Application Note 166. 2012 Harvest Validation Study for the CropScan 1000B Whole Grain Analyser: Australian Wheat.

Introduction:

Near Infrared Transmission analysers are used in the Australian grains industry to measure protein, moisture and oil in wheat, barley, canola and other grains and oil seeds as they are received into bulk storage silos and bunkers. NIT provides a rapid and cost effective means of measuring every load of grain stored in the system, however NIT is only a correlated method to the reference methods for protein, Dumas Combustion, for moisture, Oven Drying, and for oil, Soxhlet Extraction. As such, NIT analysers need to be validated against these techniques annually.

GrainCorp Technical Services Laboratory, Narrabri, NSW, offers NIT instrument manufacturers the opportunity to have a large number of samples run through instruments during harvest. This study shows the results of the tests performed during the 2012 harvest for Australian Wheat.

The CropScan 1000B Whole Grain Analyser is used widely throughout Australia and the world. It is based on a novel diode array spectrometer that scans the wavelength range from 720-1100nm. Whole grains of wheat, approximately 500ml, are poured into a hopper and then up to 15 sub portions are scanned in transmission mode. Wheat is analysed for protein and moisture in approximately 45 seconds. A built-in Test Weight Module also provides a means of determining Test Weight and calculating the % Screenings. The CropScan 1000B is certified under the NMI V10 guidelines as being suitable for use for measuring protein in wheat and barley.

Procedure:

GrainCorp collected approx 440 samples of wheat during the 2012 harvest. 190 samples were analysed for nitrogen and thereby protein using a Leco Combustion analyser and for moisture using the Oven Drying method. The other samples were analysed using the Foss Infratec 1241 Whole Grain Analyser as this is the standard analyser used by GrainCorp at their receival depots. The wheat samples were analysed through several brands of NIT whole grains analysers, including the CropScan 1000B. For the sake of confidentiality only the data showing comparison between the Leco and Oven Drying methods vs the CropScan 1000B are presented in this report.

Results:

Figure 1 shows the NIT spectra of the 190 wheat samples. The spectrum represent the amount of light that is absorbed at each wavelength of light. Protein and water absorb NIR energy at approx 1020 and 970nm respectively. Starch and oil also absorb NIR energy in this region.

