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Livestock Production Towards Climate Change

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ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
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Outline:

- Introduction

  - Livestock production and challenges

- Impact of Climate Change on Animal Production
- Impact of Animal Production on Climate Change
- Sources of GHG emissions on a livestock
- Mitigation strategies
- Farming systems and GHG emissions
- Conclusions

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Animal Production and Livestock products

- The increased demands for livestock products is nowadays a certainty
  - population growth
  - urbanization
  - income rise
  - different nutritious needs

- Livestock products are an important agricultural commodity for global food security because they provide the:
  - 17% of global energy consumption
  - 33% of global protein consumption
  - 1.1 billion employees

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Animal Production & Population Growth

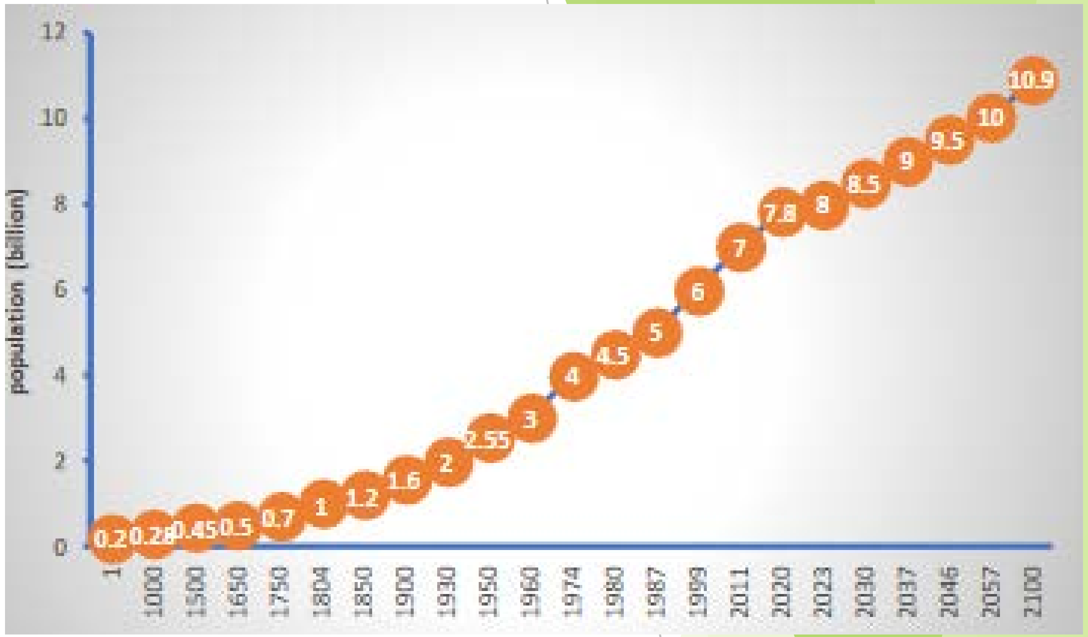
- World's population reaches almost 7.8 billion with a growing rate of almost 1.05%

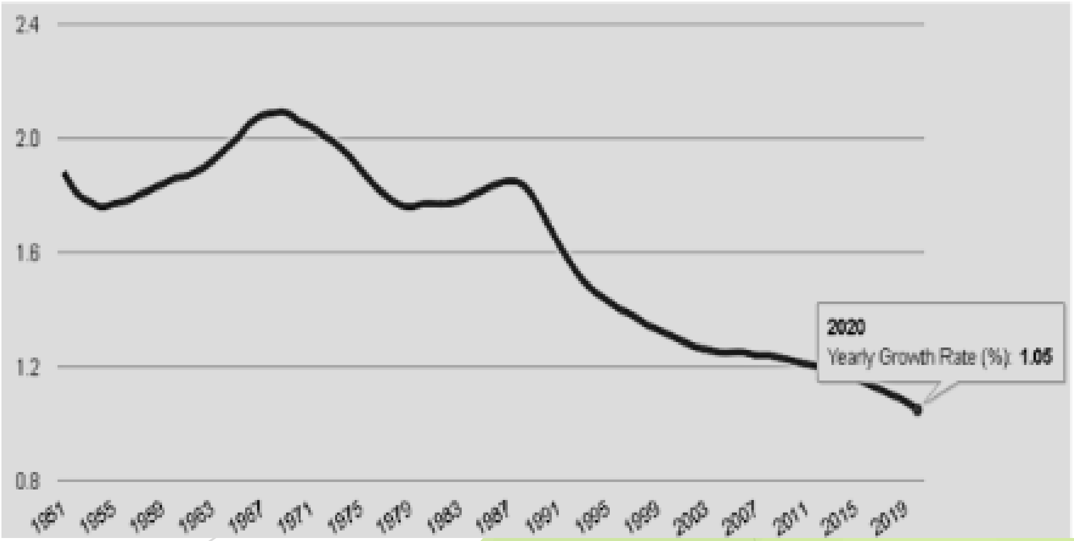
- The global population is expected to reach about:
  - 8.6 billion in 2030 and 9.7 billion in 2050

- As a result:

- the needs for animal products are estimated to be almost **doubled** up to 2050
  - milk production will increase from 664 million tn to 1077 million tn (by 2050)
  - meat production will double from 258 to 455 million tn

- the livestock sector will requires a **significant** amount of natural resources





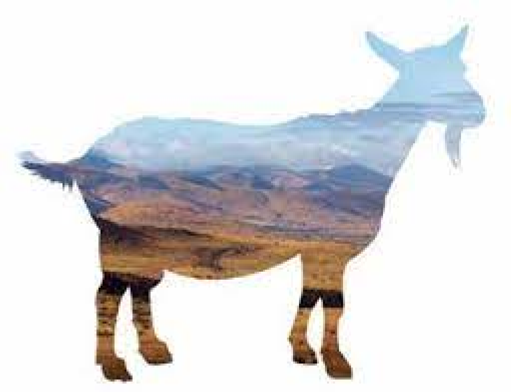
Source: www.worldometers.info/world-population

