



เศรษฐศาสตร์เกษตร
และทรัพยากร
มหาวิทยาลัยเกษตรศาสตร์

Livestock Sustainability

Livestock sector affects at least 58% (10 out of the 17) of the SDG goals and 16% (28 out of the 169) of the SDG targets (Mehrabi et al., 2020)



Goal 2

- “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”

Goal 3

- “ensure healthy lives and promote well-being for all at all ages”

Goal 8

- “promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”

Goal 11

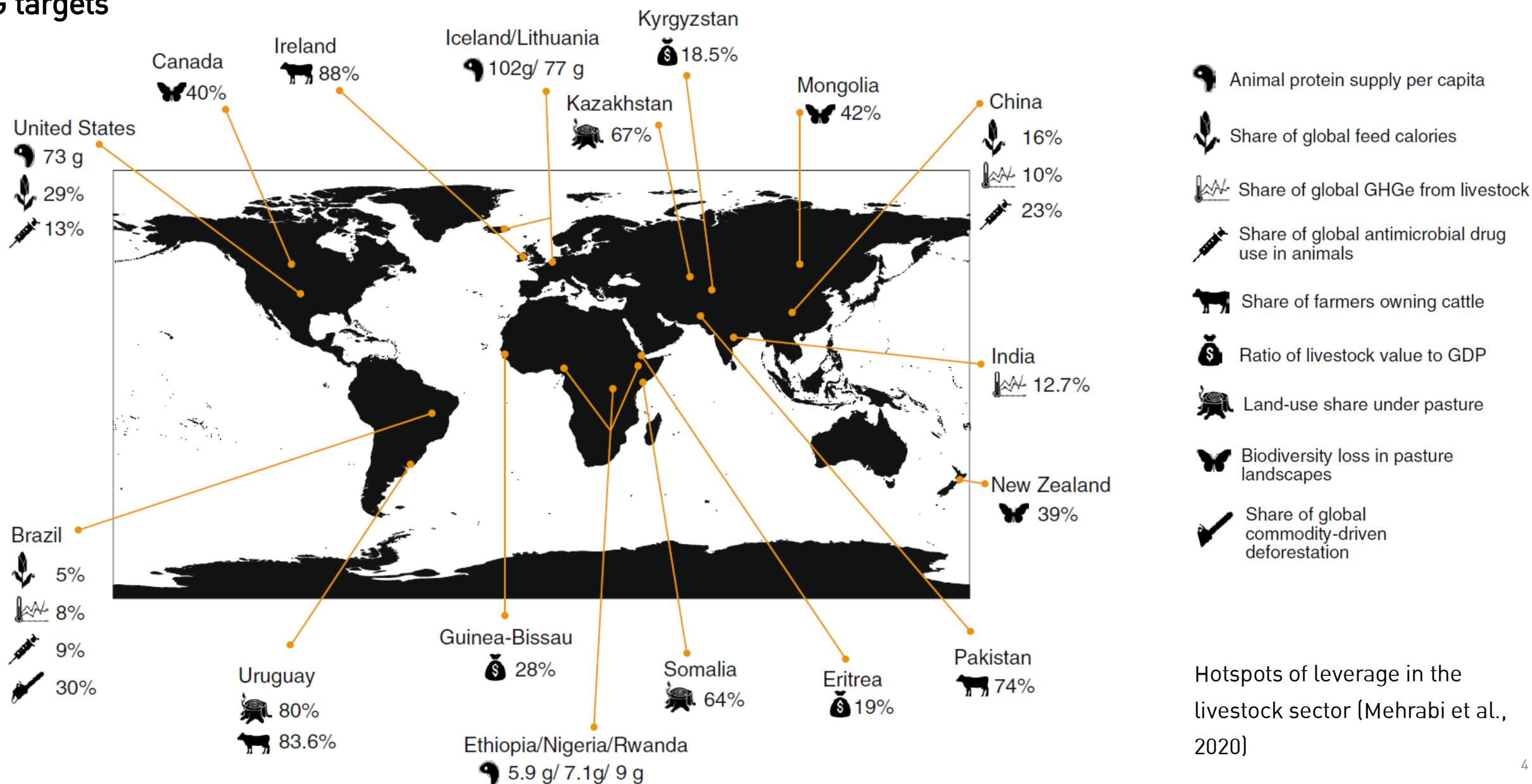
- “make cities and human settlements inclusive, safe, resilient and sustainable”

Goal 12

- “responsible consumption and production”

- Livestock products provide a vital means to improve malnutrition and stunting in the poor.
- The large health care is costly.
- Livestock sector boosts the economic growth
- The livestock sector contributes disproportionately to GHG emissions, thus contributing to extreme events such as heat waves that harm dense human populations
- Excessive overconsumption leads to negative health outcomes that contribute to the double burden of malnutrition

Top ranking nations for nine different environmental and social metrics are shown as a mechanism for identifying how interventions in the livestock sector may differentially influence SDG targets



Hotspots of leverage in the livestock sector (Mehrabi et al., 2020)

Interventions in the livestock sector for sustainable development

Objective	Mechanism	Examples
Reduce consumption	Meat tax	Denmark (proposed) ⁶⁹
Reduce consumption	Revised national dietary guidelines	Canada ⁷⁰
Increase consumption	School meal programmes	Sub-Saharan Africa, Latin America and Asia ⁷¹
Reduce GHGe	Carbon-neutral red meat	Australia (proposed) ⁷²
Reduce GHGe	Adoption of technologies to reduce enteric methane intensity	South America, West Africa, East Africa, South Asia ⁷³
Reduce GHGe	Methane capture and abatement	Mexico and more than forty other countries ⁷⁴
Reduce waste and pollution	National plans for circular livestock supply chains	The Netherlands ⁷⁵
Increase productivity and livelihoods	Sustainable intensification of dairy production	Tanzania, Uganda, Rwanda and, Kenya ⁷⁶
Reduce fertilizer pollution	Regulate use and monitor impacts (for acidification, eutrophication, climate)	European Nitrates Directive ⁷⁷

Objective	Mechanism	Examples
Reduce antibiotics	Limit non-therapeutic use and monitor.	European Union ⁵⁴
Facilitate sustainable consumption and production	Market signalling. Supply-chain traceability and carbon accounting for beef and feed exports, certification schemes for farmer adoption of improved management practices.	Uruguay (carbon traceability) ⁷⁸ , Canada, United States, Australia, Europe, Latin America (Organic Certification); Canada (Certified Sustainable Beef Framework) ⁷⁹ .
Improve communication and policy coherence	Facilitate dialogue between the public, private bodies, industry, academia and NGOs	Global Agenda for Sustainable Livestock ⁸⁰
Create industry standards for sustainability	Multistakeholder platform for implementation and monitoring of sustainable beef production	Global Roundtable on Sustainable Beef (https://grsbeef.org)

(Mehrabi et al., 2020)

Livestock are important for smaller farms with lower income levels

Source: The State of Food and Agriculture: Livestock in Balance (FAO, 2009); [https://doi.org/10.1016/S0140-6736\(75\)92740-3](https://doi.org/10.1016/S0140-6736(75)92740-3)



COP28 climate talks agree on
transitioning away from fossil fuels

COP
UAE 28

30 Nov - 12 Dec 2023





The background of the slide features a large, light blue, stylized leaf or petal shape that curves around the central text. A solid yellow vertical bar is positioned on the left side of the slide, partially overlapping the blue shape.

Increasing the efficiency of
livestock supply chains
is key to limiting the growth of
GHG emissions in the future.

Source: <https://www.worldbank.org/en/topic/agriculture/brief/moving-towards-sustainability-the-livestock-sector-and-the-world-bank>

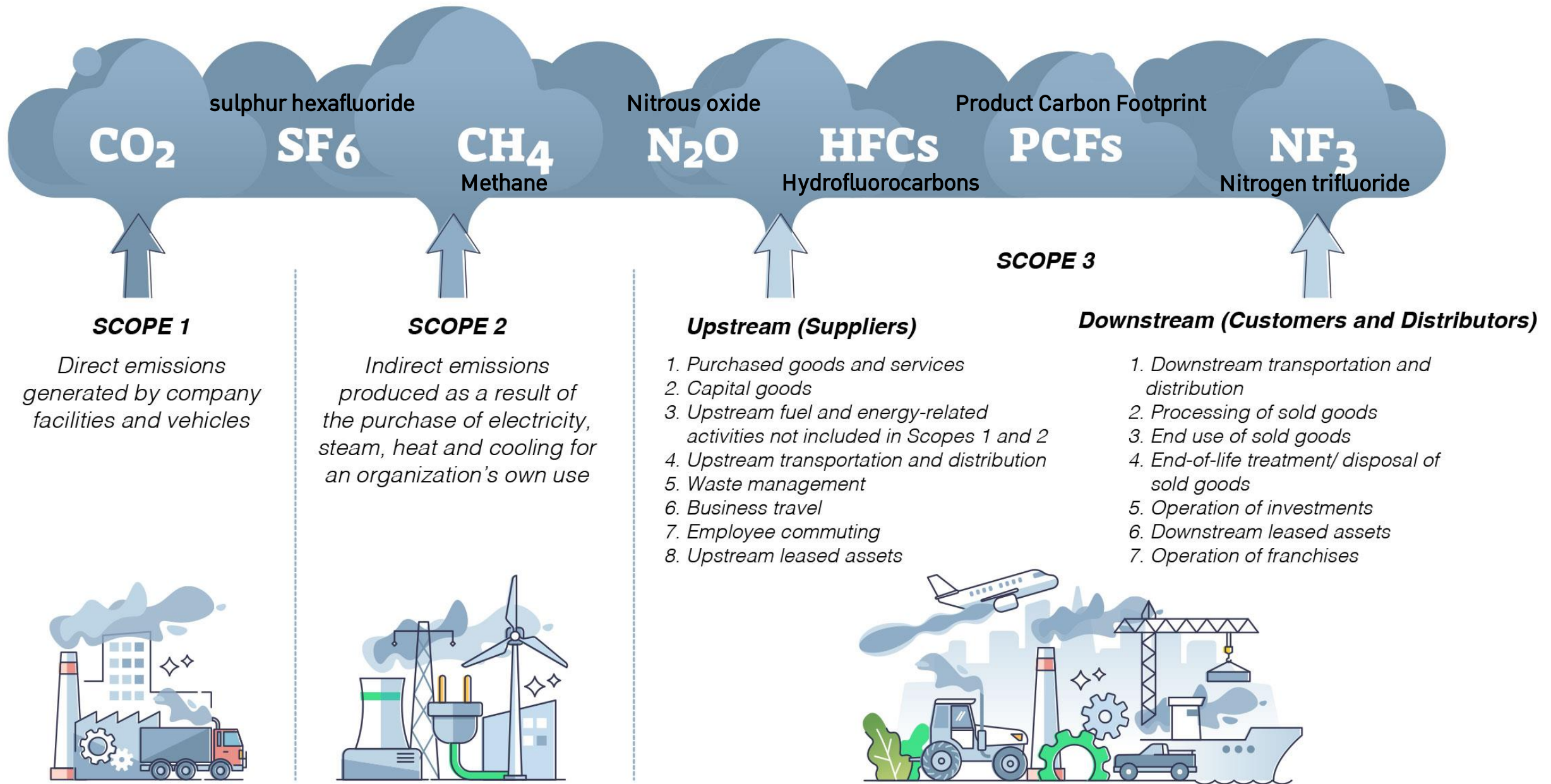
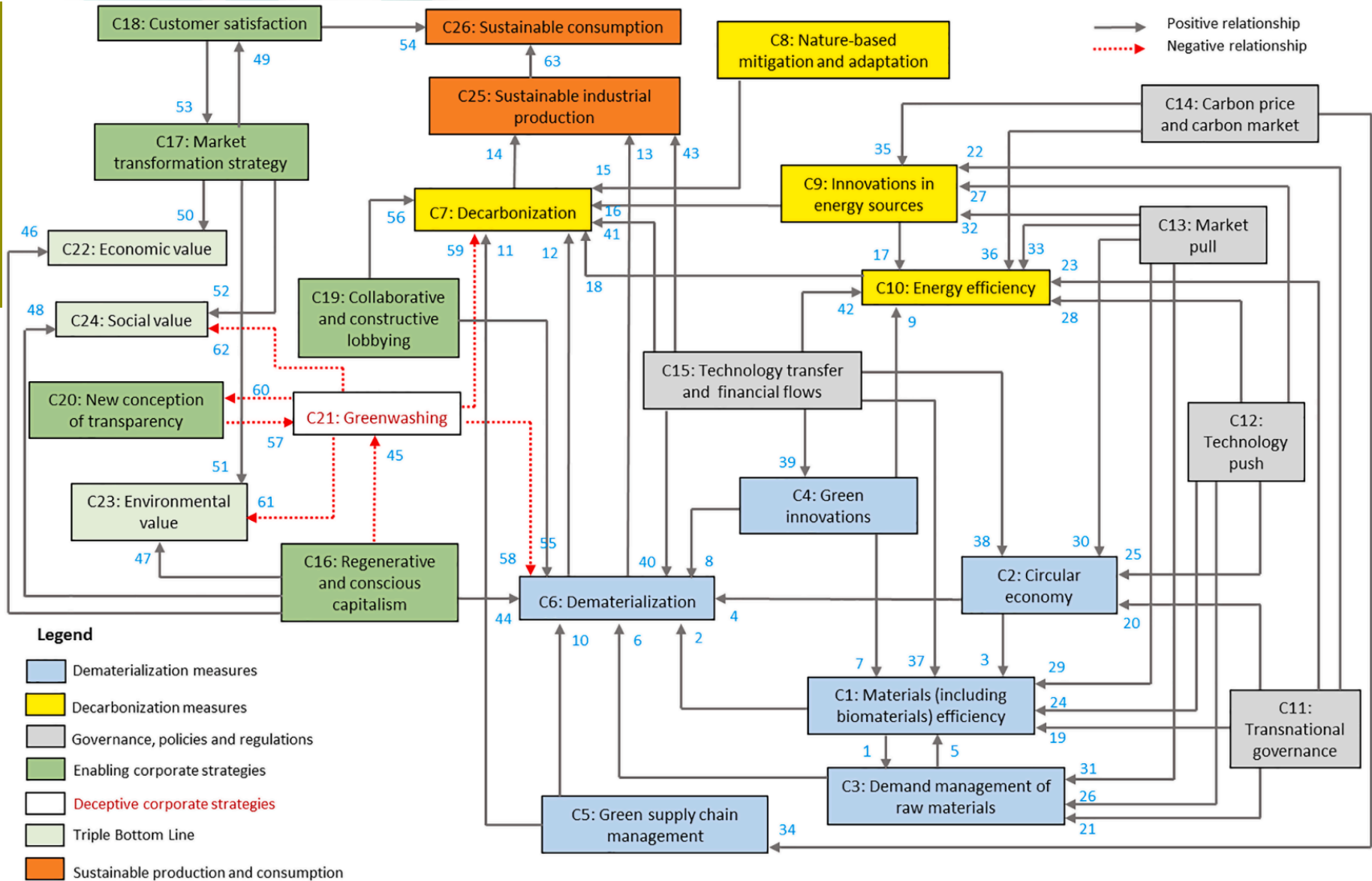


Figure 1: Definitions of Scopes 1, 2, and 3 Emissions

Causal relationships of various concepts of industrial system transition

การฟอกเขียว(greenwashing)
การอ้างเพื่อสร้างภาพลักษณ์ที่
รับผิดชอบต่อสังคมและรักโลก
แก่บริษัท แต่อาจไม่ได้มีการลด
ผลกระทบต่อสิ่งแวดล้อมจริง