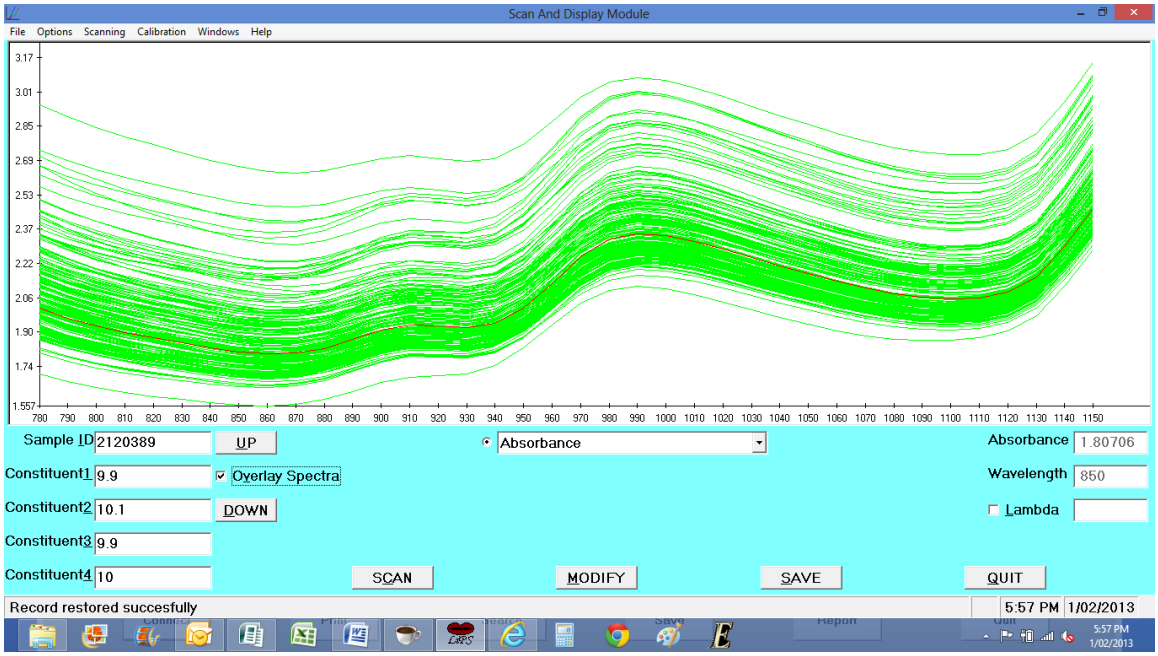

Figure 2 shows the protein prediction plot for the wheat samples that were analysed using the Leco Combustion method.

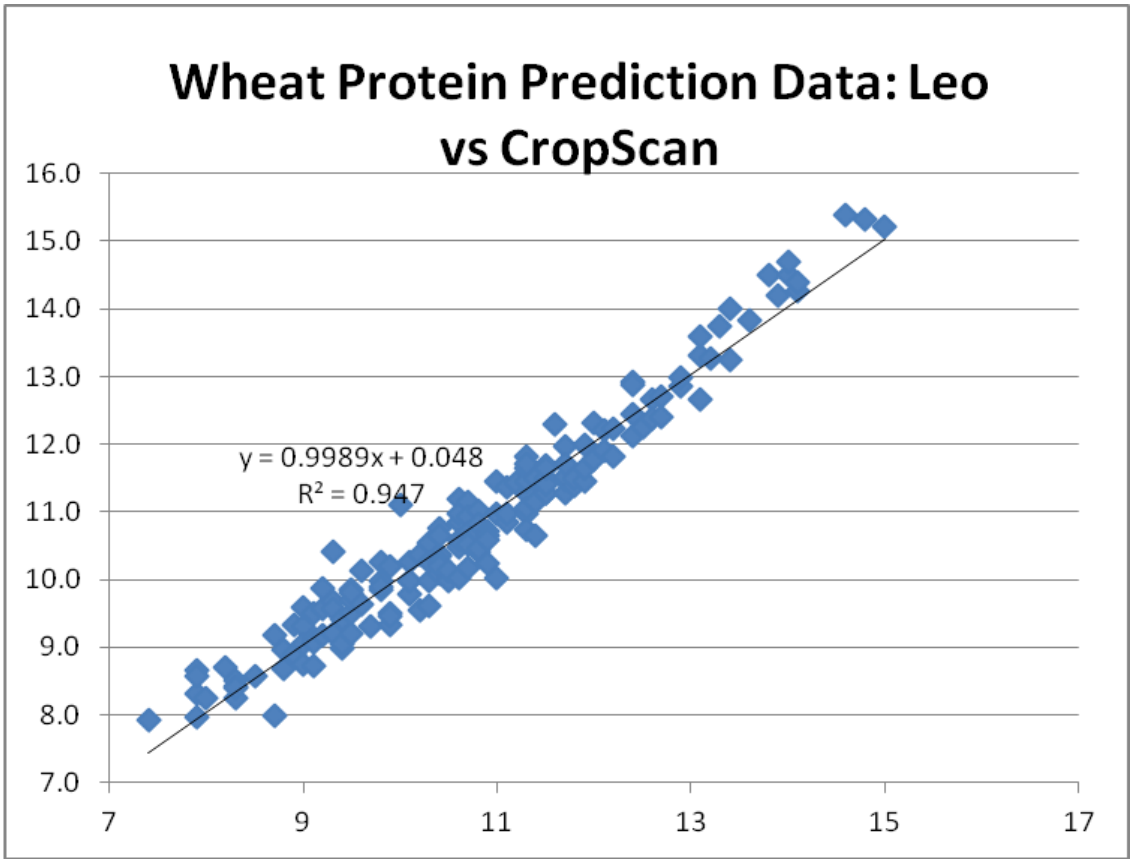

Figure 3 shows the moisture prediction plot for the wheat samples analysed by Oven Drying.

