ACIDF FEED GRAIN RESEARCH UPDATE 2008 Issue #2

NIRS COULD TRANSFORM ALBERTA'S FEED GRAINS ECONOMY

by **KIERAN BRETT**

With a secure foothold today, and new capabilities on the way, this technology could improve the business for both buyers and sellers of grain.

When you buy a new car, you know how far it'll take you on a litre of gasoline. When you buy groceries at the supermarket, a glance at the label will tell you a product's nutritional profile.

Until recently, the exchange of value between buyers and sellers of feed grain hasn't been nearly so transparent. With no proven, dependable way to demonstrate the feeding quality of grains in livestock rations at point of sale, grain growers and livestock producers have based their transactions on simple physical measurements such as bushel weight or plumpness.

But this long-standing value estimation is changing, led in large part by the demand for measurements that more accurately represent animal performance and the development of a technology known as Near Infra Red Spectroscopy (NIRS).

"Probably the simplest way of describing NIRS is to compare it to x-ray technology," says Mary-Lou Swift, Research Scientist, Feed Quality, with Alberta Agriculture and Rural Development (ARD) in Lacombe, who's worked with NIRS for over two decades.

"NIRS is a secondary, non-destructive, 'green' technology that uses light energy to measure the amount of chemical bonds containing hydrogen within a sample. This produces a 'spectral' fingerprint which is unique for each sample. This fingerprint is compared to the chemical composition of a sample to produce a calibration model. These models are routinely used in many laboratories around the world to predict dry matter, protein and fiber concentrations in grains and forages."

A greater role for NIRS in agriculture

While NIRS seems futuristic at first glance, the technology is long-established in other industries.

"The technology began in agriculture some 50 years ago," says Jim Helm, ARD's Head of Research, Feed Crops Branch, in Lacombe. "It's now used a lot in the pharmaceutical and food processing industries. Within agriculture, almost every grain elevator has an NIRS system that's used for protein and moisture."

Knowledge of protein and moisture, while useful, doesn't tell nearly enough about feed grains to make an assessment of issues like digestibility. Over the past decade, Helm and Lori Oatway from the Field Crops Development Centre have developed calibrations to predict the digestibility of energy and protein as well as the content of starch and lysine in barley.

This information can be used when evaluating and selecting genetic material to develop, for example, better lines of barley. In addition, Oatway and Helm have recently developed a NIRS model to determine the concentration of DON, a toxin produced by Fusarium that can be detrimental to animal performance and health.

Bringing the full potential of NIRS to feed grains is the work of many hands, and is fuelled by research funding from the Alberta Crop Industry Development Fund (ACIDF) and others. From plant breeders like Helm to animal nutrition scientists like Swift, to manufacturers of NIRS units to developers of calibrations for many grains and species, this is an enterprise with lots of moving parts.

Next year, and the years after that

From where Helm and Swift are sitting, 2009 is shaping up as a big year in the ongoing development of NIRS in Western Canada.

"We are planning to start testing several NIRS prediction models with several companies and manufacturers of NIRS," says Helm. "Working with these end-users will serve as an indicator of progress to date and what remains to be done."

These researchers can see a time, not too distant, when the everyday method of buying and selling feed grains is integrated with the knowledge made possible by NIRS. In such a market, producers of high feed-value grain could realize a premium when they sell. Conversely, the end-user should be able to pay appropriately for a grain not meeting feed grain specifications.

This new paradigm of feed grains marketing isn't here yet, but as a critical mass develops around NIRS, you can see it just down the road.

Says Swift: "Some of us have been working on this for years and it would be very gratifying to see it adopted. NIRS technology is getting cheaper, software easier to work with and calibrations developed that can be transferred between machines. The next five years will be very exciting."

MADE-IN-ALBERTA NIRS CALIBRATIONS ON THE WAY

A five-year research project, funded by ACIDF Ltd., is closing the gap between scientific potential and practical application.

When someone buys feed grains, they typically measure the weight of the grain and visually assess its plumpness. This process is fast but, in terms of determining its value in feeding livestock, highly inaccurate.

A sure way to assess feeding value is to send a representative sample of the grain to a lab for wet chemistry analysis. This process will tell you everything you want to know about feeding value. As for speed, well, can you call back in a week or two?

"Grains have mostly been graded in Western Canada based on volume or bushel weight," explains Ruurd Zijlstra, Associate Professor of Agricultural, Food and Nutritional Science at the University of Alberta. "We continue to do this even though we've known for quite awhile that bushel weight is a poor indicator of quality. But at least it's fast.

"We need to be accurate and fast. And with NIRS, we can have our answer within one to two minutes."

