Appl Note 185 On Line Analysis of Wheat using the CropScan 3000S In Line Whole Grain Analyser

Introduction.

Flour milling requires control of the protein and moisture content of wheat. Traditionally samples of wheat are collected from each truck load and decisions are made to segregate the wheat into low, medium and high protein silos. These grab samples do not necessarily reflect the protein variation within the truck load. As such a major flour mill in rural NSW installed a CropScan 3000S In Line Whole Grain Analyser to measure protein and moisture in wheat at the in-take elevator of the mill.

A calibration was developed by collecting spectral data from daily intake loads over several weeks. Having a good range of samples with low to high protein and moisture values and different varieties helps to develop a calibration that predict accurately in the future. To validate the CropScan 3000S calibration for wheat, samples from many weeks were compared to the flour mills bench top NIR analyser. This study compares the protein and moisture in wheat as analysed by the CropScan 3000S In Line Whole Grain Analyser with the flour mills' bench top NIR analyser.

Instrumentation.

The CropScan 3000S In Line Whole Grain Analyser uses a remote sampling head to trap a sub sample of grain taken from the in-take elevator and collect the NIR spectra of the grain before returning it to the a conveyer belt. A fiber optic cable transmits the NIR light back to the CropScan 3000S NIT spectrometer located in a Nema IV enclosure that is mounted on the wall near the in-take elevator. The CropScan 3000S uses a diode array spectrometer to scan the wavelength region 720-1100nm. The instrument scans a sample every 11 seconds and displays the individual and averaged protein and moisture values for each load received by the mill on a PC located in the mill's laboratory,.

Calibration:

380 truckloads of wheat were speared and a 500ml sub sample was collected and analysed using the Foss Infratec 1214 NIR Analyser. Each truck load of wheat was emptied into the in-take elevator. The CropScan 3000S In Line Whole Grain Analyser scanned sub sample from the in-take elevator every 11 seconds or 0.35 Tonne of grain loaded into the mill. The spectral data from the CropScan 3000S was averaged for each

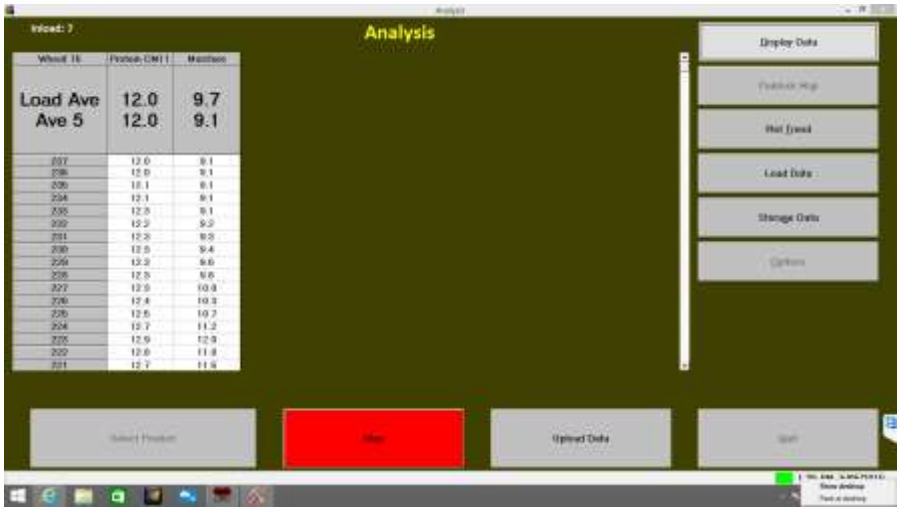
load. The lab data were collected from the Infratec 1241 and combined with the CropScan spectral file. A Partial Least Squares Regression was performed on the combined calibration file using NTAS (NIR Technology Analysis Software) to develop calibration models for protein and moisture.

