

NATIONAL CONCLAVE

SUSTAINABLE FOOD SYSTEMS

October 27-29, 2025

Anil Agarwal Environment Training Institute, Nimli, Rajasthan



**Emission Mitigation in Livestock
through Breed Improvement**

Emission Mitigation in Livestock through Breed Improvement

Emissions

GHG >>> CO₂, CH₄, N₂O, +

Mitigation

Why? >>>

For slowing the rate of climate change and
its severe consequences for
health, ecosystems, and the global economy.



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INDIGENOUS LIVESTOCK SOCIETY-INDIA

Earlier, Scientist at: ICAR - NATIONAL BUREAU OF ANIMAL GENETIC RESOURCES, KARNAL



CO₂ equivalent

	GHG	In Atmosphere	Impact on Global Warming	
			per molecule	overall
		[in ppm]		
	CO ₂	424		
	CH ₄	1.94		
	N ₂ O	0.338		
	CO ₂			
	CH ₄			
	N ₂ O			



CO₂ equivalent

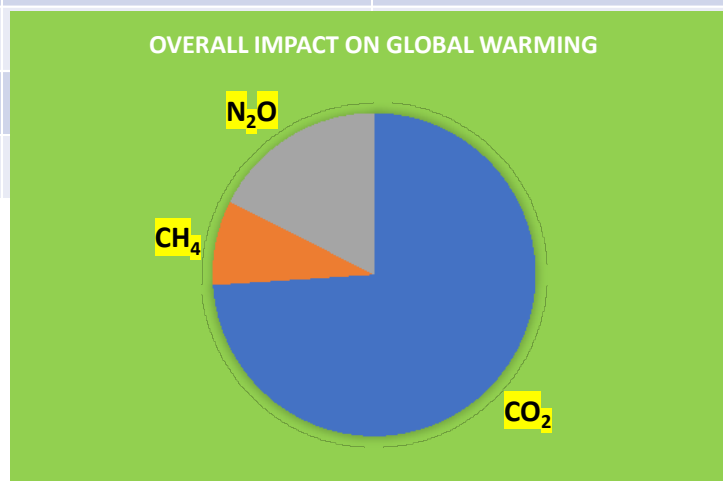
	GHG	In Atmosphere	Impact on Global Warming	
		[in ppm]	per molecule	overall
	CO ₂	424	1	424
	CH ₄	1.94	25	48.5
	N ₂ O	0.338	298	100.724
	CO ₂		OVERALL IMPACT ON GLOBAL WARMING	
	CH ₄			
	N ₂ O			



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CO ₂	424
CH ₄	48.5
N ₂ O	100.7



GHG Source>



Sources of **Carbon Dioxide** into Atmosphere

Natural sources

- **Respiration**
- **Decomposition**
- **Ocean release**
- **Volcanic eruptions**
- **Forest fires**

Human (anthropogenic) sources

- **Burning fossil fuels:** (for energy, transportation, and industry)
- **Deforestation and land use change:** (Clearing forests releases stored carbon, reduces absorption by photosynthesis)
- **Cement production**
- **Waste:** (Burning)



Sources of **Methane** into Atmosphere

Natural sources

- Wetlands: (largest natural source, bacteria in low-oxygen, waterlogged soil decompose OM)
- **Termites**: (A natural source of methane emissions)
- **Oceans and sediments**: (Methane is released from ocean sediments)
- **Volcanoes and wildfires**: (contribute to natural methane emissions)

Anthropogenic sources

- **Livestock**: (enteric fermentation) and also from their dung.
- **Rice cultivation**: Flooded paddy fields create anaerobic conditions that allow methane-producing microbes to thrive.
- **Fossil fuels**: (production, processing, and transport of coal, natural gas, and oil + leaks)
- **Waste**: (decomposition of organic waste in landfills and at wastewater treatment facilities)
- **Biomass burning**: (combustion of biomass, such as in forest fires or burning of wood for fuel)



