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Planetary boundaries and livestock

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My dual passions, commitment to family farming and a possible conflict of interest

Village chickens and their owners

Merino sheep and Australian farmers

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Acknowledgements

- **GASL South Asia Conference Organizing Committee**, especially Drs Nitya Ghotge and Ilse Köhler-Rollefson
- **FAO, ILRI**
- **Small-scale and family farmers and producers** in the Indo-Pacific
- **Kyeema Foundation** colleagues

KYEEMA FOUNDATION

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Our challenge

How do we deliver
optimal,
ethical,
safe and
sustainable
livestock production
by 2050?

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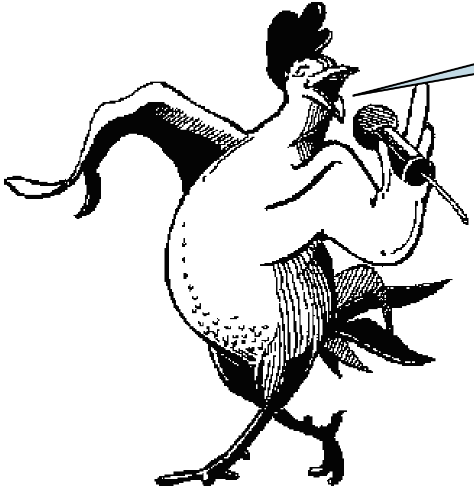
Presentation outline

1. Introduction to Planetary boundaries
2. Planetary boundaries and livestock
3. Sustainable & circular bioeconomies
4. Key recommendations

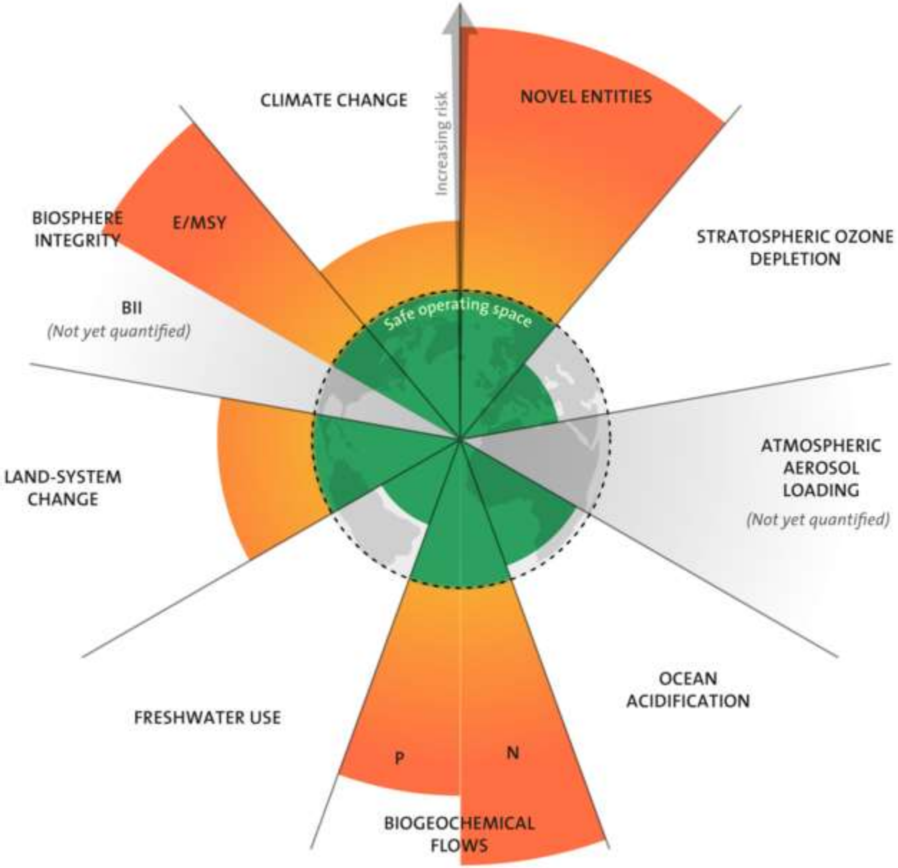
1. Introduction to planetary boundaries



Planetary Boundaries: an introduction

Planetary boundaries are

- A communication device for conceptualising **a Safe Operating Space for Humanity**
- Help to focus attention and define overarching goals for the livestock sector
- Consist of **nine Earth system metrics**:
  - biosphere integrity
  - biogeochemical flows
  - ocean acidification
  - land-use change
  - global freshwater use
  - stratospheric ozone depletion
  - atmospheric aerosol loading
  - chemical pollution
  - novel entities

