KANSAS STATE UNIVERSITY

ESTIMATING CRUDE PROTEIN CONCENTRATION OF SMOOTH BROMEGRASS PASTURE USING NDVI DATA

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Pasture forage quality should be considered along with forage mass (FM) to indicate adequacy for grazing livestock. Certain optical sensors provide data that are used to calculate Normalized Difference Vegetation Index (NDVI), which is related to chlorophyll content and may also indicate sward crude protein (CP). This study used seven years of bromegrass pasture data to relate NDVI and plate height to forage CP.

PROCEDURE

Plate height and NDVI data (using a Trimble GreenSeeker®), along with CP of randomly sampled forage, were collected at approximately monthly intervals during 2008 to 2014 grazing seasons and used as a calibration set. Step-wise multiple regression (SAS Institute) was performed using pasture CP as the dependent variable and plate height (an indirect measure of FM) and NDVI as independent variables to partition those effects. Regression equations were developed and used with 2015 data to test their predictive potential, with and without removal of effects due to FM differences.

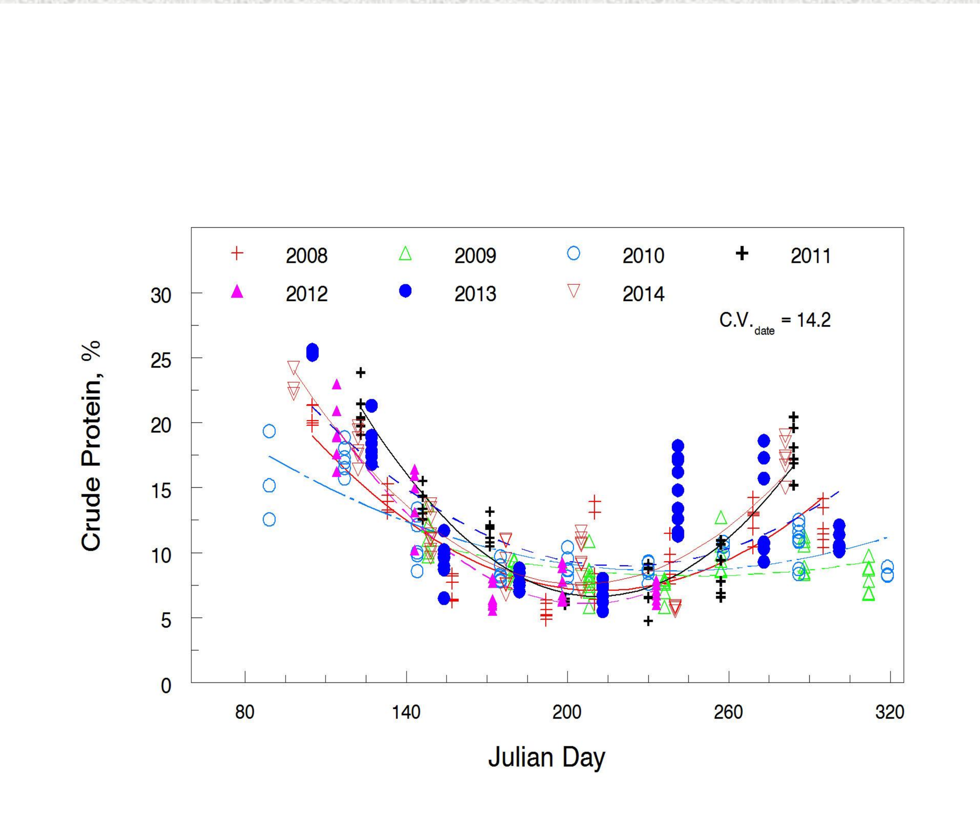

Figure 1. Forage CP sampled from pastures corresponding to time of plate height and NDVI data collection.

RESULTS

Linear and quadratic regressions with and without removing effects of FM were calculated from the seven seasons' calibration data (n=320, Fig. 1). Coefficients of determination (R^2) ranged from 0.23 for the linear equation without FM correction, to 0.40 for the quadratic equation with correction. The R^2 were not improved by separately analyzing early and late segments of the growing season, with early July (seed ripening) as the point of division.

Whatever calibration statistic is used, the predictive potential of these equations will likely be limited. This may partly be due to variability of the standards from the set of pastures within a date, resulting in a CV (coefficient of variation) of 14.2 (Fig. 1), compared with the CV of corresponding NDVI readings of 5.9.