Software

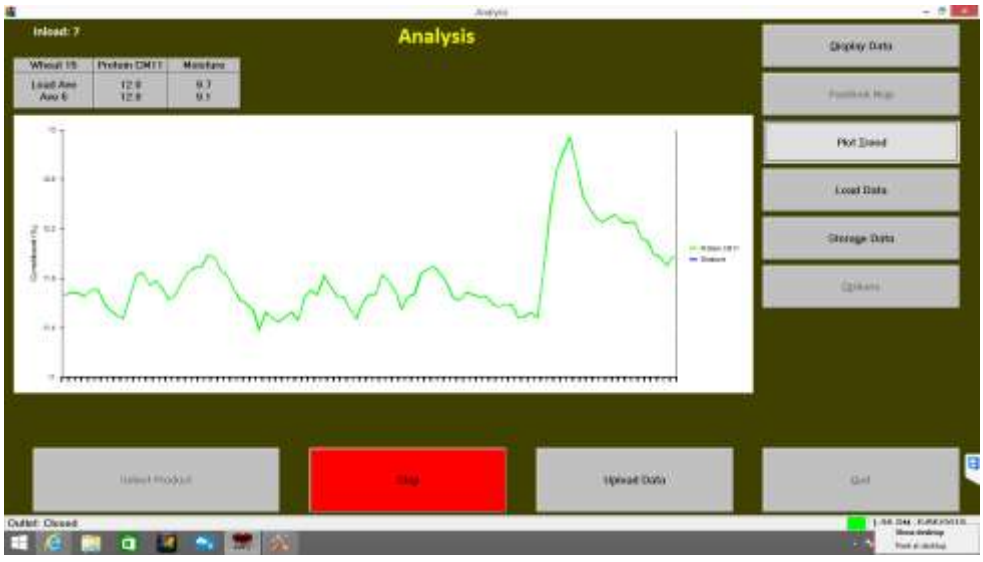
The CropScan 3000S Analysis software displays the Load Ave and Ave of 5 Scans for protein and moisture of the wheat on the systems PC screen. The data provided by the CropScan 3000S allows the mill operators see the real variability of the protein and moisture of the wheat being received and potentially enabling the grain to be segregated in real time as it is received.

The Analysis Software provides 4 screens for the operator to toggle between to retrieve the information quickly.

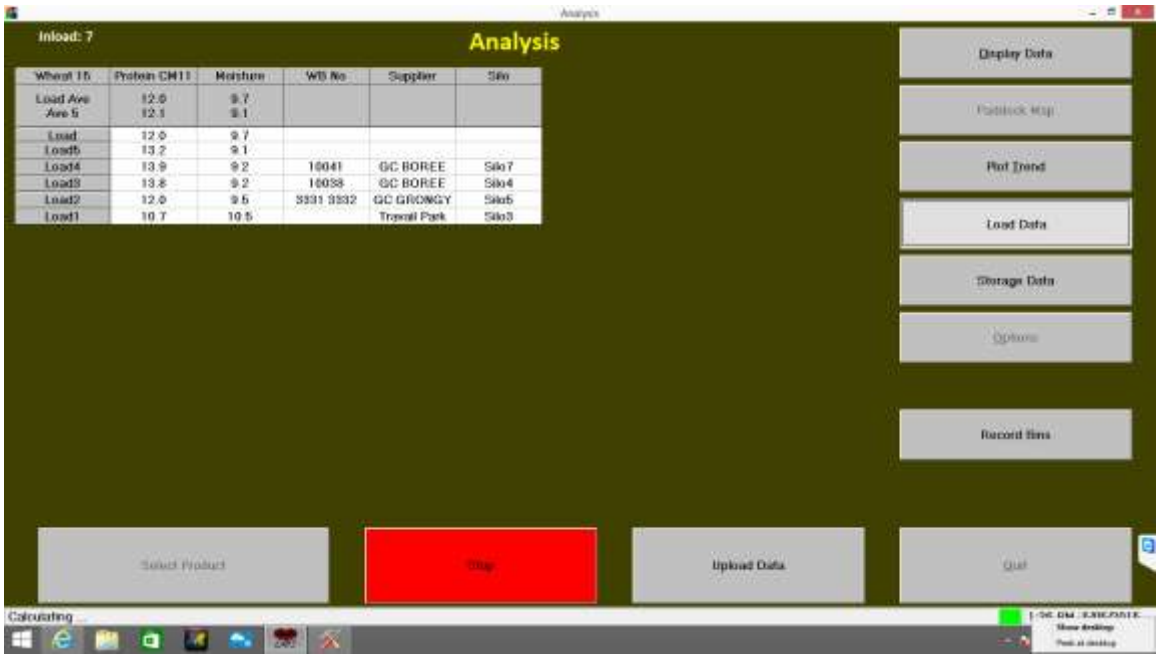
Display Data screen shows the Load Average, Moving Average and the last 100 results scanned by the CropScan 3000S.



