GLOBAL AND REGIONAL ASSESSMENTS OF GHG EMISSIONS AND MITIGATION POTENTIAL IN LIVESTOCK SUPPLY CHAINS

Modelling management interventions

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THE IMPORTANCE OF HAVING INTERNATIONAL GUIDELINES

FAO's work on GHG emissions in the livestock sector to identify low emission pathways

Pierre Gerber (team leader), Henning Steinfeld, Benjamin Henderson, Carolyn Opio, Anne Mottet, Tim Robinson, Alessandra Falcucci, Giuseppe Tempio, Rubén Martinez, Michael MacLeod (SRUC), Theun Vellinga (WUR)…

Produce disaggregated assessments of emissions and mitigation potential

Carry out economic analyses of mitigation costs and benefits

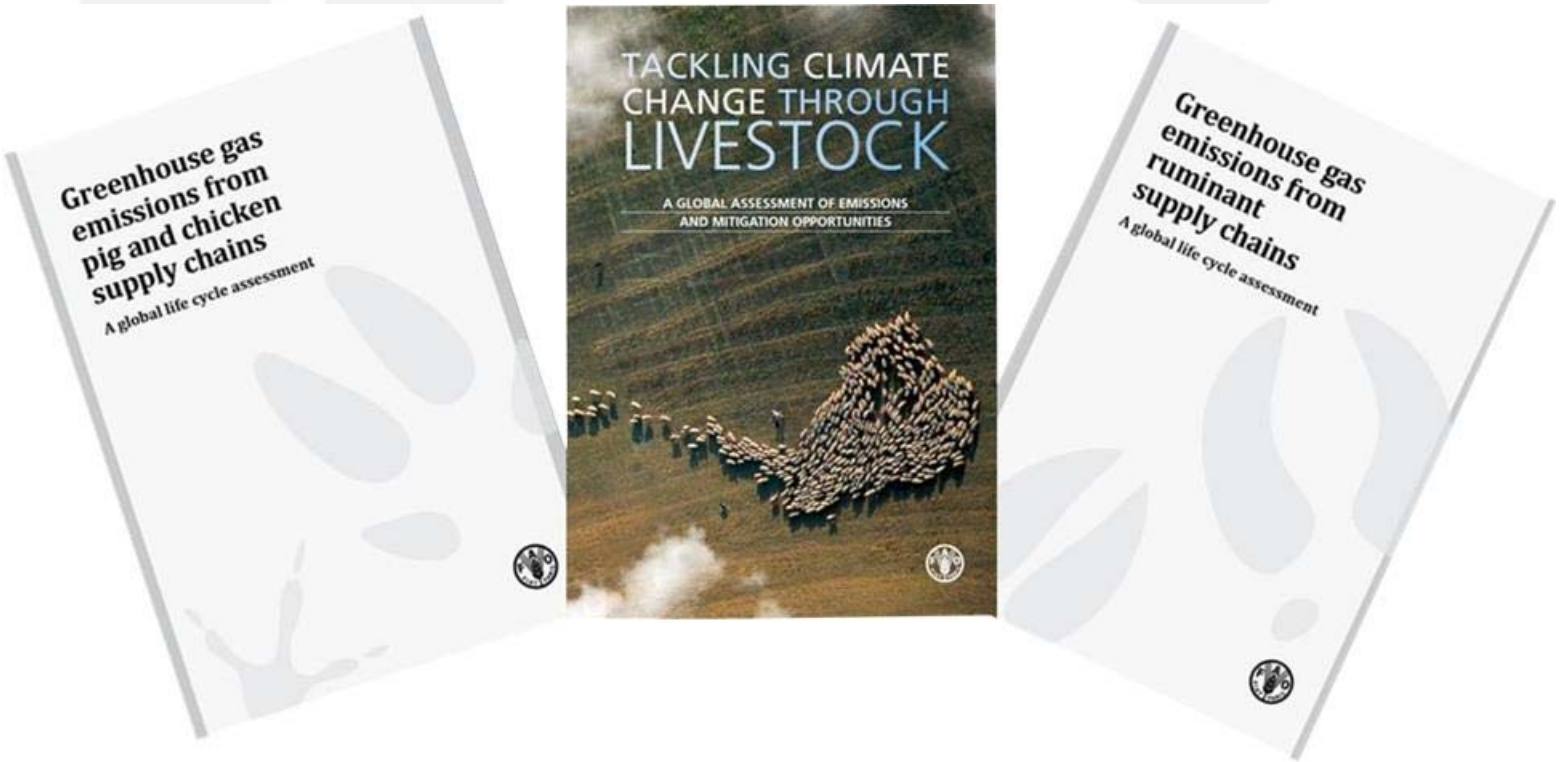
Engage in multi-stakeholder initiatives on methods and practice change

LEAP, THE LIVESTOCK ENVIRONMENTAL ASSESSMENT AND PERFORMANCE PARTNERSHIP

To develop comprehensive guidance and methodology for understanding the environmental performance of livestock supply chains

