Greenhouse Gas (GHG) Emissions Reductions and Carbon Sequestration Potential of Climate-Resilient Livestock Farming Practices

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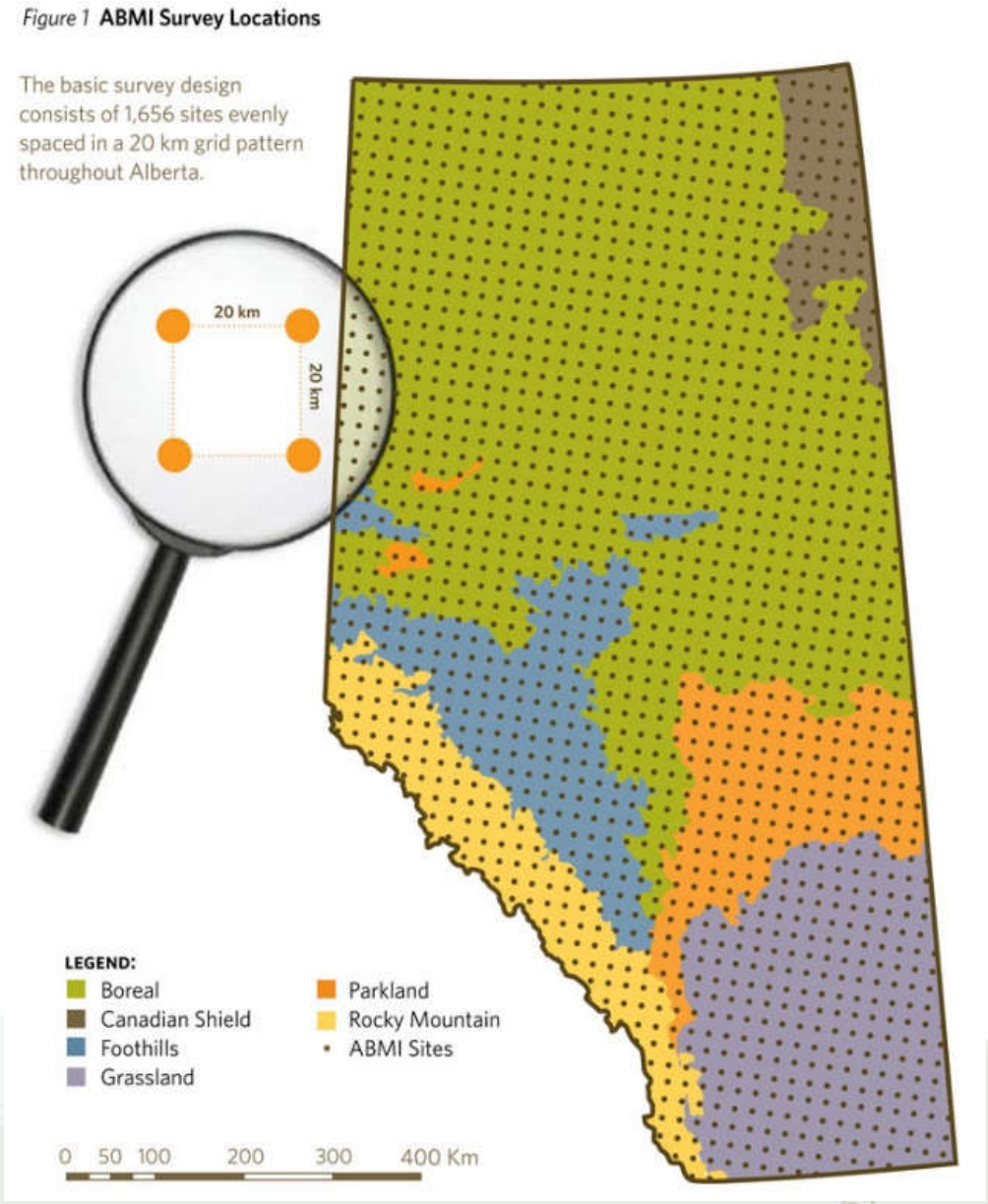
Alberta Biodiversity Monitoring Institute (ABMI)

Full service "research to action" organization: track changes in Alberta's biodiversity, habitats and ecosystems to support natural resource and land-use decision making.

Birds
Mammals
Vascular Plants
Mosses
Lichens
Mites
Aquatic Vascular Plants
Aquatic Invertebrates

Data collection
Sample processing
Data verification & storage
Data Analyses
Reporting and Communications



Presentation Outline

- Introduction
- Direct and Indirect GHG Emissions Sources
- Potential for GHG Emissions Reductions
- Potential for GHG mitigation through Carbon Sequestration
- Implications for Policy and Programs
- Open Discussion

Livestock Production Contributes to Climate Change?

Some key literature influencing wider debate on livestock and climate change

REPORT TITLE	ORGANISATION	AUTHOR	DATE
Farming for Failure: How European Animal Farming Fuels the Climate Emergency	Greenpeace	Greenpeace	2020
Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems	IPCC	Shukla et al.	2019
Food in the Anthropocene: the EAT–Lancet Commission on Healthy Diets from Sustainable Food Systems	EAT–Lancet Commission	Willet et al.	2019
Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050	World Resources Institute (WRI)	Searchinger et al.	2019
Less is More: Reducing Meat and Dairy for a Healthier Life and Planet	Greenpeace	Greenpeace	2018
Grazed and Confused: Ruminating on Cattle, Grazing Systems, Methane, Nitrous Oxide, the Soil Carbon Sequestration Question – And What It All Means for Greenhouse Gas Emissions	Food Climate Research Network	Garnett et al.	2017
Changing Climate, Changing Diet: Pathways to Lower Meat Consumption	Chatham House	Wellesley et al.	2015
Tackling Climate Change through Livestock	United Nations FAO	Gerber et al.	2013
Livestock's Long Shadow	United Nations FAO	Steinfeld et al.	2006

Houzer, E. and Scoones, I. (2021) Are Livestock Always Bad for the Planet? Rethinking the Protein Transition and Climate Change Debate. Brighton: PASTRES.

Livestock Production Contributes to Climate Change?

Ten claims about livestock and climate change

	Emission from agriculture are projected to increase to 52% of global emissions in the next decades, with approximately 70% of the increase coming from animal production(Greenpeace 2020).
	Livestock production is responsible for approximately 33% of global methane emissions and 66% agricultural emissions (IPCC/Shukla et al. 2019).
	Livestock produce approximately 18% of global calories consumed, but use 83% of all farmland (Poore and Nemecek 2018)
	An estimated 33% of global cropland is used to grow animal feed (Poore and Nemecek 2018).
	Animal-sourced foods have the highest impact, between 20 and 100 times more than plant- based alternatives (Clark and Tilman 2017).
	Animal and feed production contributes significantly to deforestation and land use change, accounting for nearly one-third of global deforestation and associated emissions (Wellesley et al. 2015)
	Pastoral livestock systems are associated with higher GHG emissions due to low production efficiency and higher methane emissions from low-quality diets (Steinfeld et al. 2006; Garnett et al. 2017)
	Red meat consumption needs to reduce by 50% by 2050 for the food system to remain in a ‘safe operating space’ (Willet et al. 2019).
	A 75% reduction in animal farming would save an equivalent of 376 million tonnes of CO2 emissions (Greenpeace 2020).
	A 50% global reduction in the production and consumption of animal-sourced foods is needed by 2050 (Greenpeace 2018).

Houzer, E. and Scoones, I. (2021) Are Livestock Always Bad for the Planet? Rethinking the Protein Transition and Climate Change Debate. Brighton: PASTRES.