Animal Production and Climate Change

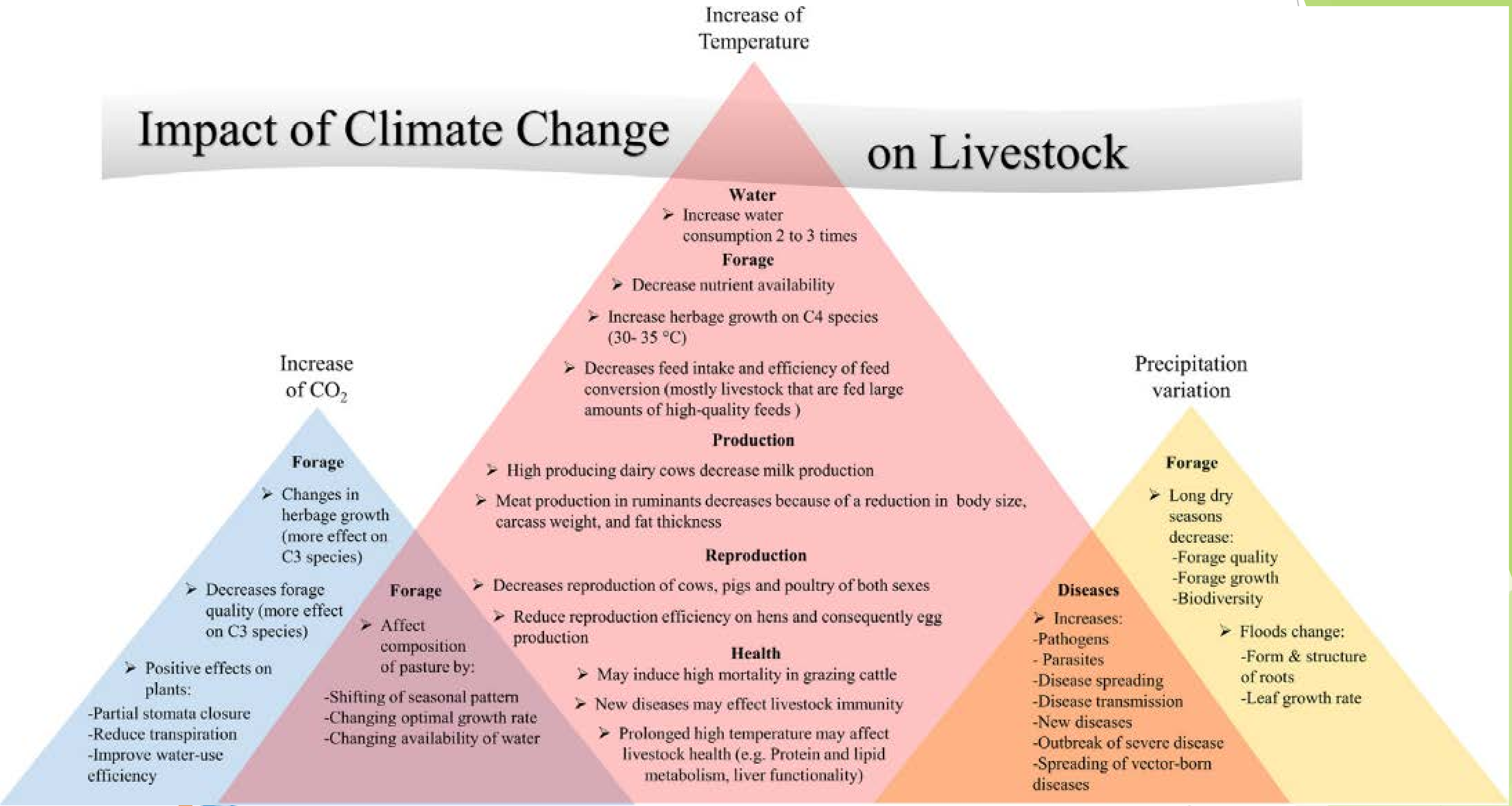
- **Climate change**:
  - long-term change in the distribution of weather patterns (e.g. temperature, precipitation etc.) over decades to millions years of time **OR**
  - climate transformation observed in the climate of the planet caused by human activities

- Global climate change is primarily caused by greenhouse gas (GHG) emissions that result in warming of the atmosphere (IPCC, 2013).

- Between Livestock production and climate change exists a two-way effect





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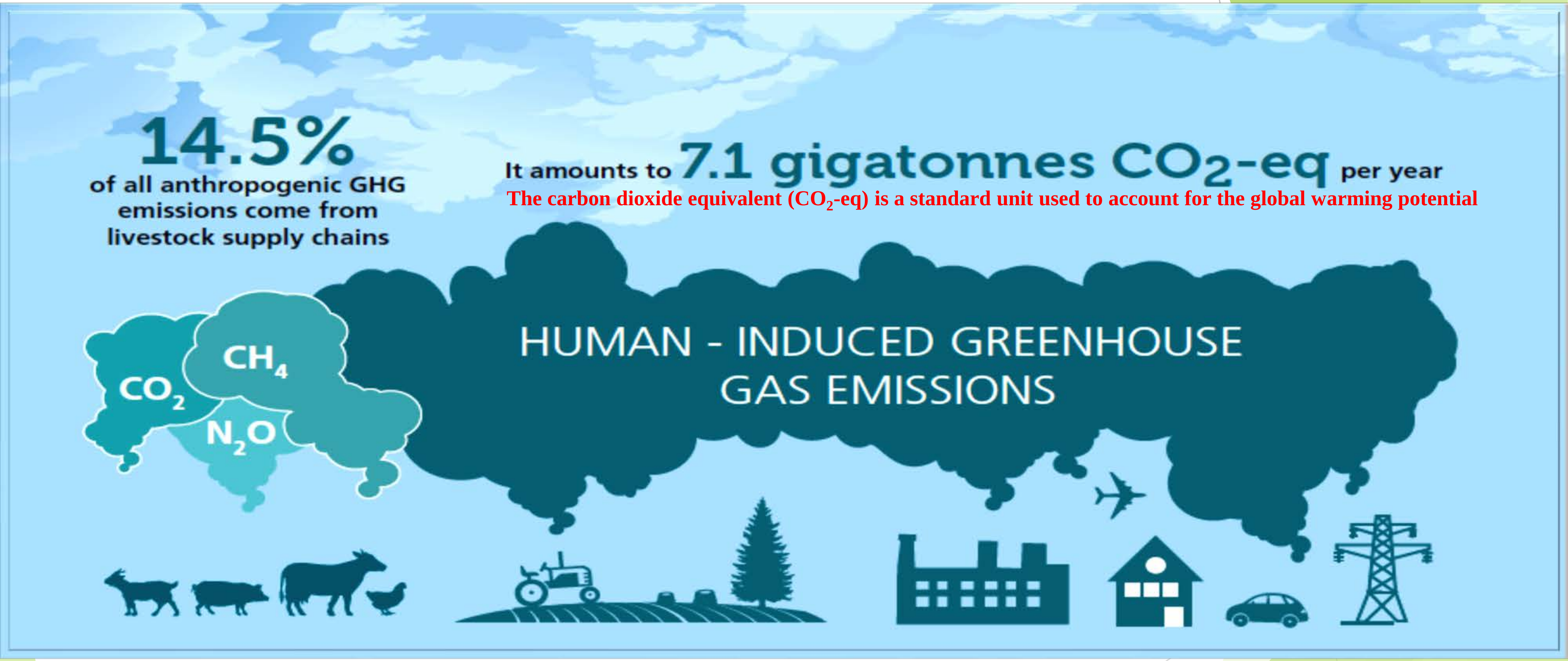
Impact of Animal Production on Climate change



The carbon dioxide equivalent (CO_2-eq) is a standard unit used to account for the global warming potential

