Silage content analysis with NIRONE™ Scanner

Introduction

As smart farming and digitalization are making their way to livestock farms, spectral sensors are becoming more and more important in increasing the productivity of farms and the welfare of animals. Spectral sensors and IoT bring a variety of possibilities to farming, from improving the quality of produced milk to soil analysis and fertilization optimization.

In dairy and beef production farms the quality of silage plays an important role and is essential to animal wellbeing and productivity. Many nutritional parameters contribute to the overall silage and feed quality. Two parameters that have a high impact on the quality are dry matter- and crude protein contents.

The dry matter content is the proportion of fibers, proteins, carbohydrates, etc. after the water has been removed; generally, the higher the dry matter the better. However, if the dry matter is too high, heat damage can occur, and mold may start to grow. Usually, dry matter varies between 250-400 g/kg in silages.

Proteins are molecules that consist of long strands of amino acids containing a high amount of nitrogen. Protein is an essential part of the ruminal diet and optimized levels enhance fertility and productivity of livestock, especially for milking cows in dairy farms. However, too much protein may lead to health problems. Protein in forage and silage is generally reported as crude protein value, which is calculated as 6.25 times the nitrogen content. The crude protein content varies between 100-200 g/kg in typical silages.

Many farms prepare feed using TMR (Total Mixed Ration) method, where feeds are combined into a single mix that has a specific optimized nutrient content. The advantages are that cows will always eat nutrient balanced ration, lowers the risk of digestive upset, and gives rumen microorganisms a uniform supply of carbohydrates and proteins throughout the day. It is estimated that feeding correctly balanced TMR can increase milk production 1 to 2.5 kg per cow daily.

For TMR calculators to work correctly, the silage dry matter and protein content must be given as input to the program. Currently, farmers routinely send samples of their silage for analysis in central laboratories. The laboratory analysis introduces notable recurring costs and by the time the results arrive the information may be too late to be useful.

Gathering data via smart sensors to a cloud and analyzing it helps reaching the full potential of farming operations, and the small size of the sensors together with their high sensitivity make them a good fit for practical on farm use.

The benefits of Spectral Engines' solutions are:

· Fast and accurate measurements in the field
· Real-time measurement data realized with compact spectral sensors
· No sample preparation
· Affordability, portability and connectivity enables online analytics
· Easy-to-use mobile app
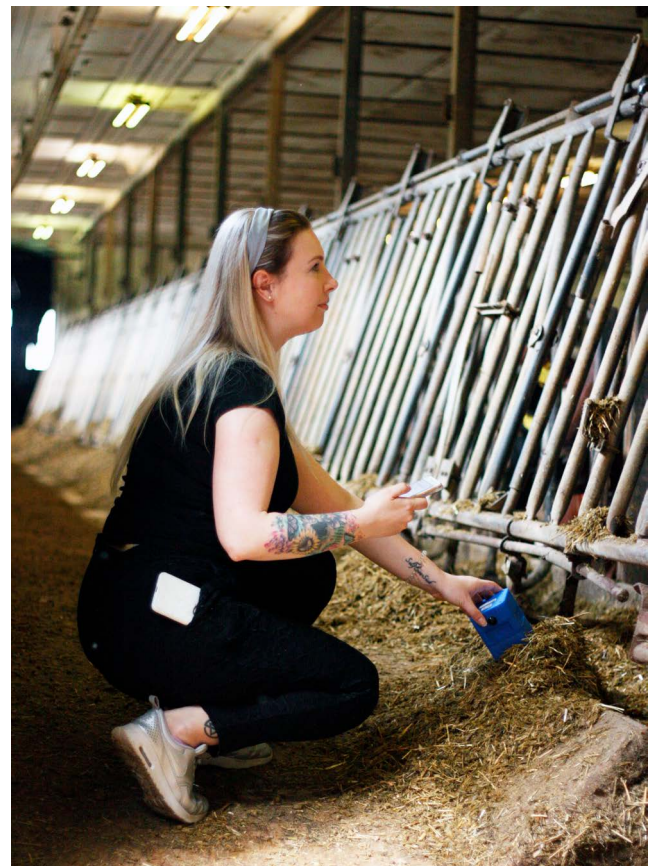
We investigated the feasibility to obtain results from silage dry matter and crude protein on-site at the farm using Silage Scanners based on three different NIRONE sensors 1.4, 2.0 and 2.5, combined with tube optics to increase the analysis spot size.

The Scanners based on sensors 1.4 and 2.0 showed most promising results and we were able to generate an analysis model for the measurement of dry matter with accuracy of about ± 20 g/kg in the range of 250 – 450 g/kg and crude protein with accuracy of about ± 10 g/kg in the range of 80 – 180 g/kg.

In the figures, the NIR spectra measured from silage reference samples are shown for each tested sensor type, and the predicted vs. reference plots for the dry matter- and crude protein content in case of sensors 1.4 and 2.0 based Scanners.

Conclusion

We demonstrated that the spectral ranges of 1.4 and 2.0 can be used to measure silage content. The cost-effective price point and small size makes it possible to integrate Spectral Engines' NIRONE products into your smart farming solution or you can develop your own smart farming application with our NIRONE Scanner solution.

Our field tests at dairy farms have verified the accuracy and applicability of the Silage Scanner. The dairy farms operators have reported that they are able to monitor the nutritional status of the dairy cows in almost real time resulting in improved productivity.
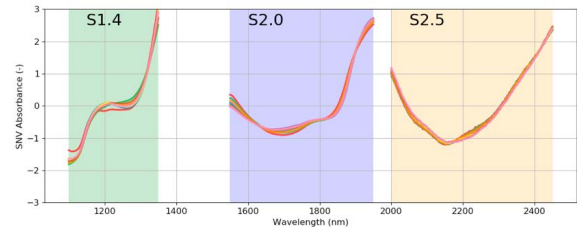
Example spectra from eight silage samples collected with three NIRONE variants. Each spectrum is a sample average over 60 scans and preprocessed with SNV.
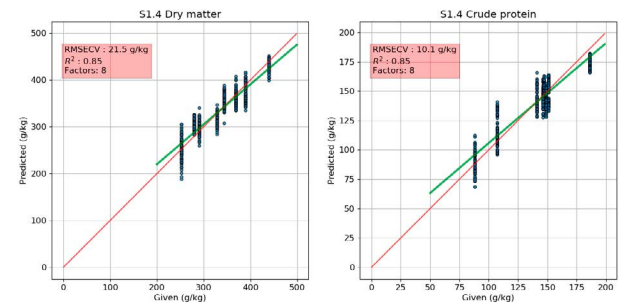
Predicted vs. reference plots for Dry matter and Crude protein determination using NIRONE S1.4
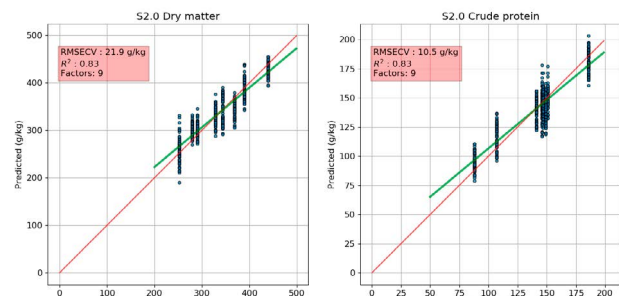
Predicted vs. reference plots for Dry matter and Crude protein determination using NIRONE S2.0

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