New Grain and Soil Sensors at the 5th European Precision Agriculture Conference

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Introduction

The Zeltex "AccuHarvest On-Combine Grain Analyzer" and a Soil pH and Lime Requirement Measurement System (SpHLRMS) prototype were presented at the 5th European Precision Agriculture Conference (5ECPA), June 9-12 in Uppsala, Sweden. These technologies open new opportunities for Corn Belt farmers. The grain quality sensor could be used to segregate grain by protein or oil content for better marketing, or by mapping protein to diagnose nitrogen efficiency problems. The buffer pH sensor could eliminate the need for manual soil sampling to guide lime application.

5ECPA was held on the main campus of the Swedish University of Agricultural Sciences (SLU) at Uppsala, Sweden, June 9-12, 2005. The conference was organized by SLU and the Swedish Institute of Agricultural and Environmental Engineering (JTI). It drew some 420 participants from 38 countries. There were 158 oral presentations at the conference and 130 poster abstracts.

The Zeltex on-combine grain analyzer samples every eight seconds (Zeltex, Inc.)

Overall, there were many new and recycled ideas at the conference. Researchers from the Royal Agricultural and Veterinary University of Denmark (KVL) presented new ideas for robot use in weed control and pest management. As in previous conferences several presentations purported to show that variable rate fertilizer application would reduce overall fertilizer use and increase profits, without mentioning the cost of soil testing and variable rate application. Other presentations replowed old ground in discussing the use of satellite and aerial remote sensing to measure various crop and soil properties, put did not mention the problems encountered by entrepreneurs trying to commercialize such imagery.

Zeltex Grain Quality Sensor

The grain quality sensor is mounted on the combine clean grain elevator. Depending on the combine ground speed, the sensor automatically samples grain four or five times per minute. The sensor works by analyzing near infrared (NIR) light transmitted through a grain sample. The conference featured presentations on use of the sensor for wheat protein in Australia and in Montana.

NIR technology is widely used for countertop grain quality assessment in laboratories and offices. There have been several attempts to develop on-combine quality sensors. Case New Holland (CNH) tested a grain quality sensor in Australia and was poised to introduce it in the

North American market, when it decided to abandon the product. It is rumored that the CNH sensor had technical problems, particularly in calibration, and that CNH marketing was concerned that the potential market for the sensor was too small to justify production.

"You can't test the quality of moving grain," said Todd Rosenthal, president of Zeltex, Inc. explicitly criticizing previous attempts to measure protein and oil content of grain as it moved past a sensor. The Zeltex monitor takes a sample from the clean grain elevator, analyzes it and exhausts the sample back into the elevator, all in about eight seconds per sample.

Rosenthal said that the sensor is on the market priced at $11,000 including a global positioning systems (GPS) unit and a personal digital assistant (PDA) to record data. More information is available at http://www.zeltex.com.