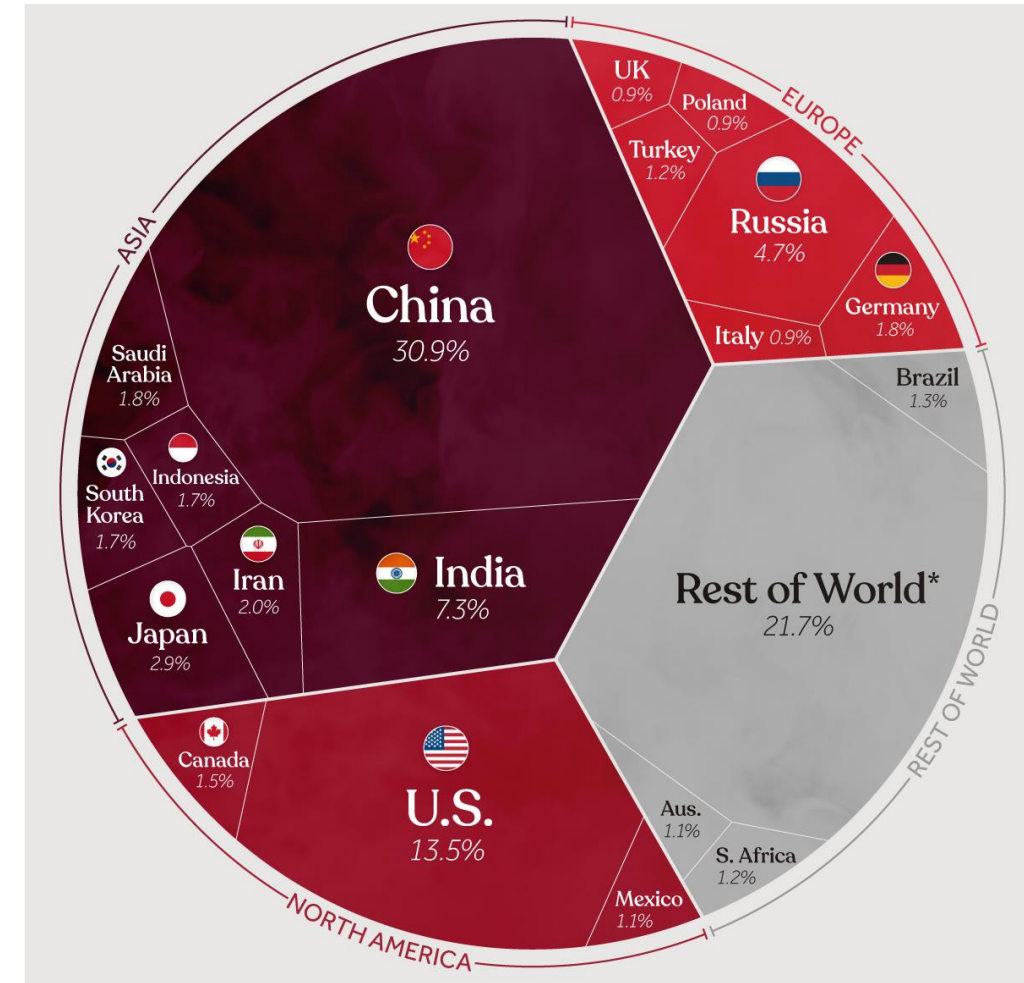
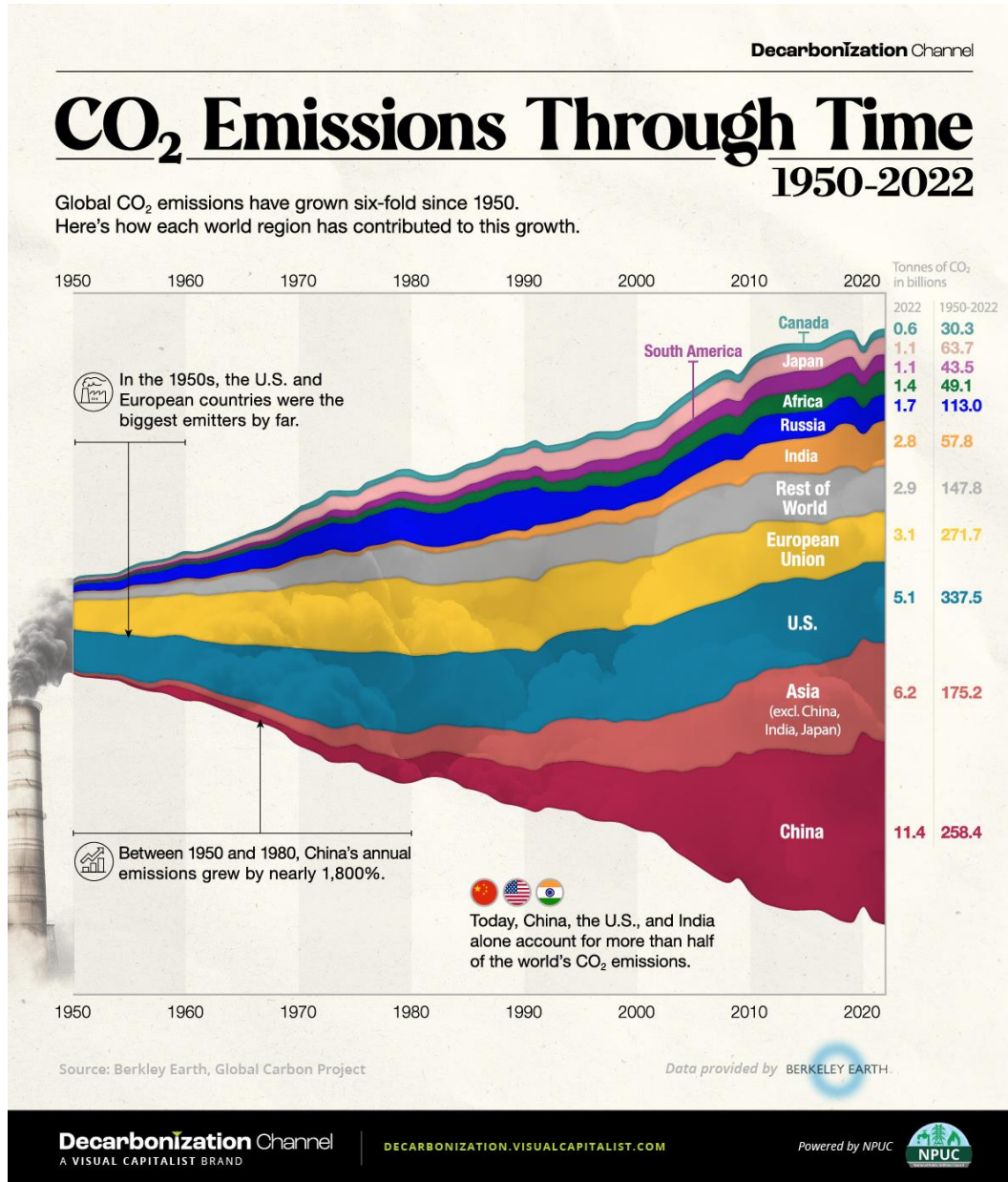


(Singh & Chudasama, 2021)

Fig. 1. Causal relationships of various concepts of industrial system transition Note: Numbers on arrow tips represent the corresponding serial number of causal relationships in Table 1.

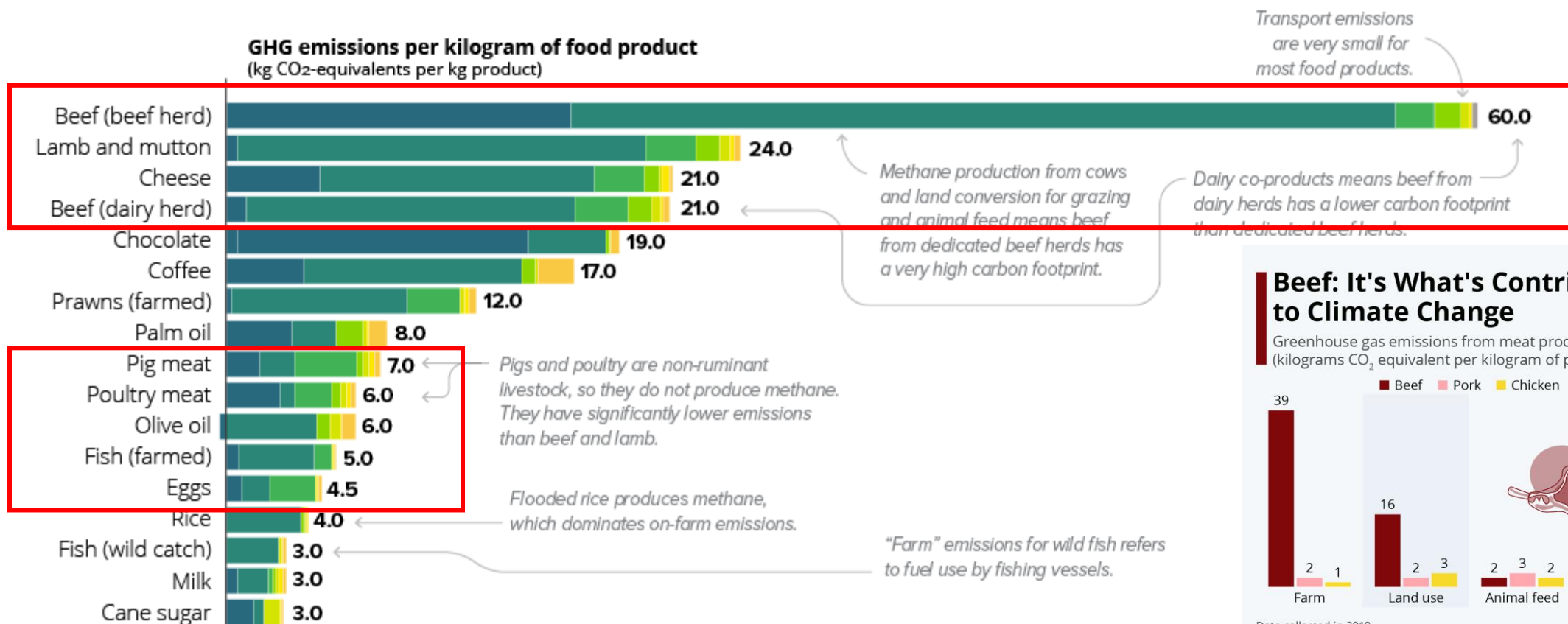
All the World's Carbon Emissions

% of total global emissions in 2021



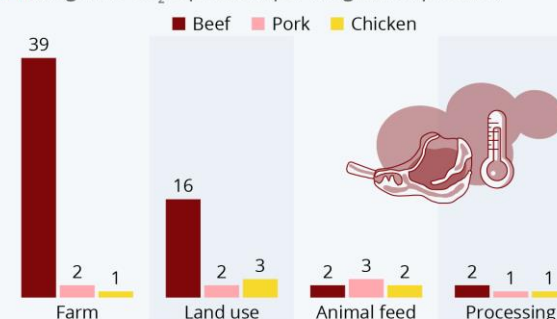
The Carbon Footprint of the Food Supply Chain

There is a vast difference in greenhouse gases (GHG) that are produced across various food types.



Beef: It's What's Contributing to Climate Change

Greenhouse gas emissions from meat production (kilograms CO₂ equivalent per kilogram of product)



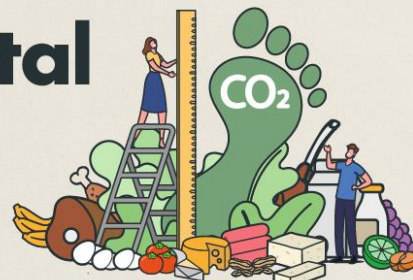
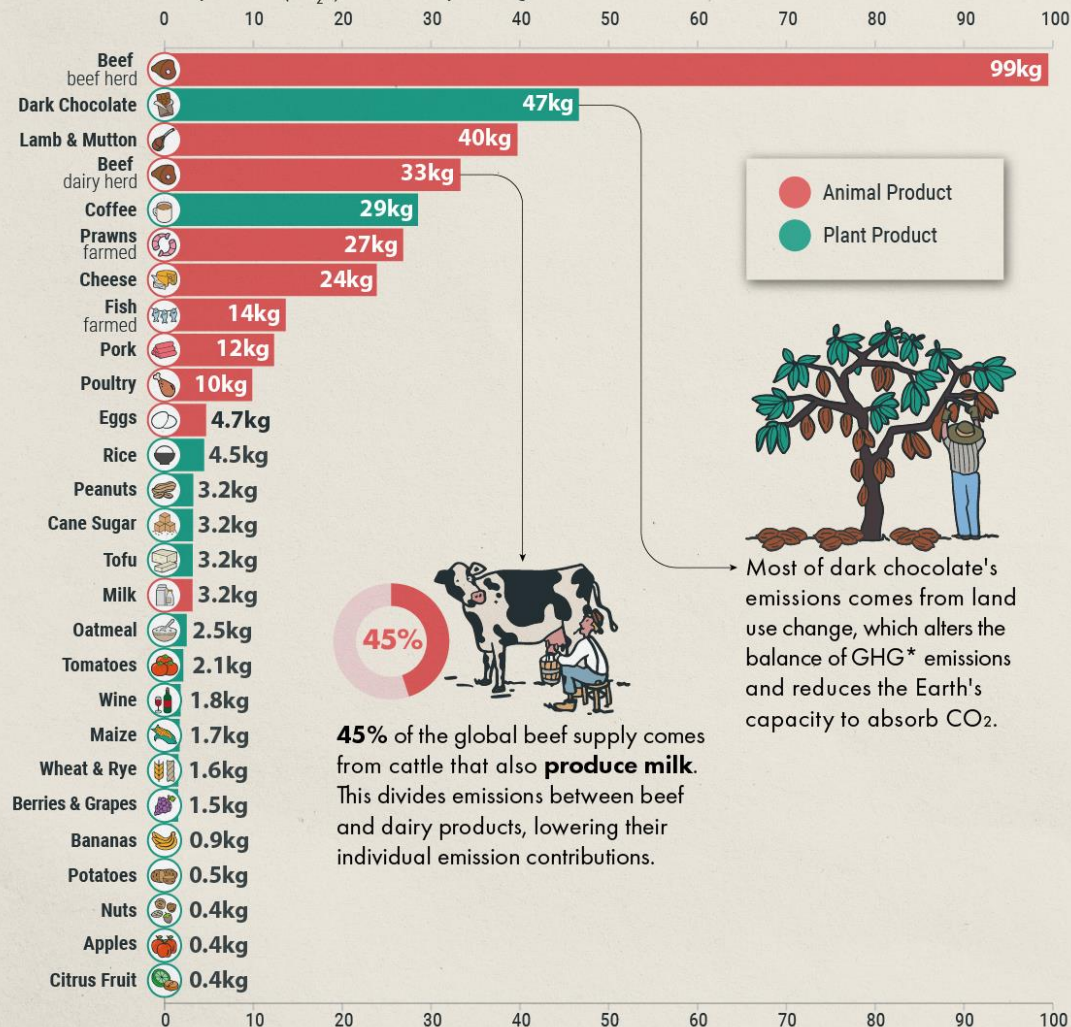
Data collected in 2018
Sources: Poore and Nemecek, Bloomberg



The Environmental Impact of Foods

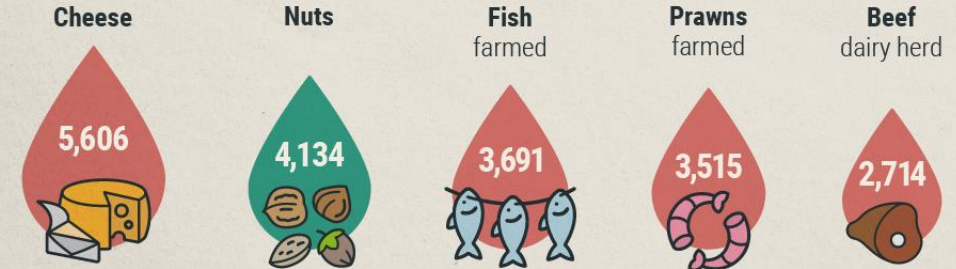
Food production is responsible for 26% of global greenhouse gas emissions. How do different food items contribute to this figure?

