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By Dr. Ingolf Reimann

Head of Analytical Services at Evonik Nutrition & Care GmbH

Making the most of Near Infrared Spectroscopy (NIRS)

Our increasingly detailed knowledge and understanding of the nutritional needs of production animals means we now have the potential to provide feeds which optimise health, growth, and hence, financial return. Near Infrared Spectroscopy (NIRS) has provided the feed industry with the means to meet that potential by accurately measuring key nutritional components, such as essential amino acids, in feed ingredients as they arrive at the feed mill, and finished feeds as they leave. This fast, accurate and cost-effective technology has thus become an industry standard in most markets around the world.

As with most technology, NIRS is only as good as the system within which it is used. The aim of this short article is, therefore, to provide some guidance on how to make the most of NIRS as an animal feed quality control tool.

Sampling goods in Variability of feed ingredients is unavoidable. Differences in climate, soil, plant genetics, fertiliser use, transport, storage, for example, mean that deliveries into the feed mill from different suppliers, or even on different days, can contain different nutrients. Using a rapid NIRS system for quality control as the feed ingredient arrives means that storage can be rationalised and, if necessary, prices renegotiated, or deliveries refused, based on the results. But to achieve this level of quality control, the sampling must be undertaken in a consistent and reproducible way to avoid any bias or variability generated by the sampling technique. It is, therefore, essential to develop, and always follow, an agreed sampling protocol, including when, where, how and how often. The same applies when NIRS analysis is used to check outgoing, finished feeds.

Sampling should be designed to capture a truly representative cross section of the batch being assessed. Statistically, the more samples taken, the more accurate the result. The sampling protocol should specify that samples are taken from different parts of the batch, including middle, top and edges, using standard equipment and techniques.

The sampling device should catch a truly representative sample, and not miss particularly large or small particles. If samples are to be ground before being analysed, then a grinder with an inbuilt sieve, such as Retsch ZM200 or Foss Cyclotec sample mill, is preferable. NIR spectra are strongly influenced by particle size distribution and an incorrect grinding procedure can result in incorrect amino acid estimations. Whatever system is selected, it should be the same as that used on the reference samples for calibration.

To avoid the potential pitfalls of ground samples, Evonik has recently introduced NIRS calibrations which can provide accurate analysis of raw (unground) feed ingredients. The AMINONIR Advanced service is quick (less than three minutes) and accurate, and so facilitates the assessment and optimal handling of feed ingredients as soon as they arrive at the feed mill.

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The more samples are taken, the more accurately any variation within a batch can be defined. However, the number of samples that can be taken in practice is usually limited by factors such as available time and labour. The number of samples to be taken should, therefore, reflect the expected variation within a given batch, which can, in turn, be defined by previous data based on deliveries from the same or similar sources. The ideal number of samples to be taken from a given batch can be calculated using a formula based on the variance of nutrients within the load. For example, if the aim is to analyse the crude protein content in a delivery of 100 bags of fish meal (where variance is 0.7 according to previous data and the intended result of the analysis must not differ by more than five per cent from the actual value), then 10 bags should be sampled.

Data analysis

The key to gaining insight into raw material variation by NIRS analysis is having access to a comprehensive pool of analytical results, achieved by measuring each batch of incoming raw material. All analytical data should relate to the corresponding batch information, such as batch number, supplier, origin country of raw material, country of processing and date of receipt. Then data is statically evaluated for the relevant parameter sets, e.g. "amino acid and energy content – purchasing prices – supplier's reliability in delivery" and translated into decisions. If NIRS prediction services are outsourced, the service provider should visit the feed mill, advise on sampling method, train the lab staff on good NIRS praxis, check for correct NIRS equipment set-up and validate the performance of the NIRS instrument using current calibration versions which, in turn, should be reliable and robust. The AMINONIR service, for example, is based on remote calibrations being updated frequently and containing a huge number and range of feed ingredient and feed samples from around the world. It provides customers with fully automated results 24/7 via a dedicated software package.

As well as holding a large number of sample data, it is important that NIRS calibrations are continually updated, comprehensibly validated and checked in terms of their performance for current raw material qualities in the network. Evonik conducts regular global ring tests in which homogeneous and representative feed ingredient sub-samples are sent to NIRS laboratories all over the world, including those of feed producers, Evonik satellite laboratories and the company's master laboratory. The results are then analysed and compared to check there is minor variation. In fact, the results from the AMINONIR network – utilizing professionally maintained calibrations and a well-implemented quality management system – show that the variation in amino acid prediction by NIRS can be in the same low range as the variation of a reliable and professionally-managed, quality, wet chemical laboratory.

This experience supported Evonik in the decision to develop a service based on unground feed ingredient samples, called AMINONIR Advanced.

The network currently includes more than 800 customer NIRS and 14 analytical service laboratories on four continents, conducting about one million NIR spectra each year.

Summary

Precise information on the nutrient contents of feed ingredients facilitates the production of predictable, consistent, safe and cost-effective animal feeds, and hence optimal animal performance. NIRS has become a global industry standard to achieve that goal, but the usefulness of this technology relies heavily upon sound operating procedures and reliable, comprehensive calibration data, as well as consequent data monitoring.

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MAKING THE MOST OF NIRS

CEREALS, PLANT PROTEIN

PROCESSED BYPRODUCTS

RAW MATERIALS DELIVERED TO MILL

SAMPLING PROTOCOL – ACCORDING TO HACCP

NIR SPECTROSCOPY TO ASSESS CONTENT AND VARIATION

STORAGE AND FEED FORMULATION BASED ON NIRS RESULTS

Variability within and between batches
- Seed variety
- Growing conditions
- Transportation
- Time of year
- Fertilization
- Processing conditions

Standardised sampling protocol essential
- Number of samples to take
- Location/s from which to take
- Method of sampling
- Ground/not ground
- Sample devices

Accurate calibration essential
- Specific to equipment/situation
- Comparison with local and global database
- Regularly updated
- Automated interface
- Global ring tests

Benefits of NIRS analysis
- Enables informed storage of feed ingredients
- Enables price negotiation / refusal of deliveries dependent on nutritional quality
- Facilitates precise formulation of feeds
- Ensures quality control to customers
- NIRS used again to check outgoing finished feeds