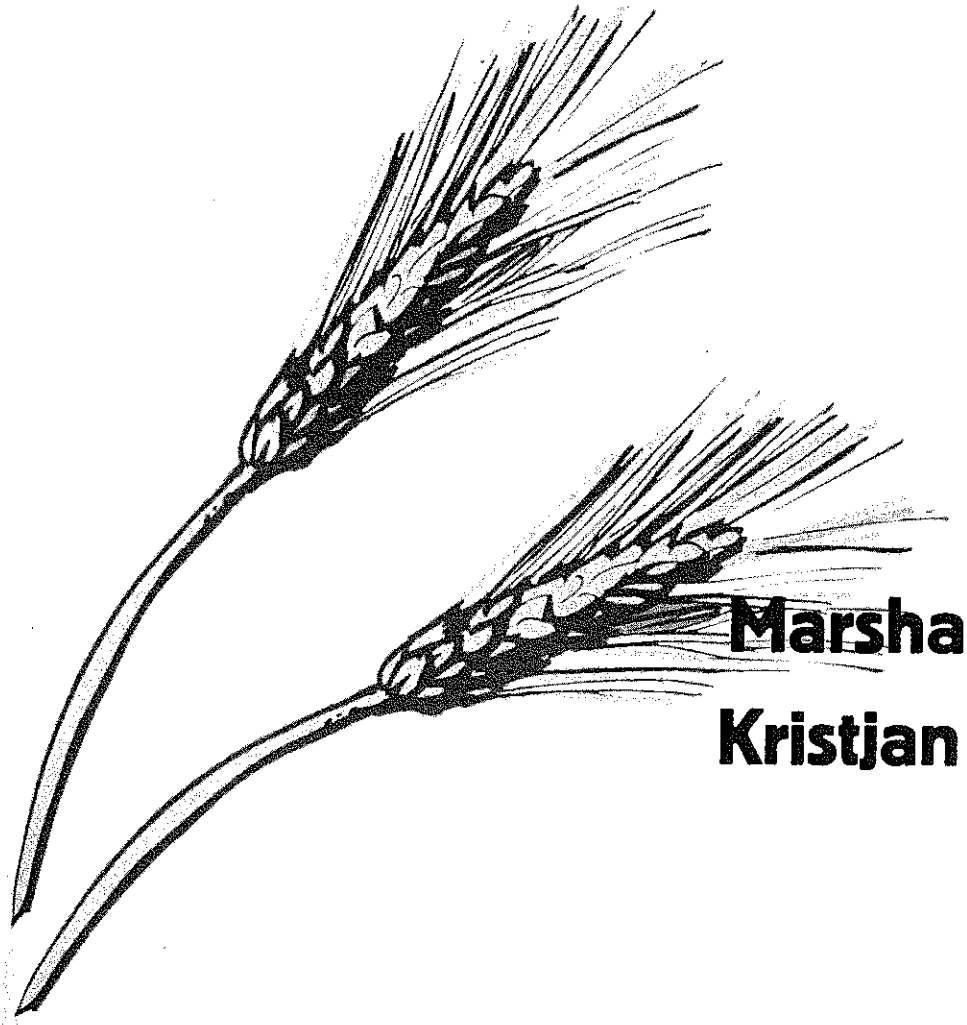
Animal Feeding and Nutrition



Tenth Edition

Marshall H. Jurgens

Kristjan Bregendahl

Iowa State University

KENDALL/HUNT PUBLISHING COMPANY

4050 Westmark Drive Dubuque, Iowa 52002

Book Team

Chairman and Chief Executive Officer Mark C. Falb
Director of National Book Program Paul B. Carty
Editorial Development Manager Georgia Botsford
Developmental Editor Tina Bower
Vice President, Production and Manufacturing Alfred C. Grisanti
Assistant Vice President, Production Services Christine E. O'Brien
Prepress Editor Angela Puls
Permissions Editor Colleen Zelinsky
Designer Jenifer Chapman
Senior Vice President, College Division Thomas W. Gantz
Managing Editor, College Field Jay Hays

ISBN 13: 978-0-7575-3176-7
ISBN 10: 0-7575-3176-8

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

the field, such as at a hay auction, it can provide valuable information quickly. As the instrumentation continues to improve, new applications, such as amino acid analysis and the detection of molds and mycotoxins, may become possible.