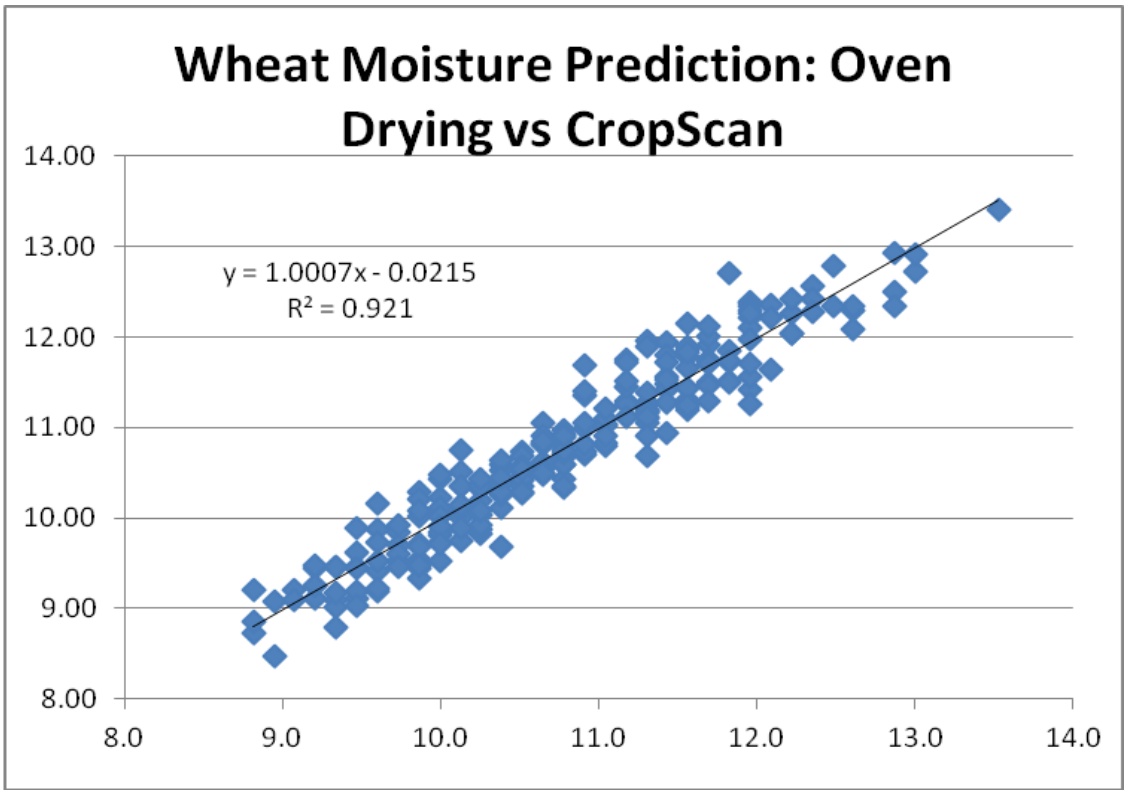

Table 1 shows the CropScan 1000B predicted data versus the reference data for protein and moisture.

CropScan P	Leco	Diff	CropScan M	Oven Moisture	Diff
7.4	7.9	0.5	12.0	12.37	0.4
7.9	8.0	0.1	11.3	11.96	0.7
7.9	8.3	0.4	11.3	11.89	0.6
7.9	8.7	0.8	10.1	10.75	0.6
7.9	8.6	0.7	12.0	12.38	0.4
8	8.3	0.3	11.4	11.95	0.5
8.2	8.7	0.5	11.8	12.71	0.9
8.3	8.5	0.2	11.2	11.75	0.6
8.3	8.4	0.1	11.6	12.15	0.6
8.3	8.3	0.0	10.6	11.06	0.4
8.3	8.4	0.1	10.1	10.51	0.4
8.5	8.6	0.1	12.0	12.22	0.3
8.7	9.2	0.5	12.4	12.57	0.2
8.7	8.0	-0.7	12.0	12.10	0.1
8.8	9.0	0.2	9.9	10.28	0.4
8.8	8.7	-0.1	9.9	10.21	0.4
8.9	8.9	0.0	9.6	10.16	0.6
8.9	9.3	0.4	10.9	11.35	0.4
9	8.7	-0.3	10.0	10.22	0.2
9	9.3	0.3	10.8	10.97	0.2
9	9.0	0.0	10.3	10.32	0.1
9	9.6	0.6	12.2	12.25	0.0
9.1	9.1	0.0	10.0	10.02	0.0
9.1	8.7	-0.4	9.9	10.02	0.2

