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Impact of Livestock on the Environment

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(EAAP)

Aim

Overview of the impacts that the livestock industry have on the environment

- Mitigation (and Adaptation?)
- Strategies
- Implementation of Strategies

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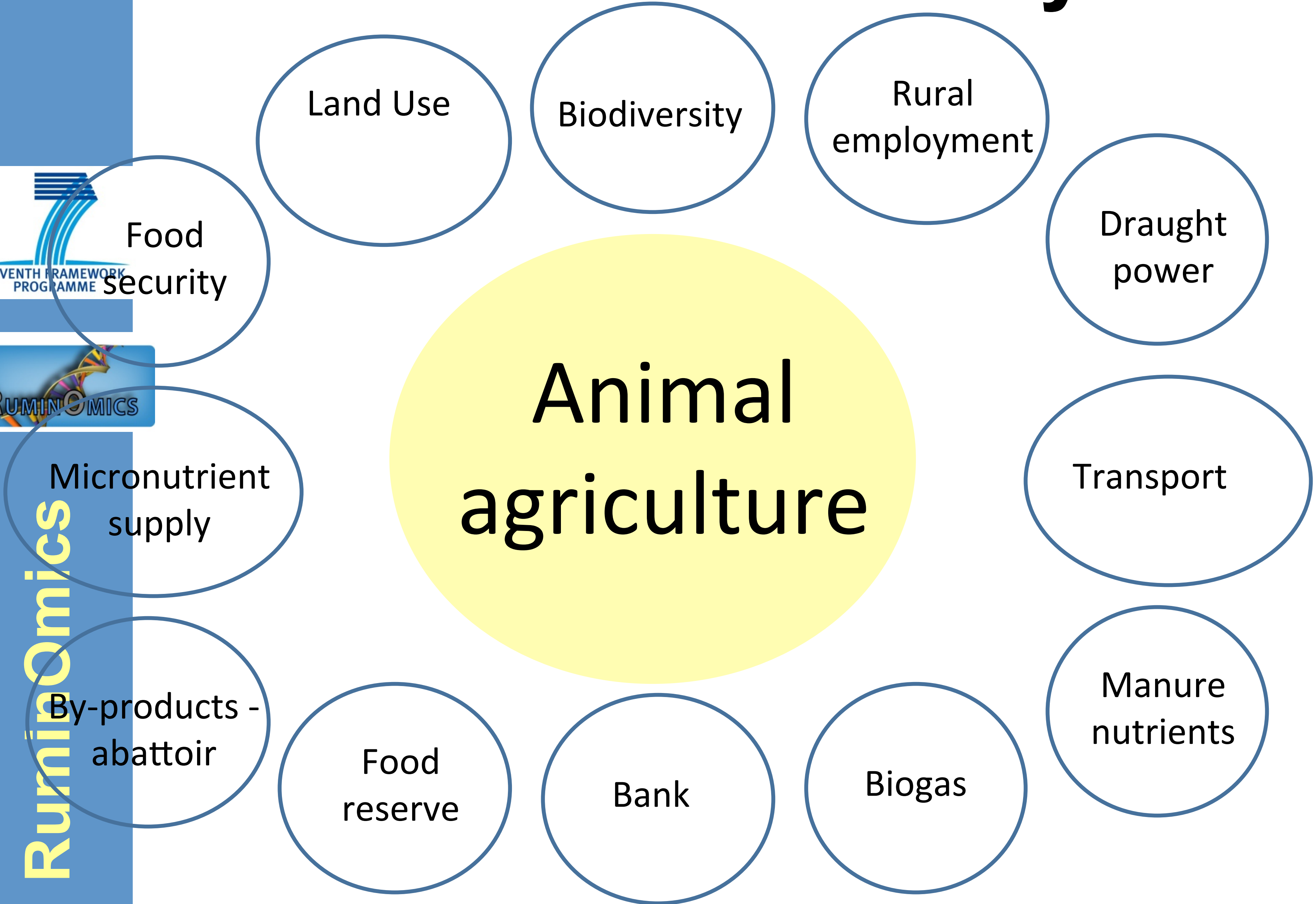
Livestock in Society



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Environmental Impact

- Resource use
- Habitats/ Lanscape
- Pollution
- GHG

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Future

- Increased global population
- More demand on primary crops for humans
- More demand for animal products
- More demand on productive land area
- Environment Regulation / Targets

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Environmental Impacts

	Positives
Grazing	Ecosystem and Landscape Maintenance
Pigs	Soil fertilization

Environmental Impacts

Intensification →

	Positives	Negatives
Grazing	Ecosystem and Landscape Maintenance	Destruction of natural habitats/ overgrazing
Pigs	Soil fertilization	Diffuse and Particulate Pollution

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Landscape/ Ecosystems

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Environmental Impacts

Intensification

	Positives	Negatives
Grazing	Ecosystem and Landscape Maintenance	Destruction of natural habitats/ overgrazing
Pigs	Soil fertilization	Habitat Destruction Pollution

Negatives overcome through Technology/Management

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Greenhouse gas (GHG) and livestock

Fundamentally different from diffuse and particulate pollution, etc

Impact is GLOBAL

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Greenhouse gas and agriculture

