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Knowledge of alfalfa nutritive value is essential for making informed forage management decisions in alfalfa-based livestock production systems. However, most harvest management and storage decisions are made with no chemical composition information because obtaining analytical data is time consuming and expensive. The quality of forage needed for a particular operation is influenced by the intended use of the forage and by the dietary requirements of a given class of livestock.

The detergent fiber system of forage analysis (neutral detergent fiber, NDF; and acid detergent fiber, ADF) coupled with a measure of crude protein (CP) provide vital information for balancing rations of lactating dairy cows (Van Soest, 1994; Mertens, 1983). Therefore, knowledge of the preharvest concentration of NDF, ADF, and CP in alfalfa would allow producers to harvest, store, and inventory this feed resource based on its potential value in a ration.

Standard laboratory analyses for NDF, ADF, and CP are available from various commercial laboratories throughout the region. Forage testing labs provide quality analyses using either near infrared reflectance spectroscopy (NIRS) or standard wet-chemistry techniques. Wet-chemistry methods do not provide results quickly enough to be of practical use in predicting preharvest alfalfa quality. While NIRS is faster than wet chemistry, both methods would likely be too costly to be used routinely for numerous preharvest measurements.

Predictive Equations for Alfalfa Quality (PEAQ)

Predictive equations for alfalfa quality were developed and tested in Wisconsin in the late 1980's and early 1990's (Hintz and Albrecht, 1991; Owens et al., 1995). Researchers in Wisconsin determined that NDF and ADF could be accurately determined in the field by measuring height of the tallest stem and maturity of the most mature stem in a sample area. The PEAQ method was accurate over a range of environments and locations in Wisconsin. In addition, PEAQ has been successfully evaluated in Ohio, New York, Pennsylvania, Kansas, and California.

PEAQ validation began in South Dakota in 1997. Three samples from each of five environmentally diverse locations were gathered approximately weekly from first-, second-, and third-growth alfalfa. Environmental conditions were extremely variable during the growing season ranging from very dry to quite wet depending on location. PEAQ accurately estimated fiber composition at all locations. PEAQ was most accurate on alfalfa ranging in height from 14 to 40 inches, heights typical of harvested alfalfa. Results from 1997 indicate that PEAQ could be used to estimate preharvest alfalfa fiber composition in South Dakota.

Practical application of PEAQ might include:

- Determining, in conjunction with weather forecasts, whether to harvest on a given day.
- Deciding the order in which particular fields will be harvested.
- Selecting storage locations for given alfalfa lots.
- Establishing an initial inventory of the amounts and quality of feed, thus helping a producer estimate the requirements for purchased feedstuffs.

Using PEAQ

A detailed outline of how to use PEAQ in the field is shown in Table 1. Tables 2 to 4 can be used to estimate NDF, ADF, and relative feed value (RFV) without a calculator. Otherwise, values for height of the tallest stem and maturity stage of most mature stem can be used to estimate NUF and ADF using the equations shown in Step 4 of Table 1.

Example Calculation

Step 1: Choose a representative 2-square-foot area in a field.

Step 2: The most mature stem in the same area is in the early flower stage of development. Therefore, the maturity rating is 5.

Step 3: The tallest stem is 34 inches.

Step 4: Solve the equations or use Tables 2 to 4 to determine NDF, ADF, and RFV. From Tables 2 and 3 we determine that

this area of the field contains approximately 43.4% NDF and 32.8% ADF. An RFV of approximately 137 can be determined from Table 4 using the estimated values for NDF and ADF.

Step 5: Repeat the PEAQ procedure once for each 5 to 10 acres.

If this alfalfa field were harvested the day it was tested, prime quality hay (RFV of 151 or greater) would not be produced. Furthermore, since PEAQ does not account for quality or dry matter losses that occur during harvest and storage, alfalfa should be harvested when the estimated RFV is 20 to 30% higher than that desired in the final product. Therefore, to produce prime quality hay, alfalfa should be harvested when the estimated RFV of the standing alfalfa crop is 175 to 190.

Considerations with PEAQ

The PEAQ method can be used to estimate preharvest alfalfa fiber composition for all growth cycles. Fields to be tested should be pure alfalfa stands without severe weed, disease, or insect infestations.

It is also important to remember that PEAQ estimates the quality of the standing crop and does not take into account quality losses that may occur during harvest and storage.

