

Application Note 131: Australian Wheat and Barley Validation Study using two Cropsan Loren 1000G



Introduction:

On farm storage is becoming a common practice in the Australian grains industry. By storing grain on farm, growers can gain advantages in marketing their grain by blending to meet specific grain grades. As well, growers can improve the efficiency of their harvest program by reducing the lost time due to long queues at silos during harvest peak periods. To optimize the payback for investing in on farm storage, growers require a rapid and accurate NIR analyser to measure the protein and moisture of their grains.

The Cropsan Loren 1000G On Farm Analyser has been developed to provide growers with a transportable NIR analyser that can be used in the field or in the shed. The Loren 1000G uses the same near infrared transmission technology as used in the Cropsan 1000B and Cropsan 2000B analysers that are certified under the NMI V10 protocol. The Cropsan Loren 1000G incorporates a flow through sampling system to collect up to 10 scans from a sample of wheat or barley as they are passed in front of the light beam. The sample scans are averaged and results for protein and moisture are predicted based on Partial Least Squares (PLS) calibration models stored in the instrument's memory.

NIR Technology Systems has accrued spectra of several thousand samples of wheat and barley, which have been used to develop a calibration for protein and moisture in Australian Hard Wheat and Malting grade and feed Grade Barley samples.

This study provides a validation of the wheat and barley calibration models that are provided with the Cropsan Loren 1000G On Farm Analyser.

Validation:

In order to validate the calibration models developed for Wheat and Barley samples, two sets of Certified Reference Materials, 5 wheat and 5 barley, were sourced from Ceretec Pty Ltd, a subsidiary of ABB Grains, Adelaide, SA, and Graincorp Technical Centre Laboratory, Graincorp Narrabri, NSW. These samples have been tested at least 6 times and as such have highly accurate protein and moisture values.

These samples were scanned in duplicate on 2 Cropsan Loren 1000G analysers. The results were tabulated and the Standard Error of Prediction (SEP)* and the Standard Deviation of Differences (SDD) were calculated for protein and moisture.

* SEP indicates accuracy where as SDD indicates precision of the measurements.

Figures 1 a&b and 2a&b show the prediction plots for protein and moisture in Wheat using the 2 Cropsan Loren 1000G's.