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Livestock sector emits

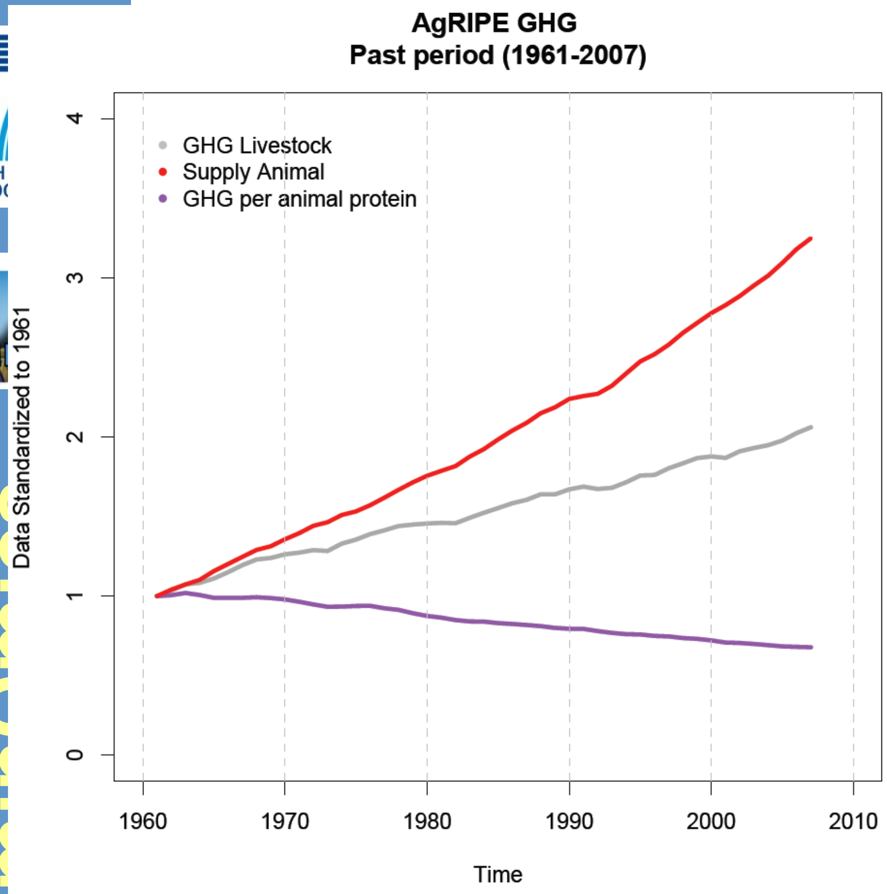
- 4.1 and 7.1 billion tonnes of (CO_2e) each year
- 18% now down to 14% average

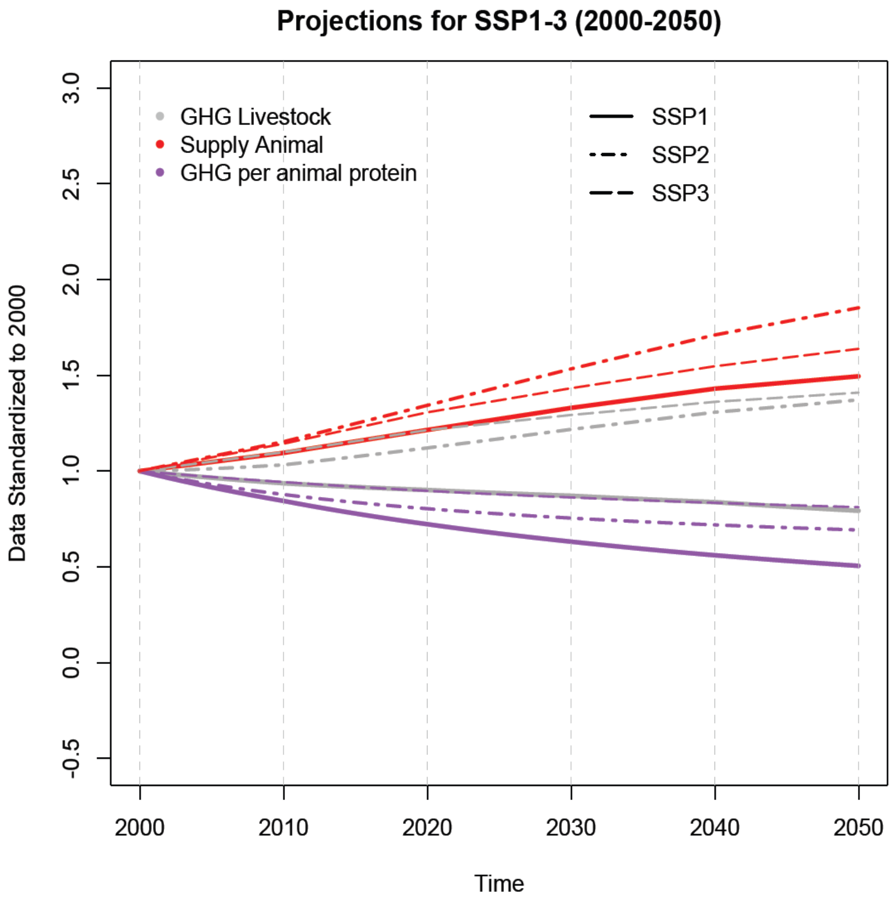
Contributes

- 37% of CH_4 emissions
- 65% of N_2O emissions

Figures challenged (some higher, some lower)
High level of uncertainty but we cannot do nothing

