

**Tender No. AGRI-2008-EVAL-09**

**Title: Study on modelling of feed consumption in the European Union**

---

# **Final Deliverable**

# **Executive Summary**

## ➤ Context and objectives

Livestock production constitutes one of the largest agricultural sectors in Europe. In 2007, animal feed manufacturers in the EU produced 150 Mt of industrial compound feed<sup>1</sup>. Fully 60 % of all grains produced in the EU are used in livestock feeds<sup>2</sup>.

Industrial compound feed is manufactured using a variety of raw materials that are specially selected to meet predetermined performance objectives in terms of the animals' nutritional needs<sup>3</sup>. The raw materials used come from a wide range of sources. The feed industry therefore constitutes an important market for cereals, oilseeds and protein crops in the EU. Some raw materials used in livestock feeds are obtained from by-products of the food industry. Others ingredients, of which domestic EU production is insufficient to meet these needs, are imported from third countries.

Livestock producers and feed manufacturers are constantly striving to meet the nutritional requirements of animals for the best possible cost and therefore frequently substitute some types of feed ingredients for others. The price of most of the ingredients is therefore closely related to their energy or protein content.

Given this context, the DG Agri is seeking to develop a quantitative modelling system that allows the user to estimate levels of animal demand for the raw materials (in particular cereals and oilmeals) used in both manufactured industrial feeds and on-farm feeds.

The aim of the study is to analyse feed consumption by livestock in the EU and based on this analysis, to develop a quantitative model that allows the user to estimate annual demand for animal feed concentrates in the EU as a whole, in each individual Member State and for each major livestock category. The model should also take account of raw material prices and availability levels, and will use data on livestock numbers and livestock production (meat, milk, and eggs) to carry out simulations to generate estimated demand values for past crop marketing years and forecast for current and future crop years. Tallage and CÉRÉOPA have developed the method and tools to meet these needs. Our model uses linear programming to evaluate consumption of feed concentrates in industrial animal feeds; to estimate on-farm consumption of feed concentrates, we have developed an original system that is based on the animals' energy requirements and uses linear regression.

Our modelling system, FeedMod, has been developed to allow the user to estimate the consumption of raw materials in the EU by industrial compound feeds and on-farm feeds in each EU Member State. FeedMod, developed by Tallage and Céréopa, allows the user to estimate tonnages of raw materials consumed by the livestock sector in Europe. It is not a statistical tool: it has been created with the aim of producing forecasts and historical estimates by species and by Member State. It can be used to compare different scenarios and to test out different hypotheses. It allows the user to make inter-crop year comparisons and to analyse the consequences of past evolutions. With a view to simplicity of use, FeedMod has been developed in such a way as to keep required input data to a minimum. The user should nevertheless be vigilant when inputting data. Lastly, a periodic update of FeedMod's parameters (every 4 to 5 years) is highly recommended when FeedMod is envisaged for long-term usage.

---

<sup>1</sup> <http://www.fefac.org/statistics.aspx?EntryID=268>

<sup>2</sup> FEFAC

<sup>3</sup> Séminaire « Valoriser les céréales & protéagineux en alimentation animale ». Recueil de communications. Arvalis-UNIP. Paris, septembre 2008.

## ➤ Specifications

One of the main preconditions for the modelling of raw material consumption in industrial compound feeds was the existence of industrial feed output statistics for **each category of animal**. Such statistics were only available for the cattle, pig and poultry feed sectors, and therefore only these feed categories could be studied. Industrial compound feeds for other types of livestock (sheep/goats, horses etc) have not been included in this study. They represent only 7% (or 10.2 Mt in 2007) of industrial feed production in the EU27<sup>4</sup>.

We studied thirteen “principal” **Member States** for the industrial compound feed model. Seven Member States (Germany, France, Italy, Netherlands, UK, Spain, Poland) represent more than 5 % of total industrial compound feed production in the EU 27. We have added to this list Belgium and Denmark, as their pig compound feed production is significant in the EU 27; and Ireland because its cattle compound feed production represents 5 % of the EU 27 cattle compound feed production. As it is important to cover new Member States, we decided to classify the Czech Republic, Hungary and Romania as “principal” Member States. These Member States account for 92 % of industrial compound feed production in the UE27. The remaining 14 Member States, referred to as “secondary” Member States have been linked to the “principal” Member States on the basis of information gathered during the analysis of their livestock production systems. By contrast, each EU27 Member State was studied individually for the modelling of on-farm raw material consumption.