LIVESTOCK ENVIRONMENTAL ASSESSMENT AND PERFORMANCE PARTNERSHIP

3 RECENT PUBLICATIONS



EXPLORE MITIGATION STRATEGIES IN LIVESTOCK

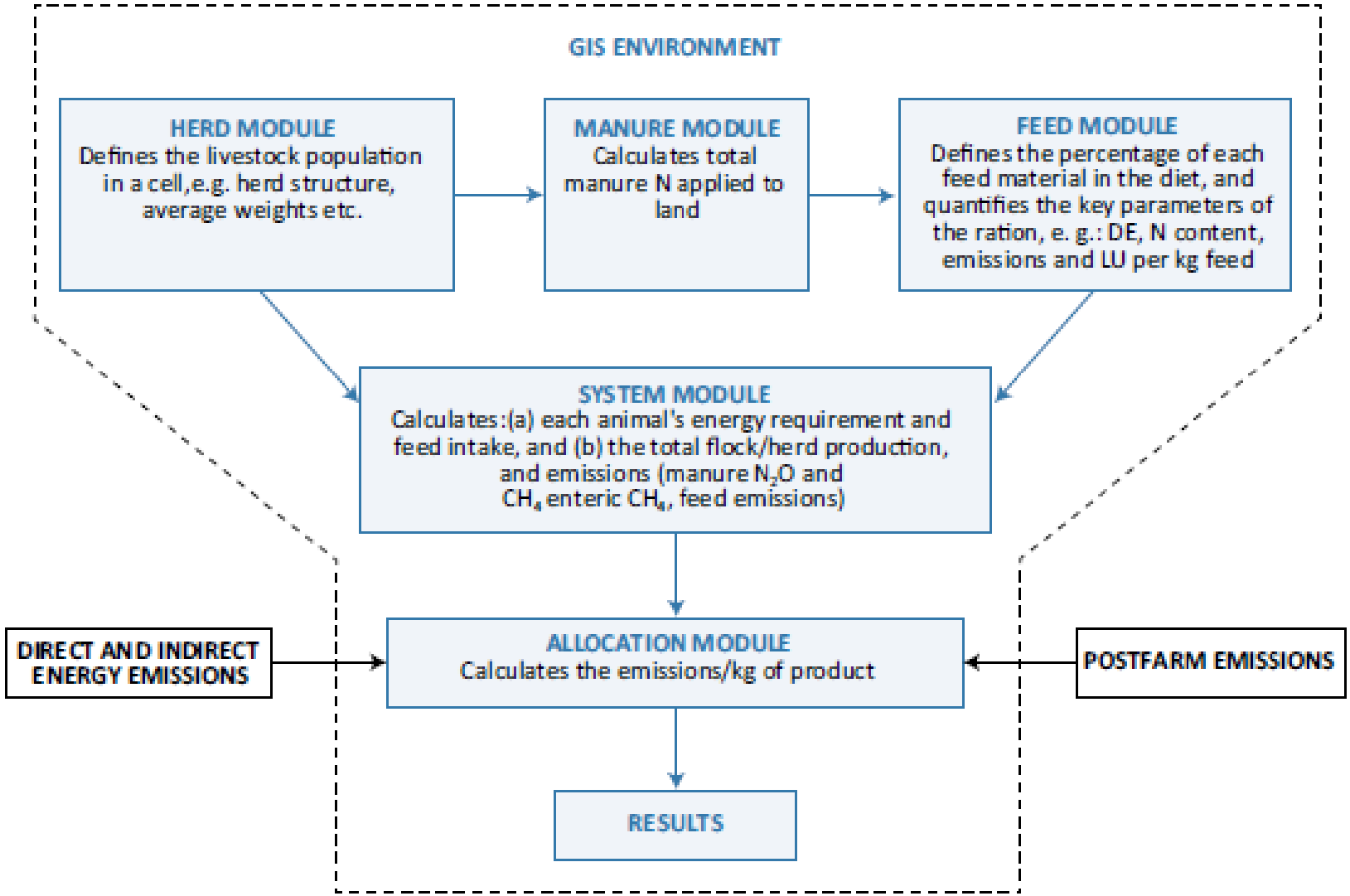
Requires Tier 2 approach to identify interventions in practice

GLEAM

Global Livestock Environmental Assessment Model

- Life Cycle Analysis modelling
- Cradle to retail, all major sources of emissions included
- Computes emissions at local level (cells on a map)
- Can generate averages and ranges at different scales
- Developed at FAO, in collaboration with other partners
- Allows for scenario analysis

GLEAM


GIS ENVIRONMENT
HERD MODULE
Defines the livestock population in a cell,e.g. herd structure, average weights etc.
MANURE MODULE
Calculates total manure N applied to land
FEED MODULE
Defines the percentage of each feed material in the diet, and quantifies the key parameters of the ration, e. g.: DE, N content, emissions and LU per kg feed
SYSTEM MODULE
Calculates:(a) each animal's energy requirement and feed intake, and (b) the total flock/herd production, and emissions (manure N_2O and CH_4 enteric CH_4, feed emissions)
DIRECT AND INDIRECT ENERGY EMISSIONS
ALLOCATION MODULE
Calculates the emissions/kg of product
POSTFARM EMISSIONS
RESULTS

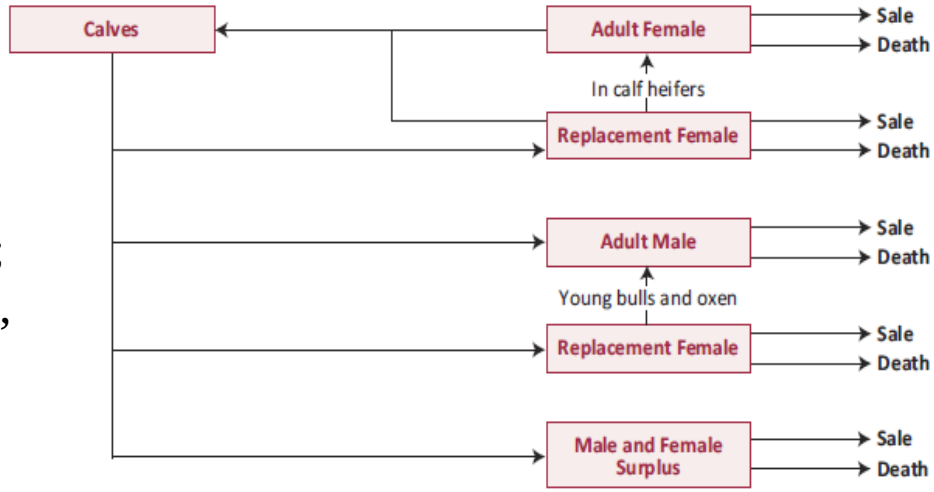
HOW DOES GLEAM USES IPCC (2006) GUIDELINES ?