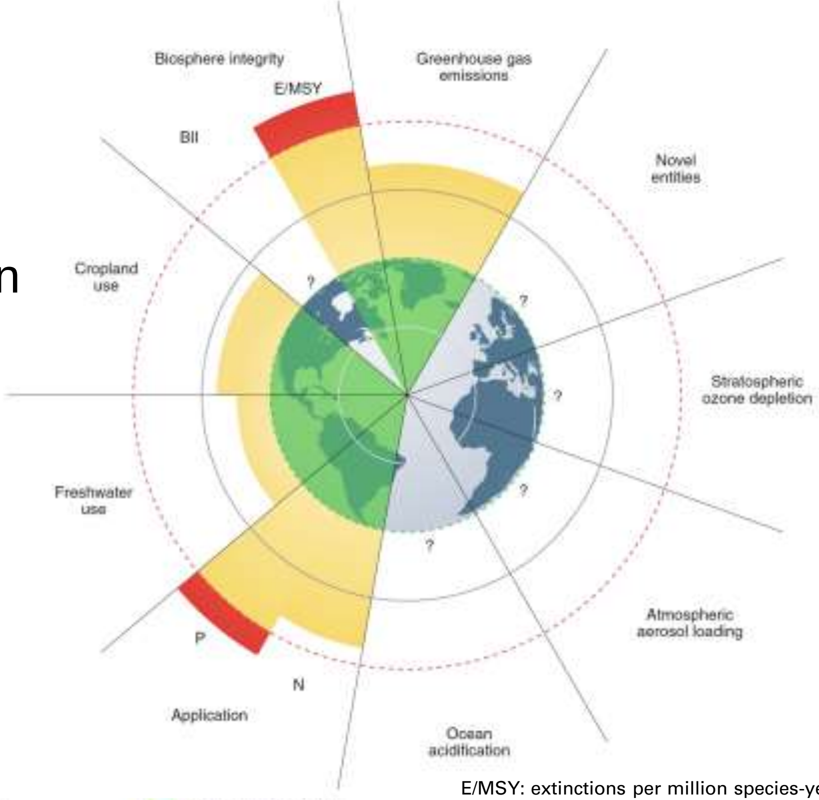


Source: Steffen et al. (2015)

Planetary Boundaries and food systems

An estimate of the global food system's transgression of planetary boundaries

- **safe operating space** (green) provides an estimate of the food-related share of the planetary boundaries
- **zone of uncertainty** (yellow) defines dangerous risk
- **high-risk zone** (red) indicates where production has exceeded the assessed uncertainty range

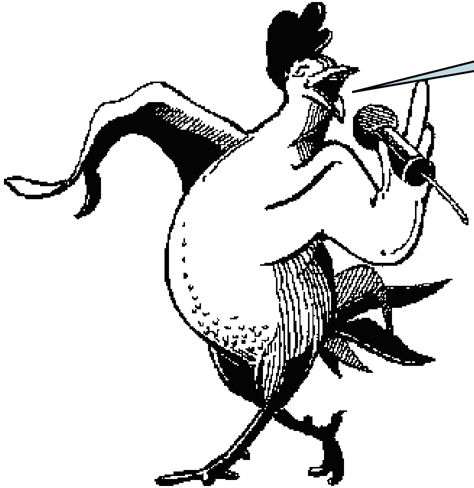


Beyond zone of uncertainty (high risk)
In zone of uncertainty (increasing risk)
Below boundary (safe)
Food boundary not yet quantified

E/MSY: extinctions per million species-years
BII: Biodiversity Intactness Index
P: phosphorus
N: nitrogen

Source: Rockström et al. (2020)

2. Planetary boundaries and livestock



Examples of the range of positive and negative effects of aquatic and terrestrial animals on Earth processes

Boundary (i.e. Earth system process)	**Positive examples** (i.e. relieving strain on planetary boundaries)	**Negative examples** (i.e. placing strain on planetary boundaries)
1. Biosphere integrity Indicators: Extinctions per million species-years Biodiversity Intactness Index	Sustainable, safe harvesting of animal species well adapted to local environments Adaptation of welfare-friendly livestock production practices that enhance plant and animal biodiversity and ecosystem function	Animal-source food produced by a limited number of species and breeds at the global level Feed demands for intensively raised animals requiring the expansion of livestock and crop production into new landscapes, including forests and wetlands → loss of biodiversity → increased risk of pathogen spillover events from wild animal and bird reservoirs to domestic animals and humans

(Alders et al., 2021a)

Agrobiodiversity loss

- The 9 million Holstein dairy cows in the US
  - descended from 2 sires
  - female effective population size < 50

- Commercial chicken genetics lack diversity and are controlled by 4 major companies for both broilers and layers

Freeimages.com

Biodiversity loss

- Biodiversity reflects overall environmental health
- Diminishing numbers of key species
- **Extinction of pollinator bees would severely affect food security** and destroy the delicate balance of the Earth's ecosystem
- Essential to encourage livestock production systems that promote biodiversity

Shutterstock

Sociocultural & religious diversity

A. Chiapas Sheep breed cared for by Tzotzil shepherdesses in Mexico; prohibited to kill them
B. Mayan Tzotzil weaver transforming wool into traditional garments

Photo credit: Raul Perezgrovas-Graza, 2019

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Examples of the range of positive and negative effects of aquatic and terrestrial animals on Earth processes