ACIDF funding five-year calibration project

Scientists like Zijlstra and Plant Breeder Jim Helm are quick to point out that NIRS doesn't actually measure the nutritional composition of grain. What it does is predict what a wet chemistry analysis of that same sample would show. NIRS does this by means of a complex set of values and relationships known as calibrations. Developing these calibrations is the scientific heavy-lifting that links what NIRS should do in theory with what it can do in practice.

"We know that the discovery part of the research around NIRS has been done," says Zijlstra. "The next stage is to develop the calibrations."

The Alberta Crop Industry Development Fund (ACIDF) is currently funding a five-year research project led by Zijlstra and Helm. Its purpose is to build calibrations for several feed grains (barley, wheat, field peas, canola meal and dried distillers grain solubles) and several livestock species (cattle, swine and poultry).

While the questions at the heart of this work might seem simple – how much barley does it take to pack a pound on a steer? – finding reliable answers is anything but. One limitation for researchers is lack of access to statistically significant numbers of livestock for testing purposes.

To get around this obstacle, Zijlstra, Helm and several other collaborators are using laboratory-based reference analyses such as InVitro Digestibility Analysis. "This technique allows us to mimic the digestion of a pig inside a test tube," says Zijlstra. "This analysis allows us to screen a large number of samples for differences in digestibility relatively quickly, and do it in a more cost-effective way. Obviously, these analyses need to be validated in animal models."

A work in progress

Helm believes that during 2009, researchers will be move closer to their goal of scientifically valid NIRS calibrations for key feedstuffs and key livestock species. Bringing this work to commercial fruition will take several years beyond that. Even when a comprehensive set of calibrations is done, the work will continue. Calibrations will need to be updated regularly, constantly cross-checked with wet chemistry analysis.

However complex and long term this work is, for Helm and Zijlstra, the prospect of making a historic contribution to the feed grains industry is fundamentally worthwhile.

"There has always been a problem between the science of NIRS and the practical application of it," says Helm. "It's good to see something happening to advance a technology that will benefit both the farmer who grows the crop and the livestock producer who buys it."

WILL CATTLE RESPOND?

This feedlot nutrition scientist has been studying NIRS for two years. So far so good, he says, but a significant question remains.

Before Western Feedlots decides to make a change to its grain buying and cattle-feeding protocols, that decision must be supported by extensive research. After all, with tens of thousands of cattle on feed at any one time, the potential risk of excessive haste would be significant.

Consistent with this philosophy, Head of Research Dr. Robert Peterson has been studying NIRS for the past two years at the company's facilities in Strathmore, High River and Mossleigh. While he likes what he sees to this point, he isn't ready to give NIRS a wider job description just yet.

"So far, we see a correlation between an NIRS calibration and the wet chemistry for the type of barley we receive," says Peterson.

While having NIRS and wet chemistry in synch is obviously essential, that's not all he wants to know. To have a practical application in a commercial feedlot, in Peterson's view, NIRS must be able to predict cattle performance. In other words, if cattle don't grow more efficiently when they consume barley judged by NIRS to be nutritionally superior, then the technology isn't ready for prime time.

"We can attempt to value barley based on what NIRS tells us," says Peterson, "but first, we need to validate that there's a biological response associated with NIRS valuation. Everybody at Western Feedlots is quite optimistic if we do get to that stage, and find a biological response to this differentiated barley, then there could be a big opportunity on procurement."

PULSES SEEK A PLACE ON NIRS EXPRESS

While barley and wheat dominate livestock rations, NIRS could help field peas and faba beans find a bigger role in the feed bunk.

Today, NIRS units are a common sight in grain elevators and feed mills across Western Canada, where they are used to measure simple components including protein and moisture.

Tomorrow, they could be used to measure more complex and valuable nutrients such as energy, ensuring that producers are fairly compensated for what they provide to the feed industry. That's the vision seen by Michelle Fleury, Feed Market Development Consultant with pulse grower associations in Alberta and Saskatchewan.

"Pulse growers see two main applications for NIRS," says Fleury. "The first is to help make our breeding program more efficient, by allowing quick and cost-effective screening of traits. The second application is to use NIRS to rapidly analyze the nutritional qualities of feed pulses."

While pulses are more widely grown in Saskatchewan than in Alberta, Fleury notes that the cooler, wetter climate of Alberta's Peace Country is well-suited to faba beans. She sees a growing role for faba beans in hog rations, provided producers understand their nutritional benefits, a challenge NIRS could help with.

