Mechanising on-the-run grain sampling

T. Jensen, L. Zeller, and R. Kelly

Department of Primary Industries, Toowoomba, Queensland, Australia

ABSTRACT

Capturing grain samples at harvest for later grain protein analysis creates logistical complications when spatial position and yield are to be monitored coincidently. The objective of the present study was to develop a sampling device that automatically captures grain during machine harvesting. The device consisted of an on-board GPS, a palm-top computer, a John Deere GreenStar™ moisture meter, and an interface box linking the components.The device has been tested on John Deere and Case harvesters. Grain samples of wheat, barley and sorghum crops were taken as frequently as every 25 m of travel. After protein analysis, the resultant protein map has been able to improve the interpretation of coincident yield maps for grain growers in eastern Australia. Additional qualitative information that influence grain price or which highlight yield-limiting factors, such as kernel weight, moisture, density or colour, may be also obtained from samples captured by the device.

KEY WORDS

Sampling, precision agriculture, grain protein, mapping.

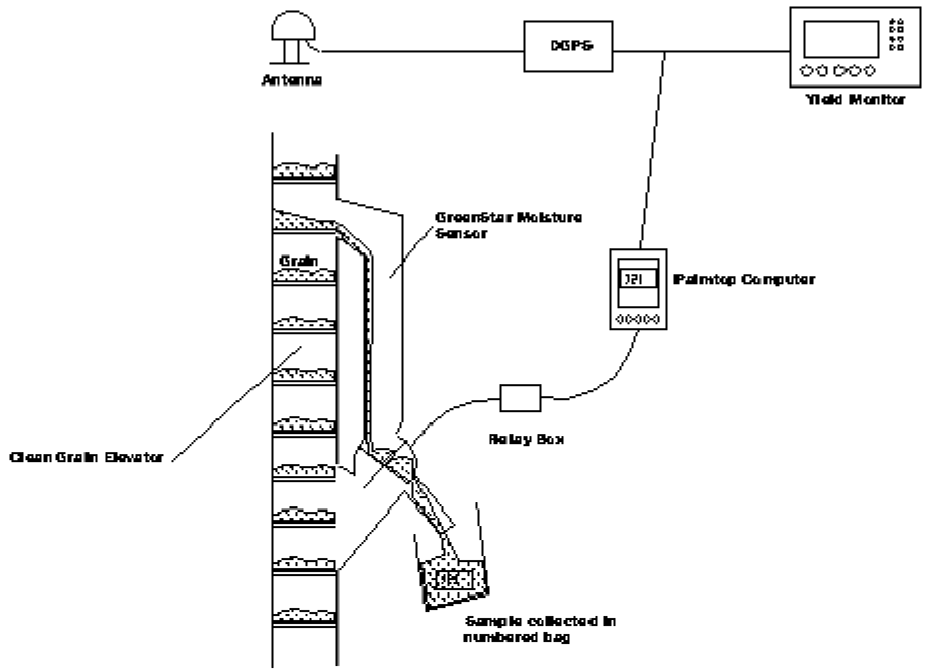
INTRODUCTION

At the commencement of the GRDC funded project "Strategies to apply yield maps to identify and correct yield limiting factors for northern cereal crops" we were led to believe that an 'on-the-go' grain protein meter would be available. This proved not the case. Thus, we have invested considerable project resources to enable us to collect grain samples intensively during commercial grain harvesting. The primary intention was to use these grain samples to create a high-resolution grain protein map to coincide with a yield map created with data captured from the yield monitor. The device could also be used to enable other grain measurements such as kernel weight, moisture, density, colour etc.

DEVICE

The sampling apparatus (schematically represented in figure 1) consisted of several components that will be detailed below.

Figure 1 Schematic representation of the sampling apparatus



Positional Signal

In order to create a grain protein map that was coincidental with a yield map generated by a yield monitor, the samples had to be geo-referenced. Rather than running an additional GPS, the output of the GPS was split before the yield monitor. Because the positional data is from the same source, yield and protein data can be accurately overlayed during map creation.

Palm-top Computer

A palm-top computer (COMPAQ Aero 2100) was utilised to capture the positional data (latitude and longitude), compute distance travelled, initiate the sampling sequence and record data. The Aero 2100 was selected for the highly reflective thin film transistor (TFT) screen that is visible in direct sunlight. Being able to see the screen was essential to ensure the samples did not get out of order and to enable the fine-tuning of the operating parameters. The ability to modify the sample number and sampling distance on-the-go was an essential feature of the program.

The data that was stored for each sample included the positional data (latitude and longitude), GPS time, distance travelled since last sample and the sample number.

Sampler

The sampler consisted of a modified John Deere GreenStar^{TM} moisture sensor. In normal operating mode, the sensor diverted a small continuous grain flow from the clean grain elevator. The grain passed over capacitance plates and was returned to the elevator via a paddle wheel driven by a direct current motor. To meet our needs, we removed the capacitance plates and electronics of the moisture sensor. The polarity of the voltage supply to the motor driving the paddle wheel was controlled enabling it to rotate in both directions. A slot was cut in the existing housing that enables a subsample to be diverted for capture.