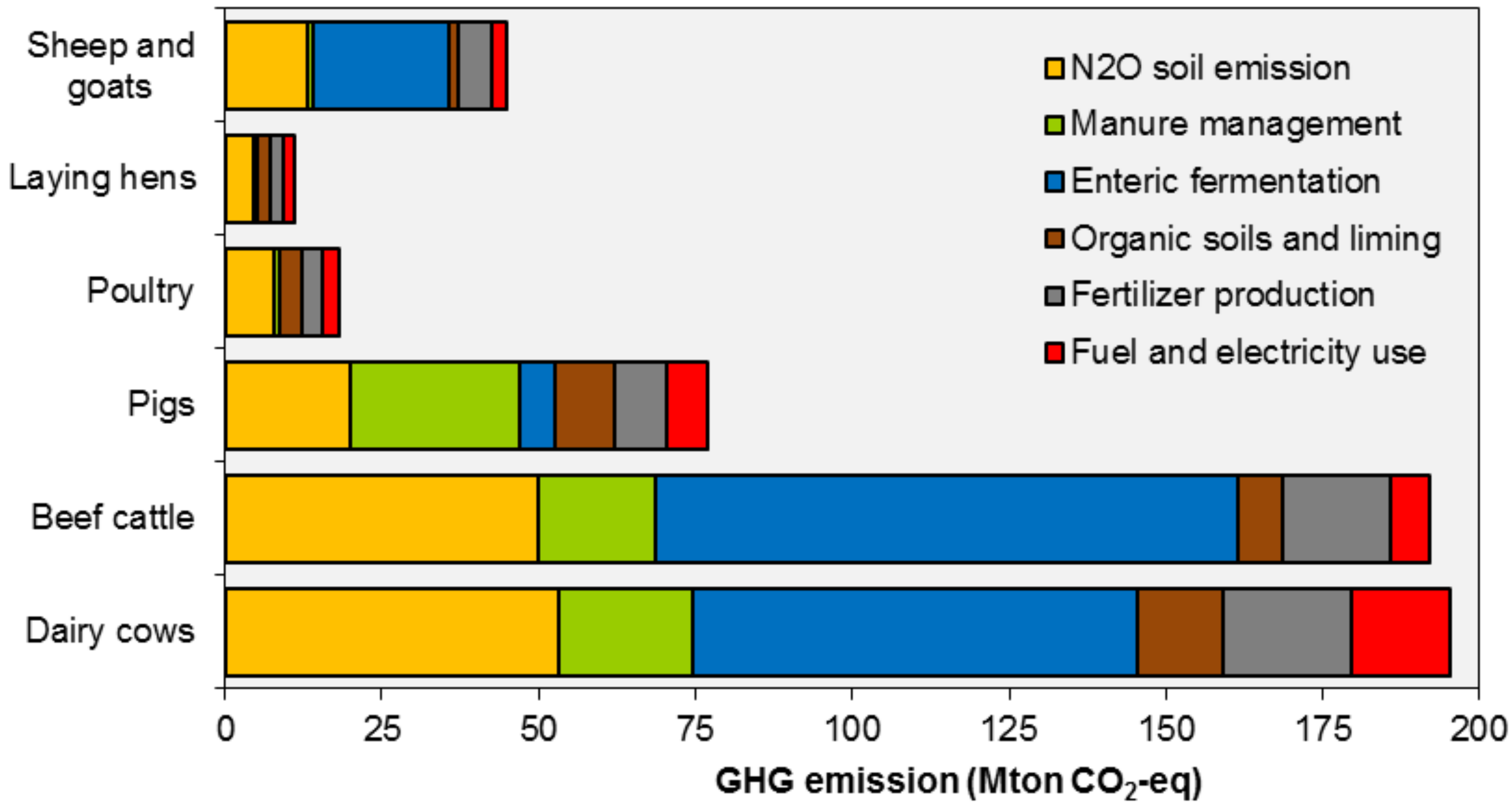
Past and future changes in GHG emissions from livestock





GHG emissions from livestock production in EU-27

(AnimalChange)



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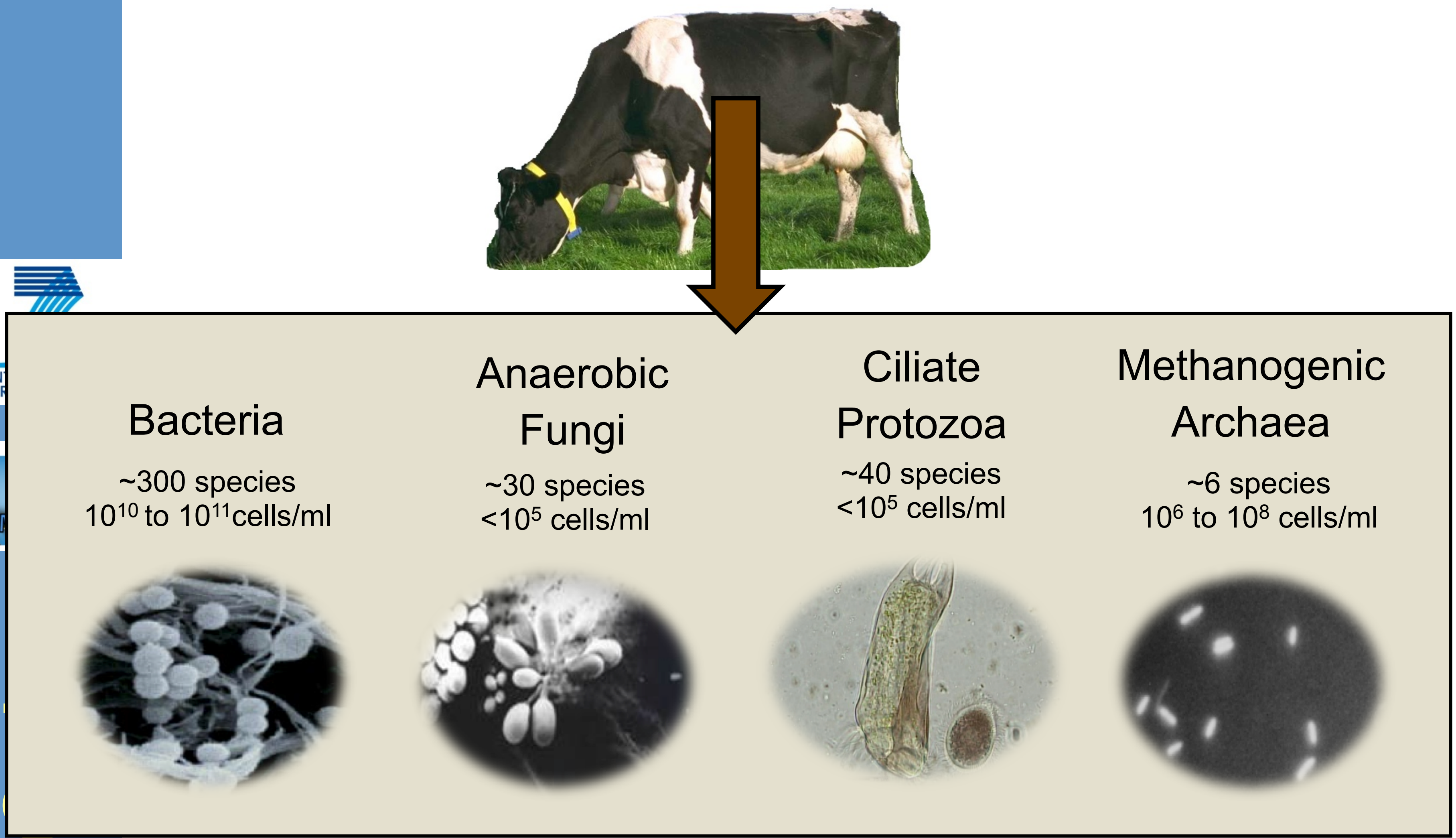
Enteric Fermentation Methane



