Livestock and climate change
Mitigation and adaptation options for a sustainable future

Jean-François Soussana\textsuperscript{1}
and the EC FP7 ‘AnimalChange’ consortium

\texttt{www.animalchange.eu}

Inra, Paris, France.

Montpellier
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The AnimalChange Project

- **Funding scheme:** FP7 European Collaborative Project
- **Budget:** 9 Million euros
- **Start date:** 01/03/2011
- **Duration:** 48 months
- **Consortium:** 25 partners
- **Represented countries:** 13 European Countries, 4 African Countries, Brazil, New Zealand
- **Web site:** [www.animalchange.eu](http://www.animalchange.eu)
Dissemination component

• Stakeholder platform including key end-users

• Side events at conferences

• Development of eLearning courses
  – Mitigation and Scale, Adaptation, Equipment and Techniques for Measurement, Inventories and General Awareness for policy makers.

• Regional face-to-face training events:
  – Hungary: 27 to 31 October 2014,
  – Kenya: 1 to 5 December 2014,
  – Senegal: 12 to 16 January 2015,
  – Brazil: 9 to 13 February 2015.

  The format is 3 days of training (25 Students) and 2 days of workshop

YOU ARE WELCOME TOMORROW (THURSDAY) AT THE ANIMALCHANGE SIDE-EVENT
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CP1
BaU livestock under climate change

CP2
Field, animal scale M&A options

CP3
Farm scale M&A options

CP4
Regional scale barriers & policies

Stakeholders
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CP4 Regional scale barriers & policies

Stakeholders
BaU scenarios for livestock
(90% increase in demand by 2050)

Livestock product price change compared to 2000 [%]
NO climate change, Middle of the road socio-economic scenario (Havlik et al.)

Increased deforestation and increased grassland cover, leading to increased GHG emissions
Reduced demand in alternative socio-economic scenarios

SSP1: more environmental
SSP3: more fragmented

Small effects of climate change on ruminants number,
Climate change impacts on land use

- Technological change and less livestock product intensive diets would lead under SSP1 to savings of 300 million hectares of forests and other natural land compared to SSP2 and to reduced emissions.
- Under SSP3, because of slow productivity growth, the same amount of land would be cultivated as under SSP3, also the total livestock production is projected some 10% lower.
- Due to climate change, when CO$_2$ fertilization effects accounted for, the cropland is under SSP2 projected to expand by 33 million ha more than without climate change, and grassland even by 79 million ha more than without climate change.
- Given land use change, global animal numbers are not affected by climate change.
Understanding and reducing uncertainties: GHG emissions (Miterra framework)
Reducing uncertainties for soil carbon: Carbon sequestration ($NCS$) in European grasslands (g C m$^{-2}$ yr$^{-1}$)

Carbon sequestration

$NCS = 76 \pm 11$ gC m$^{-2}$ yr$^{-1}$ (P < 0.001)

$NCS = (f_2 + k_N \cdot N_s) \cdot GPP + k_C \cdot L_C$ (P<0.001, $r^2$=0.65)
Critical animal stocking density for ‘zero carbon’ pastures

• Does C sequestration compensate for non CO₂ emissions (CH₄, N₂O) on-site?

  a. Unfertilized pasture (200 d grazing)  
  b. Mineral N fertilized pasture (200 d grazing)  
  c. Manure fertilized pasture (200 d grazing)

Critical herbage use efficiency* = 0.20

‘Zero carbon’ pastures are very extensive
Reducing uncertainties: grassland ecosystem manipulation
Reducing uncertainties: climate change impacts on global grasslands

From 2005-2015 to 2090-2099, Orchidee (LSU/ha)

**Hadgem2 Rcp 4.5**

**Hadgem2 Rcp 8.5**

Difference between the mean values of the aridity index (b) calculated for the years 2005-2099 and 1951-2004 with $b<25^{th}$ percentile, as represented by two climate models and two RCPs. Red to bleu colours indicate growing aridity under future climate (and vice versa for red to brown colours).
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MITIGATION OPTIONS: Meta-analysis of enteric CH$_4$ mitigation from diet changes and additives
M&A option: grass-legume mixtures have increased total N yield