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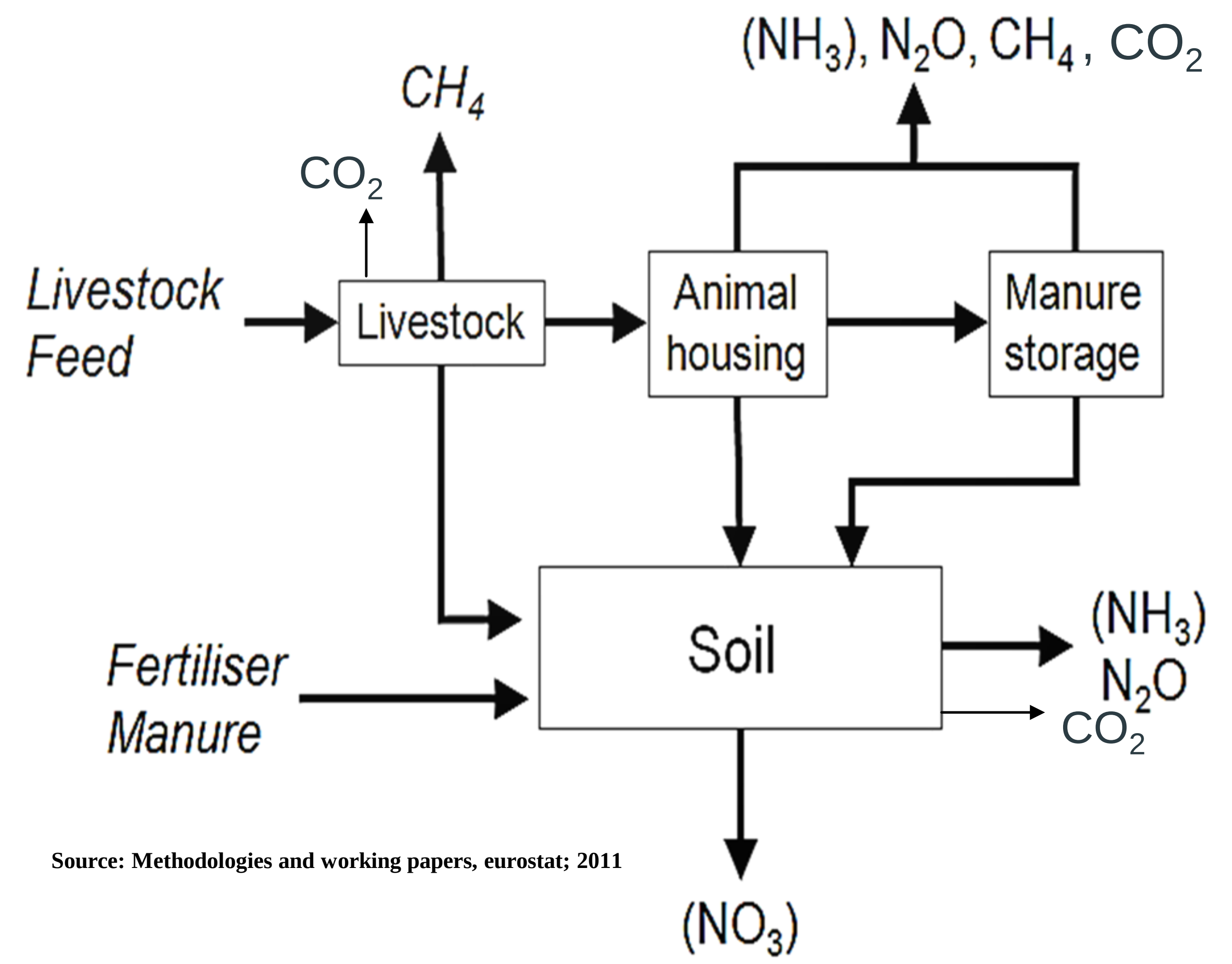
Schematic representations of the main GHG emissions in farming systems



Source: Methodologies and working papers, eurostat; 2011

The **most important** greenhouse gases from livestock are: **methane, nitrous oxide and carbon dioxide**.

- **Methane** is mainly produced by enteric fermentation and manure storage (it has an effect on global warming 28 times higher than carbon dioxide)
- **Nitrous oxide**, is arising from manure storage and the use of organic/inorganic fertilizers, (it has a warming potential 265 times higher than carbon dioxide).
- **Carbone dioxide** is produced mainly from energy consumption or on / post -farm gate processing

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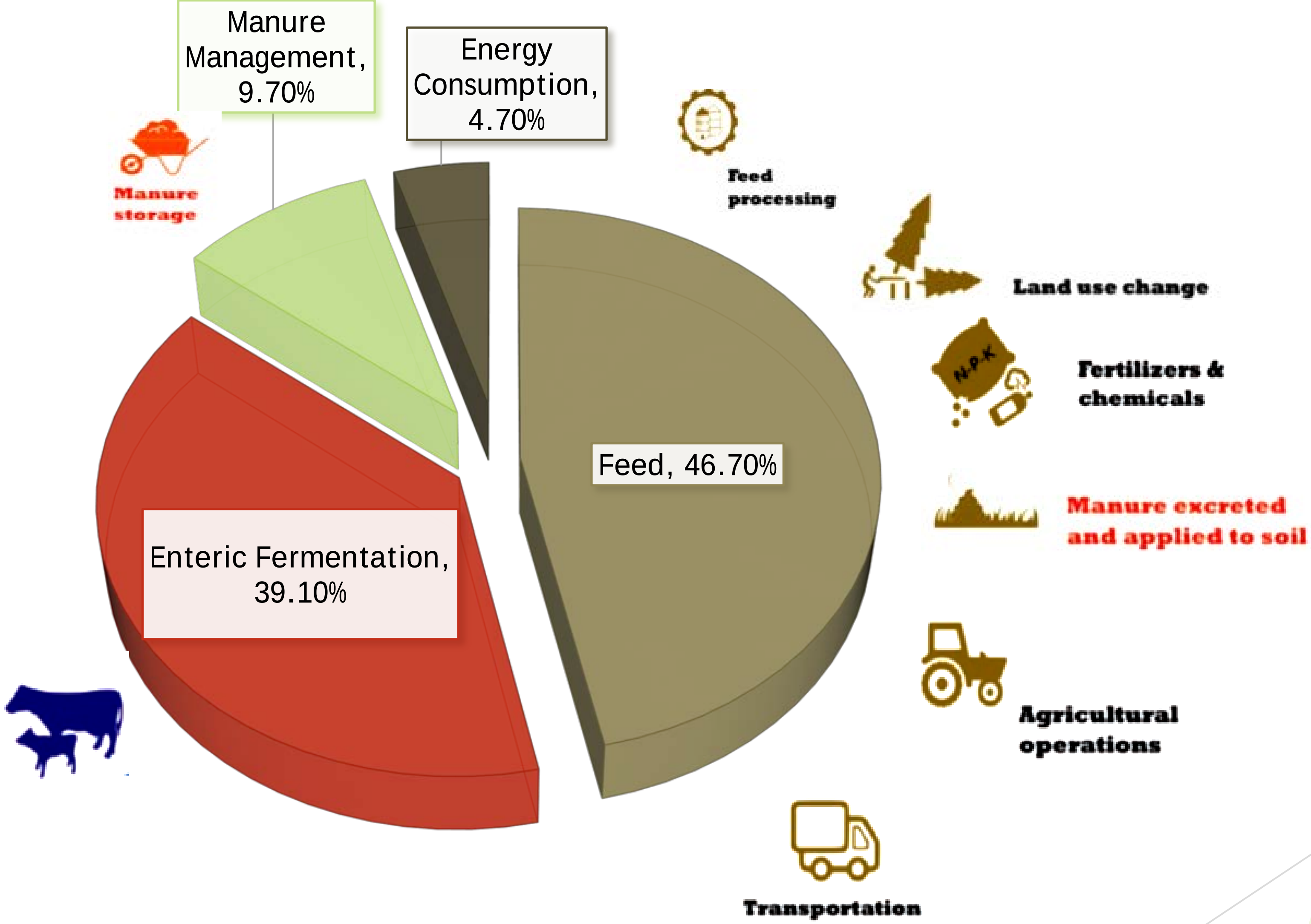
Major source of GHG emissions for livestock production



Source: Grossi et al., 2019

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Major source of GHG emissions by livestock specie at farm level

	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%)

- Emission intensities vary among different commodities

- Methane emissions are the most important in almost all farm animals.