ANIMAL COHORTS

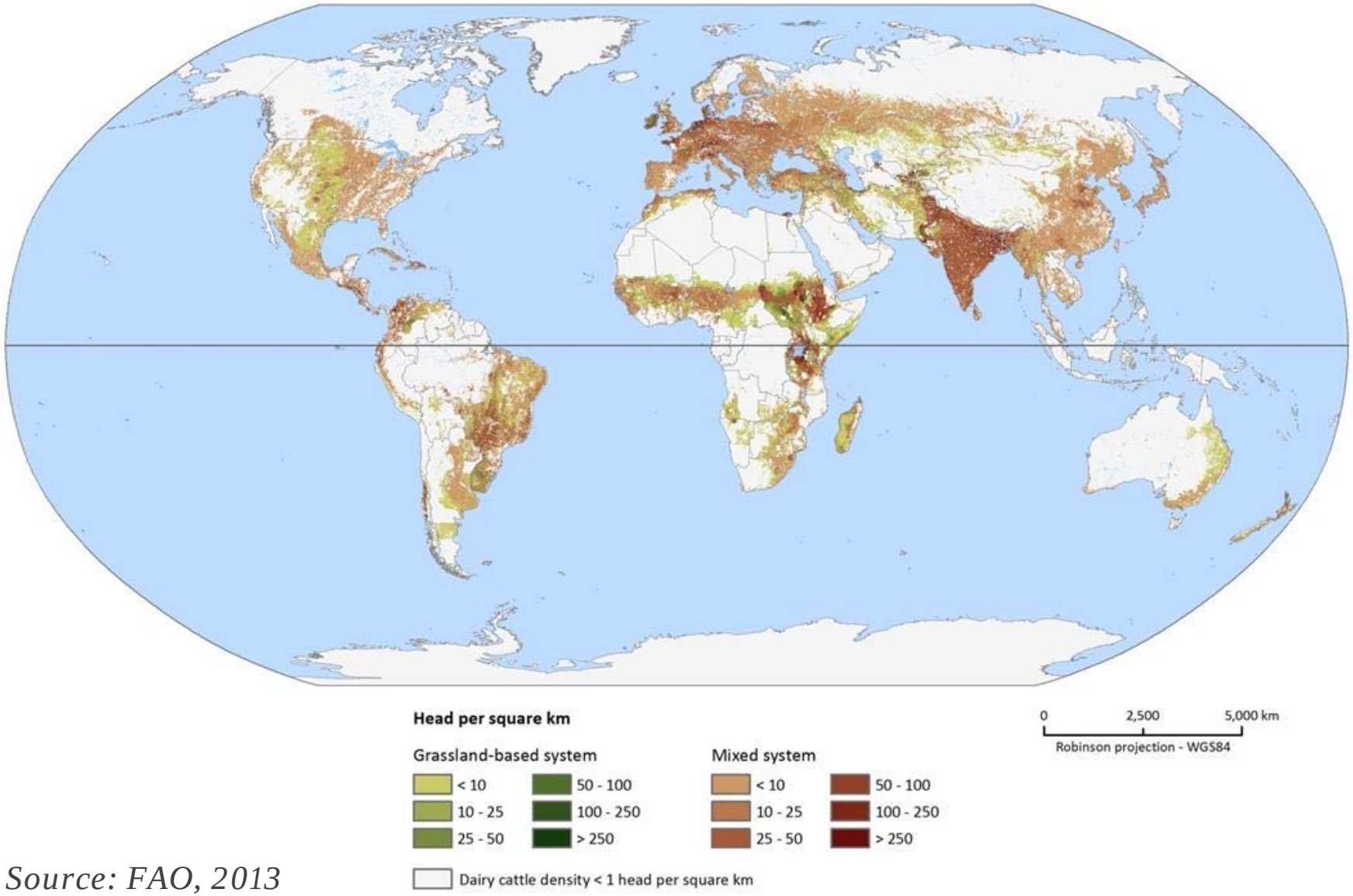
- IPCC (2006) Tier 2 requires the animal population to be categorized into distinct cohorts (types, weights, phase of production…)
- But data on animal herd structure generally not available

→ GLEAM herd module : 6 cohorts

Key production parameters: mortality, fertility, growth and replacement rates, age or weight at which animals transfer between categories (e.g. age at first parturition); duration of key periods (e.g. gestation), and the ratio of breeding females to males.



DAIRY CATTLE SYSTEMS



Source: FAO, 2013

ANIMAL ENERGY REQUIREMENTS & FEED INTAKE

- ***Calculation of animal energy requirement for each cohort (system module)***

IPCC (2006) Tier 2 (Equations 10.3 to 10.13)

Gross energy requirement = maintenance + lactation and pregnancy + animal activity + weight gain and production.

IPCC (2006) does not include equations for calculating the energy requirement of pigs or poultry

→ Equations derived from NRC (1998) for pigs, Sakomura (2004) for chickens

- ***Calculation of feed intake, total feed emissions and land use***

Feed intake of each animal category (in kg DM/day) animal's energy requirement / average energy content of the ration (feed module)

→ **GLEAM feed module**

FEED MODULE: EMISSIONS FROM FEED CROPS

- ***N2O from pasture and crop cultivation***

Direct and indirect N_2O: IPCC (2006) Tier 1 methodology.

Synthetic N application rates for each crop at national level: existing data sets (FAOSTAT)

Manure N application rates: manure module.

Crop residue N: crop yields and IPCC (2006, p. 11.17) crop residue formulae

- ***CO2 and N2O from fertilizer manufacture***

Average European fertilizer emissions factor of 6.8 kg CO_2-eq per kg of ammonium nitrate N in all regions (Jenssen and Kongshaug, 2003)

- ***CO2 from field operations, where mechanized***

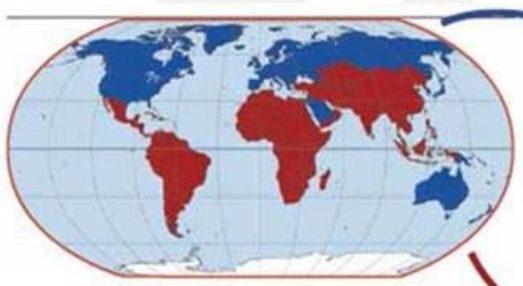
Average level of mechanisation and energy type consumed/ha x EF

- ***CO2 from blending and transport of compound feed***

186 MJ of electricity and 188 MJ of gas for 1 000 kg of DM

Average transport distance 200 km.

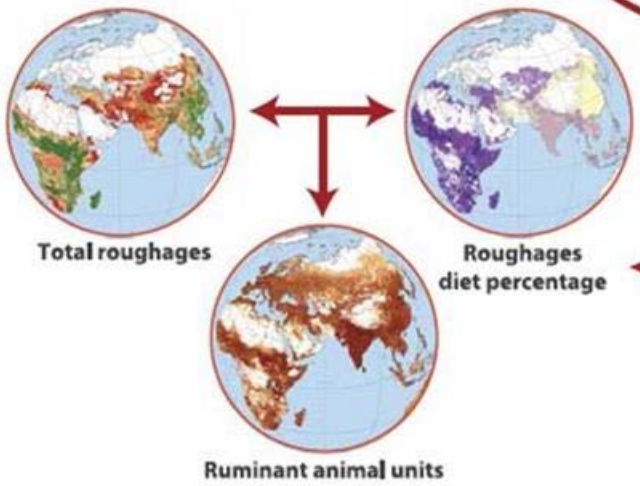
GLEAM FEED BASKETS



The feed basket (29 feed components) is **defined** for **industrialized** countries, because the relationship between land-use and feed basket is not as strong as in developing countries.

