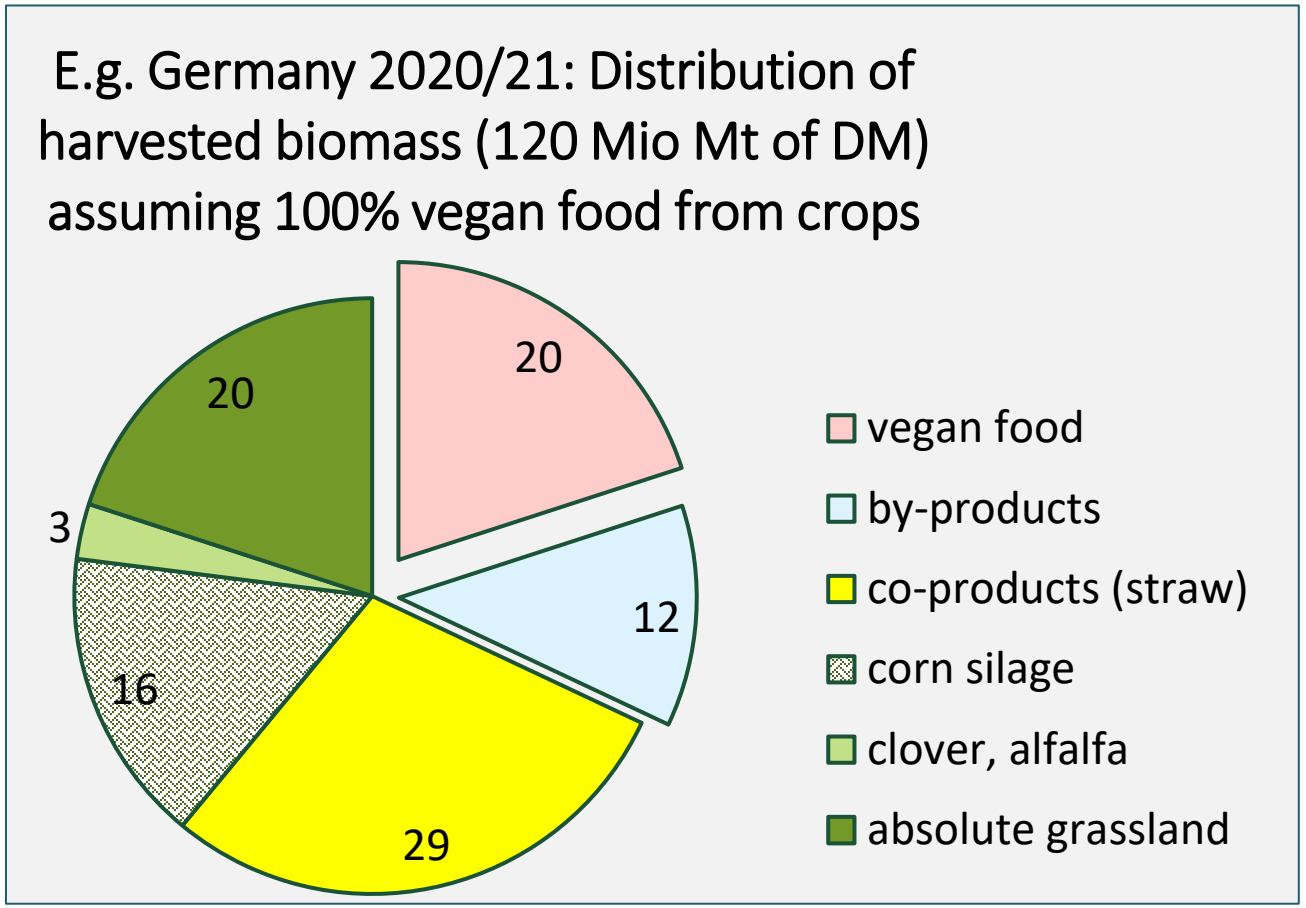
Technology	Proportion of inevitably occurring by-products (% of dry matter input)
Milling cereals	20-30
Starch production	25-30
Sugar production	45
Oil production	55 – 60
Alcohol production (brewery, bioethanol), (1/3 of biomass is lost as CO_2 along with fermentation)	25-35