9.1	9.1	0.0	10.5	10.42	-0.1
9.1	9.5	0.4	11.4	11.79	0.4
9.2	9.2	0.0	11.7	11.92	0.2
9.2	9.6	0.4	11.2	11.45	0.3
9.2	9.9	0.7	13.0	12.72	-0.3
9.3	9.7	0.4	9.2	9.44	0.2
9.3	9.6	0.3	9.9	10.08	0.2
9.3	9.2	-0.1	8.8	8.73	-0.1
9.3	10.4	1.1	9.3	9.46	0.1
9.4	9.0	-0.4	10.1	10.35	0.2
9.4	9.4	0.0	9.6	9.88	0.3
9.4	9.1	-0.3	8.8	9.21	0.4
9.5	9.2	-0.3	9.5	9.46	0.0
9.5	9.5	0.0	10.6	10.83	0.2
9.5	9.8	0.3	10.9	10.71	-0.2
9.5	9.7	0.2	11.2	11.29	0.1
9.5	9.8	0.3	9.5	9.62	0.2
9.5	9.8	0.3	11.3	11.28	0.0
9.6	10.1	0.5	9.2	9.25	0.0
9.7	9.3	-0.4	10.3	10.37	0.1
9.8	10.0	0.2	10.1	10.15	0.0
9.8	10.3	0.5	11.6	11.30	-0.3
9.8	9.8	0.0	10.4	10.53	0.1
9.9	9.3	-0.6	10.9	11.68	0.8
9.9	10.2	0.3	11.2	11.73	0.6
9.9	9.5	-0.4	10.5	10.73	0.2
9.9	9.5	-0.5	10.9	10.99	0.1
10	11.1	1.1	12.9	12.93	0.1
10.1	10.3	0.2	11.6	11.87	0.3
10.1	10.0	-0.1	10.5	10.69	0.2
10.1	9.8	-0.3	9.5	9.88	0.4
10.1	10.0	-0.1	11.4	11.48	0.0
10.2	9.5	-0.7	11.6	11.89	0.3
10.2	10.4	0.2	11.7	12.00	0.3
10.3	10.0	-0.3	9.2	9.48	0.3
10.3	9.6	-0.7	10.9	11.39	0.5
10.3	10.6	0.3	10.0	10.07	0.1
10.3	10.3	0.0	11.3	11.25	0.0
10.4	10.3	-0.1	10.6	10.50	-0.2
10.4	10.4	0.0	10.3	10.35	0.1
10.4	10.8	0.4	11.0	11.04	0.0
10.4	10.2	-0.2	10.4	10.60	0.2
10.4	10.6	0.2	11.3	11.19	-0.1
10.4	10.1	-0.3	11.3	11.18	-0.1
10.4	10.3	-0.1	12.4	12.42	0.1
10.4	10.2	-0.2	13.5	13.41	-0.1
10.5	10.0	-0.5	9.2	9.12	-0.1
10.5	10.0	-0.5	12.2	12.04	-0.2
10.5	10.1	-0.4	9.7	9.83	0.1

