

A practical analysis of the Near Infrared Spectroscopy platform in the U.S. market

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Target Audience: Nutritionists, feed mill managers, QA managers, live production managers, procurements managers.

The Problem: NIRs (Near InfraRed Spectroscopy) is a useful tool to manage quantitative and qualitative aspects of incoming ingredients in theory. However, in practicality, many platforms and programs are currently not equipped to completely support the practical demands required by many organizations.

The Solution: Working together with the NIR end user to understand their needs and addressing those necessities in a platform designed directly for their unique requirements.

Introduction

Near Infrared Spectroscopy (NIRs) is the study of the near-infrared region of the electromagnetic spectrum (780-2500nm). The excitation and vibration of chemical bonds create absorptions at certain wavelengths in the near-infrared region known in its entirety as spectra. Spectra can be measured and a specific “fingerprint” can thereby be observed within them. The ability to deduce and utilize “fingerprints” in this region has enabled researchers and organizations to correlate spectra to values, such as crude protein, moisture, fatty acids, amino acids, and more. The ability to correlate confers the ability to use NIR technology as a predictive tool for feed ingredient analysis.

In the feed industry, using NIRs as an analytical tool provides the ability to collect data rapidly, accurately, and at a fraction of the price it would cost to obtain information traditionally derived through analytical chemistry labs. Furthermore, the utilization of NIRs at the ingredient receiving location provides an opportunity to address variation in ingredients and implement that information to adjust the rolling averages when economically justified. This allows for trends in ingredient quality to be addressed much earlier, rather than retroactively after performance begins to decline in the field.

While the technology of NIRs is unquestionably powerful in theory, oftentimes the practicality of implementation can be challenging. Prolonged, applied usage is often the Achilles’ heel of most NIRs platforms and the reason campaigns to use them to their full advantage have failed to adhere in the feed industry. The key to NIRs being successful depends on a multitude of factors of which we can’t cover fully in this paper. However, there are four integral features that are instrumental components in creating a successful real-world NIR platform that should be considered.

A Defined QA Program

Having a clearly defined quality assurance (QA) program is necessary for NIRs to be successfully implemented. There has to be broad investment in a user to run the machine(s), collection of the data, and transformation of the raw data into useful information for the nutritionist to make decisions and inform the organization on the quality of ingredients received. Notably, the entire organization needs to believe this investment is a beneficial long-term value.

Training users is the first step required for a successful QA program. Without a competently trained staff who understand the expectations, their value in the process, and the significance of the data, the program will rarely be successful. The QA team needs to understand key features, such as general reference values of ingredients, how to correctly label samples for tracking procedures, what information is pertinent to track, and an appreciation of the measurement process.

In the measurement process, reducing human error in processing samples should be taken into consideration. For example, it is common with NIRs programs to have to preprocess samples before they can be analyzed. Processing usually consists of grinding the sample into one homogenous particle size. To accurately perform this step, a grinder must be used that creates a consistent particle size reflective of the specific size used to create the calibrations. In reality, a coffee grinder is often used instead. The challenge with using a coffee grinder is that it creates varied particle sizes that are not consistent. The dearth of a constant particle size causes deviations in the NIRs readings leading to inaccurate values. To combat this propensity for variation and error, some organizations have introduced unground calibrations. Unground samples do not have to be ground to a specific particle size. Because unground calibrations are not dependent on particle size and require less time to obtain the necessary data, which is advantageous. With unground calibrations, the error and variation associated with processing/grinding samples is significantly reduced allowing for assurance in the reported data.

Consideration of the NIRs program as a long-term investment is critical to maximizing the value that NIR can provide. NIRs programs are commonly used to reduce costs in wet chemistry and for ingredient rebates/claims process. While these areas certainly pay for the cost of the machine and program, they are not the only areas where money lost can be recouped. Specifically, with a well-run QA program, the data from the NIRs machine may be utilized for formulation decisions and generating a more accurate rolling average. By having a more accurate rolling average, this may lead to a more precise formulation that is not over or under-formulated. Ultimately, this offers the ability to save money in feed cost and the potential to recuperate performance.

In a recent university trial managed by a third party, the researchers were able to demonstrate that when the exact same nutrient specs were formulated with wet chemistry values or NIR values, the NIR formulated diets were superior. NIR-formulated diets were able to reduce feed costs by nearly two dollars. In addition, feed conversion was improved by two points. The economic implications of this research trial support a more lucrative use for NIR outside of a simplistic quality control tool.

Calibrations and the Analytical Reference Lab

Calibrations are only as good as the wet chemistry lab that they are built against. Calibrations are created by correlating NIRs spectra on a feed ingredient with the corresponding wet chemistry lab values for the feed ingredient. This is done many times over a wide range of different ingredient specifications to make calibration curves. Therefore, the key aspect of successful calibration curves are how well they predict the analytical value of the ingredient in question. This can only be accurately accomplished by correlation to a singular analytical lab. Therefore, it is key to choose one analytical lab as the reference lab and to stay that course. Oftentimes, users will cross reference values across different analytical labs. The challenge to glean useful data from this is that most labs will vary slightly from one another due to intrinsic differences whether that be the type of tests they run for analysis (e.g., Kjeldahl versus Dumas), all the way to the individual carrying out the test on a particular day. If there are slight differences between wet chemistry labs and calibration output, they will need to be adjusted, or biased for accurate readings, so that the data is useful. Technical service and support from a calibration company should assist in this area.