Agriculture produces mainly **non-edible** biomass

Technische Universität München

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

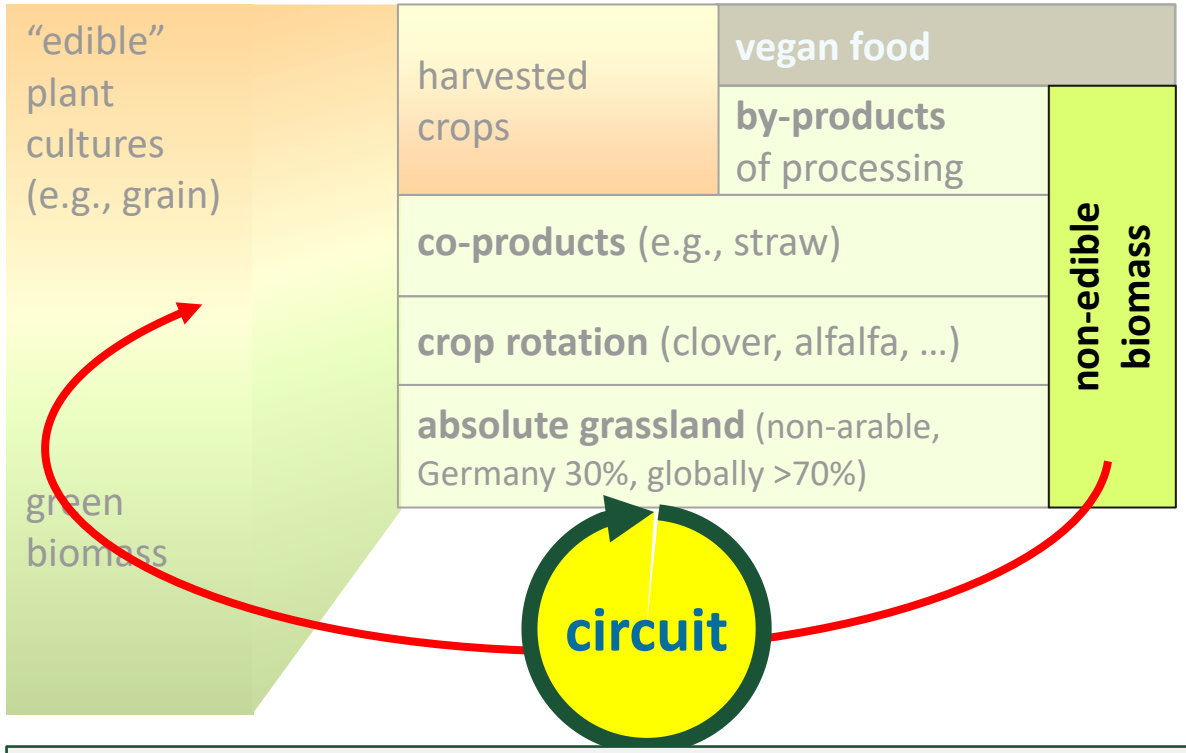




Agriculture produces mainly **non-edible** biomass

Technische Universität München

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



Strategies to recycle plant nutrients:

- **directly back to the soil ("vegan agriculture"):** inefficient, high emissions.
- **fermentation to biogas (CH_4):** biogas residuals are storable fertilizers; it may be applied precisely according to the plant's need.
- **feeding to livestock:** livestock dung is a storable fertilizer; it may be applied precisely according to the plant's need.

