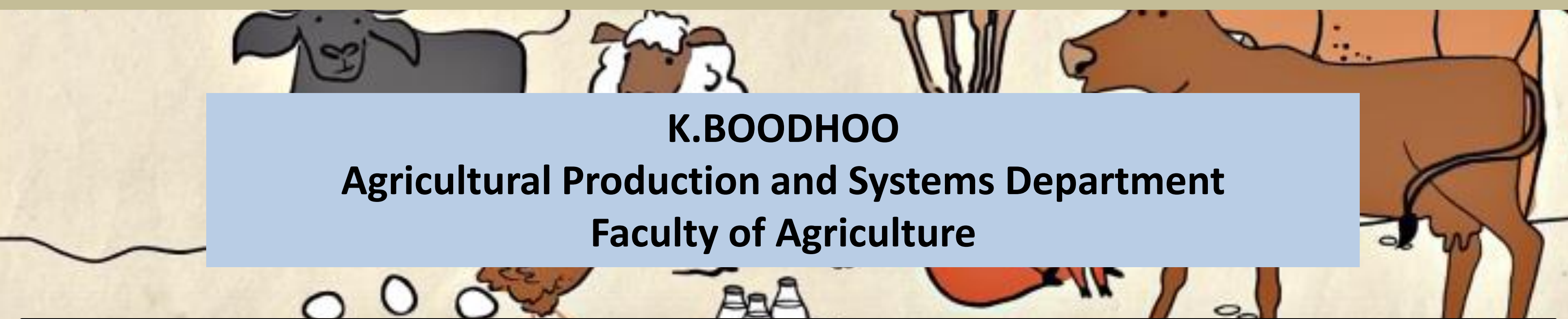
Strategies in Sustainable Intensification of livestock Production and its role in Climate Smart Agriculture



K.BOODHOO
Agricultural Production and Systems Department
Faculty of Agriculture

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University of Mauritius , Reduit, Mauritius

OUTLINE

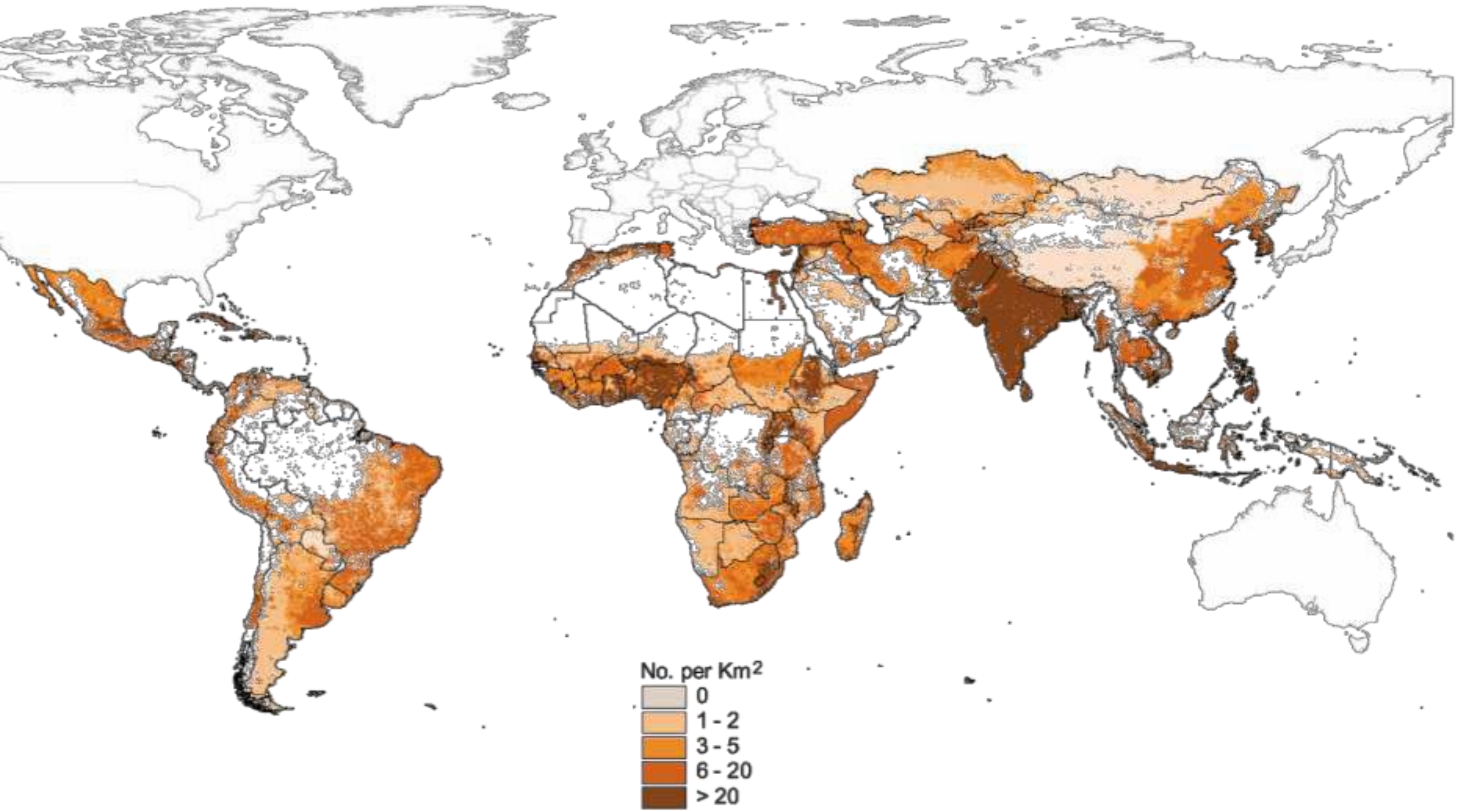
- Background Information
- Role of Livestock Production and the SDGs
- Typical Animal Production Systems
- The Livestock and climate change dynamics
- Areas of CSA interventions in livestock
- Barriers to implementation of adaptation and mitigation practices

STATUS OF LIVESTOCK IN SMALL SCALE PRODUCTION

- 70% of the world's rural poor rely on livestock for their **livelihoods.**
- **600 million poor** livestock keepers in the world, around two-thirds are rural women.
- Over **100 million landless people** keep livestock.
- For the vulnerable, up to **40% of benefits** from livestock keeping come from non-market**, intangible benefits**, mostly insurance and financing.
- In the poorest countries, **livestock manure** comprises over 70% of soil fertility amendments.
- Many employed in local **informal livestock product markets**
- 90% of animal products are produced and **consumed locally** or in region
- Over 70% of livestock products are **sold 'informally**'

Source: Tarawali, S (2016), ILRI

At least 600 million of the World's poor depend on livestock

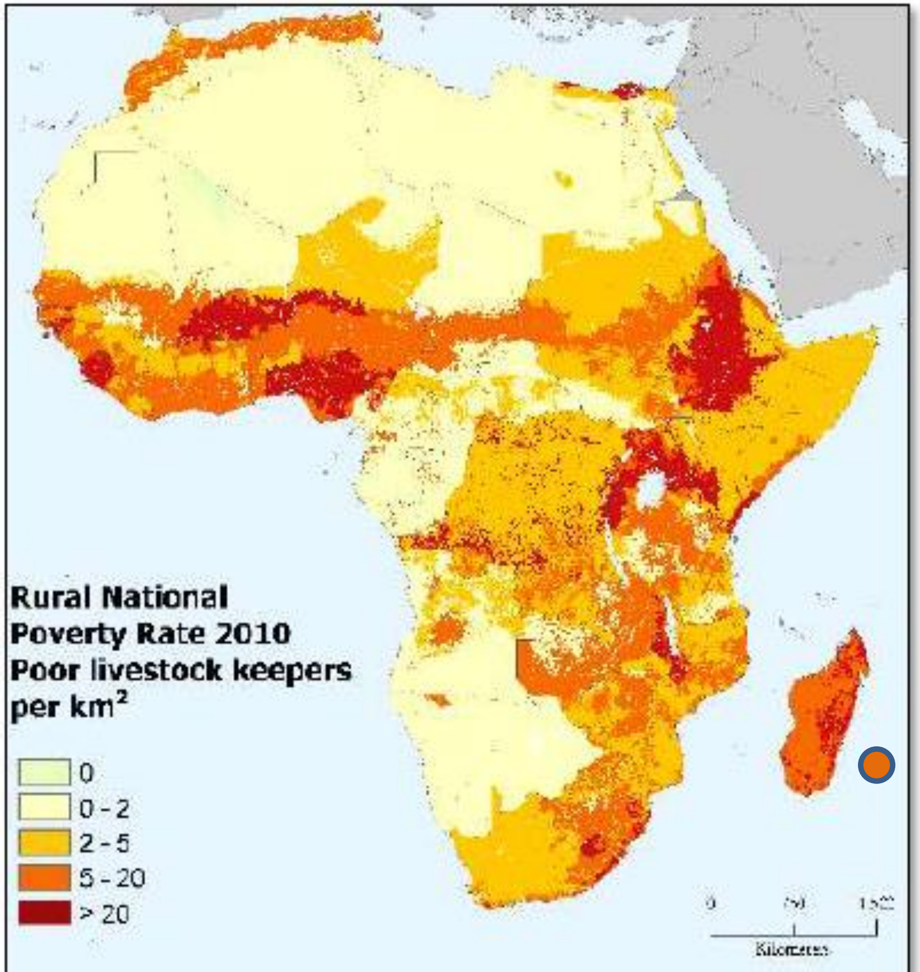


Thornton et al. 2009

Smallholders still dominate livestock production in many countries

Region (definition of 'smallholder')	% production by smallholder livestock farms					
	Beef	**Chicken meat**	**Sheep/goat meat**	**Milk**	**Pork**	**Eggs**
East Africa (≤ 6 milking animals)				60-90		
Bangladesh (< 3ha land)	65	77	78	65		77
India (< 2ha land)	75	92	92	69		71
Vietnam (small scale)					80	
Philippines (backyard)		50			35	

Mapping poor livestock keepers



165 million poor people in Africa depend on livestock for their livelihoods

Livestock system	PLK
Livestock only – arid & semi-arid	22,582,000
Livestock only – humid & sub-humid	7,456,000
Livestock only – tropical highlands	653,000
Mixed rain-fed – arid & semi-arid	51,394,000
Mixed rain-fed – humid & sub-humid	41,647,000
Mixed rain-fed – tropical highlands	28,343,000
Mixed irrigated – arid & semi-arid	432,000
Mixed irrigated – humid & sub-humid	139,000
Mixed irrigated – tropical highlands	179,000
Other (forest)	11,701,000

Increases to 230 million PLK using the international $2.00 per day poverty rate

Source: Robinson et al. 2011

Three major livestock production systems

Grazing systems

Mixed systems

Industrial systems










FOOD AND NON FOOD FUNCTIONS of LIVESTOCK

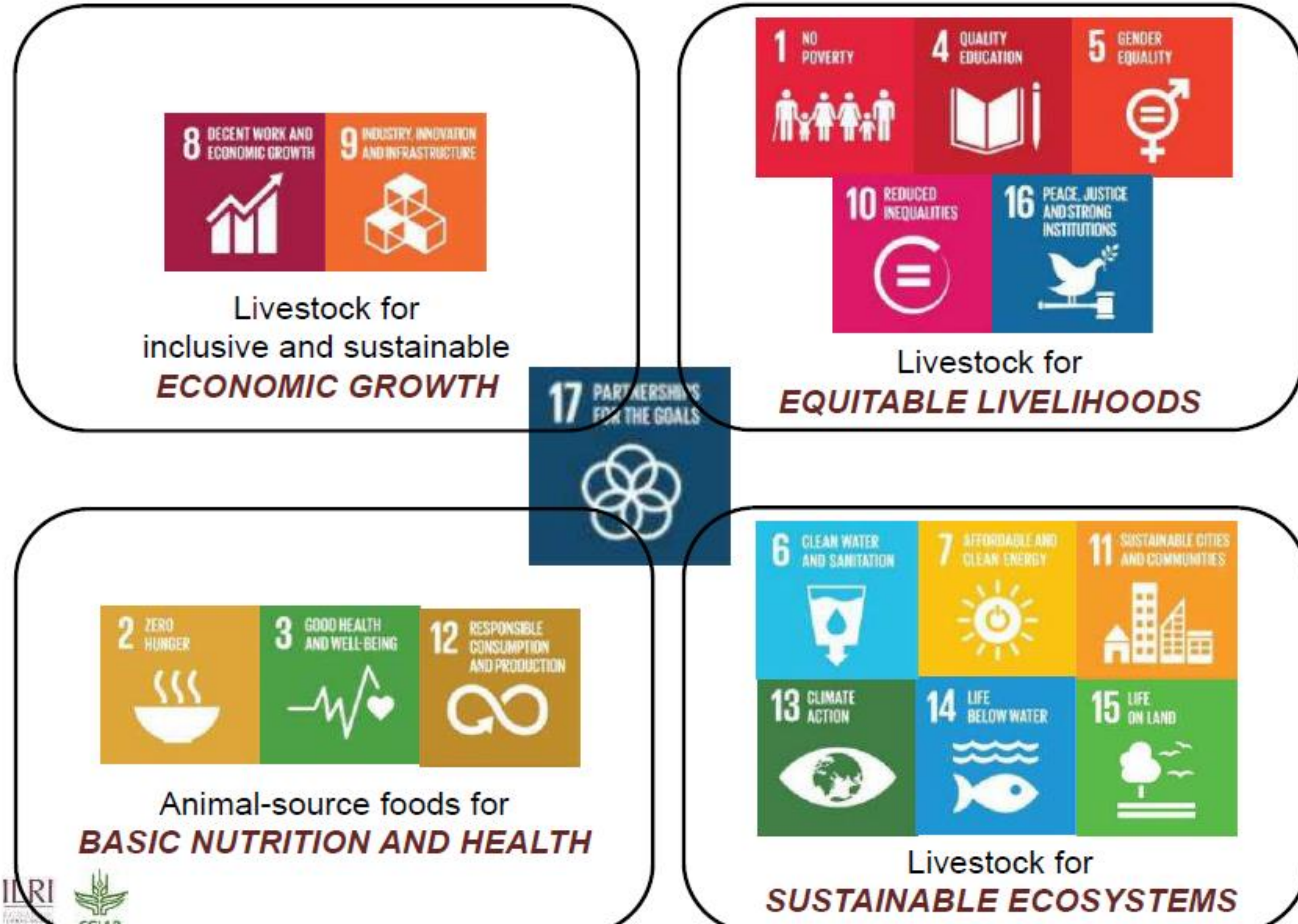
- **Multiple benefit (milk, meat, eggs, labour, manure, wool, hides, skins…)**
- **Regular income generation**
- **Use of marginal land/weed control**
- **Convert human inedible plant materials into food**
- **Financial security/Assets**
- **Socio-cultural status**

