# The sense in real-time sensing

*Clive Blacker*

**Emma Leonard**, *AgriKnowHow*

While many Australian broadacre croppers have embraced autosteer as the entry point into precision agriculture (PA), UK farmers have focused their PA investments into variable rate technologies. Consequently, much can be learnt from the UK about the possibilities and pitfalls of adopting variable rate. At the SPAA Expo, UK farmer and PA consultant Clive Blacker of Precision Decisions shared his experience and knowledge of prescription mapping, real time sensing and new developments in the European PA market.

Farming in Yorkshire with his brother, Clive Blacker adopted PA eight years ago with the main aim of reducing input costs. With highly variable soils across small areas (average paddock size eight hectares), he rapidly came to the conclusion that uniform applications could not satisfy the in-paddock variability. In order to manage his crops more effectively he investigated different methods of in-paddock mapping.

"Soil moisture is not generally a limiting factor for us, so, a yield map is really a historic picture of where seasonal factors such as combinations of moisture and temperature impacted on crop nutrition, disease and ultimately grain yield."

***Using real-time data for on-the go input variation has resulted in yield improvements of 3.5 per cent.***

"I concluded that as soon as the crop emerges real-time sensing was required to help me maximise grain production in relation to inputs and gross margin across each paddock.

"There is little value for me in treating crops based on previous performance as the greatest returns will be gained from the here and now."

For a typical cereal crop a UK farmer could have up to 14 input passes, 12 of which are post emergent and include up to four applications of nitrogen, two applications of each growth regulator and herbicide and three applications of fungicide; although some of these chemicals may be combined reducing one or two input passes.

To help put this in perspective Clive Blackers's average yields, input costs and operations costs are detailed in Table 1.

"In the UK we have focused attention on canopy management, aiming to achieve target levels of green area index by manipulating seeding rates, in-crop nitrogen timing, nitrogen rates, fungicides and growth regulants.

"However, a constant rate of fungicide applied across a crop, in reality, results in more active ingredient delivered to thin areas of the crop and less in dense areas, which have more leaf area and with certain diseases are more likely to be disease hot spots."

### *Real time sensing*

Based on a desire to manage inputs to thick and thin canopies more appropriately Clive trialled the tractor mounted Yara N-sensor; the same sensor used by Allan Mayfield and colleagues in the SPAA variable rate trials.

The N-sensor measures crop light reflectance from four angles, with approximately 50m$^2$ measured every second. As information on chlorophyll and crop biomass come from different parts of the light reflectance curve, the sensor is able to distinguish between these attributes. Consequently, the sensor, which is more sensitive than the human eye, is able to differentiate between dense or thin crops, and poor and 'healthy' crop colour. The sensor has been calibrated initially for nitrogen and latterly for growth regulants and crop desiccants. The reflectance information is rapidly translated into an application rate and a signal sent to the spreader or sprayer on-the-go without a time delay, or any previous requirement for paddock maps.

Other similar sensors are on the market but these are not able to make recommendations on-the-go. Another difference is the 40 degree angle of measurement used by the N-sensor. This ensures it measures the crop canopy and not dead material deeper in the canopy, nor the soil surface, even in wide row spacing or low crops such as lentils.

"I am trying to manage the canopy, therefore, it is essential that the sensor accurately gathers information about the crop canopy."

SPAA experiments indicate a separate use for the N-sensor could be the identification of inter row weeds.

Working with Yara, Clive has helped develop N-sensor calibrations for in-crop nitrogen applications at tillering, stem elongation, ear emergence and flowering, for wheat, triticale, maize and barley as well as in-crop nitrogen applications in canola and potatoes. Calibrations have also been developed for growth regulants.

Using real-time data to modify in-crop nitrogen inputs has resulted in yield improvements of 3.5 per cent and 0.5% increase in protein from the same total fertiliser input in a field. These results are in line with experiments with the N-sensor in Australia.

Grain drying can represent a considerable cost to UK farmers and a major benefit from varying nitrogen and growth regulant inputs in relation to the canopy, has


been a 26% increase in harvester output, primarily due to reduced crop lodging.

Calibrations for fungicides and crop desiccants (used on canola or potatoes) are currently being developed. Using the version of the N-sensor that includes an active light source, Clive is looking at the potential to sense plant water stress before symptoms are observed.

### *Direct injection and variable rate nozzles*

Another potential use for real-time sensing is with direct injection sprayers for selective weed control. Clive believes the ability to mix chemicals in-line, to provide appropriate control of a target population, will help reduce inputs of expensive selective herbicides. Direct chemical injection provides users with the opportunity to have a clean tank of water and the ability to change agrochemical input rates without adjusting water flow.

With a fellow UK farmer Clive is currently working on the development of a rapid response direct chemical injection system. Direct injection systems that are on the market have a lag of 100m between the introduction of a chemical and its delivery at the correct concentration across the boom. The system under development is able to reduce this to 16m with chemical delivered to the first nozzle within three seconds and the last nozzle within six seconds. These delivery distances and times are for spray booms up to 24m wide and travel speeds up to 14 km/hr.

