Predictive Equations of Forage Nutritive Value for Use Under Quebec's Environmental Conditions

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Introduction

- Predictive equations of pre-harvest forage nutritive value have been developed for pure alfalfa fields.
- These equations use simple measurements such as maximum alfalfa height to predict important variables including NDF concentration.
- Parsons et al. (2006, 2013) adapted this system to predict the pre-harvest forage nutritive value of alfalfa-grass mixtures, which are predominant in some regions including the province of Quebec.

Objectives

- Determine if equations developed in New York State (NYPEAQ) to predict pre-harvest forage nutritive value for the first growth cycle of alfalfa-grass mixtures can be used in Quebec.
- Develop and validate equations specific for Quebec that could be used to predict a large number of forage nutritive attributes for both the first and second growth cycles.

Methodology

- 2014: Establishment of alfalfa mixtures with tall fescue or timothy in different proportions (80:20; 60:40; 40:60; and 20:80) at three research sites in Quebec (Sainte-Anne-de-Bellevue, Lévis, and Normandin).
- 2015 and 2016: Collection of 1156 samples during the first and second growth cycles, with observations of alfalfa and grass morphological traits (e.g., AMAXHT, alfalfa height; AMAXSTAGE, alfalfa maximal development stage; GFRAC, grass proportion) and collection of weather data (e.g., GDD5, growing degree days). Additional collection of 353 samples and associated observations on commercial farms in twelve regions of Quebec to validate predictive equations we developed.
- Samples analyzed for aNDFom (Neutral detergent fibre concentration assayed with a α-amylase and corrected for the ash content of the fibre residue) and other nutritive value attributes using standard laboratory techniques, with results compared against values predicted using equations of Parsons et al. (2006, 2013).
- Samples from research sites were also used to develop new predictive equations for Quebec; equations were then validated using samples collected on commercial farms.
- Data analysed with SAS, PROC REG and RSQUARE being used to develop and validate predictive equations. Equations evaluated based on statistics including the coefficient of determination (R^2) between predicted and observed values and the root mean square error (RMSE).

Results

- Existing NYPEAQ equations predicted satisfactorily the spring regrowth aNDFom (Fig. 1) and acid detergent fiber (ADFom) concentrations, as well as relative feed value (RFV) and relative feed quality values of alfalfa-grass mixtures grown in Quebec. Several equations had a significant bias, primarily for high values associated with later stages of development.
- New equations developed in Quebec predicted satisfactorily aNDFom (R^2 = 0.82) and ADFom (R^2 = 0.81) concentrations (Table 1), the *in vitro* digestibility of the NDF (R^2 = 0.84) and true digestibility of the dry matter (R^2 = 0.82), as well as the RFV (R^2 = 0.80) of both the spring growth and the first summer regrowth, but not crude protein concentration.
- Validation of the new equations using samples from commercial farms demonstrated that some equations can be used across Quebec to predict aNDFom concentration (R^2 = 0.80; Fig. 2) and RFV (R^2 = 0.75; Fig. 3), but the proportion of alfalfa must be precisely determined.

Results

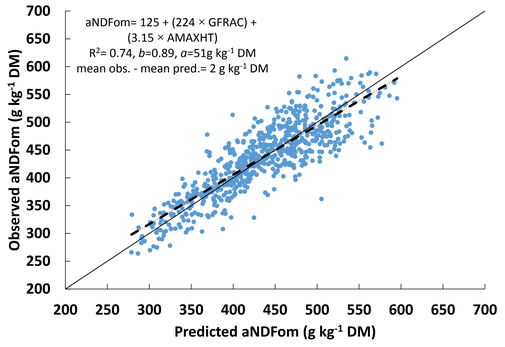

Fig. 1: Forage neutral detergent fiber (aNDFom) concentrations of first growth alfalfa-grass mixture samples predicted using an equation developed by Parsons et al. (2013) in New York State and compared to observed values. AMAXHT, alfalfa maximum height in cm; GFRAC, proportion of grass within samples based on DM weight. The solid line indicates the ideal 1:1 relationship while the dashed line represents the regression line (n=679).

Table 1. Equations created using data from three sites in Quebec, Canada of mixed alfalfa-grass samples from the first and second growth cycles to predict neutral detergent fiber (aNDFom; g kg^{-1} DM), acid detergent fibre (ADFom; g kg^{-1} DM) and relative feed value (RFV) (n= 1156).