And increased drought tolerance in European drought experiments

- Mixtures, on average, outperform grass monocultures at majority of site
- Average N yield of mixtures is at level of legume monocultures
Tropical grazing and browsing: mitigation from secondary plant compounds

- Tropical (e.g. legumes) tannin-rich forage plants reduce methane production \textit{in-vitro},
- Some of the saponin-rich browsed species could also lead to reduced enteric methane emissions,
- This questions the validity of \textit{CH}_4 emission factors for some of the tropical grazing/browsing systems
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Stakeholders
The model farms are virtual farms representing a livestock system in a region. These virtual farms are created combining estimated data and information based on regional production systems and national statistics.

Showcase farms, however, are real farms. Real-life data are collected on these farms. Data from showcase farms are used in calculations of model farms.
Farm AC model: modeling M&A options

Carbon fluxes

Nitrogen fluxes
M&A options: trade-offs and synergies (Dutch dairy farm example)

<table>
<thead>
<tr>
<th>Mitigation Measures</th>
<th>Adaptation Measures</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Water management</td>
</tr>
<tr>
<td>Genetic improvement in dairy cattle</td>
<td>No Effect</td>
</tr>
<tr>
<td>Increasing housing</td>
<td>+</td>
</tr>
<tr>
<td>Feeding maize and less grass</td>
<td>-</td>
</tr>
<tr>
<td>Legumes in the rotation</td>
<td>+</td>
</tr>
<tr>
<td>Replacement rate cattle</td>
<td>No Effect</td>
</tr>
</tbody>
</table>

Note ++ is highly positive, + is positive, - is negative and – is highly negative, boxes coloured green are associated with low uncertainty, yellow is medium uncertainty and red is high uncertainty.
Distribution of the adaptation and mitigation options proposed by farmers

Survey of 196 livestock farms spread over 10 countries: France, Scotland, Netherlands, Ireland, Senegal, Burkina-Faso, Kenya, South Africa, Madagascar, Brazil.
Mitigation abatement cost curve for the Brazilian cerrado (2006-2030)

Marginal Cost Effectiveness (Reals per tonne of CO₂ equivalent per year)

- Supplementation: Concentrate
- Supplementation: Protein
- Pasture Restoration
- Feedlot Finishing
- Nitrification Inhibitors

Approx. 27 million tonnes of CO₂ equivalent per year

Annual Abatement (thousand tonnes of CO₂ equivalent per year)
Index of Behavioural Barriers (IBB)

Low IBB: low uptake of M & A strategies

Behavioural barriers in Eastern Kenya

- Scepticism
- Lack of concern
- Fatalism and helplessness
- Externalising responsibility
- Blaming a lack of adequate policy
- Reluctance to change
- Lack of knowledge to change

Data unavailable
## Mitigation package for Europe

<table>
<thead>
<tr>
<th>Total emissions from ruminants</th>
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<tbody>
<tr>
<td>Ruminants</td>
<td>496 Mt CO2-eq.</td>
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<tr>
<td>Mixed dairy</td>
<td>166 Mt CO2-eq.</td>
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### Mitigation potential

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<tr>
<td>Fat supplementation (mixed dairy cows)</td>
<td>2.3 to 6.8 Mt CO2-eq.</td>
</tr>
<tr>
<td>Manure management (mixed dairy)</td>
<td>5.3 Mt CO2-eq.</td>
</tr>
<tr>
<td>Biogas production (mixed dairy)</td>
<td>4.4 Mt CO2-eq.</td>
</tr>
<tr>
<td>Energy use efficiency (all ruminants)</td>
<td>23.2 Mt CO2-eq.</td>
</tr>
<tr>
<td>Increase legumes in grassland (all ruminants)</td>
<td>14.6 Mt all systems</td>
</tr>
<tr>
<td>Grazing management (all ruminants)</td>
<td>0.17 Mt all systems</td>
</tr>
<tr>
<td>Total</td>
<td>50 to 54.5 Mt CO₂-eq Or c.a. 11%</td>
</tr>
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Thank you for your attention!