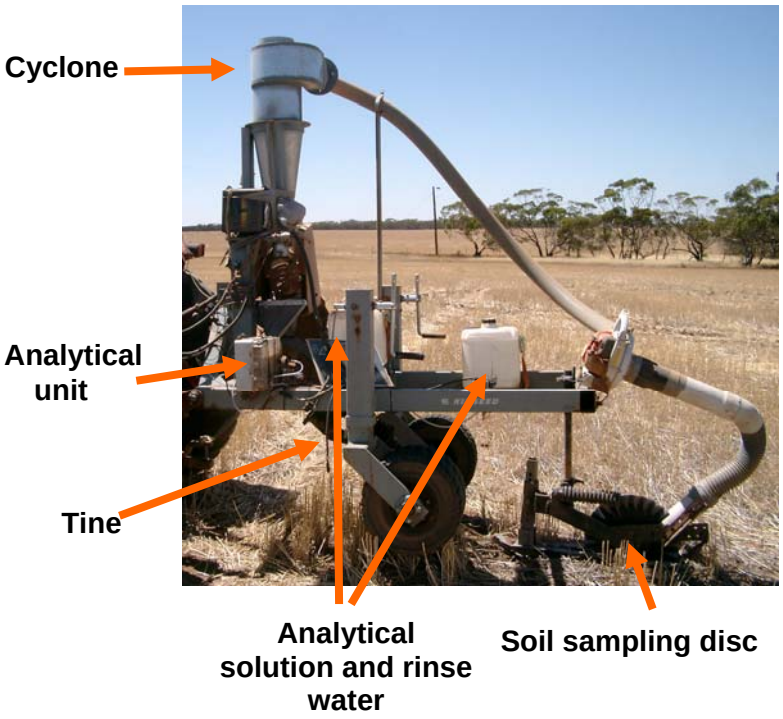
Buffer pH Sensor

The buffer pH sensor is being developed by researchers from the Australian Centre for Precision Agriculture, the Swedish Institute for Agricultural and Environmental Engineering (JTI) and Computronics Holdings Limited (a company based in Perth, Australia). The sensor takes a soil sample, mixes it with a buffer solution and a reading is taken by an ion sensitive field effect transistor (ISFET). A test of the sensor in West Australia was reported at the 5ECPA.

The Swedish-Australian sensor differs from the pH senor developed at Purdue and commercialized by Veris (see http://www.purdue.edu/SSMC, click on December, 2004 for more details) by providing a measure of reserve acidity in addition to active acidity. Because soils differ in chemical composition, the amount of lime needed to change pH levels differs widely. Buffer pH takes those differences in neutralizing power into account and can be used directly to create lime recommendations.

Users of the Veris sensor typically must do some manual sampling to obtain buffer pH. They use the active pH data and electrical conductivity (EC) from the sensor to identify spatial patterns in pH and develop pH management zones, but often must use some manual sampling to determine the amount of lime needed within each zone.

The SpHLRMS uses a fluted coulter to throw soil into a hopper for sampling instead of the piston mechanism in the Veris machine. This results in the SpHLRMS sample being a strip rather than a point.



The on-the-go soil pH and lime requirement measuring system uses a fluted coulter to collect samples (Australian Centre for Precision Agriculture)

Alex McBratney, director of the Australian Precision Agriculture Center, and one of the developers of SpHLRMS, said that one concern about the sensor is disposal of the caustic solution needed to determine lime requirements. Most soil sensors simply eject the tested sample back into the field. The quantity of soil and amount of buffer solution is small, but concerns are being raised about the potential environmental effect of these spent samples.

Viacheslav (Slava) Adamchuk, University of Nebraska, said that he is working with Veris to develop an improved Mobile Sensing Platform (MSP) that would measure potassium (K) and nitrate, as well as buffer pH. While a graduate student at Purdue, Adamchuk played a key role in developing the Veris pH sensor.

Implications

One potential use of grain quality sensors would be to identify protein, oil content and other characteristics in the field, and use that information to harvest selectively and route loads to different markets. Rosenthal gave the example of an Australian producer who harvested strips through several fields to find wheat that would satisfy the protein requirements of a contract and thereby avoided the substantial penalties for delivering low protein product.

In the longer run, it is possible to imagine growers identifying landscape areas that consistently produce grain with specific characteristics (e.g. higher protein on hilltops) and harvesting those separately. Alternatively, inventors are already thinking about combines with multiple bins, so that grain can be segregated on-the-go.

Another use of the grain quality sensor would be to identify nitrogen deficient and excess areas. Grain protein is often highly correlated with the nitrogen status of the plant. Low grain protein is often a good indicator of inadequate nitrogen. Grain protein could be one layer in the crop GIS used to generate nitrogen management strategies.

Variable rate application of lime is standard practice for many Eastern Corn Belt farmers, but soil sampling to gather the required information is time consuming and relatively expensive. Because of the expense the spatial density of sampling is often much lower than soil scientists recommend (e.g. 2.5 acre grids). The Veris pH sensor provides a higher density of information, but still often requires some manual sampling. A buffer pH sensor would eliminate the manual sampling and improve on a practice that is already profitable and practical for many producers.