- Methane emissions represent 30% of global anthropogenic emissions

Source: Grossi et al., 2019

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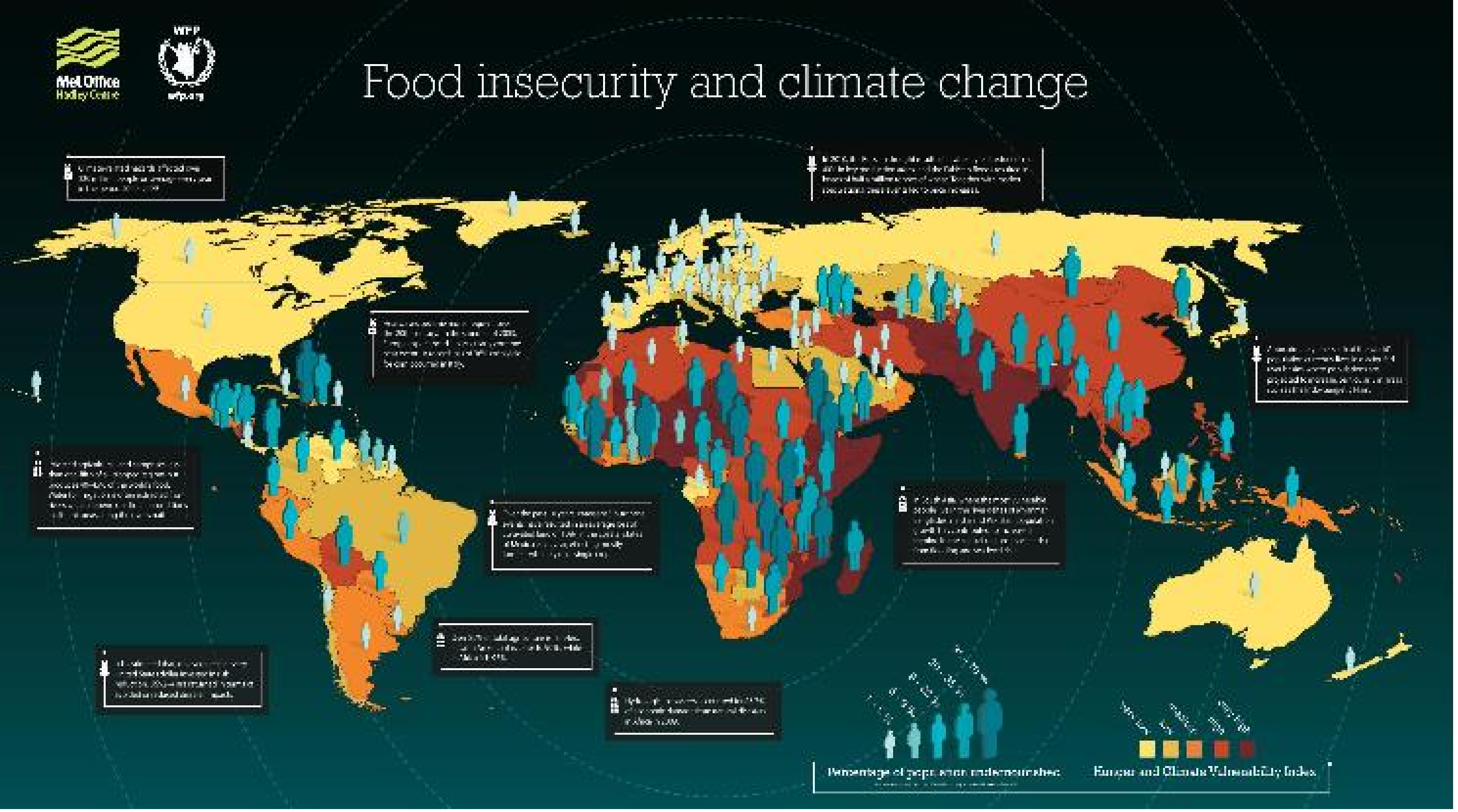
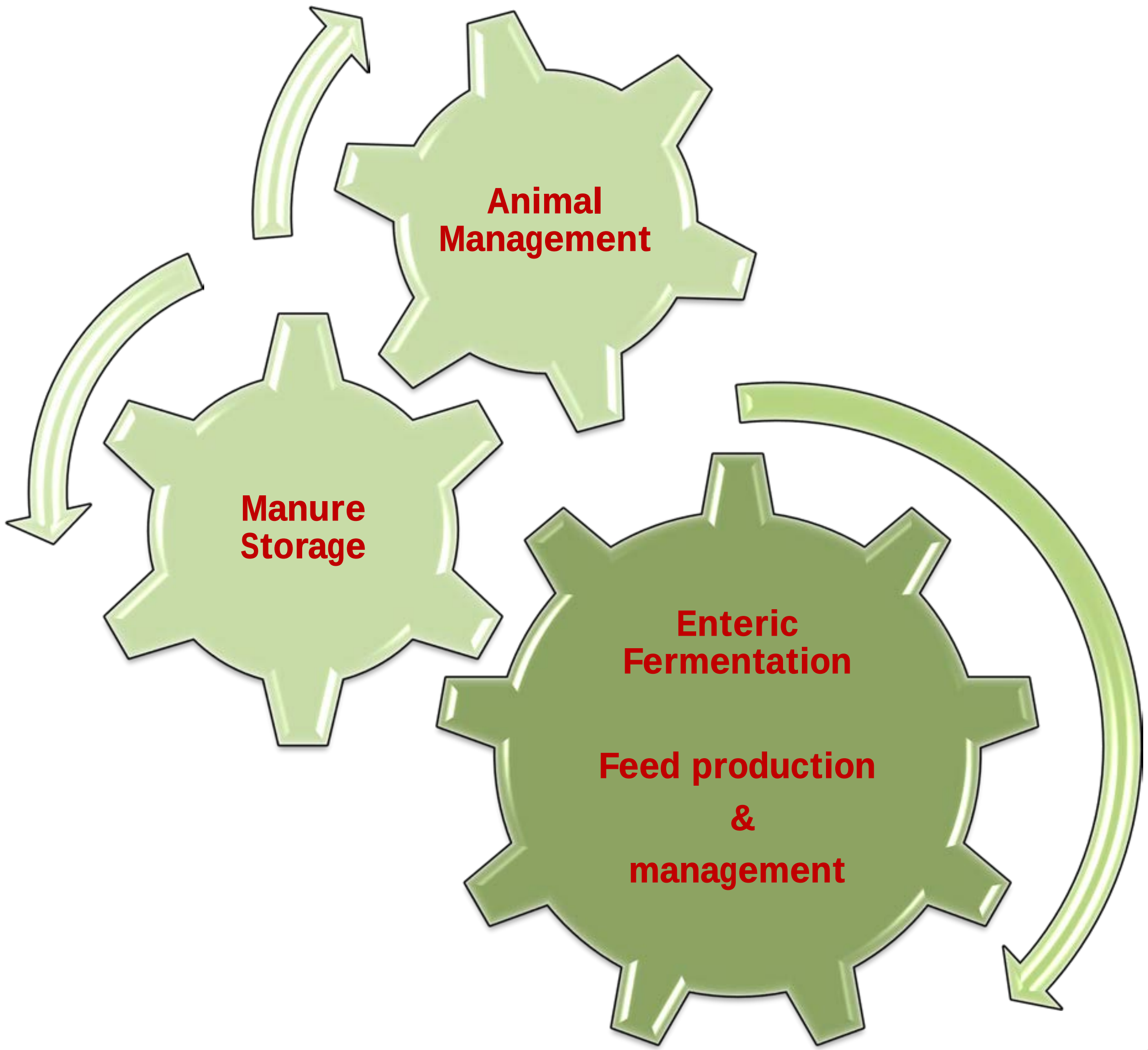


- Can livestock production cover the future food demands as emerged by population growth with a greener footprint?


1. CAN WE TACKLE THE IMPACT OF LIVESTOCK PRODUCTION ON CLIMATE CHANGE ???
2. UNDER WHICH TYPE OF FARMING SYSTEM CAN WE MEET THE INCREASED DEMANDS OF LIVESTOCK PRODUCTS WITH A GREENER FOOTPRINT ???

