The net contribution of ruminant production
to the protein supply for humans

S. Laisse 1, R. Baumont 2, P. Veysset 2, M. Benoit 2, P. Madrange 3, B. Rouillé 1, J.-L. Peyraud 4

1 IDELE, Service Lait, Monvoisin, 35650 Le Rheu, France
2 INRA, UMR Herbivores, 63122 Saint-Genès-Champanelle, France
3 IDELE, Service Viandes, 63170 Aubière, France
4 INRA, UMR PEGASE, 35590 Saint-Gilles, France
Livestock in a circular bioeconomy: Efficient use of biomass

→ Imply a decrease of feed/food competition

(ATF, 2016)
How to evaluate the contribution of Livestock to human food production?

Feed conversion efficiency of LFS

Only human edible vegetable feed material is in competition with human food

Net contribution to human protein food supply
Indicators of Feed Conversion Efficiency

**Total Efficiency** = \frac{\text{Proteins produced (whole carcasses, milk)}}{\text{Proteins consumed by livestock (total feed)}}

**Net Efficiency** = \frac{\text{Human edible proteins produced}}{\text{Human edible proteins consumed}}

(adapted from Wilkinson, 2011; Ertl et al, 2015)

→ What is human-edible?
Human edible fraction of animal products

- **Milk**  → 98% of volume edible

- **“Meat”**

<table>
<thead>
<tr>
<th>Animal</th>
<th>% of live weight</th>
<th>% of proteins in live animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy Cow</td>
<td>45 %</td>
<td>55 %</td>
</tr>
<tr>
<td>Beef Cow</td>
<td>49 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Bull-calf</td>
<td>51 %</td>
<td>63 %</td>
</tr>
<tr>
<td>Lamb</td>
<td>41 %</td>
<td>43 %</td>
</tr>
</tbody>
</table>
Human edible fraction of feedstuffs

→ Grass : non edible

→ Cereals grain : partly edible

→ By-products : often non-edible

→ Soybean meal : protein extraction is possible
<table>
<thead>
<tr>
<th>Feedstuffs</th>
<th>Current Scenario</th>
<th>Potential Scenario</th>
<th>Hypothesis for Potential scenario (best use of plant protein)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td>0%</td>
<td>0%</td>
<td>/</td>
</tr>
<tr>
<td>Maize silage</td>
<td>10% [grain part]</td>
<td>20%</td>
<td>According to maize grain</td>
</tr>
<tr>
<td>Wheat grain</td>
<td>66%</td>
<td>74%</td>
<td>More complete flours, bran use</td>
</tr>
<tr>
<td>Maize grain</td>
<td>15%</td>
<td>30%</td>
<td>Less starch extraction for flour</td>
</tr>
<tr>
<td>Peas</td>
<td>74%</td>
<td>92%</td>
<td>Less protein extraction for more grain consumption</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>60%</td>
<td>92%</td>
<td>Better protein extraction process</td>
</tr>
<tr>
<td>Rapeseed meal &amp; sunflower meal</td>
<td>0%</td>
<td>55%</td>
<td>Protein extraction</td>
</tr>
<tr>
<td>DDGS, sugar beet pulp</td>
<td>0%</td>
<td>0%</td>
<td>/</td>
</tr>
</tbody>
</table>
Ruminant Farming Systems studied

→ Productions: Dairy cattle, Beef cattle, Sheep

→ Examples of existing French farming systems, chosen according to contrasted feeding systems (“Inosys” – Réseaux d’élevage)

→ Calculations made at farm level including all products (e.g. milk and meat for dairy farms) and all animals (heifers).
## Animal performances and diet composition

<table>
<thead>
<tr>
<th>Production system characteristics</th>
<th>Diet composition (% of total dry matter consumed)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of production</strong></td>
<td><strong>Maize silage</strong></td>
</tr>
<tr>
<td>Dairy cattle</td>
<td>Maize silage</td>
</tr>
<tr>
<td>DC1 “Maize”</td>
<td>8490 L/Cow</td>
</tr>
<tr>
<td>DC2 “Grass”</td>
<td>5745 L/Cow</td>
</tr>
<tr>
<td>Beef cattle</td>
<td>BC1</td>
</tr>
<tr>
<td>Beef cattle</td>
<td>BC2</td>
</tr>
<tr>
<td>Sheep</td>
<td>Sh1 “High-Conc.”</td>
</tr>
<tr>
<td>Sheep</td>
<td>Sh2 “Low-Conc.”</td>
</tr>
</tbody>
</table>
Total protein conversion efficiency of ruminant systems

≈ 4 kg of feedstuff protein for 1 kg of animal protein (milk, whole carcasses)

≈ 10-15 kg of feedstuff protein for 1 kg of animal protein (whole carcasses)
Net protein conversion efficiency of ruminant systems

- Ruminant systems have the capacity to produce more edible protein than they consume
- High variability between and within production systems
Net protein conversion efficiency of ruminant systems

High impact of the scenario of plant protein utilisation in food industry
Conclusion

- Net protein conversion efficiency brings a new insight on feed/food competition
- Ruminants can positively contribute to human protein supply by efficient use of grasslands and non-edible by-products
- Margins of progress exist for all types of production systems
- Future utilization of feedstuffs in the food industry needs to be taken into account
- Feed conversion efficiency has to be evaluated in conjunction with:
  - Land use
  - Other indicators of economical, environmental and social performances
Thank you for your attention
Human edible fraction of animal products

→ Literature synthesis (edible fraction, protein content)

- Milk
  → 98% of volume edible

- “Meat” – example of beef cow
  
  Live weight (100%)
  
  Slaughter
  
  Carcass weight (57%)
  
  Water losses (1%)
  
  Meat (38%)
  
  Losses (15%)
  (dead animals, digestive content, etc.)
  
  Edible offal (6%)

  Leather, non-edible offal, fat (20%)

  Edible by-products (bone for gelatin, fat for tallow) (6%)

  Non-edible by-products (14%)

Edible fraction
In beef cattle:
50% of live weight
61% of proteins

Human edible fraction of animal products

→ Literature synthesis (edible fraction, protein content)

- Milk
  → 98% of volume edible

- “Meat” – example of beef cow
  
  Live weight (100%)
  
  Slaughter
  
  Carcass weight (57%)
  
  Water losses (1%)
  
  Meat (38%)
  
  Losses (15%)
  (dead animals, digestive content, etc.)
  
  Edible offal (6%)

  Leather, non-edible offal, fat (20%)

  Edible by-products (bone for gelatin, fat for tallow) (6%)

  Non-edible by-products (14%)

Edible fraction
In beef cattle:
50% of live weight
61% of proteins
Human edible protein fraction of feedstuffs

Example of Wheat grain

Wheat grain
Initial protein (100%)

Food processing
Milling, Starch and gluten extraction, Other

Food products
Flour (+ bran) starch + gluten, other

Byproducts
Milling byproducts gluten feed, DDGS...

Currently in France:
Edible protein in wheat grain = 66%

If more consumption of complete flour, and more consumption of wheat bran in food sector

Potential scenario:
74% or more

June, 18, 2018