Boundary	Positive examples	Negative examples
2. Biogeochemical Indicators: Amount of nitrogen removed from the atmosphere for human use Quantity of phosphorus flowing into the oceans	Integrated aquaculture−agriculture closed circular systems Appropriate use of manure for organic fertiliser Maintaining wetlands as part of an integrated aquaculture−agriculture closed circular system and ecological balance of ecosystems	Excessive use of nitrogen fertiliser to grow feed for aquatic and terrestrial animals and subsequent spillover/leakage of excess fertiliser into water ways Inefficient and improper management of livestock manure and aquaculture waste generated by intensive production systems

(Alders et al., 2021a)

Examples of the range of positive and negative effects of aquatic and terrestrial animals on Earth processes

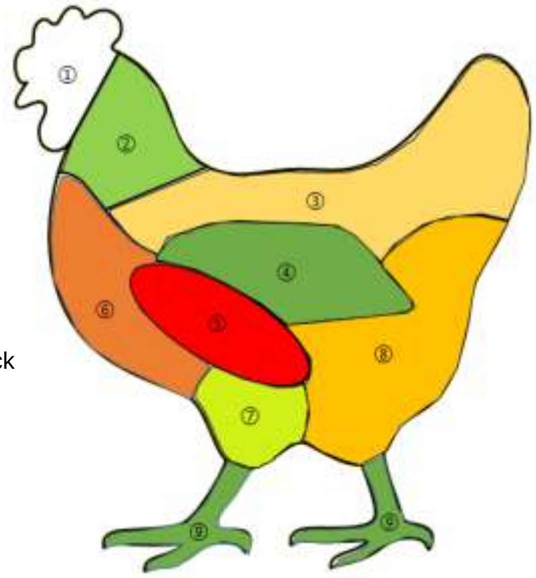
Boundary	Positive examples	Negative examples
4. Land use change Indicator: Area of forested land as percentage of original forest cover	Introduction of agro-ecological/regenerative livestock and crop production systems that reduce net greenhouse gas (GHG) emissions and improve overall soil health Greater yields per hectare into the human food chain from livestock in high-income countries – both by weight and nutrient yields – through enhancing animal genetics and husbandry practices and reducing pre-consumer losses, i.e. eating more of the animal, including offal → less land clearing and fewer flow-on effects	Clearing forests for livestock production and coastal mangrove forests for coastal shrimp farming for human and companion animal food chains Arable land, particularly near cities, being built on for housing or industry and becoming urban Poor land/agricultural husbandry practices leading to land degradation, fertility loss

(Alders et al., 2021a)

Efficient use of nutrients (i)

Nutrient distribution in chicken carcases

① = Head
② = Neck
③ = Back
④ = Wing
⑤ = Giblets
⑥ = Breast
⑦ = Drumstick
⑧ = Thigh
⑨ = Feet



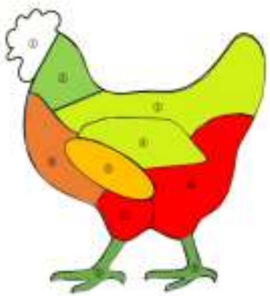
Distribution of **iron** amongst a whole chicken carcass

Distribution of nutrients across a chicken carcass								
	Fe (mg)	Zn (mg)	Vitamin B12 (ug)	Vitamin A (IU)	Folate (ug)	Thiamine (mg)	Protein (g)	Energy (kj)
Back	10.7	11.5	2.9	5.0	2.5	9.2	9.3	18.5
Breast	20.1	17.4	9.4	4.0	4.0	27.1	33.1	23.9
Drumstick	9.1	19.2	7.0	1.0	1.4	17.0	13.6	10.6
Thigh	12.7	19.4	11.8	2.6	2.1	21.6	18.1	21.1
Wing	5.0	10.5	2.7	0.6	2.8	10.2	11.7	11.9
Neck	6.0	4.7	0.8	1.2	0.6	2.3	2.6	4.8
Giblet	31.7	14.4	62.9	84.7	69.6	7.5	5.7	3.4
Feet	4.8	2.9	2.5	0.9	16.8	5.0	6.0	5.8

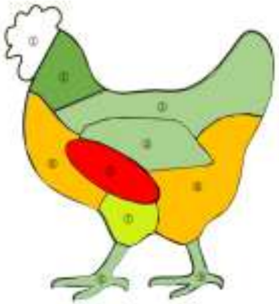
Chan, et al. 2017. What's in a Chicken? Comparing the nutrient value, potential to meet nutrient requirements and health-cost effectiveness of whole and frozen chickens. BVSc Honours Dissertation, University of Sydney.