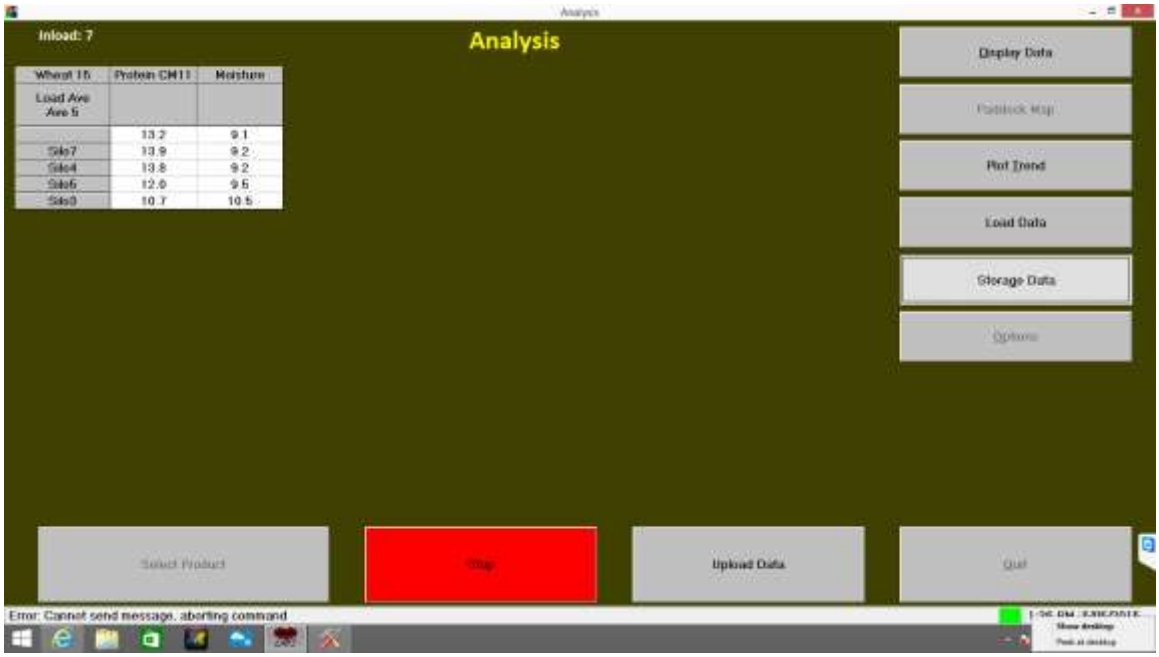
Plot Trend screen shows the results in a trend line plot to show the protein distributing across the entire load.



Load Data screen shows the summary of the day's load averages for protein and moisture with the Weighbridge No, Supplier Name and which Silo the grain was stored into. This allows the operator to quickly view any previous loads results and receival information throughout the day.



Storage Data screen shows the protein and moisture stack averages for each day's in-take.



Results

Calibration Data

Figure 2.1, below, shows the NIT spectra for the Wheat samples.

