Application Note 121: Validation of CropScan 1000G for Wheat and Barley

Introduction: The CropScan 1000G On Farm Analyser has recently undergone a number of hardware changes, including a new power supply, reduced sample cell pathlength, new software and implementation of Z Score outlier detection. A three-day Validation study was conducted to test the accuracy, precision, reproducibility and temperature stability of the CropScan 1000G running under the new calibration for protein and moisture in wheat and barley..

Procedure:

Four standard experiments were conducted on three CropScan 1000G Analysers. Tests from day one were conducted in duplicate.

Test 1: Accuracy

Ten certified reference samples (5 wheat and 5 barley) supplied by Graincorp were tested in duplicate on each CropScan 1000G analyser. The results were recorded and compared with the known reference results. The accuracy of each analyser is indicated through the Standard Error of Prediction, which is the standard deviation of difference between the reference results and the predicted results for the wheat and barley samples.

Test 2: Precision

The precision of each analyser is indicated through the Standard Deviation of Differences (SDD) of the duplicate analyses performed above.

Test 3: 3-Day Reproducibility

The same ten certified reference samples supplied by Graincorp were tested in duplicate on each CropScan1000G analyser over a three-day period. The Reproducibility is defined as the Standard Deviation of Differences between the average of the protein and moisture over the three days, and the daily results.

Test 4: Temperature Stability

The three CropScan1000G instruments were placed in the incubator set at 45C for several hours. The ten certified reference samples were analysed immediately after the instruments were removed from the incubator. The SDD between the predicted protein and moisture at ambient and 45˚C were calculated.

Results Summary:

Protein

Test	Instrument S/N	Standard Error Wheat	Standard Error Barley
Accuracy	G004	**0.164**	**0.305**
Accuracy	G019	**0.810**	**0.292**
Accuracy	G015	**0.163**	**0.340**
Precision	G004	**0.045**	**0.152**
Precision	G019	**0.402**	**0.148**
Precision	G015	**0.167**	**0.224**
3-Day Rept	G004	**0.088**	**0.161**
3-Day Rept	G019	**0.191**	**0.149**
3-Day Rept	G015	**0.071**	**0.143**
Temp Stab	G004	**0.230**	**0.228**
Temp Stab	G019	**0.545**	**0.778**
Temp Stab	G015	**0.335**	**0.192**

Moisture

Test	Instrument S/N	Standard Error Wheat	Standard Error Barley
Accuracy	G004	**0.079**	**0.062**
Accuracy	G019	**0.063**	**0.079**
Accuracy	G015	**0.266**	**0.123**
Precision	G004	**0.084**	**0.100**
Precision	G019	**0.164**	**0.100**
Precision	G015	**0.071**	**0.152**
3-Day Rept	G004	**0.068**	**0.069**
3-Day Rept	G019	**0.146**	**0.024**
3-Day Rept	G015	**0.041**	**0.047**
Temp Stab	G004	**0.071**	**0.219**
Temp Stab	G019	**0.045**	**0.219**
Temp Stab	G015	**0.141**	**0.071**

Discussion:

Test 1: Accuracy

Results from the Accuracy and Precision tests depict Standard Deviation of Predicted Values. All moistures readings for both wheat and barley passed the accuracy test

Protein Wheat : The two instruments G004 and G015 both depicted a SEP of **0.16**, however instrument 019 depicted a SEP of **0.8!** This was mainly due to 1 particular reference sample (W4), which had a 1% difference in protein predicted results on G019 than on G004 and G015.

The scan of sample W4 on all three instruments was obtained using HyperTerminal and spectra depicted on NTAS and the second derivative was examined (Figure 1).