Efficient use of nutrients (ii)

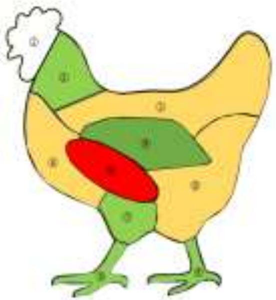
Nutrient distribution in chicken carcases



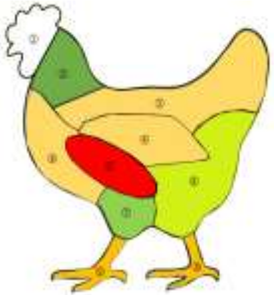
Zinc



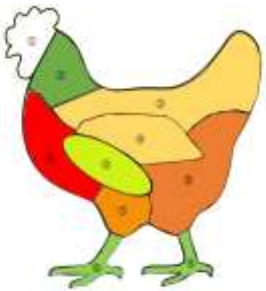
Vitamin B12



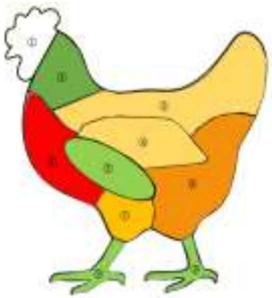
Vitamin A



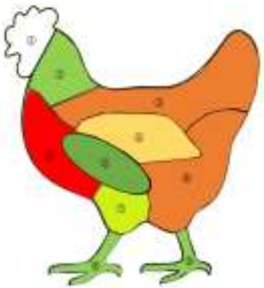
Folate



Thiamine



Protein



Energy

Chan et al. (2017)

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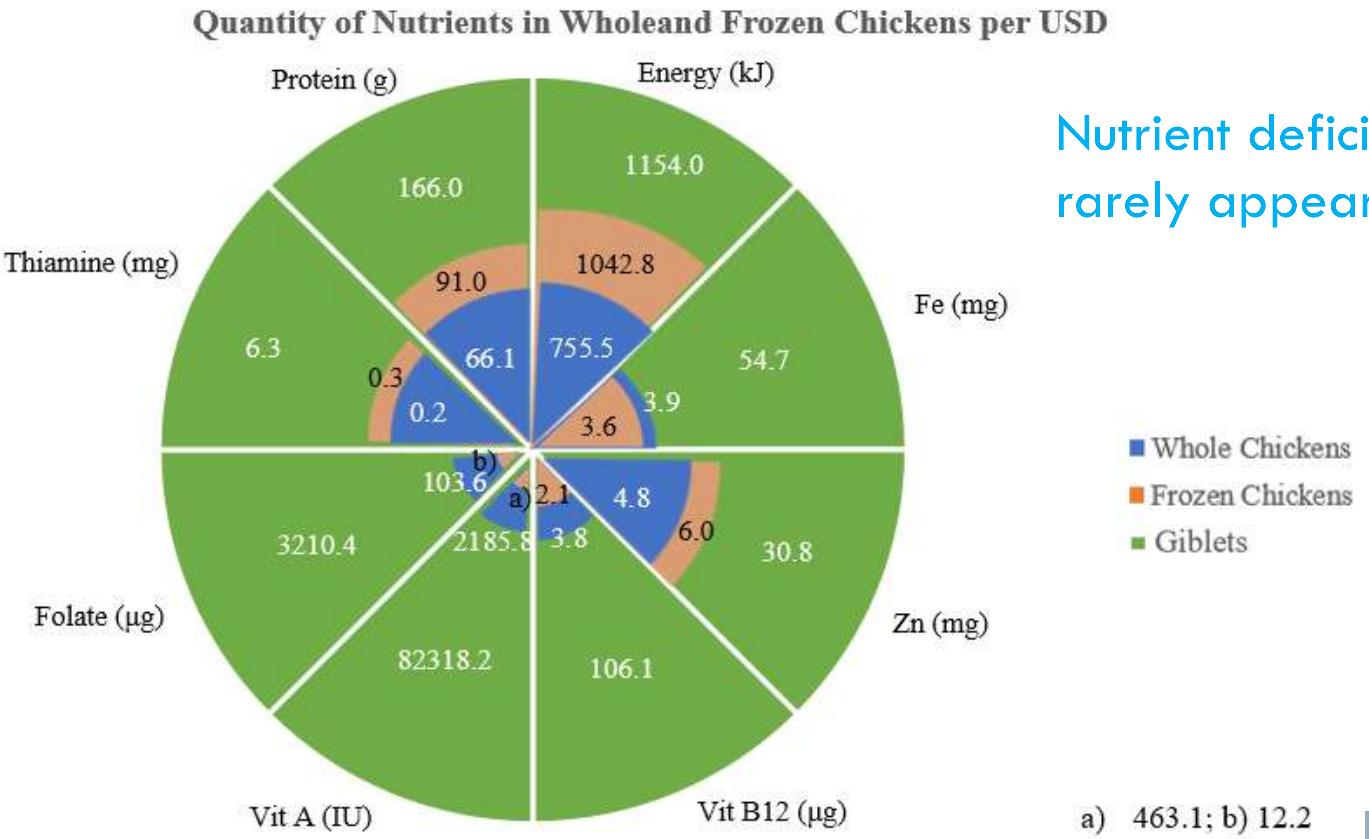
Efficient use of nutrients (iii)