Equations	R^2	RMSE (g kg^{-1})	Mean 95% CI
EQ1: aNDFom= 384.15 + (2.60 × AMAXHT) - (230.62 × AFRAC)	0.78	32.0	63.0
EQ2: aNDFom= 356.26 + (1.79 × AMAXHT) + (0.93 × GMAXHT) - (202.78 × AFRAC)	0.81	30.1	59.1
EQ3: aNDFom= 352.10 + (6.88 × AMAXSTAGE) + (1.34 × AMAXHT) + (1.05 × GMAXHT) - (205.23 × AFRAC)	0.82	29.3	57.6
EQ4: ADFom= 159.18 + (1.29 × AMAXHT) + (0.83 × GMAXHT)	0.77	21.2	41.7
EQ5: ADFom= 154.78 + (5.42 × AMAXSTAGE) + (0.93 × AMAXHT) + (0.93 × GMAXHT)	0.79	20.5	40.3
EQ6: ADFom= 143.60 + (0.90 × AMAXHT) + (0.77 × GMAXHT) + (22.56 × GGRP) + (0.10 × GDD5)	0.81	19.7	38.7
EQ7: RFV= 164.50 - (1.17 × AMAXHT) + (89.87 × AFRAC)	0.76	14.2	27.8
EQ8: RFV= 184.97 - (0.67 × GMAXHT) - (0.10 × GDD5) + (66.45 × AFRAC)	0.79	13.4	26.3
EQ9: RFV= 177.93 - (3.62 × AMAXSTAGE) - (0.61 × AMAXHT) - (0.44 × GMAXHT) + (77.95 × AFRAC)	0.80	12.9	25.4

R^2, coefficient of determination; RMSE, root mean square error; CI, confidence interval.
AFRAC, alfalfa fraction of sample written as a decimal; AMAXHT, alfalfa maximum height (cm); AMAXSTAGE, alfalfa maximum staged based on Kalu and Fick (1981); GDD5, growing degree days base 5°C; GGRP, grass fraction group written as a decimal; GMAXHT, grass maximum height (cm).

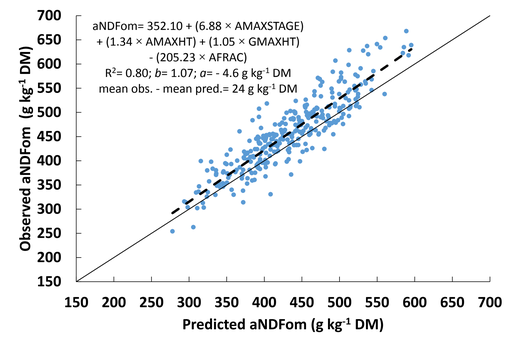

Fig. 2: Forage neutral detergent fiber (aNDFom) concentrations of alfalfa-grass mixture samples predicted using an equation developed in Quebec and compared to observed values. AFRAC, proportion of alfalfa within samples based on DM weight; AMAXHT, alfalfa maximum height in cm; AMAXSTAGE, alfalfa maximum stage of development; GMAXHT, alfalfa maximum height in cm. The solid line indicates the ideal 1:1 relationship while the dashed line represents the regression line (n= 353).

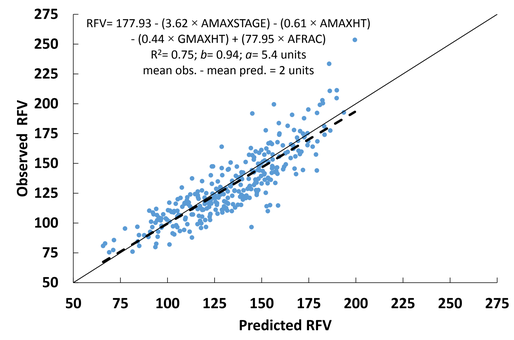

Fig. 3: Forage relative feed value (RFV) of alfalfa-grass mixture samples predicted using an equation developed in Quebec and compared to observed values. AFRAC, proportion of alfalfa within samples based on DM weight; AMAXHT, alfalfa maximum height in cm; AMAXSTAGE, alfalfa maximum stage of development; GMAXHT, alfalfa maximum height in cm. The solid line indicates the ideal 1:1 relationship while the dashed line represents the regression line (n= 353).

Conclusions

- Equations developed in New York have potential to predict the first growth cycle pre-harvest nutritive value of alfalfa-grass mixtures in Quebec.
- New equations developed locally, can be used across the province to predict aNDFom concentrations and RFV values for both the first and second growth cycles with precision. However, equations require precise determination of the alfalfa proportion for predictions to be accurate.

References

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