Carbon Dioxide Equivalent (CO₂e) Emissions per Kilogram



The Top 5 Most Water-Intensive Foods

Water withdrawal per kilogram (liters)



*Greenhouse gas. Data shows global averages across 119 countries. Source: Our World in Data, Poore & Nemecek (2018)



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/visualcapitalist



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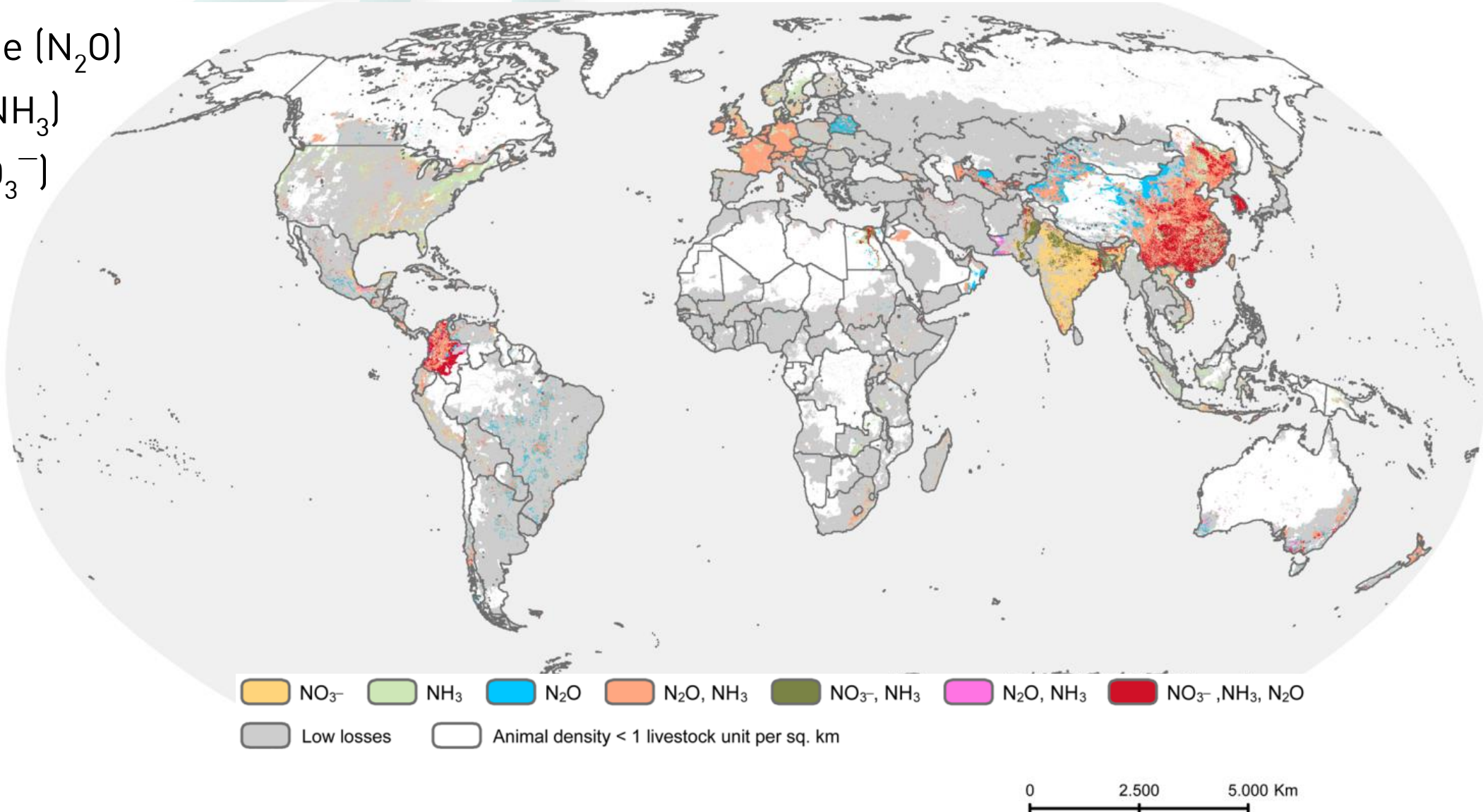


visualcapitalist.com

<https://www.visualcapitalist.com/ranked-foods-with-the-largest-environmental-impact/>

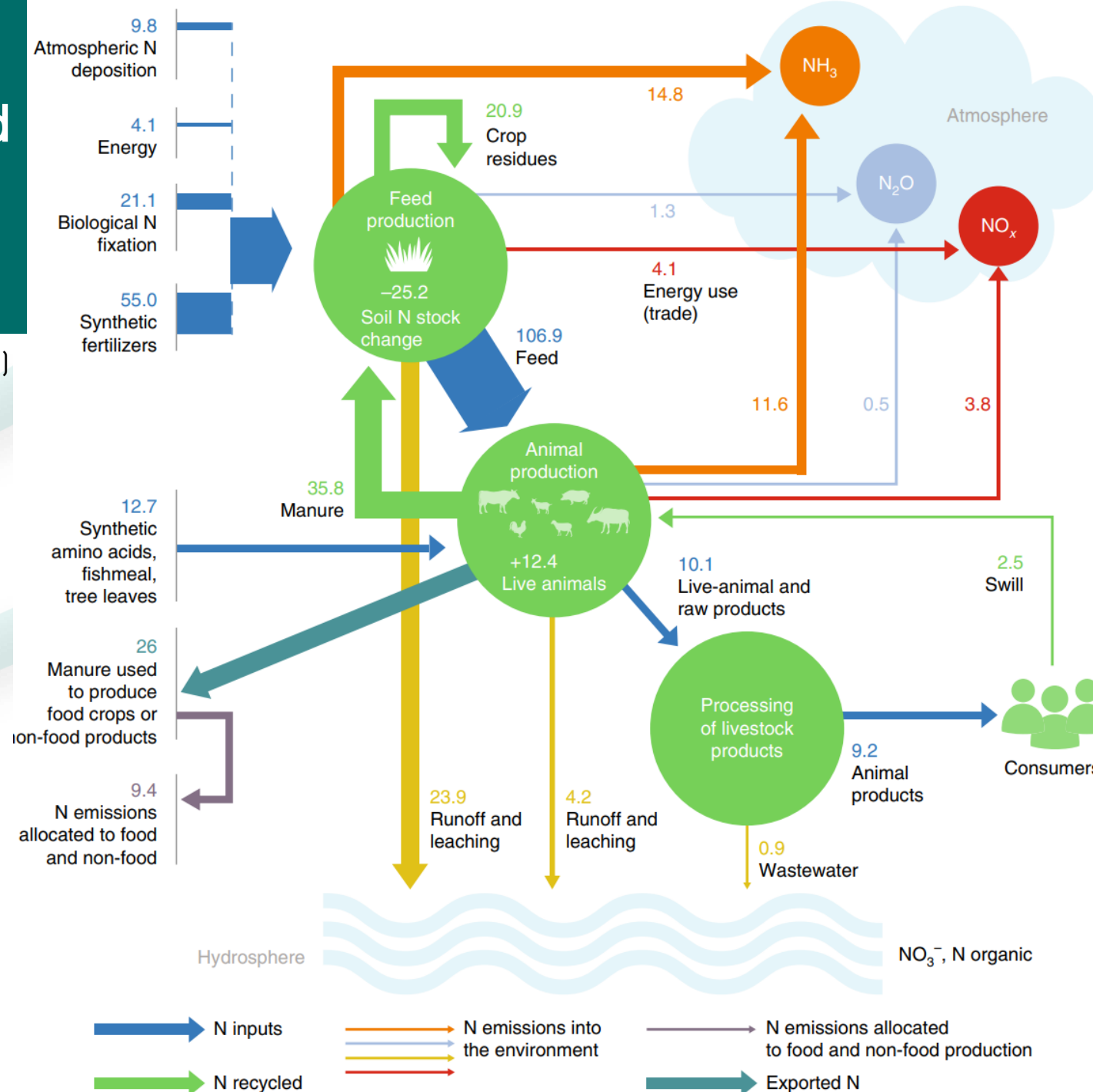
N_2O , NH_3 and NO_3^- emissions from global livestock supply chains

- Nitrous oxide (N_2O)
- Ammonia (NH_3)
- Nitrates (NO_3^-)



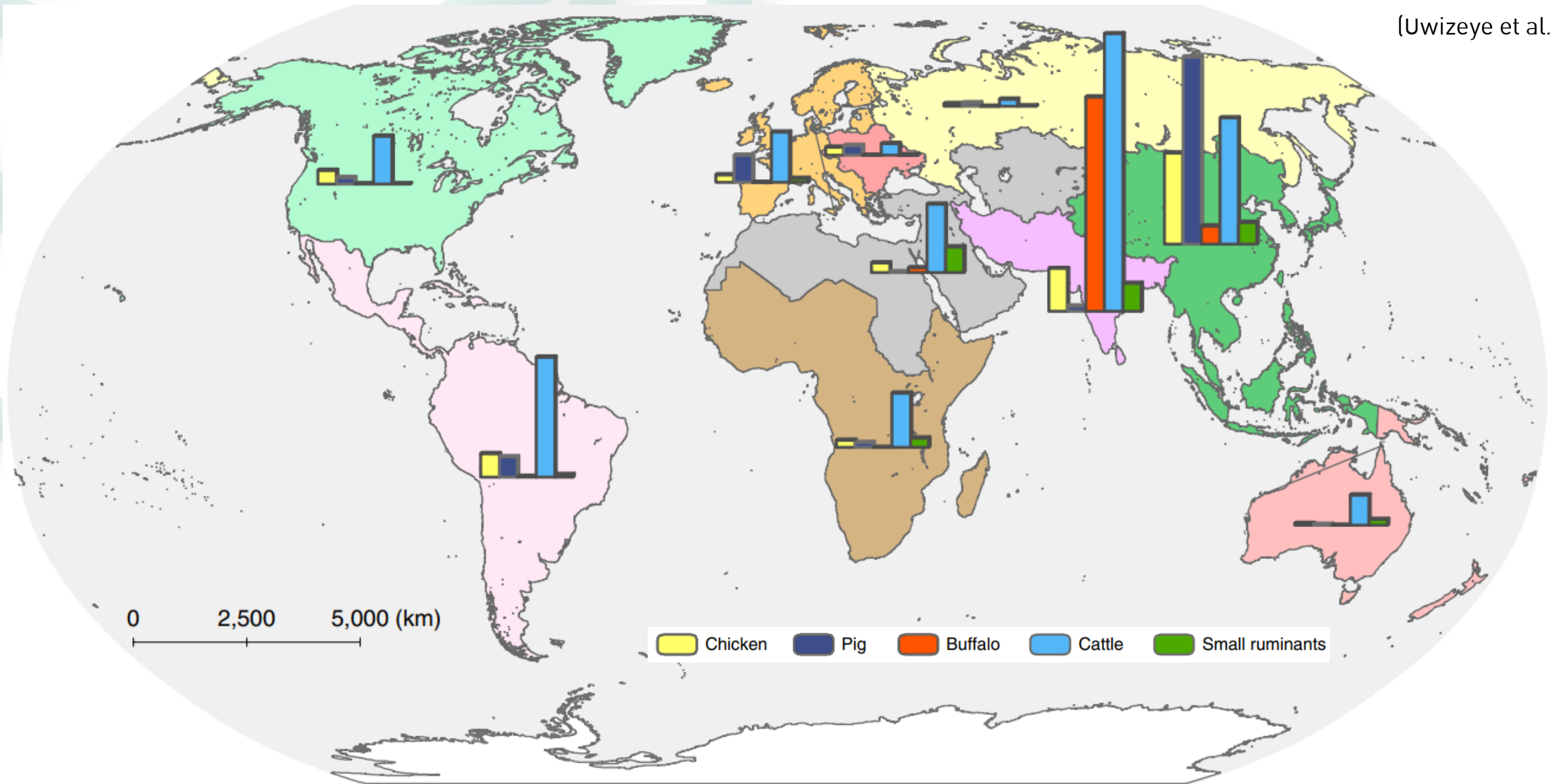
Global N flows and sources of N compound emissions allocated to the livestock sector

(Uwizeye et al., 2020)



Regional N emissions from livestock species in Gg N

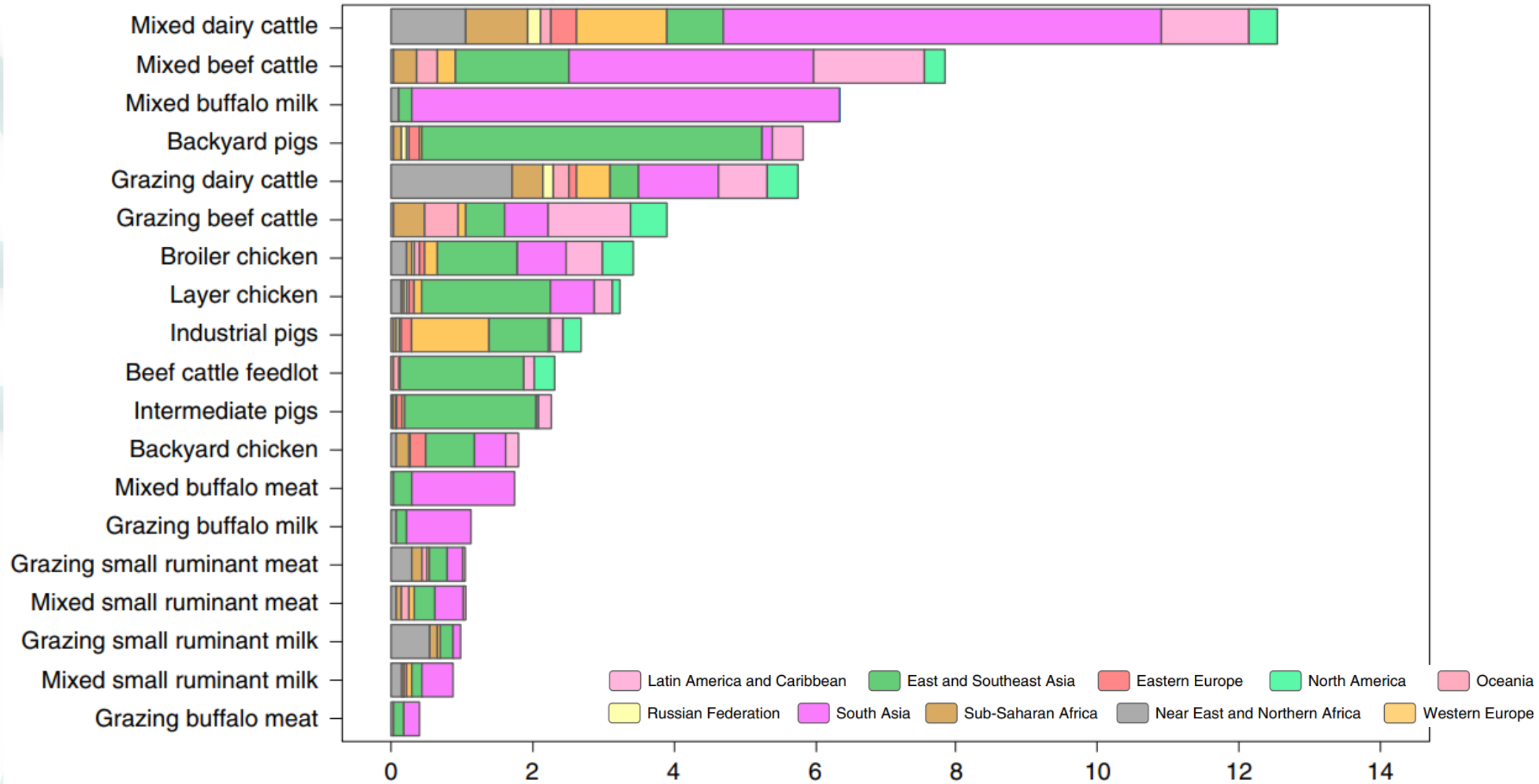
(Uwizeye et al., 2020)



Regional N emissions from livestock species in Gg N

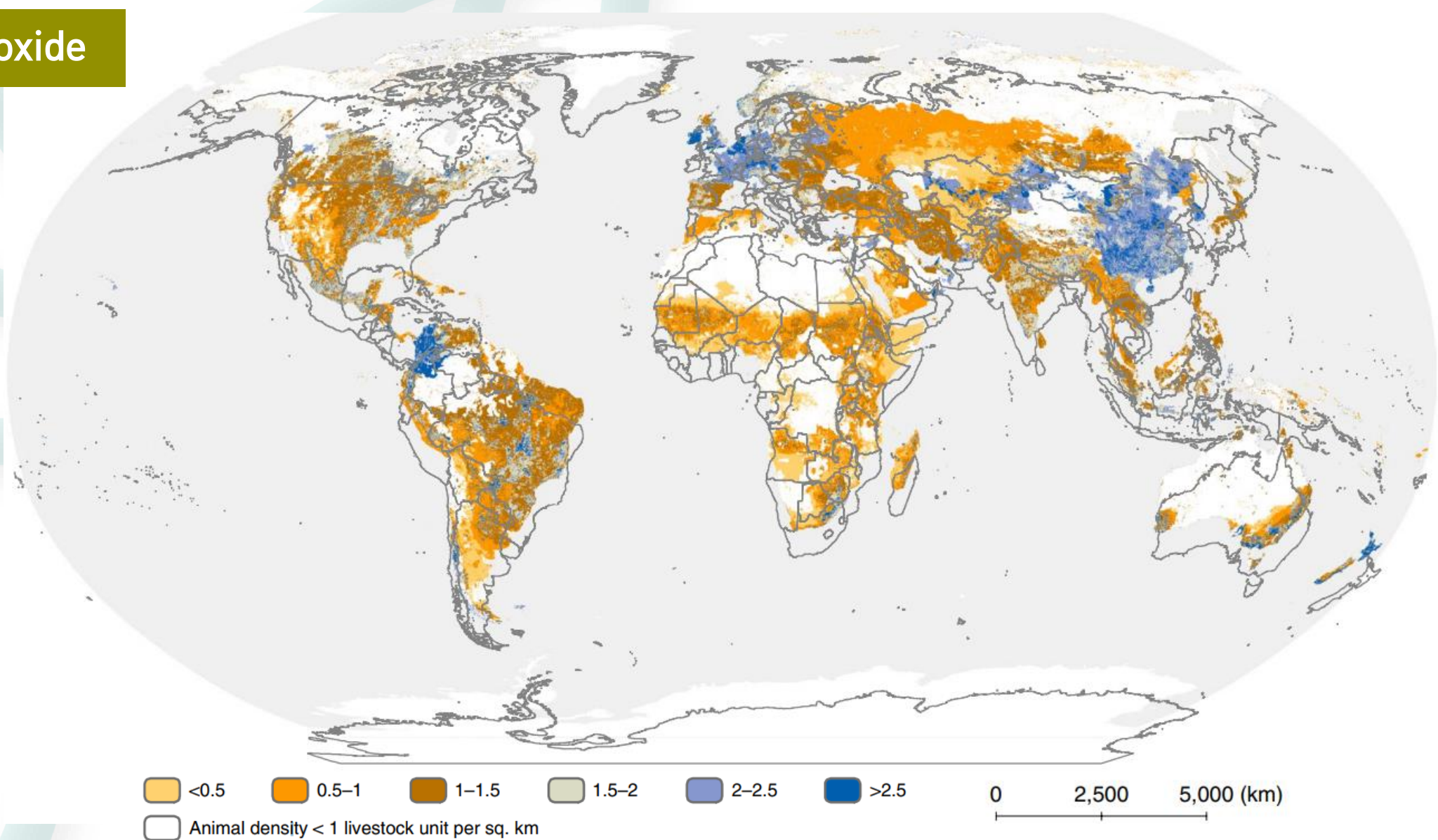
 1,000 Gg N

Regional contribution of different livestock systems to total N emissions (in Tg N yr⁻¹).



