<< A2. Adjusted Crude Protein Appendix B - Predicting Minerals by&=bsp;NIR >>

A3. Estimates of Energy Availability

Scope:
The following equations are applicable for the = estimation of energy in forages for ruminants. Prediction of =nergy availability from laboratory analyses usually requires specific =quations for each type of feed. The accuracy of energy predictions is a =unction of the accuracy of laboratory analyses and the accuracy of the animal = experimentation used to develop the prediction equation. =igestibility and energy value can be measured under a variety of conditions that =nfluence the values that are obtained. Compared to cattle, sheep will =btain different digestibilities for the same feed. In addition, the =evel of feed intake of the animal has a significant effect on the =igestibility of the feed and the utilization of its energy. For dairy cows, each =evel of intake above maintenance (the amount of feed needed to maintain a nonproducing animal's weight) reduces digestibility by about 4%. =he dairy NRC assumes that lactating cows eat at 3X maintenance and reduces digestibility to 92% of that measured at maintenance.

Another major variable affecting the measurement of =igestibility is the amount of selection allowed by the animal. Given a choice, =ost animals will eat the high protein, low fiber part of the feed =leaves) and leave the high fiber part (stems). Methods used to measure =igestibility vary. Some scientists restrict the amount offered to the animal =hereby encouraging the animal to consume it all. In this case a core =ample of the feed represents what the animal consumed. However, most =cientists measure ad libitum intake and digestibility in the same trial by =ffering the animals 5 to 15% more than they consume. Because they =electively consume the feed, a core sample may not represent the feed =ctually consumed and regression equations from these trials will be =iased. Unfortunately it is difficult to uncover the exact techniques used =o develop many of the equations for predicting energy value.

Basic Principle:
Available energy and digestibility =annot be measured in the laboratory and is estimated from chemical =omposition. Most energy values are predicted from fiber analyses because fiber =s negatively related to the animal's ability to digest and use =utrients in the feed. Various groups have developed equations for predicting =nergy value and several are provided in the following tables for your consideration. Comparisons of the predictions of the various =quations are given in tables 6 and 7. National Research Council (NRC) values =re given for comparison, but it should be recognized that the source and =ccuracy of NRC values are also unknown.

Total digestible nutrients (TDN) is the sum of digestible =rotein, digestible carbohydrates and digestible fat (fat is multiplied by =.25 to adjust for its higher energy content). In general TDN is highly =orrelated with digestible dry matter (DDM) and digestible energy (DE). =stimated net energy (ENE) is a term formerly used to estimate net energy for =roduction (weight gain or milk). Net energy of lactation (NEL) is the =urrent term used by NRC for assessing the energy requirements and feed values =or lactating cows. All equations express ADF, NDF, TDN and DDM as =ercentages (1 to 100) and ENE and NEL are expressed as =cal/lb.

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Table 1. Prediction Equations from Midwest

Legume and Grass Forages
%DDM = 88.9 - (0.779 x ADF)a

Corn Silage
%TDN = 87.84 - (.70 x ADF)b

Shelled Corn
%TDN = 92.22 - (1.535 x ADF)c
NEL (Mcal/lb) = 0.905 - (0.0026 x ADF)c

Ear Corn
%TDN = 99.72 - (1.927 x ADF)c
NEL (Mcal/lb) = 1.036 - (0.0203 x ADF)c

TDN conversion to NEL
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NEL (Mcal/lb) = (TDN x .01114) - 0.054d

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a Source: Rohweder, Barnes and Jorgensen, J. Anim. Sci. 68:403
b Source: Schmidt et al., Agron. J. 68:403
c Source: Pennsylvania State
d Source: NRC, Dairy Update, 1989

Table 2. Prediction equations from Pennsylvania =tatea

Legumes
%TDN = 4.898 + (89.796 x NEL)
ENE (Mcal/100 lb) = NEL x 82.6
NEL (Mcal/lb) = 1.044 - (0.0119 x ADF)

Mixed Forages
%TDN = 4.898 + (89.796 x NEL)
ENE (Mcal/100 lb) = NEL x 82.6
NEL (Mcal/lb) = 1.0876 - (0.0127 x ADF)

Grasses
%TDN = 4.898 + (89.796 x NEL)
ENE (Mcal/100 lb) = NEL x 82.6
NEL (Mcal/lb) = 1.0876 - (0.0127 x ADF)

Corn Silage
%TDN = 31.4 + (53.1 x NEL)
ENE (Mcal/100 lb) = NEL x 82.6
NEL (Mcal/lb) = 1.044 - (0.0124 x ADF)

Sorghum, Small Grain Forages
%TDN = 4.898 + (89.796 x NEL)
ENE (Mcal/100 lb) = NEL x 82.6
NEL (Mcal/lb) = 0.7936 - (0.00344 x ADF)

Complete Rations
%TDN = 93.53 - (1.03 x ADF)
ENE (Mcal/100 lb)= 82.04 - (0.76 x ADF)
NEL (Mcal/lb) = (TDN x 0.0234) - 0.5448

Grain Mixtures (CF = crude fiber)
%CF = ADF x .80
%TDN = 81.41 - (0.60 x CF)
ENE (Mcal/100 lb) = 90.02 - (1.0532 x CF)
NEL (Mcal/lb) = (TDN x 0.0234) - 0.5448

Ear Corn
%TDN = 99.72 - (1.927 x ADF)
ENE (Mcal/100 lb) = TDN x 1.025
NEL (Mcal/lb) = 1.036 - (0.0203 x ADF)

Shelled Corn
%TDN = 92.22 - (1.535 x ADF)
ENE (Mcal/100 lb) = TDN x 1.053
NEL (Mcal/lb) = 0.950 - (0.0026 x ADF)

Small Grains
%TDN = 4.898 + (89.796 x NEL)
ENE (Mcal/100 lb) = 96.0548 - (0.8929 x ADF)
NEL (Mcal/lb) = 0.9265 - (0.00793 x ADF)

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a Source: Proceedings 41st Semiannual Meeting,
1981. Am. Feed Manufacturers Association.
Lexington, Ky. p16-17.