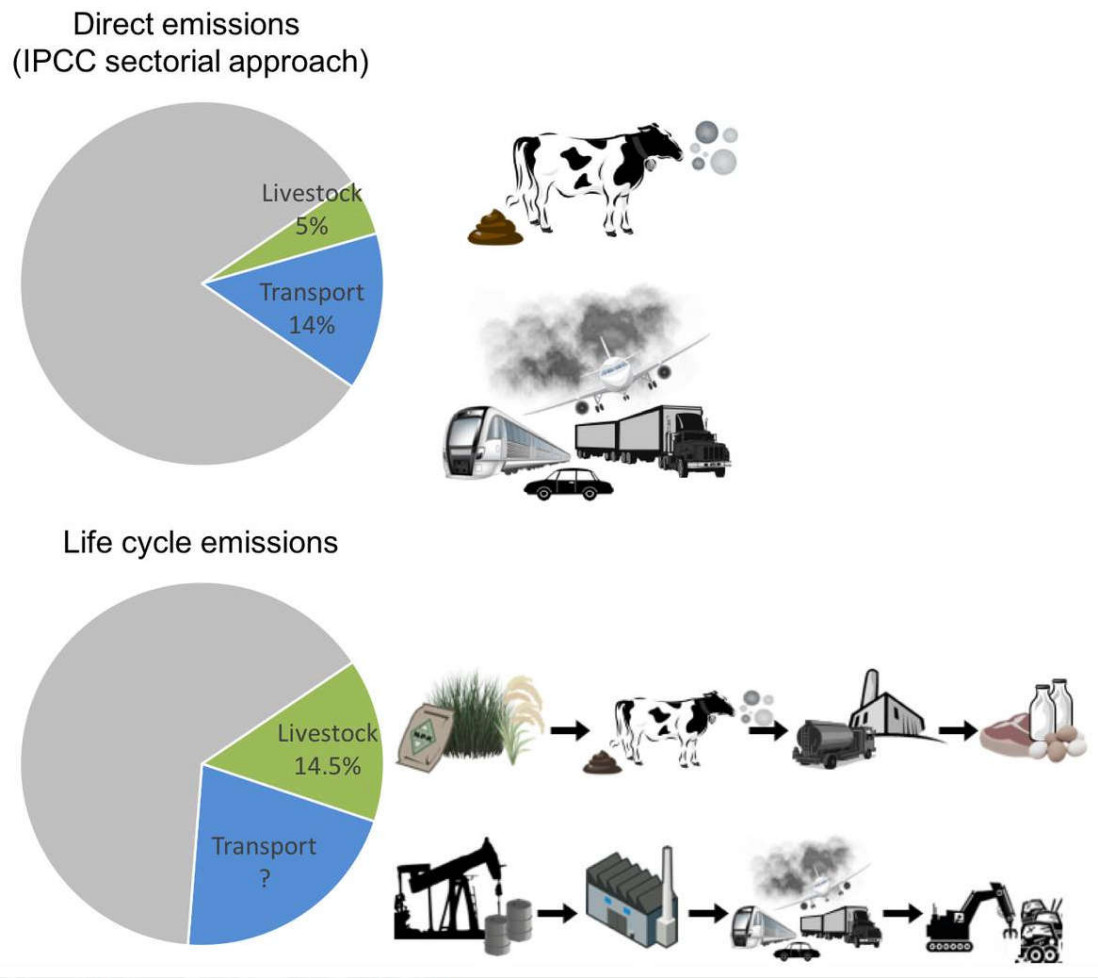
Environmental Concerns over GHG Emissions from Livestock Sector

Cars or livestock: which contribute more to climate change?

GHG emissions from livestock and transport are often compared, but in a flawed way.

The world needs both consumers that are aware of their food choices and producers and companies that engage in low carbon development.

Livestock can indeed make a large contribution to climate change mitigation, food security and sustainable development in general.

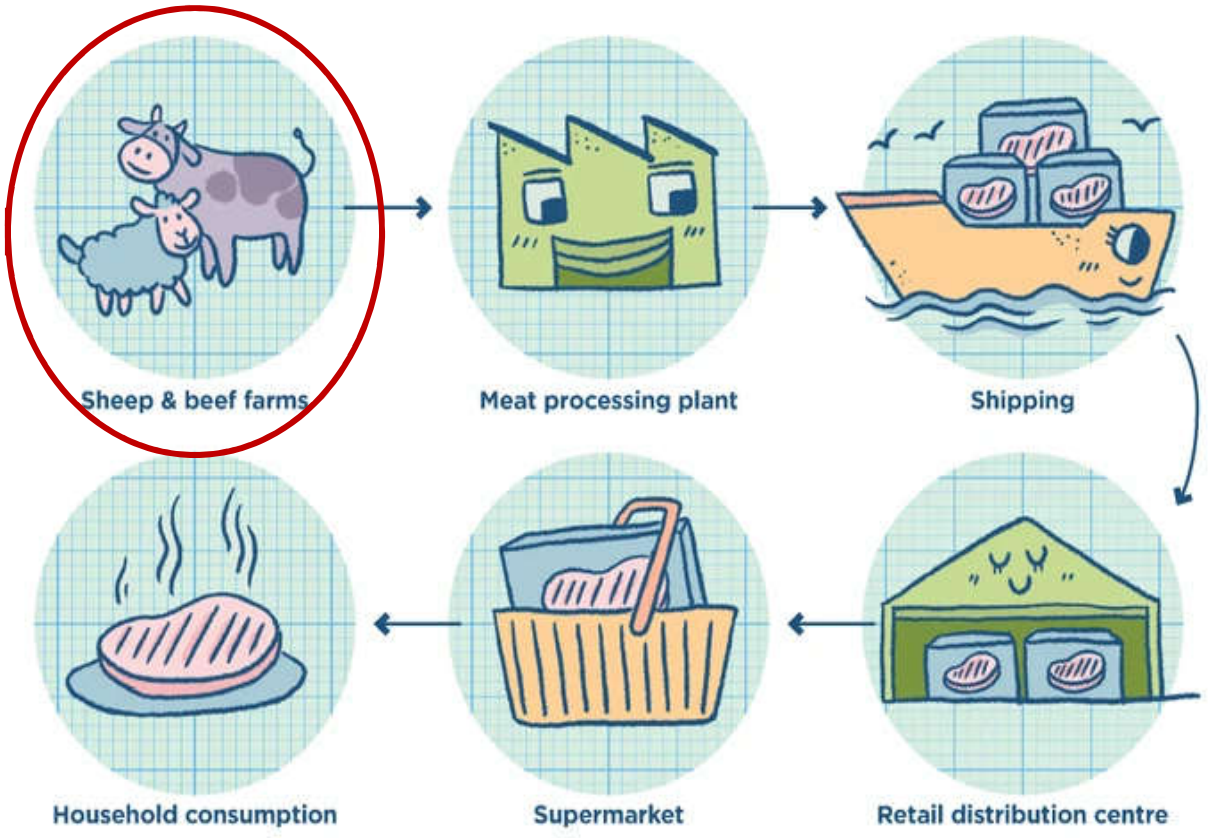


Source: International Livestock Research Institute (ILRI)

GHG Emissions across the Entire Livestock Production Chain

- Edible (meat and milk) *vs.* non-edible products (natural fiber, hides and skin and manure).

- Cradle to retail:
  - ✓ Cradle to farmgate: All processes up to the farmgate where the animals or products leave the farm.
  - ✓ Farmgate to retail: processing and transport of animals and product to market and the retail distributor.



(Illustration: Marc Conaco)

GHG Emissions from Livestock Farming Practices

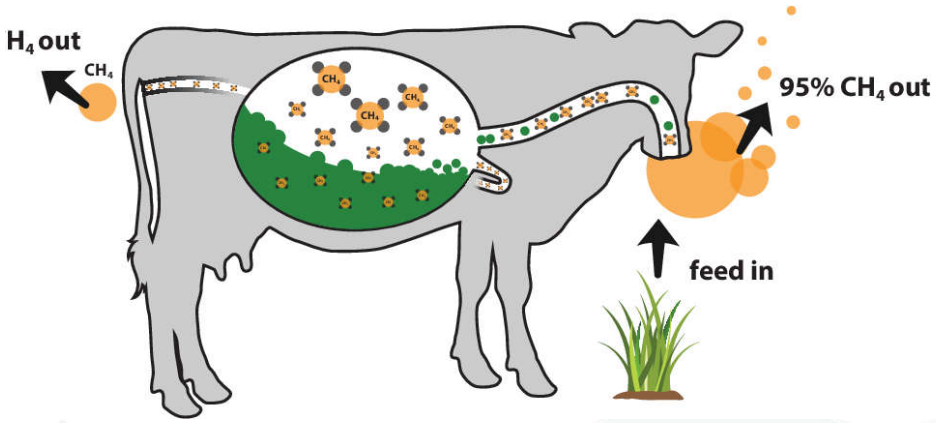
CO_2 and CO_2e are two different things!

CO_2e allows "bundles" of greenhouse gases to be expressed as a single number.