PEAQ estimates should not be used to balance rations. Stored alfalfa should be tested commercially to determine actual quality concentrations before feeding to livestock.

Further Resources Regarding PEAQ

Hintz, R.W. and K.A. Albrecht. 1991. Prediction of alfalfa chemical composition from maturity and plant morphology. Crop Sci. 31:1561-1565.

Mertens, D. 1983. Using neutral detergent fiber to formulate dairy rations and estimate the net energy content of forages. Proc. Cornell Nutr. Conf. for Feed Manuf. p. 60-69.

Owens, V.N., K.A. Albrecht, and R.W. Hintz. 1995. A rapid method for predicting alfalfa quality in the field. J. Prod. Ag. 8:491-495.

Van Soest, P.J. 1994. Nutritional ecology of the ruminant. 2nd ed. Cornell University Press, Ithaca, NY.

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Table 1. Step-by-step outline for using PEAQ in the field.

Step 1: Choose a representative 2-square-foot area in the field.

Step 2: Determine the maturity index number or stage of the most mature stem in that area using the following criteria:

Maturity index	Stage name	Stage description
2	Late vegetative	Stem is more than 12 inches tall, no visible buds or flowers.
3	Early bud	1 to 2 nodes with visible buds, no open flowers.
4	Late bud	More than 2 nodes with visible buds, no open flowers.
5	Early flower	1 node with at least one open flower.
6	Late flower	2 or more nodes with open flowers.

Step 3: Measure the height (in inches) of the tallest stem in the 2-square-foot area. Measure from the soil surface (at the base of the crown) to the tip of the stem (NOT the tip of the highest leaf). Note that the tallest stem may not be the most mature stem.

Step 4: Solve the PEAQ equations to estimate NDF and ADF:

NDF = 15.86 + (0.69 x HEIGHT) + (0.81 x MATURITY INDEX)

ADF = 10.78 + (0.53 x HEIGHT) + (0.79 x MATURITY INDEX)

OR

Use tables 2 to 4 to determine estimated NDF, ADF, and RFV values.

Step 5: Repeat steps 1 through 4 in five representative areas of the field. Sample more times if the field is larger than 30 acres. Calculate value for NDF, ADF, and RFV for each sample, then average all values to get one value for the field.

Note: This procedures estimates the quality of the standing alfalfa crop and does not account for changes that occur during, harvesting, wilting, and storage. These factors will raise NDF and ADF and lower RFV. PEAQ is most accurate on pure alfalfa stands that are relatively weed free and under little insect pressure.

Table 2. Estimating the NDF concentration of standing alfalfa using PEAQ.

Height of tallest stem (inches)	Stage of most mature stem				
	2 Late veg. (Stem > 12 inches no buds visible)	**3** Early bud (1 to 2 nodes with buds)	**4** Late bud (more than 2 nodes with buds)	**5** Early flower (1 node with 1 open flower)	**6** Late flower (2 or more nodes with open flower)
16	28.5	29.3	30.1	31.0	31.8
17	29.2	30.0	30.8	31.6	32.5
18	29.9	30.7	31.5	32.3	33.1
19	30.6	31.4	32.2	33.0	33.8
20	31.3	32.1	32.9	33.7	34.5
21	32.0	32.8	33.6	34.4	35.2
22	32.7	33.5	34.3	35.1	35.9
23	33.4	34.2	35.0	35.8	36.6
24	34.0	34.9	35.7	36.5	37.3
25	34.7	35.5	36.4	37.2	38.0
26	35.4	36.2	37.0	37.9	38.7
27	36.1	36.9	37.7	38.5	39.4
28	36.8	37.6	38.4	39.2	40.0
29	37.5	38.3	39.1	39.9	40.7
30	38.2	39.0	39.8	40.6	41.4
31	38.9	39.7	40.5	41.3	42.1
32	39.6	40.4	41.2	42.0	42.8
33	40.3	41.1	41.9	42.7	43.5
34	40.9	41.8	42.6	43.4	44.2
35	41.6	42.4	43.3	44.1	44.9
36	42.3	43.1	43.9	44.8	45.6
37	43.0	43.8	44.6	45.4	46.3
38	43.7	44.5	45.3	46.1	46.9
39	44.4	45.2	46.0	46.8	47.6
40	45.1	45.9	46.7	47.5	48.3

Table 3. Estimating the ADF concentration of standing alfalfa using PEAQ.

