Northern NY Agricultural Development Program
2015 Project Report

Evaluation of Alfalfa-Grass for Maximizing Economic Return in NNY

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Background:
Mixed stands are the norm for dairy farms in New York State and other parts of the Northeastern U.S. As mixed stands increase in grass percentage (%), the level of management typically declines, and so does fiber digestibility. Dairy researchers are convinced that relatively high fiber digestibility is essential for high milk production, making harvest management decisions for spring forage harvests critical, given the small range in optimal fiber content (NDF) to make silage for lactating dairy cows.

Fiber digestibility declines over one percentage unit per day in spring growth, and spring harvest accounts for about 50% of the total yield used as forage for lactating cows. Each one percentage unit decline in fiber digestibility decreases milk production by 0.5 to over 1 lb per cow per day.

To optimize harvest management, and achieve desired nutrient reductions and increased efficiencies in perennial forage stands, it is essential to know the alfalfa percentage in a mixed alfalfa-grass stand. Both pre- and post-harvest estimates of alfalfa % are useful for the following reasons:

1) Alfalfa % information is required to identify the optimum quality harvest date (pre-harvest estimate).
2) Allow ranking the harvest order of fields, based on alfalfa% (pre-harvest estimate).

3) Help decide when to start treating a stand like a grass from a fertility standpoint (pre- and post-harvest estimates).
4) Provides information to assist in the decision as to when to rotate a field (pre- and post-harvest estimates).
5) Allow ranking the harvest order of fields the following spring, based on alfalfa % (post-harvest estimate).
6) Assessment of stand deterioration due to ASB damage (pre- and post-harvest estimates).
7) Allows estimation of alfalfa nitrogen fixation for nutrient management purposes.
8) Nutrient management recordkeeping: some spreadsheets require input of the alfalfa % of mixtures (post-harvest estimate).
9) Allows calculation of milk yield in programs such as the Wis. Milk2006 spreadsheet for alfalfa-grass, which requires grass % data (post-harvest estimate).
10) Knowing the alfalfa percent in a silage sample may help with ration balancing (post-harvest estimate).

Additionally:

- Having an accurate record of alfalfa-grass composition over the life of a stand provides useful information when deciding whether to keep or rotate the stand.
- Knowing the alfalfa-grass composition of all fields helps a producer sort and rank fields for time of harvest.
- From an alfalfa snout beetle (ASB) standpoint, having a record of alfalfa % in a given field over time will document the decline in alfalfa due to ASB feeding and stand age. It can be difficult to visually estimate the decline in alfalfa % in a mixed stand over years, and can result in an underestimation of the impact of ASB on the stand.

Pre-Harvest Estimation of Alfalfa-Grass:
Accurate prediction equations exist for estimating nutritive value and timing of spring alfalfa-grass harvest. The weak link is estimating the alfalfa fraction in the sward, which is very difficult to estimate by visual observation alone.

An innovative interdisciplinary approach that combines forage science and computer science has been applied to develop a useful user-friendly application called AGES (Alfalfa-Grass Evaluation System) to assess mixed-stand composition from digital images and generate optimal timing estimates for spring forage harvests. This system can contribute to improving the sustainability of quality forage production on northern NY dairies by reducing uncertainty in spring forage harvests. It can also improve productivity by reducing purchased forage costs and ultimately increasing dairy farm net incomes.

Post-Harvest Estimation of Alfalfa-Grass:
Commercial labs have not shown interest in generating an accurate NIRS (Near-Infrared Spectroscopy) prediction equation for alfalfa % in a mixture until recently. Dairy One< Ithaca, NY, is currently generating a prediction equation to determine alfalfa % in mixed

alfalfa-grass samples in northern NY, using samples collected in all six NNY counties (Clinton, Essex, Franklin, Jefferson, Lewis, St. Lawrence) in 2014. Samples were collected in the spring, summer and fall, alfalfa and grass were hand-separated, and most of these samples were ensiled using vacuum-sealed bags. More than 500 mixed samples of known species composition for fresh and ensiled alfalfa-grass were submitted to Dairy One for NIRS calibration.

By calibrating an NIRS prediction equation for both fresh forage and ensiled forage, the prediction will work for fresh forage, hay, and ensiled forage. Ensiled forage may provide a more representative sample of the field, as the forage has been chopped and mixed prior to sampling.

Methods:

Dairy One decided that an independent set of samples needed to be collected to validate the grass % calibration that they developed in 2014. One hundred (100) samples were collected across northern NY in 2015, including a few samples from western and central NY, for the purpose of validating the Dairy One NIRS grass % calibration. Mixed alfalfa-grass samples, all collected from farmer's fields, were hand-separated, dried, and mixed back together in known proportions to test the calibration. Three different NIRS instruments were calibrated for grass %.

Samples collected in 2014 to further refine AGES resulted in considerable adjustment of the software for estimating grass % in standing alfalfa-grass, so it was decided that more samples needed to be collected in 2015 to improve estimates. One hundred ninety-nine (199) samples were collected in 2015 to refine the software. Pictures were taken of a defined area, then the area was clipped and samples were separated and dried to determine actual grass %.

Results:

Validation of Dairy One's NIRS calibration to determine grass % of alfalfa-grass mixtures was successful, and Dairy One has become the first commercial forage testing lab to offer this service to farmers (Figure 1, Tables 1 and 2).

