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Tables of nutritive values for farm animals in tropical and Mediterranean regions: An important asset for improving the use of local feed resources

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Abstract. The demand for livestock products has been growing steadily in emerging and developing countries, and this requires a better knowledge of available animal feeds. However, in these countries, available information is either obsolete or about temperate feedstuffs. The project "Tables of nutritive values for farm animals in tropical and Mediterranean regions" led by INRA, CIRAD and AFZ (and supported by FAO) aims to create an updated and comprehensive set of datasheets for more than 700 fodders and raw materials. The datasheets provide information on physical descriptions, feed availability and environmental impact, as well as feeding recommendations and nutritional values of local feedstuffs for the main farm animal species. The first goal of the project is to better identify and characterize local feed resources in order to improve the technical and economic performance of farms. Nutrition modelling, collaboration between research teams and identification of gaps in knowledge are part of the scientific objectives. The datasheets are created by a group of 20 scientists and engineers, who rely on a massive collection of scientific literature and experimental data to write qualitative and quantitative syntheses (via methods such as meta-analysis) and build representative and consistent tables of composition and nutritional values. The publication of the datasheets is due in 2013, first as a website (www.feedipedia.org) and later as a book.

Keywords. Feed evaluation – Tables – Farm animals – Tropical and Mediterranean areas.

Tables de la valeur nutritive des aliments pour les animaux domestiques dans les régions tropicales et méditerranéennes : Un important atout pour améliorer l'utilisation des ressources alimentaires locales

Résumé. *La demande en produits animaux augmente dans les pays émergents et en développement avec comme corollaire un besoin d'information pour les aliments locaux destinés aux animaux. Cependant, les tables d'aliments disponibles dans ces pays sont obsolètes ou issues des aliments des pays tempérés. Le projet "Tables de la valeur nutritive des aliments pour les animaux domestiques dans les régions tropicales et méditerranéennes" conduit par l'INRA, le CIRAD et l'AFZ (et soutenu par la FAO) a pour but la création d'un ensemble de 700 fiches à jour et cohérentes concernant des matières premières ou des fourrages. Les fiches donnent des informations, comme la description physique, la disponibilité et l'impact environnemental, les recommandations alimentaires et la valeur nutritive pour les principales espèces d'animaux domestiques. Ce projet a d'abord pour objectif de mieux identifier et caractériser les ressources locales afin d'augmenter les performances techniques et économiques des fermes. La modélisation, les collaborations entre les équipes de chercheurs et l'identification des trous dans la connaissance font partie des objectifs scientifiques. Les fiches sont créées par un groupe d'une vingtaine de chercheurs et ingénieurs qui se basent sur une importante masse de données issues de la littérature ou de résultats expérimentaux pour écrire les synthèses quantitatives et qualitatives (en utilisant des méthodes comme les méta-analyses) et construire des tables de composition chimique et de valeur nutritive. La publication des fiches est prévue pour 2013, d'abord sur un site web (www.feedipedia.org), puis sous forme de livre.*

Mots-clés. *Valeur nutritive – Tables – Animaux domestiques – Régions tropicales et méditerranéennes.*

I – Introduction

There is an abundance of studies concerning the nutritive value of feeds. However, these studies are often difficult to synthesize due to their dispersion, heterogeneity and to the various languages used (Morand-Fehr and Lebbie, 2004). In this context, the approach chosen for the Feedipedia project is valuable (Devendra and Leng, 2011).

II – Historical perspective

Profitable and sustainable animal production can only be achieved by the rational use of feed resources, which requires comprehensive and updated information about both the chemical composition and nutritional values of feeds and feeding recommendations. These data are usually collected in feed tables that allow farmers to formulate diets that meet animal requirements at the lowest cost. From the late 19th century up to the 1980s, spurred by breakthroughs in animal nutrition and chemistry and by the establishment of agricultural experimental stations, feed tables have accompanied the rise of animal productions, particularly in developed countries (Europe and United States). Numerous landmark books have been written. In the USA, *Feeds and feeding* was published by Henry in 1898 and revised several times by Morrison until 1956. Another important compendium was *Feeds of the World* (Schneider, 1947). In Germany, Becker and Nehring published *Handbuch der Futtermittel* in 1965. In North America, NRC published the *Atlas of nutritional data on United States and Canada feeds* in 1971. In France, INRA published *Alimentation des ruminants* (Jarrige, 1978) and other tables. Tables for non-Western countries were also published: *Latin American tables of feed composition* (McDowell *et al.*, 1974), *Nutrient composition of some Philippine feedstuffs* (Castillo and Gerpacio, 1976), *Malaysian feedingstuffs* (Devendra, 1979), *Middle East feed composition tables* (Kearl *et al.*, 1979), and the fundamental FAO book *Tropical feeds* (Göhl, 1975), which summarized one century of worldwide research. One of the latest global efforts was the CIHEAM book: *Tables of the nutritive value for ruminants of Mediterranean forages and by-products* (Tisserand and Alibes, 1991).