The raw materials selected for inclusion in FeedMod are the main raw materials used in animal feeds. Raw materials of which only a small tonnage is used, or of which usage is difficult to track, have not been included. A priori, the exclusion of these raw materials could lead FeedMod to over-estimate consumption of other raw materials selected for inclusion in the model. However, a comparison of the results from FeedMod’s consumption modelling with historical supply and demand data for the products in question shows that the extent of any over-estimate is in fact extremely small. For modelling of raw material consumption in on-farm feeds, the study focuses on the main ingredients used in on-farm feeds, namely grains, oilmeals and by-products.

## ➤ Methodology

### ***Analysis of livestock production systems***

The first part of this study comprises an analysis of livestock production systems in each EU Member State. For each Member State we provide a description of:

- Breakdown of industrial compound feeds by species;
- Changes in cattle, pig and poultry numbers;
- The main characteristics of livestock farming and production, plus the parameters used in the model (choice of industrial animal feed formulas, tonnage composition coefficients for industrial compound feed in animal feed formulas).

Lastly, we created a map dividing the Member States in question into geographical zones in which are located of “virtual” feed factories in each Member State: this allows the user to model, if required, the differences between livestock production systems in each region. Based on the distinction made at the beginning of the study between “principal” and “secondary” Member States, for the section of the study on

---

<sup>4</sup> <http://www.fefac.org/statistics.aspx>

raw material consumption in industrial compound feeds, we have linked each “secondary” Member State or each animal species in a “secondary” Member State to a “virtual” factory in a “principal” Member States.

### **Forecasting model for industrial feeds**

The tool developed to model raw material consumption in industrial compound feeds is based on an application (Xpress IVE) that allows the user to write and execute a classic feed optimisation programme using linear programming. The user interface is created with Microsoft Access (FeedMod).

In order to limit the amount of time spent updating the data formulated by the DG Agri in FeedMod, we adopted a three-monthly operating cycle for the modelling and analysis of the last four crop years. We do not believe it is possible to work using longer periods of time (such as yearly or six-monthly), due to the different harvest dates of the various grain crops and the requirement for homogeneity within each period. Thus, when the DG Agri uses the model in predictive mode, the timescale for the optimisations will also be three-monthly.

The data files required for FeedMod’s usage on this three-monthly operating cycle are contained in the Microsoft Access interface in the format of database tables. The database tables are as follows: list of raw materials studied in the model, nutritional requirements of industrial compound feed formulas, composition of raw materials, minimum and maximum raw material incorporation levels, conversion coefficients, price/factory-delivered parities, calculation parameters for on-farm feed requirements.

There are three categories of input data used directly for estimate purposes: animal data (livestock numbers or production), which are used to calculate provisional tonnage values; tonnage data from FEFAC for past periods; and raw material price data. On the basis of this input data and using its archive data files and an optimisation carried out by Xpress IVE, FeedMod produces an estimated quantity for each raw material used in the production of each formula, at each “virtual” factory in each three-monthly period. These results can then be combined into different layers (species, Member State, crop marketing year...).

### **Forecasting model for on-farm feeds**

The forecast for consumption of each raw material used in on-farm feed differs substantially from the forecast for those used in industrial compound feeds. The main problem is that only a limited range of raw materials are used in on-farm feed and that this range does not necessarily change on the basis of cost price alone. Furthermore, no statistics are produced for on-farm raw material consumption, either for total consumption volumes or consumption of any individual raw material used.

Therefore to estimate raw material consumption in on-farm feeds, we have developed a two-stage method. The first stage involves calculating the total volume of feed concentrate required on-farm for all species combined; the second stage involves breaking this tonnage down between the raw materials used (grains and oilmeals) on the basis of each ingredient’s relative harvest size and/or relative consumption volume in industrial compound feeds.

For the on-farm forecasting model to work, it is necessary to input a further layer of data: known production volumes/estimates for each crop in each Member State.

## **➤ Results**

Using pre-existing production statistics and historical price data for crop years 2003/04 through 2007/08, FeedMod provided a first generation of output results giving raw material consumption levels in each of the 27 EU Member States.

