AACC Intl - ILSI SEAR Australasia

Seminar to be held at AGSA annual meeting

on

Advances in Precision Agriculture and Big Data for Grain Quality Management

Melbourne - 29 August 2019

Biographies and Abstracts

Moderator: Prof Les Copeland, University of Sydney
Phillip Clancy  
CEO, Next Instruments, Condell Park, NSW, Australia.

Phillip James Clancy, Founder of NIR Technology Systems and Next Instruments. Designs, manufactures and markets analysers for the agriculture and food industries since 2000. He has contributed articles and papers on NIR spectroscopy, seed image analysis and enzymatic digestion analysis around the world for 30 years. In 2013 Next Instruments launched a On combine NIR Analyser for measuring protein, moisture and oil in grains and oil seeds as they harvested. This technology is now the major focus of Next Instruments. Mr. Clancy is working on introducing this technology to farmers, agronomists and ag scientists through giving talks and writing papers.

Finding the sweet spot in nitrogen fertilization by measuring protein with an on combine NIR analyser

What is the yield and protein balance?

The growth and development of plants undergoes a number of stages; Emergence, Tillering, Flowering, Filling. Water is the major driver for successful plant and seed development. There are many other nutrients that influence the plants development, but Nitrogen is definitely the next most important driver for plant development.

The primary objective of all plants is to reproduce themselves by producing seeds to carry forward the genetic information in the next crop. Plants are programmed through millions of years of evolution to modify the plants growth cycle to ensure that some seeds are produced to procreate the next crop. As such if there are not sufficient nutrients available at the various stages of development, then the plant will reduce the number of stems, heads or even seeds to ensure that what nutrients are available are used to ensure that seeds are eventually produced and released. These changes to the plants development effect the Yield potential for the plant. Nitrogen is the key nutrient that dictates how the plant will make these changes during the stages of the plant development.
Proteins are composed of approximately 17.5% of Nitrogen by weight. As such, measuring the Protein in the seeds at harvest provides a direct measurement of the availability and uptake of Nitrogen in the plants. By measuring protein in real-time on a combine harvester and combining the data with the yield and GPS coordinates, provides a means of generating field maps including: Protein, Yield, Nitrogen Removal, Gross Margin and Protein/Yield Correlation. These maps provide a means of establishing zones where Nitrogen has been deficient and has caused either or both yield and protein to be less than the field average. Figure 2 shows Protein/Yield Correlation Quadrant map for a wheat field in South Australia.

The four quadrants are:

- High Protein/Low Yield
- Low Protein/High Yield
- Low Protein/Low Yield
- High Protein/High Yield

A discussion of the causes for each quadrant is complex because there are several inter-related parameters that influence the development of the plant. A simplistic yet meaningful explanation is presented below:

- High Yield and Low Protein: There was enough Nitrogen available for emergence and tiller formation but not enough to fill the grain and produce higher protein.
- Low Yield and High Protein: There was insufficient Nitrogen available to support full tiller development and therefore there was not enough heads produced to reach the full yield potential. However, there was sufficient Nitrogen available in the reproductive and grain filling stage to produce protein in the seeds. This Nitrogen was probably applied late in the growth cycle, ie, top dressing of urea, or was deep in the soil profile and accessed late as the roots grew down to the deeper soil.
- Low Yield and Low Protein: The yield has been limited by insufficient Nitrogen in the soil at leaf emergence and then in the growth phase. Other nutrient deficiencies may also be impacting the yield.
- High Yield and High Protein: There was enough Nitrogen available for development of tillers and through the entire plant development to achieve the full yield potential and to produce higher protein in the seeds, ie, “Sweet Spot”.

What is the significance of Protein to Yield?

In 2013, Greg McDonald and Peter Hooper, University of Adelaide, School of Agriculture, wrote an article for the GRDC titled: Nitrogen Decisions – Guidelines and rules of thumb. They referenced a paper written in 1963 by JS Russell for the Australian Journal of Experimental Agriculture and Animal Husbandry where he “described the idea of using grain protein concentration to assess the likelihood of N responsiveness in wheat cropping systems. He suggested that yield responses were most likely when grain protein concentration was < 11.4%”. McDonald and Hooper went on to say, “Based on recent trial data, the general conclusion still appears valid: 100% of all trials where grain protein concentration of the unfertilised control was < 8.5% were responsive to N and would have given yield response of 14kg/kg N. When grain protein concentration was > 11.5%, only 32% of the trials were
responsive to N and the mean yield response was zero”. They concluded; “While this relationship can’t be used to make in-season N decisions it may be useful in helping to assess the degree of N stress during the previous season and making post-harvest assessments of N management strategies, which can help in future plantings.”

What is the message that all these agronomist and researchers are stating?

If the protein concentration in the final grains seeds is less than 11.5% in wheat and 12% in barley then the crop has not had sufficient Nitrogen available to achieve the full yield potential. The soil Nitrogen may have been low or it may not have been accessible to the plant at the correct times. Nonetheless, all the research supports the premise that Yield Response would have been positive to N fertilization if the protein levels in the grains is less than 11.5%.

This paper will demonstrate the use of an on combine NIR analyser to measure protein and moisture in wheat as the grains are harvested. Examples of protein yield and protein/yield correlation maps will be provided.