10.6	10.0	-0.6	9.1	9.20	0.1
10.6	10.9	0.3	11.6	11.78	0.2
10.6	11.2	0.6	10.0	10.43	0.4
10.6	10.5	-0.1	10.4	10.38	0.0
10.6	10.6	0.0	10.4	10.63	0.2
10.6	11.0	0.4	12.0	12.34	0.4
10.7	10.2	-0.5	11.3	11.16	-0.1
10.7	10.7	0.0	9.7	9.52	-0.2
10.7	11.1	0.4	9.6	9.41	-0.2
10.7	10.9	0.2	12.1	12.36	0.3
10.7	10.7	0.0	10.4	10.11	-0.3
10.7	10.5	-0.2	11.6	11.27	-0.3
10.8	10.7	-0.1	10.5	10.27	-0.2
10.8	10.4	-0.4	10.8	10.43	-0.4
10.8	10.5	-0.3	11.8	11.72	-0.1
10.8	11.0	0.2	12.0	11.41	-0.5
10.8	10.8	0.0	10.3	9.82	-0.4
10.9	10.7	-0.2	11.7	11.73	0.0
10.9	10.2	-0.7	10.9	10.73	-0.2
10.9	10.7	-0.3	10.3	10.03	-0.2
10.9	10.6	-0.3	11.6	11.66	0.1
11	10.0	-1.0	12.6	12.29	-0.3
11	11.4	0.4	11.0	11.02	0.0
11	11.0	0.0	12.0	11.25	-0.7
11.1	10.8	-0.3	11.6	11.19	-0.4
11.1	11.0	-0.1	12.9	12.49	-0.4
11.1	11.4	0.3	10.8	10.34	-0.4
11.2	11.4	0.2	12.6	12.34	-0.3
11.3	11.3	0.0	12.1	11.64	-0.5
11.3	11.4	0.1	10.4	10.28	-0.1
11.3	11.8	0.5	10.3	10.19	-0.1
11.3	11.0	-0.3	9.6	9.19	-0.4
11.3	10.7	-0.6	11.0	10.80	-0.2
11.3	11.6	0.3	10.8	10.59	-0.2
11.3	11.1	-0.2	11.3	10.68	-0.6
11.3	11.7	0.4	10.3	9.87	-0.4
11.4	11.1	-0.3	8.9	8.48	-0.5
11.4	10.7	-0.7	9.5	9.12	-0.4
11.4	11.5	0.1	11.7	11.49	-0.2
11.5	11.3	-0.2	11.4	11.56	0.1
11.5	11.5	0.0	11.2	11.25	0.1
11.5	11.3	-0.2	10.0	10.11	0.1
11.5	11.7	0.2	10.0	10.47	0.5
11.5	11.5	0.0	9.9	9.53	-0.3
11.5	11.4	-0.1	11.8	11.51	-0.3
11.5	11.6	0.1	10.1	9.99	-0.1
11.6	12.3	0.7	11.2	11.11	-0.1
11.7	11.5	-0.2	9.5	9.19	-0.3
11.7	11.3	-0.4	10.1	9.89	-0.2
11.7	12.0	0.3	10.0	9.74	-0.3

11.7	11.5	-0.2	10.6	10.62	0.0
11.7	11.5	-0.2	10.0	9.81	-0.2
11.7	11.7	0.0	10.6	10.48	-0.2
11.8	11.4	-0.4	10.6	10.81	0.2
11.8	11.5	-0.3	10.1	10.11	0.0
11.9	11.4	-0.5	9.3	9.10	-0.2
11.9	12.0	0.1	8.9	9.07	0.1
11.9	11.6	-0.3	9.9	9.71	-0.2
12	11.8	-0.2	11.7	11.47	-0.2
12	12.3	0.3	11.7	11.30	-0.4
12.1	11.9	-0.2	12.4	12.27	-0.1
12.1	12.2	0.1	11.6	11.44	-0.1
12.2	11.8	-0.4	10.0	9.84	-0.2
12.2	12.2	0.0	11.3	11.09	-0.2
12.4	12.1	-0.3	11.0	10.83	-0.2
12.4	12.5	0.0	10.6	10.53	-0.1
12.4	12.9	0.5	10.1	10.08	0.0
12.4	12.9	0.5	10.4	10.37	0.0
12.5	12.3	-0.2	10.4	10.26	-0.1
12.6	12.7	0.1	10.8	10.68	-0.1
12.6	12.4	-0.2	11.3	11.38	0.1
12.7	12.4	-0.3	10.5	10.53	0.0
12.7	12.7	0.0	10.0	10.02	0.0
12.9	12.9	0.0	12.1	12.22	0.1
12.9	13.0	0.1	9.7	9.92	0.2
13.1	12.7	-0.4	13.0	12.91	-0.1
13.1	13.3	0.2	12.5	12.79	0.3
13.1	13.6	0.5	9.3	9.46	0.1
13.2	13.3	0.1	10.5	10.46	-0.1
13.3	13.7	0.4	11.4	11.42	0.0
13.4	13.2	-0.2	12.6	12.08	-0.5
13.4	14.0	0.6	11.3	11.17	-0.1
13.6	13.8	0.2	10.6	10.81	0.2
13.8	14.5	0.7	10.8	10.59	-0.2
13.9	14.2	0.3	11.3	11.05	-0.3
14	14.5	0.5	10.1	9.75	-0.4
14	14.7	0.7	9.6	9.22	-0.4
14.1	14.3	0.2	12.5	12.35	-0.1
14.1	14.4	0.3	9.9	9.49	-0.4
14.6	15.4	0.8	10.3	9.92	-0.3
14.8	15.3	0.5	11.8	11.49	-0.3
15	15.2	0.2	12.0	11.56	-0.4
9.6	9.6	0.0	9.7	9.69	0.0
9.8	9.9	0.1	9.3	9.02	-0.3
			10.6	10.49	-0.2
	SEP	0.37	9.3	9.18	-0.2
	Bias	0.0	11.8	11.84	0.0
			10.1	10.35	0.2
			11.4	11.27	-0.2

