Application Note 011: Chalk Analysis on Long and Medium Grain White Rice

Introduction:

Currently, SeedCount has been used to accurately determine the percentage of chalk higher than 30% present on an individual rice grain. The objective is to test the instrument's capability to detect rice kernels with a percentage of chalk higher than 10%.

Procedure

Experiment 1:

From a set of 120 samples of white long grain rice, which had been assessed for Chalkiness, 50 samples were randomly selected to be analysed with SeedCount.

From each sample, 2 long grain rice trays were filled in order to study a representative number of kernels. This corresponds approximately to 1000 seeds analysed per sample. SeedCount software generates the following data for each tray of sample.

Chalkiness: Sum of the % chalk in each seed analysed.

0-10%: % of seeds with no chalk present

10-25%: % of seeds with 10-25% chalk present

25-50%: % of seeds with 25-50% chalk present

50-75%: % of seeds with 50-75% chalk present

75%+: % of seeds with great than 75% chalk present

Then all the results were compared with original Chalkiness data supplied with the samples

Experiment 2:

The same procedure was performed with a set of 50 out of 120 samples of white medium grain rice.

Results:

Experiment 1:

The results obtained by both instruments are expressed in table 1. Each sample has its own ID which is also attached in table 1.

Chalkiness - Long Grain Rice			
ID	**Cervitec**	**SeedCount**	Difference
YRD09 30-08	**0.91**	**1.15**	-0.24
YRD09 18-05	**2.22**	**1.23**	0.99
YRD09 02-09	**2.82**	**1.91**	0.91
YRD09 11-19	**4.25**	**1.77**	2.48
YRD09 08-01	**1.25**	**2.08**	-0.83
YRD09 14-14	**3.18**	**2.09**	1.09
YRD09 22-06	**1.95**	**2.07**	-0.12
YRD09 14-09	**3.72**	**2.34**	1.38
YRD09 06-04	**5.26**	**2.69**	2.57
YRD09 30-07	**4.06**	**3.14**	0.92
YRD09 08-08	**4.83**	**2.67**	2.16
YRD09 03-06	**3.46**	**3.20**	0.26
YRD09 07-15	**6.32**	**3.02**	3.30
YRD09 24-16	**4.01**	**3.92**	0.09
YRD09 08-10	**3.35**	**3.87**	-0.52
YRD09 29-08	**4.82**	**3.38**	1.44
YRD09 18-14	**6.54**	**4.41**	2.13
YRD09 16-13	**4.00**	**4.38**	-0.38
YRD09 03-20	**5.12**	**4.60**	0.52
YRD09 13-06	**6.54**	**4.67**	1.87
YRD09 08-12	**4.94**	**4.84**	0.10
YRD09 01-09	**1.95**	**4.86**	-2.91
YRD09 02-18	**3.97**	**5.27**	-1.30
YRD09 30-03	**3.94**	**5.36**	-1.42
YRD09 06-09	**2.38**	**5.45**	-3.07
YRD09 22-16	**4.63**	**4.71**	-0.08
YRD09 04-20	**7.82**	**5.78**	2.04
YRD09 26-11	**7.01**	**5.10**	1.91
YRD09 17-17	**8.28**	**6.31**	1.97
YRD09 05-16	**5.79**	**5.61**	0.18
YRD09 17-18	**3.75**	**6.51**	-2.76
YRD09 07-17	**6.54**	**6.69**	-0.15
YRD09 16-20	**5.20**	**7.12**	-1.92
YRD09 30-09	**6.03**	**6.78**	-0.75
YRD09 03-05	**6.15**	**7.40**	-1.25
YRD09 12-04	**7.72**	**8.31**	-0.59
YRD09 03-02	**8.21**	**8.65**	-0.44
YRD09 23-16	**9.27**	**8.05**	1.22
YRD09 22-01	**10.32**	**10.56**	-0.24
YRD09 10-16	**13.57**	**12.15**	1.42
YRD09 10-18	**14.23**	**13.07**	1.16
YRD09 23-01	**12.95**	**13.90**	-0.95
YRD09 28-14	**10.82**	**13.18**	-2.36
YRD09 25-17	**14.71**	**13.82**	0.89

Average	**0.24**
Std Dev	**1.53**

Table 1 – Chalkiness Results for Long Grain Rice

Figure 1 represents in a graphic format the results from table 1. A slope of 0.914 and an intercept close to .25 were calculated. The correlation (R^2) = .81 and the Standard Deviation of Differences between the two instruments was 1.53.