Mitigation strategies towards environmental impact of livestock production



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Mitigation measures and feed: Some examples….

- Strategies for reducing methane emissions focus on improving the efficiency of animal productivity through the improvement of enteric fermentation process itself.

- Changing feeding practices moderate emissions.

  -A 1% increase of dietary fat can decrease enteric methane emissions between 4-5%.

  -Feed antibiotics can reduce enteric fermentation (reduce feed intake/ produced kg + increase BW).

  -Reduced protein intake may lead to decrease the nitrogen excreted by animals.

  -Improving diet digestibility by increasing concentrate feeding may reduce by 15% methane emissions per unit of fat protein corrected milk.

  -Antimethanogen vaccines can directly reduces methane emissions in the rumen (little research)

  - Feed additives (electron receptors, chemical inhibitors, etc.) are able to decrease methane emissions (toxicity / health risks ???)

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Mitigation measures and feed: Some examples....

- Feed production and management:

  - Increasing the use of organic fertilizers would also decrease emissions (organic fertilizers do not produce as much nitrogen oxide as synthetic fertilizers)

  -Rotational grazing systems may lead to reduce nitrous oxide emissions (via stocking densities and grazing duration management)

  -Improving grazing land management could sequester around 0.15 gigatn CO_2-eq/yr globally.

  -Physical processing of forages, i.e. chopping or grinding, improve digestibility lower (in a small extent <2%) enteric methane production in ruminants

  -Targeting for higher-yielding crops for feed production with better climate change adapted varieties, improvement of land and water management promotes carbon sequestration

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Mitigation measures and manure management: Some examples….

- Changes in manure management lead to lesser emissions.

  -Frequent removal of manure to an outside storage facility could reduce methane and nitrous oxide emissions >40%.

  -Solid-liquid separation process of manure could lead to a 30% lesser emissions compared with untreated manure.

  -Same positive effect may have the anaerobic digestion of manure, when biogas generated from the process is used in the livestock

  -Lower methane emissions occur after manure land application, thus a decrease of storage time could assist in reducing GHG emissions.

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Breeding and Mitigation measures : Some examples….

- Animal management and breeding strategies

-The more productive the animal is the lower environmental impact will have (per unit of product).

-Breeding for more productive animals may lead to a diminish of the nutrient requirements→ assist to lower GHG emissions.

-Improved fertility in dairy cattle could lead to a reduction in methane emissions by 10–24% and reduced nitrous oxide by 9–17%.

- Cattle diseases can increase greenhouse gas emissions up to 24% per unit of produced milk and up to 113% per unit of produced beef carcass.

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Mitigation potential of various strategies

Strategies	Category	Potential mitigating effect*	
		Methane	Nitrous Oxide
Enteric fermentation	Forage quality	Low to medium	†
	Feed processing	Low	Low
	Concentrate inclusion	Low to medium	†
	Dietary lipids	Medium	†
	Electrons receptors	High	†
	Ionophores	Low	†
	Methanogenic inhibitors	Low	†
Manure storage	Solid-liquid separation	High	Low
	Anaerobic digestion	High	High
	Decreased storage time	High	High
	Frequent manure removal	High	High
	Phase feeding	‡	Low
	Reduced dietary protein	‡	Medium
	Nitrification inhibitors	‡	Medium to high
	No grazing on wet soil	Low	Medium
	Increased productivity	High	High
Animal management	Genetic selection	High	‡
	Animal health	Low to medium	Low to medium
	Increase reproductive eff.	Low to medium	Low to medium
	Reduced animal mortality	Low to medium	Low to medium
	Housing systems	Medium to high	Medium to high

High = ≥30% mitigating effect
Medium = 10–30% mitigating effect
Low = ≤10% mitigating effect

Mitigating effects refer to percent change over a “standard practice”

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Source: Grossi et al., 2019


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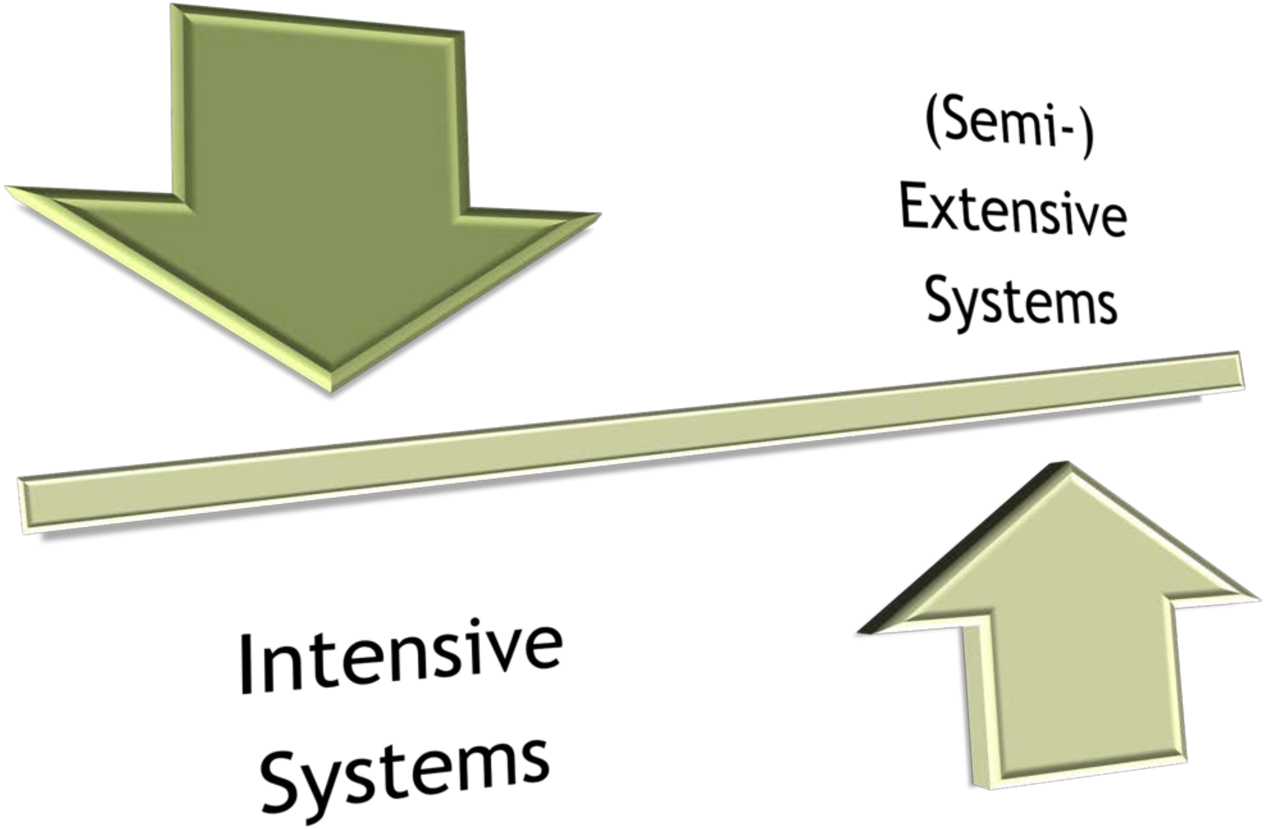
Livestock production and farming systems