The rumen microbiota is essential for ruminants to effectively utilise dietary material.

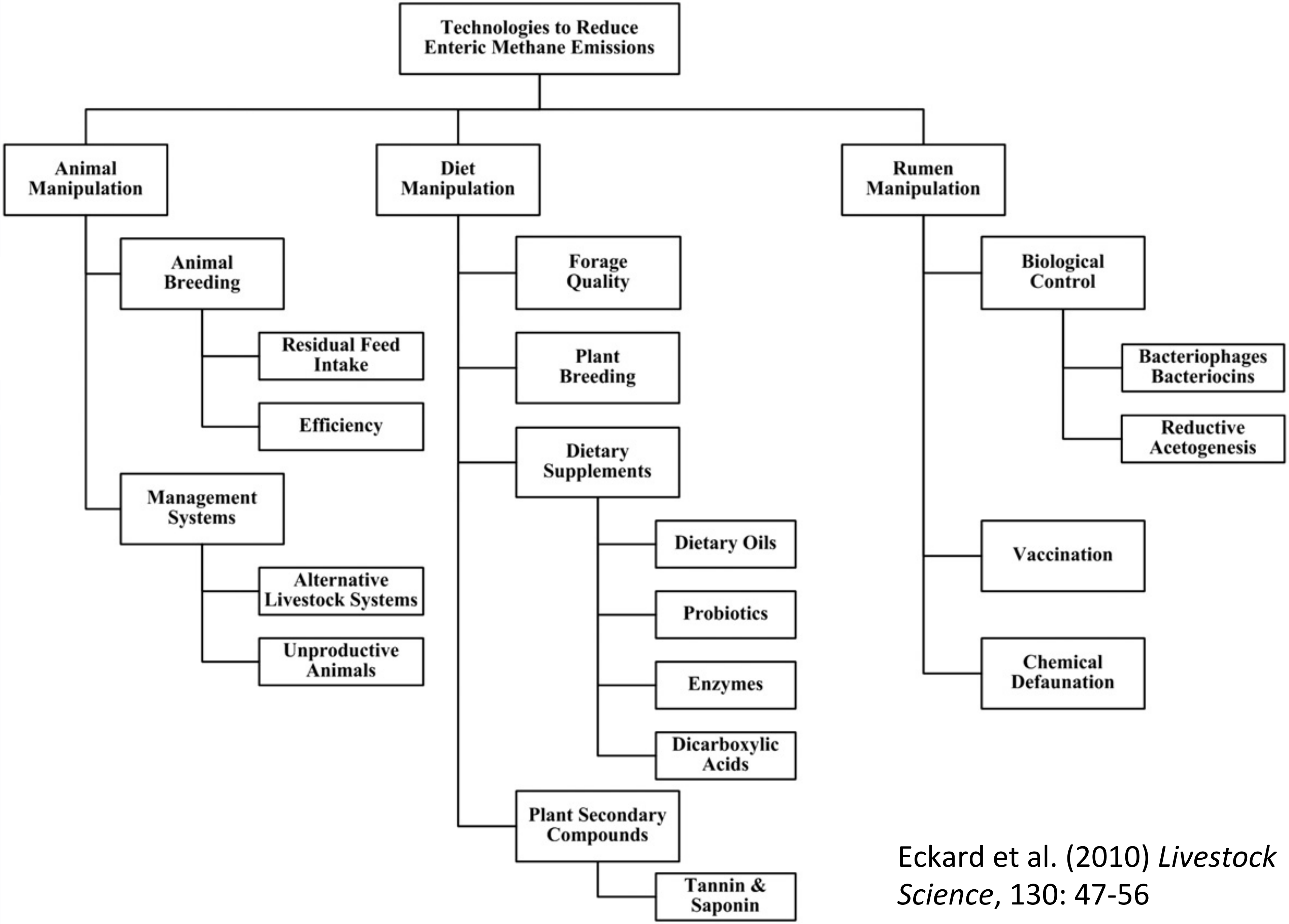
Rumen fermentation

1 mole hexose → **2 acetate + 2 CO_2 + 8 H**

1 mole hexose → **2 propionate – 4 H**

1 mole hexose → **1 butyrate + 2 CO_2 + 4 H**

Hydrogen liberated by acetate and butyrate production and utilized in propionate production



Eckard et al. (2010) *Livestock Science*, 130: 47-56

The MitiGate platform

- Flexible platform for future meta-analysis
- Updatable as new research is published (http://mitigate.ibers.aber.ac.uk).
- Quantitative estimates of mitigation potentials and variability

MitiGate

Gateway to ruminant CH_4 mitigation

Broad meta-analysis

- 147 references selected from database
  - Emission relative to intake
  - Measure of variance reported
- Moderators: Animal type, treatment type, duration, dose