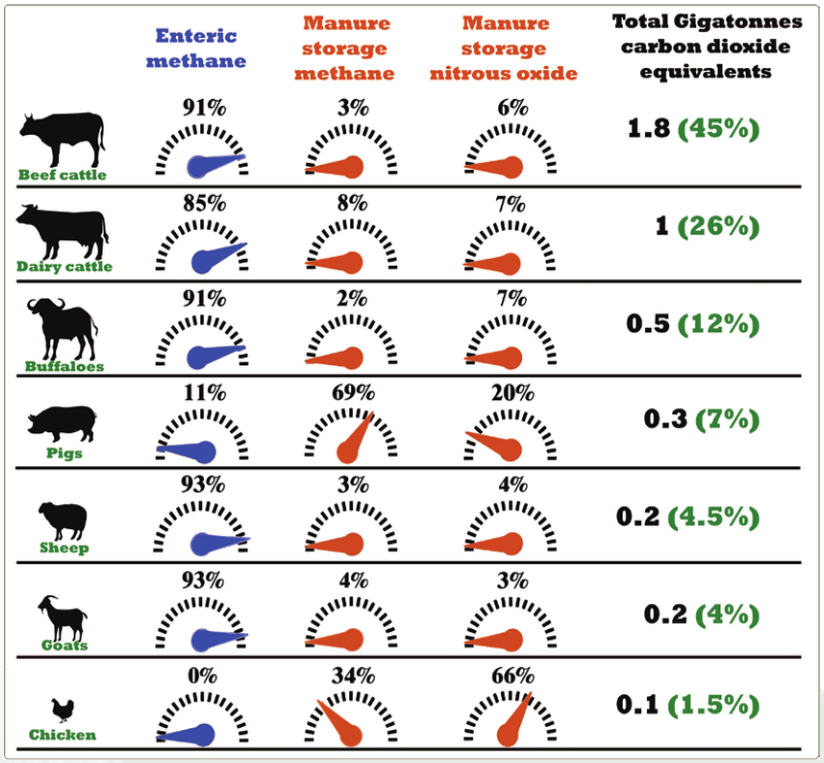
Greenhouse Gas	GWP over 100 years
Carbon dioxide	1
Methane	25
Nitrous oxide	298

GWP: Global warming potential

Complex microbial interactions in the livestock's rumen that are critical to the animal's basic function.



Aguirre-Villegas et al., 2017. Sustainabledairy.org



Gross et al., 2019

Methane is a potent greenhouse gas with a warming effect much greater than carbon dioxide.

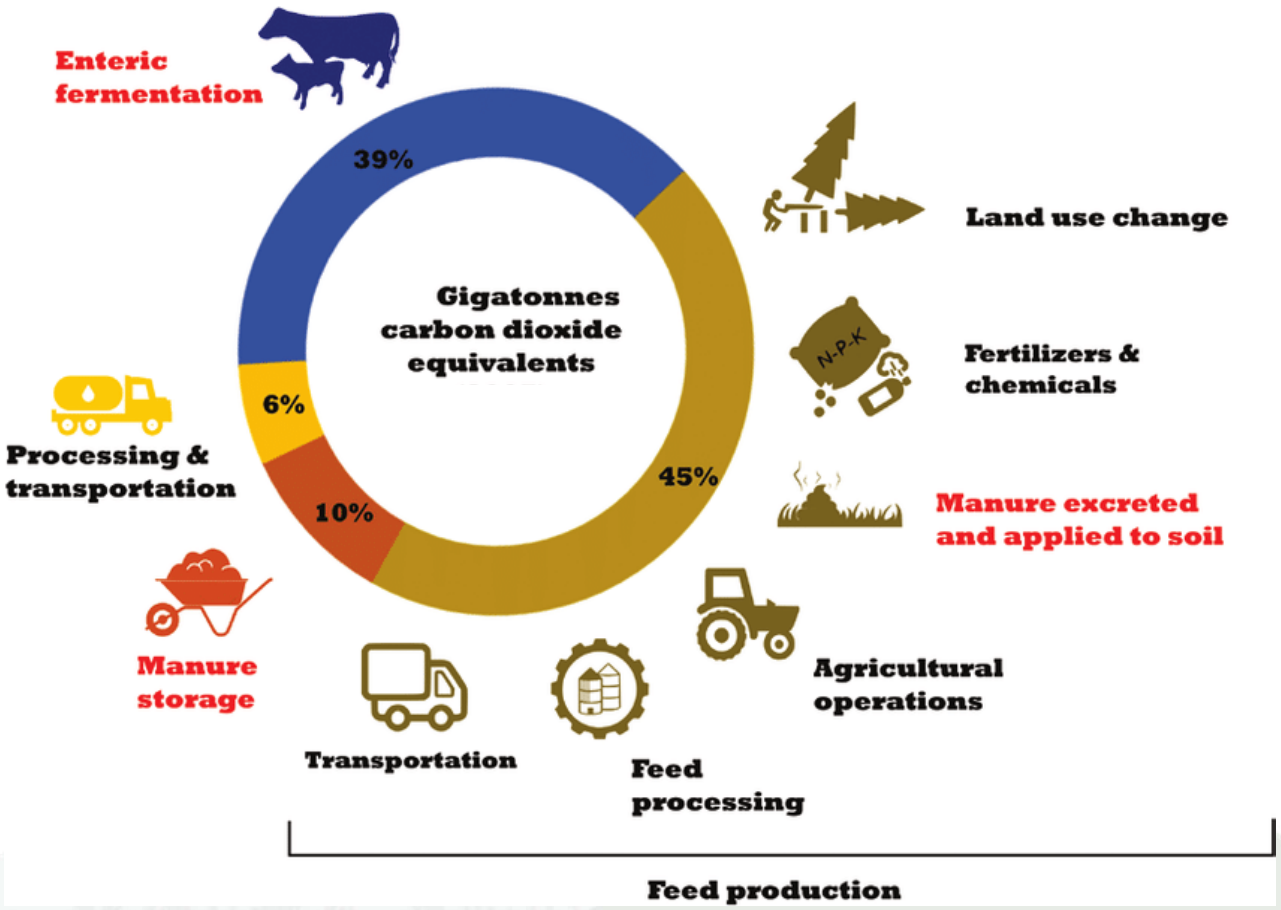
GHG Emissions from Livestock Farming Practices

Direct sources

- Enteric fermentation during digestive process (mainly methane CH4).
- Dung and urine decomposition (both nitrous oxide N2O & methane).

Indirect sources

- Haymaking or production of supplementary livestock feed and fodder (mainly carbon dioxide CO_2 & nitrous oxide).
- Use of fossil-fuel-based agricultural inputs like fertilizers and pesticides (mainly carbon dioxide CO_2 & nitrous oxide).



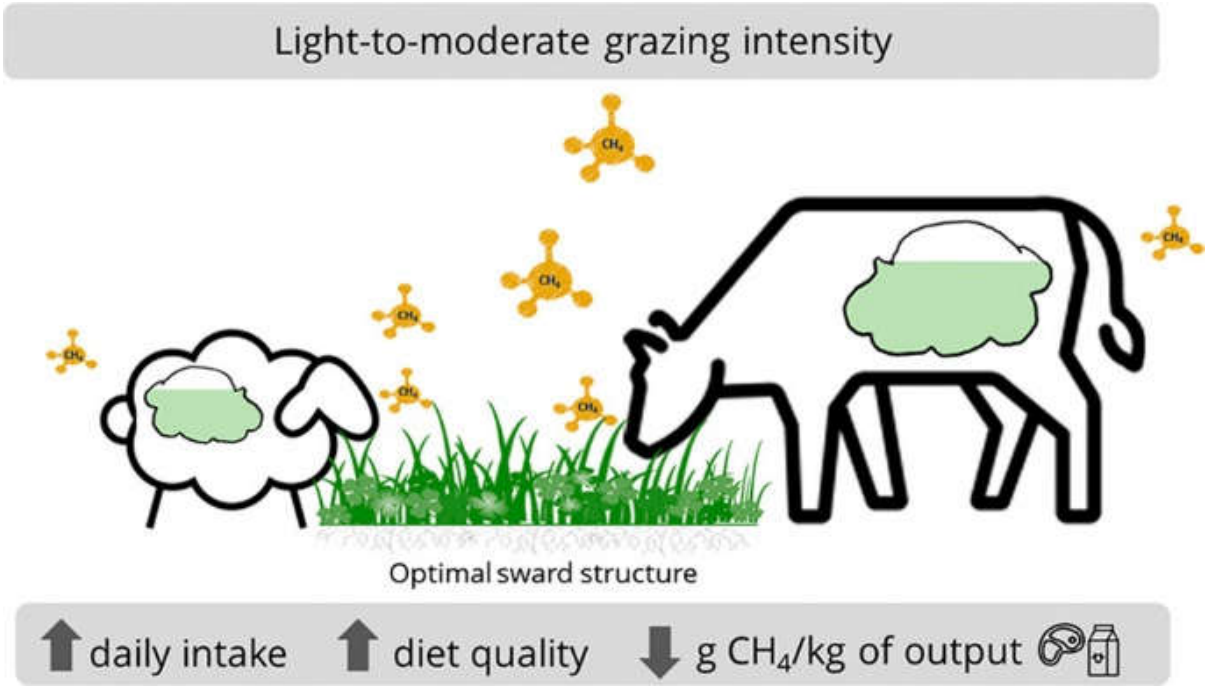
Grossi et al., 2019, Animal Frontiers 9(1).