Food Security, Poverty Reduction and Resilience

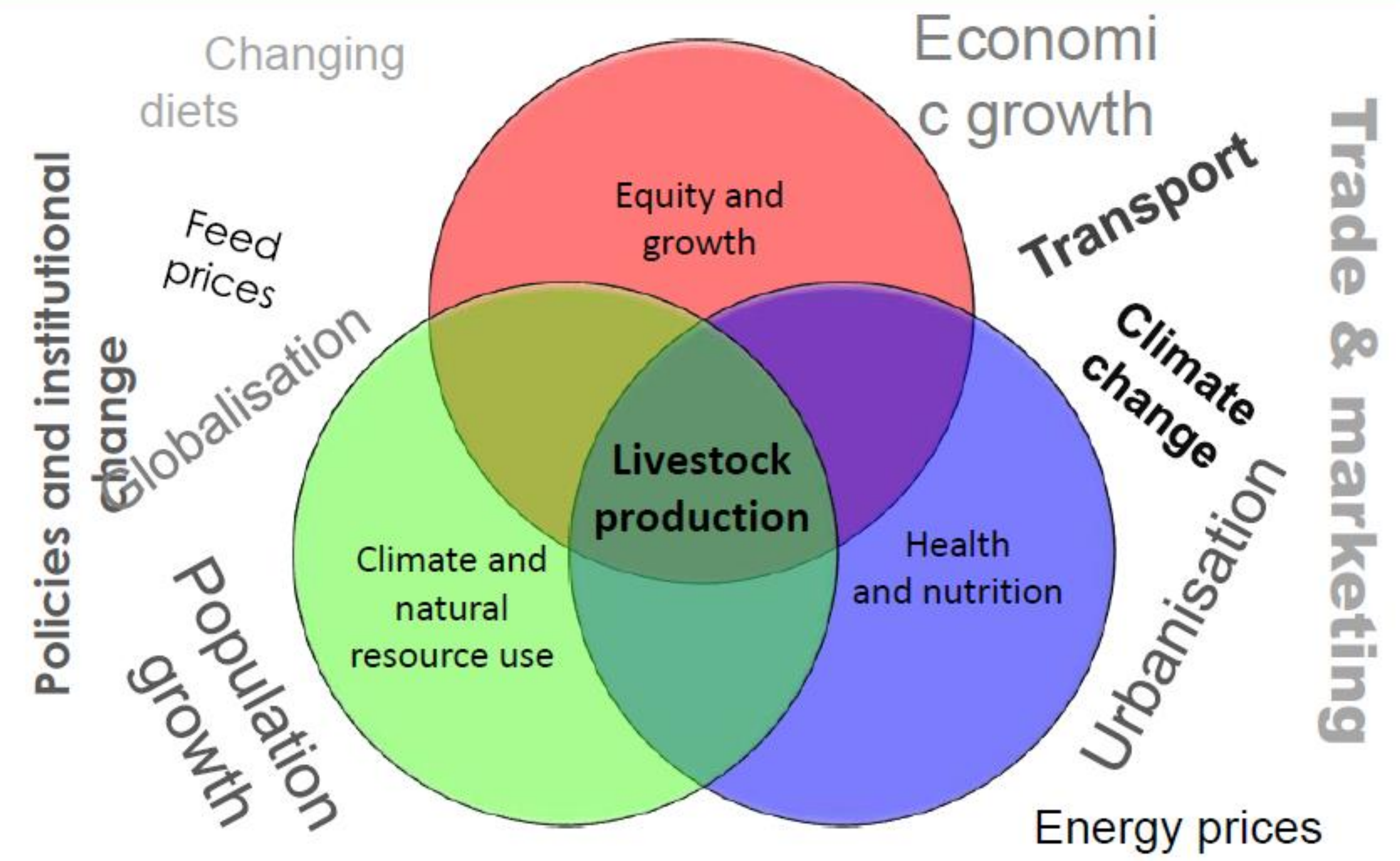
17 goals


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

Contributions of livestock to the SDGs



Drivers of change



The challenge ahead

- Need to feed more people by 2050 (1/3 more than now)

- At a lower environmental cost (roughly the same land, low emissions, water and nutrient use)

- In a socially and economically acceptable way (equitably, at the right prices, etc)

- Food systems have been changing and are likely to change even more!

- **ATTAIN THE SDGs**

The environmental impact of animal production

All anthropogenic activities have an impact – which can be positive or negative – on the environment

Animal production is not an exception:

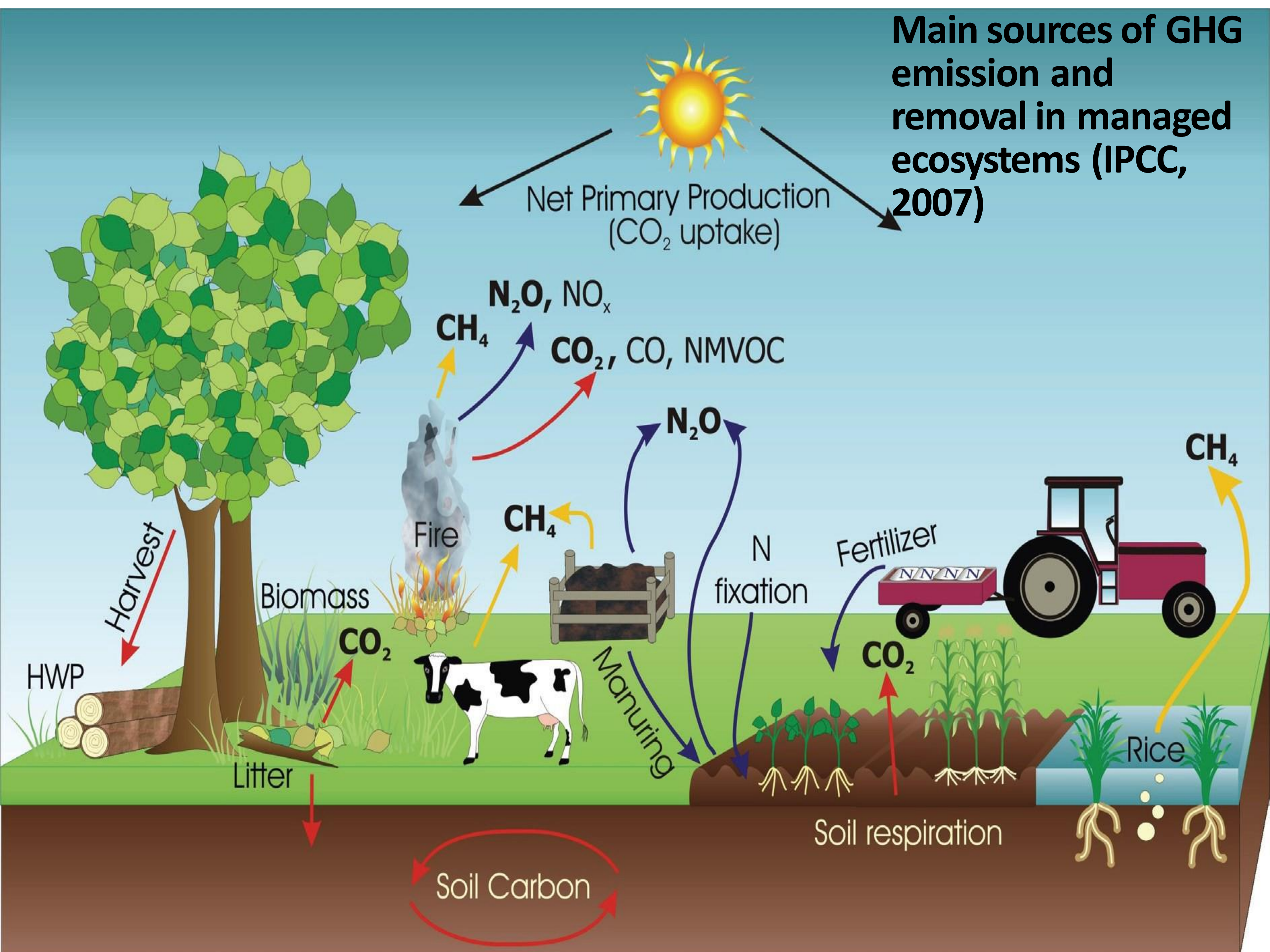
1. Greenhouse gas emissions (GHG - climate change)

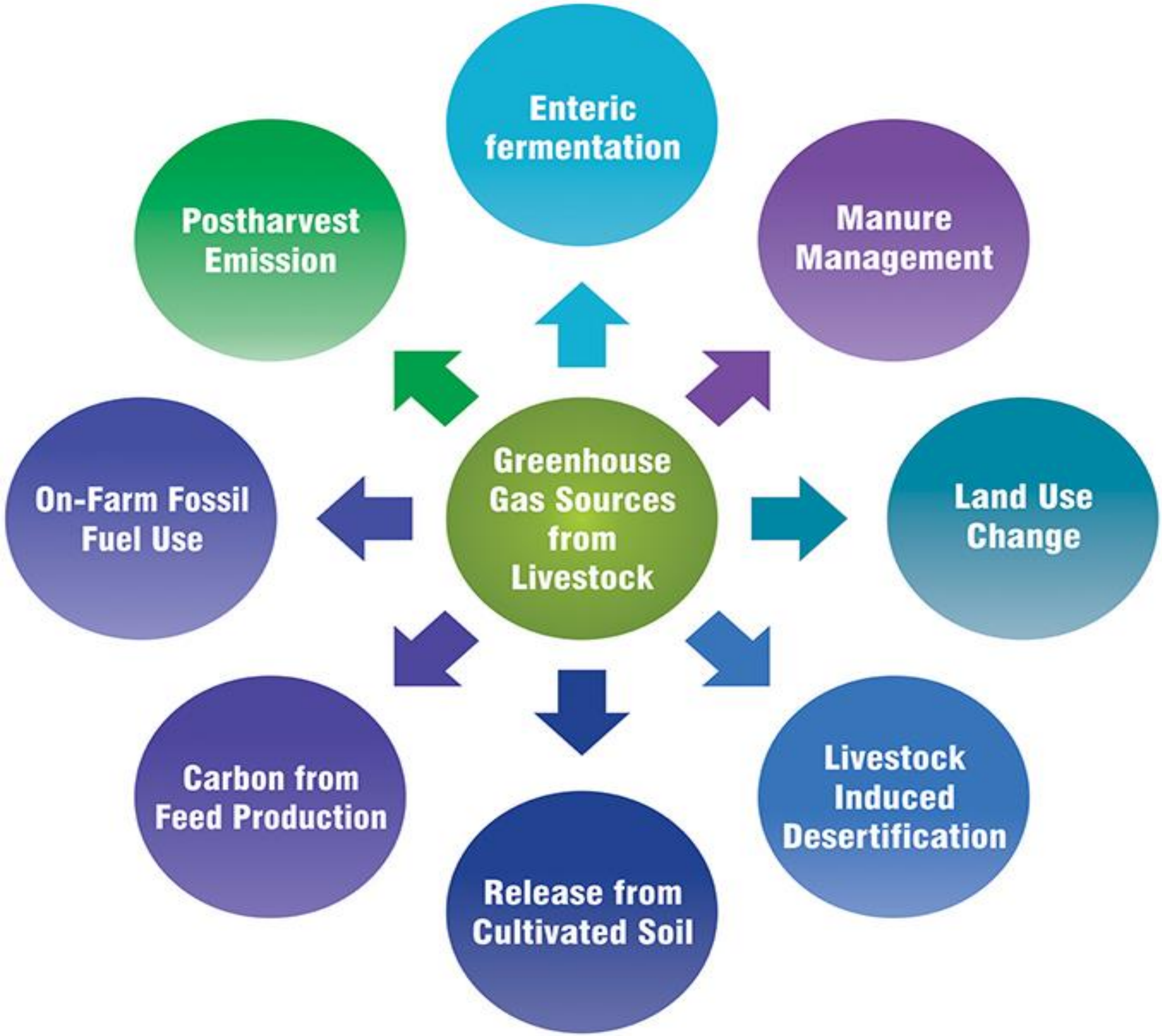
2. Nutrient excretion (nitrogen, phosphorous)