Sources of Nitrous Oxide into Atmosphere

Natural sources

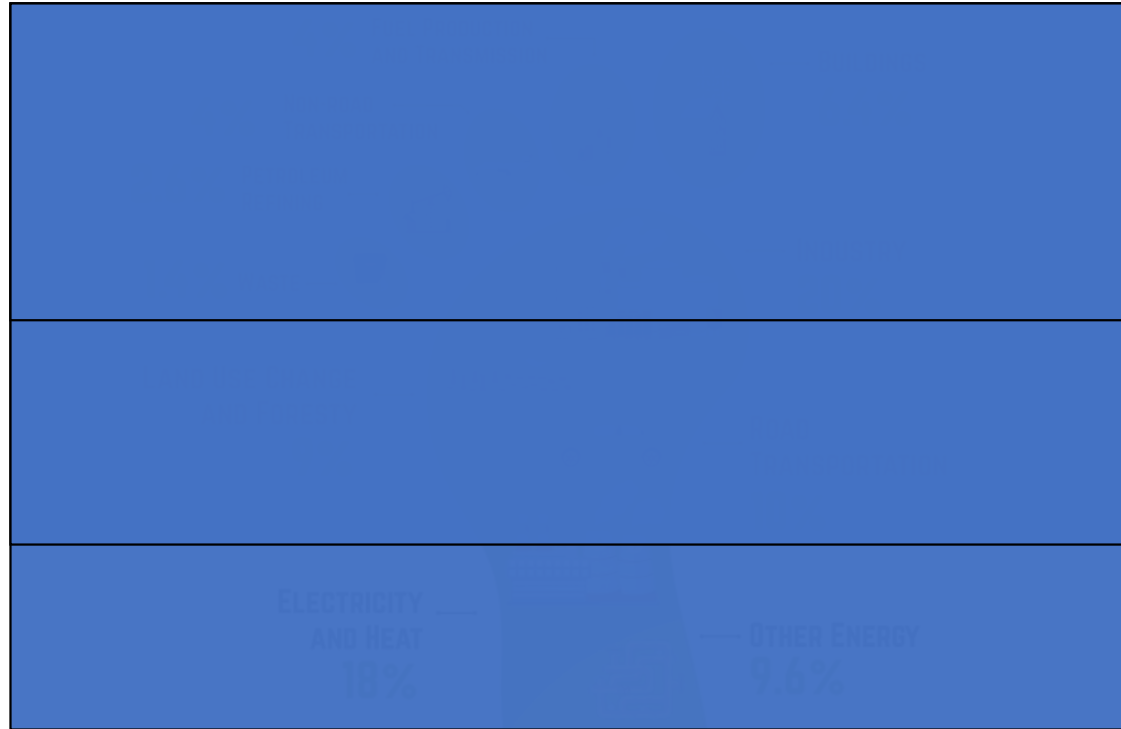
- Microbial activity: (in soils and oceans by nitrification and denitrification)
- **Lightning:** (creates high temperatures - forming nitrogen oxides)
- Permafrost melting: The thawing of Arctic permafrost can release N₂O

Anthropogenic sources

- **Agriculture:** [Largest human source, primarily synthetic nitrogen fertilizers and the management of manure]
- **Fossil fuel combustion:** (Burning fossil fuels for transportation and energy)
- **Biomass combustion:** (Burning agricultural and forest waste)
- Industrial processes: (production of nitric acid and combustion-related emissions)



CARBON FOOTPRINT



ELECTRICITY
AND HEAT
18%

OTHER ENERGY
9.6%



AGRICULTURE
15%



SCHOOL OF SUSTAINABLE
FOOD SYSTEMS
AAETI

FOOD SYSTEMS



Emission Mitigation in Livestock through Breed Improvement

Emission
&
Livestock

Livestock

Cattle

Buffalo

Sheep

Goat

Camel

Horse⁺

Pigs

Yak

Mithun

Poultry⁺

Dogs



Livestock

Contributions

Food Fiber Dung DAP Skins Storage Weed-control Cultural Recreation Companionship

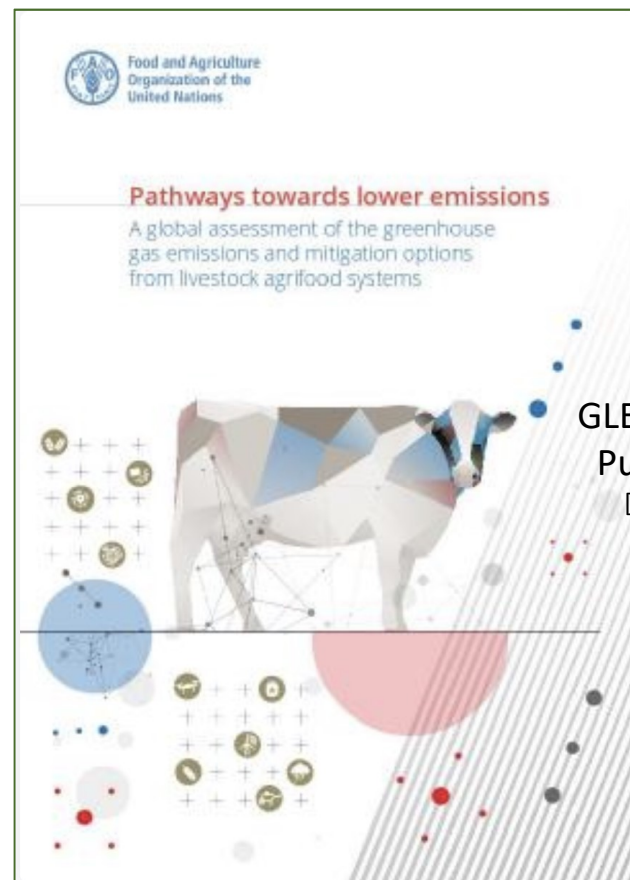
Livelihood

Better domestic nutrition

Part of circularity



Published in 2006

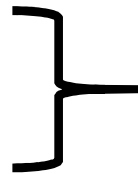


GLEAM Report (Ver.3)
Published in 2023
[data base year 2015]



