PRECISION ANIMAL NUTRITION

Feeding System Module

Prof. Antonio Gallo

COURSE AIMS AND INTENDED LEARNING OUTCOMES

The aim of the course is to teach students about animal food production systems, the technologies present in feed plants, the criteria for organising a feed system, and the meaning of the professional figures involved in the production system, including quality control, supplier selection, plant management and product formulation techniques.

The different types of plants, processes (from the arrival of the raw materials, selection and storage, grinding, dosing, mixing and pelleting) and product distribution will be described in the course.

The physical raw material transformation processes, that improve the nutritional qualities of raw materials, will be described; these include pelleting, grinding, extrusion/expansion, mollassing, flaking etc.

Students will know the functions and skills necessary for the various feeding system professional roles, including those of the raw materials purchasing offices, the quality control laboratory, the formulation office, plant management, and transport logistics for the collection of raw materials and delivery of finished products.

At the end of the course, students will know the structure and functioning of a livestock feed production system; they will also be able to interface with the various figures operating within the system, plan food mixes using formulation techniques, and know the basics of logistics organisation and the functions of the commercial figures.

COURSE CONTENT

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| Topic | | ECTS |
| General section | |  |
| Description of the national feeding system and feed market in various geographical areas. Raw materials market and national and international sourcing | | 0.5 |
| Structure and organisation of the feed mill and processes | |  |
| Process analysis and plant types | | 0.5 |
| Phases of the transformation process: reception and quality control of incoming materials, non-compliance management, supplier selection | | 0.5 |
| Analysis of the dosing, grinding, mixing processes | | 0.5 |
| Flaking, extrusion/expansion, pelleting of raw materials or mixtures and the effects on the process and nutritional value | | 0.5 |
| Approach to optimised feed formulation at minimum cost and multi-formulation | 0.5 | |
| Tutorials and Visits |  | |
| Visits to feed mills and monogastric formulation exercises | 0.5 | |
| Visits to feed mills and ruminant formulation exercises | 0.5 | |

READING LIST

Cevolani D., *Gli alimenti per la vacca da latte*, Edagricole, Bologna, 2006.

Sauvant D., Perez J.M., Tran, *Tables of composition and nutritional value of feed materials*, INRA Ed., 2002

Moughan, P. J., and W. H. Hendriks. 2018. *Feed evaluation science.* Wageningen Academic Publishers, Wageningen, The Netherlands, 524 pp.

TEACHING METHOD

Frontal lectures and classroom discussions in which the key aspects of the subject are presented along with formulation application examples and the construction of an optimisation model in Excel.

Possible application seminars incorporating the direct experiences of operators in the feed and laboratory sector.

Exercises at home with the aid of materials provided by the lecturer on the Blackboard platform.

The course also includes the analysis of case studies with feed system techniques as well as visits to feed plants.

ASSESSMENT METHOD AND CRITERIA

A final oral exam which, in addition to testing the student's knowledge of the material presented in class and during technical visits and seminars, also includes the formulation of a raw material mix using software produced by the student in Excel format during the course.

The assessment will focus on the relevance of the student's answers, their appropriate use of the specific terminology, the reasoned and coherent structuring of their discourse, their ability to identify conceptual links and open questions, and their knowledge regarding how to analyse specific formulation problems.

There is a single final mark.

NOTES AND PREREQUISITES

The student must possess knowledge of animal nutrition and the raw materials used in the animal production chain.

Should the health situation relating to the Covid-19 pandemic not allow face-to-face teaching, remote teaching in synchronous or asynchronous mode will be guaranteed; this will be communicated in good time to students.

Information on office hours available on the teacher's personal page at http://docenti.unicatt.it/.

Module on Nutritional Evaluation of Foods and Dynamic Rationing Models

Prof. Antonio Gallo

COURSE AIMS AND INTENDED LEARNING OUTCOMES

The aim of the course is to provide students with a knowledge and understanding of the chemical-nutritional characteristics of animal feeds, as well as the theoretical and practical foundations for correctly evaluating animal feeds in order to formulate balanced rations in their various components so as to maximise feed use efficiency by animals in livestock production, minimise the environmental impact of farms, and guarantee animal welfare and the safety of foods of animal origin. The course will address: the main digestive and fermentative processes of the principal nutrients that occur in the gastrointestinal tract of animals; the basic concepts of empirically static and/or mechanistic models used in animal nutritional models; the basics of the modelling applied to understanding the mechanisms of nutrient digestion in the gastrointestinal tract of animals. At the end of the course, students will be able to correctly evaluate the main chemical-physical and biological characteristics of animal feeds. They will know the main methods for evaluating feeds in animal nutritional models (empirical and mechanistic, static or dynamic). Students will be able to understand the mechanisms of digestion/degradation of the main nutrients in the gastrointestinal tract of animals and formulate balanced rations that cover the needs of animals, in order to maximise their food efficiency, and safeguard their well-being and environmental sustainability.