GHG Emissions from Livestock Farming Practices

Grazing pressure is a driver of land degradation across Mongolia.

GHG emissions from pasture vegetation and soil degradation (mainly carbon dioxide CO_2 & nitrous oxide).

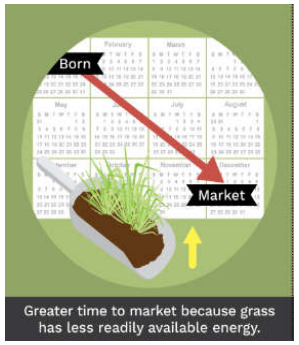
- High grazing intensity shifts pasture vegetation composition towards less desirable plant communities.
- Lowers pasture forage availability and quality, reduces livestock productivity and performance, and intensifies GHG emissions annually and per unit of live weight gain by livestock.



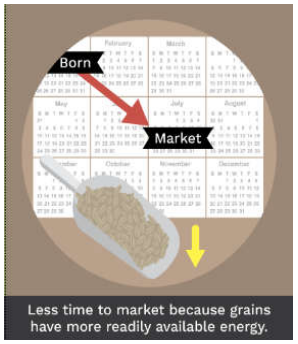
Sánchez Zubieta et al., 2021, STOTEN 754 (142029)

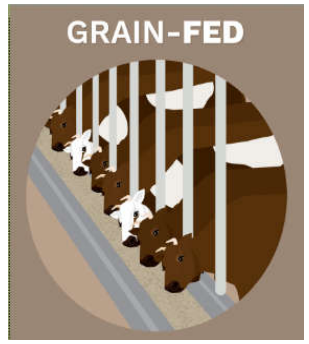
Overgrazing accelerates carbon loss from soil by increasing erosion and deterioration of soil structure.

GHG Emission from Livestock Farming Systems



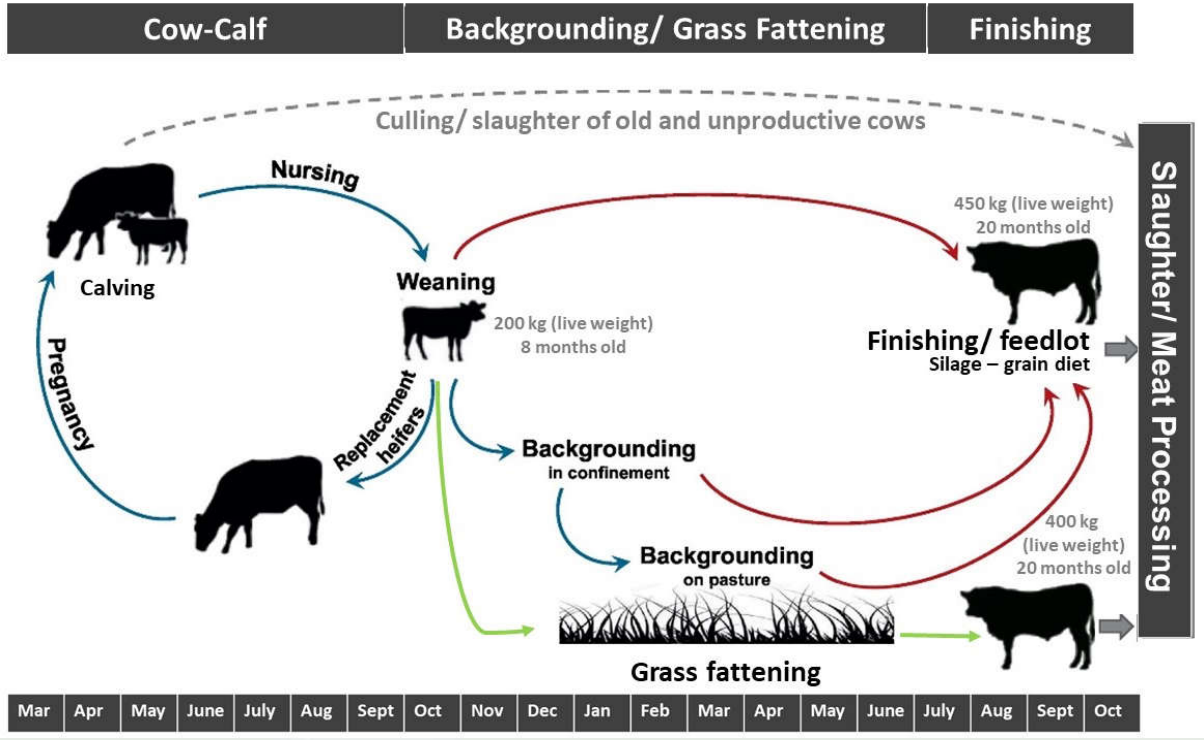
Livestock in Mongolia raised on pastures year-round and is mainly grass-fed and finished.





Pasture-raised livestock

- Grass forage and hay ingestion emit more methane.
- Methane emissions happen over a longer time.

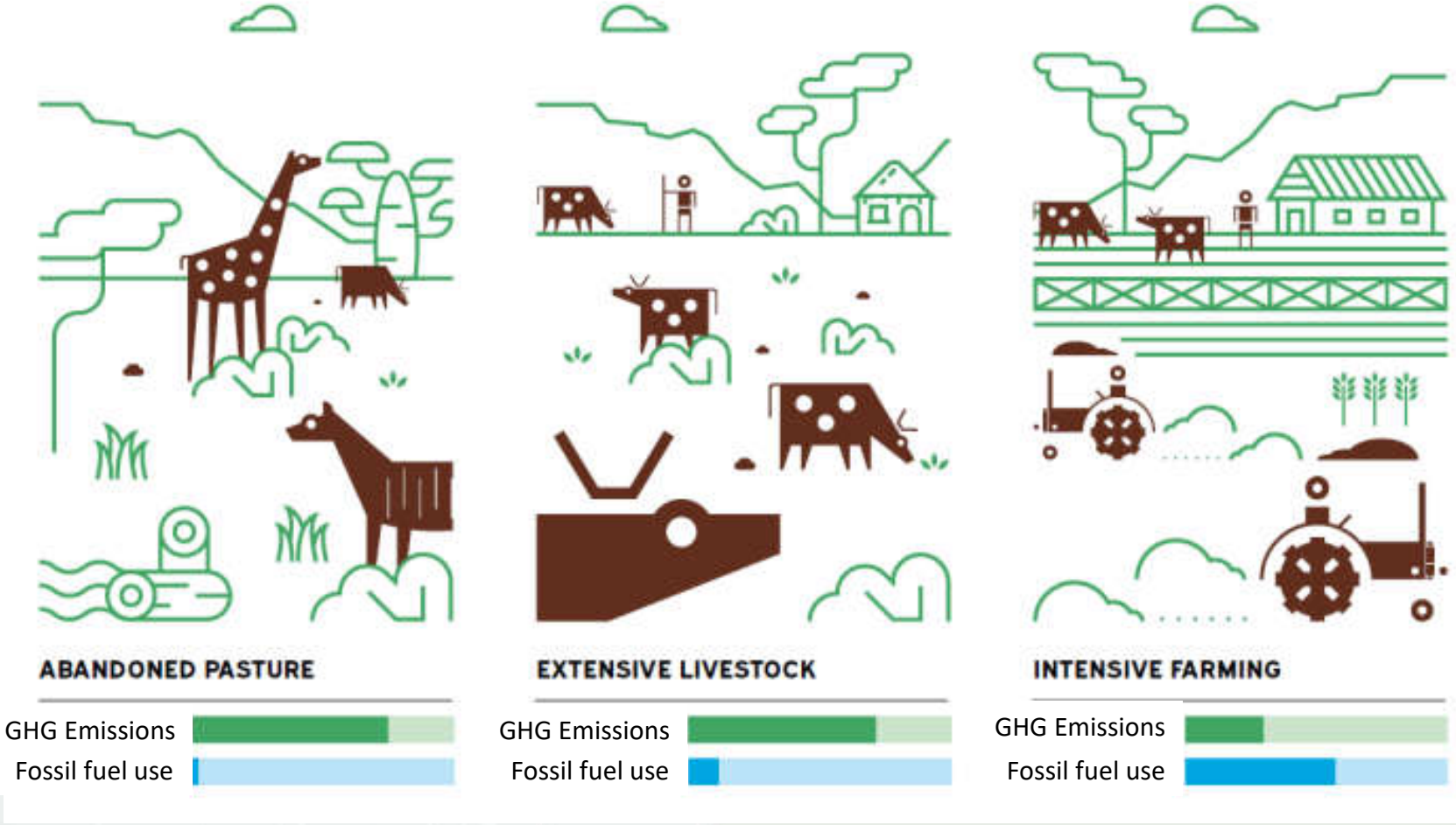


Feedlot-raised livestock

- High-quality feed ingestion emit much less methane.
- Methane emissions happen over a shorter time.