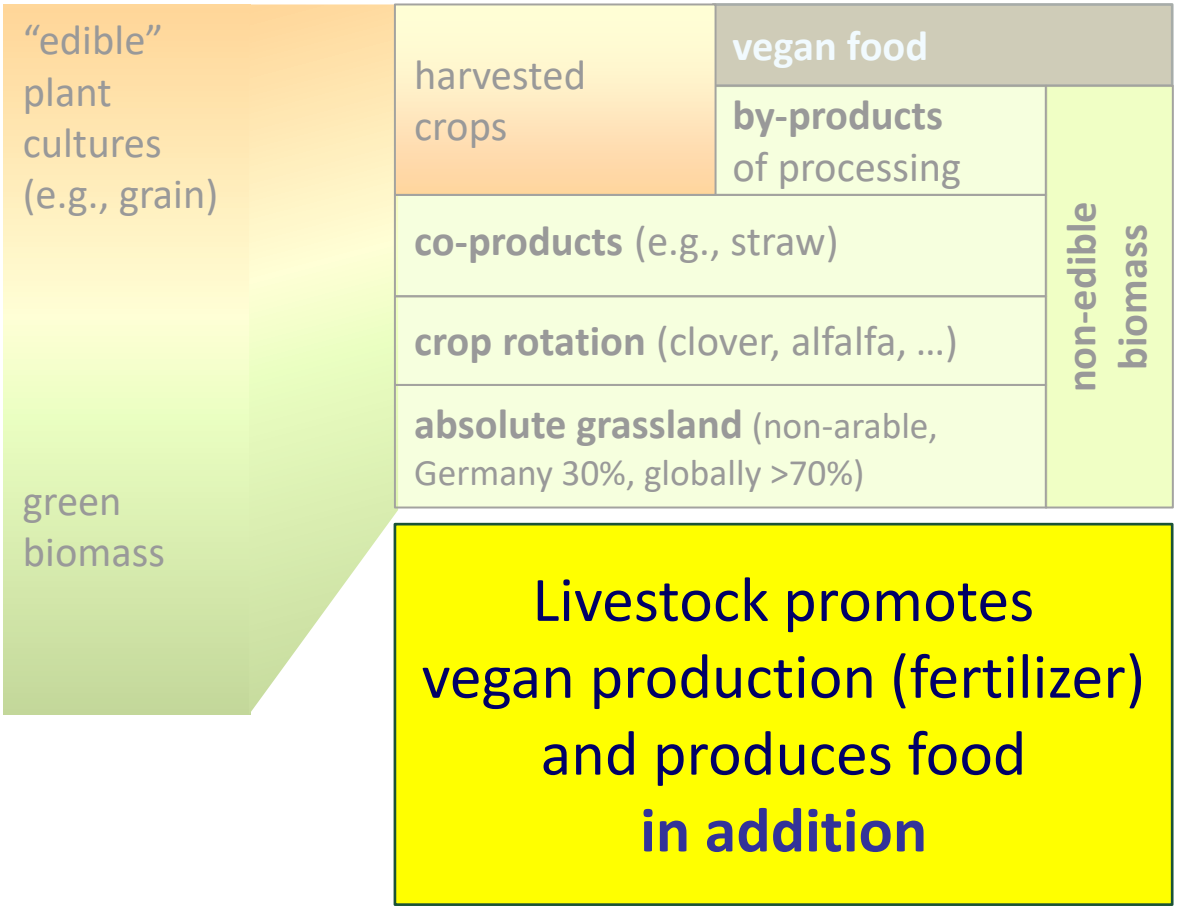
Non-edible biomass contains large amounts of plant nutrients (N, P, …)

(¾ of P withdrawal along with cereal harvest ends up in bran; 100% of P an N withdrawal along with oil seed harvest ends up in extracts)