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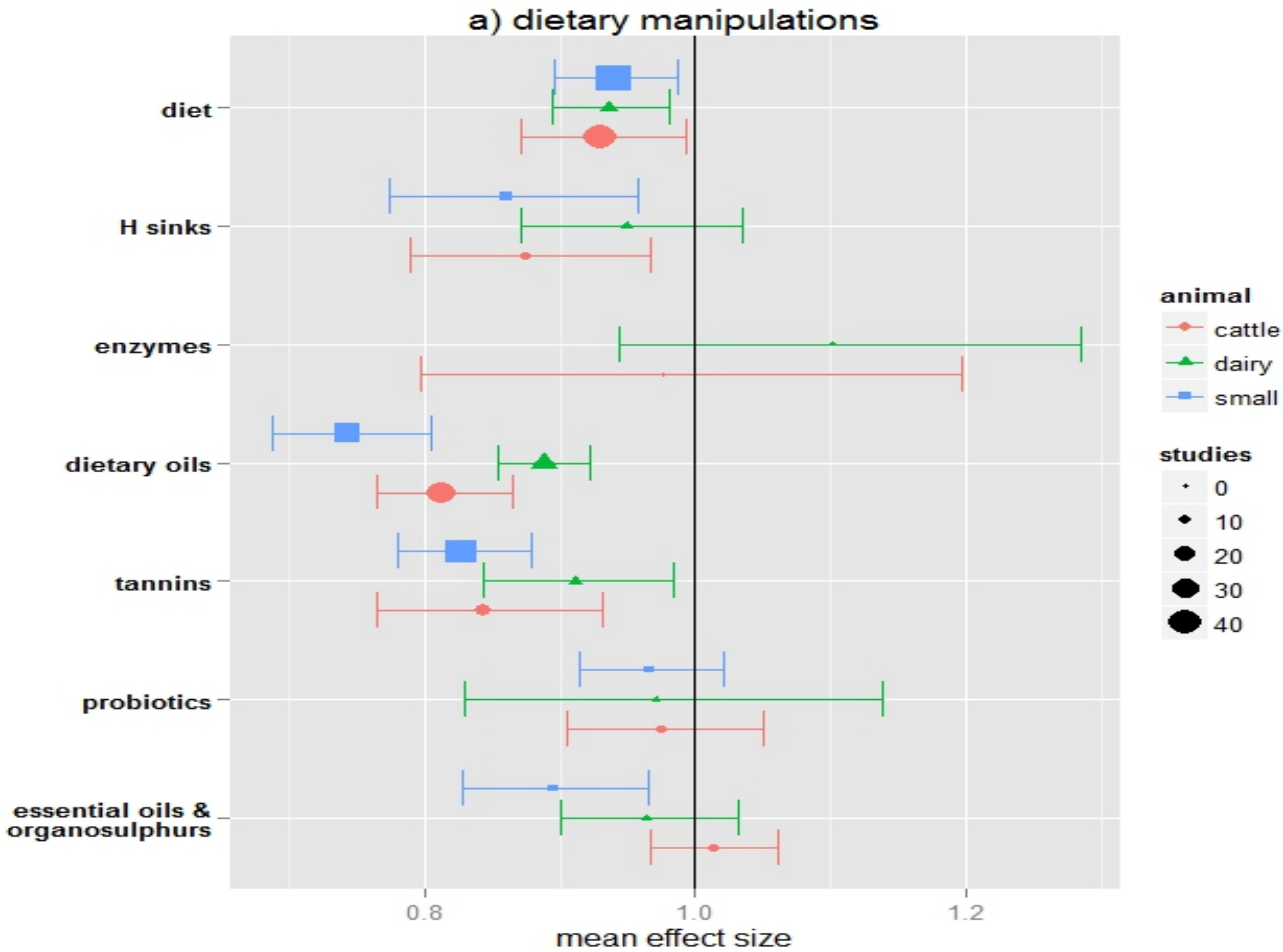