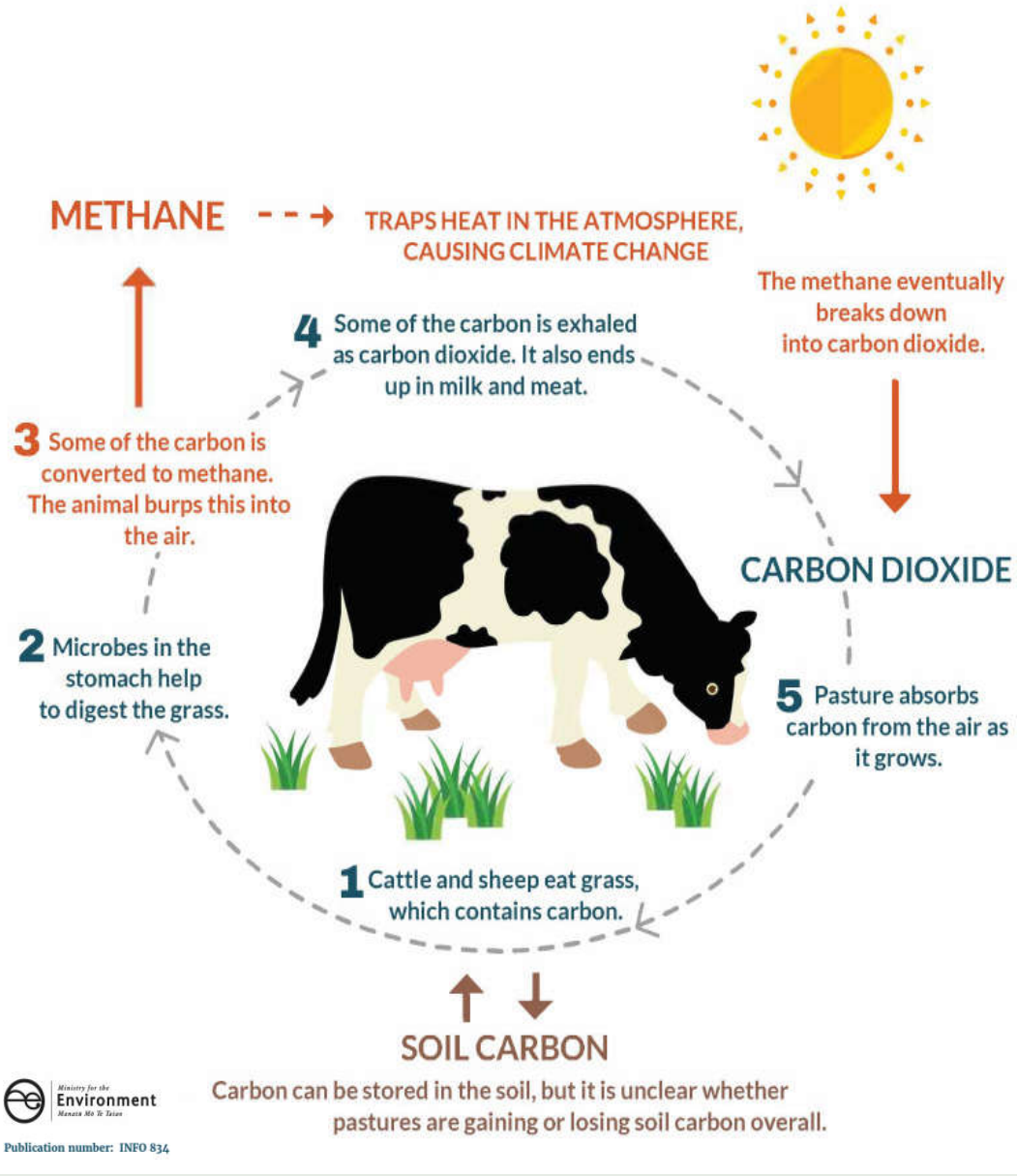
GHG Emissions from Livestock Farming Systems

- Conventional or extensive: mostly pasture-based
- Feedlot or intensive: animals fattened on a feedlot after weaning

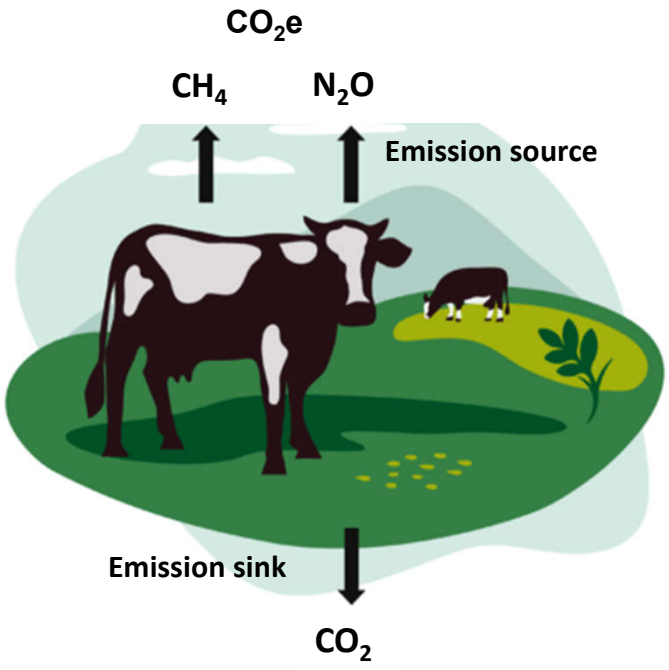


Houzer & Scoones, 2021.

GHG Emissions from Livestock Farming Systems



from a carbon footprint standpoint, this comparison of pasture-raised and feedlot raised livestock may be misleading!



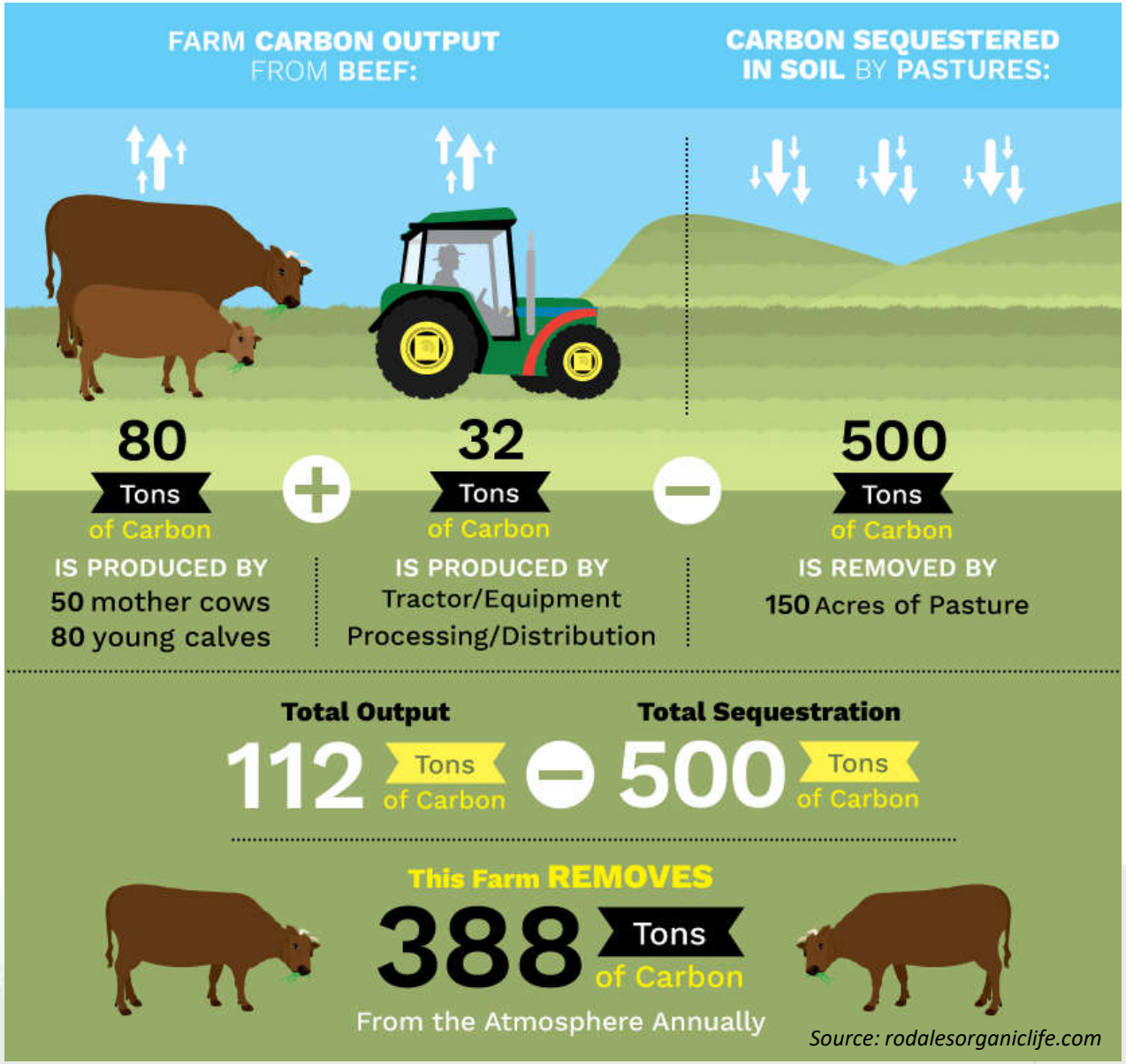
GHG Mitigation Capacity of Traditional Livestock Herding