COUNTRY	France	USA	Japan	Australia	Russia
Feed1	1	0	1	0	14
Feed...	...	...	...	...	...
Feed16	0	3	0	0	7

For developing countries, the availability of roughages is calculated, using grassland and crop residue production, and taking into account the competition between the 4 ruminant species.



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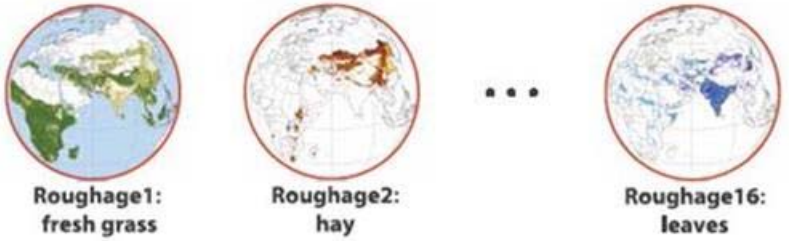


ENTERIC FERMENTATION

Calculation of CH_4 emissions arising enteric fermentation

IPCC (2006) provides default enteric methane conversion factor, Y_m (% of gross energy converted to methane)

GLEAM has specific Ym to reflect the wide-ranging diet quality and feeding characteristics globally:

$$Y_{m\ Cattle} = 9.75 - 0.05 \cdot DE$$
$$Y_{m\ mature\ sheep} = 9.75 - 0.05 \cdot DE$$
$$Y_{m\ lamb<1\ year} = 7.75 - 0.05 \cdot DE$$

where DE = feed digestibility of the ration

CH_4 emission factor:

$$EFCH_4 = (365 \cdot GE \cdot (Y_m|100)|55.65)$$

MANURE MODULE

- ***CH_4 emissions arising during manure management (Tier 2)***

Volatile solids excretion rates: Equation 10.24 IPCC (2006)

Proportion of the volatile solids converted to CH_4 during manure management: Equation 10.23 IPCC (2006)

CH_4 conversion factor: IPCC (2006, Table 10A-7)

Proportion of manure managed in each system: official statistics (such as the Annex 1 countries' National Inventory Reports to the UNFCC), other literature sources and expert judgement. IPCC systems challenging.

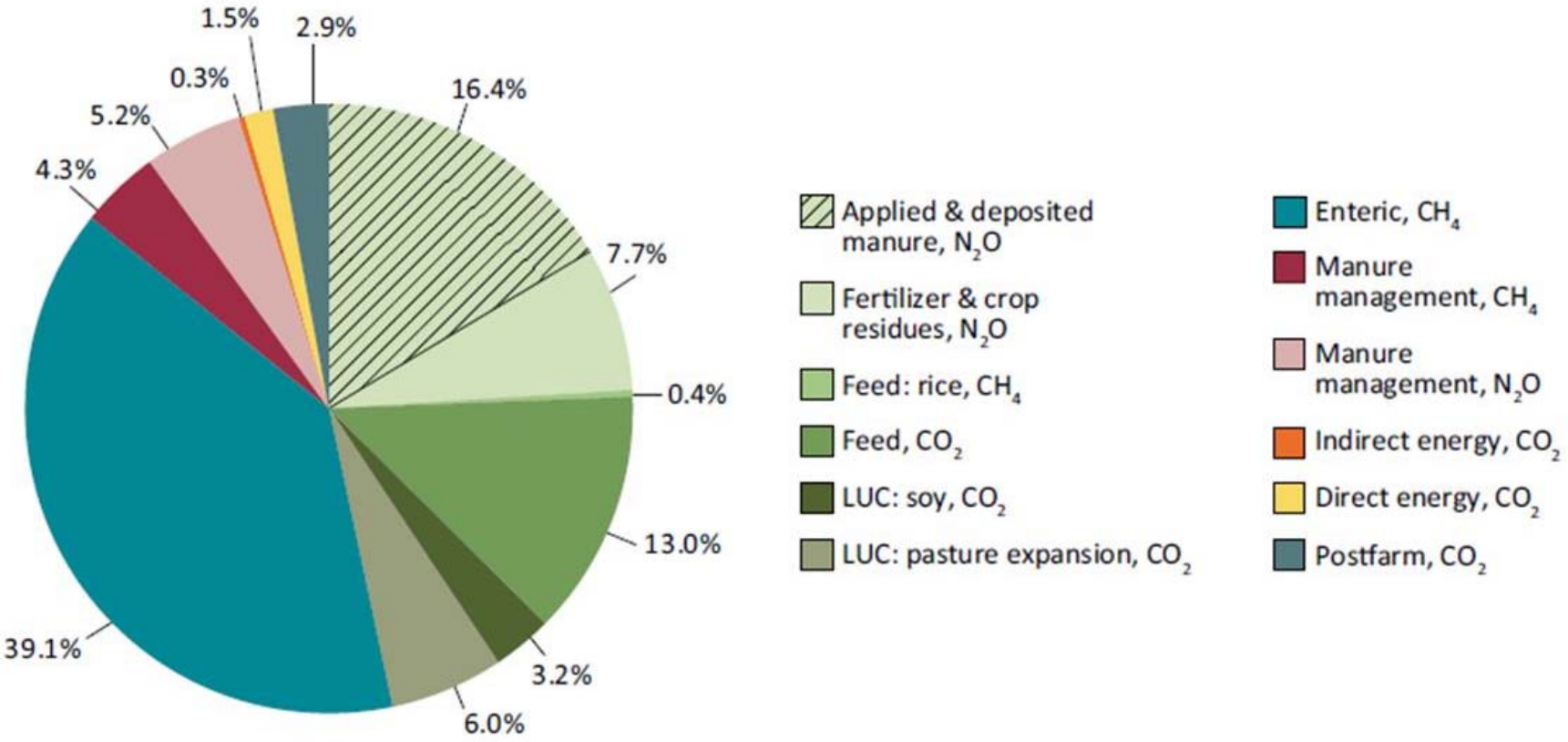
- ***N_2O emissions arising during manure management (Tier 2)***

N excretion : Equation 10.31 IPCC (2006) as the difference between intake and retention. N-intake depends on the feed dry matter intake and the N content per kg of feed.