3. Land usage

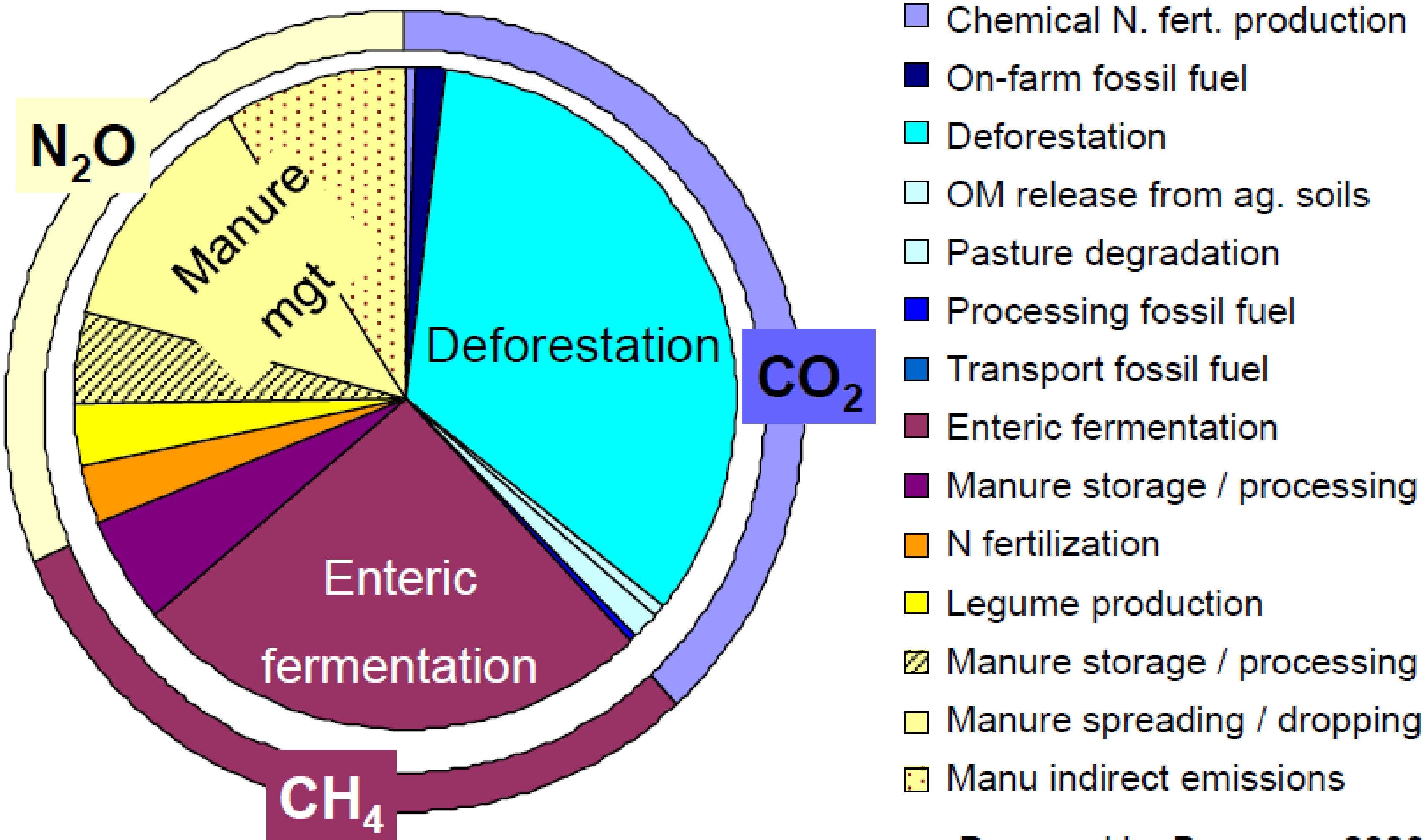
4. Energy expenditure – fossil fuel

Main sources of GHG emission and removal in managed ecosystems (IPCC, 2007)




Enteric fermentation
Manure Management
Land Use Change
Livestock Induced Desertification
Release from Cultivated Soil
Carbon from Feed Production
On-Farm Fossil Fuel Use
Postharvest Emission
Greenhouse Gas Sources from Livestock

Livestock and GHG: 18% of global emissions



Prepared by Bonneau, 2008

Carbon dioxide (CO_2)	• microbial decomposition of soil organic matter and dead organic matter (i.e. dead wood and litter) • deforestation • burning of organic matter
Methane (CH_4)	• enteric fermentation from livestock • methanogenesis under anaerobic conditions in soils (e.g. during rice cultivation) and manure storage • burning of organic matter
Nitrous oxide (N_2O)	• nitrification and denitrification due to application of synthetic fertilizers and organic amendments (e.g. manure) to soils • burning of organic matter (IPCC, 2006).

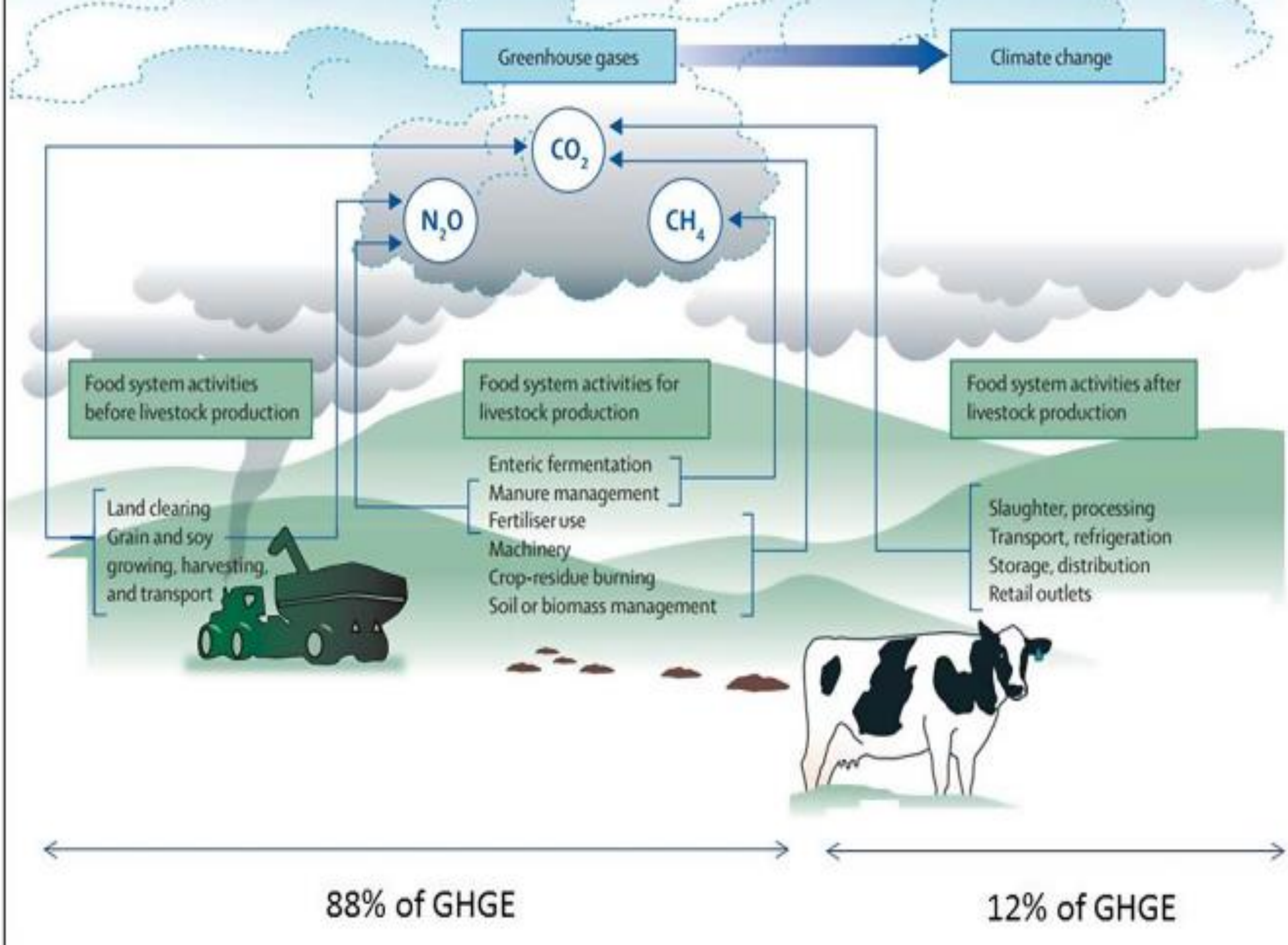


Fig. 1. Processes in the food and agriculture system that lead to greenhouse-gas emissions.

Sources of sector emissions:

- Processing and enteric fermentation 45 %
- Feed production 39 %
- Manure storage and processing 10 %
- Processing and transportation of animal products 6 %

Cattle milk & beef
4.3 GT

Pig meat
0.7 GT

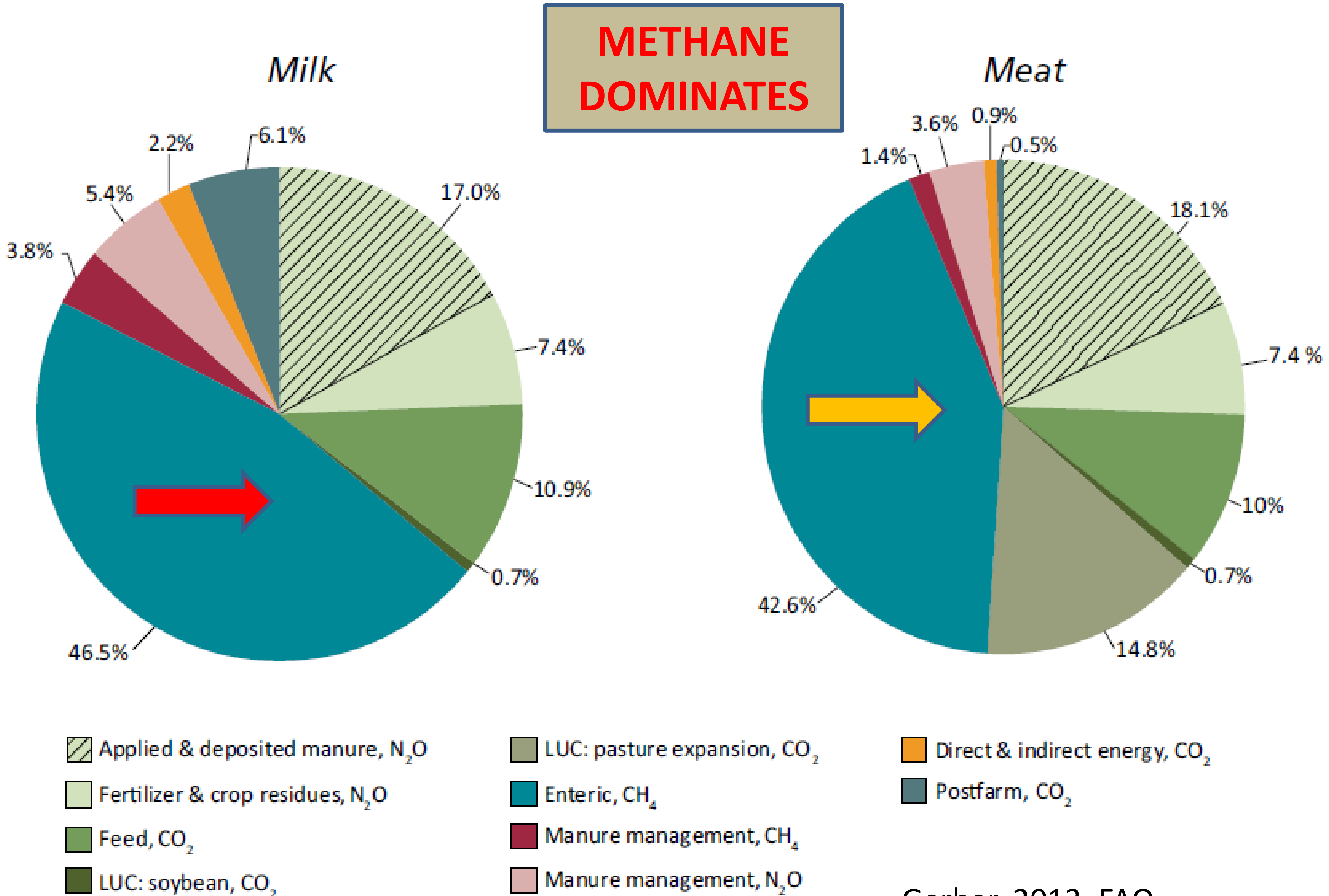
Buffalo milk & meat
0.6 GT

Small ruminant milk & meat
0.4 GT

Chicken egg & meat
0.6 GT

Gerber et al., 2013

FIGURE 7. Global emissions from cattle milk and beef supply chains, by category of emissions