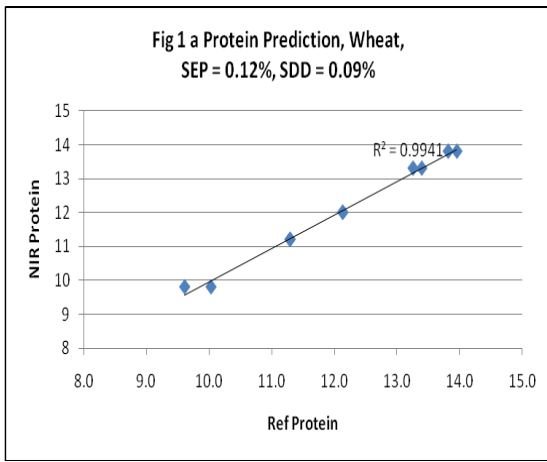


Figure 1a. Prediction Plot of Protein in Wheat

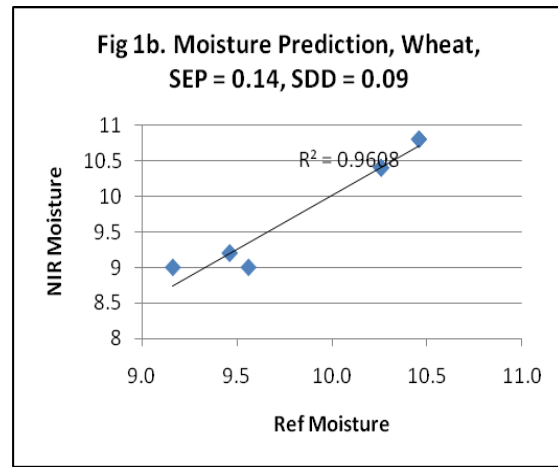


Figure 1b. Prediction Plot for Moisture in Wheat

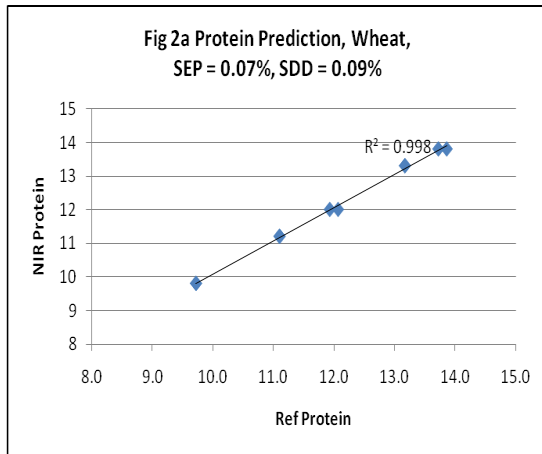


Figure 2a. Prediction Plot for Protein in Wheat

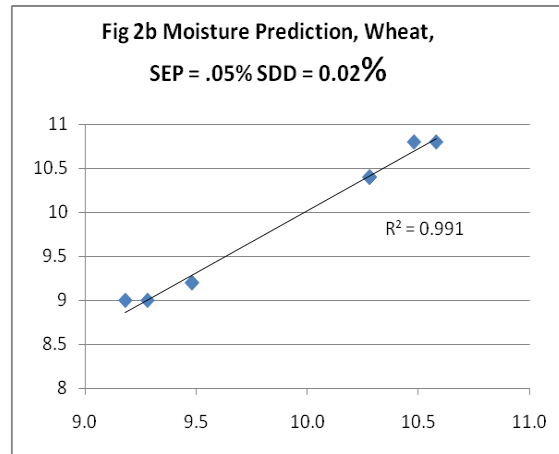


Figure 2b. Prediction Plot for Moisture in Wheat

Figures 3a&b and 4a&b show the prediction plots for protein and moisture in Barley using the Cropscan Loren 1000G