Figure 3. Grain yield (t/ha) and protein concentration (%) from 10 wheat varieties with 0, 30, 60, 90 and 120 kg/ha applied nitrogen in a trial at Parkes in 2011. (Brill et al, 2012, Comparison-of-grain-yield-and-grain-protein-concentration-of-commercial-wheat-varieties).
Dr Surya Kant
Senior Research Scientist, Agriculture Victoria Research

Dr Surya Kant has 20 years of international science and leadership experience. He is working as a Senior Research Scientist at Agriculture Victoria since 2011. Previously he had research scientist positions in Israel and Canada for 12 years. He has successfully led and co-led multiple large-scale multi-disciplinary research projects. Surya has over 40 publications in reputed international journals. His expertise includes plant phenomics, genomics, physiology and agronomy. Surya’s team has developed capabilities for digital sensor-based high-throughput plant phenotyping.

Modern trends in digital plant phenotyping for grain research

Plant phenotyping has come a long way from the traditional manual methods to non-destructive high-throughput techniques. The recent developments of advanced sensor systems and digital imaging platforms have paved the way for current high-throughput phenotyping systems. These phenotyping platforms, being precise, reliable and efficient, are increasingly used in plant science research, with potential to revolutionize the agriculture industry.

The significant benefits of digital remote-sensing phenotyping in agriculture can be realized through (i) in-field decision support tools for input use such as timely applications of fertilizers and pesticides, (ii) crop monitoring for disease incursions and abiotic stress levels, (iii) yield forecasting and (iv) increased cost-benefit ratios. Concurrently, a proper understanding of the instrumentation used in plant phenotyping, and the handling of big data analytics is required to realize the full potential of such systems.

The Plant Phenomics team at Agriculture Victoria, Horsham has established in-house capabilities for digital sensor-based plant phenotyping through automated controlled environment and aerial imaging platforms applicable for grain research. This presentation will share knowledge and experience on various aspects related to sensors, unmanned aerial vehicles, data acquisition workflows, processing and analysis of large datasets, and trait value extraction for grain crop canopies.
Dr Richard Williams  
Managing Director, groIQ

Richard has an objective scientific approach to solving problems with a proven track record of innovation. This ranges from industry changing research to leveraging big data to improve grain grower profitability. Since 2016 Richard has been Managing Director of independent consultancy groIQ that conducts research and provides service to agribusiness companies and farming enterprises across Australia. Richard is passionate about bringing together unique data sets to tackle industry issues and groIQ has published its research findings internationally. Previously, Richard held management roles with the CBH Group and AWB Limited between 1992 to 2015, taking time out to complete his big data PhD analysis of GxE effects on wheat quality in 2006.

Using big data to predict wheat quality - the value of, the next steps?

On the world stage Australian wheat farmers are leaders in adopting advanced technology and management systems. Despite their innovativeness wheat farmers continue to face challenges. One is their international competitiveness against lower-cost production from the Black Sea region and Argentina that is simultaneously improving in its quality. Another challenge are the impacts of long-term climate change, bearing in mind Australian farmers currently deal with climate change in a practical and almost business as usual sense given ‘normal’ seasonal volatility.

Structured experiments or trials can help to understand such challenges. However, budget restrictions often limit trials to only a few growing seasons and the subject(s) of interest not observed. Creating big data is a useful approach when trying to understand the impact of growing conditions on wheat quality. Big data allows multiple seasons to be assembled for analysis that otherwise would not be economical to run as a single experiment. The scale of the big data can compensate for limitations like unbalanced structure and/or missing variables. Several projects utilising big data will be discussed from a national (e.g. Australian Prime Hard and Late Maturing Alpha-amylase) and regional (e.g. protein quality and sprouting) perspective.
Prof Ross Kingwell
AEGIC (Australian Export Grains Innovation Centre)

Ross is chief economist in AEGIC (Australian Export Grains Innovation Centre), a joint initiative of the WA State Government and the Grains R&D Corporation. He is also a professor of agricultural economics in the School of Agriculture and Environment at the University of Western Australia (UWA). He chairs the Australian Farm Institute’s research advisory committee and has served as co-editor of the Australian Journal of Agricultural and Resource Economics. He is a past-president of the Australasian Agricultural and Resource Economics Society and is a distinguished fellow of that society. Ross’s research interests and expertise are principally in farming systems and industry analysis. A current emphasis in his research is grain supply chain and grain demand analysis.

The economics of the quality of wheat for South East Asia
Prof Ross Kingwell (AEGIC/UWA) and Dr Chris Carter (AEGIC)

South East Asia (SEA) imports annually over 27 million tonnes of wheat, with Indonesia being the world’s second-largest importer of wheat. Sizeable further growth in wheat importation is forecast in the region, due to rising per capita incomes, larger populations and urbanisation trends that favour greater consumption of wheat-based convenience foods. Despite the market growth opportunities, however, sales of Australian wheat are being affected adversely by the greater availability of wheat from low-cost origins like the Black Sea and Argentina. In the face of such competition, is it possible to make Australian wheat more attractive to end users in SEA by enhancing its fitness-for-purpose? This paper outlines recent research that unveils the most valued attributes of wheat in different SEA markets, when particular end products are the focus of flour milling. Knowing more accurately what wheat attributes are most (or least) preferred, and determining end users’ willingness to pay to preferred attributes, is information helpful in guiding wheat breeding and wheat marketing.