For the “principal” Member States, a comparison of these results with pre-existing statistics for grain in industrial feeds and oilmeal consumption then served as the point of reference for adapting and fine-tuning the model.

For certain Member States, in which AFMs have access to a wide range of raw materials, the fact that the range of raw materials selected for inclusion in the model is limited impacted on the quality of the results produced. However, in the case of most Member States, after some fine-tuning of the model to existing reference statistics, the model is able to accurately chart raw material consumption at the EU level.

We compared the results produced using FeedMod (industrial feeds + on-farm feeds) for the EU for each raw material with the pre-existing data (for crop years 2005/06 through 2007/08), generating results for the 27 EU Member States. We observed that compared with the pre-existing data, grain consumption (industrial feeds + on-farm feeds) had been charted accurately by FeedMod (+0.6% max). In addition, we observed that FeedMod is able to accurately model inter-crop year changes in consumption, particularly in terms of the main cereals. This comparison also shows that consumption of raw materials with low incorporation rates, such as secondary cereals, is more difficult to accurately model. This is partly due to choices of methodology (for example, some raw materials are excluded from the list of ingredients in FeedMod), and partly due to the modelling system for on-farm feed, which has greater difficulty charting consumption of raw materials with low rates of usage.

UE 27 (Mt)	FeedMod results (industrial feeds+on-farm feeds)			Pre-existing data (industrial+on-farm feeds), source: Tallage/Oilworld		
	2005/06	2006/07	2007/08	2005/06	2006/07	2007/08
Raw materials/crop year						
<b>Total cereals</b>	<b>160,7</b>	<b>163,3</b>	<b>162,2</b>	<b>161,9</b>	<b>162,2</b>	<b>161,2</b>
<b>Total oilmeals</b>	<b>47,7</b>	<b>49,2</b>	<b>48,4</b>	<b>44,4</b>	<b>44,9</b>	<b>46,4</b>

Comparison between FeedMod results and pre-existing data for cereals and oilmeals

In terms of oilmeals, the results produced by FeedMod are considered satisfactory from the point of comparison with pre-existing statistics.

## ➤ Main conclusions and recommendations

On the basis of the results detailed in this document and after having used FeedMod, we have identified several important recommendations for future users of the model, to ensure good operation of the system and a good interpretation of the results.

The table of raw material prices is one of the most important database tables in FeedMod. It has a major role in the optimisation model for estimating incorporation levels of raw materials in industrial compound feeds. The user must therefore verify the accuracy of all raw material prices before inputting these as data and must input a price value for each raw material used in FeedMod for industrial feed consumption.

Maximum and minimum incorporation levels of the raw materials and upper and lower limits of nutrient requirements need not be the subject of frequent updates. Nevertheless, industrial compound feed manufacturers are continually seeking out new raw materials that could reduce the cost of the feed whilst maintaining its nutritional value. Therefore in the future, it may be necessary to integrate new raw materials into the model. The FeedMod user would therefore need to be aware of the appearance on the market of new raw materials, such as distillers grains.

In crop year 2003/04, patterns of raw material consumption in animal feeds broke with the norm: levels of raw material consumption were heavily impacted by that year’s drought, which led to a deficit of forage availability, the rationing of certain livestock categories (e.g. post-rearing and fattening), and the adoption of drastic strategies to counter the forage shortfall (such as the usage of straw and turning set-aside over to grazing pasture). Crop years of this type are highly unusual and therefore difficult to model. The user would need to be vigilant when using FeedMod if such an atypical crop year were identified in the future.

The modelling of raw material breakdown within the on-farm feed mode is based on statistical data. It would therefore be interesting, in order to improve the viability of the model, to construct an “on-farm feed” application based on a detailed analysis of actual feed formulas as used on-farm in the different regions, which would require further detailed study.

As a result of the analysis of livestock production systems, we have been able to distinguish the feed formulas used in each Member State, in addition to their nutritional characteristics, and link “secondary” Member States to “principal” Member States. This reflects the current state of livestock production systems. Changes to the Common Agricultural Policy and to economic conditions in the Member States could lead in the future to changes in these systems. A profound change to livestock production systems in one or more Member States would necessitate a new analysis in order to update the parameters used in FeedMod.