Rate of conversion of excreted N to N_2O: IPCC (2006) default emission factors for direct N_2O (Table 10.21, IPCC 2006) and indirect via volatilization (Table 10.22, IPCC 2006) + variable leaching rates, depending on the AEZ

RESULTS

GLOBAL EMISSIONS FROM LIVESTOCK SUPPLY CHAINS, BY CATEGORY OF EMISSIONS



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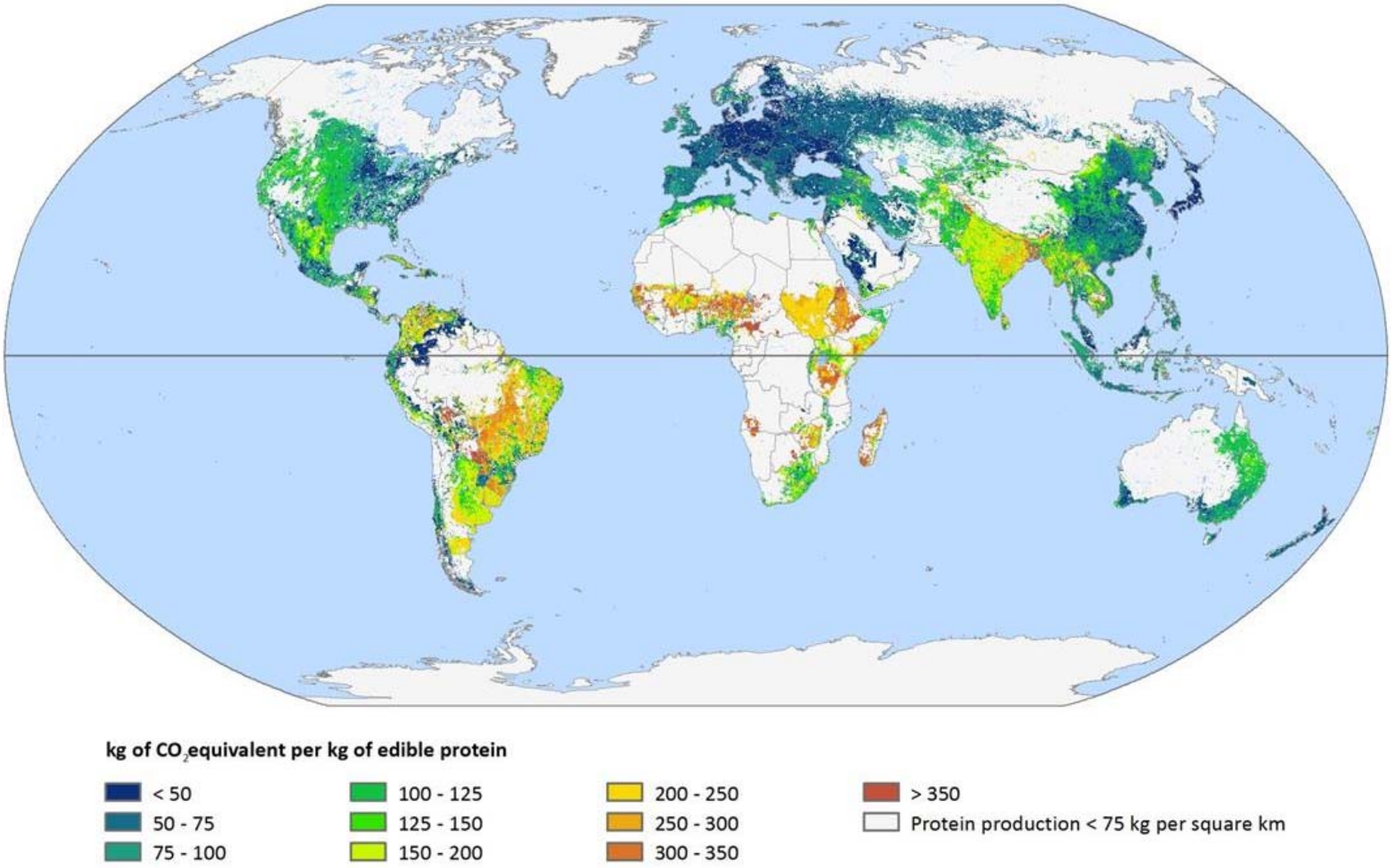
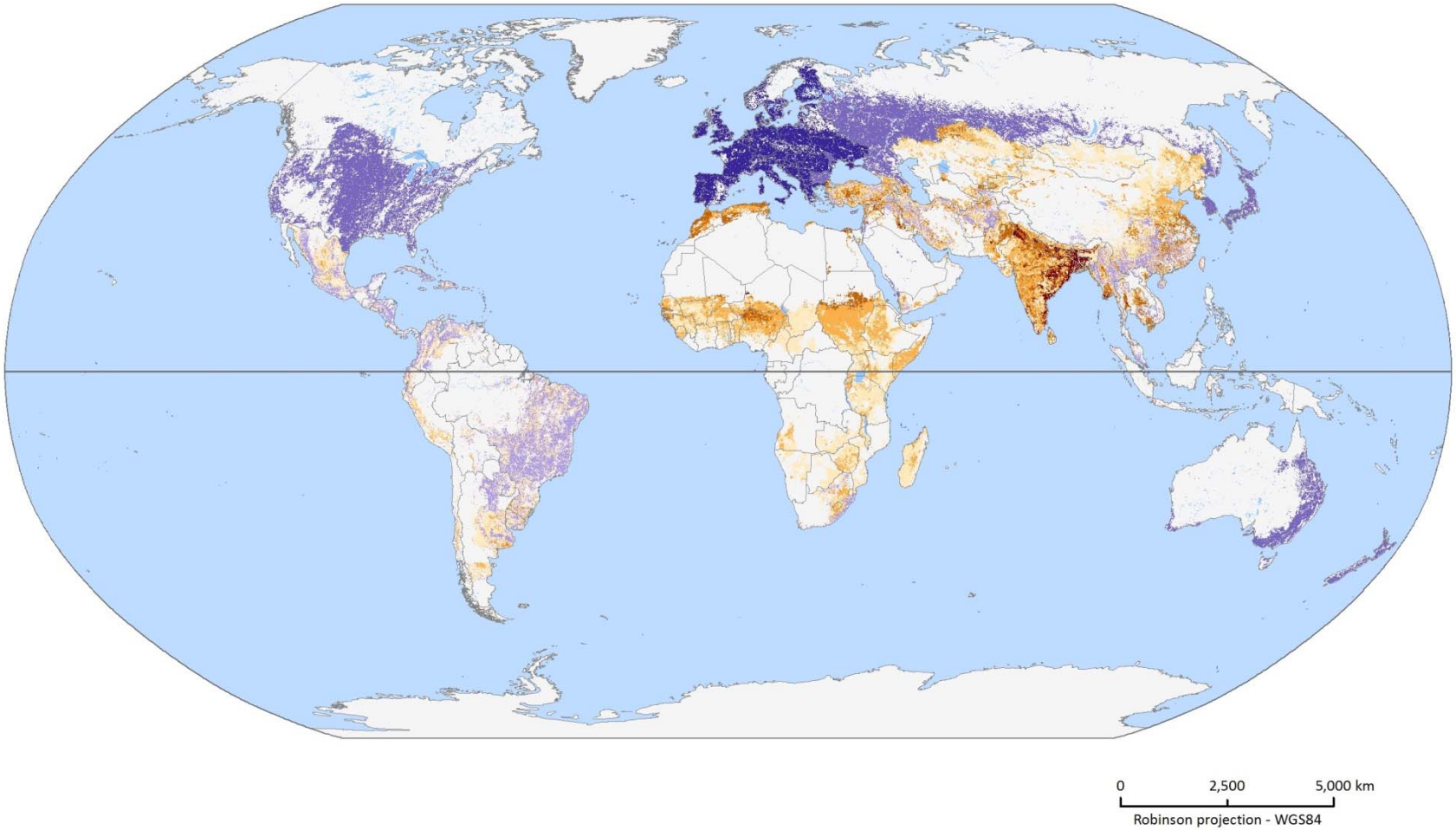
EMISSIONS INTENSITIES PER KG PROTEIN