Livestock as both part of problem and the solution.

Can sustainable livestock production deliver climate adaptation, mitigation, and food security?

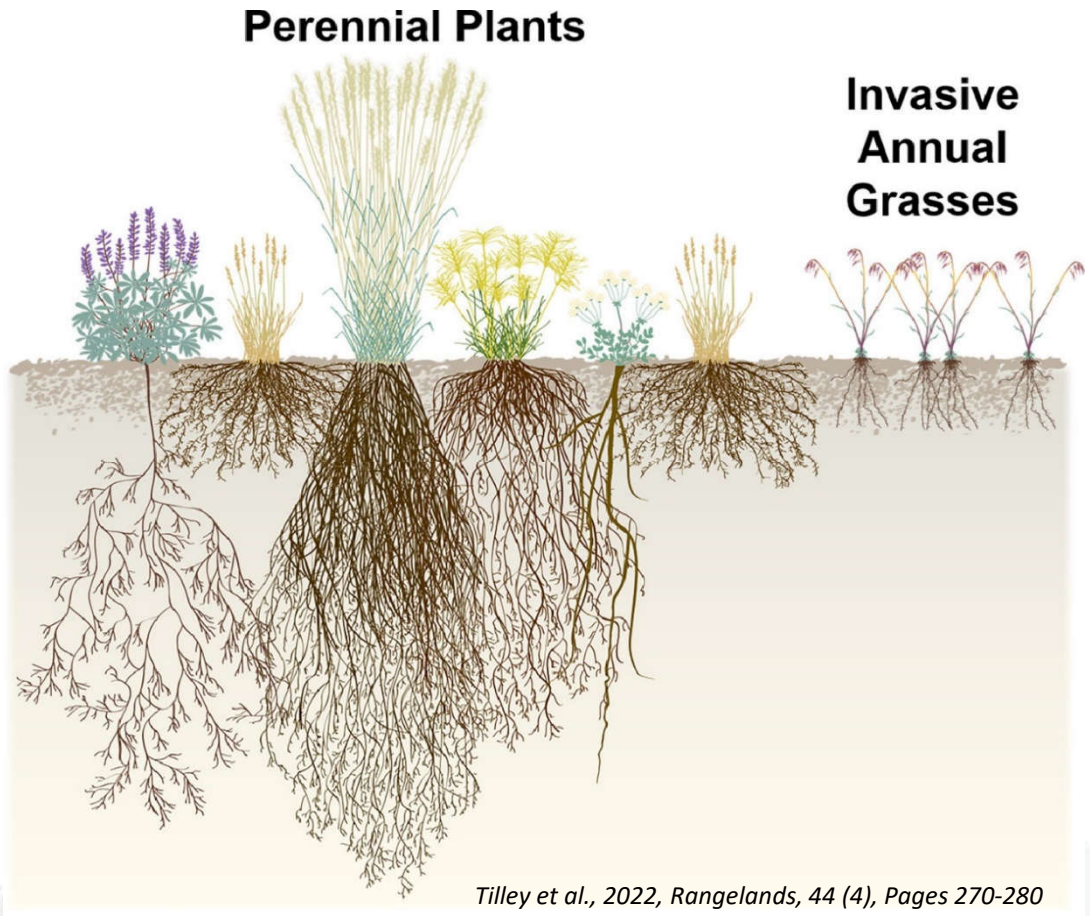
We need to understand the diversity of livestock systems.

The low-input, extensive and mobile systems, including those managed by pastoralists, can potentially offer a low-carbon alternative that is environmentally beneficial."

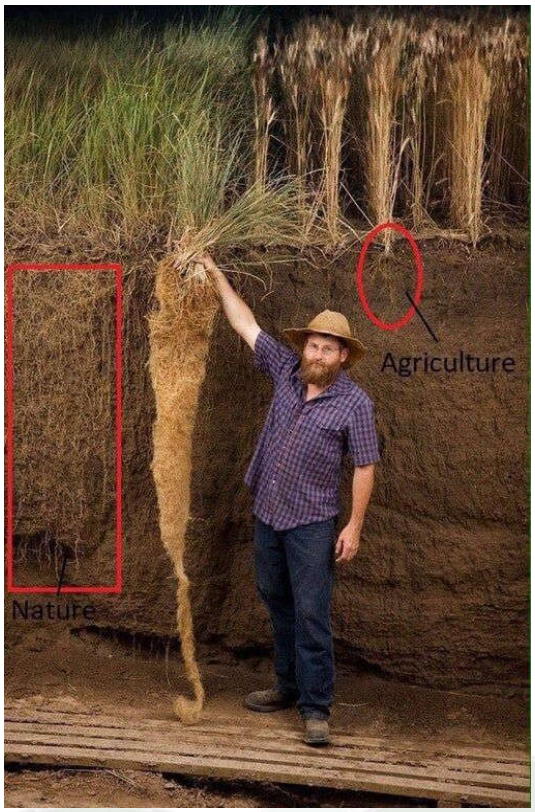


GHG Mitigation Capacity of Traditional Livestock Herding

Diversity of plants and their root structures in a healthy pasture increases resilience against challenges such as climate change and invasion.



Tilley et al., 2022, Rangelands, 44 (4), Pages 270-280



Land conversion leads to the loss of 30-55% of grassland soil carbon storage!