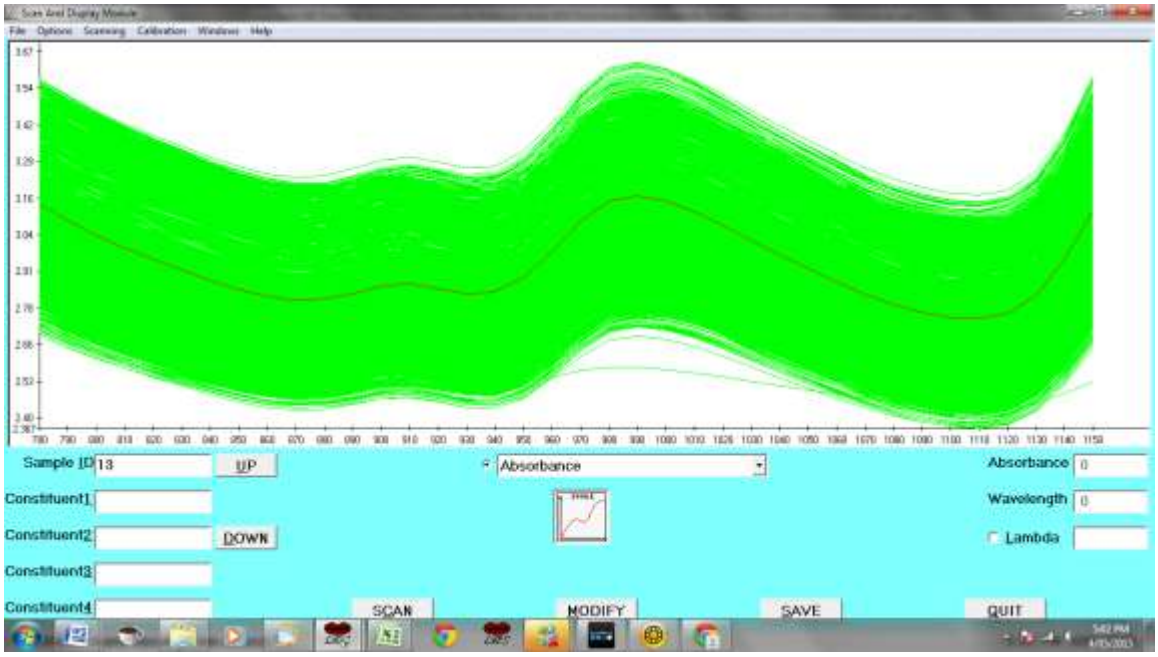


Figure 2.1: Plot of NIR Spectra for Wheat.

Figure 2.2 shows the calibration plot for protein. The Standard Error of Calibration (SEC) was 0.25% with a correlation (R^2) of 0.97.

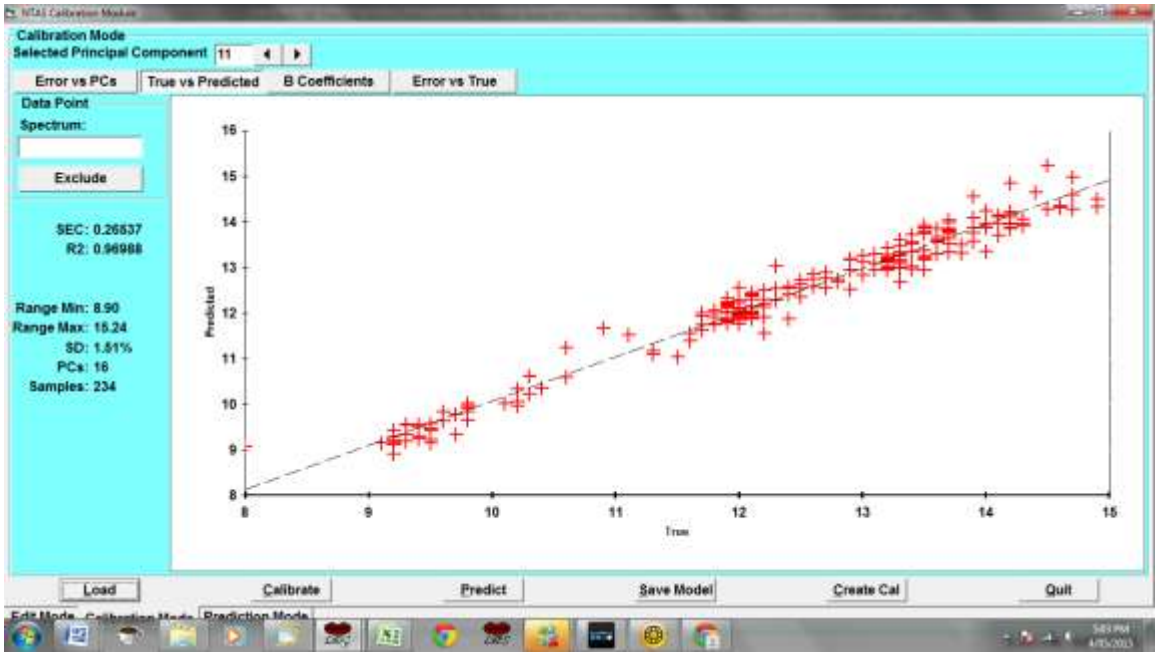


Figure 2.2: Protein Calibration Plot

Figure 2.3 shows the calibration plot for the moisture. The Standard Error of Calibration (SEC) was 0.2% with a correlation (R2) of 0.96.