Controller

The handshake lines (RTS and DTR) of the serial port of the palm-top computer were used to control the direction of the motor driving the paddle. These signals via optical isolation were used to operate relays, which control the polarity of the supply voltage to the motor and thus the direction of the paddle. The relays were housed in a sealed box that also acted as a junction for other cabling.

OPERATION

With the combine travelling at approximately 2 ms^{-1}, it is possible to collect a 70-100g sample ever 40m of travel. The sample size is somewhat dependent on the crop yield, type, moisture content etc. Of the 20 seconds between samples, only 4-5 seconds was required to direct the sample into the sample bag, the remaining time was required to close and store the bag and be ready to bag the next sample.

The sampling device described has been tested on several models of John Deere and a Case harvester (plans are underway to mount on a New Holland). Grain samples of wheat, barley and sorghum have been successfully collected from paddocks in Central Queensland, the Darling Downs and from the Moree region. Over 10 000 samples have been collected and analysed for protein since the start of the project.

RESULTS

The collected samples were taken back to the laboratory and analysed for protein using NIR analysis. The yield and protein maps (shown in Figure 2) are from a barley paddock, Jimbour Queensland harvested in 1999. The protein map can facilitate the improved interpretation of the coincident yield maps for grain growers in eastern Australia. This approach will be advanced in another paper being presented at this conference titled *“Strategies to interpret the yield map: Defining yield-limiting factors”* by R. Kelly, W. Strong, T. Jensen and D. Butler**.**

Farmers may utilise this information in the future to enable profitable segregation of grain during harvest. In the 1999 barley crop (map shown below) there would have been potential to maximise the total value of the crop by harvesting and segregating the left third of the paddock separately from the rest of the paddock. Grain in that section of the paddock would have attracted a premium for malting grade barley that was lost by harvesting the paddock as a whole production unit. Since nitrogen supplies are largely responsible for such variations in grain quality, it is likely that similar patterns of cereal crop production may recur.

Hence, it is feasible that a coincidental protein map that we can provide may enable farmers to selectively harvest areas of paddocks to meet quality market requirements. They may also enable determination of nitrogen removal spatially (discussed in the paper *“Strategies to interpret the yield map: Defining yield-limiting factors”* by R. Kelly, W. Strong, T. Jensen and D. Butler) and to provide another data layer for precision farming applications. Additional qualitative information that influence grain price or which highlight yield-limiting factors, such as kernel weight, moisture, density or colour, may be also obtained from the samples.

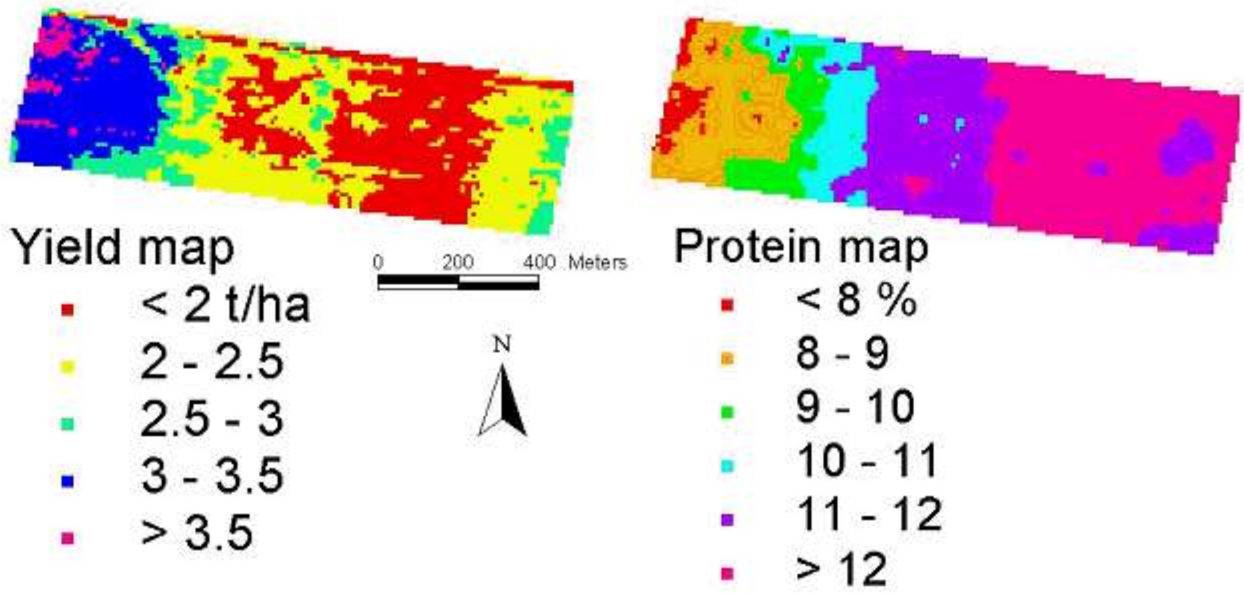


Figure 2. Yield and Protein map for a barley paddock at Jimbour, Queensland, 1999.

CONCLUSION

This sampling device is a very useful tool for capturing grain during commercial grain harvest, where grain parameters are required to be determined with very intensive sampling. The device will also provide independent measures of grain protein when it is necessary to trial on-the-go protein monitors that eventually will make obsolete the device.

ACKNOWLEDGEMENTS

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