Nutrient deficiencies rarely appear alone

Chan et al. (2017)

Examples of the range of positive and negative effects of aquatic and terrestrial animals on Earth processes

Boundary	Positive examples	Negative examples
5. Global fresh water use Indicator: Maximum amount of consumptive blue water use (km^3 per year)	Selection of animals for heat tolerance and efficient water use	Increased water consumption by animals due to increasing numbers of domestic aquatic and terrestrial animals Raising animals poorly adapted to local agro-ecological conditions

Examples of the range of positive and negative effects of aquatic and terrestrial animals on Earth processes

Boundary	Positive examples	Negative examples
6. Stratospheric ozone depletion Indicator: Concentration of ozone	None	Skin cancers in animals expected to increase until 2070, in association with ozone layer depletion due to human-made ozone-depleting substances

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Examples of the range of positive and negative effects of aquatic and terrestrial animals on Earth processes

Boundary	Positive examples	Negative examples
7. Atmospheric aerosol loading Indicators: Overall particulate concentration in the atmosphere, on a regional basis	Silvopasture production systems that reduce ground-level wind speed and enhance soil cover Production systems that conserve soil moisture, reducing the impact of bushfires	Overgrazing, leading to loss of vegetative cover and dust generation by wind

EU System Report: Cork Oak Silvopastoral Systems in Portugal

AGFORWARD
Agroforestry for Europe

Source: https://www.agforward.eu/documents/WP2_PT_Montado_system_description.pdf

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Examples of the range of positive and negative effects of aquatic and terrestrial animals on Earth processes

Boundary	Positive examples	Negative examples
8. Chemical pollution Indicator: Amount emitted, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals and nuclear waste in the global environment	Breeding to reduce livestock pests and diseases (flystrike susceptibility/intestinal worms) and hence reduce pesticide/ drench use On-farm biosecurity measures and use of vaccines that reduce the need for veterinary medicines and pesticides (e.g. grazing management to reduce environmental worm burdens, isolating new stock to manage the risk of lice and ticks, selection of specific-pathogen-free seeds for aquaculture) Use of organic fertilisers and soil amendments on land used to grow fodder	Heavy metal pollution affects animal health and the safety of aquatic and terrestrial animal-source foods Antibiotic pollution of the environment including water ways

Examples of the range of positive and negative effects of aquatic and terrestrial animals on Earth processes

Boundary	Positive examples	Negative examples
9. Climate change Indicators: Atmospheric carbon dioxide and methane concentrations Change in radiative forcing	Well-managed perennial pasture and silvopasture can sequester carbon, reducing atmospheric levels; good animal husbandry and efficient use of animal products can reduce GHG emissions per unit of production	Emissions of methane and nitrous oxide and the loss of organic carbon in the soil and biomass carbon associated with animal raising and animal feed production and supply lines Energy consumption associated with heating and cooling intensive rearing enterprises Transport of feed in and animals out for slaughter Decreased animal welfare due to increased heat stress, pathogen circulation, droughts and bushfires

Low emission transport

Supporting crop production with draught power, transport, and manure

Draught horses used in logging in Germany have lower GHG emissions than mechanized fossil fuel tractors (Engel et al., 2012)

Photo credit: Fallou Gueye, FAO, 2020

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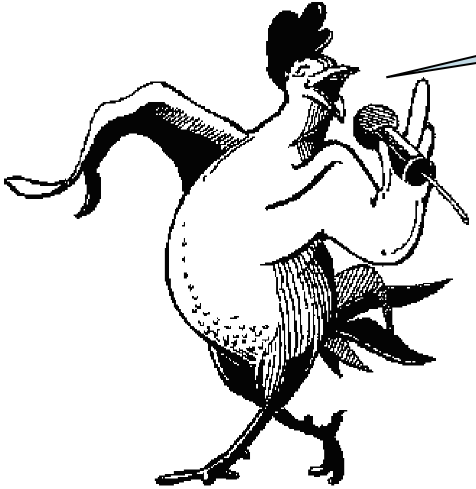
Regenerative natural fibre production

<u>Natural fibre</u>
- Biodegradable
- Fire resistant

<u>Regenerative</u>
- Carbon sequestration
- Perennial pastures
- Increased biodiversity