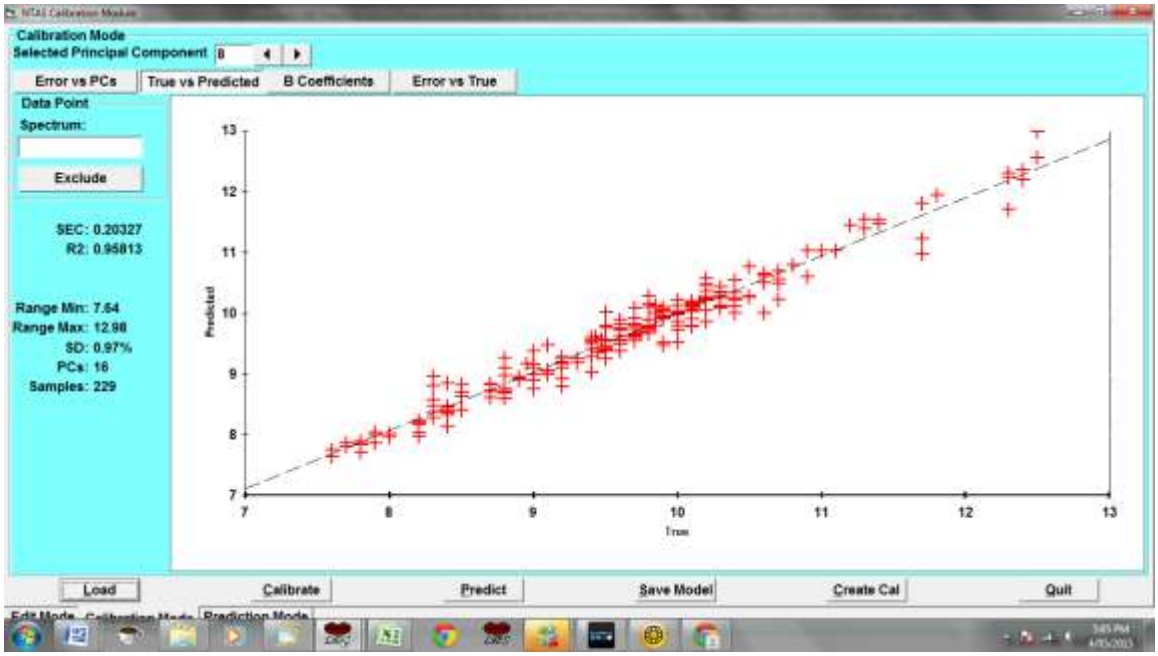


Figure 2.3: Moisture Calibration Plot

Prediction.

82 truckloads of wheat were measured over two weeks to check for accuracy and stability. The table below shows the average protein and moisture results from the CropScan 3000S versus the average results from the laboratory NIR analyser.

Table 1: Predicted CropScan Protein Vs Lab Protein and Moisture.

Load No	Date	Protein	Moisture	Av Foss P	Av Foss M	Diff Protein	Diff Moist
1	10/08/2015	11.9	10.2	11.5	10.3	-0.4	0.1
2	10/08/2015	11.6	9.4	12.4	10.0	0.8	0.6
3	10/08/2015	12.8	9.8	13.1	10.3	0.3	0.5
4	10/08/2015	11.8	8.8	12.0	9.1	0.2	0.3
5	10/08/2015	11.8	8.6	11.8	8.2	0.0	-0.4
6	10/08/2015	9.2	9.0	9.2	9.2	0.0	0.2
7	10/08/2015	13.7	10.3	13.2	10.7	-0.5	0.4
8	10/08/2015	11.9	8.5	11.8	8.6	-0.1	0.1
9	10/08/2015	9.0	9.0	9.1	9.0	0.1	0.0
10	10/08/2015	13.4	9.6	13.5	9.9	0.1	0.3
1	11/08/2015	11.6	9.4	12.5	10.1	0.9	0.7
2	11/08/2015	14.7	9.5	14.6	9.4	-0.1	-0.1
4	11/08/2015	11.8	8.8	12.0	9.1	0.2	0.3
5	11/08/2015	13.6	8.5	13.6	8.8	0.0	0.3
6	11/08/2015	11.6	8.4	11.9	8.7	0.3	0.3
7	11/08/2015	13.2	11.1	12.7	11.2	-0.5	0.1
8	11/08/2015	14.8	9.5	15.0	9.1	0.2	-0.4