GHG Mitigation Capacity of Traditional Livestock Herding

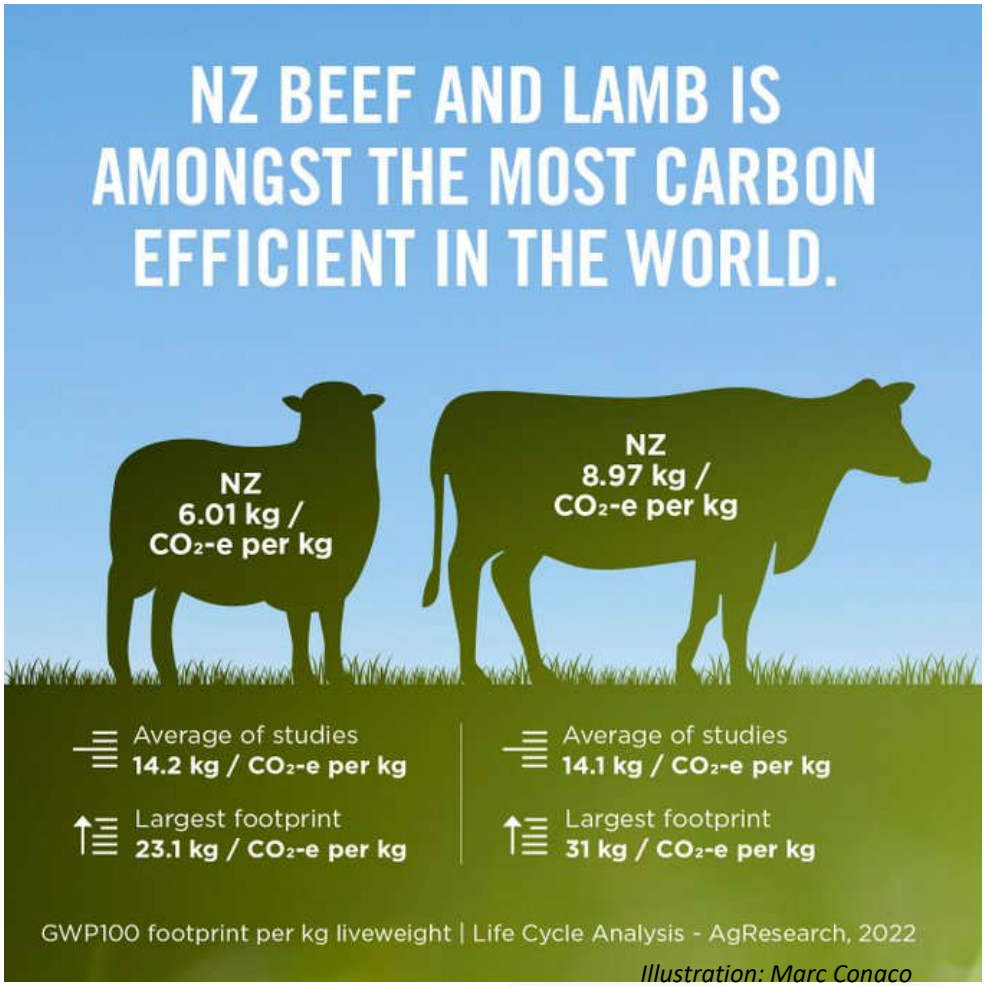


Illustration: Marc Conaco

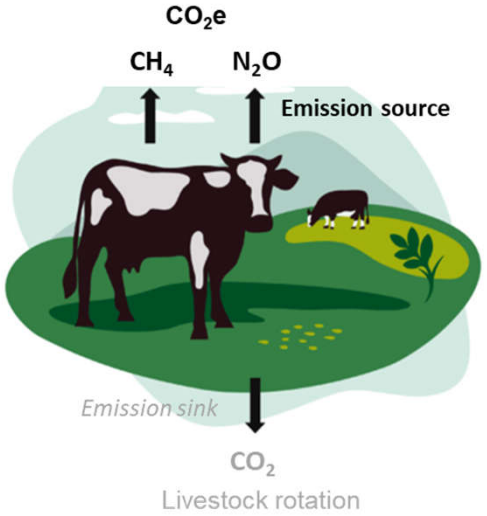
New Zealand's average carbon dioxide equivalent (CO2-e) per kilogram of sheep meat is less than half the international average, and about 30% lower than the international average for beef.

when taking into account sequestration on farms absorbing emissions – New Zealand's sheep meat is arguably "climate neutral" and New Zealand beef is also well on the way towards that.

For this number to remain low in future, it's dependent on either **no increase in sheep numbers**, or **reductions in greenhouse gas emissions per kg of live weight stock** on our farms.

GHG Emissions Reductions Strategies

At animal level, GHG emission intensity can be reduced by increasing livestock productivity through improving feed quality and feeding practices, genetics, animal health, reproduction strategies (age at first calving), and herd restructuring (reducing the relative number of unproductive animals in the herd).



Livestock Health and Productivity Improvement

Feed Management and Nutrition

- Increase production (less methane per unit of product)
- Increase forage intake
- Improve feed supplementation

Genetics

- Improve breeding (more productive cows)
- Improve cow health
- Genetic selection based on microorganism population in the rumen

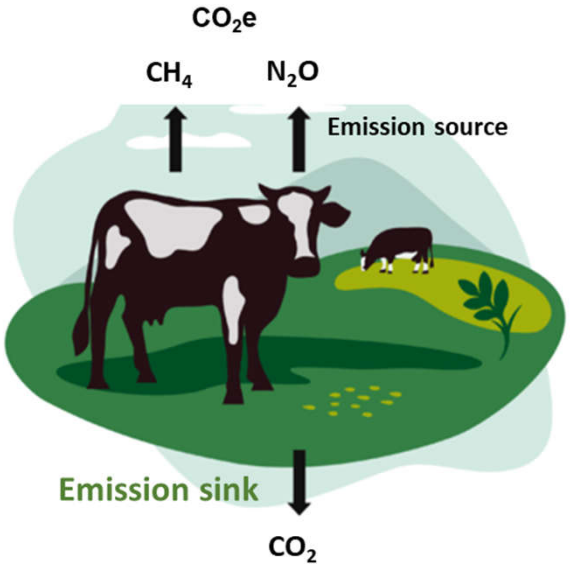
Herd Management Practices

- Reduce number of unproductive animals
- Reduce animal decease
- Improve feeding and housing technologies

GHG Emissions Reductions Strategies

At pasture level, GHG mitigation capacity of traditional livestock herding can be restored through:

- Supporting the stocking rates that are in line with pasture carrying capacity.
- Promoting seasonal pasture rotations and traditional four-season nomadic rotational grazing.
- Rehabilitating vegetation and enhancing soil carbon sequestration capacity in degraded pastures.



Optimizing grazing pressure and improving grazing livestock distribution is critical to fully benefit from the GHG mitigation capacity of natural grasslands and traditional livestock herding in Mongolia.

Environmental Services from Traditional Livestock Herding

Raising cattle on pasture is inherently more challenging than fattening them on feedlots, but the results are **worth the extra effort**.

Pasture-raised livestock

Multi-functional systems that **deliver** multiple environmental services, including mitigating GHG emissions through carbon sequestration services.

Feedlot-raised livestock

Single-function system that **impacts** multiple environmental services, including carbon sequestration and water quantity and quality services.

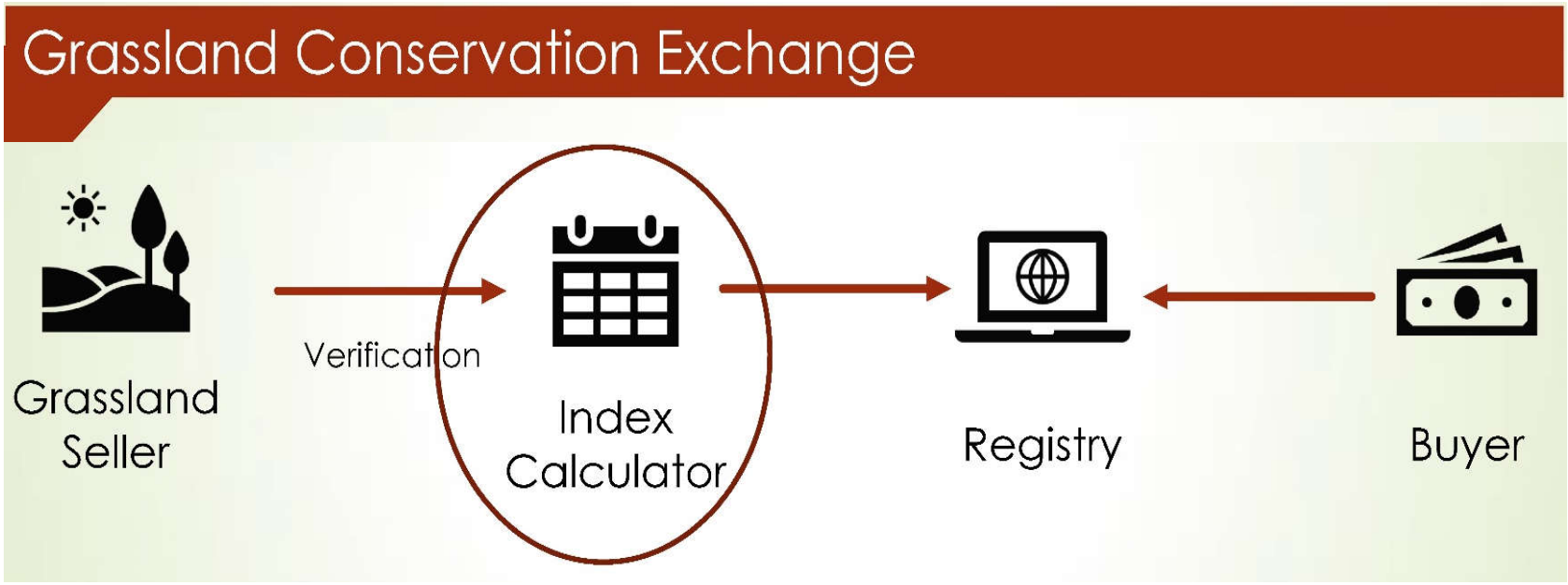
- Feedlots in mixed systems require special diet composition that can potentially increase GHG emissions from cultivated lands.
- Concentration of livestock over small areas can lead to challenges in manure management and, eventually, higher GHG emissions and water pollution issues.