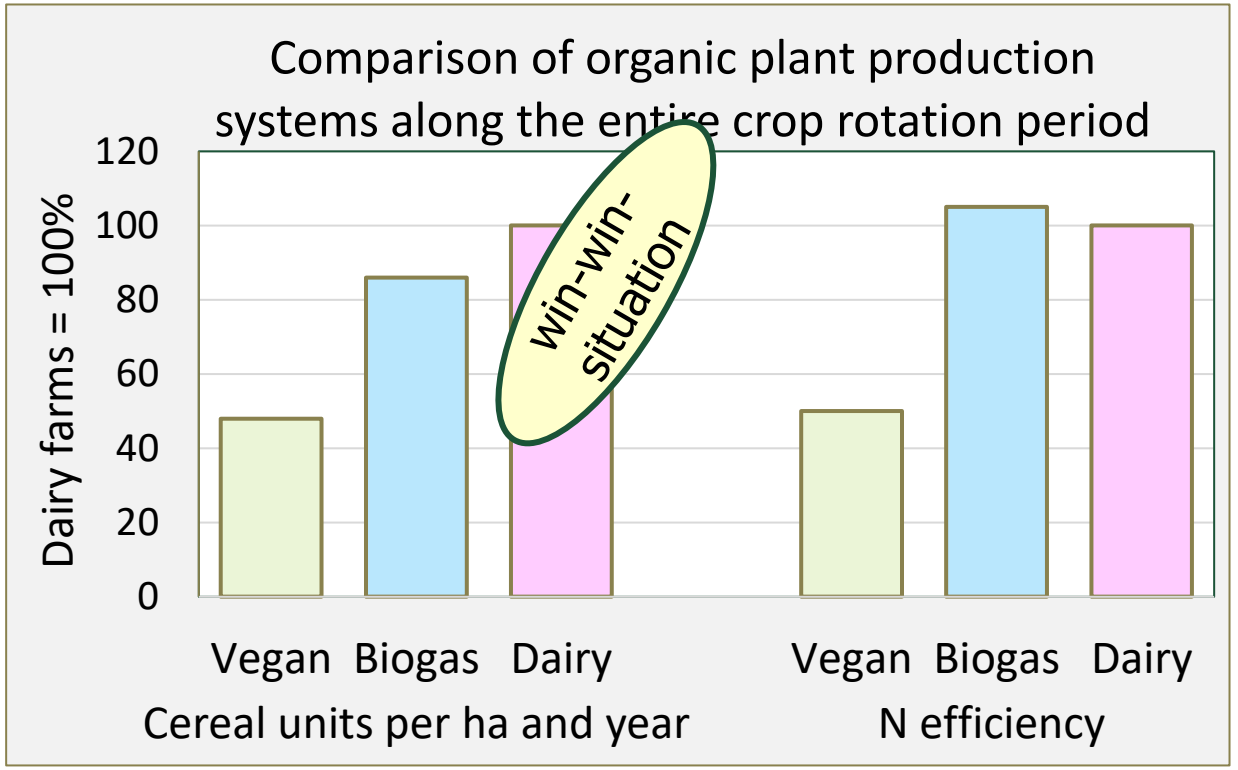
Agriculture produces mainly **non-edible** biomass

Technische Universität München

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



Livestock promotes vegan production (fertilizer) and produces food **in addition**

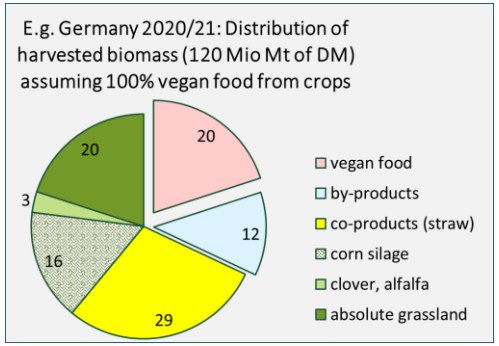


Bryzinski (2020); https://hypel.ink/bryzinski; ISBN: 979-8574395912

Feeding inevitably occurring, non-edible biomass to livestock adds up significant amounts of extra food

Technische Universität München

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



Net gain of food from 4kg of non-edible biomass (corrected for feed required to maintain animal herds):

- grassland and co-products fed to ruminants:
  min. 3kg milk
  min. 0.4kg meat
- By-products fed to pigs, poultry:
  min. 0.4 kg meat

Added value:
1000 to 2000 kilocalories,
100g high-quality protein

Livestock delivers high-quality food protein and kilocalories from a given agricultural area equivalent to

50 to 100% of primary vegan food

without food competition, solely from circulation of inevitably occurring, non-edible biomass,

simultaneously delivering **fertilizers promoting vegan food production**.