Photo credit: Robyn Alders, 2021

3. Sustainable & circular bioeconomies



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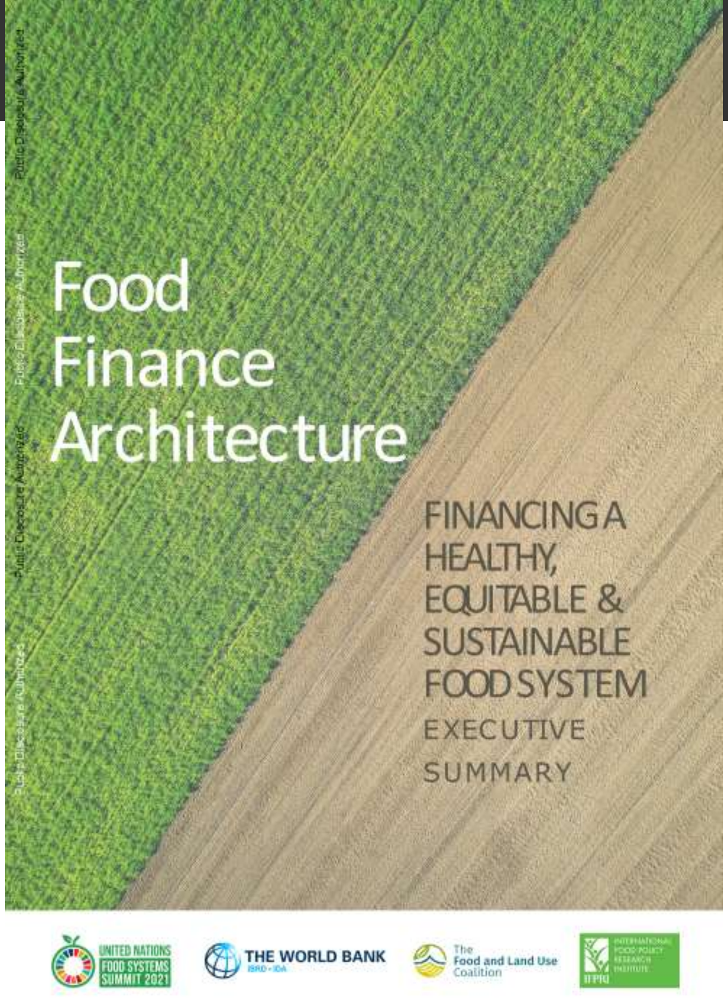
World Bank et al. 2021

“Food systems must change rapidly and fundamentally in the coming decades to become more regenerative, resilient, and inclusive, while increasing food supply for an additional 2 billion people by 2050**”**

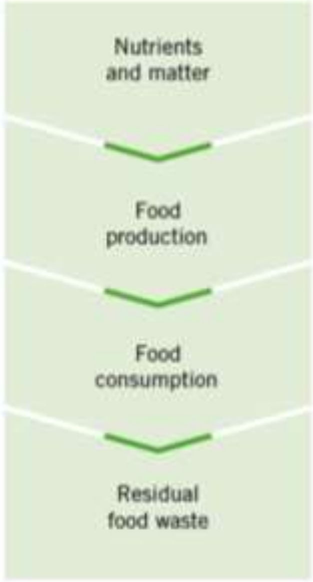
“Today’s food systems generate $12 trillion in hidden social, economic, and environmental costs”

Proposes 5 imperatives needed to optimize public spending and mobilize private capital for a global food system transformation, including **intersectoral collaboration**