Height of tallest stem (inches)	Stage of most mature stem				
	2 Late veg. (Stem > 12 inches no buds visible)	**3** Early bud (1 to 2 nodes with buds)	**4** Late bud (more than 2 nodes with buds)	**5** Early flower (1 node with 1 open flower)	**6** Late flower (2 or more nodes with open flower)
16	20.8	21.6	22.4	23.2	24.0
17	21.4	22.2	23.0	23.7	24.5
18	21.9	22.7	23.5	24.3	25.1
19	22.4	23.2	24.0	24.8	25.6
20	23.0	23.8	24.5	25.3	26.1
21	23.5	24.3	25.1	25.9	26.7
22	24.0	24.8	25.6	26.4	27.2
23	24.6	25.3	26.1	26.9	27.7
24	25.1	25.9	26.7	27.5	28.2
25	25.6	26.4	27.2	28.0	28.8
26	26.1	26.9	27.7	28.5	29.3
27	26.7	27.5	28.3	29.0	29.8
28	27.2	28.0	28.8	29.6	30.4
29	27.7	28.5	29.3	30.1	30.9
30	28.3	29.1	29.8	30.6	31.4
31	28.8	29.6	30.4	31.2	32.0
32	29.3	30.1	30.9	31.7	32.5
33	29.9	30.6	31.4	32.2	33.0
34	30.4	31.2	32.0	32.8	33.5
35	30.9	31.7	32.5	33.3	34.1
36	31.4	32.2	33.0	33.8	34.6
37	32.0	32.8	33.6	34.3	35.1
38	32.5	33.3	34.1	34.9	35.7
39	33.0	33.8	34.6	35.4	36.2
40	33.6	34.4	35.1	35.9	36.7

Table 4. Relative feed value of standing alfalfa based on PEAQ estimates of NDF and ADF.

	NDF (%)																				
ADF (%)	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
20	227	220	213	207	201	195	189	184	179	175	171	166	162	159	155	152	148	145	142	139	136
21	225	218	211	204	198	193	187	182	178	173	169	165	161	157	153	150	147	144	141	138	135
22	223	215	209	202	196	191	185	180	176	171	167	163	159	155	152	148	145	142	139	136	134
23	220	213	206	200	194	189	183	178	174	169	165	161	157	154	150	147	144	140	138	135	132
24	218	211	204	198	192	187	181	177	172	167	163	159	155	152	148	145	142	139	136	133	131
25	215	208	202	196	190	185	179	175	170	166	161	158	154	150	147	144	140	137	135	132	129
26	213	206	200	194	188	182	177	173	168	164	160	156	152	149	145	142	139	136	133	130	128
27	210	204	197	191	186	180	175	171	166	162	158	154	150	147	143	140	137	134	132	129	126
28	208	201	195	189	184	178	173	169	164	160	156	152	149	145	142	139	136	133	130	127	125
29	206	199	193	187	181	176	171	167	162	158	154	150	147	143	140	137	134	131	129	126	123
30	203	197	190	185	179	174	169	165	160	156	152	149	145	142	139	135	133	130	127	124	122
31	201	194	188	183	177	172	167	163	159	154	151	147	143	140	137	134	131	128	125	123	120
32	198	192	186	180	175	170	165	161	157	153	149	145	142	138	135	132	129	127	124	121	119
33	196	190	184	178	173	168	163	159	155	151	147	143	140	137	134	131	128	125	122	120	118
34	194	187	181	176	171	166	161	157	153	149	145	142	138	135	132	129	126	124	121	118	116
35	191	185	179	174	169	164	159	155	151	147	143	140	137	133	130	127	125	122	119	117	115
36	189	183	177	172	167	162	157	153	149	145	142	138	135	132	129	126	123	120	118	116	113
37	186	180	175	169	164	160	155	151	147	143	140	136	133	130	127	124	121	119	116	114	112
38	184	178	172	167	162	158	153	149	145	141	138	135	131	128	125	123	120	117	115	113	110
39	181	176	170	165	160	156	151	147	143	140	136	133	130	127	124	121	118	116	113	111	109
40	179	173	168	163	158	153	149	145	141	138	134	131	128	125	122	119	117	114	112	110	107