In the past decades, attempts at summarizing feed information at international level have been less successful. FAO's International Network of Feed Information Centres (INFIC), which provided data to some of the tables cited above, stopped its activities in the 1980s and a similar project by the European Union (ENFIC) failed to take off in 1996. Today, initiatives are mostly local: feed tables targeting specific animal production systems are published in several countries and regions, including the USA, Brazil, China, India, France, the Netherlands, Germany, Spain and Scandinavia. Their content varies: some tables are built on top of comprehensive database systems (France, Netherlands) while others are compilations of previous tables mixed with local data. Some of them are based on research reports from agricultural stations and are thus purely regional.

Local tables are highly relevant since animal production systems, including animals, feeds, agricultural practices and even some scientific concepts are generally specific to a geographical area. Still, the current situation of feed information is not fully satisfying. During the past two decades, human consumption of animal products increased in developing countries whereas global animal production was shifting from industrial to developing regions (Rae and Nayga, 2010). However, only a few countries have been able to develop national feed tables including accurate and updated feed information. Outside developed countries, and even in some developed ones, users must rely on data obtained in other agronomic conditions or use obsolete or incomplete sources. New productions (such as aquaculture) are still poorly represented in feed tables. Information about non-conventional feeds – which may be locally significant – is still relatively difficult to obtain and many of these feeds are often badly known and described in the literature. The latter point is of particular importance in emerging and developing countries where feed resources available locally are often under-utilized due to a lack of information. Moreover, feed efficiency is no longer the sole criteria of performance and

new concerns have arisen. The impact of feeding on the sustainability and environmental footprint of animal productions, its effect on the quality and safety of animal products as well as on animal health and welfare need to be taken into account in livestock farming practices. As a consequence, the global animal response has become more complex and must include new criteria besides the usual physiological and economic performance parameters. Feed tables will have to adapt their content to this rapidly evolving multi-criteria approach in animal feeding.

Paradoxically, feed information has never been so abundant. The widespread implementation of quality control in feed laboratories, notably in the private sector, generates large amounts of data. Also, feed data, which were once produced almost exclusively in Western countries (or by Western organizations established in developing countries), are now being produced massively outside Europe and North America, for the benefit of the local animal production sectors. This information, however, remains largely scattered in papers, books, reports and dissertations.

III – The Feedipedia project

The Feedipedia project results from the merging of two projects. The first one was launched by INRA, CIRAD (two French public research institutes in agriculture) and AFZ (French association for animal production, in charge of the French Feed Database). INRA and AFZ collaborated to publish in 2002 the French feed tables (Sauvant *et al.*, 2002). After this book was translated into other languages, it emerged that there was a strong interest in other countries, especially in Mediterranean and tropical regions, for a similar work that would contain information on local feeds. INRA and AFZ then collaborated with CIRAD (specialized in tropical agriculture) to start a project on international feed tables for tropical and Mediterranean regions. The second project originated from FAO and aimed at renovating the Animal Feed Resources Information System (AFRIS) website, which was the on-line version of the *Tropical feeds* book cited previously. While being an important resource for feed information, particularly for non-conventional feeds, the AFRIS website needed to be updated: the median year of publication of the papers originally reviewed for *Tropical feeds* was 1960. Moreover, AFRIS data mostly concerned ruminants, with limited information on pigs, poultry and other species. In 2009, FAO, INRA, CIRAD and AFZ agreed to collaborate for the creation of an updated version of AFRIS, named Feedipedia, using the methodology developed in 2002 by INRA and AFZ.

Feedipedia is an open access information system on animal feed resources that provides information on the nature, occurrence, chemical composition, nutritional value and safe use of more than 1,300 worldwide livestock feeds. Its main objective is to provide extension workers, planners, project formulators, feed manufacturers, farmers, science managers, policy makers, students and researchers with the latest scientific information. Two series of benefits are expected. Feedipedia should help feed users to better identify, qualify and quantify local feed resources, resulting in improved technical, economic and environmental performance in the livestock sector, better opportunities for livestock in sustainable integrated farming systems and a better use of local feeding practices with less reliance on imported feeds and techniques. In a near future, it will also be possible to include quantitative environmental data in the tables. Feedipedia should also help to promote collaboration between research teams working on tropical and Mediterranean animal feeding to identify areas of incomplete knowledge, thereby stimulating needed research. Feedipedia is on-line at www.feedipedia.org.