For users wanting to take the simpler route and vary water or fertiliser volumes the use of variable rate nozzles may be of interest. These

***Table 1. Production costs in dollars per hectare and yield for three key grain crops produced by Clive Blacker, Yorkshire, UK.***

| Product Category | Winter Barley | Canola | Winter Wheat |
|---|---|---|---|
| Herbicides | 148.99 | 342.06 | 114.97 |
| Fungicides | 209.77 | 153.89 | 223.55 |
| Molluscicides | 6.54 | 57.02 | 12.61 |
| Insecticides | 3.71 | 3.54 | 3.12 |
| Growth Regulator | 15.45 | 0.00 | 11.76 |
| Fertiliser | 394.13 | 470.33 | 605.34 |
| Seed | 228.90 | 762.74 | 181.73 |
| Inputs Total | 1007.48 | 1789.59 | 1153.10 |
| Operations | 1232.20 | 1500.60 | 1427.40 |
| Total Production Costs $/ha | 2239.68 | 1348.44 | 1057.58 |
| Output Average t/ha | 6.38 | 3.95 | 10.26 |

Clive Blacker (R) discusses the use of real-time sensing as part of the SPAA trials with Sam Trengove (SPAA) (L) and Yorke Peninsula agronomist Ian Koch.

nozzles (marketed as VariTarget™ nozzles) offer additional flexibility to those wanting to deliver specific rates and coverage to varying crop canopies or weed burdens. They can be adjusted on-the-go to change flow rate and/or droplet size. One variable orifice nozzle can replace eight conventional nozzles of varying orifice size.

## Prescription maps

There are only a few situations in UK cropping systems where Clive believes prescription maps are of value; one is for designing variable seeding rate zones. Clive is experimenting with producing seeding rate zone maps from a combination of electromagnetic conductivity (EM) data, historic yield data and plant emergence data, produced from a scan carried out by an N-sensor mounted on the tractor used for post emergent herbicide application. Sensor values are recorded and correlated to plant density, producing plant emergence and biomass information. So far, trial results are impressive but are not as conclusive or replicable as expected. Further research in a range of locations is continuing.

In a farmer's paddock that Clive is using for his research, a yield map was used to target soil sampling points. From these samples a variation in pH from 5.5 to 8 was identified. Combining these data sources Clive developed a prescription lime map. Clive also finds seasonal yield data vital for the creation of seeding fertiliser application plans. Firstly, nutrient removal by the previous crop is calculated using the yield map. Targeted soil samples are taken to ensure nutrition is not the limitation to yield. This information is combined and converted into nutrient application plans. The result is nutrient levels are maintained at minimum cost.

The fourth place where Clive supports the use of maps is in the form of gross margin maps. He encourages growers to use their input and output data to produce gross margin maps as it is the cost per tonne of production that really controls the bottom line.

## New developments

Two other new developments presented by Clive related to telematics and traceability.

Telematics can be defined as the science of sending, receiving and storing information via telecommunication devices; this can include linkages to GPS in relation to vehical navigation.

Claas is using telematics in the latest grain harvesters released in Europe, to provide a centralised monitoring system that allows authorised external users to gather data from the harvester. The system enables remote diagnosis of mechanical problems, identification of poor set-up and consequent performance. A league table of performance is produced to encourage users that improving set-up can not only reap more crop but other rewards, for example, save time or improve sample quality.

Tracebility is a hot topic in Europe driven by food scares. Clive sited one example, where a 30% reduction in the consumption of leafy greens occurred following the death of an individual from E.coli and the hospitalisation of 19 others; all of whom had consumed spinach. The cost to the horticultural industry was estimated to be at least $120 million.

A new system of automated agrochemical identification and delivery, offers improved traceability as well as accuracy and health and safety benefits. This system, being developed at Silsoe College, has been designed to reduce the burden on farmers and operators to keep records. By using the latest Radio Frequency Identification Systems (RFID, as used in retail outlets) attached to agrochemical packs it is possible to log and track a product or container through the application process from delivery to application without having to write anything down.

This system has the ability to show users the required products and application rates; an alarm sounds if an operator tries to add the wrong product into the spray tank. By combining the product, local weather and GPS information it is possible to provide a true picture of where, when and how products were applied with the minimum of errors and pen pushing.

In 2004, Clive Blacker used his Nuffield Scholarship to explore the evolving topic of PA, the technologies and their application. One of the outcomes of his study was to start the PA consultancy business Precision Decisions, to help arable farmers use precision technology to make money. His business offers advice on: equipment purchase, equipment hire, technical support, full project management including experiment management and training.

Clive Blacker is working closely with Allan Mayfield Consulting and SPAA committee member Ashley Wakefield on researching and verifying the use of real-time sensing in Australian broadacre cropping.

***For more information***
***Clive Blacker***
***00 11 44 7808 367456***
***clive@precisiondecisions.co.uk***