Gerber, 2013, FAO

CO_2-eq

- The greenhouse effect is different for different gases involved
- The effects of emissions conform with the "CO_2 equivalent" (IPCC, 2007)

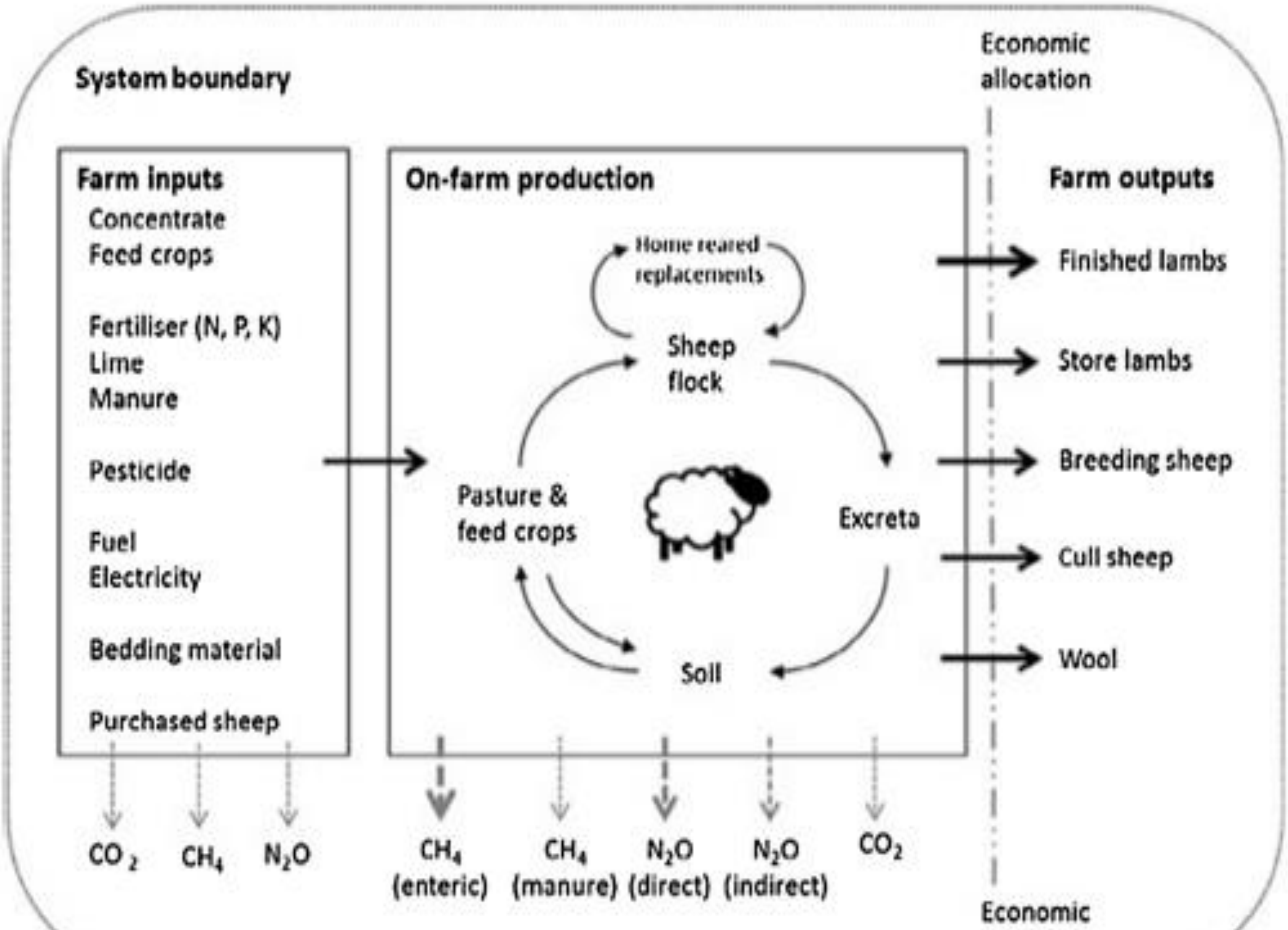
Carbon dioxide-equivalent (CO_2-eq)