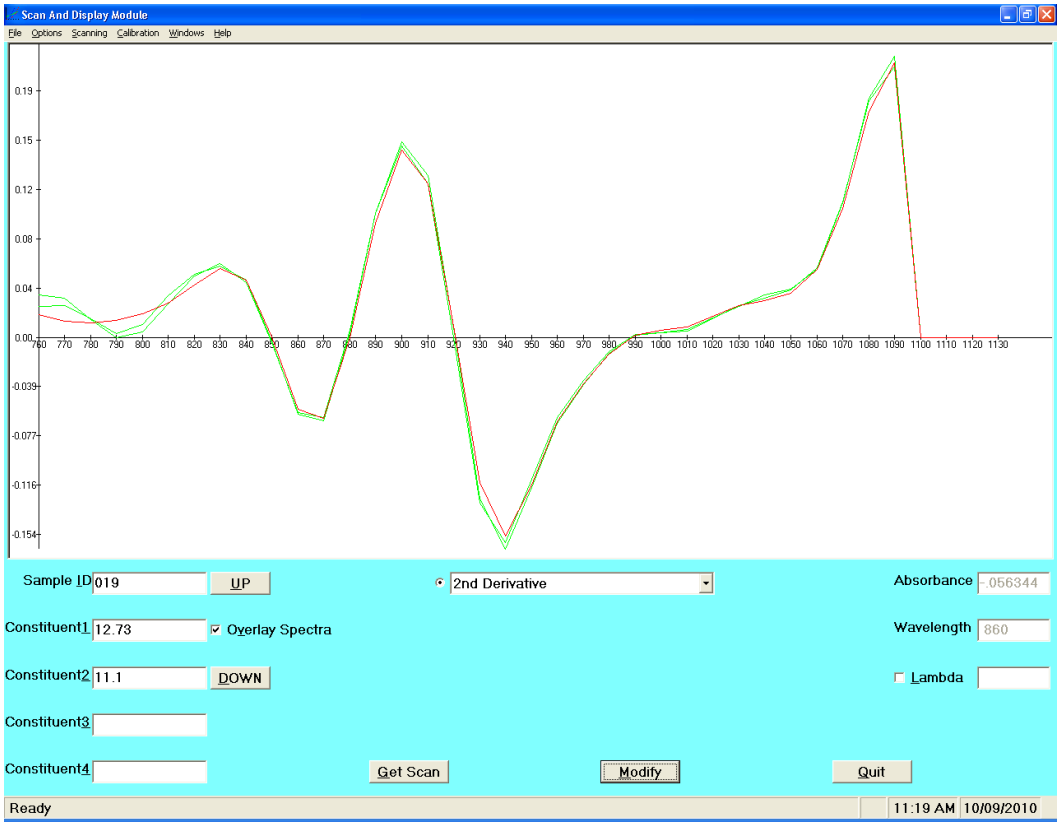

Figure 1: W4 spectra on three CropScan Instruments

NTAS showed that the spectrums were similar from 1130-830nm and onwards but variations could be seen below 830nm. However, these variations are excluded from the result since the calibration has ß1-ß8 set to zero and hence discrepancies below 830nm are negligible. It should be noted that the results gained from the spectra using Hyper Terminal, and averaged did not correlate with the result on 1000G display

Protein Barley: Barley results seemed to show reasonable results, all depicting standard deviations bellow **0.34 %.**

Test 2: Precision

Protein Wheat: The result of the precision test depicted reasonable for G004 with an SDD of **0.084 %**. G015 was borderline with its result of **0.167 %**, however G019 depicted an SDD of **0.4%**. This again is due to a large change in W4 sample which depicted a change of **0.6%.** It is unknown at this at this stage this result occurs only for W4 sample.

Protein Barley: The results for the G004 and G019 were border-line for barley, each having a SDD of **0.15%.** G015 depicted the greatest variance depicting a SDD of **0.22%.**

Moisture Wheat and Barley: The result of the precision test depicted reasonable for moistures of wheat and barley.

Test 2: 3-day Reproducibility

The Standard Deviation of the differences of the samples over the 3-day period were

Protein	Serial No	Wheat	Barley
3-Day Rept	G004	**0.088**	**0.161**
3-Day Rept	G019	**0.191**	**0.149**
3-Day Rept	G015	**0.071**	**0.143**
Moisture			
3-Day Rept	G004	**0.068**	**0.069**
3-Day Rept	G019	**0.146**	**0.024**
3-Day Rept	G015	**0.041**	**0.047**

The specifications for the validity check require the **SDD<0.15** for protein. The results depict the Wheat calibration file failed to display consistent results for G019 and the Barley calibration failed show consistent results for G004.

Test 3: Temperature Stability

There were large standard deviations observed between varying temperatures for wheat and Barely samples for protein. In particular, the largest variation occurred when the G019 instrument was heated at 45°C and produced deviations of **0.545** for wheat and **0.778** for Barley Protein. There were even instances were 2% jumps in protein had occurred but they were treated as outliers and not considered as accurate data.

Conclusion:

Wheat four reference sample (393790) was dynamic between the three 1000G Cropscan instruments, and accounts for the source of these larger than expected results in the standard deviations. The G019 failed the temperature stability for wheat. The Barley calibration passed the accuracy, precision and 3-day reproducibility. The G019 failed the temperature stability for Barley. Further study into the software and hardware is needed to investigate the cause of these large variations in deviations and effects of temperature.

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