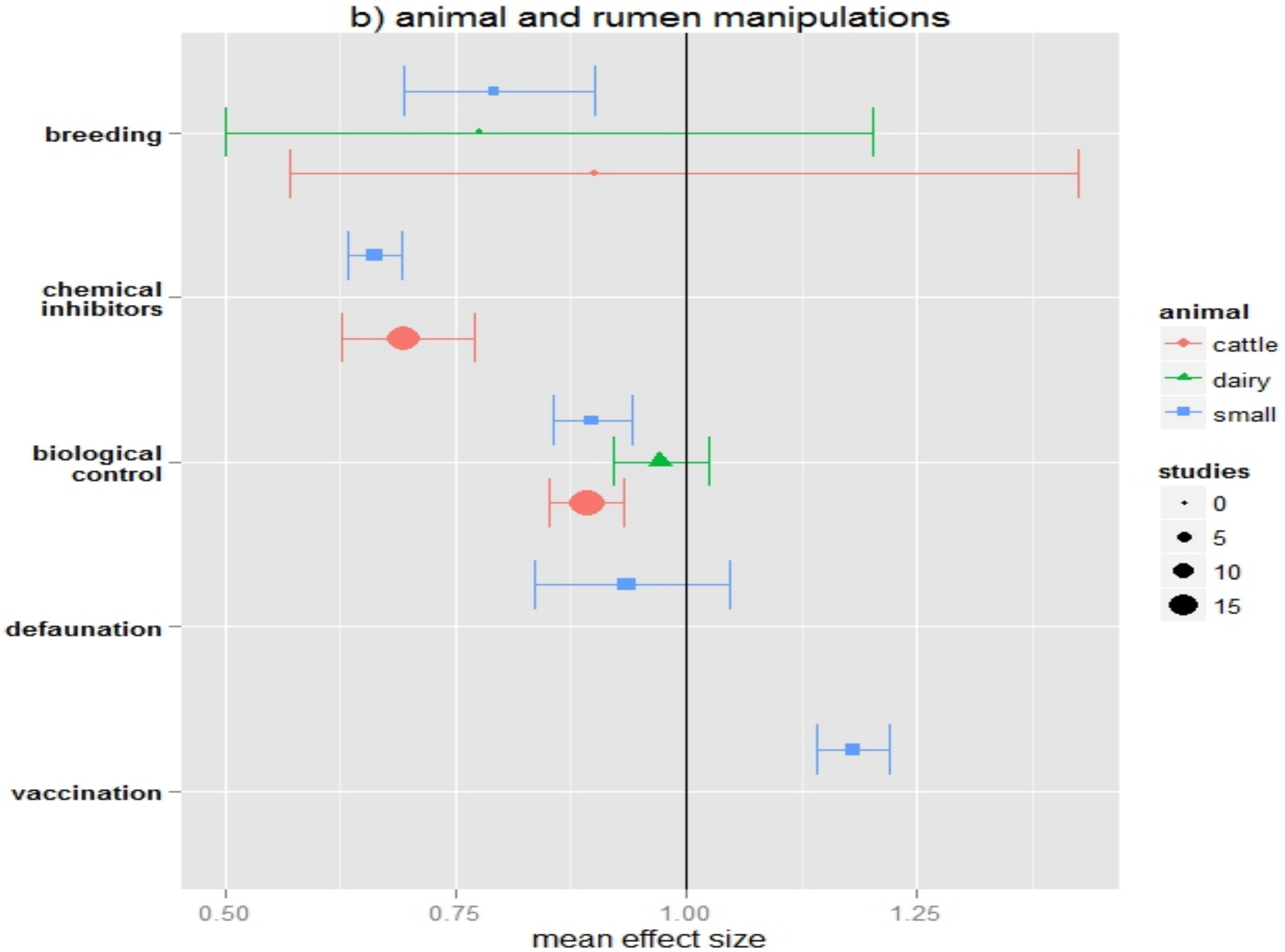
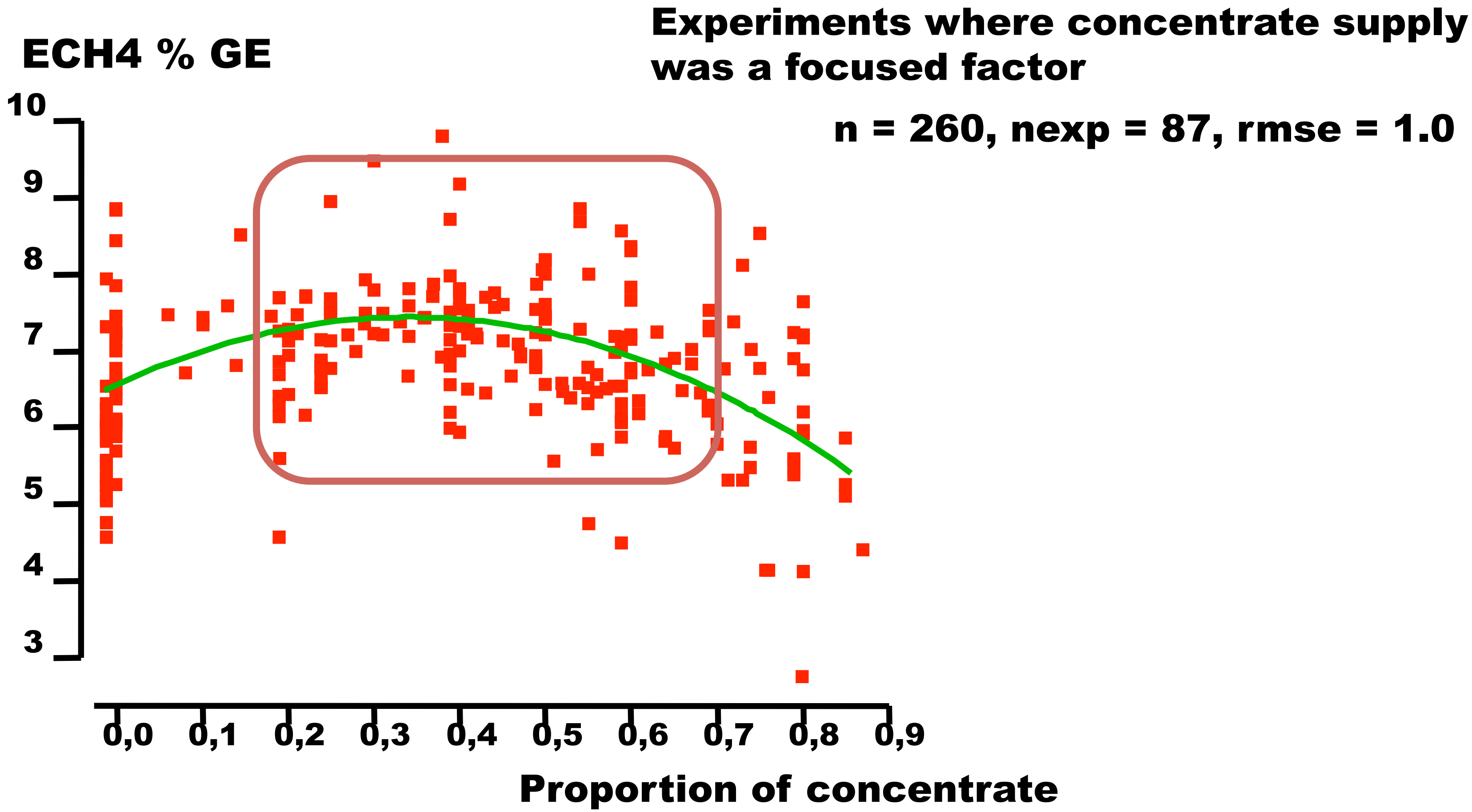