The quadratic prediction equations with and without FM correction were used with data from the 2015 grazing season. The comparison of observed and predicted CP are shown in Fig. 2. The Pearson correlation coefficient obtained when predictions were corrected by forage FM was r=0.48, P=0.04, and when predicted without FM correction it was r=0.41, P=0.09.

The relationship of observed and expected pasture CP is shown in Fig. 3. This illustrates the similarity of results, with the primary difference being that corrected data were sometimes closer to the trend line, resulting in less scatter than was apparent with uncorrected data.

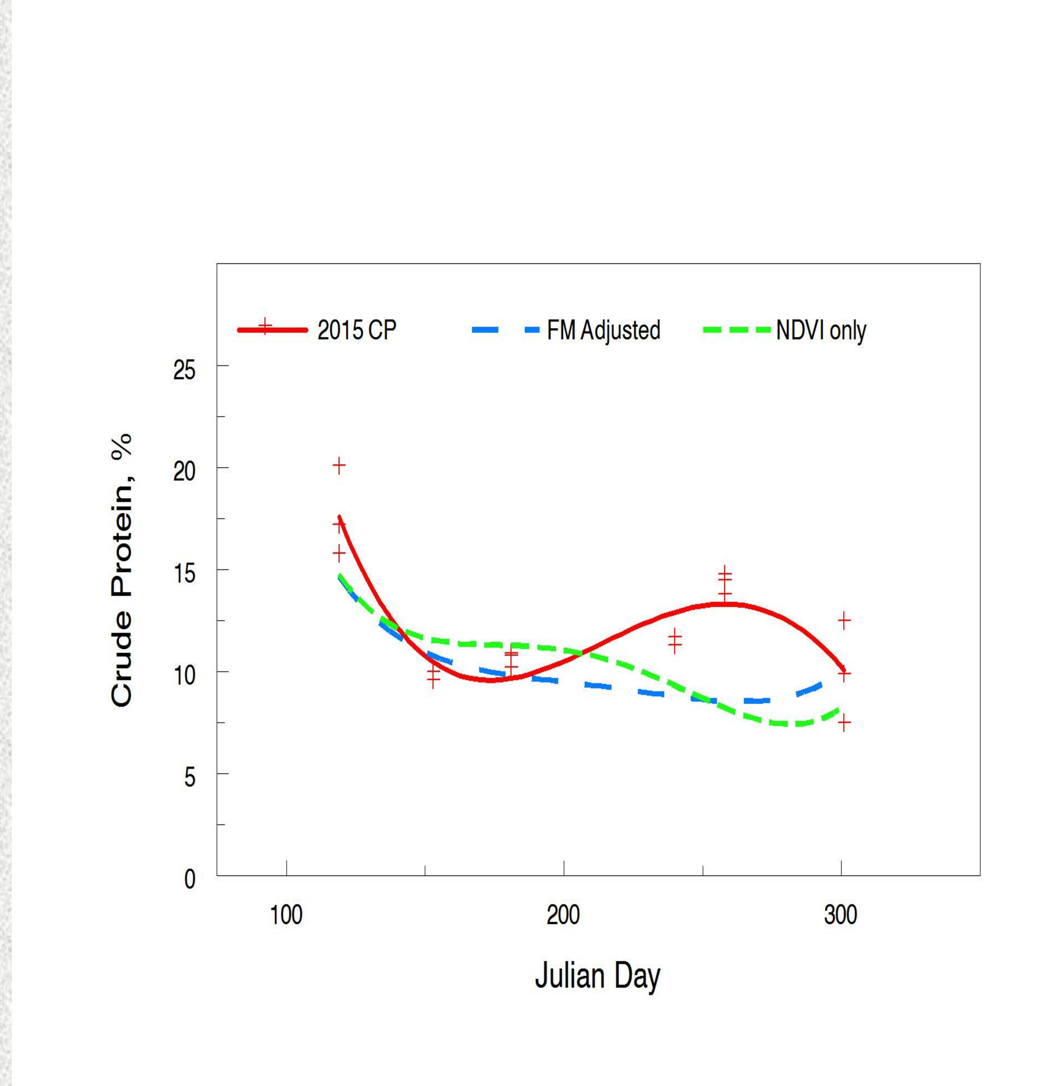

Figure 2. 2015 pasture CP, and predicted CP from equations with and without FM adjustment.

