Alfalfa-Grass Forage Quality Prediction in New York

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Abstract

Stands of first-cut pure alfalfa and alfalfa and grass mixes were sampled at two experimental sites and farmers' fields in 19 New York counties during May and June 2004 and 2005. A range of plant measurements and environmental characteristics were recorded and used to develop prediction equations for pure alfalfa and mixed alfalfa-grass stands. For pure alfalfa, equations based solely on alfalfa height were adequate - stage of maturity did not improve prediction accuracy. For stands of mixed alfalfa-grass, the most important explanatory variables were the fraction of grass and alfalfa height. Presence of grass increases the number of nodes and increases alfalfa height, however, the relationship between alfalfa height and NDF is not changed. Thus, models based on alfalfa height can be used for to estimate the alfalfa component of mixed stands. Reference photos were developed to aid in estimation of fraction grass.

Introduction

Timing of spring forage harvest is critical to obtain optimal quality for animal production. For forage that serves as the primary fiber source in the diet, neutral detergent fiber (NDF) is the principal forage quality variable of concern. A number of methods have been developed to estimate alfalfa NDF, the most widely used of these are the PEAQ equations (Hintz & Albrecht, 1991).

The situation in New York is more complex, as a high proportion of forage stands are a mixture of alfalfa and grass (see Fig. 1). Added difficulties include estimating the proportion of grass in the stand, estimating the NDF of the grass portion, and knowing how the grass portion affects the quality of the alfalfa.

The objectives of the study were i) Validate an equation for estimating alfalfa NDF in New York using only plant height, ii) Develop equations for estimating total mixed stand NDF using a combination of environmental measurements and sward characteristics, and iii) Determine a robust method of visually estimating the percentage of grass in mixed alfalfa-grass stands.

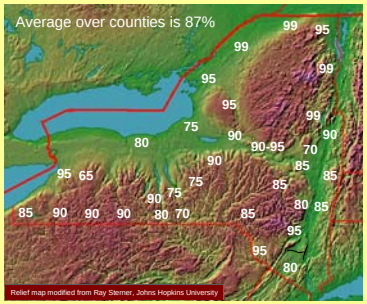

Fig. 1 Percentage of alfalfa acreage across New York State that is seeded as mixtures of alfalfa and grass (estimates from extension specialists).

Materials and Methods

Spring growth of alfalfa and grass mixed stands were sampled at two experimental sites and 150 producers' fields in 19 New York counties during May and June 2004 and 2005. Fields were identified with alfalfa height of at least 30 cm. To define a representative portion of the field or plot as the sample area, an area of approximately 1 m^2 was visually identified in 2004, and in 2005 a hoop of comparable area was used. The data collected and variable abbreviations are summarized in Table 1.

Table 1. Descriptions of variables evaluated as potential predictors of NDF content in pure alfalfa or swards of mixed alfalfa and grass.

Variable	Description
ALTD	Difference between altitudes of weather station and field (m)
ALTF	Altitude of sampling field (m)
ALTWS	Altitude of weather station (m)
GCANOPY	Height of the grass canopy in the sample area (cm)
GDD0	Accumulated growing degree days, base 0°C
GDD5	Accumulated growing degree days, base 5°C
GEST	Estimated fraction of grass in the sample area
GFRAC	Actual fraction of grass in the sample
GGRP	Grouped fraction of grass in the sample (0.2, 0.4, 0.6, 0.8)
GMAXHT	Height of the tallest grass plant in the sample area (cm)
GMAXNDX	Developmental stage of most mature grass tiller[1]
GMAXSTG	Developmental stage of most mature grass tiller in the sample area using simplified system[2]
GSPECIES	Major grass species in each sample area
JDATE	Number of days from the beginning of the year
MAXHT	Height of the tallest alfalfa stem in the sample area (cm)
MAXSTAGE	Morphological stage of development of the most mature alfalfa stem in the sample area[3]
TIME	Time of sampling (decimal hours)

[1] Determined using system of Moore and Moser, 1995.
[2] Simplified system based on Moore and Moser, 1995.
[3] Determined using system of Kalu and Fick, 1981.

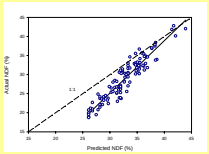

Fig. 2 Relationship between predicted and actual NDF using the PEAQ model.

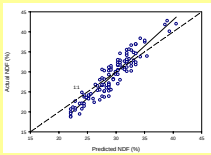

Fig. 3 Relationship between predicted and actual NDF using the NYPQ model.

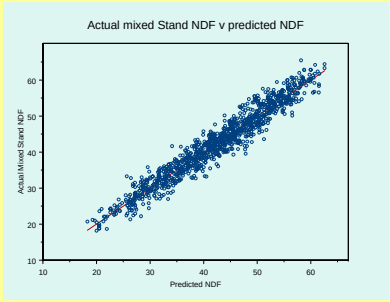

Fig. 4 Relationship between actual and predicted mixed stand NDF.