a) dietary manipulations
diet
H sinks
enzymes
dietary oils
tannins
probiotics
essential oils &
organosulphurs
0.8
1.0
1.2
mean effect size
animal
cattle
dairy
small
studies
0
10
20
30
40


b) animal and rumen manipulations
breeding
chemical inhibitors
biological control
defaunation
vaccination
0.50
0.75
1.00
1.25
mean effect size
animal
cattle
dairy
small
studies
0
5
10
15

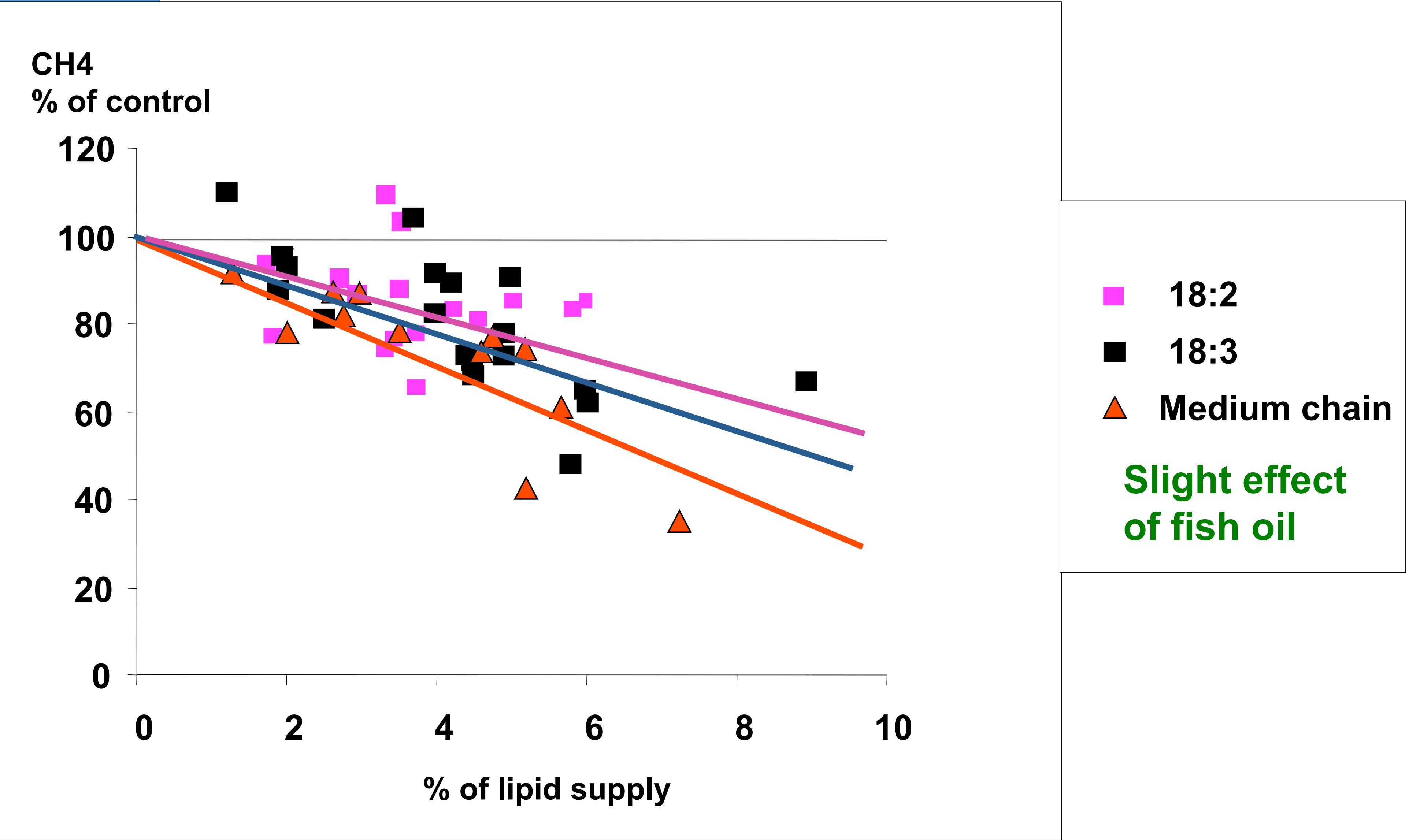
proportion of concentrates (1)



Sauvant and Giger-Reverdin, 2007

Rum

Effect of lipids : available literature



Slight effect of fish oil

Biotechnologies (M Doreau)

Vaccination against methanogens	In vitro
Antibodies	
Acetogens	In vitro
Yeast addition	Some of them are efficient in vitro
Introduction of specific bacteria	Some may be efficient in the short term

Long and complex research needed.
Might be used in the medium / long term

Additives : chemicals (M Doreau)

Antibiotics (monensin)

Decrease cellulolytic bacteria

Efficient at least in the short term
Forbidden in the EU

Organic acids

Use H for propionate pathway
Action on bacteria

In vivo effect, variable extent
Cost

Chloroform, BES, BCM

Methanogen inhibition

In vivo strong effect
Negative image, potential toxicity

Nitrates

Use H for NH_4 formation

Negative image, potential risks for the animal

Often efficient but use is questionable

Effect of Nitrate (2%)

	Control	Nitrate
DMI, kg/day	7.1	6.6
Methane		
g/kg DMI	18.2	13.3
% GE intake	5.9	4.2

No increases in performance.

More recently 3-nitrooxypropanol (3NOP) -30% reduction with no increase in Milk but some gains in Body weight. Hristov et al., 2015

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Additives : natural compounds (M Doreau)

Tannin-rich plants or extracts

Decrease methanogens — effect in vivo; often decrease digestion

Saponin-rich plants

Decrease protozoa — effect in vitro; to be proven in vivo

Essential oils, plant extracts

decrease bacteria, protozoa, or methanogens — effect in vitro; to be proven in vivo

Active research for several years.

Might be used in the short term, but efficiency remains to be proved

Nature of forages

Few data, few differences have been shown

Methane emission could be lower for lucerne than for grasses (-10%)

Methane emission varies to a low extent with grass stage of vegetation and chemical composition

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CH_4 Mitigations

- Many feed (bio)technologies potentially available for mitigation.
- Some of these have risks and some only at *in vitro*/short term trial stage (no production data)
- Effects can be transient
- Few have measurable effects on production/efficiency

Questions

- What are the cost benefits?
- Can we make mitigation strategies profitable (win-win)?
- Can we scale up from the animal effect into farm and regional?