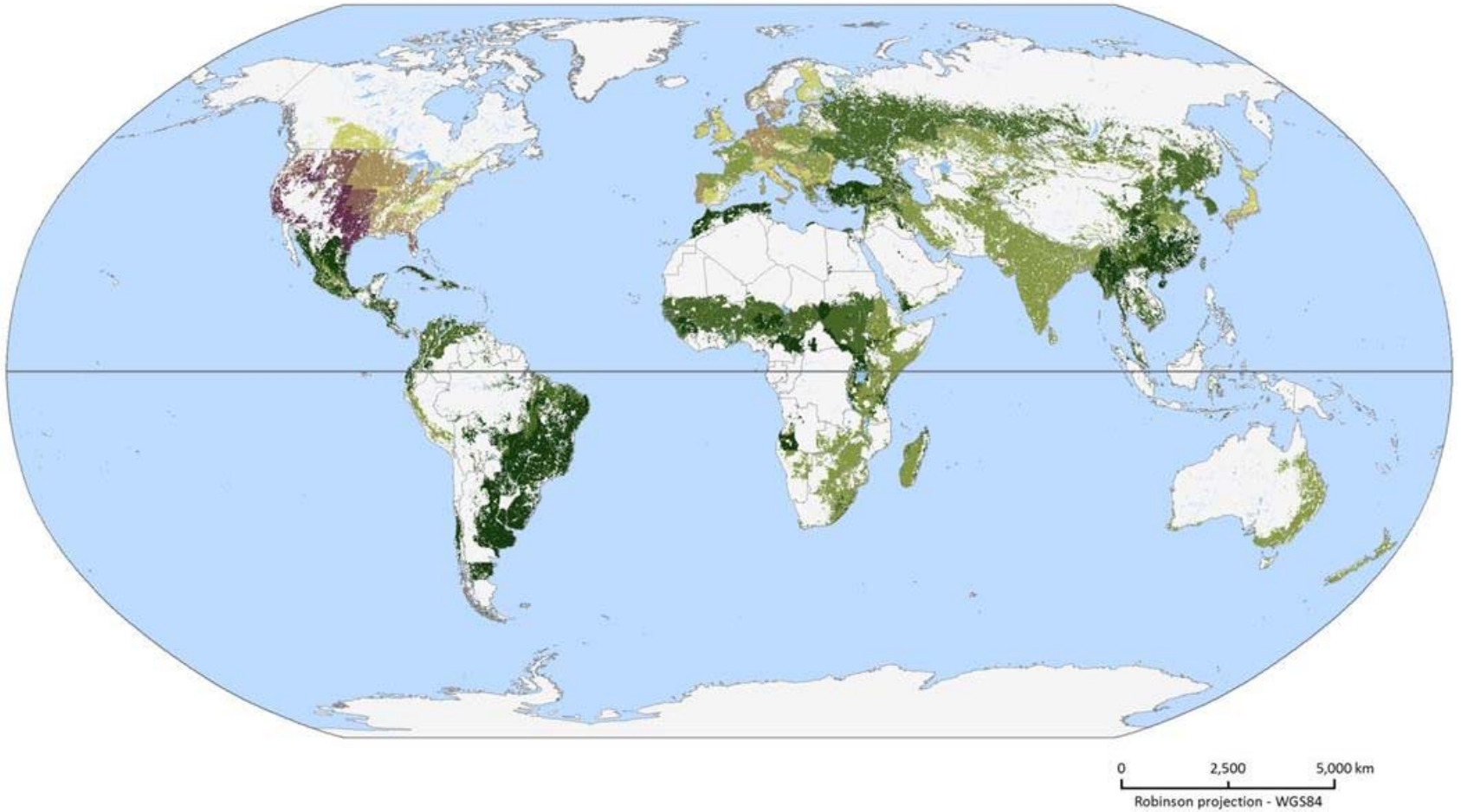
Source: FAO, 2013

AVERAGE FEED DIGESTIBILITY FOR DAIRY CATTLE



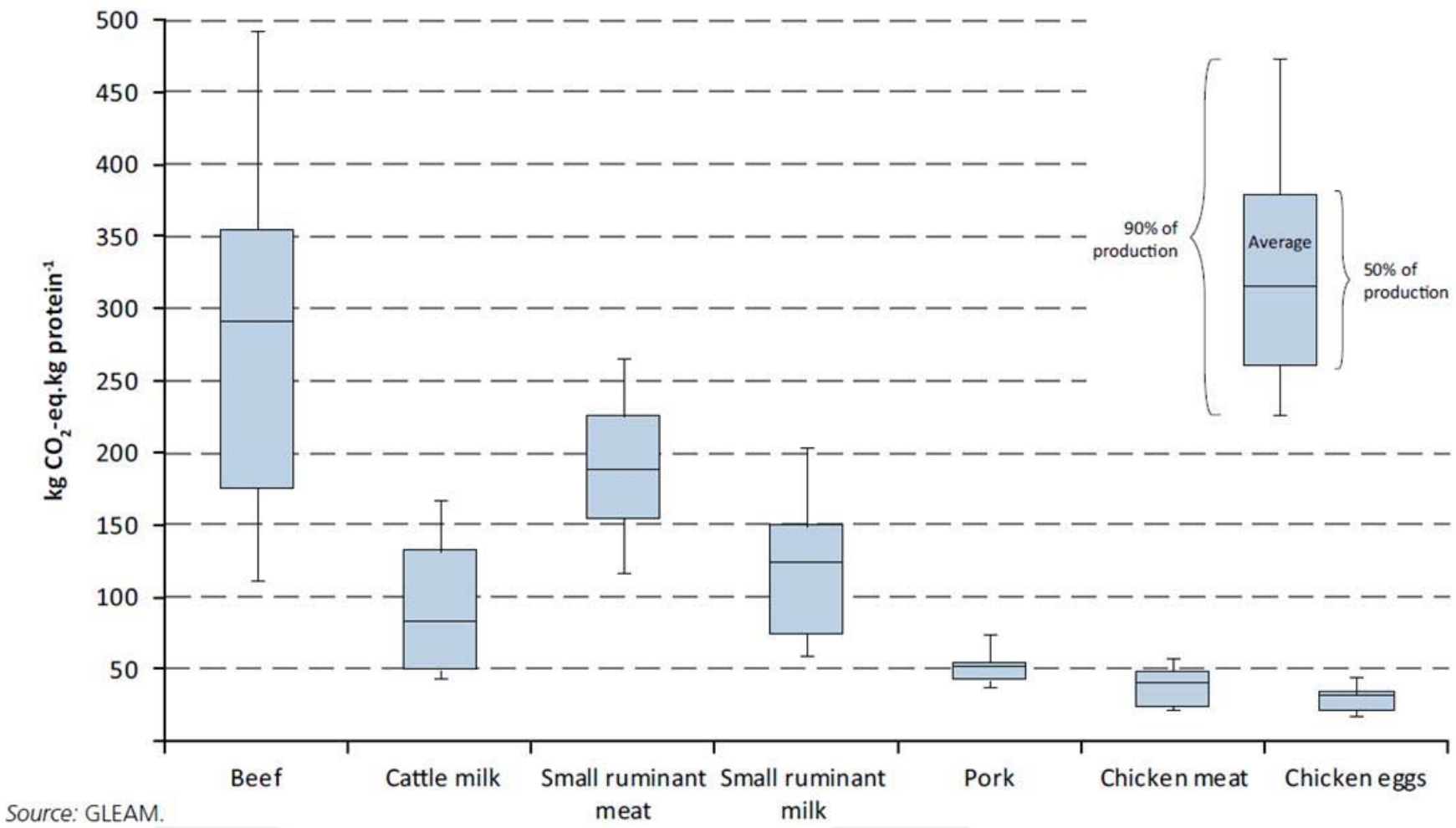
Source: FAO, 2013

MANURE METHANE CONVERSION FACTOR FOR DAIRY CATTLE



