B) Topics on calculation tools that retrieve information from the feed database

**1. Topic: Online calculation of the energy and nutritive value of feedstuffs for pigs**

Project description

The energy value offeedstuffs for pigs is experimentally determined in so-called digestibility trials. Digestible energy (DE) is thus defined as feed gross energy – feces gross energy. It implies that feed intake as well as feces output must be collected quantitatively and followed by detailed chemical analysis. This procedure is time consuming and cost intensive. It is common practice in animal nutrition to estimate the energy value of feedstuffs by regression technique. The multivariate equations rely on the proximate analysis of feedstuffs alone or in combination with digestibility coefficients. Proximate analysis consists of ash, crude protein (CP), fat (ether extract, EE), crude fibre (CF), and N free extract (NfE) complemented with sugar (Su) and starch (ST). The advantage of such derived equations is that the energy value of feedstuffs can easily be estimated even if they deviate in their chemical analysis from feedstuffs that were used in digestibility trials. The interest for having an online tool that calculates the energy value simply based on proximate analysis of feedstuffs as input parameter is big.

For pig feed, the following equations are used in Switzerland (Agroscope 2004):

**a) Single feedstuffs** (all nutrients must be given as g/kg dry matter (DM))

DEPig (MJ/kg DM) = [0.02255 \* CP\*(dCP/100)] **+** [0.03728\*EE\*(dEE/100)] **+** [0.01736 \* CF \* (dCF/100)] + [0.01753 \* NfE \* (dNfE/100)] **-** [0.00185 \* SU] **-** [0.0070 \* (BFS – 100)]

**(Eq 1-4)**

condition 1 condition 2

if SU > 53 g/kg DM if BFS > 100 g/kg DM

BFS g/kg DM= (CF\*dCF/100) + (NfE\*dNfE/100) – ST - SU

In single feedstuffs, the equation for digestible energy contains two conditional correction terms that depend on the sugar and starch content which results in 4 different cases of calculation. The digestibility coefficients depend on the feed type and have to be retrieved from the feed database.

For the following feed types, exceptions exist and alternative procedures have to be chosen:

* Mineral compounds: due to the complete lack of organic material, they do not have any energetic value and the default value for DE is zero.
* Feed additives: the DE of chemically pure substances such as organic acids and synthetic amino acids is not calculated with the equation. These feedstuffs take a fixed energy value derived from the gross energy content.
* Oil and fats: the energy value of oil and fats cannot be estimated from the crude fat content alone. For non processed oil and fats (no oil hardening), an alternative equation based on the fatty acid composition is proposed (Stoll 2009):

DEPig (MJ/kg DM = 37.788724 – 0.010444\*(ƩSFA >C12:0 <C18:0) + 0.062693\*C18:0 - 0.174496\*(ƩMUFA<>C18:1 + ƩPUFA >C18:2) + 0.136053\*(ƩSFA >C18:0) **(Eq 5)**

* Sugar beet, fodder beet and sugar beet pulp: ignore condition 2, i.e no correction for BFS
* Straw: fixed value for DE

**b) Compound feed** (all nutrients must be given as g/kg dry matter (DM))

In compound feed (mixture of several feedstuffs), the equation, which contains quadratic terms and interactions, relies on nutrient analysis alone.

DEPig (MJ/kg DM) = (**–** 16.691\*CP) + (26.992\*EE) **–** (25.291\*CF) **+** (16.085\*NfE) **–** (433.463 \*CF**2)**) **+** (73.372\*CP x EE) **+** (301.491\*CP x CF) **+** (46.321\*CP\*NfE) **(Eq 6)**

The equation is applicable only within the following range of validity:

* Crude protein (CP): 100 – 240 g/kg DM
* Fat (EE): 10 – 130 g/kg DM
* Crude fibre (CF): 10 – 80 g/kg DM

Objective and deliverables of the project

The implementation of the online calculation tool consists of several parts that are interlinked.

1. User interface: field for input parameters (chemical analysis), selection of reference feed category and feed type, selection of result type
2. Retrieval of corresponding feed data from the feed database, processing of input parameters if necessary (conversion to dry matter basis, complementation of missing parameters), calculation of the energy value
3. Result output
4. Additional functionalities:

a) formula editor

b) amino acids display if asked for

c) calculation of sample series

Input of the users mainly consists of inserting the chemical analysis of a given feed sample that either is defined as single feedstuff or compound feed. In the case of single feedstuff, the user has to select the corresponding reference feed type what determines the digestibility coefficients that have to be retrieved from the feed database. If available, the digestibility coefficients are uploaded and displayed in the result sector. The user can either directly activate the calculation button or overwrite the displayed coefficients with own values. When activating the calculation button, the displayed digestibility coefficients are inserted in the regression equation. Thereby, the above described conditional checks, restrictions and exceptions have to be taken into account as illustrated below.

Equations used to calculate the energy value of feedstuffs may change. An online formula editor helps to efficiently update any modification. A restricted access to this functionality may be useful.

User interface

input feed name selection of feed category

input chemical analysis selection of reference feed type (modify, add, remove )

DM, ash, CP, CF, EE, NfE, selection of result type

SU, ST

result display

digestibility coefficients BFS amino acids

DEpig

Formula editor

calculate

Feed data base: digestibility coefficients, additional feed data (missing parameters, amino acid profile, …) for selected reference feed type

calculation