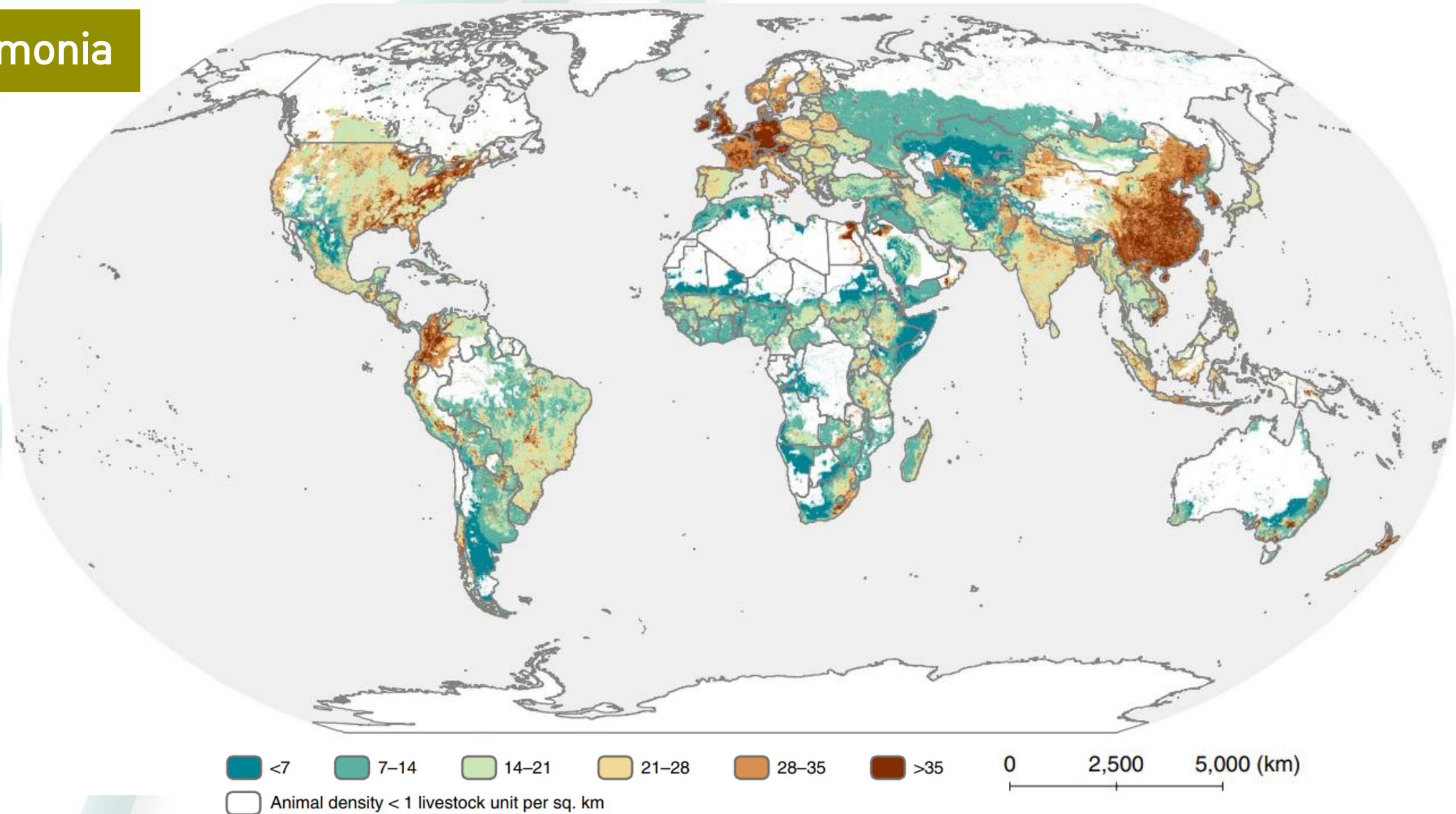
N_2O emissions from livestock supply chains ($\text{kg N-N}_2\text{O ha}^{-1}$)

Nitrous oxide



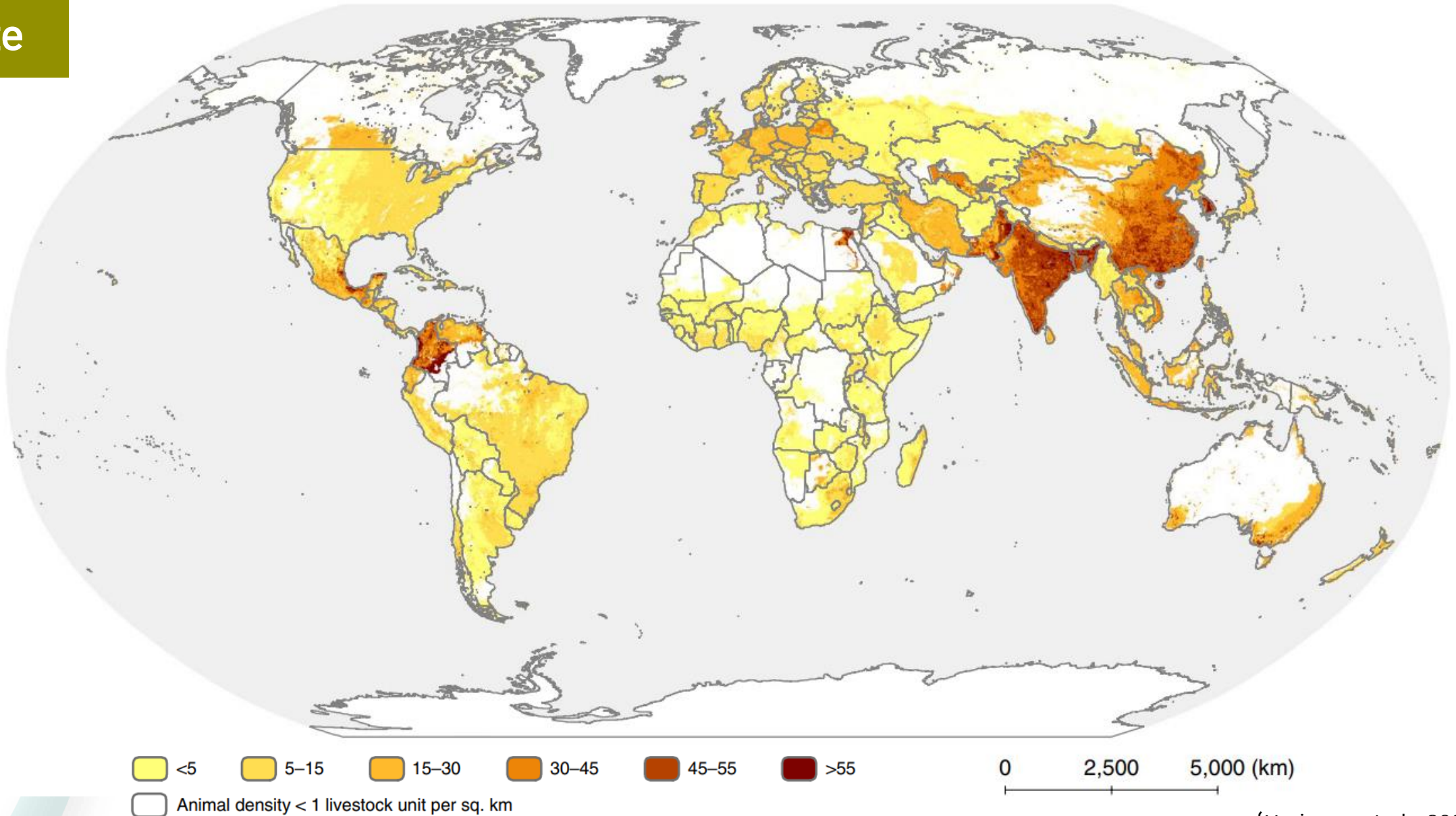
NH₃ emissions from livestock supply chains (kg N-NH₃ ha⁻¹)

Ammonia



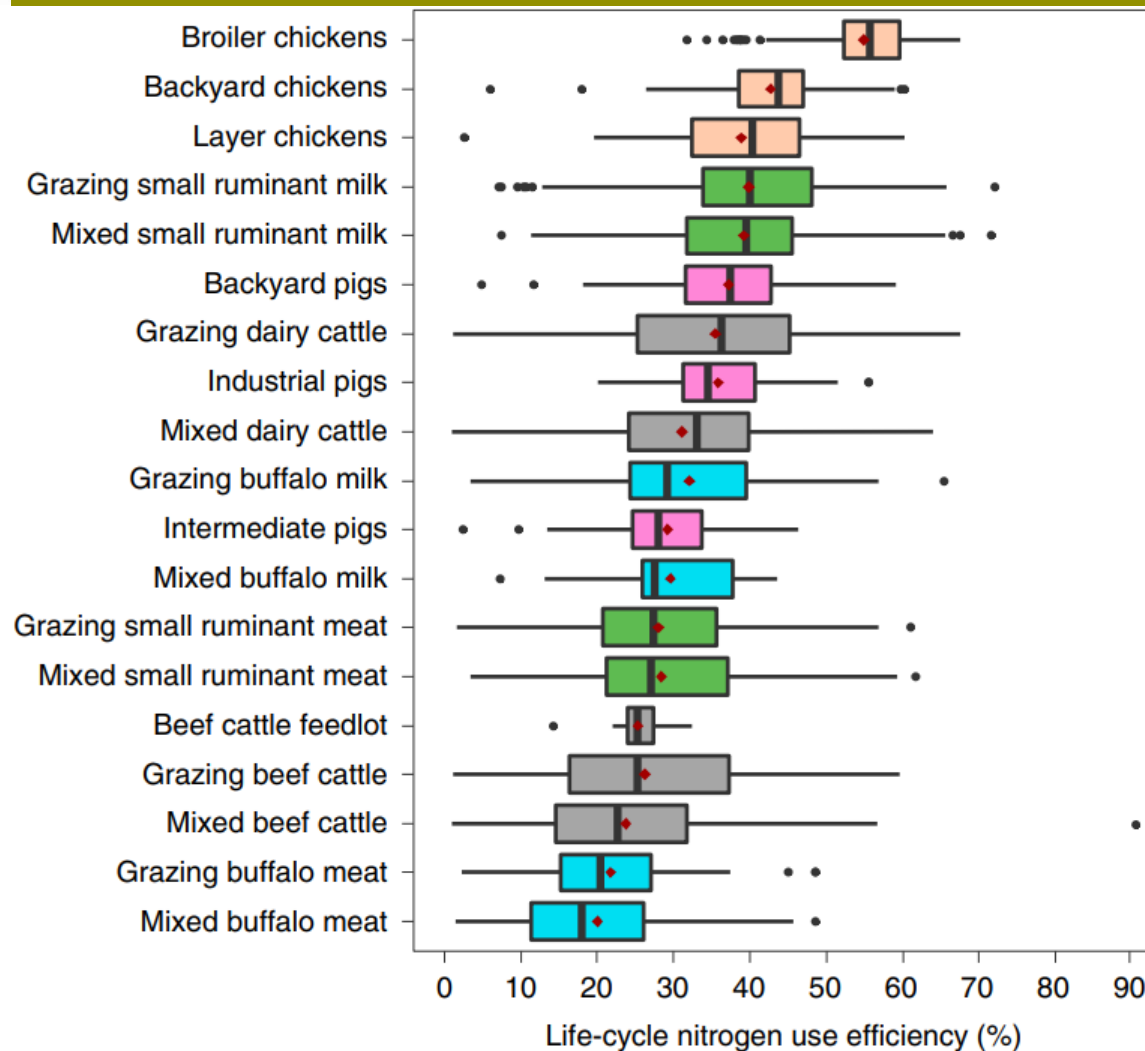
NO_3^- emissions from livestock supply chains ($\text{kg N-NO}_3^- \text{ ha}^{-1}$)