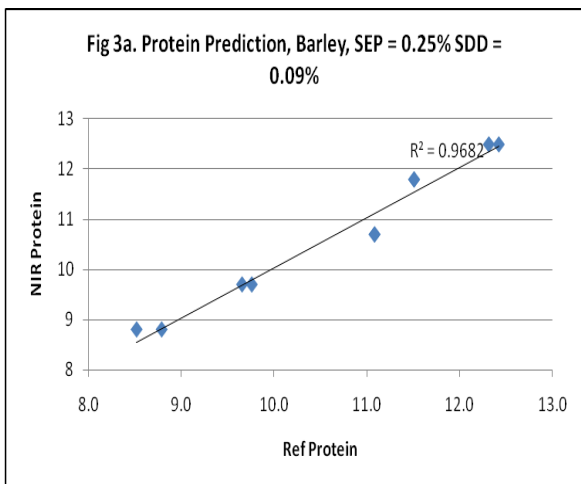


Figure 3a. Prediction Plot for Protein in Barley

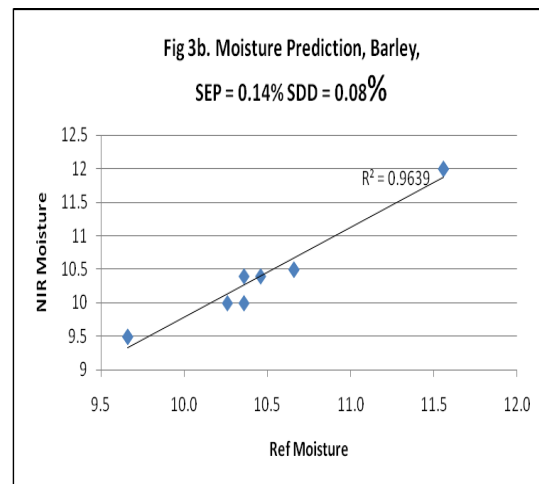


Figure 6. Prediction Plot for Moisture in Barley

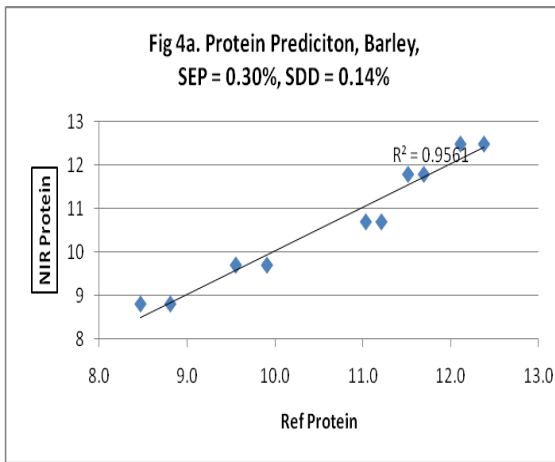


Figure 4a. Prediction Plot for Protein in Barley

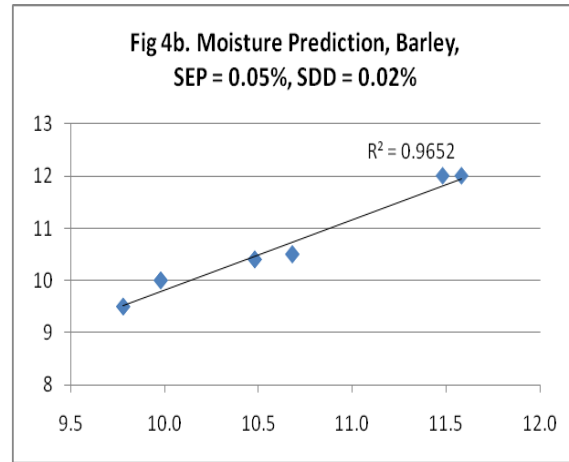


Figure 4b. Prediction Plot for Moisture in Barley

The Standard Error of Prediction (SEP) and Standard Deviation of Differences (SDD) for each set of data are show in table 1.

Table 1.

| Product | Cropsan 1000G –S/N 06 | | | | Cropsan 1000G – S/N 08 | | | |
|---------|-----------------------|------|----------|------|------------------------|------|----------|------|
| | Protein | | Moisture | | Protein | | Moisture | |
| | SEP | SDD | SEP | SDD | SEP | SDD | SEP | SDD |
| Wheat | 0.12 | 0.09 | 0.14 | 0.09 | 0.07 | 0.09 | 0.05 | 0.02 |
| Barley | 0.25 | 0.09 | 0.14 | 0.08 | 0.30 | 0.14 | 0.05 | 0.02 |

3 Day Stability Tests

The same 5 wheat and barley samples were analysed on the next two days in order to assess the 3 day stability of the analysers. Table 2. Shows the results for wheat and Table 3 shows the results for barley.

Table 2. Wheat 3 Day Stability

| Protein | Day 1 | Day 2 | Day 3 | Ave | Ave - Day 1 | Ave - Day2 | Ave - Day3 |
|---------|-------|-------|-------|------|-------------|------------|------------|
| 11.3 | 11.3 | 11.2 | 11.3 | 11.3 | 0.0 | 0.1 | 0.0 |
| 11.3 | 11.3 | 11.3 | 11.3 | 11.3 | 0.0 | 0.0 | 0.0 |
| 13.4 | 13.4 | 13.0 | 13.2 | 13.2 | -0.2 | 0.2 | 0.0 |
| 13.3 | 13.3 | 13.1 | 13.1 | 13.2 | -0.1 | 0.0 | 0.1 |
| 10.0 | 10.0 | 10.0 | 9.8 | 10.0 | -0.1 | -0.1 | 0.2 |
| 9.6 | 9.6 | 9.9 | 10.0 | 9.8 | 0.2 | -0.1 | -0.2 |
| 12.1 | 12.1 | 12.0 | 12.0 | 12.0 | -0.1 | 0.0 | 0.0 |
| 12.1 | 12.1 | 12.0 | 12.2 | 12.1 | 0.0 | 0.1 | -0.1 |
| 13.8 | 13.8 | 13.8 | 14.0 | 13.9 | 0.1 | 0.1 | -0.2 |
| 14.0 | 14.0 | 14.1 | 14.0 | 14.0 | 0.1 | -0.1 | 0.0 |