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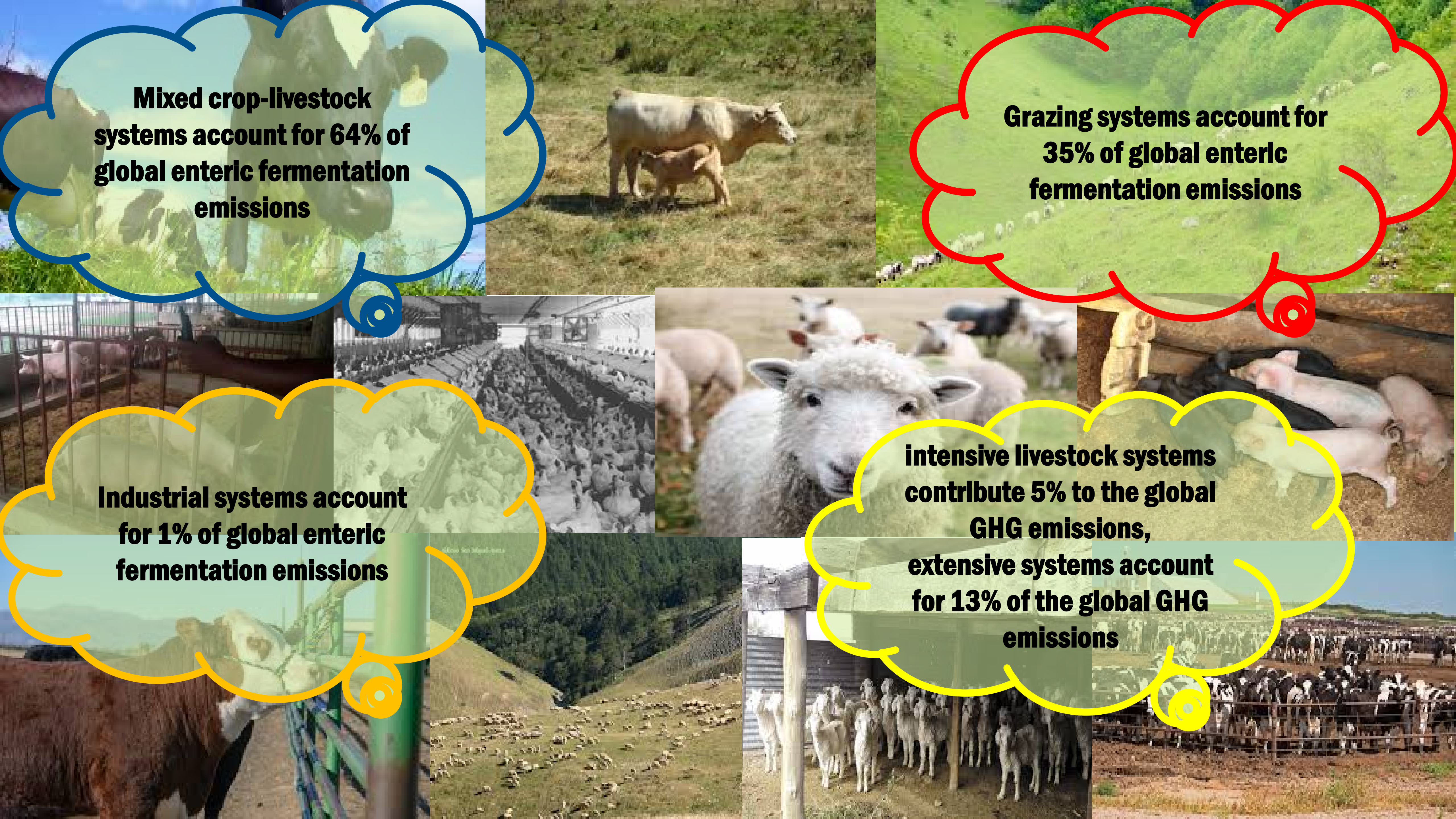
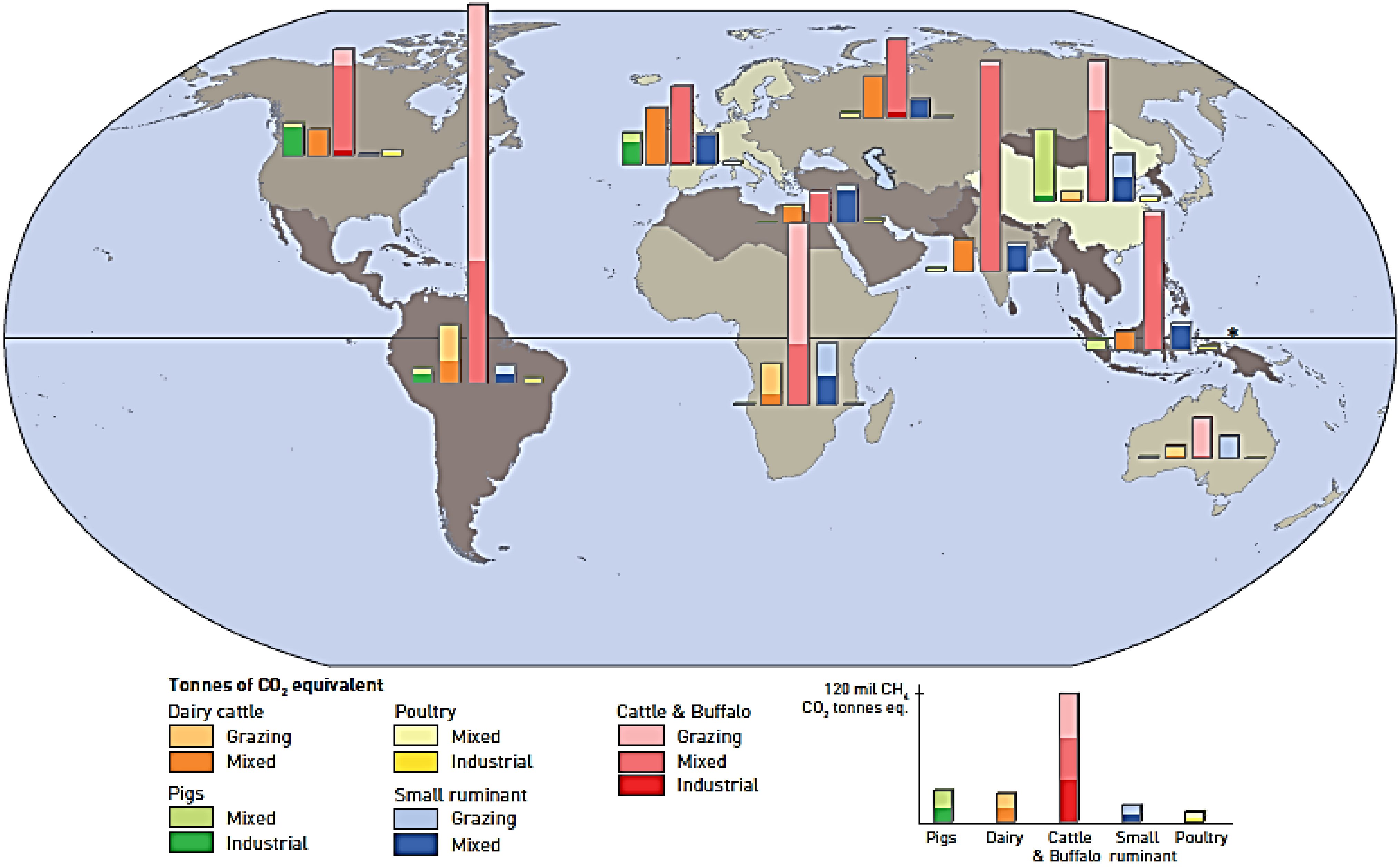