1 kg CO_2 = 1 kg CO_2 equivalent

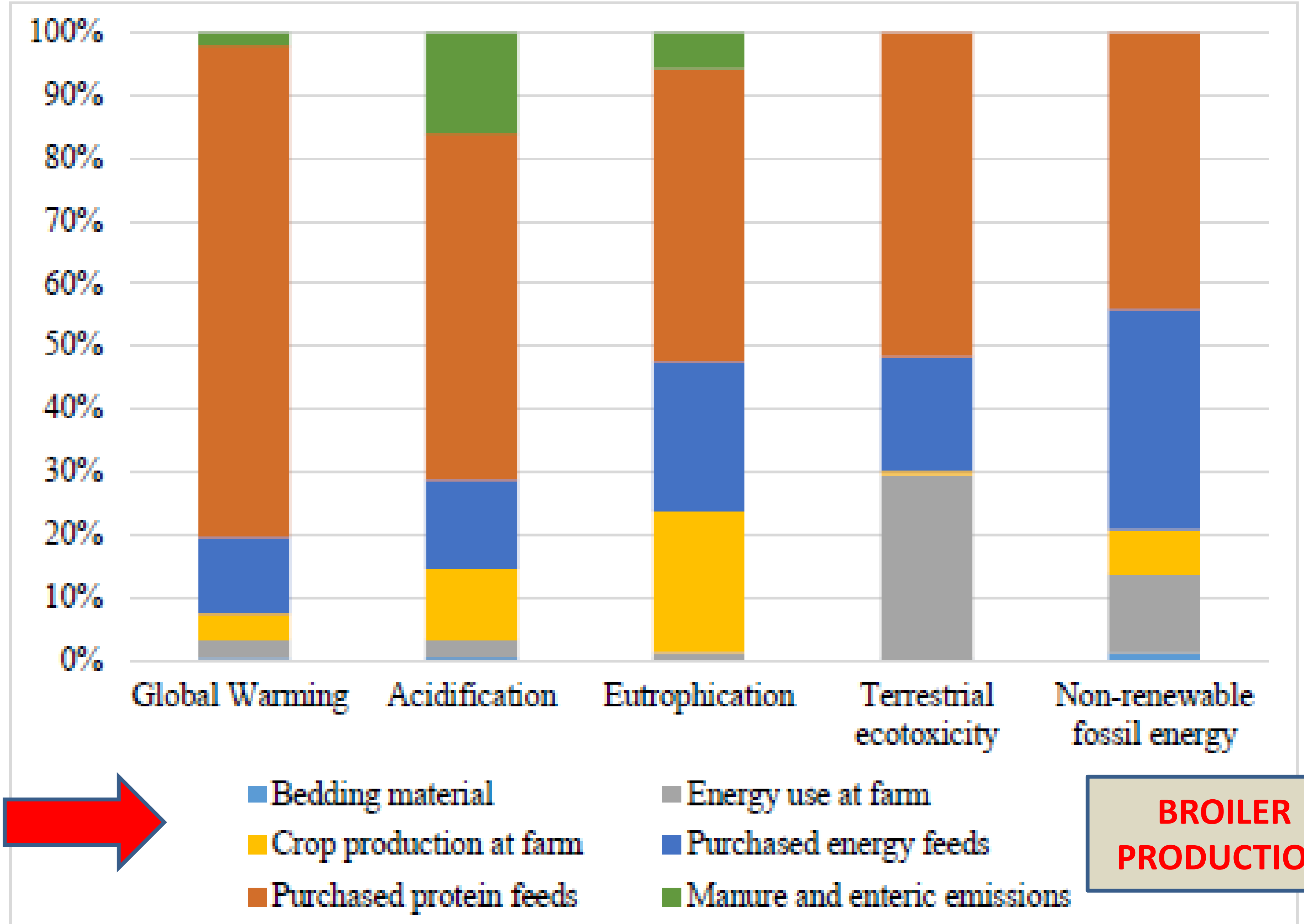
1 kg CH_4 = 25 kg CO_2 equivalent

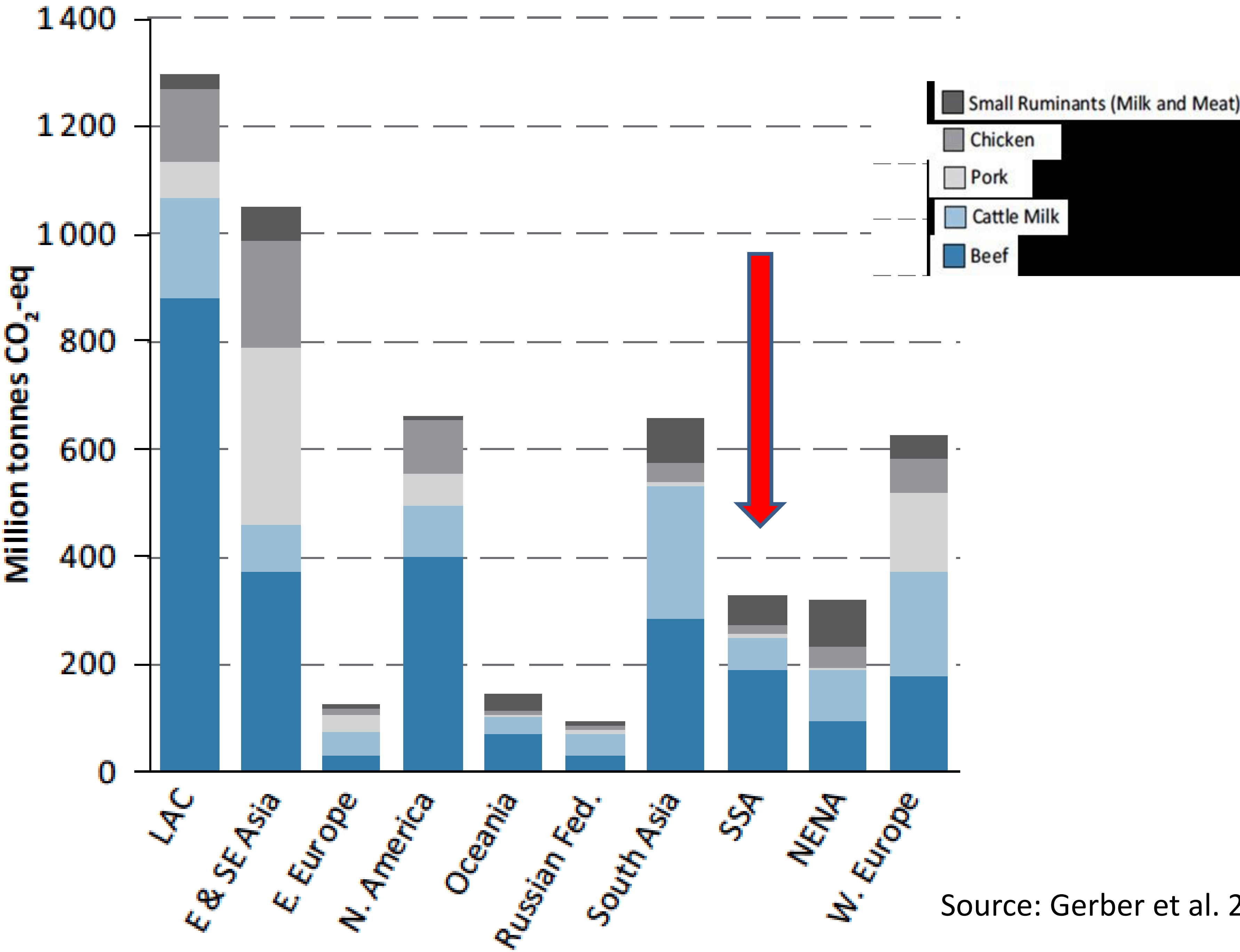
1 kg N_2O = 298 kg CO_2 equivalent

LIFE CYCLE ASSESSEMENT IN SHEEP FARMING



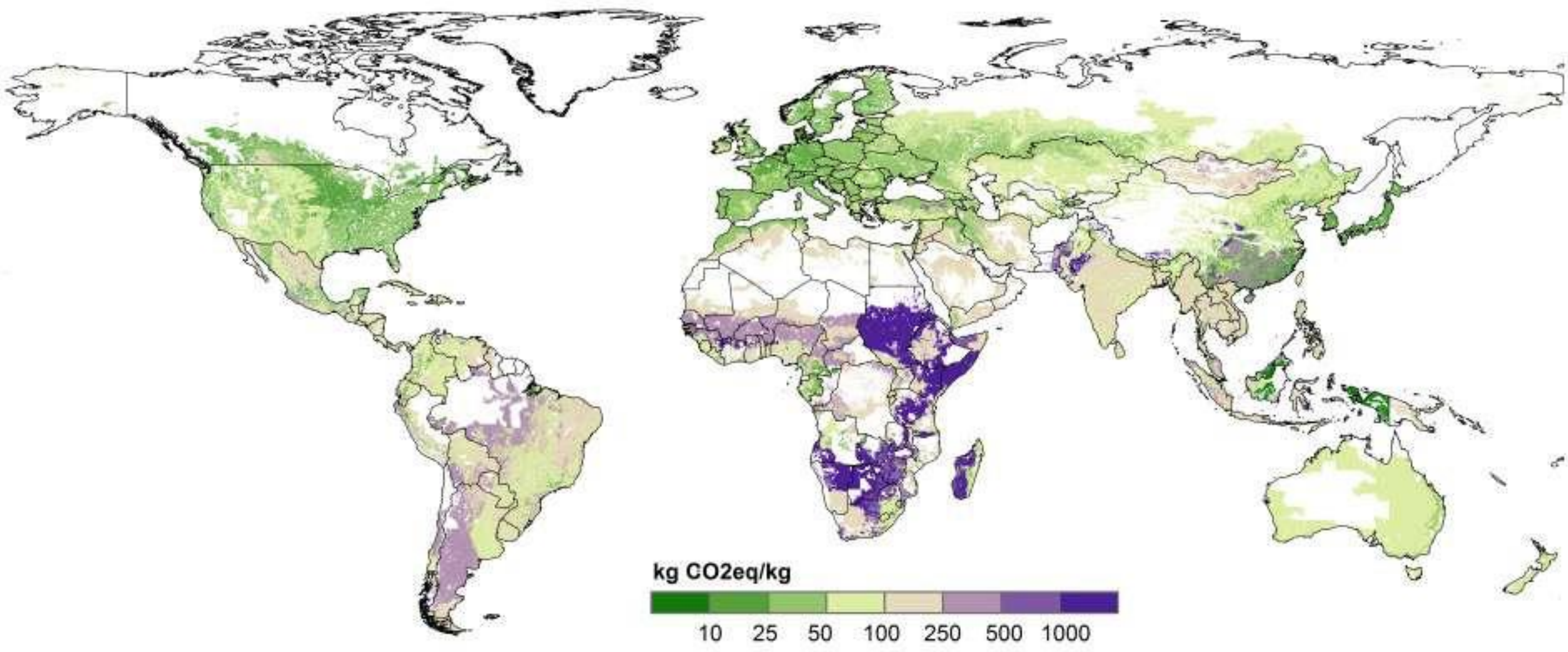
Jones, et al (2014) The carbon footprint of lamb: sources of variation and opportunities for mitigation. Agric. Sys. 123, 97–107.


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Global Warming
Acidification
Eutrophication
Terrestrial ecotoxicity
Non-renewable fossil energy
Bedding material
Energy use at farm
Crop production at farm
Purchased energy feeds
Purchased protein feeds
Manure and enteric emissions
BROILER PRODUCTIO



Source: Gerber et al. 2013

Global greenhouse gas efficiency per kilogram of animal protein produced



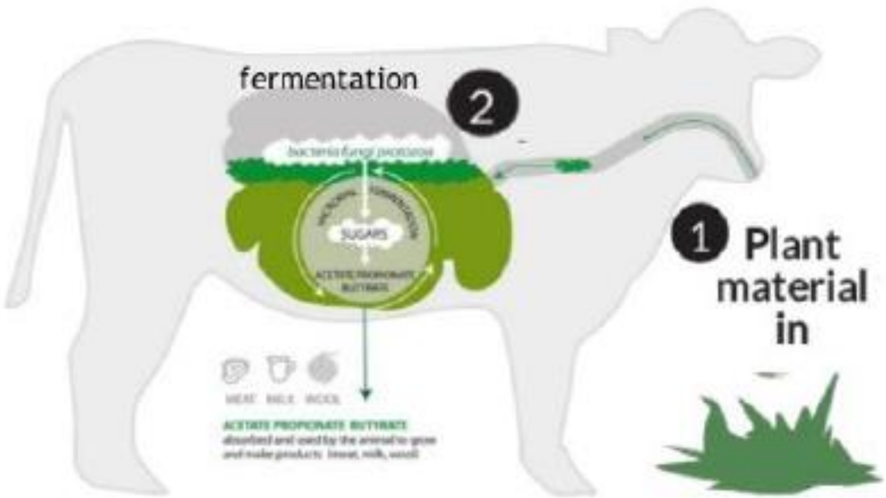
Large inefficiencies in the developing world – an opportunity?

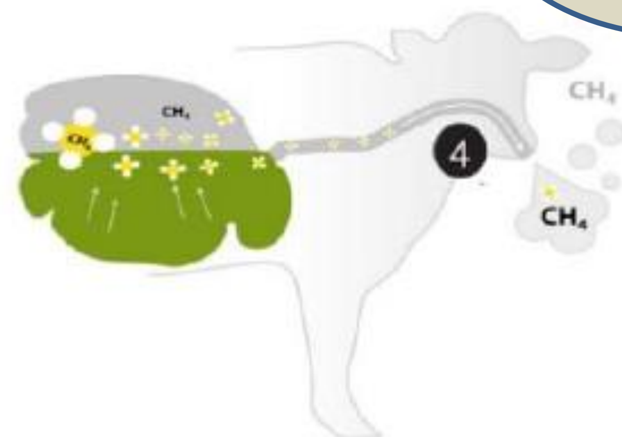
Source Herrero, (2013) ILRI

Methane Emissions from Enteric Fermentation
Source of Emissions

2-12% Energy loss

THE RUMEN: MICROBIAL FERMENTATION



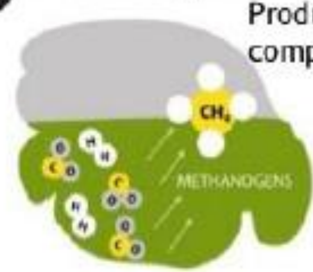


Rumen microorganisms and their roles

- **Bacteria:** ferment fiber, starch, sugar in feed to VFA, H2, CO2
- **Protozoa:** consume and ferment bacteria to VFA and NH3, ferment starch, recycle N
- **Funghi:** assist in fibre digestion

3 Methanogens

Produce CH4, but allows for more complete feed utilization



Source: FAO, Mitigation of enteric methane emissions from ruminant animals, 2016.

Table 1. Direct and indirect impacts of climate change on livestock production systems, adapted from Thornton and Gerber (2010).

Grazing Systems	Non-grazing Systems
Direct impacts	
• extreme weather events • drought and floods • productivity losses (physiological stress) owing to temperature increase • water availability	• water availability • extreme weather events
Indirect impacts	
• fodder quantity and quality • disease epidemics • host–pathogen interactions	• increased resource price, e.g. feed and energy • disease epidemics • increased cost of animal housing, e.g. cooling systems

Climate Change Impacts

- Increasing temperatures -> heat stress
- Changes in rainfall -> crop and pasture growth, water, pests and diseases
- Changes in feed resources will occur (pasture, crop residue, suppl. feed)
- Highest impact on dryland grazing systems
- Higher Risk of Disease – some diseases are especially sensitive to climate change (e.g. food and vector borne disease)
- Low Reproductive Performance

SUMMARY OF PART 1

- Livestock have key roles to play in achieving the Sustainable development Goals
- Multiplicity of Animal Production Systems
- Variable Sources of Emissions but sources vary and its not solely the ruminants
- Low emissions of GHG by the monogastrics but the GWP of feeds is high
- Livestock has other impacts other than Global Warming Potential
- Be cautious on interpretation of figures, (e.g. emission per animal or a functional unit (e.g., per litre of milk)
- Emissions varies across and within continents
- The meaning of CO2 Equivalent
- Loss of methane is a loss of potential **metabolic energy** for ruminants
- Climate Impacts on Animal Production

QUICK REFILL on CSA

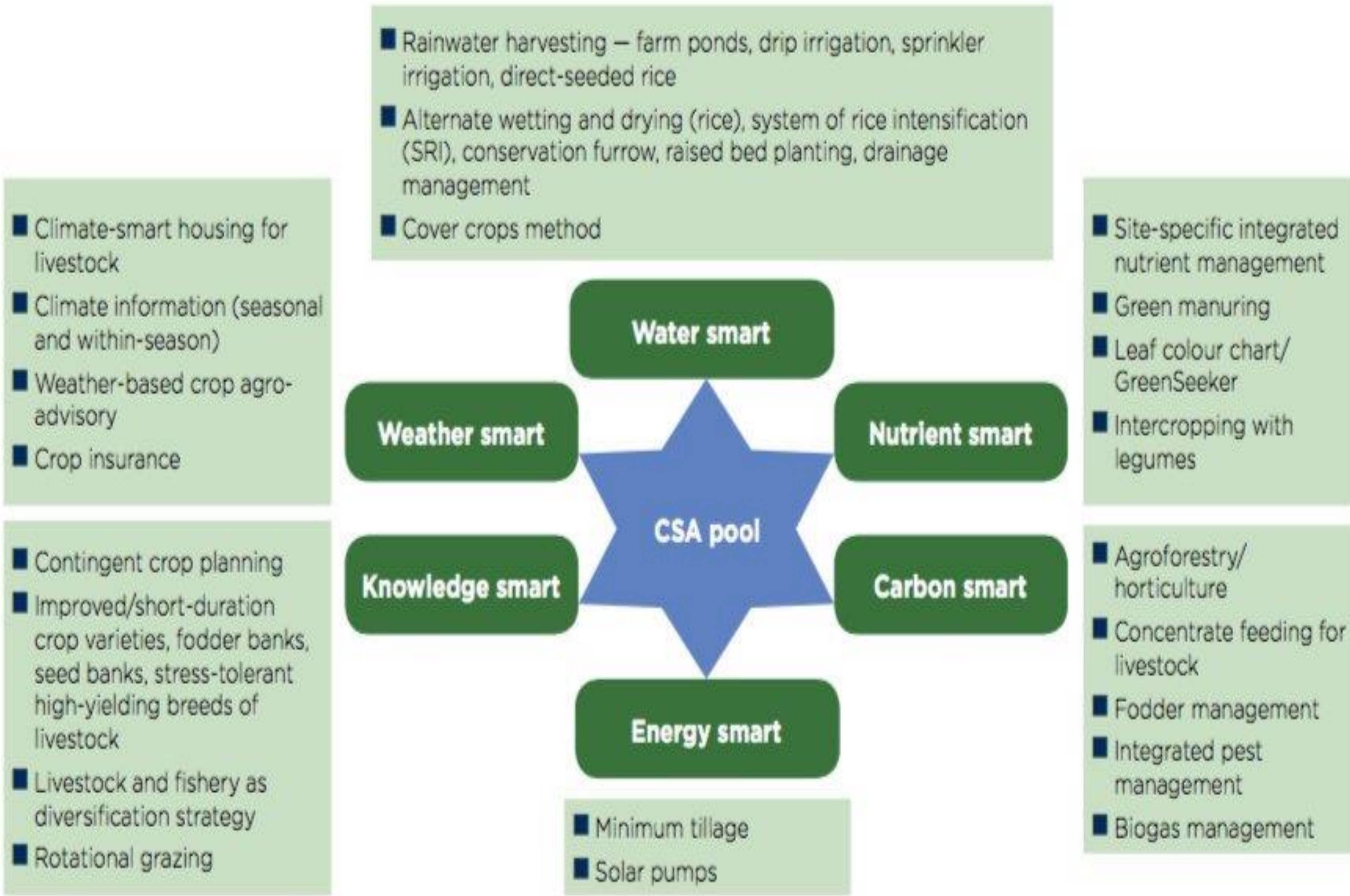
Climate-smart agriculture (CSA) is an integrative approach that explicitly aims for **three** objectives:

A. **Sustainably increasing agricultural productivity**, to support equitable increases in farm incomes, food security and development goals;

B. **Adapting and building resilience** of agricultural and food security systems to climate change at multiple levels; and

C. **Reducing greenhouse gas emissions** from agriculture (including crops, livestock and fisheries).

CLIMATE SMART TOOLS CATEGORIES



Assessing CSA

Adaptation

Altering exposure	Reducing Sensitivity	Improving adaptive capacity
• Assess impacts and map hazard zones • Conduct proper land and wateruse planning • Protect watersheds and establish flood retention zones • Change cropping patterns	• Develop or adopt suitable crop, plant and animal varieties • Improve irrigation and drainage systems • Diversify cropping and agricultural activities • Adopt disaster-prevention	• Develop adaptive strategies and action plans • Diversify sources of household income • Improve water and other infrastructure systems • Establish disaster and crop insurance schemes

Mitigation

↘CO_2

↘ rate of deforestation and forest degradation,

↗ adoption of improved cropland management practices *(soil conservation)*

↘CH_4, N_2O

improved animal production and management of livestock waste,

more efficient management of irrigation water on rice paddies,

improved nutrient management on cropland

↗Sequestering carbon

restoration of degraded soil, increased organic matter inputs to cropland, improved forest management practices, afforestation and reforestation, agro-forestry, improved grasslands management

Carbon finance to bring back grasslands in Three Rivers region of China

CLIMATE SMART Agriculture

271 Households	22,615 ha	14,354 sheep	9,216 yaks

…are part of the project to improve livelihoods and resilience through sustainable grassland management and better livestock marketing while receiving carbon credits

What makes it Climate Smart?

What makes it Climate Smart?

Food and income: Improved pastures feed more animals and people. Upgraded husbandry and marketing add value to products.

Adaptation: Restoring degraded grassland builds resilience to climate change by increasing soil moisture and nutrient retention.

Mitigation: Thriving grasslands are a huge carbon sink. In its first 10 years, the mitigation potential is estimated at 63,000 tonnes of carbon dioxide equivalent per year.