Source: FAO, 2013

VARIABILITY OF EMISSION INTENSITIES



Source: GLEAM.

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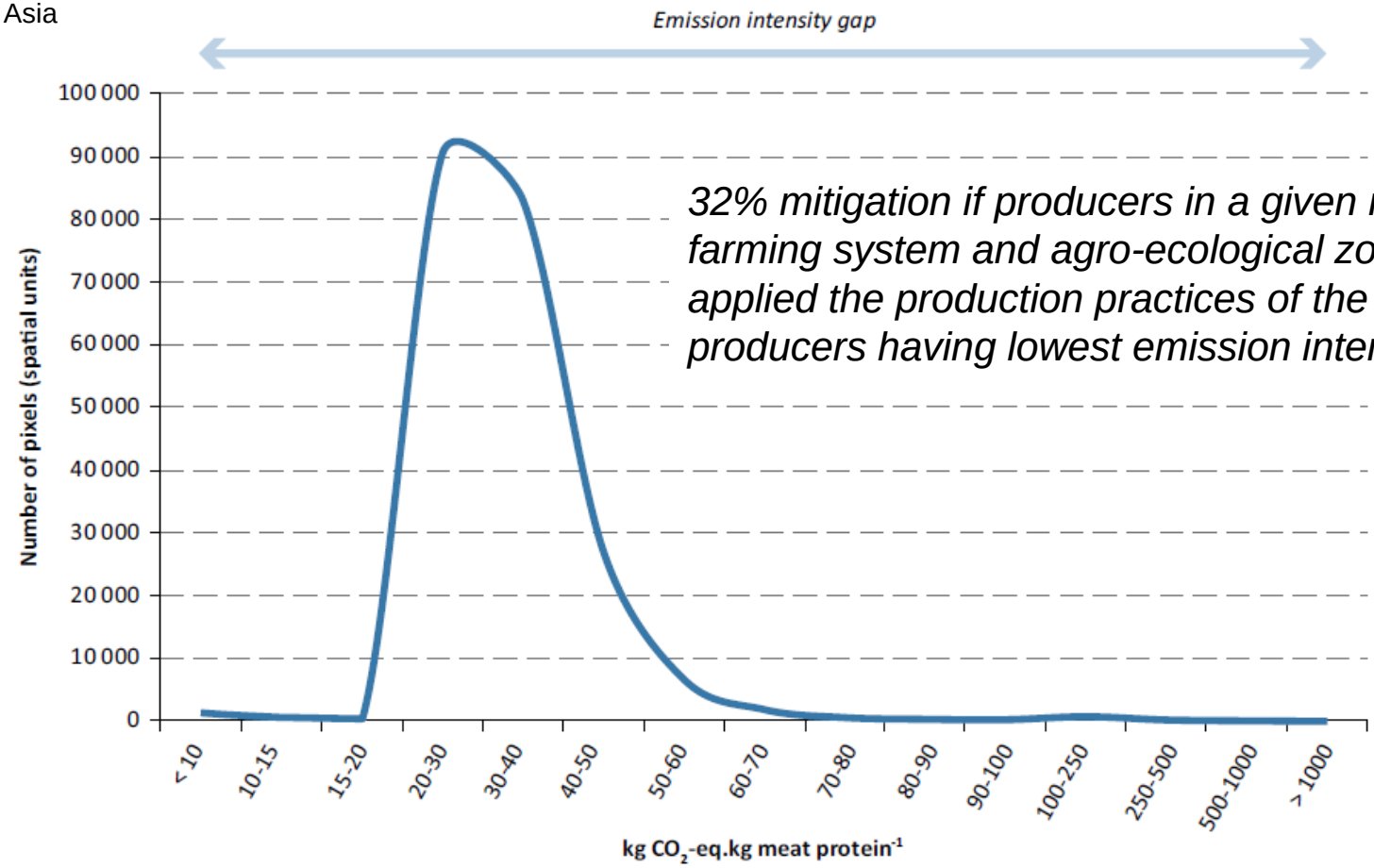
MITIGATION POTENTIAL LIES IN THE VARIABILITY OF EMISSION INTENSITIES