E. Determination of Vitamins

Because of the diversity of compounds in this class, there is no routine analysis for vitamins. However, methods are available for assaying individual vitamins. Biological assays are used for some vitamins, whereas others are determined strictly on the basis of chemical analysis.

F. Determination of Energy

The bomb calorimeter is an instrument used for determining the gross energy content of a material (solid, liquid or gas). The energy value of a given sample is determined by burning it in an atmosphere of oxygen. When the sample is burned, the heat liberated raises the temperature of water surrounding the container in which the sample is enclosed, and the temperature increase provides the basis for calculating the energy value.

The energy value is expressed in units called calories where 1 calorie is the amount of heat required to raise the temperature of 1 g water from 14.5° to 15.5° C.

G. The nutrient or energy content of a feed may be expressed as a percentage or quantity per unit of weight (mg/kg, g/lb, etc.) on one of the following bases:

1. Dry matter basis—amount contained in only the dry matter fraction, without water.
2. As-fed basis—amount contained in the feed as it would be fed to the animal, including water.
3. Air-dry basis—generally assumed to be approximately 90% dry matter. Most feeds will equilibrate to about 90% dry matter after prolonged storage (aerobic). Air-dry and as-fed basis may be the same for many common feeds.
4. Since feeds contain varying amounts of dry matter, it would be much simpler, and more accurate, if both feed composition and nutrient requirement values were on a dry matter basis.
5. Conversion of feed nutrients from an as-fed to a dry matter basis.
   a. Assume alfalfa silage analyzed 7% crude protein on an as-fed basis and contained 40% dry matter. What percent crude protein would the alfalfa silage contain when expressed on a dry matter basis?

   The solution for this example can be obtained by the following equation:

$$\frac{\%\text{ nutrient as fed basis}}{\%\text{ feed dry matter}} = \frac{\%\text{ nutrient dry matter basis}}{100\%\text{ dry matter}}$$

   Thus:

   (1) $\frac{7}{40} = \frac{X}{100}$

   (2) $40X = 700$ (values obtained by cross-multiplying)

   (3) $X = \frac{700}{40} = 17.5$

   (4) The alfalfa silage contains 17.5% crude protein on a dry matter basis.

   b. Two samples of shelled corn were sent to a laboratory for analysis of crude protein. One sample was "dry" corn and the other "high-moisture" corn. The laboratory sent back the following analysis:

"Dry" corn		"High-moisture" corn
89.0	% dry matter	75.0
8.8	% crude protein (as-fed basis)	7.4

To compare crude protein content to the two samples, calculate the composition on a dry matter basis.

(1) "Dry" corn:

(a) $\frac{8.8}{89} = \frac{X}{100}$

(b) $89X = 880$

(c) $X = \frac{880}{89} = 9.89$

(2) "High-moisture" corn

(a) $\frac{7.4}{75} = \frac{X}{100}$

(b) $75X = 740$

(c) $X = \frac{740}{75} = 9.87$

(3) Thus, the two samples of corn contain the same percent crude protein when expressed on a dry matter basis.

6. Conversion of feed nutrients from a dry matter to an as-fed basis.

a. Assume a feed nutrient composition table lists linseed meal as containing 10% crude fiber on a dry matter basis. If the linseed meal contains 91% dry matter, what is the percent crude fiber expressed on an as-fed basis? The solution for this problem can be obtained by the same equation given in the previous example.