Sustainable intensification is an approach to increase food production from existing farmland in ways that place far less pressure on the environment and that do not undermine our capacity to continue producing food in the future (Garnett et al. 2013).

Sustainable intensification seeks to improve yields of crops and livestock per unit of land, water, energy, nutrients and labour through conventional, "high-tech," agro-ecological, or organic technologies. SI intersects with management of biodiversity, animal welfare, human nutrition and sustainable development (Garnett et al. 2013). SI and CSA are viewed as highly complementary. According to Campbell et al., "SI is an essential means of adapting to climate change, also resulting in lower emissions per unit of output. With its emphasis on improving risk management, information flows and local institutions to support

AREAS OF INTERVENTIONS FOR CLIMATE SMART LIVESTOCK PRACTICES

TABLE A. Available techniques and practices for non-CO_2 mitigation: feed additives and feeding practices

Practice/technology	Potential CH_4 mitigating effect[1]	Long-term effect established	Environmentally safe or safe to the animal
Feed additives			
Nitrate	High	No?	NK
Ionophores	Low	No?	Yes?
Plant bioactive compounds			
Tannins (condensed)	Low	No?	Yes
Dietary lipids	Medium	No?	Yes
Manipulation of rumen	Low	No	Yes?
Concentrate inclusion in ration	Low to Medium	Yes	Yes
Forage quality and management	Low to Medium	Yes	Yes
Grazing management	Low	Yes	Yes
Feed processing	Low	Yes	Yes
Macro-supplementation (when deficient)	Medium	Yes	Yes
Micro-supplementation (when deficient)	NA	No	Yes
Breeding for straw quality	Low	Yes	Yes
Precision-feeding and feed analyses	Low to Medium	Ye	Yes

[1] High = ≥ 30 percent mitigating effect; Medium = 10 to 30 percent mitigating effect; Low = ≤ 10 percent mitigating effect. Mitigating effects refer to percentage change over a "standard practice", i.e. study control that was used for comparison and based on a combination of study data and judgement by the authors of this document.

NK = Unknown.

NA = Not applicable.

? = Uncertainty due to limited research, variable results or lack of/insufficient data on persistence of the effect.

TABLE C. Available techniques and practices for non-CO_2 mitigation: animal husband

Practice/technology	Species[1]	Effect on productivity	Potential CH_4 mitigating effect[2]	P mit
Animal management				
Genetic selection (Residual feed intake)	DC, BC, SW?	None	Low?	
Animal health	AS	Increase	Low?	
Reduced animal mortality	AS	Increase	Low?	
Optimization of age at slaughter	AS	None	Medium	
Reproductive management				
Mating strategies	AR, SW	High to medium		High to mec
Improved productive life	AR, SW	Medium		Medium
Enhanced fecundity	SW, SH, GO	High to medium		High to mec
Periparturient care/health	DC AR, SW	Medium		Medium
Reduction of stress	AR, SW	High to medium		High to mec
Assisted reproductive technologies	AR, SW	High to medium		High to mec

[1] DC = dairy cattle; BC = beef cattle (cattle include *Bos taurus* and *Bos indicus*); SH = sheep; GO = goats; AR = all ruminants; SW = swine; P

Strategies to reduce enteric emissions

Among the many possibilities, these have received a great deal of attention:

1. Forage nutritional quality, focused on reducing fiber content in the diet while ensuring adequate protein supply
2. Ensuring adequate forage availability throughout the whole year

Improved feeding

:

- Integrate trees & shrubs with animals - reduced heat stress, improved supply and quality of forage to help manage overgrazing, improved resilience (e.g. *Acacia)*
- Supplement diets with better quality green fodder (e.g. (*Leucaena leucocephala)*

- Fodder conservation (e.g. silage, hay
- Higher-digestibility crop residues (e.g. treat straw with urea)
- Fodder banks
- Supplementation with concentrates

Dry season management

- Periods of reduced forage availability are likely to increase under climate change
- Mixed systems can deliver multiple benefits and spread risk
- Make use of different feeds to cover the gap

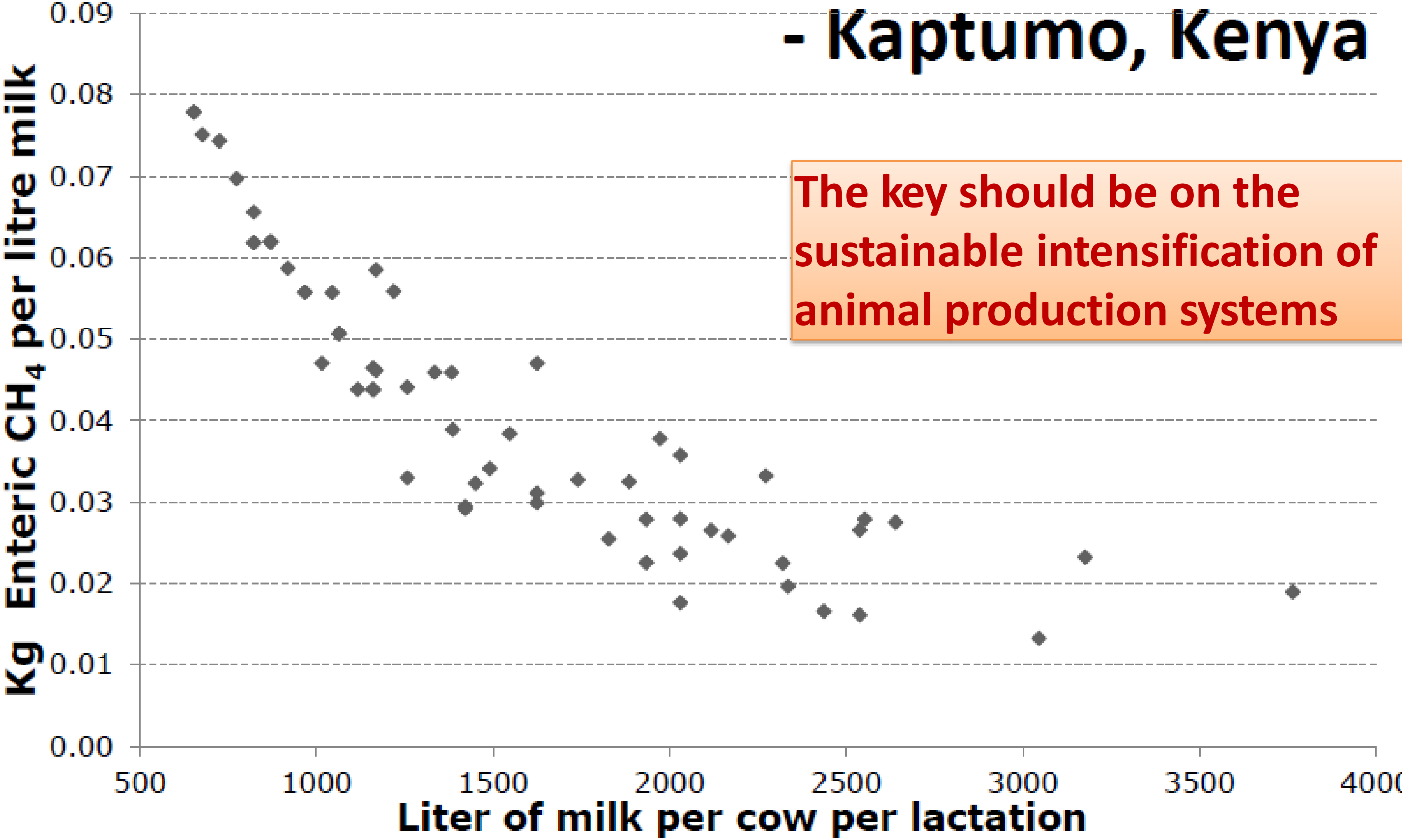
  - Crop residue
  - Small areas of planted legumes (fodder banks)
  - Opportunistic feeds cut, Storage
  - Plant tree species that have good nutritivevalue

Climate smart options for livestock

- **Herd management**
  - Management herd size and age structure
  - Better nutrition, improved husbandry – reduce mortality, improve reproduction, reduce slaughter age
  - Manage disease risk
  - Maintain herd health
  - Livestock housing
- **Manure management**

- Improve handling to ensure recovery and recycling of nutrients and energy contained in manure, storage and application techniques
- Biogas production

Enteric methane emissions at farm scale - Kaptumo, Kenya



The key should be on the sustainable intensification of animal production systems

Source: Based on Global Environmental Assessment Model (GLEAM), farm scale LCA based on Household data, Opio et al., 2013

Intensive Silvopastoral Systems

Fodder shrubs in high densities (>5000/ha) associated to improved grasses, with intensive rotational grazing and electric fences

Murgueitio et al., 2015

Feeding of Leucaena and methane emissions

Average daily intake of nutrients and energy of Lucerna heifers receiving a star grass (*C. plectostachyus*) diet with (S+L) or without (S) leucaena (*L. leucocephala*).

Item	Diet[1]		*P*-value			SD
	S+L	S	Diet	Run	Diet*Run	
Protein, g	755a	504b	<0.01	0.09	0.04	16.81
NDF[2], Kg	3.72	3.51	0.40	0.38	0.71	13.53
ADF[3], Kg	2.39	2.02	0.06	0.43	0.62	13.57
Fat, g	65.3	55.0	0.29	0.23	0.49	15.82
Ash, g	549.4a	477.8b	0.02	0.53	0.26	13.55
Calcium, g	23.0a	17.2b	<0.01	0.13	0.37	15.06
Phosphorus, g	18.7	15.6	0.09	0.21	0.36	14.33
Gross Energy, Mj	102.9a	83.6b	0.02	0.33	0.47	13.50

[a,b]Means in the same column and item with different letters are statistically different according to Tukey's test ($P < 0.05$).
SD=Standard Deviation.

[1] Diet: S=Star grass 100; S+L=Star grass 76+Leucaena 24%.
[2] NFD=Neutral Detergent Fiber.
[3] ADF=Acid Detergent Fiber.

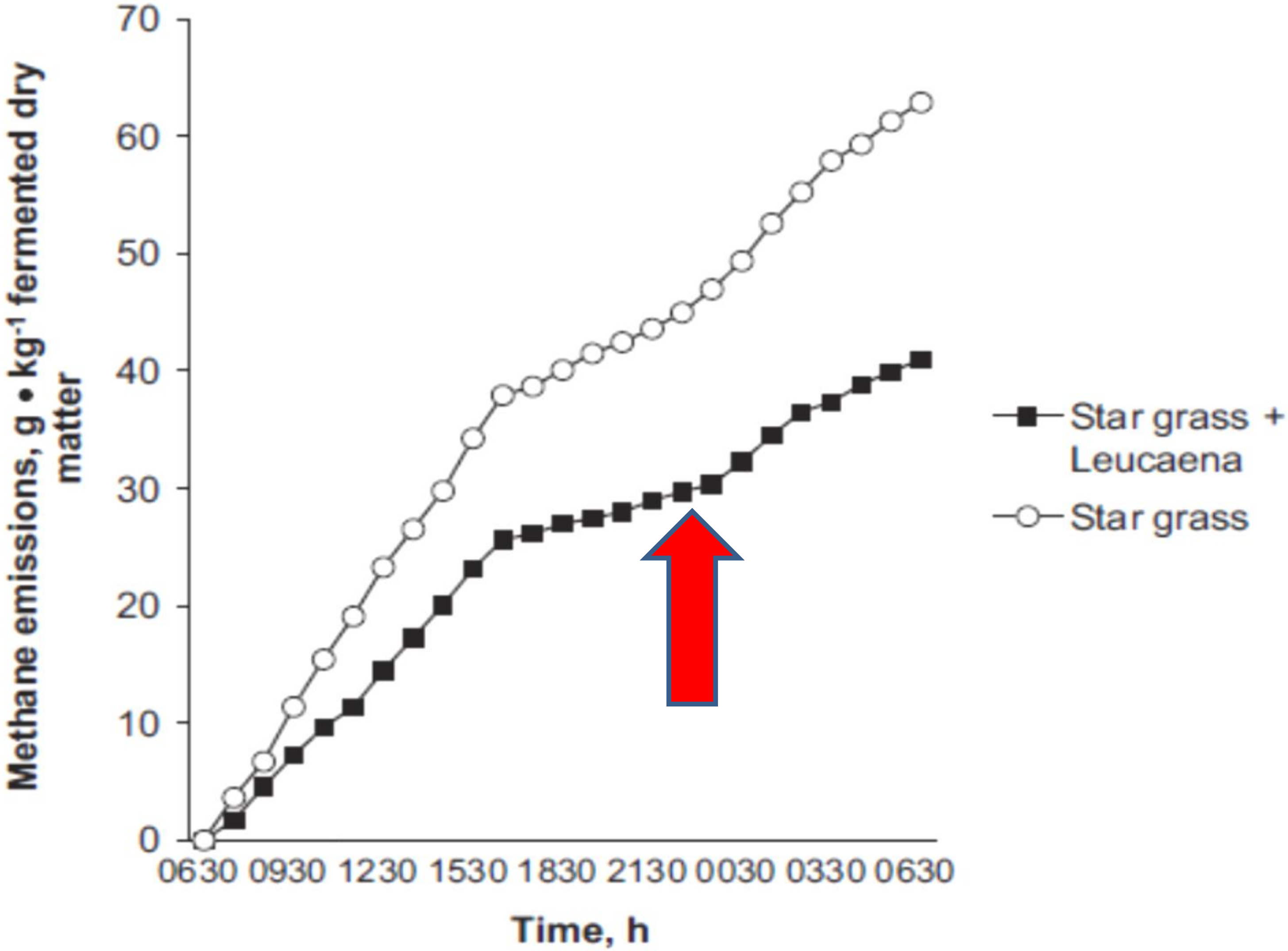


Fig. 2. Methane produced during 24 h by animals fed 100% star grass or a mixture of leucaena and star grass.