The myth of animal feed being unsustainable

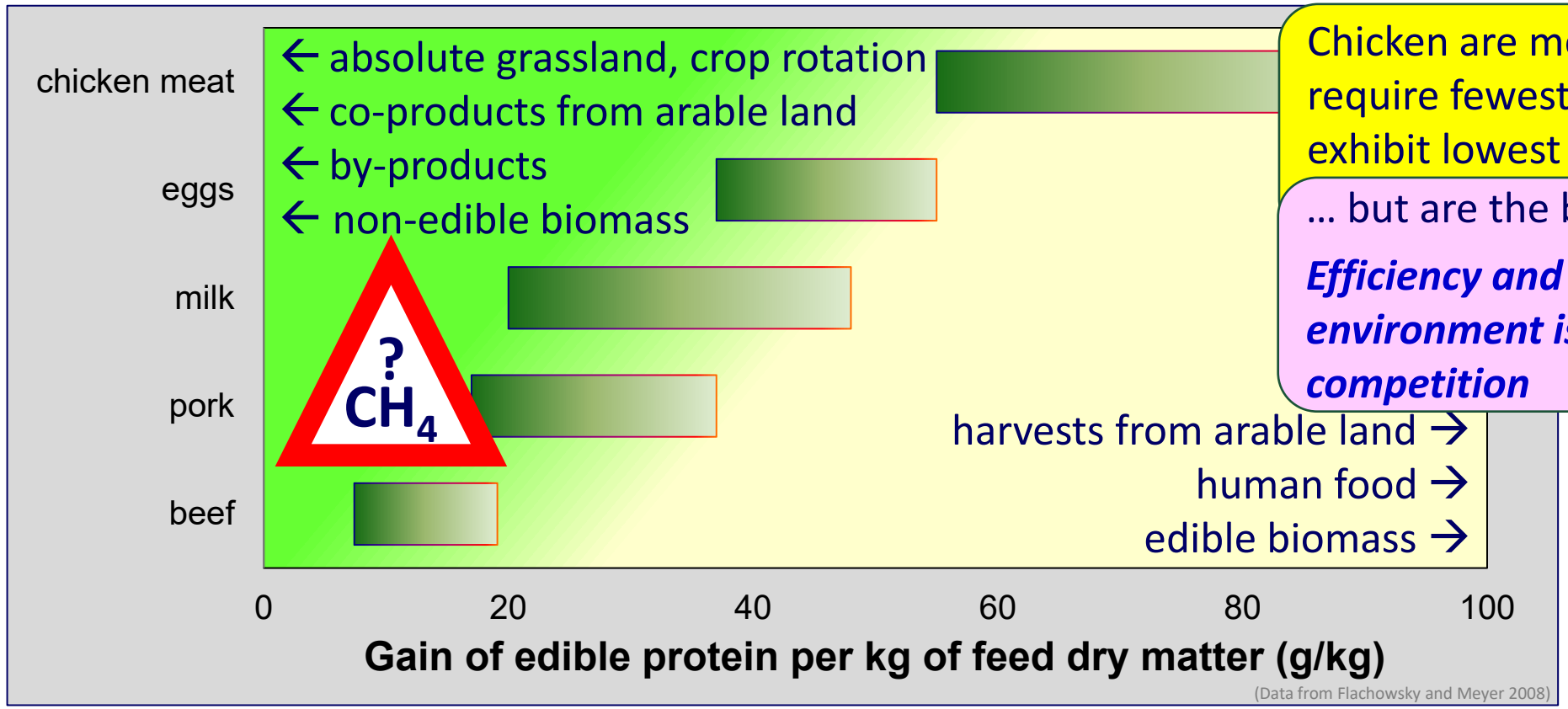
Technische Universität München

The role of livestock in utilizing agricultural biomass

Trade off between emissions, efficiency, and food competition

Where to go?

Trade off between emissions, efficiency, and **food competition**



Chicken are most efficient, require fewest resources, exhibit lowest footprints,

… but are the biggest food competitors.

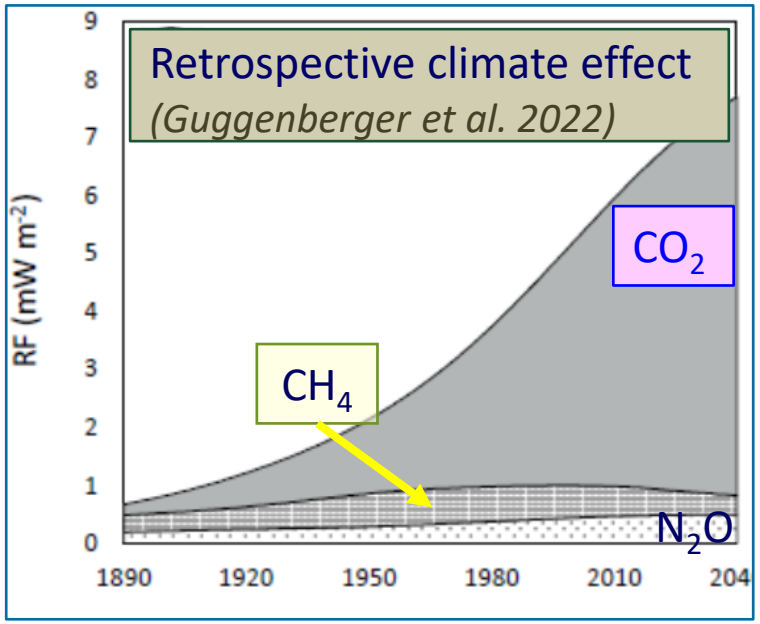
Efficiency and protection of climate and environment is bought mainly by food competition

Feeding ruminants just seems to be inefficient and "dirty". At absence of food competition, however, it is the most efficient way to make use of it.