Distribution of intensive broiler supply chains according to their emission intensity in temperate zones of East and Southeast Asia



32% mitigation if producers in a given region, farming system and agro-ecological zone applied the production practices of the 10% producers having lowest emission intensity

Source: GLEAM.

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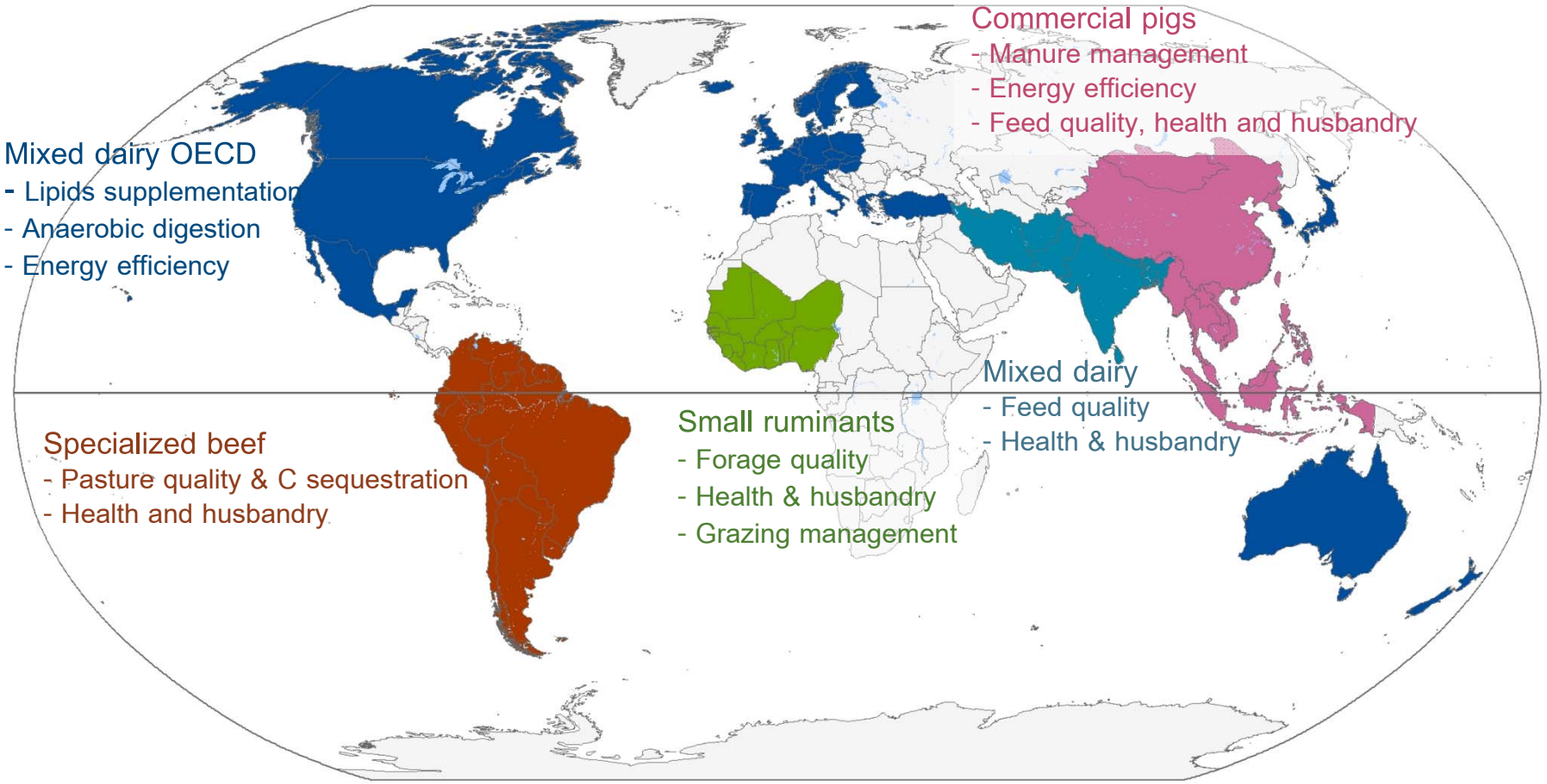
CASE STUDIES OF MITIGATION INTERVENTIONS IN PRACTICE



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CONCLUSION

- IPCC guidelines provide fundamental international standards that don’t exist for other environmental assessments
- Tier 1 emission factors in livestock could be improved

- By providing guidance on how herds can be split into production systems and animal cohorts

- By introducing management practices, such as MMS, feed rations…

- By using results from global LCA assessments relying on Tier 2 calculations

- Sectorial approach and Tier 1 : wrong incentive for mitigation

→ guidance should be given: LCA & Tier 2 to allow for mitigation assessments (cf AnimalChange project)

THANK YOU