Optimizing Forage Quality of Alfalfa-Grass Mixtures

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Introduction

The ratio of alfalfa:grass is critical, as well as selection of alfalfa & grass cultivars, to optimize forage quality of mixtures. The optimum mixture for a production year stand is 20-40% grass. Knowing the grass percentage of a stand will help decide when to start treating the stand like grass, from a fertilization standpoint. It can provide info about crop rotation, and help decide the order at which fields are harvested. Variability in mixed stands reduces the accuracy of a single scissor-cut sample; methods for multiple sampling of mixed stands have the potential to be more accurate. Visual estimation of grass% in a stand is subjective.

Materials and Methods

Selection of Alfalfa and Grass:

Two studies were sown in 2015 to evaluate Hi-Gest 360 vs. a Pioneer check cultivar. Ten grasses were sown in binary combinations with both alfalfas, and included tall fescue (TF), meadow fescue (MF), orchardgrass (OG) and festulolium entries selected for potentially higher quality.

Estimation of Grass% using NIRS:

Alfalfa-grass samples were collected from spring growth and regrowth across a wide range of locations in NY in 2011, 2012, 2014, and 2015, separated, and some were ensiled. Samples were mixed in known proportions to calibrate three NIR instruments at Dairy One Forage Laboratory (n=525). 2015 samples were used for validation only.

Estimation of Grass% from photos:

Local binary patterns (LBP) were extracted from whole images and 64x64 pixel tiles, to develop regression equations for estimating grass%. Tiles were manually classified as alfalfa, grass, or unknown, and used to train the software.

Results

Alfalfa and Grass Selection:

Cold spring weather in 2016 delayed alfalfa maturation, but not grass. In late May alfalfa averaged 30% CP and 28% NDF, while grass averaged 53% NDF. Hi-Gest 360 was significantly higher in NDFD than Pioneer (5% higher). BARfPf32 MF (Hidden Valley) was similar to festulolium in NDFD (84 vs. 85%). As grass% increases, NDFD of mixtures increases, while CP decreases. Grass CP is a function of grass% in mixtures (Fig. 1). Perseus festulolium overwhelmed alfalfa.

NIRS estimation of Grass%:

Grass composition was predicted with good precision and accuracy showing biases of 2.49 and standard errors of prediction (SEP) of 5.06, with R^2 of 0.972, using the equation developed across multiple instruments (Fig. 2).

Photo estimation of Grass%:

Predictive accuracy in whole image models was highest for models generated from LBP tile histogram bin means (R^2_{pred}=0.85) (Fig. 3).

Conclusions

➢ Meadow fescue provides a combination of high quality and moderate grass% in mixtures. Environment has a major impact on the alfalfa-grass ratio.

➢ With selection of a robust set of calibration samples over many environments, NIRS can be used to determine the botanical composition of fresh-dried or ensiled-dried alfalfa-grass samples, and replicate scans from multiple instruments can be combined to develop a single calibration that will perform with equal efficiency across different instruments.

➢ Local binary patterns are effective in differentiating alfalfa and grass under field conditions, because the method is robust to changes in color and illumination.

Fig. 1. Grass CP vs. Grass%

Alfalfa-Grass, two sites, spring harvest, 2016
4 Grass species, 10 cultivars

10%units of grass = drop of 1%unit CP

r = 0.79

Grass CP, %

Grass, % (separated quadrat sample)

Fig. 2. NIRS Grass% Validation

Grass% is currently offered as a service from Dairy One Cooperative.

Real grass %

Validation
y = 1.09x - 1.28
R^2 = 0.97
n = 98

NIR estimate

Fig. 3. Tiles from original images were sorted to bins for analysis.