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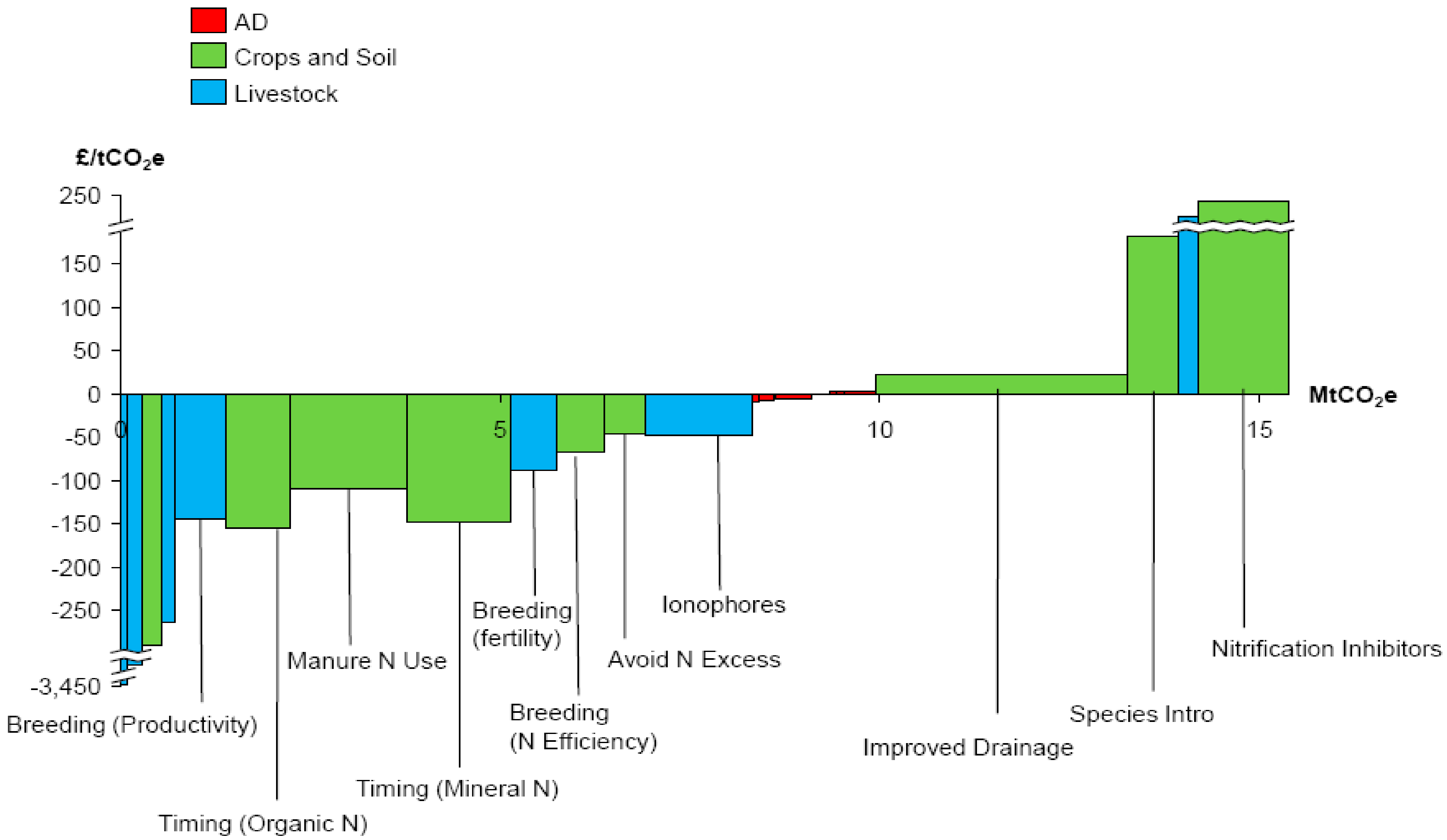
A marginal abatement cost schedule



Source: CCC modelling

Notes: N = Nitrogen, AD = anaerobic digestion
Measures do not appear in exact cost-effectiveness order due to interactions between options. More details and a full measures list is available in the accompanying technical papers.

On Farm Emission kg CO_2/ha
Eq 100= Base value
Farm AC model (Animal Change)

Farm	Dutch Grassld Dairy	French Mixed Dairy
Nitrate	95	99
Reduced Replacement	95	
Feeding more fat		98
Biogas	77	

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Conclusions

- Units
  - GHG per kg milk or meat
  - GHG per Ha or per Farm or Region
- Many promising mitigations at animal scale (GHG/kg milk or meat) may result in only small effects at farm scale (GHG / ha or per farm).
- Effects at farm scale depend on how mitigations implemented (reduced GHG/kg milk overcome at farm/regional scale if numbers of animals not reduced or increased.)

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Strategies to achieve targets

- Seek win – win strategies (greatest reduction for least cost)
- Some key strategies are limited by current bans (ionophores, growth promoters)
- Some key conflicts (higher performance needs to be supported by higher density diets and hence conflict with human needs)
- Key Unknown - Soil C sequestration offset up to 4%?? of the global GHG emissions

Implementation of Mitigations

Through

- Increased profit
- Legislation (Inventory issues)
- Government policies (evidence led!)
- Retail pressure (C footprint)

Future

- More emphasis on management strategies (vast range in GHG outputs within countries/ within systems)
- Better integration of Dairy and Beef
- More work on adaptation strategies (resilience both animal and plant)
- New approaches to breeding (as in linking the genome to the microbiome to efficiency and emissions)

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Finally

- Emphasise milk and meat systems ***can*** deliver +ve environment, ecosystem landscape benefits
- Promote evidence led policies and public debate to recognize the challenge and new technologies available

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To Know more

- www.ruminomics.eu
- www.animalchange.eu
- www.multisward.eu
- www.legumefutures.de
- www.solidairy.eu

Thank you for listening

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