'Climate killer cow' is a misleading narrative

Technische Universität München

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



Rumen CH_4 formation is biologically essential.
Germany: Current ruminant head counts and their CH_4 emissions already fell below the pre-industrial level (Kuhla et al. 2022)

CH_4 is a strong greenhouse gas (84xCO2) but is quickly degraded (t½ 8 a).
At constant head counts, ruminants do not increase atmospheric CH_4 concentration and hence do not additionally heat up the atmosphere.

CO_2 is extremely stable and accumulates in the atmosphere. Once emitted from fossil energy sources, CO_2 does not stop heating up the atmosphere.

→ Actions against CH_4 emissions from ruminant livestock don't exhibit lasting effects.
→ Stop of fossil energy use, building up CO_2 sinks = grassland, clover/alfalfa, agroforest, …
→ Maintaining ruminant production at minimized CH_4 burdens.

Feeding livestock in harmony with circularity supports environment and climate protection (1)

Technische Universität München

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

Abstinence from feeding to livestock

→ does not relieve the environment or climate.

→ destroys food delivered from livestock „for free“.

→ forces doubling of “vegan” harvest on limited arable land = severe rise in emissions per unit of nutrients.

- Non-edible biomass inevitably undergoes circulation.
- Carbon, nitrogen, phosphorus, etc. will be released **irrespective** of the pathway of circulation *(e.g. rotting, biogas, livestock feed)*

The impact of livestock feeding on environment and climate has two steps:

1. **Feeding within circularity:** fully sustainable, but limited production capacity.
2. **Feeding through food competition:** burden to environment and climate, but highly productive.

Feeding livestock in harmony with circularity supports environment and climate protection (1)

Technische Universität München

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

Received: 18 December 2018 | Revised: 2 April 2018 | Accepted: 30 April 2018
DOI: 10.1111/gcb.14321