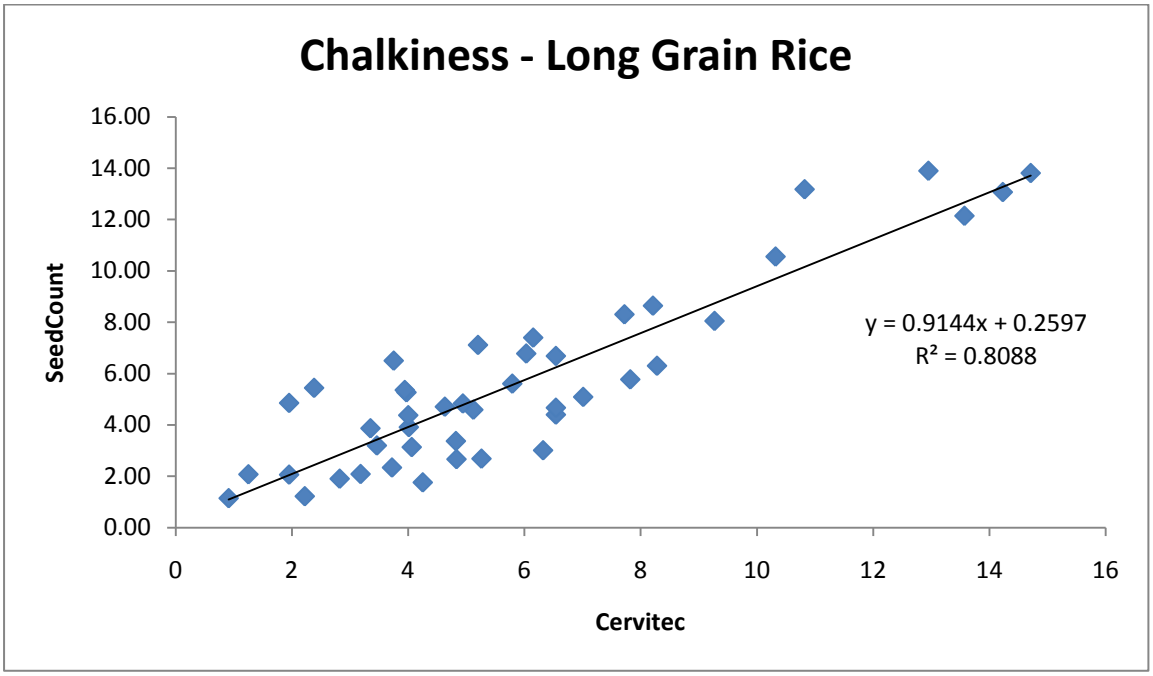

Figure 1 – Chalkiness measured by SeedCount vs Cervitec on Long Grain Rice

Table 2 represents in percentage the amount of all the kernels categorised as having less than 10% chalk by both instruments.

Chalk 0-10 % - Long Grain Rice			
ID	**Cervitec**	**SeedCount**	Difference
YRD09 30-08	96.5	92.8	3.7
YRD09 18-05	90.8	94.2	-3.4
YRD09 02-09	92.8	91.5	1.3
YRD09 11-19	87.2	92.5	-5.3
YRD09 08-01	95.1	89.6	5.5
YRD09 14-14	88.3	91.1	-2.8
YRD09 22-06	91.2	90.2	1.0
YRD09 14-09	85.7	90.2	-4.5
YRD09 06-04	84.2	86.2	-2.0
YRD09 30-07	86.2	87.5	-1.3
YRD09 08-08	83.1	88.5	-5.4
YRD09 03-06	87.2	87.2	0.0
YRD09 07-15	83.4	90.8	-7.4
YRD09 24-16	86.3	83.9	2.4
YRD09 08-10	89.9	83.3	6.6
YRD09 29-08	83.5	84.7	-1.2
YRD09 18-14	76.5	84.7	-8.2
YRD09 16-13	81.8	83.5	-1.7
YRD09 03-20	83.5	82.8	0.7
YRD09 13-06	79.6	86.4	-6.8
YRD09 08-12	85.8	84.3	1.5
YRD09 01-09	92.1	86.2	5.9
YRD09 02-18	87.8	85.5	2.3
YRD09 30-03	86.3	83.7	2.6
YRD09 06-09	91.8	82.1	9.7
YRD09 22-16	84.0	84.2	-0.2
YRD09 04-20	77.1	81.2	-4.1
YRD09 26-11	78.0	84.2	-6.2
YRD09 17-17	74.7	82.7	-8.0
YRD09 05-16	80.8	83.9	-3.1
YRD09 17-18	86.3	77.5	8.8
YRD09 07-17	77.0	77.3	-0.3