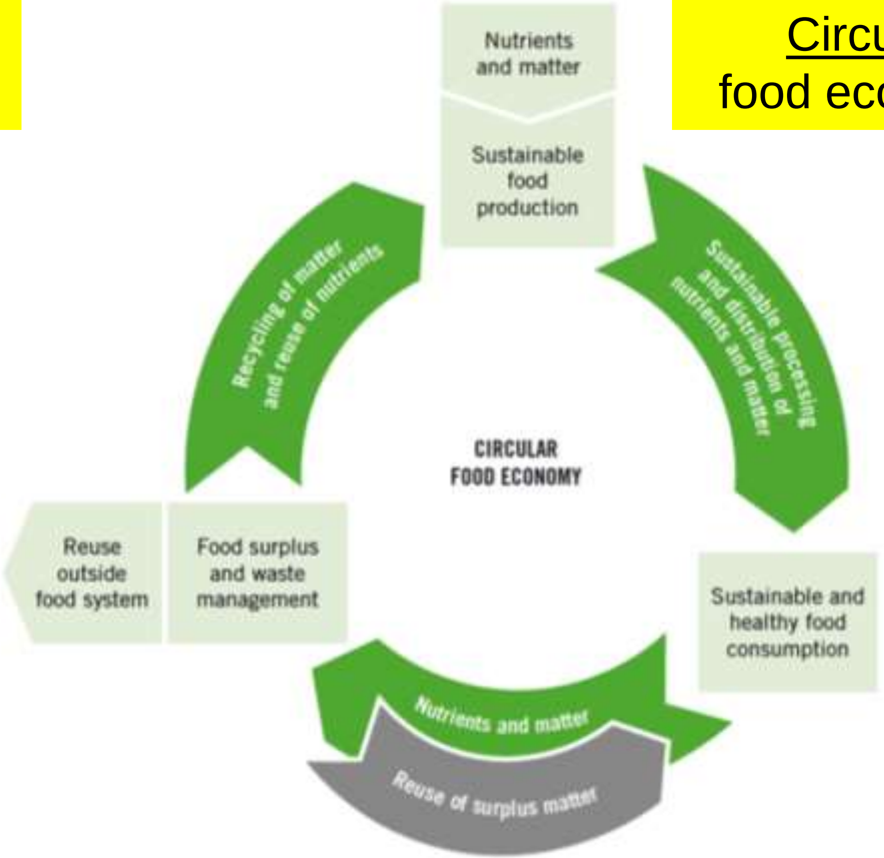


Sustainable and circular bioeconomies

Linear food economy



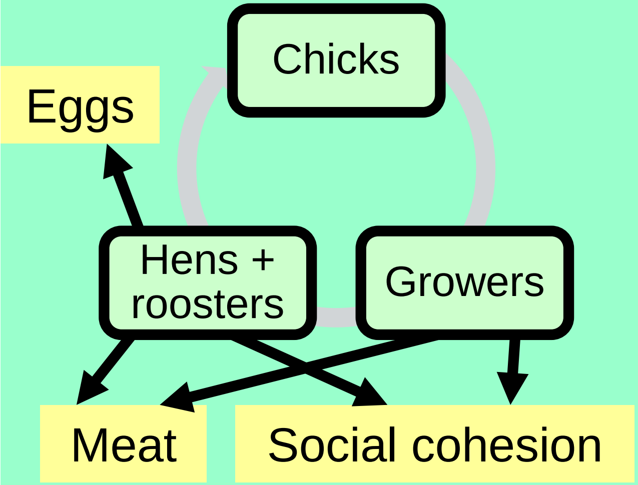
Circular food economy



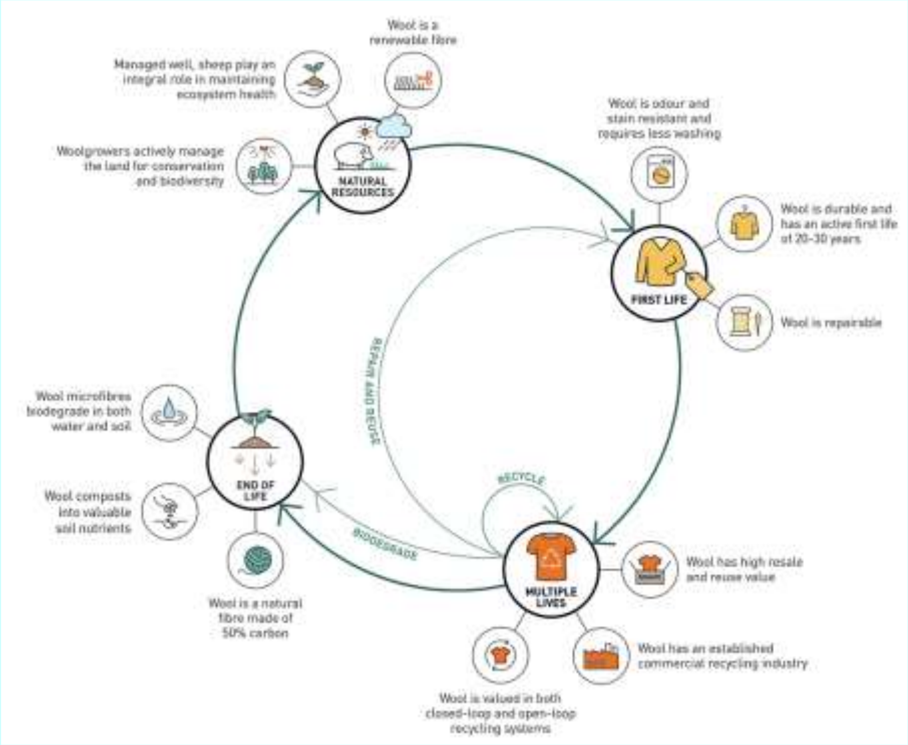
Source: Alders et al. (2020)

Circular economies: two examples

Mozambique: village chickens



Australia: merino wool



Source: Robyn Alders, 2022

Source: Beyond the Bale, AWI

Ecosystems services

Ecosystem services = multiple benefits to humans (e.g., food, clean water, shelter, and raw materials for our basic needs) provided by healthy ecosystems

Extensively raised livestock

- frequently integral to provision of ecosystem services
- essential to many agroecosystems
- contribute to circular food and fibre systems

Roles include:

- **transforming feed inedible by humans** into nutritious foods

- **useful products** such as pharmaceuticals and companion animal feed, fuel (through manure), and transport