Effect of Leucaena leucocephala on methaneproductionofLucerna heifers fed a diet based on Cynodon plectostachyus I.C. Molina et al (2016) Livestock Science 185

Supplementary feeding with *Leucaena leucocephala*

Relationship to CSA

- Leucaena are highly nutritious and, when fed as a supplement to livestock, can substantially **increase meat and milk yield** compared with a low-quality baseline diet.

- The planting of species like Leucaena on a mixed farm can thus increase productivity per animal while also **increasing resilience** by making substantial impacts on income.

- Improve the diet of ruminant livestock, the **amount of methane produced** by the animal per kilogram of meat and milk produced is **substantially reduced**.

- In addition, planting Leucaena trees on farms **increases carbon sequestration** in the soil, possibly by up to 38 tonnes of carbon per ha. (can be sold!!)

Efficiency gains in dairy production systems

CSA practices : **feed quality improvements, breeding improvements, herd size management, and feed quantity**

The Relationship with CSA

- Farmers benefitted from **increased herd size and cow weight** and increased efficiencies in the dairy value chain.
- Farmers' **improvements in productivity** also resulted in relative **mitigation benefits**.
- Although total annual GHG emissions increased due to increased herd size and cow weight, the project caused a **strong decrease in GHG emission intensity of milk production.**

Use of balanced feeding of livestock in India

Relationship to CSA

Environmental benefits:

- a 15–20 percent decrease in methane emissions per kg of milk produced;
- reduced nitrogen excretion into the environment.

Health benefits:

- improved animal immunity due to a reduction in the parasitic load.

Improved livelihood benefits:

- significant decrease in average cost of feeding;
- increased average milk yield, milk protein output and fat content;
- improved growth rate of calves, leading to early maturity and earlier calving; and
- 10-15 percent increase in the net daily income per animal for farmers.

Changing from local breeds to cross-bred cattle

Relationship to CSA

- Cross-bred cattle developed for the tropical grasslands of northern Australia demonstrate greater heat tolerance, disease resistance, fitness and reproductive traits compared with the breeds normally used.

- Cross-breeding coupled with diet intensification can lead to **substantial efficiency gains** in livestock production and **methane output**.

- With widespread uptake, this would result in **fewer but larger, more productive animals being kept,** which would have positive consequences for methane production and land use.

Overall Impact

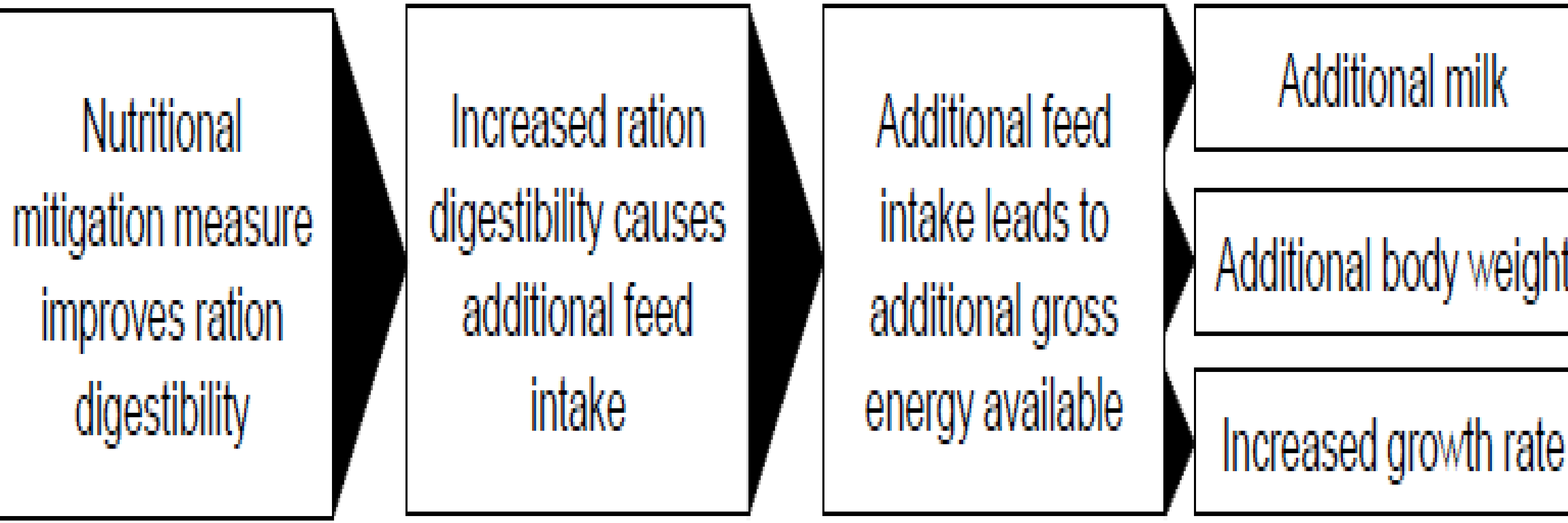


Figure 6.9. Conceptual diagram showing the model estimation of the change to animal productivity when a nutritional mitigation measure improves the ration digestibility. Whether

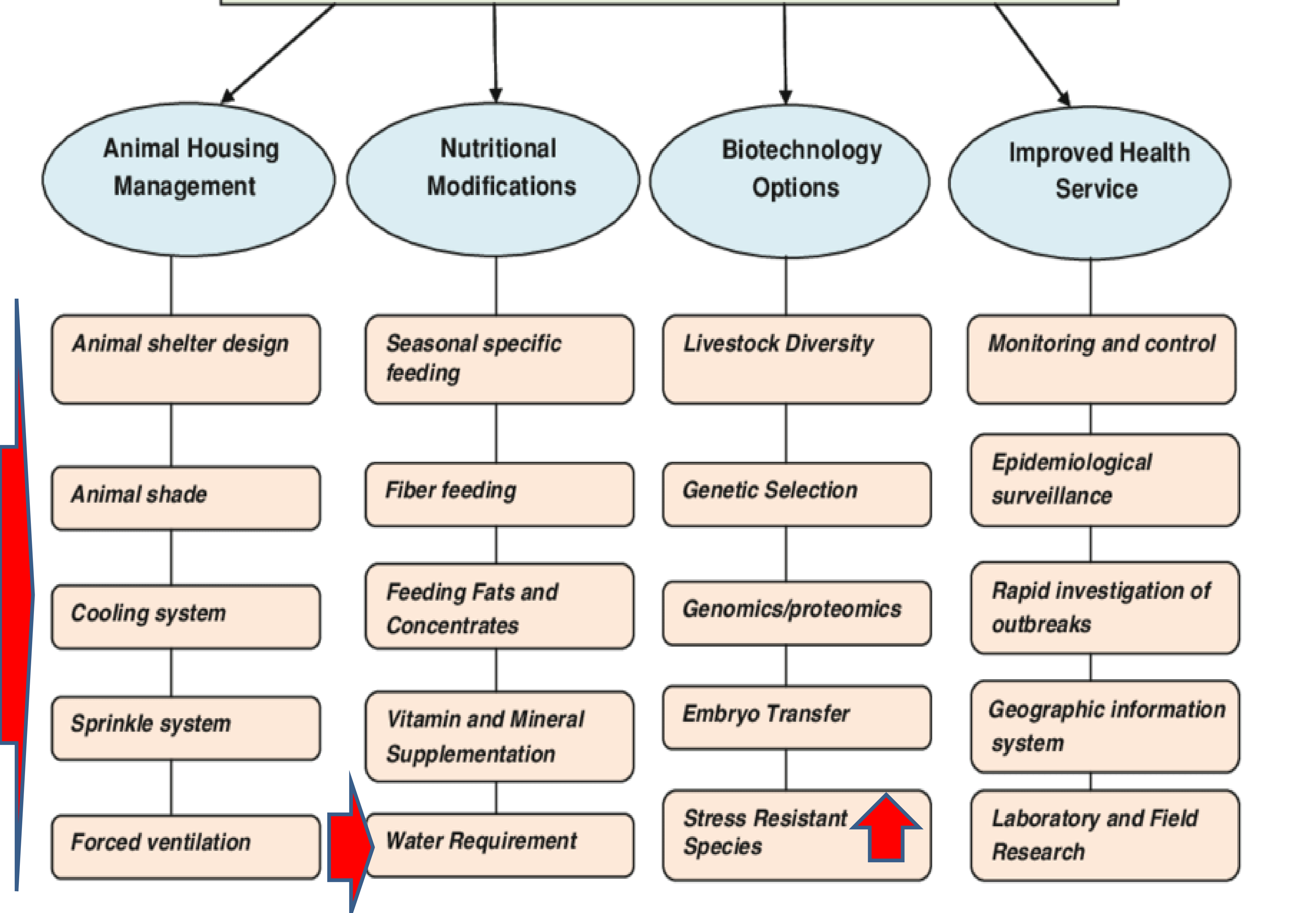
Example of technical mitigation potential of agricultural practices

Country	Climate change mitigation actions	Emission reduction potential by 2030 (in Mt of CO_2eq)
Ethiopia	Changed herd mix for more efficient feed conversion	18
	Improved feed, breed and management	17
	Reduced draught animal population	4
	Improved agronomic management of soils	40
	Increased yields through improved seeds, fertilizers and agronomic practices	27
Kenya	Agroforestry	4.2
	Conservation tillage	1.1
	Fire reduction in crop and grasslands	1.2
Brazil	Reduction of Amazon deforestation	564
	Reduction of Cerrado deforestation	104
	Restoration of grazing land	83-104
	Integrated crop-livestock system	18-22
	No-till farming	16-20
	Biological nitrogen fixation	16-20

Table 5.1: Summary of selected interventions for dairy cattle systems in Sri Lanka

Intervention	Objective and constraint addressed	Mitigation mechanism
Supplementation with fodder trees and low cost concentrate	• Minimize quantitative and qualitative deficiency of basal diet to address feed seasonality and quality constraints	• Lower CH_4 observed with legumes is attributed to lower fiber content and faster rate of passage of feed through the rumen and therefore intakes are higher with legume forages
Supplementation with rice straw concentrate mixture	• Supplementation of diet with good-quality concentrates helps overcome problem of palatability and digestibility	• A high proportion of concentrate in diet reduces rumen pH and consequently affects the protozoa population
Use of total mixed ration	• Increase efficiency of dietary nutrient use by providing critical nutrients that are deficient in the diet and therefore balancing nutrient availability with animal requirements	• Alters rumen fermentation towards more production of microbial protein and lower volatile fatty acid production. Improves efficiency of nutrient utilization, improves productivity and reduces methane emissions
Supplementation of forage diet with Gliricidia blocks	• Improve the quality of low basal diets and addresses feed availability during periods of scarcity	• Provides rumen fermentable nitrogen and by-pass protein to fibrous diets. Promotes high dry matter intake and have a faster rate of passage through the rumen and reduction of CH_4/FPCM
Udder health management (prevention of mastitis)	• Improve health status of animals, increase productivity, reduce • Economic losses for farmers and reduce human health risks • High morbidity, reduced milk production and milk wastage	• Enhanced animal productivity and reduced GHG emission intensity
	• Improve productive and reproductive	

Approaches to alleviate thermal Stress



Methods to help animals alleviate thermal stress will be useful to reduce the impacts of climate change on livestock production. These may include:

