Precision Agriculture Tools for Optimizing Alfalfa Production & Marketing

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In a changing world, management of alfalfa and other forages will increasingly rely on high-tech, big-data, and precision agricultural technologies. While these methodologies are developing at a staggering pace, application to alfalfa production has generally lagged other field crops. Our project funded by NIFA-ASAFS assesses two aspects of these emerging technologies in relation to alfalfa: 1) effective use of hand-held and small farm-scale benchtop units to estimate postharvest forage nutritive value, and 2) development of new landscape-scale remote sensing technologies for pre-harvest estimation of alfalfa yield and quality.

As part of the second objective, we collected spectral measurements from second and third cuttings of replicated (n=4) variety test plots of alfalfa (10 varieties), orchardgrass (4 varieties), tall fescue (4 varieties), and festulolium (2 varieties) using ASD FieldSpec 4 Hi-Res Spectroradiometer (350-2500 nm) with common plant measurement accessories and a 10″×10″ Spectralon panel. Variety test plots were used to provide an opportunity to capture spectra from multiple genotypes within each species. This should reduce the uncertainty level associated with data collection, making the remote-sensing-based predictive models more robust. In addition to spectra, we collected ancillary data from each plot, including same-day forage yield and nutritive quality data. Forage yield was determined using standard procedures for public forage variety testing. Samples for nutritive quality were hand-clipped from plots immediately before harvest, dried at 55 C, and analyzed using near-infrared reflectance spectroscopy (Foss Model DS2500, Eden Prairie, MN) with prediction equations from the NIRS Consortium (NIRSC, Berea, KY). Results for CP, aNDF, ADF, lignin, NDFD48, IVTD48, ash, and fat are included. Other ancillary data include overhead photographs taken 60 cm above the canopy with quantification of green pixel cover (Canopeo), plant height, photosynthetically active radiation flux above and below the canopy, volumetric soil water content at harvest, and plant maturity stage.

To house these spectra and ancillary data, we created and populated a publicly available Forage Spectral Library (https://dsiweb.cse.msu.edu/fsd/). The Forage Spectral Library is comprised of four major functions, including the forage spectral viewer, the ancillary dataset search, the compare spectral graph tool, and an upload data function. The forage spectral viewer allows users to graph a spectral library associated with certain plant species, varieties, and locations. Further analysis can be performed under the ancillary dataset search function in which the full dataset can be queried using different combinations of ancillary variables. The next function (the compare spectral graph tool) allows users to compare several spectral plots while comparing their associated ancillary data. Finally, through the upload data function, a new set of spectral information can be added to the library along with their associated ancillary data. As the project continues, we plan to use our Spectral Library data along with new measurements on pure and mixed alfalfa/grass plots to develop unmixing equations that will allow prediction of the proportion of species, yield, and nutritive value from the spectra of standing forage. Such equations could ultimately be used with drone-mounted sensors to help inform forage harvest timing decisions.