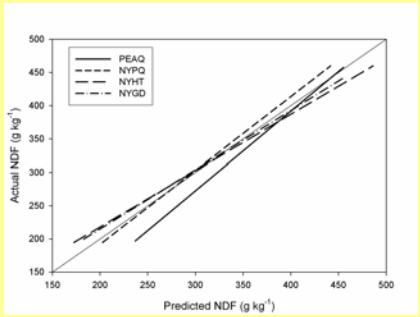

Fig. 5 Comparison of regression models used to estimate the NDF of the alfalfa component of mixed stands. NYHT and NYGD based on alfalfa height and growing degree days. NYPQ developed previously using alfalfa height.

Results and Discussion

Validation tests were applied to the PEAQ model and also to an equation derived by Cherney (1995) for NY State, referred to as NYPQ. The relationships between predicted and actual NDF for the PEAQ and NYPQ models (Fig. 2 and Fig. 3) indicate bias in both models.

The following model was developed to estimate the total NDF of mixed stands:

$$NDF = 87.1 + 3.2(MAXHT) + 313(GFRAC)$$

The model had an R^2 of 0.89 and RMSE of 29.9 g kg^{-1}. Figure 4 is a plot of actual v predicted mixed stand NDF for this equation. Table 2 is a practical tool for producers to estimate the NDF of mixed stands, based on alfalfa height and percent grass.

Fig. 4 is a comparison of using various models to estimate the alfalfa NDF of mixed stands. The PEAQ model showed the most bias, particularly at lower NDF values, likely due to the lower cutting height used to develop the PEAQ equations.

Examples of reference photos to assist producers in estimating percent grass in a mixed stand are shown in Fig. 6.

Table 2. Estimated stand NDF of a mixed alfalfa-grass stand based on alfalfa height and the percent grass in the stand. Harvest target standing NDF for each mixture is highlighted.

Max. alfalfa height, in.	%Grass in the stand (dry matter basis)								
	10	20	30	40	50	60	70	80	90
14	23.5	26.7	29.9	33.1	36.3	39.5	42.7	45.9	49.1
15	24.3	27.5	30.7	33.9	37.1	40.3	43.5	46.7	49.9
16	25.1	28.3	31.5	34.7	37.9	41.1	44.3	47.5	50.7
17	25.9	29.1	32.3	35.5	38.7	41.9	45.1	48.3	51.5
18	26.8	30.0	33.2	36.4	39.6	42.8	46.0	49.2	52.4
19	27.6	30.8	34.0	37.2	40.4	43.6	46.8	50.0	53.2
20	28.4	31.6	34.8	38.0	41.2	44.4	47.6	50.8	54.0
21	29.2	32.4	35.6	38.8	42.0	45.2	48.4	51.6	54.8
22	30.1	33.3	36.5	39.7	42.9	46.1	49.3	52.5	55.7
23	30.9	34.1	37.3	40.5	43.7	46.9	50.1	53.3	56.5
24	31.7	34.9	38.1	41.3	44.5	47.7	50.9	54.1	57.3
25	32.5	35.7	38.9	42.1	45.3	48.5	51.7	54.9	58.1
26	33.4	36.6	39.8	43.0	46.2	49.4	52.6	55.8	59.0
27	34.2	37.4	40.6	43.8	47.0	50.2	53.4	56.6	59.8
28	35.0	38.2	41.4	44.6	47.8	51.0	54.2	57.4	60.6
29	35.8	39.0	42.2	45.4	48.6	51.8	55.0	58.2	61.4
30	36.7	39.9	43.1	46.3	49.5	52.7	55.9	59.1	62.3
31	37.5	40.7	43.9	47.1	50.3	53.5	56.7	59.9	63.1
32	38.3	41.5	44.7	47.9	51.1	54.3	57.5	60.7	63.9
33	39.1	42.3	45.5	48.7	51.9	55.1	58.3	61.5	64.7
34	40.0	43.2	46.4	49.6	52.8	56.0	59.2	62.4	65.6
35	40.8	44.0	47.2	50.4	53.6	56.8	60.0	63.2	66.4

Low grass
Alf. Height: 17 in.
% Grass: 20

Medium grass
Alf. Height:18.5 in.
% Grass: 50

High grass
Alf. Height:13.5 in.
% Grass: 75

Fig. 6 Examples of reference photos to assist in estimating the percent grass in mixed stands.

Conclusions

For pure alfalfa in New York fields, prediction equations based solely on alfalfa height were the best. These equations can also be used to estimate the NDF of the alfalfa component of mixed stands. Predictive models were developed for the total NDF of mixed stands. The success of these models depends on the ability of producers to adequately assess percent grass in the stand.

References

Cherney, J.H. 1995. Spring alfalfa harvest in relation to growing degree days. p. 29-36 *In* Proc. Natl. Alfalfa Symp., 25th, Syracuse, NY. 27-28 Feb. 1995. Certified Alfalfa Seed Council, Woodland, CA.

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

Kalu, B.A., and G.W. Fick. 1981. Quantifying morphological development of alfalfa for studies of herbage quality. Crop Sci. 21:267-271.

Moore, K.J., and L.E. Moser. 1995. Quantifying Developmental Morphology of Perennial Grasses. Crop Sci. 35:37-43.

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