

# Overview

Since 1944, the National Research Council has published six editions of *Nutrient Requirements of Dairy Cattle*. This seventh revised edition, *Nutrient Requirements of Dairy Cattle 2001*, applies new information and technology to current issues in the field of dairy cattle production. Reflecting the rapidly changing face of dairy cattle production and dairy science, it includes more comprehensive descriptions of management and environmental factors that affect nutrient requirements and provides expanded discussions of nutrient needs for various life stages and levels of production. A revised approach to predicting nutrient requirements increases the user's responsibility for accurately defining animals, diet, and management conditions to estimate nutrient requirements. A benefit associated with the increased responsibility is the ability of the user to make more-informed decisions in the field.

A substantial part of the increase in decision-making power comes from the presentation of requirements with a computer model. Computer models are the only effective means of taking animal variation into account. Unlike static tabular values, computer models such as the one provided in this edition can describe animals in different states with differing needs. A model can accommodate fluctuations caused by the effect of feed ingredients on nutrient absorption and consequently on the animal's performance potential, which affects its nutrient requirements. The model prepared in this publication was designed to provide practical, situation-specific information in a user-friendly format.

Chapter 1 presents a discussion of dry matter intake, including factors that affect intake and methods of predicting it. Characteristics of the animal's diet, environment, and physiologic makeup are considered, as are relevant management issues. After a brief description of available equations for predicting dry matter intake, the chapter discusses the dry matter intake equations included in this edition and closes with tables and graphs of intake across a lactation.

Chapter 2 addresses energy, defining energy units and expressing methods of obtaining, estimating, and expressing energy values of feeds. The chapter discusses energy requirements for maintenance, lactation, activity, and pregnancy. Tissue mobilization and repletion and the effects of environment are discussed. The chapter concludes with a section on body condition scoring, which is accompanied by a reference chart.

Chapter 3 covers digestibility and energy values of fat. It contains information on effects of fat on rumen fermentation and the use of fat in lactation diets. A table of fatty acid composition of fats and oils is presented.

A comprehensive review of carbohydrates is provided in Chapter 4. Nonstructural and structural carbohydrates are discussed, with special attention to requirements for neutral detergent fiber (NDF) and acid detergent fiber (ADF).

Chapter 5 covers all aspects of protein and amino acid nutrition. This chapter documents an extensive literature base used in the development of equations and provides detailed explanations for estimating metabolizable-protein requirements for maintenance, pregnancy, lactation, and growth. The amino acid section is a substantial advance over the previous edition and provides readers with a discussion of predicting passage to the small intestine and equations for estimating lysine and methionine requirements.

Requirements for macrominerals and trace minerals, and information on toxic minerals appear in Chapter 6. Each category includes an extensive list of minerals and covers their function, bioavailability, requirements by different classes of dairy animals, toxicity, and symptoms of mineral deficiency.

Chapter 7 covers vitamins in a similar fashion, dividing them into fat-soluble and water-soluble categories. Like the minerals in Chapter 6, the vitamins in Chapter 7 are

## 2 Overview

discussed in the context of the animals that will be ingesting them. Sources and bioavailability of vitamins are provided, followed by a discussion of the functions of each vitamin, animal response to it, requirements for it, and factors that affect the requirements.

Metabolism and requirements open the discussion of water in Chapter 8. This chapter furnishes information on factors in the environment and the water itself that affect intake. Among the factors considered are nutrients in the water and the presence of bacteria and algae.

Chapter 9 addresses important issues peculiar to dairy nutrition. It considers the feeding of the transition cow, metabolic disorders (such as udder edema and milk fever), and performance modifiers (such as buffering agents and directly fed microbials).

Chapter 10 offers information specifically on the nutrient requirements of the young calf and Chapter 11 on the heifer, and aspects of growth, maturity, and body reserves.

One of the most important features of this revision is the inclusion of a discussion on the effect of dairy cattle feeding on the environment. Chapter 12 provides an overview of nutrients of concern and applies science to the challenges faced by managers in reducing nutrient excretion.

Chapter 13 provides a discussion of feed chemistry and processing. Analytic procedures are described, and the effects of processing on energy in feed are reviewed.

Nutrient requirement tables are presented in Chapter 14. These tables were generated with the accompanying computer model. Tables are provided for small- and large-breed cows at various stages of lactation.

Chapter 15 provides a greatly expanded set of feed composition tables and an explanation of their use. The tables include nutrient breakdowns for a comprehensive list of feedstuffs commonly present in dairy cattle diets and some feeds that are less common.

Chapter 16 presents an evaluation of the computer model. Data from experiments in which 100 different diets were fed in continuous feeding trials and published in the *Journal of Dairy Science* were used in the evaluation. After the evaluation, the anatomy and use of prediction equations in the computer program are presented. An introduction to this edition's computer model is present in a user's guide.

Finally, a glossary of terms used in this edition is provided to increase readers' ease of use and comprehension.

Although the science base for predicting nutrient requirements summarized here has greatly expanded since the previous edition of this report, there are still gaps in our knowledge, particularly for specific animals of different ages and levels of production. The users of this volume are encouraged to seek a firm understanding of the principles and assumptions described here, because this understanding is essential for proper use of the tables and text and of the computer model and its output.

The estimates of nutrient requirements that are presented in this report for different classes of animals were generated as examples and are intended for use as guidelines by professionals in diet formulation. Because there are many factors that affect requirements of animals under various conditions, the values presented here cannot be considered all encompassing and should not be interpreted as accurate or applicable in all situations.