References

- Karayilanli et al. 2016. Prediction of botanical composition of alfalfa-grass mixtures using NIRS. Crop Sci. ("First Look")
- McRoberts et al. 2016. Application of local binary patterns in digital images to estimate botanical composition in mixed alfalfa-grass fields. Computer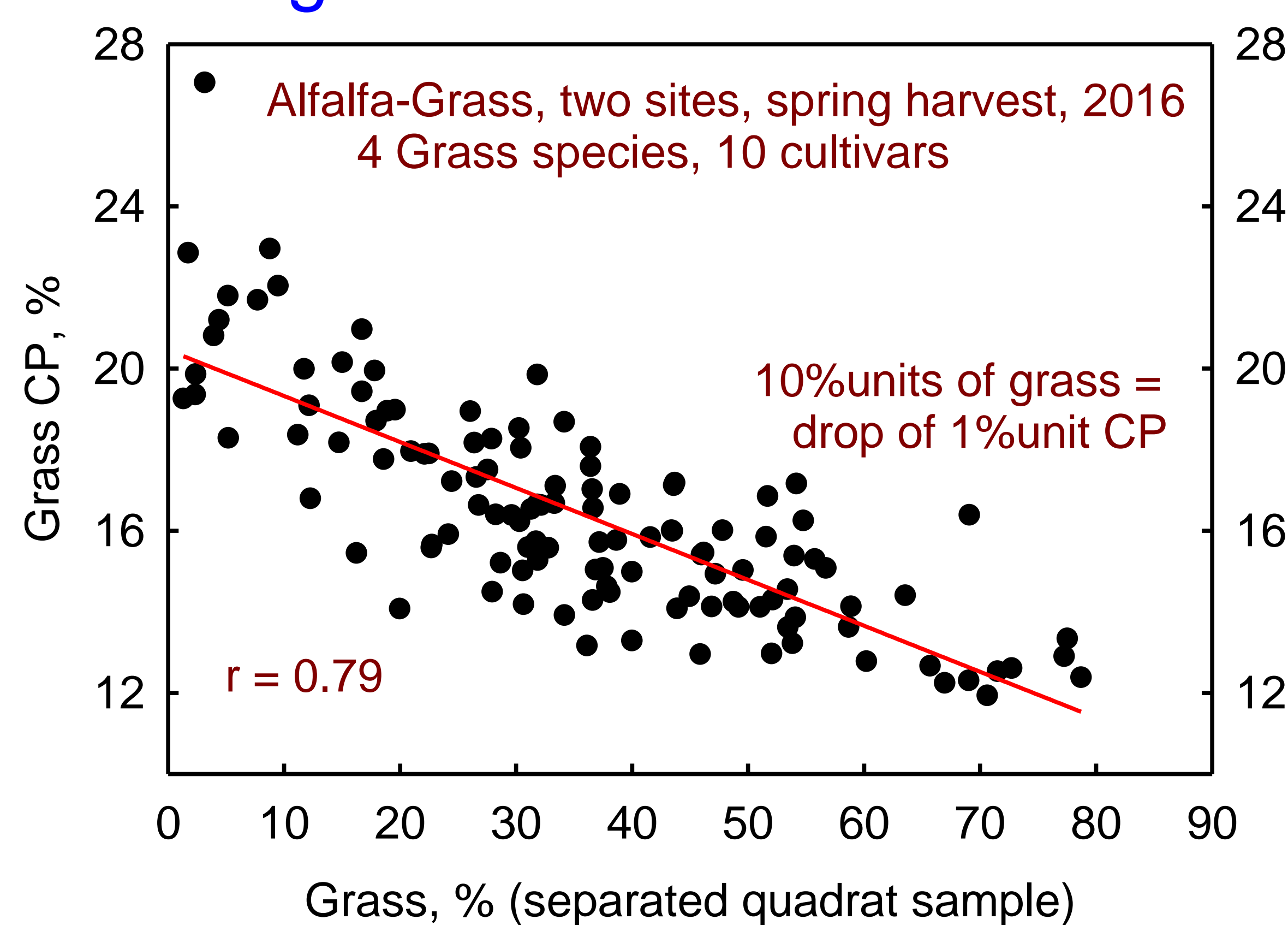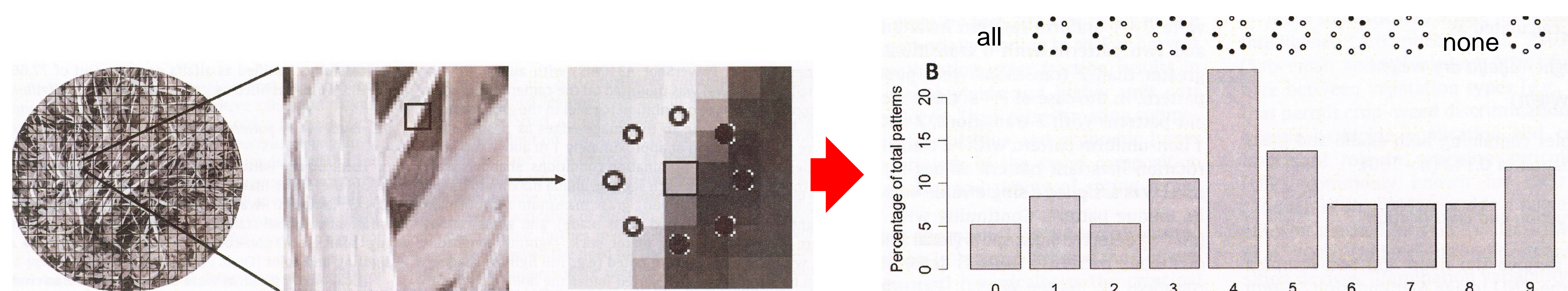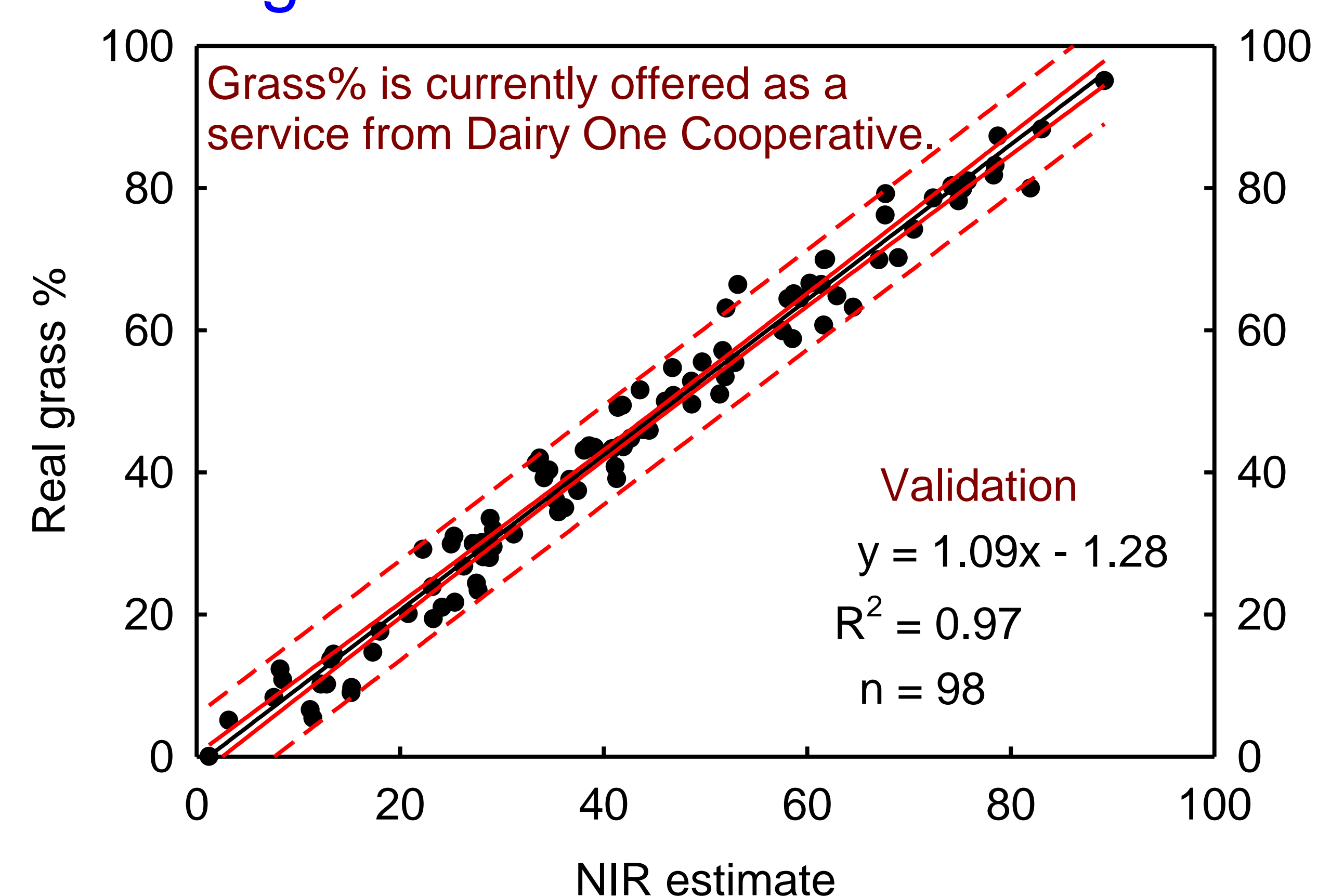s and Electronics in Agric. 123:95-103.