Mixed crop-livestock systems account for 64% of global enteric fermentation emissions
Grazing systems account for 35% of global enteric fermentation emissions
Industrial systems account for 1% of global enteric fermentation emissions
Intensive livestock systems contribute 5% to the global GHG emissions, extensive systems account for 13% of the global GHG emissions

Total methane emissions from enteric fermentation and manure per species and main production system



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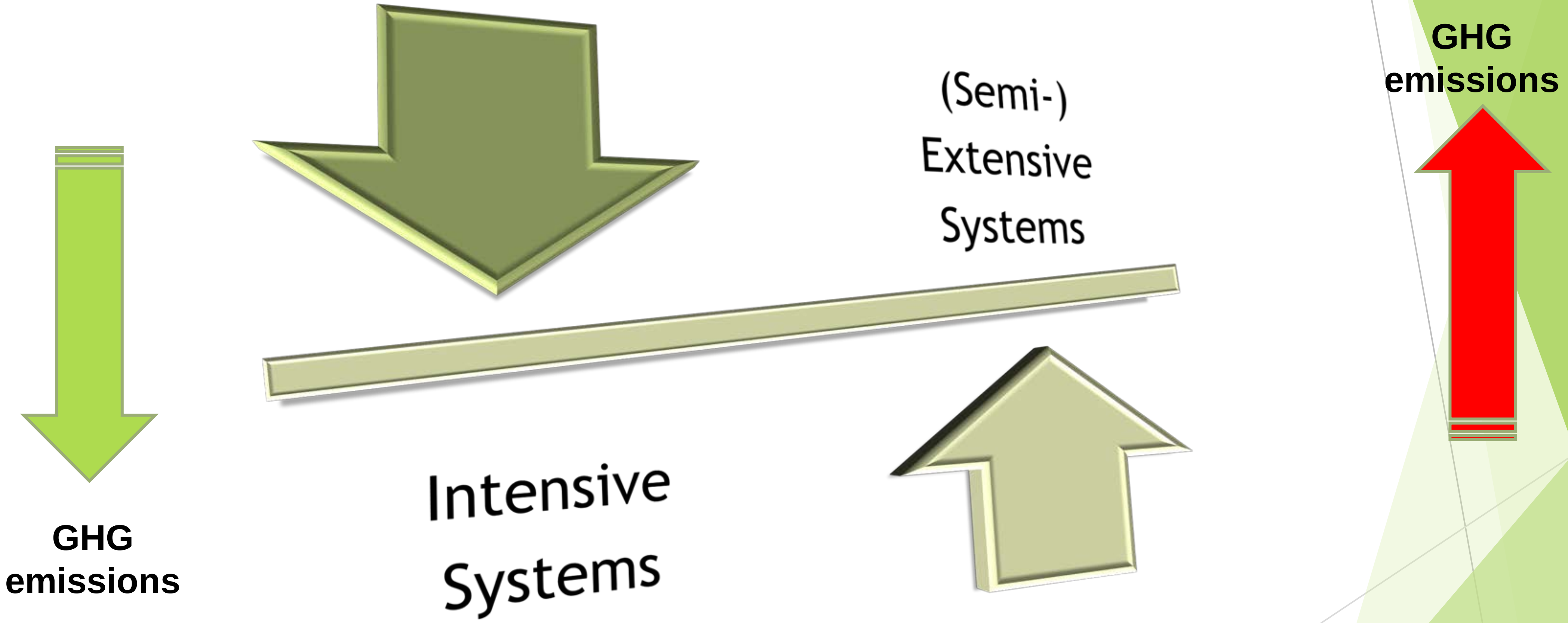
Farming systems & GHG emissions



The more extensive the system is the higher GHG emissions observed (CO_2 eq per produced kg or per area used)

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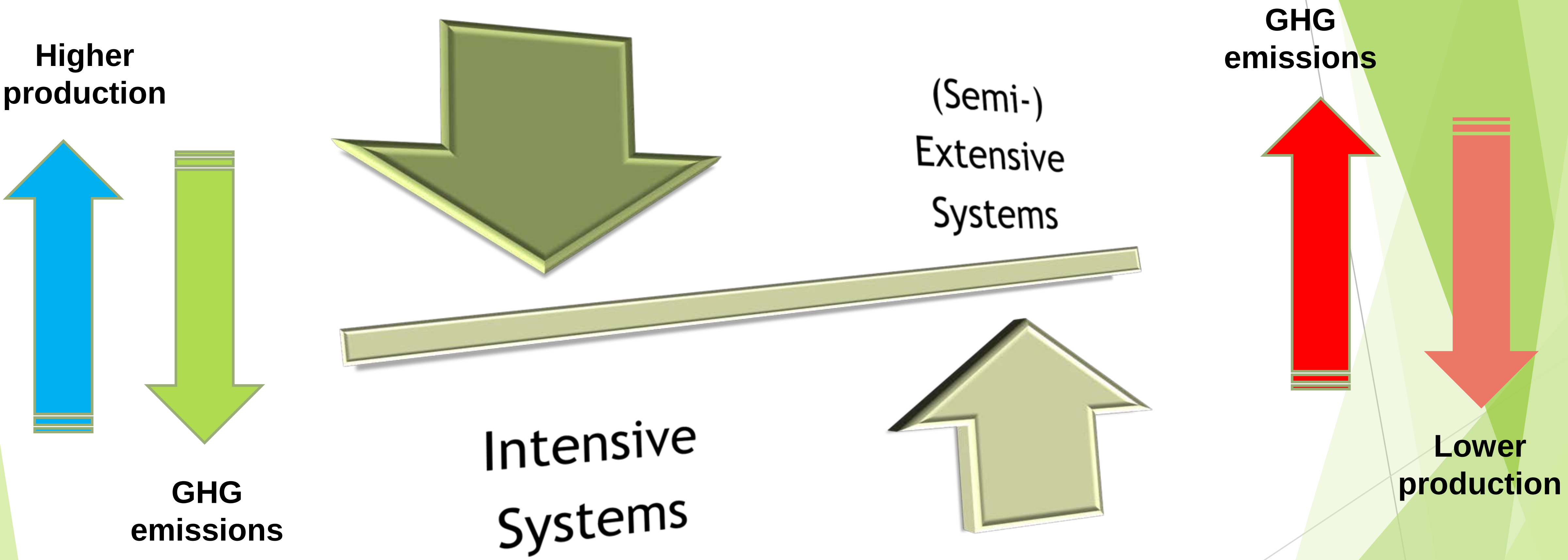
Farming systems & GHG emissions



The more productive the system is the lesser GHG emissions observed (CO2 eq / produced kg)