Table 3. Equations from Western Regiona

Alfalfa
%TDN = 82.38 - (0.7515 x ADF)
NEL (Mcal/lb) = 0.8611 - (0.00835 x ADF)

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aBath, Donald L. and Vern L. Marble. 1989. Testing Alfalfa for Its =eeding Value. Univ of CA. Cooperative Extension. Leaflet 21457. (WREP 109).

Table 5. Prediction equations from D.R. Mertens (personal =ommunication)

Legumes
%TDNm = 86.2 - (0.513 x NDF)
NEL (Mcal/lb) = 1.054 - (0.0098 x NDF)

%TDNm = 84.2 - (0.598 x ADF)
NEL (Mcal/lb) = 1.011 - (0.0113 x ADF)

Grasses
%TDNm = 105.2 - (0.667 x NDF)
NEL (Mcal/lb) = 1.297 - (0.119 x NDF)

%TDNm = 97.6 - (0.974 x ADF)
NEL (Mcal/lb) = 1.120 - (0.0159 x ADF)

Table 4. Prediction Equations from New York State

Grasses
%TDN = 34.9 + (53.1 x NEL)
ENE (Mcal/lb) = NEL x 0.826
NEL (Mcal/lb) = 1.085 - (0.0150 x ADF)

Legumes
%TDN = 29.8 + (53.1 x NEL)
ENE (Mcal/lb) = NEL x 0.826
NEL (Mcal/lb) = 1.044 - (0.0123 x ADF)

Mixed Forages
%TDN = 32.4 + (53.1 x NEL)
ENE (Mcal/lb) = NEL x 0.826
NEL (Mcal/lb) = 1.044 - (0.0131 x ADF)

Complete Feed
%TDN = 95.88 - 0.911 x ADF
ENE (Mcal/lb) = 1.0123 - (0.01432 x ADF)
NEL (Mcal/lb) = 0.866 - (0.007 x ADF)

Grain mix
%TDN = 81.41 - (0.48 x ADF)
ENE (Mcal/lb) = 0.9002 - (0.0084 x ADF)
NEL (Mcal/lb) = [(TDN x 0.0245) - 0.12] x 0.454

Ear Corn
%TDN = 99.72 - (1.927 x ADF)
ENE (Mcal/lb) = TDN x 1.025
NEL (Mcal/lb) = 0.94 - (0.008 x ADF)

Shell Corn
%TDN = 92.22 - (1.535 x ADF)
ENE (Mcal/lb) = TDN x 0.01053
NEL (Mcal/lb) = 0.94 - (0.008 x ADF)

Corn Silage
%TDN = 31.4 + (53.1 x NEL)
ENE (Mcal/lb) = NEL x 0.826
NEL (Mcal/lb) = 0.94 - (0.008 x ADF)

Table 6. Comparison of TDN prediction equation for alfalfa and =egumes.

ADF	Table 3 NRC Alfalfa %TDN	Table 1 Western Alfalfa %TDN	Table 2 Midwest Gr.&Leg %TDN	Table 4 Penn St Legume %TDN	Table 5 NY Legume %TDN	Mertens Legume %TDNm	Mertens Legume %TDN3X
27	68	62.1	67.9	69.8	67.6	68.1	62.6
29	63	60.6	66.3	67.7	66.3	66.9	61.5
31	60	59.1	64.8	65.5	65.0	65.7	60.4
33		57.6	63.2	63.4	63.7	64.5	59.3
35	58	56.1	61.6	61.2	62.4	63.3	58.2
37	55	54.6	60.1	59.1	61.1	62.1	57.1
39		53.1	58.5	57.0	59.8	60.9	56.0
41		51.6	57.0	54.8	58.5	59.7	54.9
43		50.1	55.4	52.7	57.2	58.5	53.8

Table 7. Comparison of TDN prediction equations for grasses. =

ADF	Table 1 NRC Grass %TDNa	Table 2 Midwest Gr.&Leg %TDN	Table 4 Penn St Grass %TDN	Table 5 NY Grass %TDN	Mertens Grass %TDNm	Mertens Grass %TDN3X
27		67.9	71.8	71.0	71.3	65.6
29	74	66.3	69.5	69.4	69.4	63.8
31	71	64.8	67.2	67.8	67.4	62.0
33	69	63.2	64.9	66.2	65.5	60.2
35	67	61.6	62.6	64.6	63.5	58.4
37	64	60.1	60.4	63.0	61.6	56.6
39	62	58.5	58.1	61.5	59.6	54.8
41	60	57.0	55.8	59.9	57.7	53.1
43	57	55.4	53.5	58.3	55.7	51.3

a NRC Grass is an average of bromegrass, orchardgrass and ryegrass.
NRC timothy was 7 to 8 %-units lower in TDN at each level of =DF.

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