9	11/08/2015	12.1	8.8	11.9	9.3	-0.2	0.5
10	11/08/2015	13.5	8.6	13.6	8.7	0.1	0.1
12	11/08/2015	14.1	8.5	13.9	8.6	-0.2	0.1
13	11/08/2015	9.3	8.9	9.3	9.0	0.0	0.1
1	12/08/2015	14.1	9.6	14.5	9.5	0.4	-0.1
2	12/08/2015	14.6	8.6	14.6	8.8	0.0	0.2
3	12/08/2015	9.8	11.0	9.5	10.9	-0.3	-0.1
4	12/08/2015	12.5	8.6	12.2	8.7	-0.3	0.1
5	12/08/2015	12.4	8.5	12.1	8.7	-0.3	0.1
1	13/08/2015	14.7	8.6	14.7	9.0	0.0	0.4
2	13/08/2015	9.9	9.3	9.8	9.5	-0.1	0.2
3	13/08/2015	14.4	8.8	14.4	9.4	0.0	0.6
4	13/08/2015	12.7	8.6	12.1	8.5	-0.6	-0.1
5	13/08/2015	14.5	9.1	14.5	9.2	0.0	0.1
7	13/08/2015	11.8	8.0	11.9	8.3	0.1	0.3
8	13/08/2015	10.1	9.0	9.8	9.6	-0.3	0.6
9	13/08/2015	11.7	8.3	11.8	8.9	0.1	0.6
10	13/08/2015	11.8	8.4	11.8	8.4	0.0	0.0
11	13/08/2015	11.9	8.4	11.9	8.6	0.0	0.2
12	13/08/2015	13.7	9.2	13.6	9.6	-0.1	0.4
1	14/08/2015	13.8	9.6	14.0	9.7	0.2	0.1
2	14/08/2015	13.9	9.5	14.0	9.6	0.1	0.1
3	14/08/2015	13.4	9.2	13.8	9.6	0.4	0.4
4	14/08/2015	11.9	8.4	11.9	8.9	0.0	0.5
5	14/08/2015	12.6	9.7	12.3	9.9	-0.3	0.2
6	14/08/2015	13.7	9.4	14.0	9.1	0.3	-0.3
7	14/08/2015	13.8	9.3	13.9	9.5	0.1	0.1
9	14/08/2015	12.1	9.1	12.2	9.0	0.1	-0.1
10	14/08/2015	13.5	9.3	13.7	9.4	0.2	0.1
2	31/08/2015	12.4	11.0	12.0	11.3	-0.4	0.3
3	31/08/2015	12.5	9.9	12.3	9.7	-0.2	-0.2
4	31/08/2015	14.2	10.5	13.9	10.9	-0.3	0.4
5	31/08/2015	13.6	9.7	13.4	10.0	-0.2	0.3
6	31/08/2015	12.3	11.1	11.8	11.3	-0.6	0.2
7	31/08/2015	9.4	9.3	9.5	9.5	0.0	0.1
9	31/08/2015	14.6	8.2	14.5	8.6	-0.1	0.4
10	31/08/2015	12.6	9.5	12.3	9.2	-0.3	-0.3
11	31/08/2015	12.1	11.2	11.7	11.3	-0.4	0.1
1	1/09/2015	13.6	9.3	13.5	9.6	-0.1	0.3
4	1/09/2015	9.2	10.9	9.2	10.7	0.0	-0.2
5	1/09/2015	11.8	9.1	11.7	9.0	-0.1	-0.1
6	1/09/2015	13.8	8.3	13.8	8.5	0.0	0.2
7	1/09/2015	12.0	8.9	11.9	9.0	-0.1	0.1
8	1/09/2015	9.6	9.2	9.5	9.1	-0.1	-0.1
10	1/09/2015	12.0	8.8	11.9	8.9	-0.1	0.1
11	1/09/2015	11.6	8.8	11.8	8.9	0.2	0.1
1	2/09/2015	12.4	8.7	11.9	8.9	-0.5	0.2
3	2/09/2015	12.0	8.7	11.8	8.8	-0.2	0.1

5	2/09/2015	12.0	10.4	11.7	10.4	-0.3	0.0
1	3/09/2015	12.8	10.8	12.7	11.4	-0.1	0.5
2	3/09/2015	9.8	10.6	9.5	10.5	-0.3	-0.1
3	3/09/2015	9.0	10.8	9.2	10.7	0.2	-0.1
4	3/09/2015	12.0	11.5	11.9	11.6	-0.1	0.1
5	3/09/2015	12.0	10.7	11.7	11.3	-0.3	0.6
6	3/09/2015	13.6	9.2	13.8	8.8	0.2	-0.4
7	3/09/2015	12.1	11.1	11.6	11.5	-0.5	0.4
1	4/09/2015	12.0	11.0	11.7	11.1	-0.3	0.1
2	4/09/2015	13.7	8.4	13.8	8.4	0.1	0.0
3	4/09/2015	13.6	8.3	13.8	8.5	0.2	0.2
4	4/09/2015	12.2	10.8	11.8	11.1	-0.4	0.3
5	4/09/2015	13.4	8.4	13.3	8.4	-0.1	0.0
					Average	-0.1	0.2
					STD	0.28	0.25

Figures 2.3 through 2.6 show plots and graphs comparing the results from the CropScan 3000S In Line Whole Grain Analyser vs the flour mills laboratory analyser.