SDD 0.10

| Moisture | | | | | | |
|----------|-------|------|------|----------|-----------|----------|
| Day 1 | Day 2 | Day3 | Ave | Ave-Day1 | Aved-day2 | Ave-Day3 |
| 10.3 | 10.3 | 10.2 | 10.2 | 0.0 | 0.0 | 0.0 |
| 10.3 | 10.3 | 10.2 | 10.2 | 0.0 | 0.0 | 0.0 |
| 10.5 | 10.5 | 10.4 | 10.4 | 0.0 | 0.0 | 0.0 |
| 10.5 | 10.5 | 10.4 | 10.4 | 0.0 | 0.0 | 0.0 |
| 9.6 | 9.2 | 9.1 | 9.3 | -0.3 | 0.1 | 0.2 |
| 9.2 | 9.2 | 9.2 | 9.2 | 0.0 | 0.0 | 0.0 |
| 10.3 | 10.3 | 10.2 | 10.2 | 0.0 | 0.0 | 0.0 |
| 10.3 | 10.3 | 10.3 | 10.3 | 0.0 | 0.0 | 0.0 |
| 9.5 | 9.5 | 9.4 | 9.4 | 0.0 | 0.0 | 0.0 |
| 9.5 | 9.5 | 9.4 | 9.4 | 0.0 | 0.0 | 0.0 |
| SDD | | | | | | 0.07 |

Table 3. Barley 3 Day Stability

| Protein | | | | | | |
|----------|-------|-------|------|-------------|------------|------------|
| Day 1 | Day 2 | Day 3 | Ave | Ave - Day 1 | Ave - Day2 | Ave - Day3 |
| 8.5 | 9.0 | 8.6 | 8.7 | 0.2 | -0.3 | 0.1 |
| 8.8 | 8.5 | 8.9 | 8.8 | 0.0 | 0.2 | -0.2 |
| 9.8 | 9.9 | 9.9 | 9.9 | 0.1 | -0.1 | 0.0 |
| 9.7 | 9.6 | 9.8 | 9.7 | 0.0 | 0.1 | -0.1 |
| 11.1 | 10.9 | 11.3 | 11.1 | 0.0 | 0.2 | -0.2 |
| 11.1 | 11.1 | 11.2 | 11.1 | 0.0 | 0.0 | -0.1 |
| 11.5 | 11.5 | 11.8 | 11.6 | 0.1 | 0.1 | -0.2 |
| 11.5 | 11.2 | 11.5 | 11.4 | -0.1 | 0.2 | -0.1 |
| 12.4 | 12.7 | 12.0 | 12.4 | 0.0 | -0.3 | 0.4 |
| 12.3 | 12.3 | 12.1 | 12.2 | -0.1 | 0.0 | 0.1 |
| SDD | | | | | | 0.16 |
| Moisture | | | | | | |
| Day 1 | Day 2 | Day3 | Ave | Ave-Day1 | Aved-day2 | Ave-Day3 |
| 11.6 | 11.5 | 11.4 | 11.5 | -0.1 | 0.0 | 0.1 |
| 11.6 | 11.4 | 11.4 | 11.4 | -0.1 | 0.1 | 0.0 |
| 10.4 | 10.4 | 10.3 | 10.3 | 0.0 | 0.0 | 0.0 |
| 10.5 | 10.4 | 10.4 | 10.4 | -0.1 | 0.0 | 0.0 |
| 10.7 | 10.7 | 10.6 | 10.6 | 0.0 | 0.0 | 0.0 |
| 10.7 | 10.7 | 10.7 | 10.7 | 0.0 | 0.0 | 0.0 |
| 9.7 | 9.8 | 9.6 | 9.7 | 0.0 | -0.1 | 0.1 |
| 9.7 | 9.8 | 9.7 | 9.7 | 0.0 | -0.1 | 0.0 |
| 10.3 | 10.2 | 9.9 | 10.1 | -0.2 | -0.1 | 0.2 |
| 10.4 | 10.2 | 10 | 10.2 | -0.2 | 0.0 | 0.2 |
| SDD | | | | | | 0.08 |

Temperature Stability:

To assess the effects of temperature on calibration and instruments, the five samples of wheat and barley were cooled to 10C and analysed. The same samples were then heated to 40C and analysed. Table 4. Shows the effect of temperature on the prediction of protein and moisture.