RESEARCH REVIEW

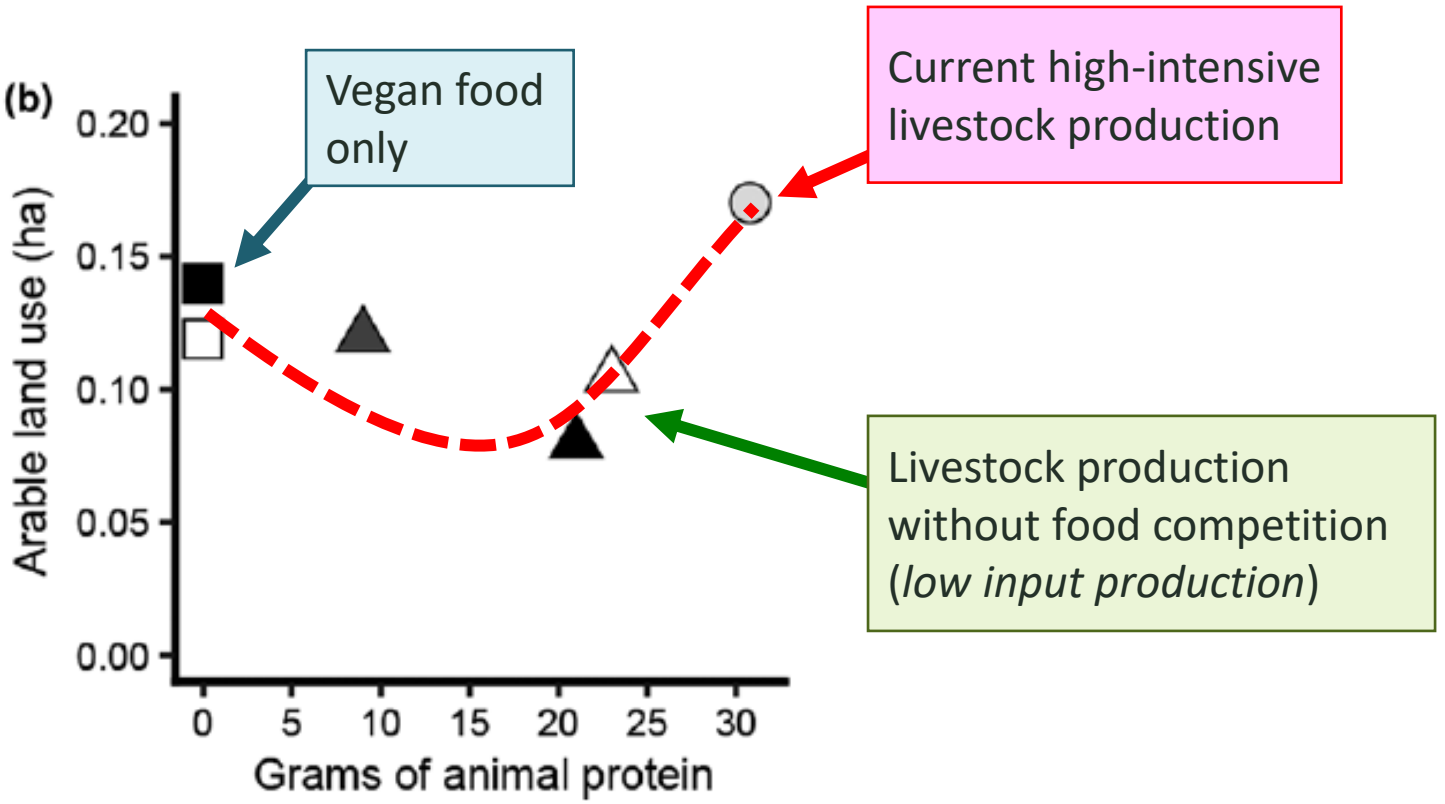
WILEY Global Change Biology

Defining a land boundary for sustainable livestock consumption

Hannah H. E. Van Zanten[1] | Mario Herrero[2] | Ollie Van Hal[1] | Elin Röös[3] | Adrian Muller[4,5] | Tara Garnett[6] | Pierre J. Gerber[1,7] | Christian Schader[4] | Imke J. M. De Boer[1]

Current high-intensive livestock production causes high footprints and emissions, but also purely vegan agriculture.

The minimum impact on environment and climate is reached only **with** livestock.



The myth of animal feed being unsustainable

Technische Universität München

The role of livestock in utilizing agricultural biomass

Trade off between emissions, efficiency, and food competition

Where to go?

Maximizing feed efficiency: *low input – high output*

Technische Universität München

- Don‘t spoil feed
  - Maximize feed quality by proper harvest and preservation
  - Innovations in process technology, cascade principle, circular economy
- Precise livestock feeding (neither deficiency nor excess of nutrients)
- Supporting digestive capacity (feed additives, proper ruminant feed composition)
- Minimizing „unproductive“ feed consumption of entire livestock systems
  - Animal health and animal welfare
  - Efficient generation of robust offspring
  - Undisturbed production cycles, longevity
  - Adaptation of breeding targets to feed with limited quality (e.g., level of performance)
- Plant breeding to improve feed quality (e.g., less lignocellulose, toxins, …)

The myth of animal feed being unsustainable
Take home messages

Technische Universität München

Don’t spoil biomass, neither edible nor non-edible. The priority is FOOD > FEED > ENERGY.

- Maximize gain of edible “vegan” biomass from primary production until processing.
- Maximize transformation of residual non-edible biomass into human food by livestock (low input → high output).

The impact of livestock on environment and climate exhibits two steps:

I. Basal production in harmony with circularity protects environment and climate.
II. Production on top of circularity may stress environment and climate.

However, the societal demand for animal derived food exceeds basal production capacity.

The challenge: finding the acceptable balance between plant and livestock production.

The myth of animal feed being unsustainable
Outlook

Technische Universität München

change in paradigm:

- Move from the concept of linear production into ***circular economy***.
- Livestock (particularly ruminants) is an essential component of circular economy.
- Circular economy includes farms, food processing, and food trading.
- Circular economy works at least on a regional scale.
- Success of regional circular economy depends on local differentiation; overall restrictions (e.g., livestock head counts) confuse cause and effect.