Importance of a common feed evaluation system

- Use of international feedstuff tables
- Use of international recommendations
- Improve and coordinate research strategy
- Advantages in general trade of feed

Basic purpose for feed evaluation

- Optimise diets according to the actual production
- Least cost diets with defined properties
- Precise formulation according to recommendations
- Optimal relation between digestible amino acids and energy

Digestible amino acids

- Ileal digestibility of amino acids
- Standardised digestible amino acids (SDAA)
- Tabulated SDAA values for feedstuffs
- Contribution of SDAA to ideal protein (protein value)
**Energy value**

- Digestible energy (DE)
- Metabolisable energy (ME)
- Net energy (NE)
- Potential physiological energy (PPE)

**Energy value for feed evaluation**

- DE is an insufficient measure
- ME is an insufficient measure
- NE is influenced by many production factors
- PPE is a basal and scientifically correct measure

**Potential physiological energy (PPE)**

- Adenosin tri-phosphate (ATP)
- Universal energy donor
- Produced from AcCoA (12 ATP)
- Precise value for each nutrient fraction

**Conversion of dietary nutrients to pig body components and physiological energy**

- Protein
- Carbohydrates
- Lipids
- Water
- Ash

**Diagram**

- Protein $\rightarrow$ AA $\rightarrow$ Protein
- Carbohydrates $\rightarrow$ Glu $\rightarrow$ AcCoA $\rightarrow$ Energy ATP
- Lipids $\rightarrow$ FA/MG $\rightarrow$ Lipids TG

<table>
<thead>
<tr>
<th>Feed</th>
<th>Digestive tract</th>
<th>Intermediary metabolism</th>
<th>Pig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td></td>
<td></td>
<td>0.2</td>
</tr>
<tr>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Determination of standardized digestibility

- **In vivo:**
  - Endogenous protein loss:
  - Undigested protein
  - Real
  - Extra
  - Basal
  - Apparent digested protein
  - Apparent

Control of digestibility in actual feed samples

- Enzyme digestibility of organic matter at faecal level (EDOM)
- Enzyme digestibility of organic matter at ileal level (EDOMi)
- Enzyme digestibility of crude protein at ileal level (EDN)
- Standardised digestibility of amino acids (Table values)

Enzyme specificity in the digestive tract

<table>
<thead>
<tr>
<th>Compartment</th>
<th>Enzyme</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>Pepsin</td>
<td>Proteolytic</td>
</tr>
<tr>
<td>Small intestine</td>
<td>Pancreatic enzymes</td>
<td>Proteolytic Amylolytic Lipolytic</td>
</tr>
<tr>
<td>Hind-gut</td>
<td>Microbial enzymes</td>
<td>Proteolytic Carbohydrolytic - amylolytic - fibrolytic</td>
</tr>
</tbody>
</table>

Degradation profiles

- Soyabean meal
- Barley

- Incubation time (hours)
- Digestibility in vitro (%)

- Pepsin
- Pancreatin
- Viscozyme
**In Vitro Digestibility of Common Feedstuffs**

**Amino acid composition (g per 160 g N) of suggested standard values for ideal protein and the endogenous protein loss at ileal level**

<table>
<thead>
<tr>
<th>Amino Acid</th>
<th>Ideal Protein</th>
<th>Endogenous Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysine</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>Methionine</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>Cystine</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>Methionine + cystine</td>
<td>36</td>
<td>-</td>
</tr>
<tr>
<td>Threonine</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>40</td>
<td>25</td>
</tr>
<tr>
<td>Leucine</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>Histidine</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>Tyrosine</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>Phenylalanine + tyrosine</td>
<td>80</td>
<td>-</td>
</tr>
<tr>
<td>Valine</td>
<td>52</td>
<td>35</td>
</tr>
</tbody>
</table>

**Standardized digestibility of protein and amino acids in selected common feedstuffs**

<table>
<thead>
<tr>
<th>Feedstuffs:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean meal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Feed optimization**

<table>
<thead>
<tr>
<th>Feedstuffs:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean meal</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diet:**

- A: UD → RD → SEL → SD
- B: UD → RD → SD
- C: UD → RD → SD

**Pig:**

- Norm
- Standarized digestible amino acids per FU
- Safety margin / economical optimum

UD = undigested
RD = real digested
SD = standardized digested
SEL = specific endogenous loss
BEL = basal endogenous loss
Feed optimisation (2)

- Energy concentration
- SDAA relative to PPE
- Effect of live weight during growth
- Effect of secondary compounds

Summary of feed evaluation

1. Chemical analyses (Feed composition)
2. In vitro analyses (Simulation of digestion)
3. Calculations (Potential energy generation and nutrient deposition)
4. Animal model (Feed intake, $P_{d_{max}}$, deposition and excretion)

Conclusion (1)

Feed optimisation is based on two independent variables:

- The properties of the feed
- The requirements of the animal
Conclusion (2)

- SDAA and PPE are well-defined properties of the feed
- Their contributions are the basis for optimal pig production

Feed evaluation need not to be complicated!