Table 4. Sample Temperature Dependence

| Sample Temperature | | Wheat Protein | | | Sample Temperature | | Wheat Moisture | | |
|--------------------|------|----------------|-----------|---------|--------------------|------|-----------------|-----------|---------|
| 10C | 24C | 40C | 24C - 10C | 24C-40C | 10C | 24C | 40C | 24C - 10C | 24C-40C |
| 11.6 | 11.4 | 11 | -0.2 | 0.4 | 10 | 10.2 | 10.4 | 0.2 | -0.2 |
| 11.8 | 11.4 | 11 | -0.4 | 0.4 | 10 | 10.2 | 10.3 | 0.2 | -0.1 |
| 13.8 | 13.1 | 13 | -0.7 | 0.1 | 10.2 | 10.4 | 10.7 | 0.2 | -0.3 |
| 13.4 | 13.2 | 13 | -0.2 | 0.2 | 10.3 | 10.3 | 10.6 | 0 | -0.3 |
| 10.2 | 9.7 | 9.6 | -0.5 | 0.1 | 9.1 | 9.1 | 9.2 | 0 | -0.1 |
| 10.2 | 9.8 | 9.6 | -0.4 | 0.2 | 9.1 | 9.2 | 9.2 | 0.1 | 0 |
| 12.5 | 12.3 | 12 | -0.2 | 0.3 | 10.2 | 10.2 | 10.5 | 0 | -0.3 |
| 12.3 | 12.2 | 12 | -0.1 | 0.2 | 10 | 10.2 | 10.4 | 0.2 | -0.2 |
| 14 | 13.7 | 13.7 | -0.3 | 0 | 9.2 | 9.4 | 9.5 | 0.2 | -0.1 |
| 14.1 | 14 | 13.8 | -0.1 | 0.2 | 9.3 | 9.3 | 9.5 | 0 | -0.2 |
| | | Average | -0.31 | 0.21 | | | Average | 0.11 | -0.18 |
| Sample Temperature | | Barley Protein | | | Sample Temperature | | Barley Moisture | | |
| 10C | 24C | 40C | 24C - 10C | 24C-40C | 10C | 24C | 40C | 24C - 10C | 24C-40C |
| 10.9 | 10.1 | 8.5 | -0.8 | 1.6 | 11.1 | 11.5 | 11.9 | 0.4 | -0.4 |
| 10.9 | 10.3 | 9 | -0.6 | 1.3 | 11.1 | 11.4 | 11.7 | 0.3 | -0.3 |
| 12 | 11.8 | 9.9 | -0.2 | 1.9 | 10.1 | 10.3 | 10.6 | 0.2 | -0.3 |
| 11.9 | 11.5 | 10.5 | -0.4 | 1 | 10.1 | 10.4 | 10.5 | 0.3 | -0.1 |
| 13.7 | 12.5 | 11.2 | -1.2 | 1.3 | 10.4 | 10.6 | 10.9 | 0.2 | -0.3 |
| 13.5 | 12.7 | 11.2 | -0.8 | 1.5 | 10.4 | 10.6 | 10.8 | 0.2 | -0.2 |
| 14.1 | 13.1 | 12.2 | -1 | 0.9 | 9.5 | 9.7 | 10 | 0.2 | -0.3 |
| 14.1 | 13 | 12.6 | -1.1 | 0.4 | 9.6 | 9.6 | 9.9 | 0 | -0.3 |
| 14.3 | 13.8 | 13.2 | -0.5 | 0.6 | 9.8 | 9.9 | 10.1 | 0.1 | -0.2 |
| 14.6 | 13.6 | 12.8 | -1 | 0.8 | 9.9 | 10 | 10.2 | 0.1 | -0.2 |
| | | Average | -0.76 | 1.13 | | | Average | 0.2 | -0.26 |

The same 5 samples were returned to room temperature, ie, 24C. The CropScan 1000G's were placed in an environmental chamber at 10C for several hours, The 5 samples were scanned in duplicate. The instruments were then placed back into the environmental chamber at 40C for several hours. Table 5. shows the results for protein and moisture at 10C, 24C and 40C.