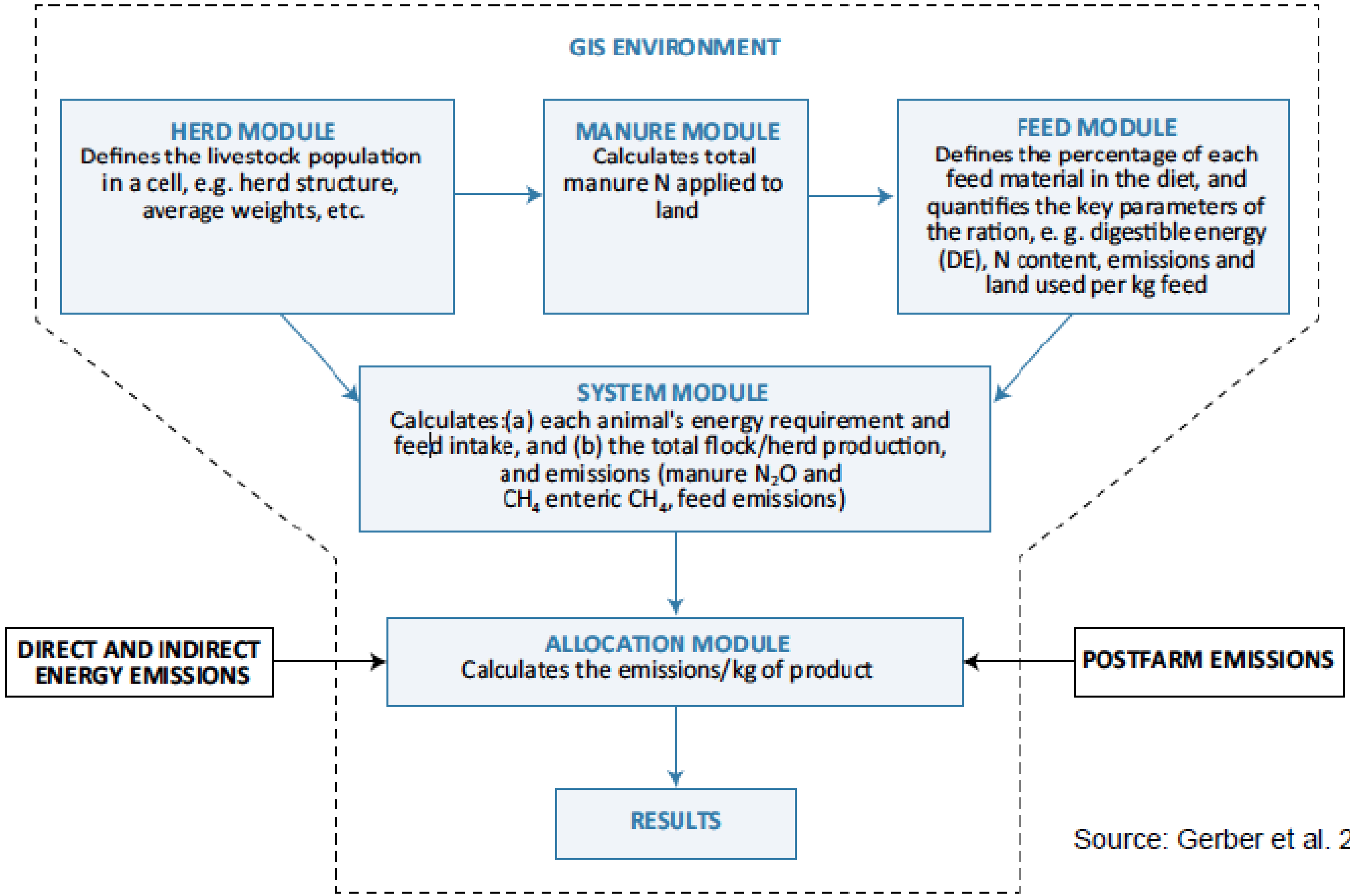
- Physical modification of the environment (shade, improved ventilation, combination of wetting and ventilation);
- Improved nutritional management schemes (e.g. adjustments of ration, fibre, fat, protein and electrolytes);
- Changing feeding patterns (e.g. cows tend to eat more feed during the cooler parts of the day);
- Providing enough water (e.g. water intake may increase by 20% to >50% as a result of heat stress);
- Genetic development of less sensitive breeds (e.g. many local breeds are already adapted to their harsh conditions).

Housing System for Micro-climate Control

- Animal comfort: basic need for improving productivity.
- Shed designs to provide appropriate environment, including shelter and a comfortable resting area.
- Automated temperature controlling devises and system.
- Foggers and sprinklers.
- High volume low-speed fans (4-12 ft long blades).
- Tunnel ventilation.

GLEAM Lifecycle Assessment

Global Livestock Environmental Assessment Model



Source: Gerber et al. 2013

3.3.4.4. Identification of mitigation hotspots with GLEAM

Identified emission hotspots do not always coincide with **mitigation potential hotspots**. In addition, default Tier 1 emission factors and a sectoral approach to GHG emission quantification may not reflect most of the mitigation efforts in agriculture. Therefore, it is recommended that **Tier 2** calculations are used for assessing the mitigation potential of technical interventions.

Modelling packages of options can support the identification of mitigation hotspots and priorities.

For instance, the **Global Livestock Environment Assessment Model (GLEAM),** a Tier 2 livestock sector specific biophysical model based on Geographic Information Systems (GIS) which adopts a life cycle assessment approach, has been developed to quantify GHG emissions in livestock supply chains and to assess the impact of mitigation and adaptation options on a national, subnational, regional and global scale.

- It differentiates emissions and emission intensities from livestock supply chains;
- assesses technical mitigation potential of interventions and their impact on productivity; and
- covers 11 main global livestock commodities and predominant livestock production systems.

GLEAM supports countries in the development of NAMAs by:

- ✓ Defining a baseline scenario and supporting countries in identifying and setting priorities for the livestock sector.
- ✓ Measuring impacts of mitigation actions on the livestock sector.
- ✓ Quantifying sustainable development benefits e.g. productivity gains.

To learn more about GLEAM, click here.

Example: Life-cycle analyses of pig production in East and Southeast Asia

The main sources of emissions in pig production systems are:

- **feed production**, which alone represents about **60 percent** of total emissions from commercial systems;
- **manure**, which accounts for **14 percent** of total methane emissions in industrial systems; and
- **on-farm energy use and post-farm activities (6 percent)**.

The following mitigation options were explored using GLEAM

- **improved manure management** (through increased use of anaerobic digestion);
- **adoption of more energy efficient technologies and low-carbon energy**; and
- **improved feed quality, animal health and animal husbandry in intermediate systems**.

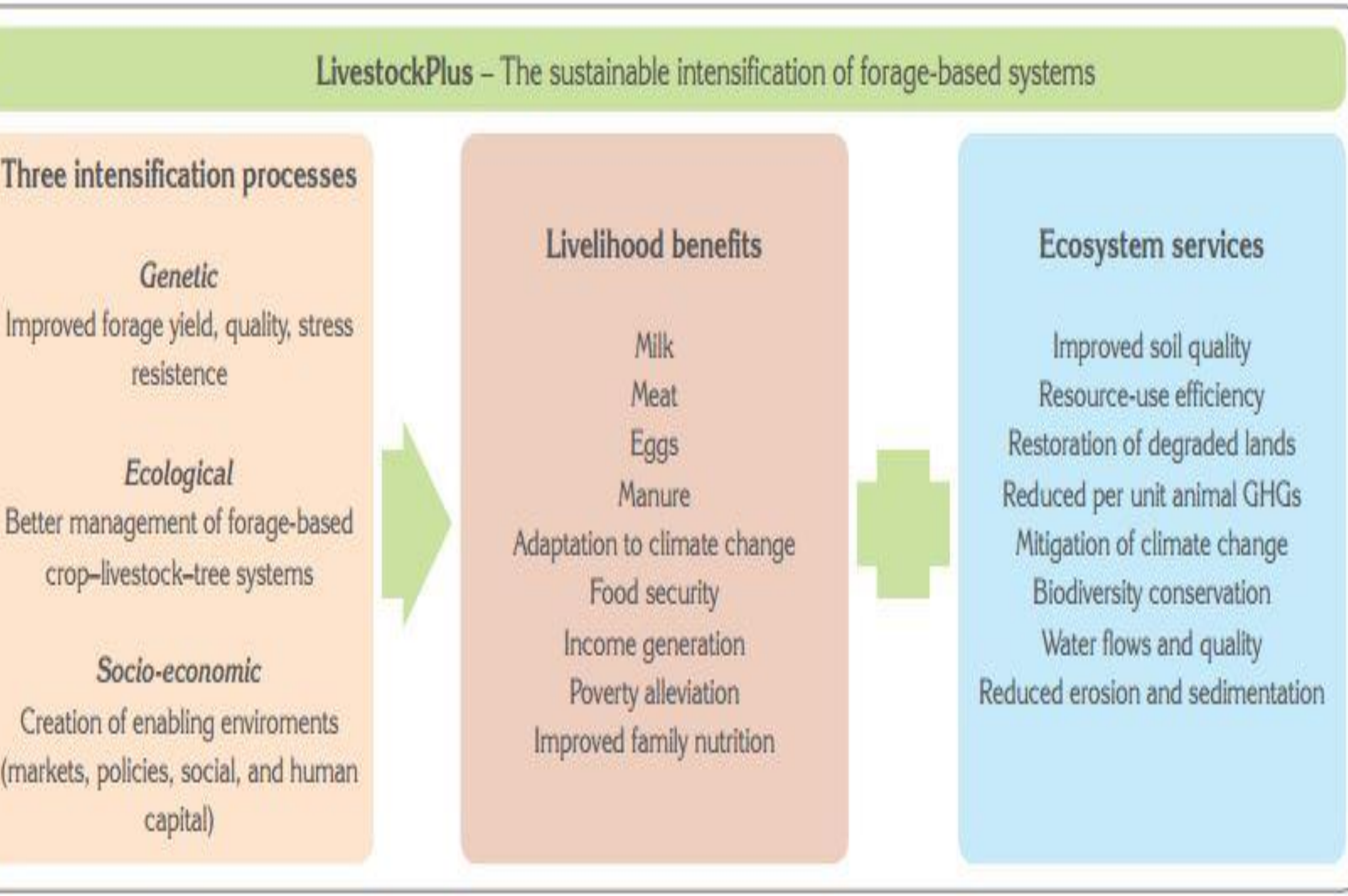
The results of GLEAM modelling demonstrated that adoption of more efficient technologies in commercial pig production could be **reduced by 20 to 28 percent** from baseline emissions with stable production.

Table 4.1. Summary of potential barriers to mitigation measures in developing countries. The scale at which they are likely to act is suggested (Fa = farm level, Lo = local, Na = national).

Barriers	Fa	Lo	Na	Details
Resource competition	X	X	X	May limit the acceptability of certain measures. For example grain based animal feeds directly compete with human consumption[1].
Sociocultural role of cattle	X			The multi-functionality of cattle (e.g. status/wealth symbols, insurance, savings and dowries[2]) may restrict efforts to reduce herd sizes, using more productive animals.
Risk	X	X	X	Climate change is likely to increase risk for livestock keepers[3] and associated investment. Certain measures could be seen as an increased reliance on expensive, unreliable inputs[4] and a loss of resilience for already high risk systems.
Cost	X	X		Expensive measures are unlikely to be adopted when savings are low and credit or funding hard to access[6].

Psychology /values	X	X	X	Despite clear evidence of benefits stakeholders do not always adopt measures[7]. This may be due to culture or tradition, self-opinion or conflicts of interest[8].
Market access	X	X	X	Improved productivity, without improved infrastructure and market access, is likely to saturate local markets and limit sustainable development[5]. Conversely, infrastructure provision could introduce other stakeholders wanting a share of market profits and reducing farm gate prices[9].
Government agenda /priorities		X	X	Investment and support for agricultural development may be a low government priority. For instance countries in Africa spend an average of 4% of national budgets on agriculture, whilst those is Asia spend 8-14%[10].There can also be a divergence from formal purpose at a higher level to experience at farm level[6].
Environmental	X	X	X	Current climate currently limits application of certain measures (e.g. use of exotic cattle breeds or cultivation of improved crops).
Availability	X	X	X	Resources to apply measures may not be readily available. For example feed resources often depend on what is locally available[11].

Example: Sustainable intensification of tropical forage-based systems



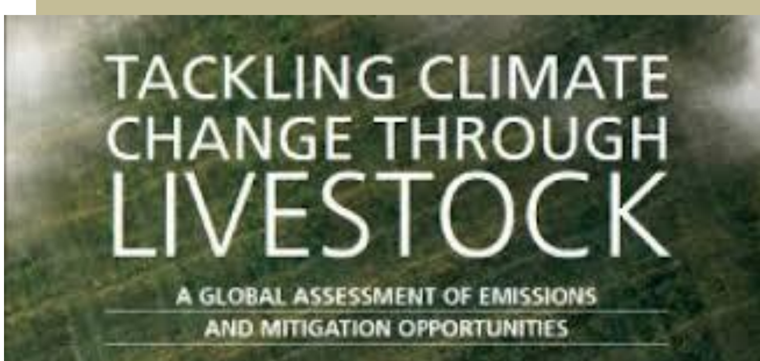
Aims: Improve livestock efficiency to produce more product per unit of Input/resource and causing less environmental harm

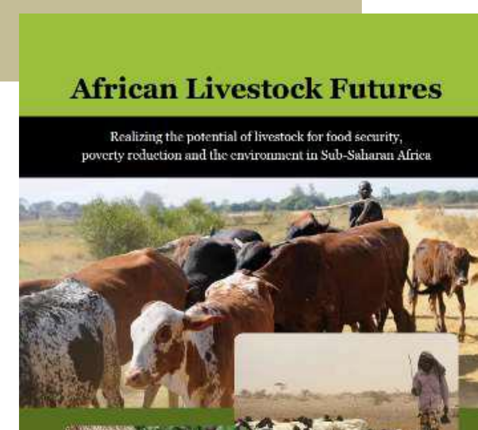
ADAPTATION AND MITIGATION POTENTIAL MEASURES ARE MOSTLY COUNTRY SPECIFIC – NO ONE SIZE FIT ALL

HUGE POTENTIAL FOR IMPROVEMENT OF PRODUCTIVITY AND REDUCE EMISSIONS INTENSITY

SOURCES OF INFORMATION

- ✓ International Livestock Research Institute
- ✓ FAO, Animal Health and Production Division
- ✓ Livestock Research Global Alliance
- ✓ African Livestock Futures
- ✓ Climate Source Book of FAO
- ✓ Global Agenda for Sustainable Livestock
- ✓ Roslin Institute, University of Edinburgh
- ✓ GLEAM





THANK YOU FOR LISTENING