It is important to note that Feedipedia is not meant to replace local feeding guides when they do exist, as it would be impractical to provide detailed recommendations and nutritive values for every system where a feed may be used. Instead, the reader will find global estimates, examples provided in the literature and links to papers that may be more directly applicable to a specific production system.

Feedipedia consists of about 700 datasheets containing the following information (in English):

(i) Feed names, including vernacular and scientific names.

(ii) Description of the plants or plant parts/products used as feed.

(iii) Feeding recommendations for the main livestock species: cattle, sheep, goats, camels, poultry, pigs, rabbits, horses, fish and crustaceans.

(iv) Tables of composition and nutritive value. There may be several tables per datasheet.

(v) These tables include averages, standard deviation, minimum and maximum values and the number of observations, as well as the list of references used to build the tables.

(vi) Illustraions, including photos and process charts.

(vii) Distribution and basic agronomic information.

(viii) Forage management.

(ix) Processes for improving nutritional value.

(x) Potential concerns such as presence of anti-nutritional factors.

(xi) Environmental impact of the production and use of feeds.

(xii) The list of references used to write the texts of the datasheets.

For the users, Feedipedia will be mainly perceived as an on-line encyclopedia. However, the project leaders will be able to leverage the underlying database and methodology to create other informational products, such as regional tables or monographs.

IV – Methodology

The following methodology is used for each feed or family of feeds. Two tasks are carried out:

The first task consists in creating texts, based on a comprehensive literature search in order to identify the scientific papers, reports, literature reviews, books etc. relevant to the feed. This task is easier nowadays due the growing availability of on-line material: both historical papers and recent research can be included in the literature survey. The AFZ staff and INRA or CIRAD researchers write a summary of the literature for the parts of the datasheet that correspond to their area of expertise. Once all the contributions are collected, they are edited and corrected to create a single consistent text. An important feature of the system is that, like a regular scientific paper, the literature used is cited in the text. When the text is uploaded on the website, those inline citations become hyperlinks that go to short bibliographical notices which, in many cases, contain a link – whenever possible a Digital Object Identifier – to the original document.

The second task consists in creating the tables themselves. Data on the composition and nutritional value of the feed are taken from the literature found during the previous task and inserted in a central database. Other data come from the databases of the project leaders or of other contributing organizations. Once these data are collected and validated, representative and consistent profiles of chemical and nutritive values are established. The main difficulty is that raw feed data are rarely ideal from a statistical point of view. For instance, crude protein value are often more numerous than fibre values. Among fibre values, crude fibre measurements are still often more numerous than Van Soest analysis. Data related to energy and nutrient availability (digestibility, degradability) are much rarer than chemical values. Creating profiles from data with different number of observations may result in inconsistent tables. Moreover, due to the natural variability of the feeds (genetics, processes, environment), analytical variations, imprecision in feed naming and actual mistakes, outliers are often quite numerous. Depending on the situation, different methods are used to create the profiles. In some cases, either because there are not enough available data to create representative profiles or because the original data are already consistent with each other, it may be enough to use simple statistics. In other cases, a more or less complex statistical approach may be necessary, and the methods of meta-analysis are used for large families of feeds. Finally, equations derived from the literature or calculated from the database itself are used to predict or correct the final values.

An innovative aspect of the development of Feedipedia is its reliance on the website as a tool for collaborative writing: writers and editors can edit the site in real time.

V – Results

In October 2013, 242 datasheets have been completed and uploaded on the Feedipedia website. The remaining datasheets are under progress and marked as such (most of them are based on the AFRIS texts). The central database used to create tables contains 2.3 million raw data about 6000 feeds, which means that there is a large reserve of data for additional datasheets and tables. The literature database now contains more than 10,000 papers.

Feedipedia is an ongoing project and a number of tasks remain to be done. The main goal is to complete the datasheets, which will take at least a couple of years. The equation system that has been implemented is fully functional in some areas but certain equations are still missing and need to be established. Particularly, many non-conventional feeds produced in tropical countries contain anti-nutritional factors that make it difficult to use generic equations obtained on conventional feeds. For that reason, the equations are not yet published on the website. Some important points are also still under discussion, notably the complex issue of the energy and protein systems to be used in ruminant feeding. As a website open to the public, Feedipedia will also have to take into account the demands of its visitors, both in terms of form (interface, features) and content (feeds, nutritional parameters, animal species).

VI – Conclusion

By providing global knowledge on feed resources, including on unconventional and lesser known ones, the Feedipedia encyclopedia contributes to the development and use of innovative and appropriate feeding options.

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