What will it take? First, while commercial NIRS calibrations for feed pulses are available, these are based on international samples that may not be representative of those grown in Western Canada. Therefore, NIRS calibrations must be developed that accurately measure the nutritional value of local varieties grown under our environmental conditions. Second, qualified NIRS personnel are in short supply within the feed industry. Whether training programs are delivered by suppliers of NIRS instruments or through educational facilities, expertise will be vital for companies to realize the benefits from their investment in technology.

"It's just a matter of somebody dedicating themselves to making sure that calibrations are developed and maintained," says Fleury, "so that companies and buyers can work with them."

MORE ACCURATE FORMULATION NOW, MORE ACCURATE PRICING LATER

NIRS is also employed as a random quality check on feed that's ready to be shipped.

To confirm the ongoing accuracy of its NIRS systems, Unifeed regularly performs traditional wet chemistry analysis on samples read by NIRS.

"We do this every couple of months," says Gabert, "and the results show that NIRS has been very accurate and also very repeatable."

While Gabert is satisfied with the performance of NIRS to date, he believes it can and will do much more in the future. He's working on ways to use NIRS in predicting the energy value of grains, especially wheat.

When a producer delivers grain to Unifeed, they receive a price that's directly related to the current cash price of the grain. Gabert expects that the evolution of NIRS technology will eventually allow the company to customize pricing to reflect the feeding value of the grain it buys. The outline of such a system comes readily to mind.

"If you established a benchmark based on protein content, that would be the place to start," says Gabert. "Let's say you're talking about peas. If we had a target value of 20% protein, and a producer brought in peas at 22% protein, we could pay a little bit more for that. On the other hand if it was 18% or 19%, there might be a discount of a dollar or two per tonne."

NIRS A GAME-CHANGER FOR ANIMAL NUTRITION

How important is Near InfraRed Spectroscopy (NIRS) technology to an animal nutritionist like Dr. John Metcalf? Consider what happens when one of his NIRS machines is out of order for an hour or two, as happened one recent afternoon. Without this essential tool available, nutrient analysis quickly came to a standstill.

"The level of disruption we see when this machine goes down tells you it's critical to what we do around here," says Metcalf, Ruminant Nutrition Research Manager with Nutreco Canada in Guelph, Ont.

While the Nutreco name might be new to many, the two feed companies it runs in Canada are well-known. Operating as Shur-Gain in the East and Landmark Feeds in the West, Nutreco's 16 feed mills make it the largest animal feed company in the country.

Nutreco produces a vast array of feeds for dairy, beef, sheep, goats, poultry, pigs and pets.

Metcalf explains that the main role of NIRS at Nutreco is to expedite the analysis of ingredients and carry out analysis of forages on-farm.

"We use NIRS to accurately predict the forage analysis in terms of protein, ash and fibre," says Metcalf. "Knowing this, we can then work out how best to complement that forage to meet the animal's nutritional needs."

Like other NIRS users, Metcalf is careful not to assume the accuracy of NIRS results or that today's calibrations are necessarily valid for the future. Results are regularly tested in relation to wet chemistry analysis.

In Metcalf's view, combining the accuracy of wet chemistry analysis with the speed and reliability of NIRS allows Nutreco to provide a timely service and quality products to the company's customers.

"The potential digestibility analysis we do takes a week by wet chemistry," he says, "and producers need the results much quicker than that. With NIRS, we can generate quick and accurate results that allow producers to make more accurate feeding decisions."

PARTNERS IN MAXIMIZING THE BENEFITS OF NIRS

The growing adoption and advancement of NIRS technology is one of the most important developments in today's feed grains research. Funded and supported by ACIDF, researchers, crop and livestock organizations and agribusiness are bringing us closer to tapping the full potential of NIRS, for the benefit of growers and buyers of feed grains.

PARTNERS IN FEED GRAINS COMPETITIVENESS

ACIDF recognizes and thanks the following organizations for their role in the development of NIRS:

Agriculture and Agri-Food Canada
Alberta Agriculture and Rural Development
Alberta Agricultural Research Institute
Alberta Barley Commission
Alberta Beef
Alberta Canola Producers Commission
Alberta Cattle Feeders Association
Alberta Chicken
Alberta Livestock Industry Development Fund Ltd.
Alberta Milk
Alberta Pork
Alberta Pulse Growers Commission
Nutreco
Prairie Swine Centre
UniFeed
Unity Scientific
University of Alberta
Western Feedlots

Over the next several months, ACIDF will be publishing follow-up articles that will look in depth at specific solutions to feed competitiveness and will outline investments being made by private industry, farmers, research organizations, government and funding agencies in present and future feed grains research and development.

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