Nitrate

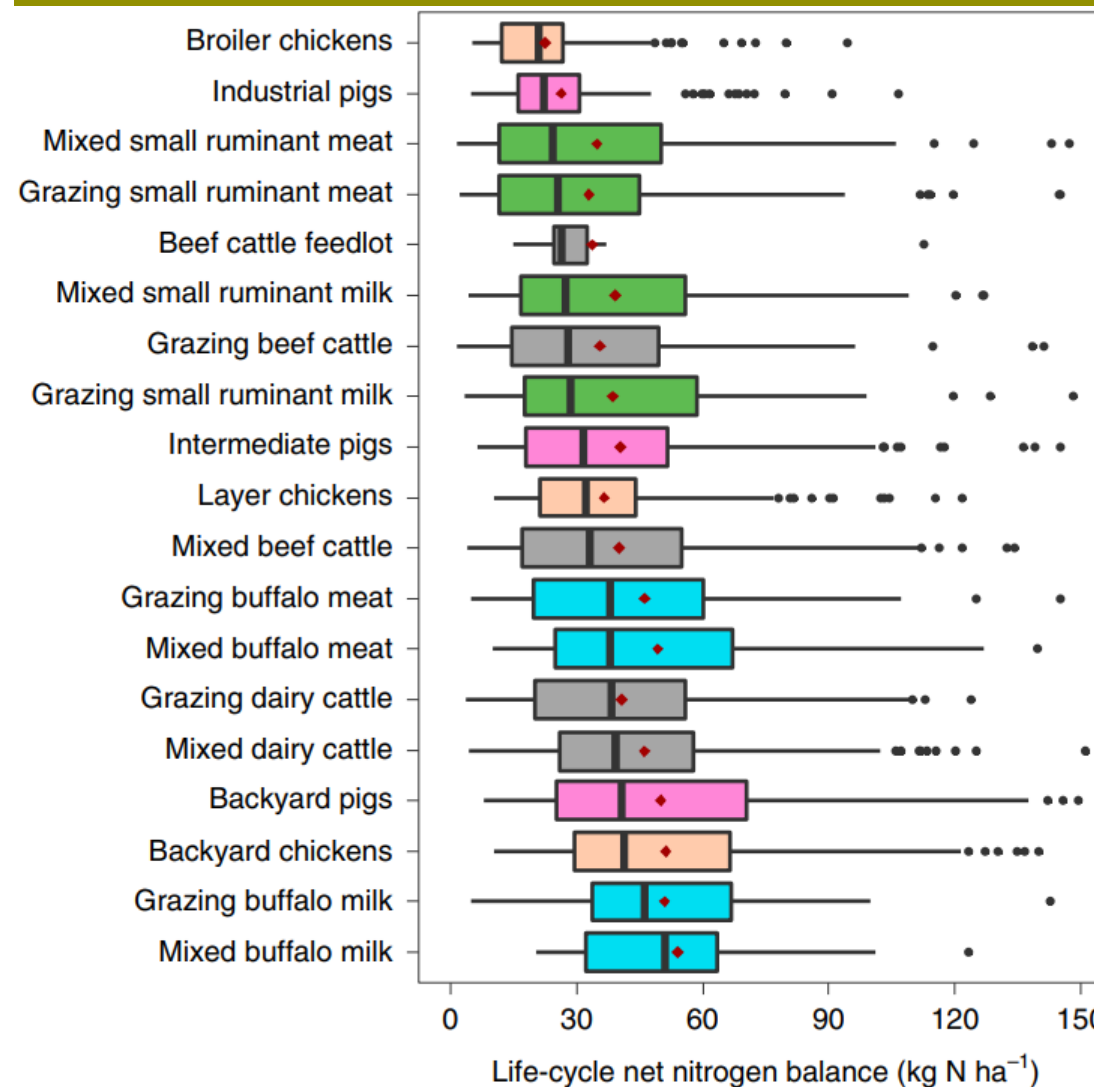


Distribution of N indicators by species, commodity and systems

Life-cycle nitrogen use efficiency

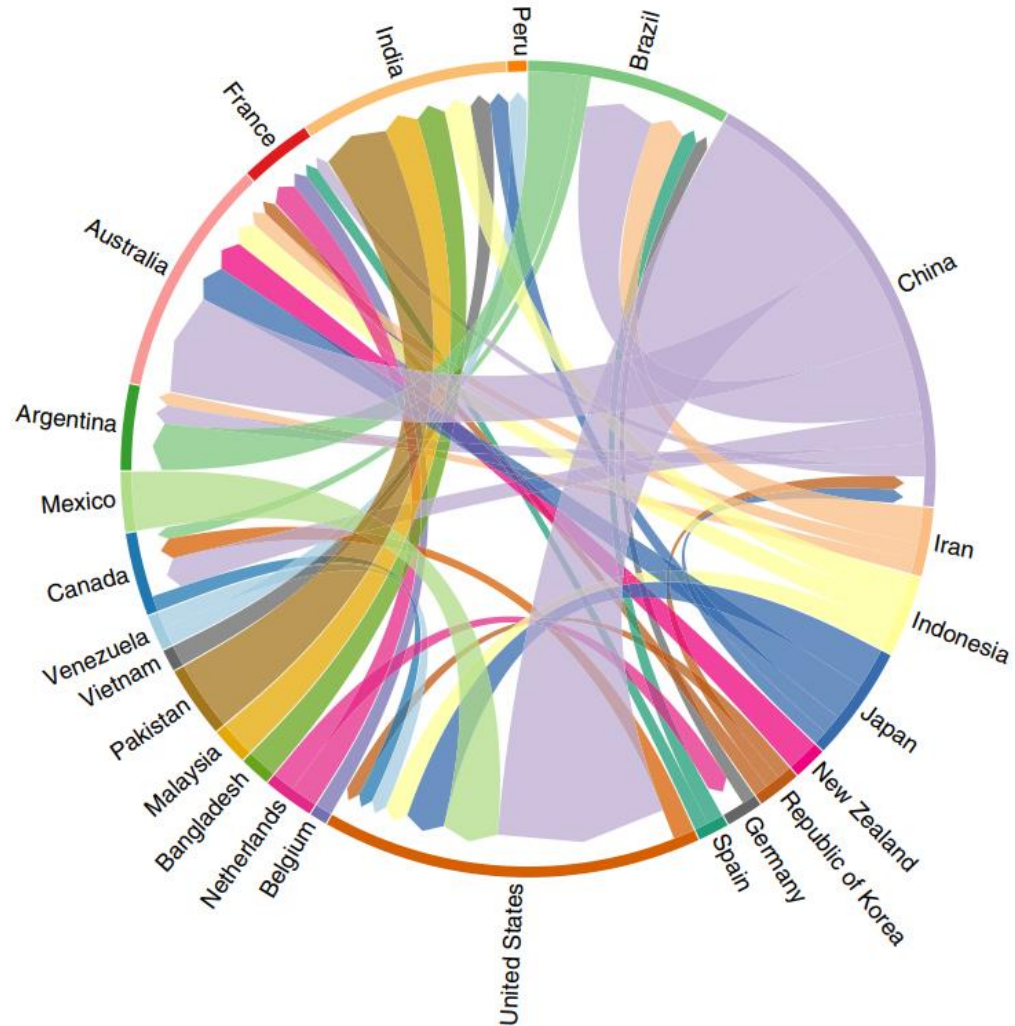


Life-cycle net nitrogen balance

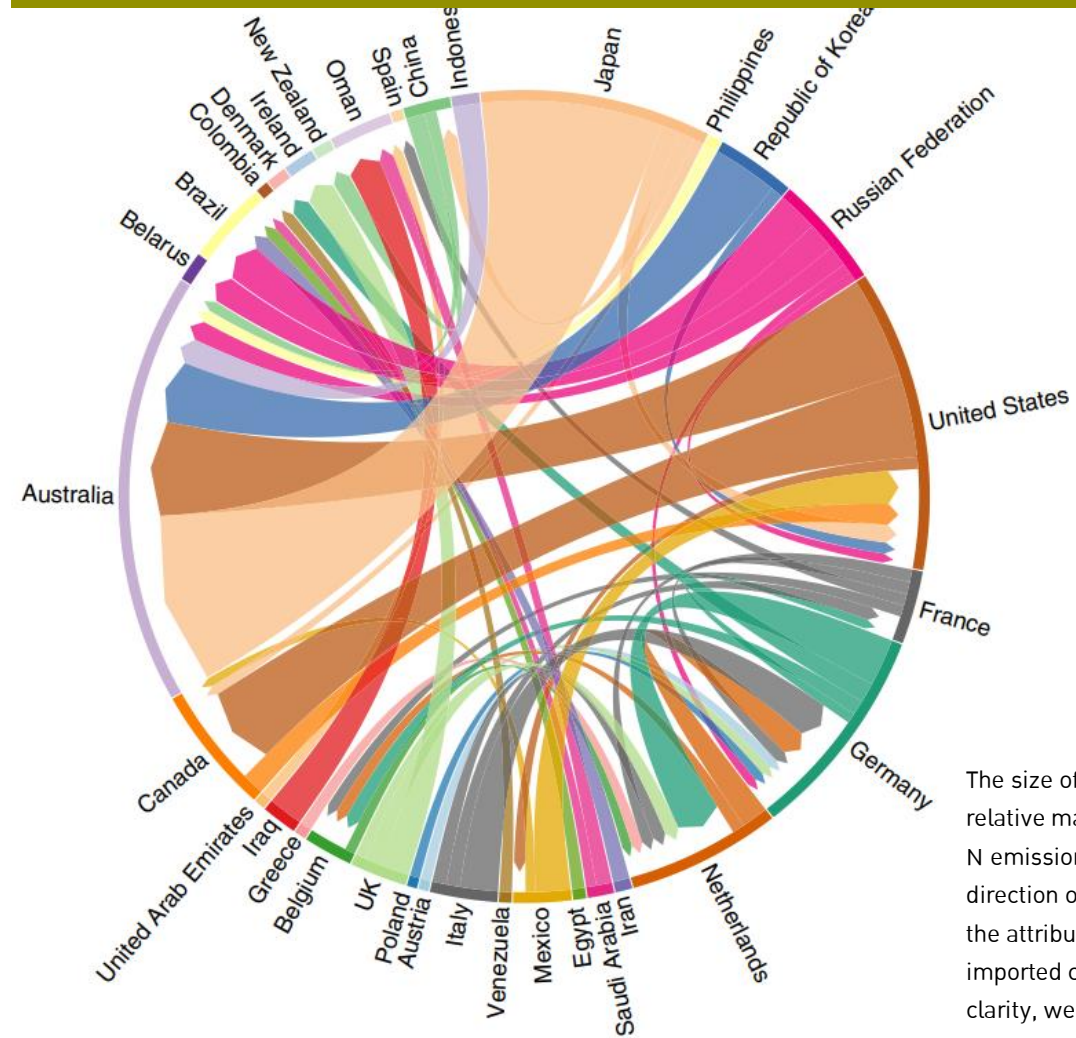


Embedded N emissions in international trade of feed and livestock commodities

Feed commodities (1.5 Tg N yr^{-1})



Livestock commodities including feed used to produce them (4 Tg N yr^{-1})



The size of the arrow indicates the relative magnitude of embedded N emissions in each graph. The direction of the arrow indicates the attribution of N emissions in imported commodities. For clarity, we represent only the major flows (representing 50% of embedded N emissions)

(Uwizeye et al., 2020)

Concentrated animal feeding operation (CAFO; popularly known as factory farm)

Manure discharge from CAFOs like this one can negatively impact water quality.

Air quality



Negative
production
externalities
Cattle manure

MRSA swabbed
from CAFO
workers' noses
was also found on
the walls and in
animals at the
facility where they
worked.



Dead infant pigs at a hog farm



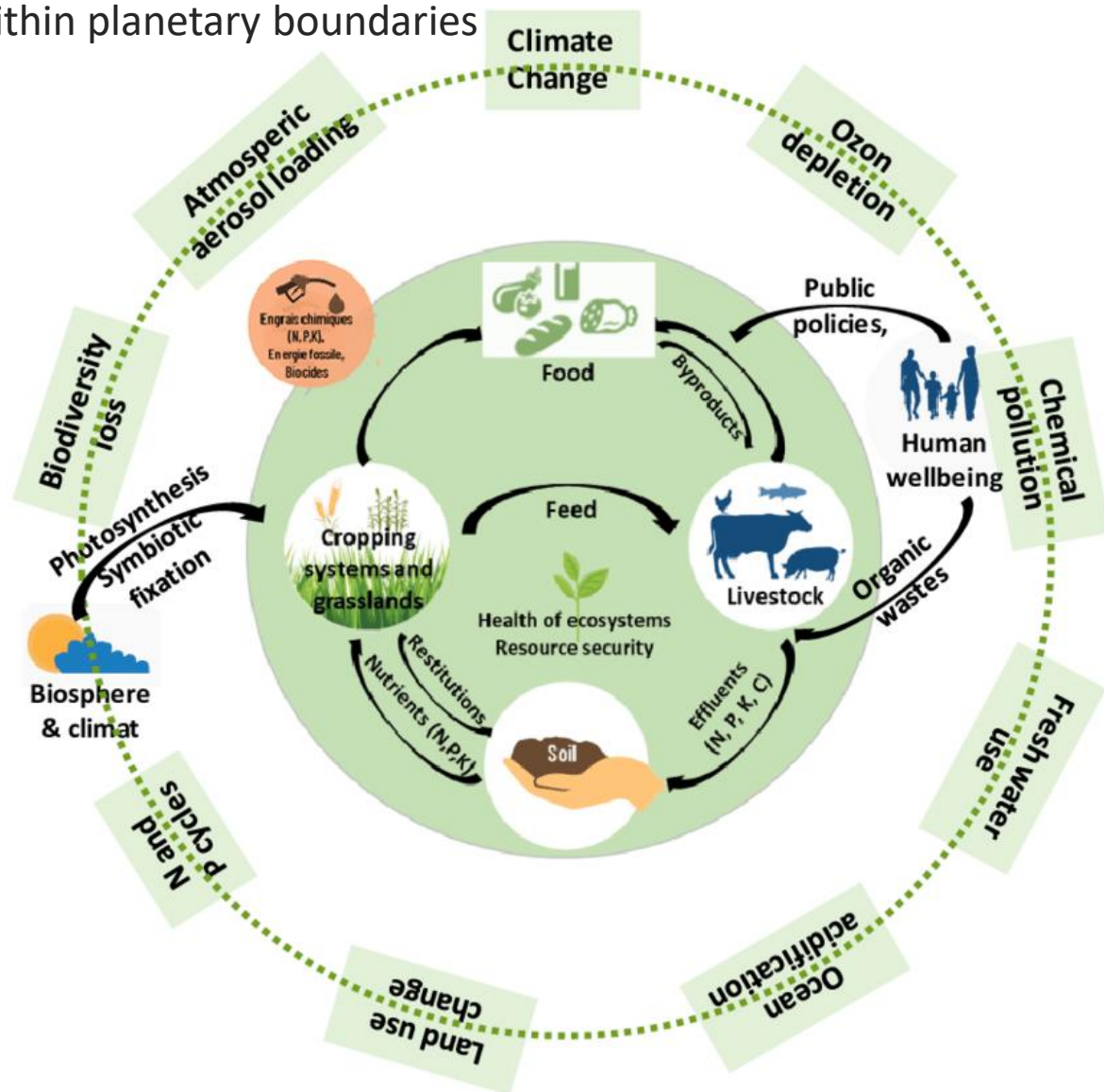
The Environmental Protection Agency (EPA) sets
discharge limits for CAFOs

- **Manure** is a critical source of natural fertilizer.
- Livestock are important **assets for vulnerable communities**. Globally, around 500 million pastoralists rely on livestock herding for food, income, and as a store of wealth, collateral or safety net in times of need.
- Livestock production systems have the potential to contribute **to the preservation of biodiversity and to carbon sequestration in soils and biomass**.
- In harsh environments, such as mountains and drylands, livestock is often the only way to sustainably **convert natural resources into food, fiber, and work power** for local communities.

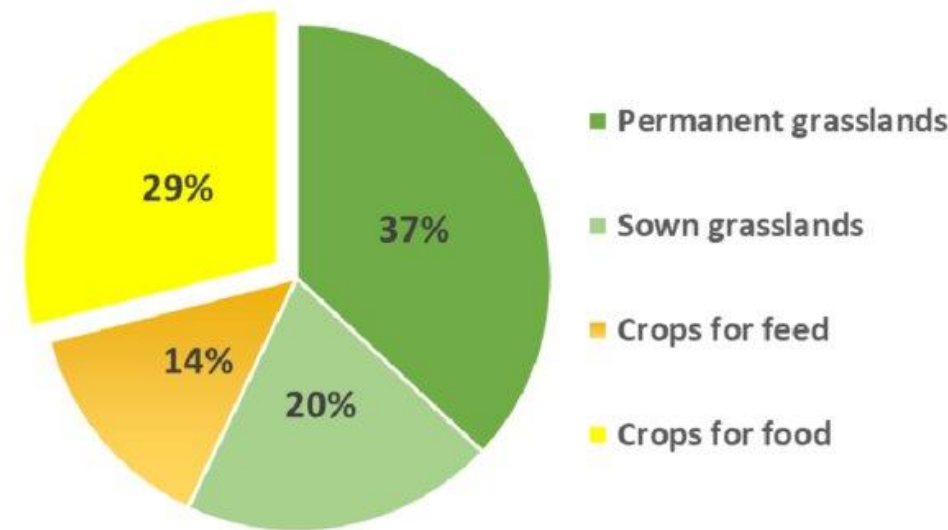
Livestock play a major role in sustainable food systems

<https://www.worldbank.org/en/topic/agriculture/brief/moving-towards-sustainability-the-livestock-sector-and-the-world-bank>

Role and place of livestock in balanced circular food production within planetary boundaries



Land use by livestock farming (% of global agricultural area)

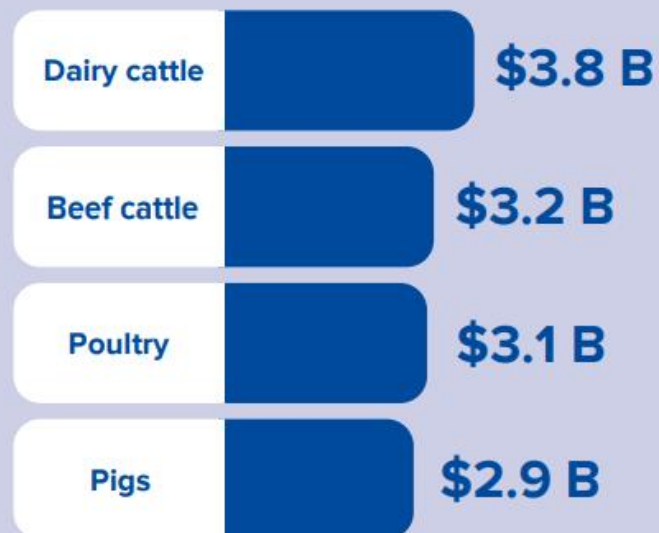


According to the FAO, livestock contributes 40% of the global value of agricultural output and supports the livelihoods and food and nutrition security of almost 1.3 billion people.

Peyraud, J. L., & MacLeod, M. (2020). Future of eu livestock—how to contribute to a sustainable agricultural sector. Final Report. Directorate-General for Agriculture and Rural Development (European Commission): Brussels, Belgium, 82.

Economics of Reducing Disease

For every one percentage point reduction in global livestock disease levels, the following additional revenue is generated*:



A case study analysis by Oxford Analytica found that livestock disease reduces global production by 80 billion kilos of meat and 179.5 billion kilos of dairy each year, reducing producer revenue by \$358.4 billion.*

Every 1% reduction in beef cattle disease rates would:

- increase production enough to meet the average beef consumption needs of 317 million people
- increase producer revenue by US\$3.2 billion.

Every 1% reduction in dairy cattle disease rates would:

- increase production enough to meet the average dairy needs of 80.5 million people
- increase producer revenue by US\$3.8 billion.