COURSE CONTENT

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| Topic | | ECTS |
| General section | |  |
| The principal animal feeds and their main chemical-nutritional characteristics. Feed characterisation by chemical analysis. | | 0.5 |
| Collection, preparation and storage of samples; main methods of chemical, physical and biological analysis. | | 0.5 |
| Near-infrared spectroscopy (NIRS) and related technologies for estimating feed quality. | | 0.5 |
| Applied section: evaluation of fodder and by-products | |  |
| Environmental factors affecting fodder quality variation; influence of the developmental stage of the plant on the characteristics of grass; effects of conservation systems. | | 0.5 |
| Evaluation of dried and ensiled fodder (critical evaluation of the main composition parameters and indicators of fermentation status; variations due to storage compared to green fodder). | | 0.5 |
| The main usable agricultural by-products; chemical, microbiological and enzymatic means for improving nutritional value. | | 0.5 |
| Applied section: evaluation of feeds for ruminants |  | |
| evaluation of complex carbohydrates in feeds for zootechnical use; digestive dynamics of complex structural and non-structural carbohydrates and study of the main in vivo, in situ, in vitro and enzymatic evaluation methods. | 0.5 | |
| evaluation of the protein fraction in feeds for zootechnical use; protein digestion dynamics and study of the main in vivo, in situ, in vitro and enzymatic evaluation methods. | 0.5 | |
| Applied section: evaluation of feeds for monogastrics |  | |
| evaluation of starch components of feeds; starch digestion dynamics and study of the main in vivo, in vitro and enzymatic evaluation methods. | 0.5 | |
| evaluation of the protein components of feeds; protein digestion dynamics and study of the main in vivo, in vitro and enzymatic evaluation methods. | 0.5 | |
| Tutorial |  | |
| Modelling the data obtained in vivo, in situ, in vitro and enzymatically through the use of exponential and sigmoidal mathematical models. In silico simulation models of digestive processes. | 1.0 | |

READING LIST

Cevolani D., *Gli alimenti per la vacca da latte*, Edagricole, Bologna, 2006.

INRA. 2018. *INRA feeding system for ruminants*. Wageningen Academic Publishers, Wageningen, The Netherlands, 640 pp.

McDonald, P., Edwards, R., Greenhalgh, J., Morgan, C., L. A. Sinclair and R. G. Wilkinson (2014). Animal Nutrition. 7th ed. Essex: Addison Wesley Longman Limited.

NASEM, 2021. Nutrient Requirements of Dairy Cattle, Eighth Revised Edition, National Academy Press, Washington DC, 2021.

NorFor. 2011*. NorFor – The Nordic Feed Evaluation System*. 1st ed. Wageningen Academic Publishers, Wageningen, The Netherlands.

NRC, Nutrient requirements of dairy cattle, National Academy Press, Washington D.C., 2001.

NRC, Nutrient requirements of swine, National Academy Press, Washington DC, 1998.

Ronchi B., Savoini G., Trabalza Marinucci M., 2020. *Manuale di nutrizione dei ruminanti da latte. EdiSES Università S.r.l. – Naples.*

Sauvant D., Perez J.M., Tran, *Tables of composition and nutritional value of feed materials*, INRA Ed., 2002

Van Soest P., *Nutritional Ecology of the Ruminant,* Cornell University Press, Ithaca, New York, 1994.

TEACHING METHOD

Frontal lectures and classroom discussions, where key issues of the subject are presented with examples applicable to laboratory practices and the use of analytical values in the evaluation of feeds.

Possible application seminars incorporating the direct experiences of operators in the feed and laboratory sector.

Exercises at home with the aid of materials provided by the lecturer on the Blackboard platform.

The course also includes hours of classroom support in which any problems are broken down and slowly solved step by step.

ASSESSMENT METHOD AND CRITERIA

An optional interim test is scheduled on the content covered in the first part of the course. This test will be carried out in writing and in the form of multiple-choice questions. At the end of the course there will be a final oral exam, both for those students who took and passed the interim test, and for those students who didn't take or failed the interim test. An oral exam during the course of the year.

The exam is divided into two parts:

1. an optional written exam (partial test) covering the general (institutional) part of the course and comprising thirty closed-ended questions. The questions asked in the interim written test will all carry the same weight, with 0 (in the case of no answer) or 1 (in the case of an exemplary answer).

2. an oral exam at the end of the course, both for students who have taken and passed the interim test, and for students who have either not taken or failed the interim test.

The assessment will focus on the relevance of the student's answers, their appropriate use of the specific terminology, the reasoned and coherent structuring of their discourse, and their ability to identify conceptual links and open questions.

The final single mark is based 50% on the mark for the written test and 50% on that for the oral interview. In the case of those students who only take the oral exam, 100% of the assessment will be based on the oral exam.

NOTES AND PREREQUISITES

Students must possess a basic knowledge of the concepts of inorganic and organic chemistry and animal nutrition.

Should the health situation relating to the Covid-19 pandemic not allow face-to-face teaching, remote teaching in synchronous or asynchronous mode will be guaranteed; this will be communicated in good time to students.

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