Emission Mitigation in Livestock through Breed Improvement

Emission
&
Livestock



Beef cattle



Dairy cattle



Buffaloes



Pigs



Sheep



Goats



Chicken

Cattle

Buffalo

Sheep

Goat

Pigs

Poultry⁺

Yak

Mithun



**Enteric
methane**

**Manure
storage
methane**

**Manure
storage
nitrous oxide**



Beef cattle



Dairy cattle



Buffaloes



Pigs



Sheep



Goats



Chicken

Livestock

Modified from
FAO (2017)
<http://www.fao.org/gleam/en/>



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STEMS

**Enteric
methane**

**Manure
storage
methane**

**Manure
storage
nitrous oxide**



Beef cattle



Dairy cattle



Buffaloes



Pigs



Sheep



Goats



Chicken



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STEMS

**Enteric
methane**

**Manure
storage
methane**

**Manure
storage
nitrous oxide**

**Total Gigatonnes
carbon dioxide
equivalents**



Beef cattle



Dairy cattle



Buffaloes



Pigs



Sheep



Goats



Chicken



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STEMS

	Enteric methane	Manure storage methane	Manure storage nitrous oxide	Total Gigatonnes carbon dioxide equivalents
 Beef cattle				(45%)
 Dairy cattle				(26%)
 Buffaloes				(12%)
 Pigs				(7%)
 Sheep				(4.5%)
 Goats				(4%)
 Chicken				(1.5%)



**Total Gigatonnes
(%) carbon dioxide
equivalents**



Beef cattle

(45%)



Dairy cattle

(26%)



Buffaloes

(12%)



Pigs

(7%)



Sheep

(4.5%)



Goats

(4%)



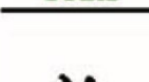
Chicken

(1.5%)

Total CO₂

Modified from
FAO (2017)
<http://www.fao.org/gleam/en/>



	Enteric methane	Manure storage methane	Manure storage nitrous oxide	Total Gigatonnes carbon dioxide equivalents
 Beef cattle	91%	3%	6%	1.8 (45%)
 Dairy cattle	85%	8%	7%	1 (26%)
 Buffaloes	91%	2%	7%	0.5 (12%)
 Pigs	11%	69%	20%	0.3 (7%)
 Sheep	93%	3%	4%	0.2 (4.5%)
 Goats	93%	4%	3%	0.2 (4%)
 Chicken	0%	34%	66%	0.1 (1.5%)



Breeding Strategies to lower emissions in Livestock

Selective Breeding

- **Lower methane emissions** [Upto 22% less CH₄]
- **Select for Longevity**
- **Improved feed efficiency**
- **Improve health and parasite resistance**
- **Increase reproductive efficiency**
- **Use sexed semen**
- **Use methane prod. as a trait in Breeding Index**
- **Reduce mature size**

Challenges

- > Low heritability
- > Measurement of Methane

Supporting strategies

- **Dietary supplements.** [seaweed, probiotics, enzymes, silage, urea & molasses treatment and specific plant extracts]
- **Balanced diets** [reduce enteric CH₄ by 10-15%]
- **Improve animal health and welfare**
- **Improve manure management**
- **Enhance productivity**

Indigenous Purebreds

>>

Indigenous purebreds exhibit superior traits



Example: A 2015 study in Central Java found that intensive crossbreeding did not lower GHG per kg of live weight produced compared to local purebreds. The faster growth of the crossbreds was offset by the higher emissions from the feed required to support them.

Indigenous Purebreds

- Indigenous breeds thrive on **native grasses, crop residues, and minimal concentrate feed**, reducing the emissions associated with feed production, processing, and transport.
- Efficient utilization of **low-quality forages** decreases dependence on industrial feed, which has a large carbon footprint.
- Indigenous animals are **disease-resistant and heat-tolerant**, reducing veterinary inputs and mortality rates.
- Their **longer productive lifespan** means fewer replacements, thereby reducing overall herd emissions.



Epilogue



Message is:

Livestock - earlier dubbed as a major reason for GHG in the FAO book 'The Long Shadow' [2006], was subsequently rectified by FAO Report 'GLEAM' [2023].

Yet, Livestock can be managed to mitigate present level of emissions to a fairly good extent by the use of indigenous breeds, selective breed improvement and by more appropriate feeding sourced from natural farming.