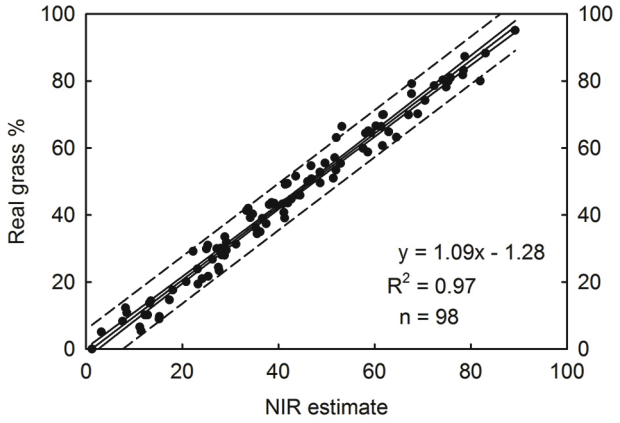

Figure 1. Relationship between real grass % of mixtures and NIR estimates for calibration samples.

Table 1. Calibration statistics for predicting the percentage of grass in alfalfa-grass mixtures.

Instrument	N[1]	mean	SD[2]	SEC[3]	R^2	SECV[4]	1-VR[5]	n T[6]
6500	1,480	54.28	35.39	2.35	0.996	3.00	0.993	16
XDSa + XDSb	2,943	54.19	35.41	2.67	0.994	2.88	0.993	16
6500 + XDSa + XDSb	4,423	54.22	35.40	2.77	0.994	3.19	0.992	16

[1] n = number of spectra used. Calibration software eliminated two samples from the 6500 calibration and one sample from the XDSa and XDSb calibrations as outliers.
[2] Standard deviation.
[3] Standard error of calibration.
[4] Standard error of cross validation.
[5] Coefficient of determination of cross validation.
[6] Number of terms used for modified partial least squares regression.

Table 2. Validation statistics for predicting the percentage of grass in alfalfa-grass mixtures.

						Reference	Predicted	
Instrument	n	SEP[1]	Bias	SEPC[2]	Slope	SD	SD	R^2
6500	98	5.35	2.33	4.51	1.10	23.28	20.84	0.971
XDSa + XDSb	196[c]	4.68	2.13	4.18	1.08	23.22	21.30	0.972
6500 + XDSa + XDSb	294	5.03	2.63	4.30	1.09	23.20	21.06	0.972

[1] Standard error of performance.
[2] Standard error of performance, corrected for mean bias.

Dairy One determined that replicate scans from multiple NIRS instruments can be combined to develop a single calibration that will perform with equal efficiency across instrumentation. This has the potential to allow other commercial laboratories the ability to determine grass % using this calibration.

This service:

- provides northern NY farmers with information to help them decide when to start treating fields like a grass stand, from a fertility standpoint,
- provides information to assist in the decision as to when to rotate a field,
- helps with the assessment of stand deterioration due to ASB damage, and
- allows for nitrogen fixation estimates, to help with nutrient management calculations.

2015 samples were combined with previous years to refine the predictive ability of the AGES artificial intelligence software program. Both the growing season (year) and the grass species present have some impact on the ability of the software to accurately estimate grass %. A web-based phone app was developed that will work on any cell phone (iPhone or Android), and will undergo testing in the spring of 2016. The user can take a photo of an alfalfa-grass stand and the photo is automatically inserted into the software program for evaluating grass %. If maximum alfalfa height is entered into the program, it will provide a grass estimate, a mixed stand NDF estimate, and an estimated optimum harvest time. Multiple photos from a field can be accumulated, generating a running average for all the parameters provided.

Conclusions/Outcomes/Impacts:

Evaluating legume content of alfalfa-grass mixtures is useful for quantifying forage and diet quality, as well as for estimating nitrogen fixation for nutrient management purposes. NIRS grass % estimates from Dairy One work equally well with fresh and ensiled samples, and all predictions were reasonable estimations of actual grass %.

Any samples submitted to Dairy One by producers from northern NY in 2016 will receive a grass % estimate along with the rest of the analysis. Any farmer outside of northern NY can receive a grass % estimate for mixed alfalfa-grass samples for a $5 fee.

The AGES cell phone app will allow farmers and consultants to get a quick and accurate estimate of grass % and NDF in mixed alfalfa-grass stands.

Since each one percentage unit increase in fiber digestibility can increase milk production by 0.5 to over 1.0 lb per cow per day, if the AGES optimum harvest date is 5 days earlier than originally planned for a harvest, this can result in up to an additional 5 lbs milk/cow/day. For 500 milking cows, that is an additional 2500 lbs milk/day.

Outreach:

King's AgriSeeds Forage Conferences, 1/26/16 in Malone, NY, and 1/26/16 in Lowville, NY, and 2/3/16 at NNY Crop Congress, Watertown, NY.

Next Steps:

The AGES estimation system will be tested in 2016 and modified as necessary so that it becomes a farmer-friendly tool that can be used by anyone with a smart phone.

Reports and/or articles in which results of this project have been published.

- Cherney, D.J. and J.H. Cherney. 2015. Alfalfa-Grass Nutritional Considerations: Pros & Cons. Progressive Dairyman, Issue 16 (Oct.):111-112.
- Cherney, J.H., and D.J. Cherney. 2015. Alfalfa-Grass Agronomy: More Pros than Cons. Progressive Forage Grower, Issue 8 (Sept.):21-23.

- Karayilanli, E., J.H. Cherney, P. Sirois, D. Kubinec, and D.J.R. Cherney. 2016. Prediction of botanical composition of alfalfa-grass mixtures using near infrared reflectance spectroscopy (NIRS): Developing a robust calibration. Crop Science (submitted).

For More Information:

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