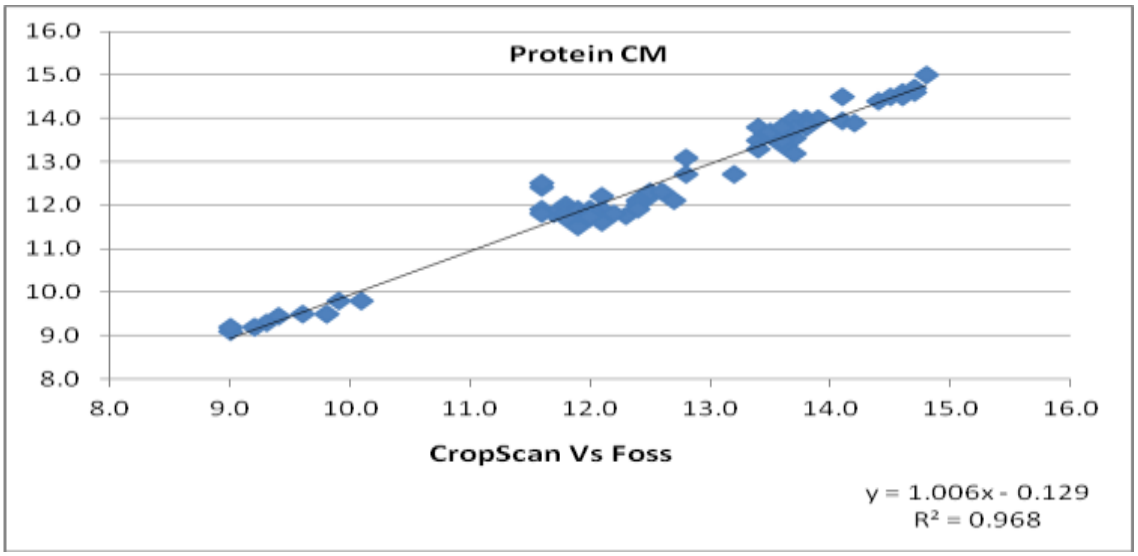


Figure 2.3 Protein Plot CropScan 3000S vs Lab NIR

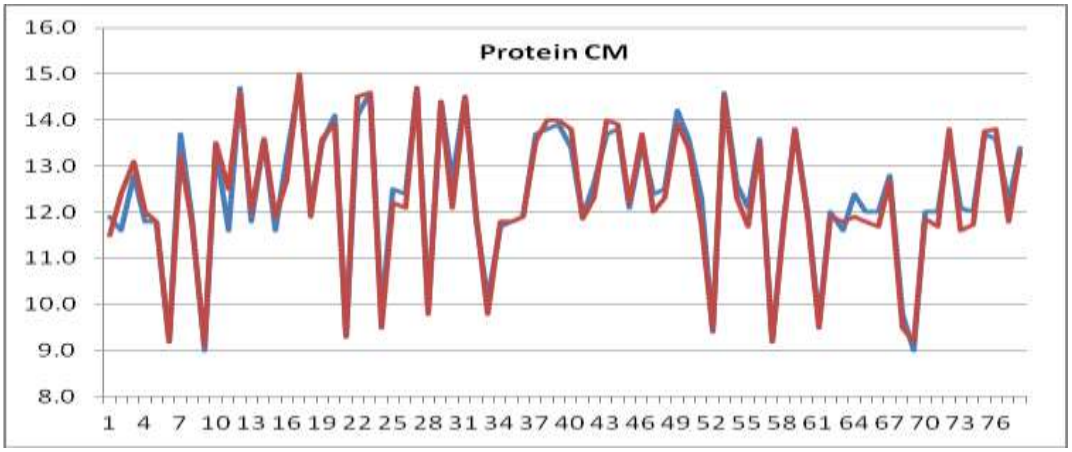


Figure 2.4 Protein Trend CropScan 3000S vs Lab NIR

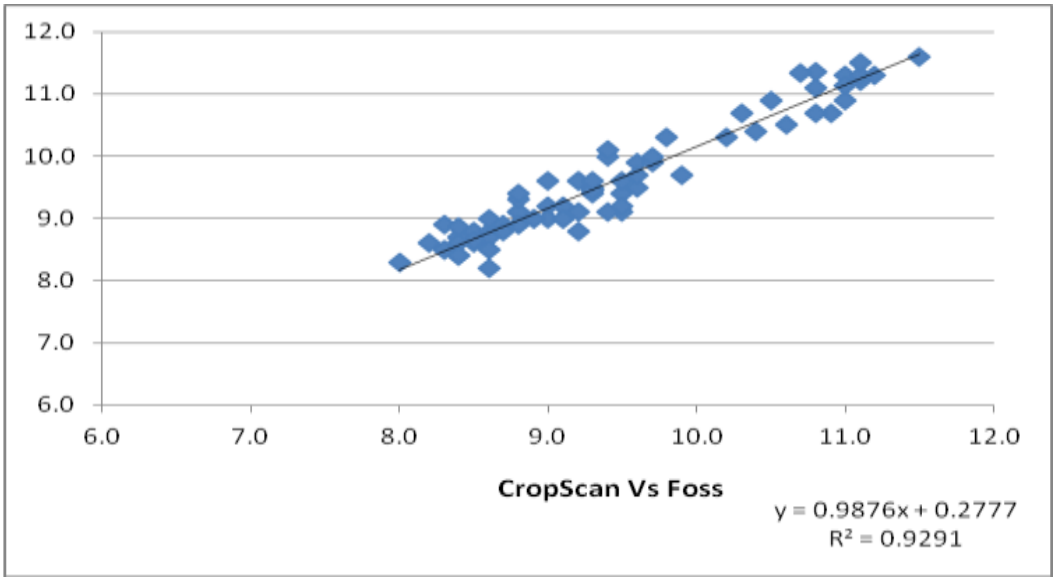


Figure 2.5 Moisture Plot CropScan 3000S vs Lab NIR

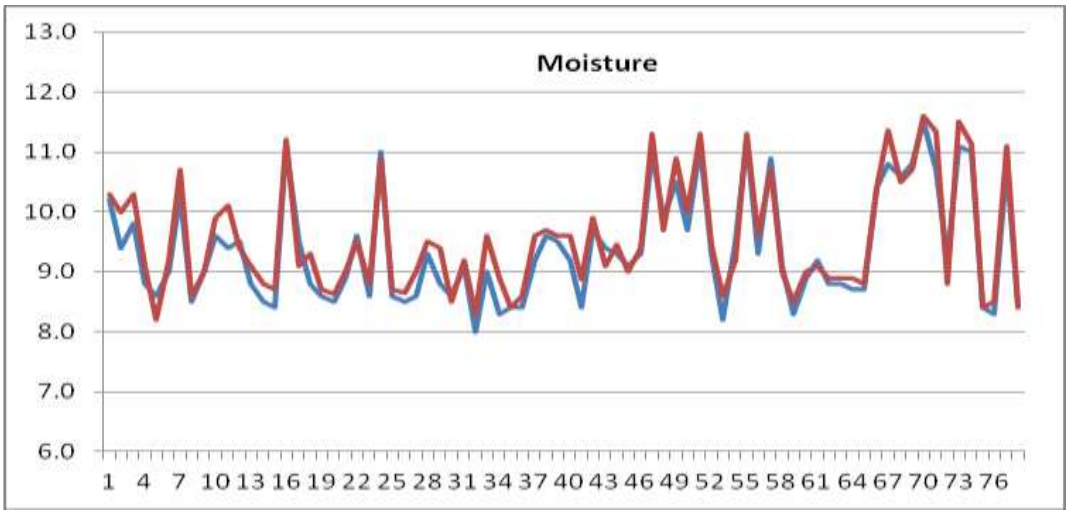


Figure 2.6 Moisture Trend CropScan 3000S vs Lab NIR

Conclusion.

This study show that the CropScan 3000S In Line Whole Grain Analyser provided a means of continuously and accurately monitoring protein and moisture as truck loads are received into this flour mill.

6months later….

The installation has been an exceptional success. The mill has been operating this system continuously for over six months. A report was supplied to Next Instruments by the mill's manager outlining a comparative analysis of the several on line analysers. The CropScan 3000S outperformed all other systems trialed, with distinction given to reliability, service, price and accuracy.

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