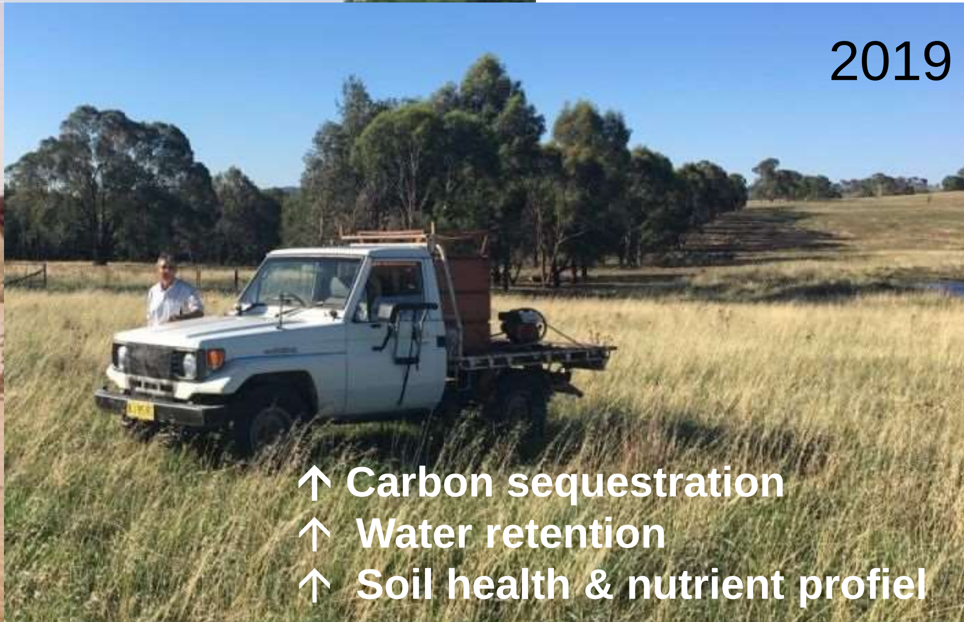
- **enhancing ecosystem health** through grazing, browsing, trampling, and the production of dung and urine

- **shifting locations** allowing them to respond to fluctuations in resource availability and weather patterns

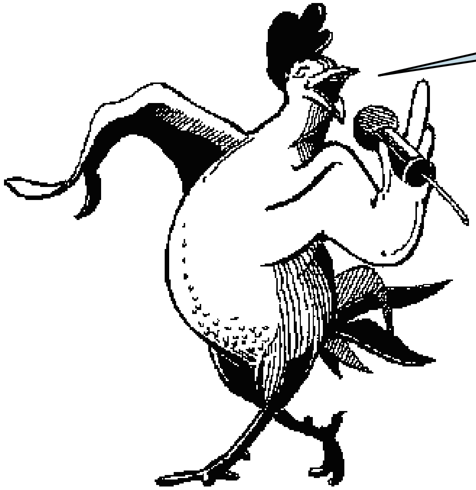
Nature-based production

Extractive

Regenerative



4. Recommendations



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Key recommendations

As livestock specialists, we have a responsibility to encourage practices that safeguard global health security and the health of the planet through:

- Evidence-based debates on **sustainable human and animal nutrition and appropriate welfare**
- Use of food for people and feed for animals that are **ecologically, economically and socially sustainable**
- Land management practices involving animals that **enhance soil health and biodiversity**, employ principles of regenerative, climate-resilient livestock production
- **Value food** - according to its natural nutrient density in addition to weight and/or volume, value nutrients and enable their recycling
- **Restructure human healthcare services** to place a higher value on the contributions of agriculture and livestock producers to preventive medicine

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Thank you for your time

No one individual, discipline or sector can deliver ethical, economically and ecologically sustainable livestock production.
Together, we have to!

- Comments and queries welcome
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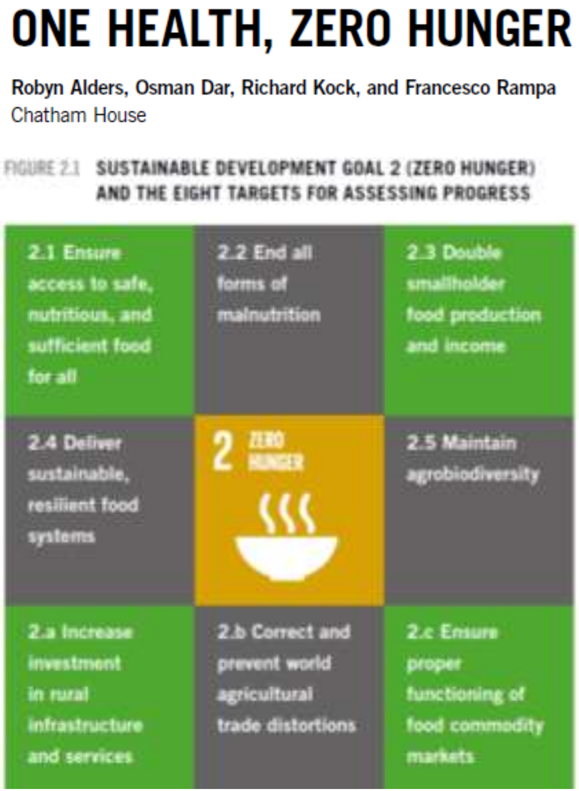

ONE HEALTH, ZERO HUNGER

Robyn Alders, Osman Dar, Richard Kock, and Francesco Rampa
Chatham House

FIGURE 2.1 SUSTAINABLE DEVELOPMENT GOAL 2 (ZERO HUNGER) AND THE EIGHT TARGETS FOR ASSESSING PROGRESS

Available: https://www.globalhungerindex.org/issues-in-focus/2020.html