The types of calibrations provided are key. Finished feed, soybean meal, corn, and wheat are major calibrations you should expect to receive because they represent the vast majority of ingredients used in formulation. Meat and bone meal, DDGs, and Bakery meal often get a reputation for being variable and therefore more difficult to use in formulation. However, with the correct NIRs calibrations lines that cover the various “versions” of these products you might encounter on a daily basis, it is possible to implement their usage under a trusted NIRs program.

Fat and oil calibrations are a newer feature in the market that offer the ability to measure the fatty acid profile and qualitative aspects of the fat or oil, leading to a more accurate energy value. This is particularly useful as fat and oil analysis at analytical labs is expensive and not time sensitive. Fat calibrations confer the ability to determine the quality of fat at receiving and offer the possibility to make the necessary formulation adjustments when lower quality fat is received. At the very least, they provide a time point to monitor performance in the field.

Calibrations maintenance is extremely challenging to manage, and oftentimes the QA manager is left to deal with this along with many other responsibilities. While it is not an impossible task if trained and studied, it can be a daunting task to manage on their own. Outliers can oftentimes be an issue when the calibration meets an ingredient that does not “fit the curve.” Calibration companies should provide a means by which those outlier samples are investigated to determine if they should be added to the calibration to improve it (e.g., low crude protein finished feed), or if they have a contamination in them which created the flagging in the first place (e.g., excessive fiber in soybean meal). It is incredibly important to work with a calibration company that manages the calibrations for you and incorporates your data into theirs, not the other way around.

User-Friendly Access to Key Data

Oftentimes a bottleneck of the NIRs data collection process is the ability to take all the data provided over two weeks or one month and understand what to do with it all or better yet, how to collect it into one place. An extremely important but often overlooked area in data collection is the ability for the end user to have the ability to take the samples they have run, process those samples, and export them in a format that is advantageous to the ingredient tracking and formulation process. Large poultry integrators may run hundreds of ingredient samples a week and if they formulate on a monthly basis, there could be upwards of 1,000 or more ingredients they have ran during that time. Due to the large volume of data they work with, it is important that the NIRs platform be able to provide them with a user-friendly experience to quickly move through the data and select which samples from a period of time they want to use to adjust their rolling averages on major ingredients.

Access to historical data, ingredient trends, and nutrient trends is an increasingly important feature for the nutritionist. The possibility to monitor and track changes in the proximate analysis, amino acid profiles, and fatty acid profiles of various ingredients from different suppliers and specific origins is advantageous. For example, the ability to witness trends in the nutrient profile of an ingredient, such as crude protein in soybean meal, can allow the nutritionist to make adjustments earlier through formulation modifications rather than after performance has started to wane in the field. Access to data away from the feed mills for the nutritionist is key. When a feed mill can be hundreds of miles and hours away from the nutritionist's central office, it is incredibly important that the nutritionist can access the data at each feed mill in a moment's notice. Having the ability to perform a function such as this can be the difference between catching a significant trend early and catching it a week or more later when the feed is in the field and the animals consumed it long ago.

Technical Service and Support from the Calibration Company

Technical support from the company providing calibrations is yet another imperative feature of an efficacious NIRs program which can make or break the program. Technical support should ensure that all the customer's users are properly trained on how to use the system, general troubleshooting, and proper sampling methods. The user is the most important decision-maker in the NIRs program as their training can create a smooth environment or make the ability to use information challenging at best. Therefore, it is technical service's responsibility to ensure everyone understands how to use the system. Training support doesn't end with initial training and should be expected that the technical service's team makes monthly visits by phone or in person to ensure everything is working well to ensure any new users are correctly trained. Additionally, when issues arise, it should be expected that the technical team respond and act accordingly within a reasonable time frame.

Overall, technical services and support on the calibrations should be an expected, value-added feature. Oftentimes many NIRs programs are not measured on the quality of customer service that will be received once the program is up and running. Prioritizing quality customer service as a non-negotiable will substantially benefit an NIRs program.

Conclusion

The area of NIRs in the animal feed industry still has improvements and significant breakthroughs in its future to make. However, the key to whether NIRs will become a commonplace tool used primarily over more expensive traditional methods will depend on how well NIRs and calibration companies seek out the opinions and thoughts of their end users. As calibration companies continue to involve the end users in the development process and tailor their technology toward their practical needs, widespread acceptance will occur.

Trouw Nutrition provides NIRs service and expert technical support through NIRs technology known as NutriOpt. NutriOpt offers organizations the ability to customize their NIR needs through a wide range of options.