Every 2 cattle vaccinated



is associated with



1 person
avoiding hunger

A reduction in global
livestock disease levels of
10 percentage
points

Leads to a drop of more than

800 ↓
million tons
of GHG emissions

Equivalent to the average
annual emissions of
117 million
Europeans
based on EU estimate of 6.8
tonnes of CO₂ per person²



Animal health and Sustainability A Global Data Analysis

In Nigeria, a country-level
vaccination rate of

40%
for cattle in a
given year



Is associated with a reduction
of severe food insecurity by

8.1% ↓

Equivalent to lifting

2.4 ↓
million people
out of severe food insecurity

<https://www.healthforanimals.org/wp-content/uploads/2023/04/AH-and-Sustainability-Report-Summary-1.pdf>

Suwanna Sayruamyat

Animal life loss share per region group compared to global population share

Table 2

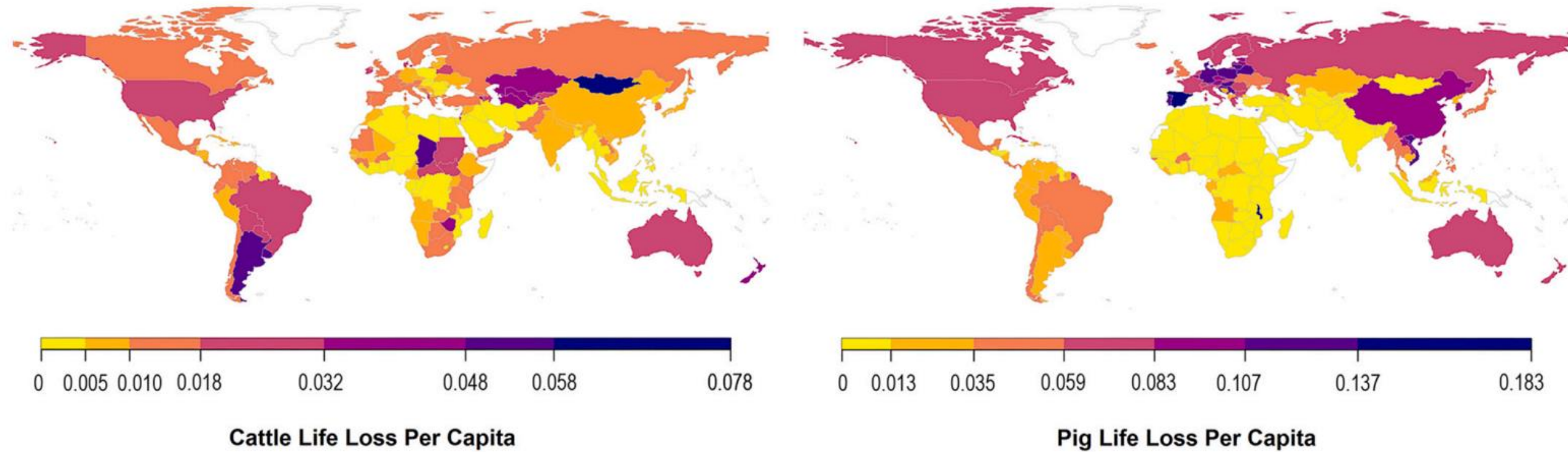
Animal life loss share per region group compared to global population share. Darker colours indicate higher values.

Region Group	No. of Countries	Total Life Loss	Life Loss Share	Population Share	GDP per Capita (USD)	Life Loss per Capita
Industrialized Asia	7	3,449,213,601	19.2%	21.8%	12,967	2.07
South & Southeast Asia	17	2,926,672,931	16.3%	33.7%	2,790	1.14
Latin America	24	2,813,967,720	15.7%	8.4%	8,347	4.39
North America & Oceania	4	2,767,792,671	15.4%	5.2%	61,448	6.98
Europe	43	2,762,316,567	15.4%	10.0%	28,653	3.61
North Africa, Western & Central Asia	22	1,728,955,657	9.6%	6.8%	7,587	3.34
Sub-Saharan Africa	41	1,522,692,752	8.5%	14.2%	1,584	1.40

(Klaura et al., 2023)

Cattle and pig live loss per capita

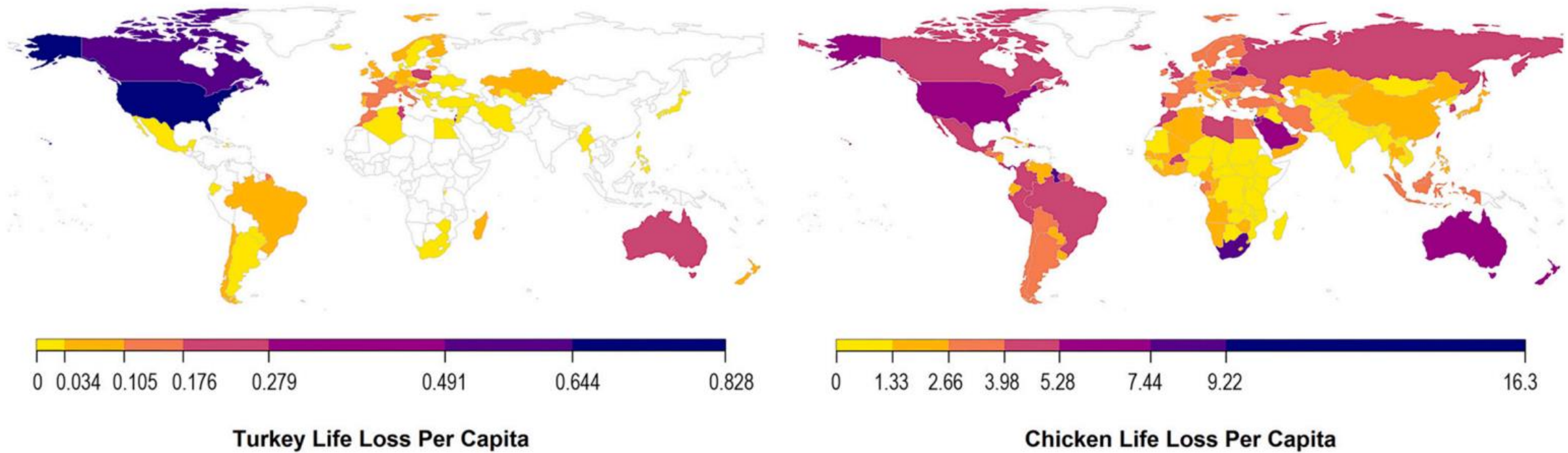
Global per-capita animal life loss embodied in MLW in 2019. Countries in white lacked data or were not covered in the analysis.



(Klaura et al., 2023)

Turkey and chicken live loss per capita

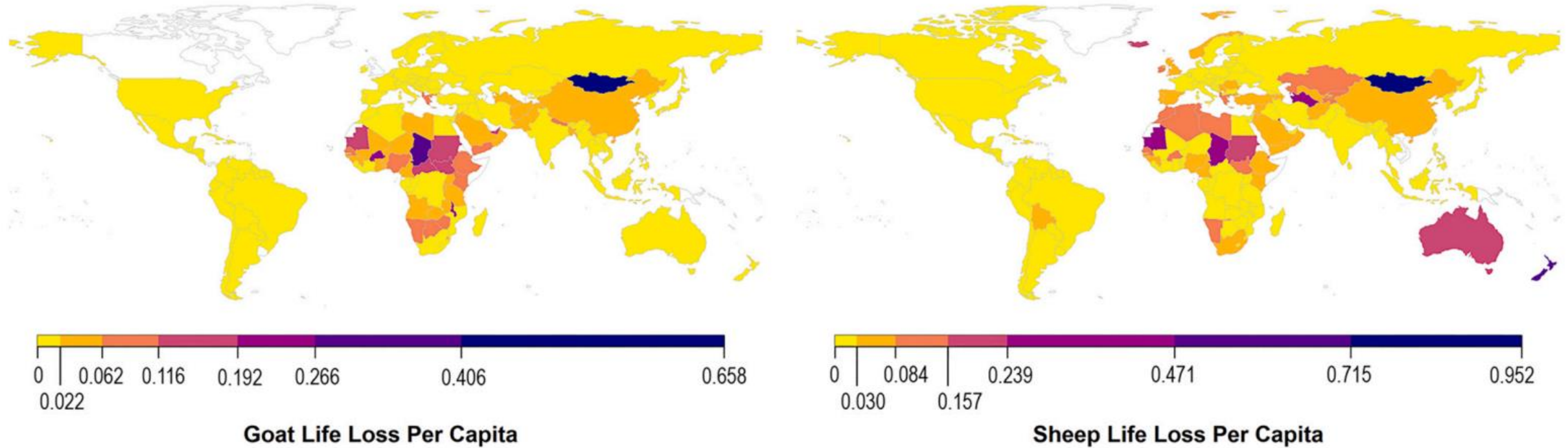
Global per-capita animal life loss embodied in MLW in 2019. Countries in white lacked data or were not covered in the analysis.



(Klaura et al., 2023)

Goat and sheep live loss per capita

Global per-capita animal life loss embodied in MLW in 2019. Countries in white lacked data or were not covered in the analysis.



(Klaura et al., 2023)

Three ways livestock farming is becoming more sustainable



The farming sector is facing a challenge. By 2030, the number of people within the global middle class is expected to grow to five billion and by 2050, 10 billion people will live on our planet. Farmers will need to supply more milk, meat, fish and eggs than ever before, while using fewer resources.

1. Good animal health = lower emissions

- By overseeing good animal health, it reduces the number of unproductive animals that emit greenhouse gas (GHG) emissions.

2. Changing the nutrition mix

- Good overall nutrition on the farm boosts the animals' natural immune systems, helping to keep them at their optimum health. This helps animals produce more, which enables farmers to meet local demand with fewer animals, thereby lowering greenhouse gas emissions.

3. New products to target methane reduction

- Innovation within supplements and vaccines is helping to cut emissions by targeting the production of methane within the digestion process.



ถั่วเหลืองที่ผลิตในสหรัฐอเมริกา มีคาร์บอนฟุตพริ้นท์
(Carbon Footprint) ที่ต่ำกว่าแหล่งผลิตอื่น ๆ หรือ
โปรตีนจากพืชชนิดอื่น นอกจากนี้กระบวนการผลิตถั่ว
เหลืองในสหรัฐอเมริกายังไม่ได้มาจากการตัดไม้ทำลายป่า

Jim Sutter

ประธานคณะผู้บริหารของ USSEC

28 กันยายน 2566

<https://www.prachachat.net/economy/news-1404299>





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Case Study: **Australian Beef Sustainability**