10.1	10.09	0.0
9.1	9.10	0.0
10.8	10.92	0.1
10.8	10.72	-0.1
10.8	10.80	0.0
9.6	9.73	0.1
10.1	10.10	0.0
10.5	10.35	-0.2
9.2	9.25	0.0
11.2	11.45	0.3
10.1	10.15	0.0
10.5	10.44	-0.1
8.8	8.86	0.0
11.7	11.74	0.0
11.0	11.09	0.1
11.7	11.70	0.0
11.8	11.73	-0.1
12.2	12.42	0.2
10.3	10.35	0.1
10.4	10.38	0.0
11.6	11.83	0.3
12.9	12.34	-0.5
10.9	11.05	0.1
10.8	10.89	0.1
11.4	11.72	0.3
12.0	12.29	0.3
11.4	11.52	0.1
11.3	11.11	-0.2
10.0	9.53	-0.5
11.4	10.94	-0.5
11.6	11.23	-0.3
10.4	9.68	-0.7
9.9	9.69	-0.2
9.5	9.04	-0.4
12.0	11.70	-0.3
9.9	9.45	-0.4
9.7	9.61	-0.1
9.3	8.80	-0.5
9.9	9.34	-0.5
10.8	10.35	-0.4
11.3	10.91	-0.4
9.9	9.47	-0.4
10.0	9.90	-0.1
9.7	9.46	-0.3
11.0	10.90	-0.1
10.3	10.08	-0.2
10.0	9.72	-0.3
10.1	9.88	-0.2
12.2	12.03	-0.2

9.6	9.53	-0.1
11.6	11.25	-0.3
10.5	10.29	-0.2
12.0	12.26	0.3
10.4	10.29	-0.1
10.8	10.75	0.0
11.7	12.11	0.4
10.9	10.81	-0.1
11.0	11.21	0.2
10.6	10.90	0.3
9.5	9.44	0.0
10.6	10.84	0.2
10.5	10.58	0.1
10.3	10.44	0.2
10.8	10.90	0.1
10.4	10.45	0.1
10.5	10.54	0.0
12.0	11.98	0.0
11.2	11.51	0.3
	SEP	0.28

Comment:

A number of samples, 10, were removed from the data set because they showed more differences more than 3 times the standard deviation. It was pointed out to GrainCorp that there were several inconsistencies in the data, such as the reference data was out of order and where all 3 NIT analysers predicted the samples similarly but the reference values were widely different. These samples will be re analysed to see if recording errors or laboratory errors caused these very large differences.

Discussion:

The above data provides a good demonstration of the validity of the calibration models used for measuring wheat using the CropScan 1000B Whole Grain Analyser. The spectra for the wheat samples will be added to the calibration set in order to make the calibrations more robust in the future.

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