(1) $\frac{X}{91} = \frac{10}{100}$

(2) $100X = 910$

(3) $X = \frac{910}{100} = 9.1$

(4) The linseed meal contains 9.1% crude fiber on an as-fed basis.

b. Three samples of corn silage contain the following digestible energy (dry matter basis) and % dry matter levels:

Sample	DE, kcal/kg	% dry matter
A	1230	40
B	1225	36
C	1237	33

Calculate digestible energy (DE) kcal/kg, on an as-fed basis. The same equation is followed with nutrient concentration per weight unit (kcal/kg) used rather than percent. (See Section IV for a definition of DE.)

(1) Sample A:

(a) $\frac{X}{40} = \frac{1230}{100}$

(b) $100X = 49{,}200$

(c) $X = \frac{49{,}200}{100} = 492$

(2) Sample B:

(a) $\frac{X}{36} = \frac{1225}{100}$

(b) $100X = 44{,}100$

(c) $X = \frac{44{,}100}{100} = 441$

(3) Sample C:

(a) $\frac{X}{33} = \frac{1237}{100}$

(b) $100X = 40{,}821$

(c) $X = \frac{40{,}821}{100} = 408$

(4) Digestible energy levels for the three samples on an as-fed basis:
A = 492 kcal/kg
B = 441 kcal/kg
C = 408 kcal/kg

7. Convert the weight of ration ingredients from an as-fed to a dry matter basis.
Problem: How many kilograms of ration dry matter are consumed daily if a steer is being fed the following amounts of as-fed feeds?

Corn silage	10.0 kg	(40% dry matter)
Corn grain	4.0 kg	(89% dry matter)
Supplement	0.5 kg	(92% dry matter)
Total	14.5 kg	as-fed ration

The solution is obtained with the following equation:
Parts dry matter feed = Parts as-fed feed × % Dry matter in feed (kg, lb, g etc.)
Thus:

Feed	kg, as-fed	×	% dry matter	=	kg dry matter
Corn silage	10.0	×	0.40	=	4.00
Corn grain	4.0	×	0.89	=	3.56
Supplement	0.5	×	0.92	=	0.46
Total	14.5 kg				8.02 kg

8. Convert the weight of ration ingredients from a dry matter basics to an as-fed basis.

Problem: The following concentrate mixture is being fed to yearling horses. Feeds are presented as pounds of dry matter. Calculate the pounds of asfed feeds in this diet.

Rolled oats	1045
Cracked corn	425
Soybean meal	182
Molasses (liquid)	80
Dicalcium phosphate	23
Vitamin-mineral premix	10
	1765 lb dry matter

The solution for the above example can be obtained with the following equation:
Parts (kg, lb,g etc.) as-fed feed = Parts dry matter feed ÷ % dry matter in feed
thus:

Feed	lb, dry matter	÷	% dry matter	=	lb, as-fed
Rolled oats	1045	÷	0.87	=	1201.1
Cracked corn	425	÷	0.90	=	477.5
Soybean meal	182	÷	0.91	=	200.0
Molasses (liquid)	80	÷	0.75	=	106.7
Dicalcium phosphate	23	÷	0.96	=	24.0
Vitamin-mineral premix	10	÷	1.00	=	10.0
	1765				2019.3

9. "Thumb rules" for converting to and from dry matter and as-fed
   a. When converting as-fed to dry matter
      (1) Nutrient concentration will increase.
      (2) Weight will decrease.
   b. When converting dry matter to as-fed
      (1) Nutrient concentration will decrease.
      (2) Weight will increase.

H. A chemical or proximate analysis fails to give adequate information regarding digestibility, palatability, toxicity or nutritional adequacy. Thus, further steps need to be taken to evaluate a feed.

II. Feeding Trial

A feeding trial simply gives an indication as to whether the animal will accept the feedstuff and the performance obtained from the feedstuff as compared to others. It tells nothing of why different results were obtained.