Environmental Services from Herd Restructuring

Environmental services	Influence of current livestock herding	Responsiveness to climate-resilient livestock farming		Opportunity to enhance via climate-resilient livestock farming	
		Grass-finished	Feedlot-finished	Grass-finished	Feedlot-finished
Provisioning services					
Meat production	Moderate	Moderate	High	Low	High
Non-meat products	Moderate	Moderate	High	Low	High
Water supply	Large	High	Low	Moderate	Low
Regulating services					
Water quality regulation	Large	High	Low	Moderate	Low
Air quality regulation	Moderate	Moderate	Low	Low	Low
Disease regulation	Moderate	High	High	Moderate	High
Soil quality regulation	Large	High	Low	High	Low
Climate regulation	Large	Moderate	Low	High	Moderate
Cultural services					
Cultural heritage	Slight	Low	*Not relevant*	Low	*Not relevant*
Recreation and tourism	Slight	High	*Not relevant*	Moderate	*Not relevant*
Biodiversity and habitat					
Biodiversity	Large	High	Low	High	Moderate
Habitat maintenance	Large	High	Low	High	Moderate

Markets for Environmental Services from Pastoral Systems

Grassland Conservation Index: a weighted combination of environmental services that are economically, environmentally and socially relevant to grasslands.



Herders who supply grasslands services benefits to potential buyers.

The system that issues, tracks, transfers and retires grassland units in the exchange.

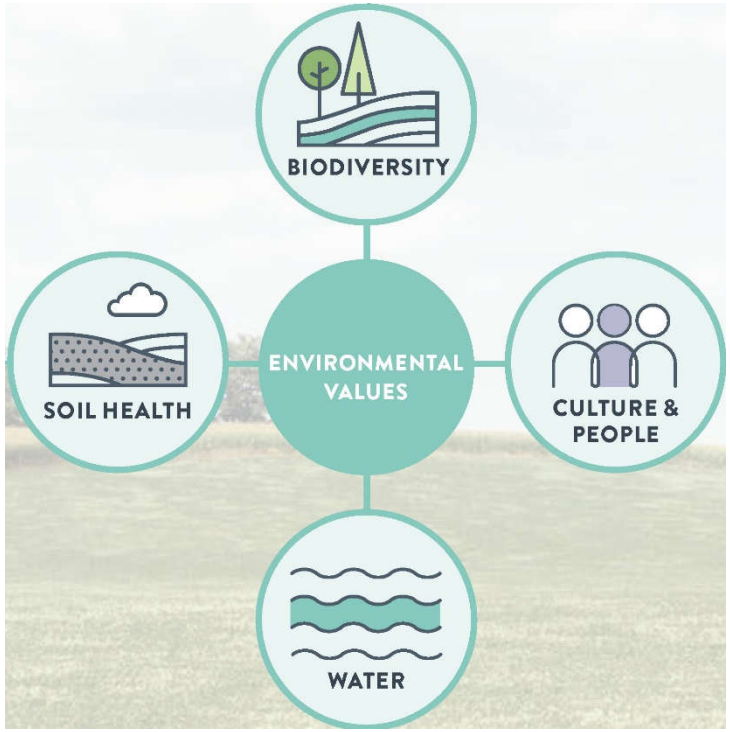
A discovery tool used to identify and calculate a weighted combination of grassland services assets in a standardized way.

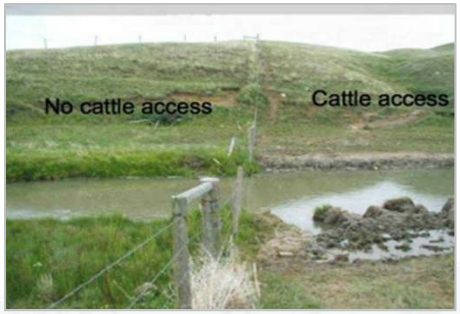
The process of authenticating the grassland services indicators and associated metrics that will be delivered to the buyer.

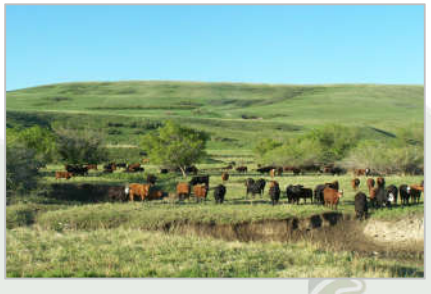
Investors in the grasslands conservation exchange who pay for and benefit from grasslands services.

Western Stock Growers' Association
EcoServices Network
ALBERTA INNOVATES

Markets for Environmental Services from Pastoral Systems

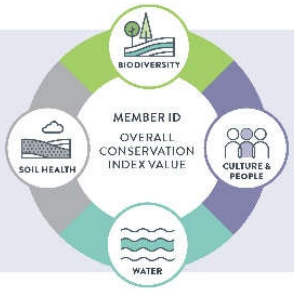






Markets for Environmental Services from Pastoral Systems

Grasslands Conservation Sample Index Report



Member ID: *123456*
Date of issue: *01/01/2021*
Year of measurement: *2020*
Grassland area (ha): *250*

Biodiversity

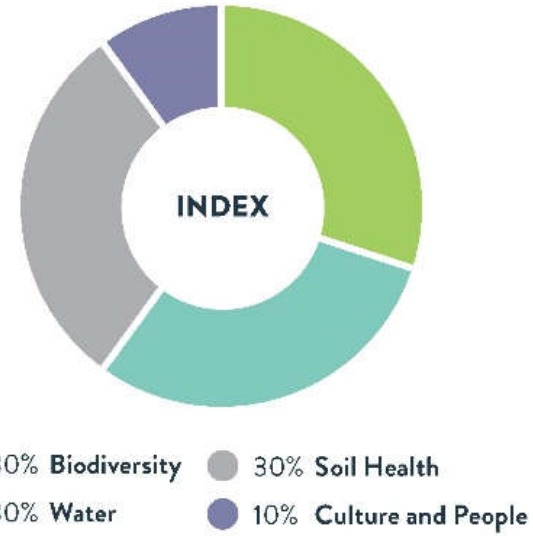
SCORE	INDICATOR	CUMULATIVE SCORE
	Biodiversity index as an indicator of species abundance and richness	150
	Landscape connectivity scores or density values	
Additional information may also be provided such as habitat for native pollinators, habitat for species at risk or species of interest for certain buyers.		

Water

SCORE	INDICATOR	CUMULATIVE SCORE
	Water quality index or estimated average nutrient loading of phosphorus, nitrogen and total suspended solids.	150
	Soil water filtration measurements	
	Estimated water storage (volume)	
Additional information may also be provided such as watershed quality, flood risk and drought.		

Soil

SCORE	INDICATOR	CUMULATIVE SCORE
	Soil aggregate stability	150
	Bacteria to fungi ratio	
	Soil microorganisms measurement e.g. soil mites	
	Estimated average of soil organic matter	
Additional information may also be provided such as estimates of soil carbon sequestration per year based on modeled and published research data.		



Implications for Policy and Programs

- Local herders must play a fundamental role in the development process of new policies, as they deeply understand the environmental good and services essential to their herding livelihood systems.
- Efforts to address livestock related GHG emission risks are likely to require systemic changes in Mongolian livestock management and marketing to sustain herders' incomes over the long term.
- Community-based rangeland monitoring and management can support local agreement on livestock mobility or seasonal pasture rotation, an adaptive strategy traditionally used by Mongolian herders to prepare for and respond to pasture and climatic conditions.
- Adaptive measures that reduce livestock mortality and increase livestock productivity are required to minimize the herders' only offset mechanism or increasing their herd size to compensate for possible livestock losses from harsh climate events.
- Reports about GHG emissions and carbon sequestration rates are particularly rare for Mongolia. More effort needs to be put into a systematic assessment of the potential GHG emissions and removal from Mongolian livestock sector.

Swainson's Hawk
(*Buteo swainsoni*)

Picture: ABMI NatureLynx

Questions and feedback

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It's Our Nature *to Know*
Alberta Biodiversity Monitoring Institute