Table 5. Analyser Temperature Dependence

| Analyser Temperature | | | Wheat Protein | | Analyser Temperature | | | Wheat Moisture | |
|----------------------|------|---------|----------------|---------|----------------------|------|---------|-----------------|---------|
| 10C | 24C | 40C | 24C - 10C | 24C-40C | 10C | 24C | 40C | 24C - 10C | 24C-40C |
| 11.6 | 11.4 | 10.9 | -0.2 | 0.5 | 10.1 | 10.2 | 10.1 | 0.1 | 0.1 |
| 11.8 | 11.4 | 10.9 | -0.4 | 0.5 | 10.1 | 10.2 | 10.2 | 0.1 | 0 |
| 13.8 | 13.1 | 12.6 | -0.7 | 0.5 | 10.3 | 10.4 | 10.4 | 0.1 | 0 |
| 13.4 | 13.2 | 12.7 | -0.2 | 0.5 | 10.3 | 10.3 | 10.4 | 0 | -0.1 |
| 10.2 | 9.7 | 9.2 | -0.5 | 0.5 | 9.2 | 9.1 | 9.2 | -0.1 | -0.1 |
| 10.2 | 9.8 | 9.6 | -0.4 | 0.2 | 9.1 | 9.2 | 9.2 | 0.1 | 0 |
| 12.5 | 12.3 | 11.9 | -0.2 | 0.4 | 10.2 | 10.2 | 10.2 | 0 | 0 |
| 12.3 | 12.2 | 11.7 | -0.1 | 0.5 | 10.2 | 10.2 | 10.2 | 0 | 0 |
| 14 | 13.7 | 13.7 | -0.3 | 0 | 9.3 | 9.4 | 9.4 | 0.1 | 0 |
| 14.1 | 14 | 13.4 | -0.1 | 0.6 | 9.3 | 9.3 | 9.4 | 0 | -0.1 |
| | | Average | -0.31 | 0.42 | | | Average | 0.04 | -0.02 |
| Analyser Temperature | | | Barley Protein | | Analyser Temperature | | | Barley Moisture | |
| 10C | 24C | 40C | 24C - 10C | 24C-40C | 10C | 24C | 40C | 24C - 10C | 24C-40C |
| 10.8 | 10.1 | 8.6 | -0.7 | 1.5 | 11.6 | 11.5 | 11.9 | -0.1 | -0.4 |
| 11.1 | 10.3 | 8.3 | -0.8 | 2 | 11.6 | 11.4 | 11.7 | -0.2 | -0.3 |
| 12.4 | 11.8 | 9.9 | -0.6 | 1.9 | 10.4 | 10.3 | 10.6 | -0.1 | -0.3 |
| 11.8 | 11.5 | 10.2 | -0.3 | 1.3 | 10.5 | 10.4 | 10.5 | -0.1 | -0.1 |
| 12.8 | 12.5 | 12 | -0.3 | 0.5 | 10.6 | 10.6 | 10.9 | 0 | -0.3 |
| 13.5 | 12.7 | 12 | -0.8 | 0.7 | 10.6 | 10.6 | 10.8 | 0 | -0.2 |
| 13.6 | 13.1 | 12.3 | -0.5 | 0.8 | 9.7 | 9.7 | 10 | 0 | -0.3 |
| 13.4 | 13 | 12.6 | -0.4 | 0.4 | 9.7 | 9.6 | 9.9 | -0.1 | -0.3 |
| 14 | 13.8 | 13.3 | -0.2 | 0.5 | 10.1 | 9.9 | 10.1 | -0.2 | -0.2 |
| 14.4 | 13.6 | 13.8 | -0.8 | -0.2 | 10.1 | 10 | 10.2 | -0.1 | -0.2 |
| | | Average | -0.54 | 0.94 | | | Average | -0.09 | -0.26 |

Discussion:

The SEP data for protein and moisture in wheat and barley lies within the Maximum Permissible Errors as described in the NMI V10 Certification Procedures:

Wheat +/- 0.4%

Barley +/- 0.5%

The fact that the same calibration models have been used on all three CropScan systems, demonstrates the transferability of these calibration models.