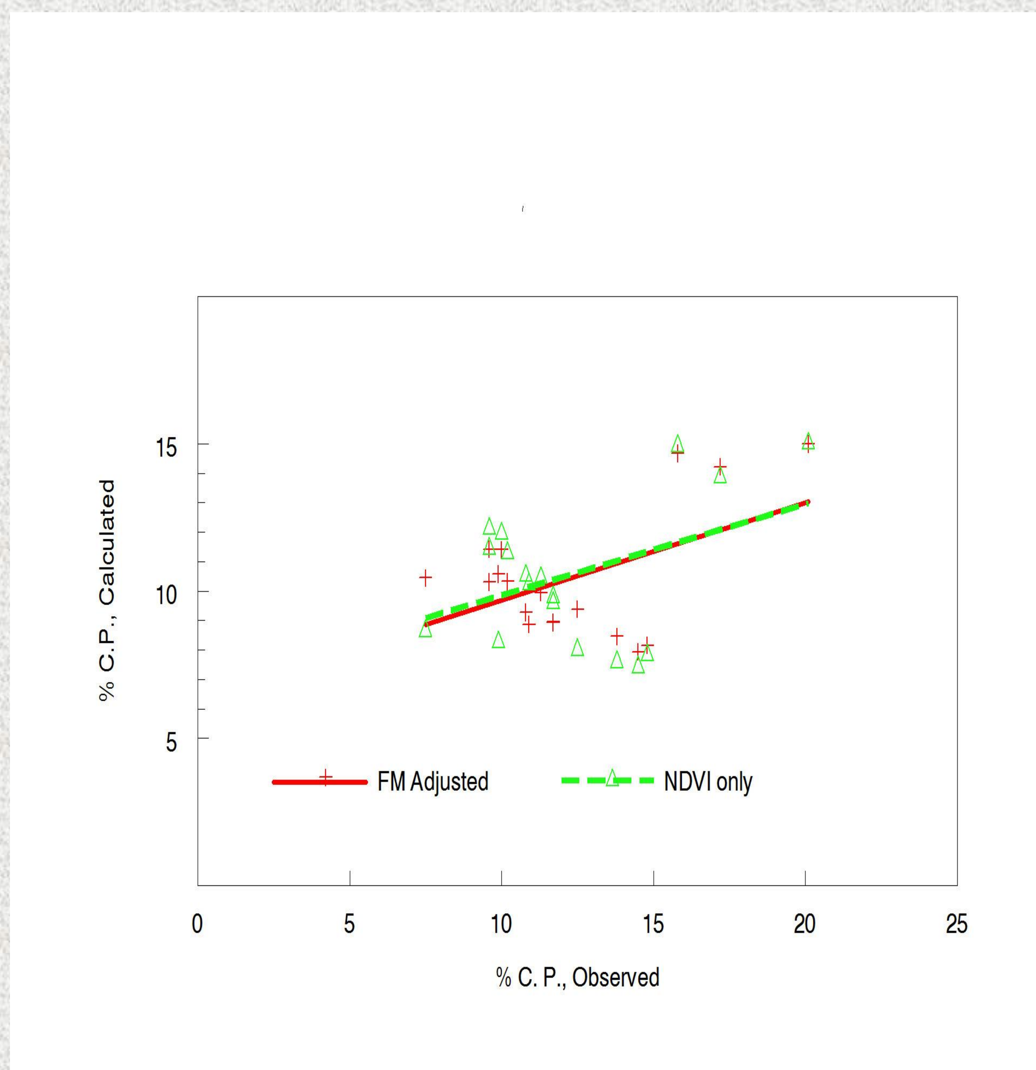

Figure 3. Relationship of sampled pasture CP and predicted CP from equations with and without FM adjustment.

SUMMARY

Seven seasons of bromegrass pasture CP data were used as a calibration set to develop predictive equations from corresponding NDVI and FM data. The best fit obtained was an R^2= 0.40. Data from an eighth season used corresponding NDVI with and without FM corrections in the developed equations to result in correlations with observed CP of r=0.48 and 0.41, significant at 5% and 10% levels, respectively. Although CP predictions were much closer to actual CP during early than the later portion of the growing season, separate analyses of the segments did not increase R^2. More intensive sampling for calibration purposes to reduce variability would likely improve the accuracy of predictive equations.