In Australia, Cowboys Use Satellites to Home In on the Range - WSJ

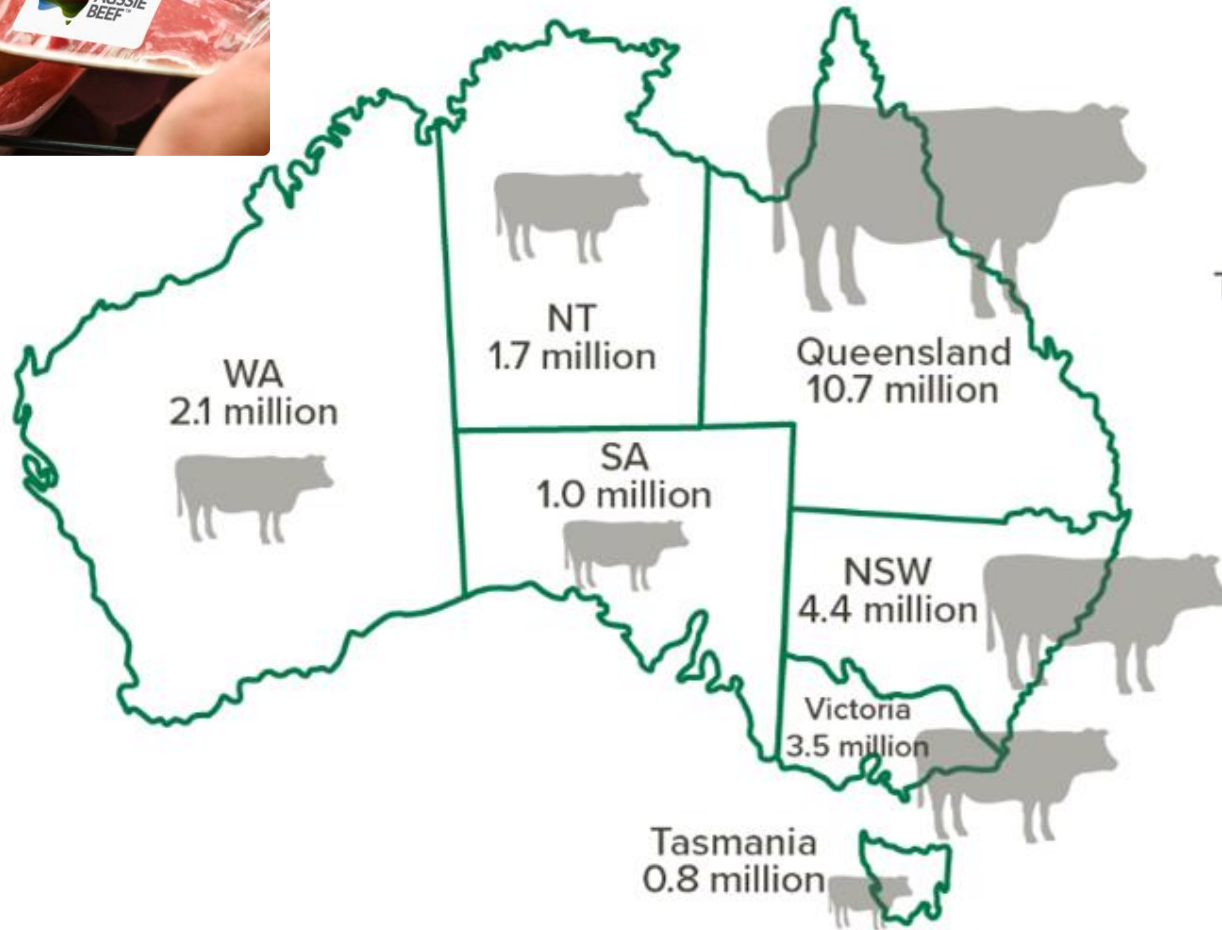


Wagyu big driver in new wave of Australian feedlot expansion - Beef Central



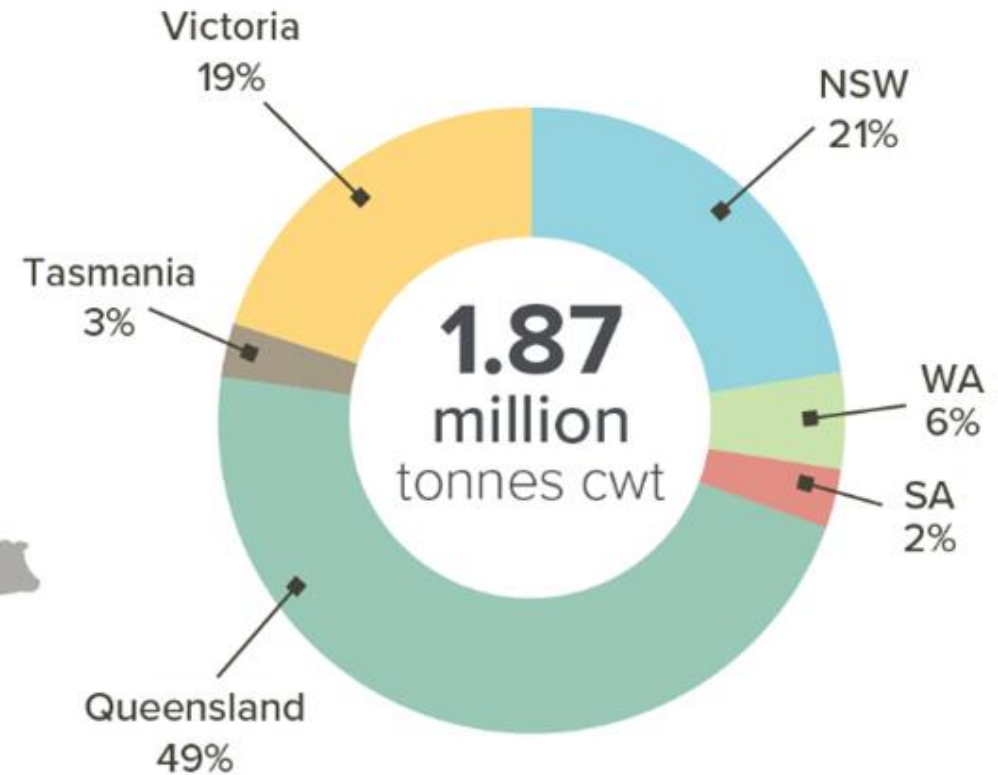
Australian beef and veal production

National cattle numbers
as at June 2022: 23.5 million head



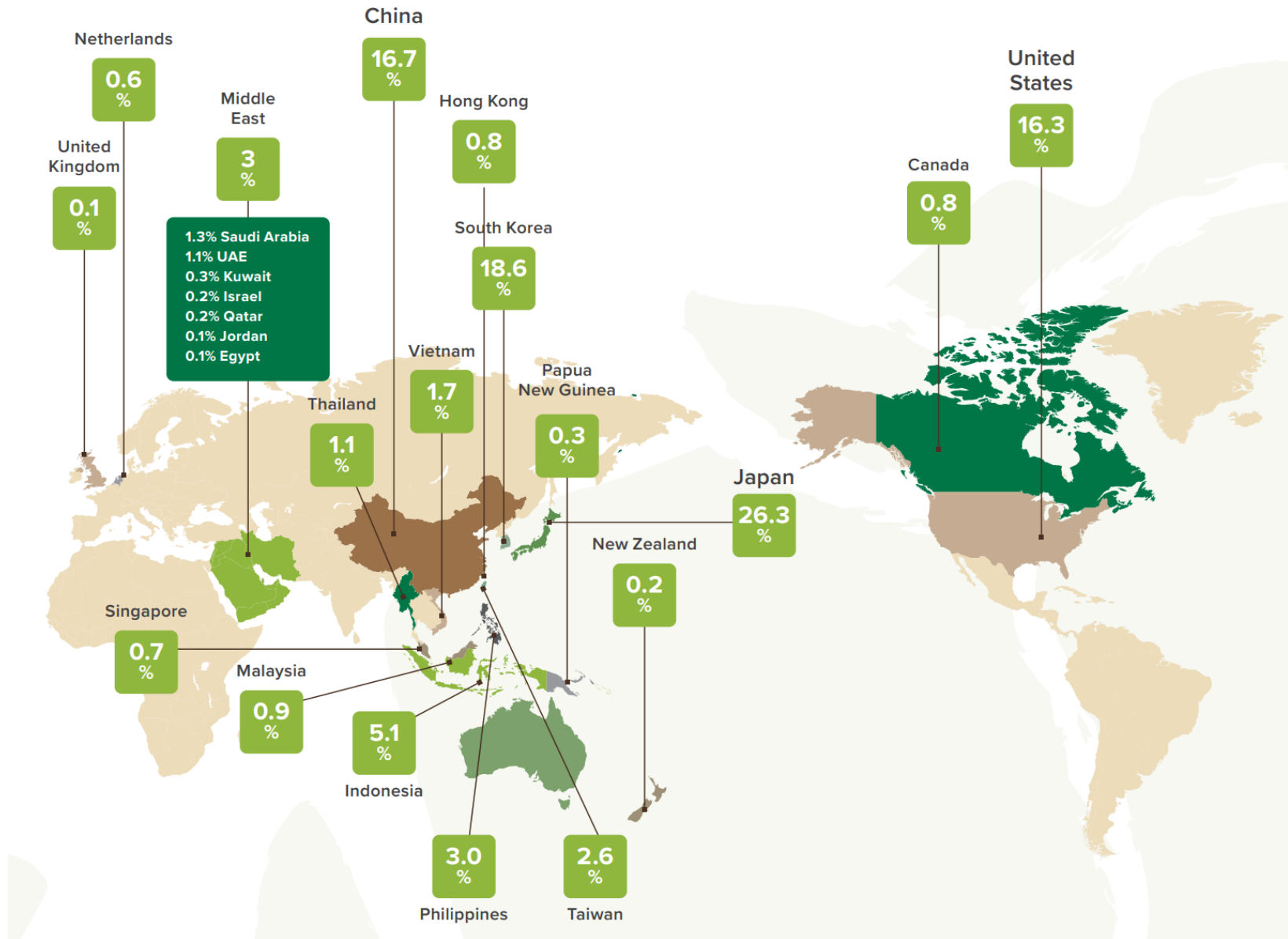
Source: ABS

Australian beef and veal production

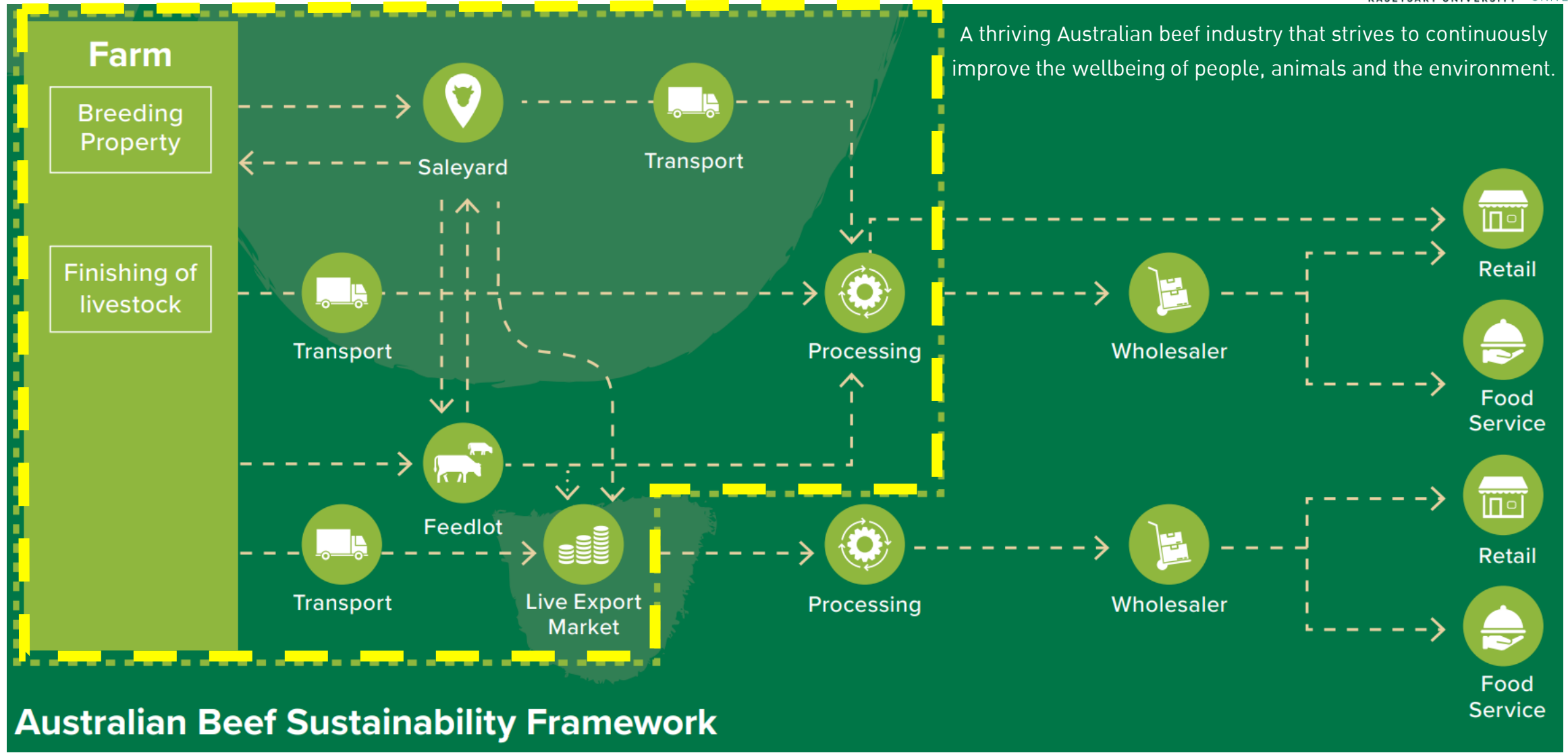


Source: ABS, 2022

Australian beef exports by volume (2021)



AUSTRALIAN BEEF SUSTAINABILITY 2023: ANNUAL UPDATE



Information for the period of 1st July 2022 to 31st May 2023.

The Australian beef industry is committed to the following five goals

 Best Animal Care	The Australian beef industry is guided by the five domains of animal welfare. The industry provides all cattle with an environment in which they can thrive in accordance with these domains.
 Environmental Stewardship	By 2030, the Australian beef industry will demonstrate its net positive contribution to nature.
 Climate	The Australian beef industry will achieve net zero greenhouse gas emissions across its production and processing sectors by 2030.
 Economic Resilience	The value of Australian beef industry products and services doubles from 2020 levels by 2030 resulting in a profitable and resilient industry.
 People & Community	The Australian beef industry is trusted, attractive to a diverse workforce, a source of pride and belonging, and makes a positive contribution to the food security of Australian and international communities.

The Five Domains of Animal Welfare is an internationally recognised standard for optimal animal health and welfare. It provides a means of evaluating the welfare of an animal, or group of animals, with a strong focus on mental wellbeing and positive experiences.

The five domains are:



Nutrition

Availability and quality of feed and water.



Environment

Atmospheric and environmental conditions.



Health

Presence or absence of a disease and injury.



Behaviour

Restriction or expression of behaviour.

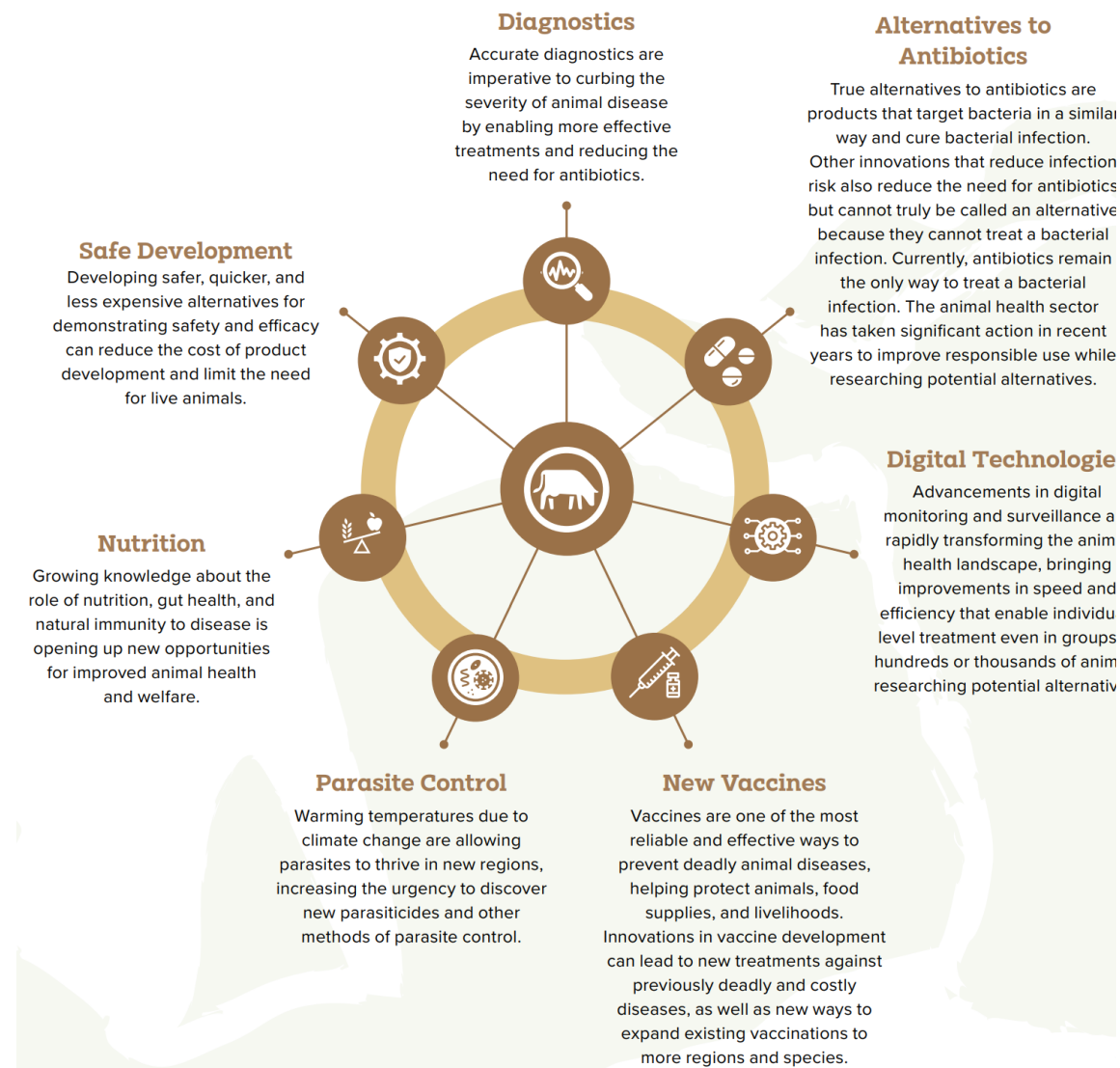


Mental State

Subjective feelings and experiences.

New Frontiers in Animal Care

- The majority of industry investment aligns with the seven focus areas highlighted below, allowing for a concerted effort in animal health and welfare.



Materiality Assessment



Best Animal Care

1. Animal husbandry
2. Processing practices
3. Livestock transport
4. Livestock health and welfare
5. Biosecurity



Economic Resilience

6. Productivity
7. Profitability
8. Market access
9. Climate change resilience



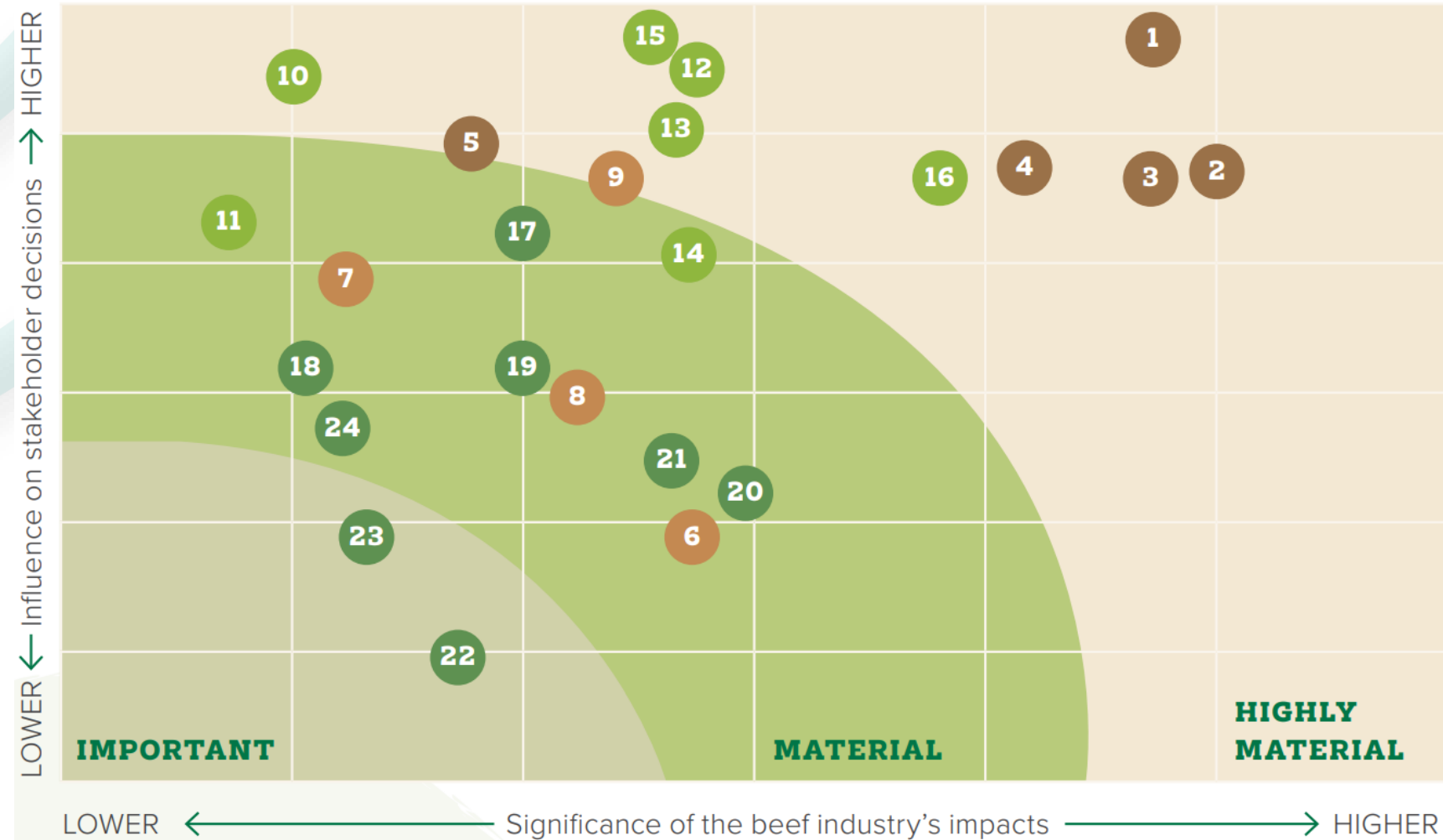
Environmental Stewardship

10. Water
11. Waste
12. Soil health
13. Balance of tree and grass cover
14. Ground cover
15. Biodiversity
16. Greenhouse gas emissions and carbon capture



People and Community

17. Food safety and quality
18. Diversity
19. Work, health and safety
20. Community contribution
21. Nutrition
22. Capacity building
23. Labour practices
24. Antimicrobial stewardship



Providing essential nutrition and food security including access to safe, sufficient and nutritious food.

Nutrition Information*	per 150g serve*
Good Source[^]	
Protein	34.3g
Iron	3.1mg
Zinc	6.7mg
Vitamin B12	1.4µg
Source[^]	
Omega-3 fatty acids	48.2mg
Riboflavin (B2)	0.29mg
Niacin (B3)	7.5mg
Pantothenic acid (B5)	0.54mg
Vitamin B6	0.21mg
Magnesium	38mg
Phosphorus	328mg
Selenium	16µg

* Average nutrition information per 150g serve raw weight of four major beef cuts.

[^] Foods that are a 'good source of protein' have more than 10g per serve; 'good sources' of essential nutrients have 25% or more and 'sources', 10% or more of the recommended daily intake (RDI) as defined for labeling purposes in the Australian Food Standards (1.2.7).