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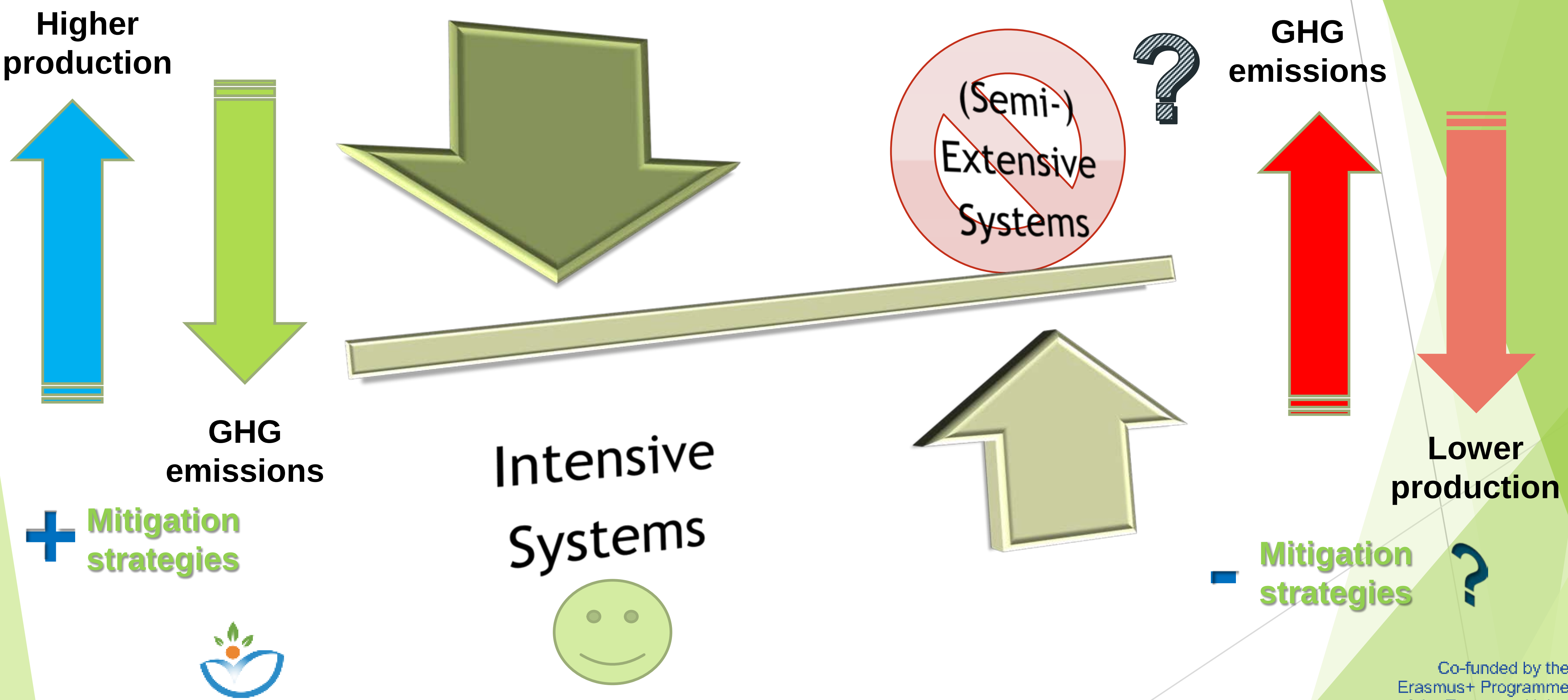
Farming systems & GHG emissions



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Pros of Extensive systems

- Breeding of local (rare) breeds specially adapted to harsh environments
- Represent a reservoir of animal biodiversity
- Constitute an "alive" genetic pool (a vehicle for overcoming future challenges)
- Assist to improve the wildfire prevention strategies
- Require less natural resources
- Enhance sequestration of CO_2
- Enhance the social cohesion
- Are linked with various customs developed over the past years

Differentiated product with added value

+ Improve productivity (i.e. better management practices)

Mitigation measures

Greener footprint

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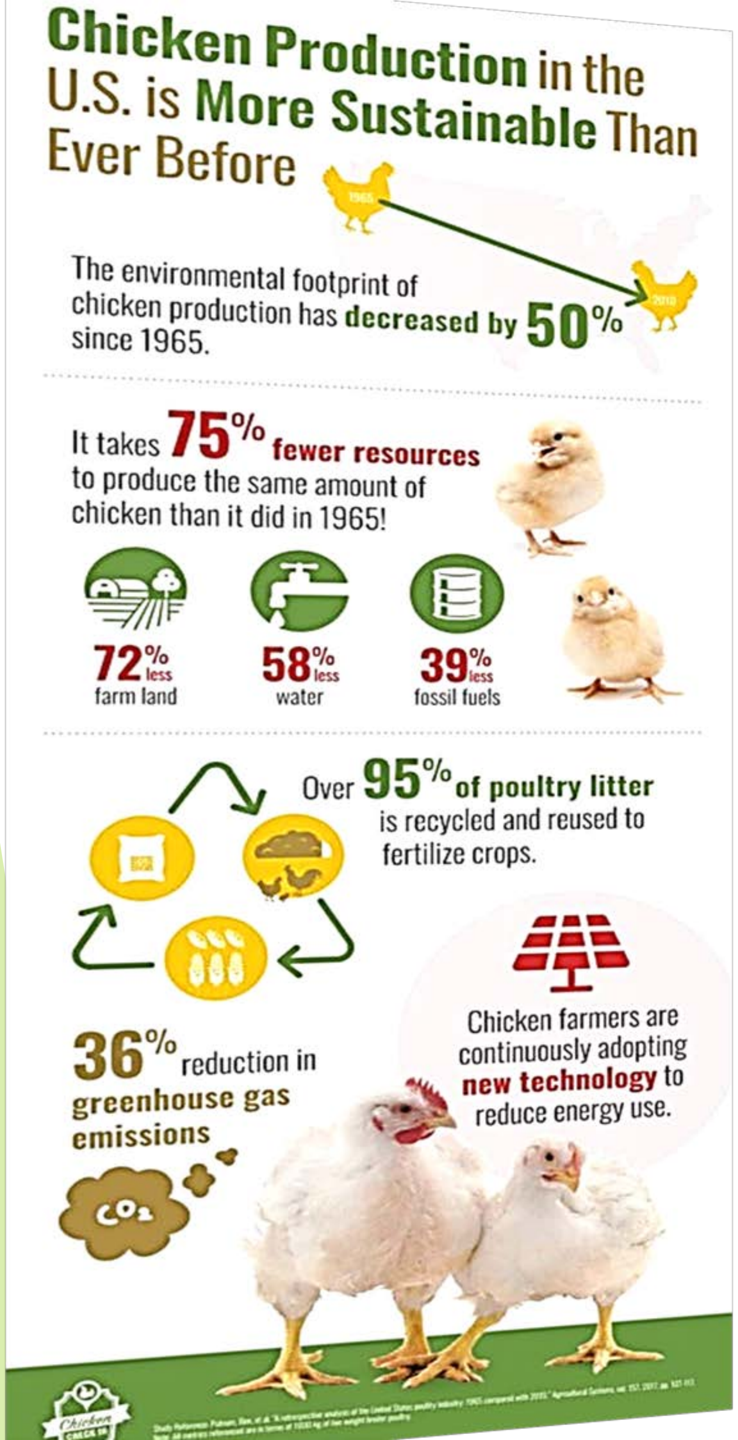

An example from the past….

Producing the same amount of chicken today as 1965 has 50% less impact on the environment.

Many factors contributed to the reduced environmental impact including:

- 75% fewer resources required in poultry production;
- 39% lesser fossil fuels;
- 72% decrease in farm land used in poultry production;
- 58% decrease in water used in poultry production.

+++ environmental friendlier energy sources ….

Shed light for adaptation of extensive systems to climate change

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Farming systems & GHG emissions

Both systems emerge advantages for mitigating future demands and challenges

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Conclusions….

- Livestock contribute both directly and indirectly to climate change
- The sector contributes ~15% of global GHG emissions
- It accounts for the 9% of global CO_2 BUT generates the 65% and 30% of human related N_2O and CH_4 respectively
- Main sources of GHG emissions from livestock are a) the digestive process of animals b) manure and c) lesser the energy use
- Mitigation strategies are focused on the aforementioned fields at livestock level
- Intensive systems seems to have a greener footprint mainly due to their higher productivity
- Extensive systems have a potential to contribute to future challenges if they further adapted to a higher productivity and/or cost-effective mitigation measures

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