Nutritional Benefits of Australian Red Meat

This report and nutrition resources for promoting the benefits of Australian beef in healthy, balanced meals are available on the MLA Healthy Meals web site.

3 to 4

balanced meals a week is a practical way to eat recommended amounts.

Amounts recommended in the Australian Dietary Guidelines is equivalent to

650g

per person per week (raw weight)

Provides Australians with a great source of high-quality

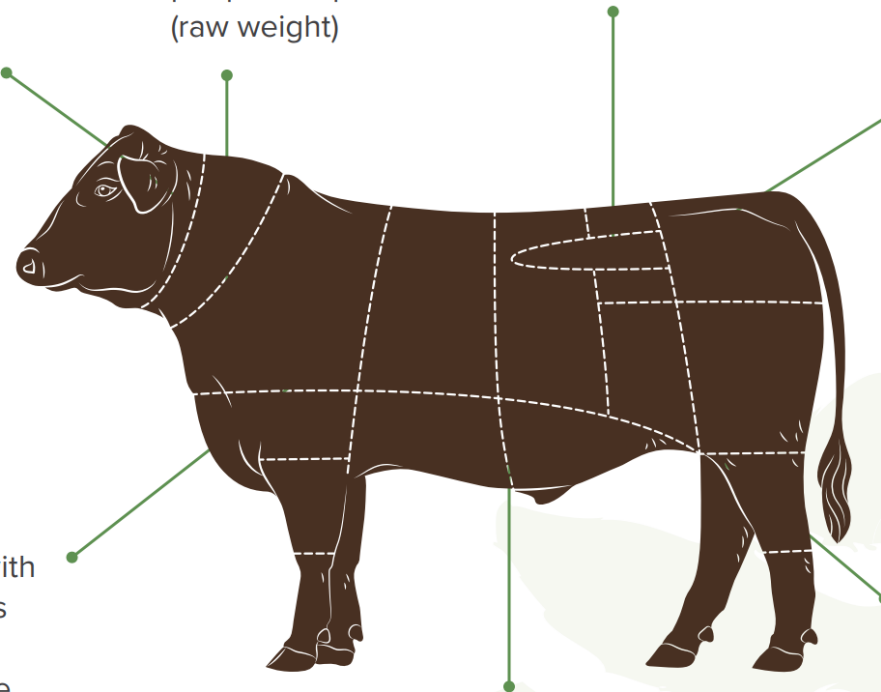
protein, bioavailable

iron and zinc, and

a source of omega-3 and vitamin B12.

Popular meals are a practical way to explain serving size, because the typical serving size ranges between 100 to 200g.

Purchase weight is a practical guide and is consistent with the way red meat is purchased and prepared (i.e. mince 500g, serves 4)



All beef cuts, including lean mince, provide **similar nutritional benefits.**

Insights suggest consumers need **'more than steak'** meal ideas to eat recommended amounts of red meat.

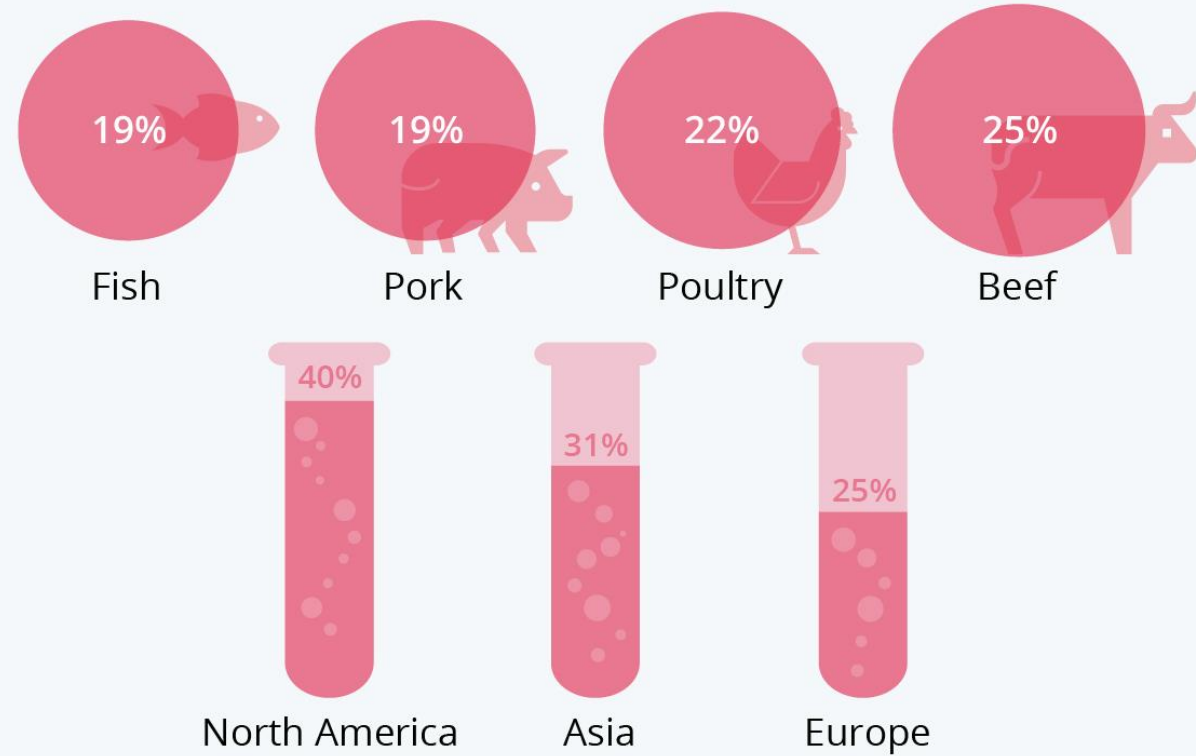


เศรษฐศาสตร์เกษตร
และทรัพยากร
มหาวิทยาลัยเกษตรศาสตร์

Alternative Protein



by focus on selected meat varieties and location

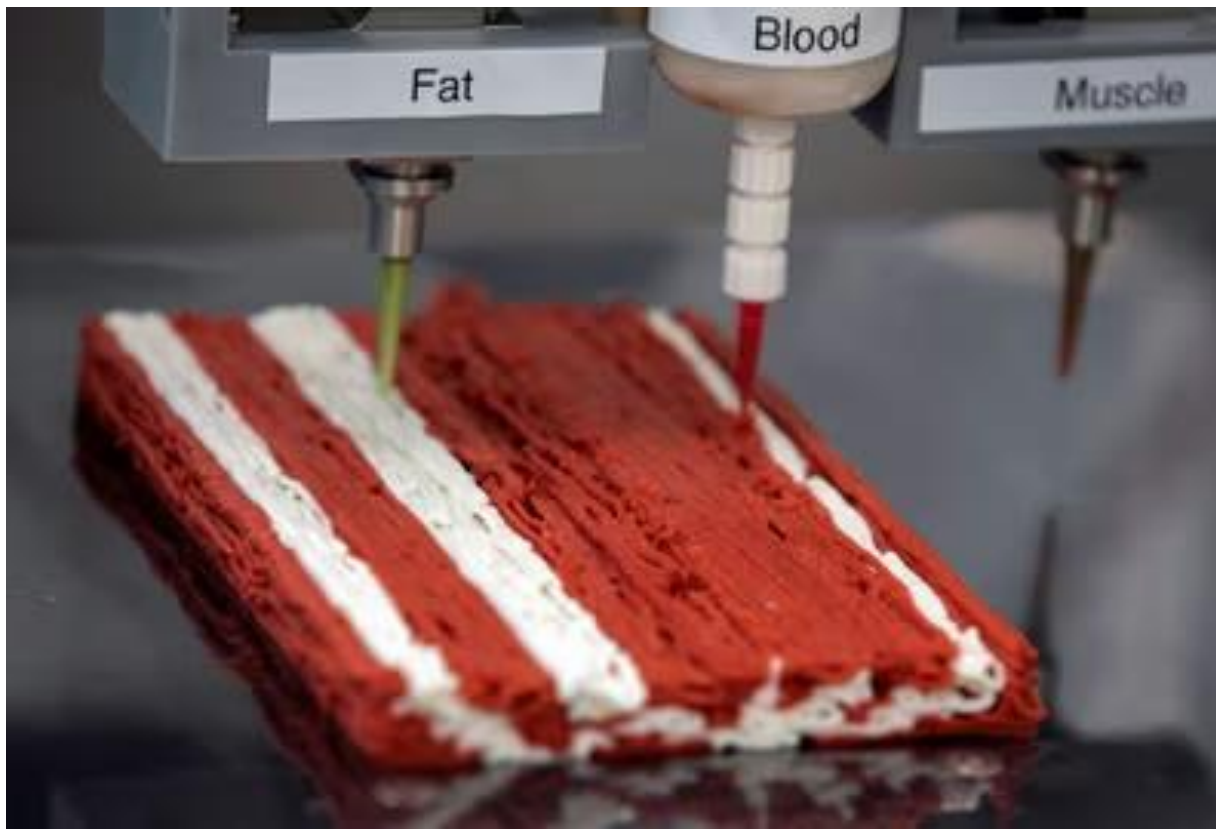


Source: Choudhury et al. The Business of Cultured Meat

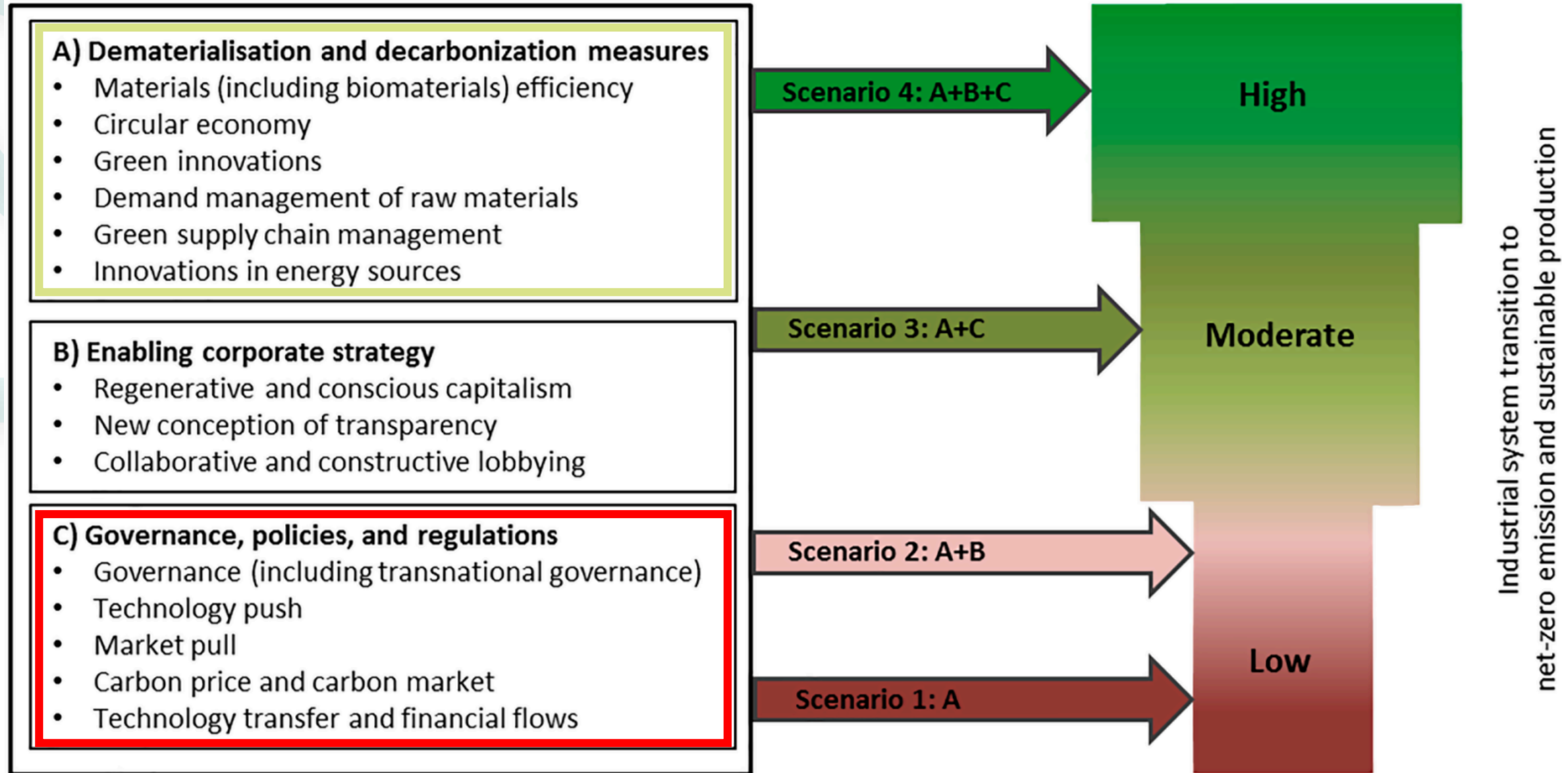
Lab-Grown Meat



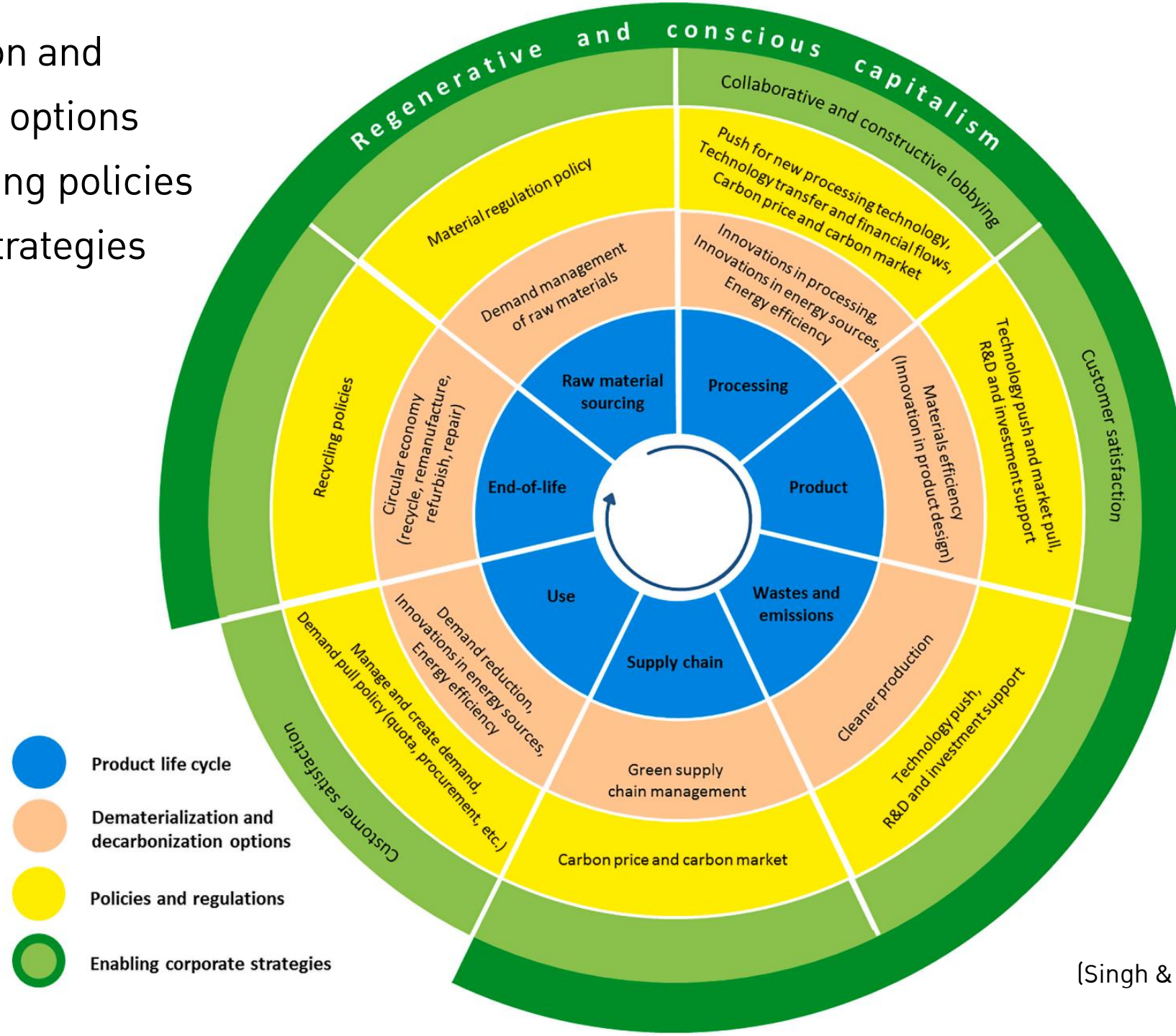
Plant-Based Meat



Redefine Meat's 3D-printing process. Photograph: Amir Cohen/Reuters



Dematerialization and decarbonization options and corresponding policies and corporate strategies



(Singh & Chudasama, 2021)