YRD09 16-20	81.1	80.5	0.6
YRD09 30-09	79.9	79.6	0.3
YRD09 03-05	75.9	76.7	-0.8
YRD09 12-04	72.7	76.1	-3.4
YRD09 03-02	75.1	71.9	3.2
YRD09 23-16	74.2	77.4	-3.2
YRD09 22-01	64.0	66.1	-2.1
YRD09 10-16	55.5	66.1	-10.6
YRD09 10-18	52.2	63.2	-11.0
YRD09 23-01	57.8	64.0	-6.2
YRD09 28-14	53.4	59.2	-5.8
YRD09 25-17	53.0	62.6	-9.6

Average	**-1.56**
Std Dev	**4.94**

Table 2 – Non Chalky Seeds Results for Long Grain Rice

Figure 2 shows the plot of the SeedCount data vs the Cervitec data.

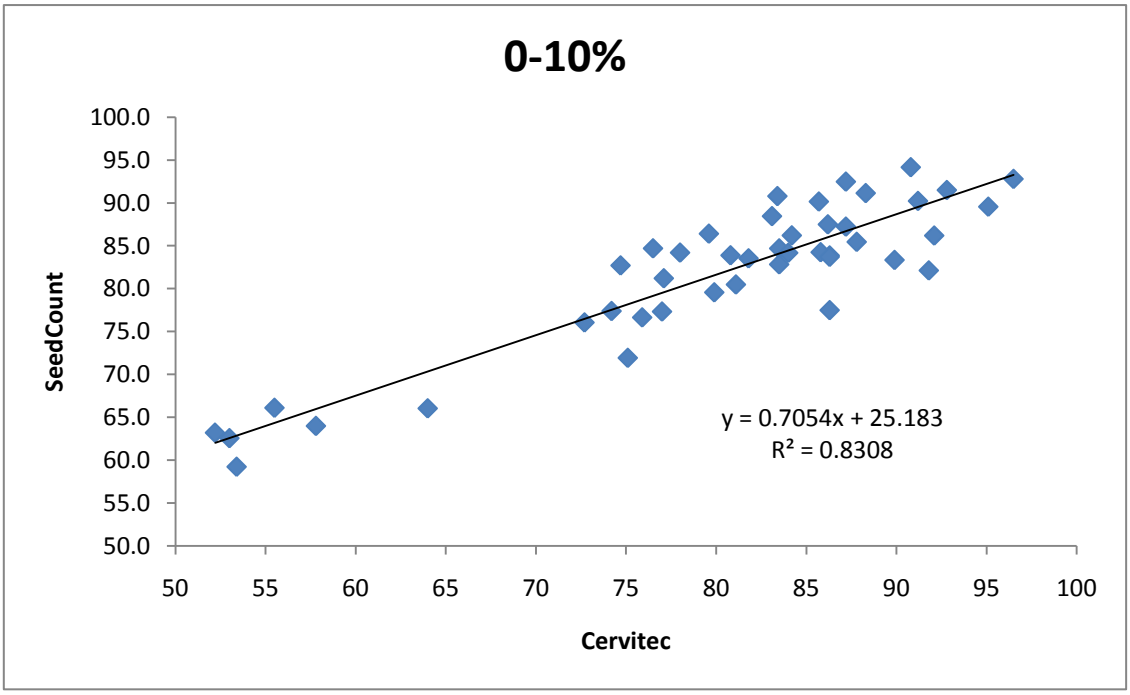

Figure 2 – Percentage of non chalky seeds on Long Grain Rice

Figure 3, 4, 5 and 6 show the plots of the SeedCount vs Cervitec data for 10-25%, 25-50%, 50-75% and 75%+ groupings.

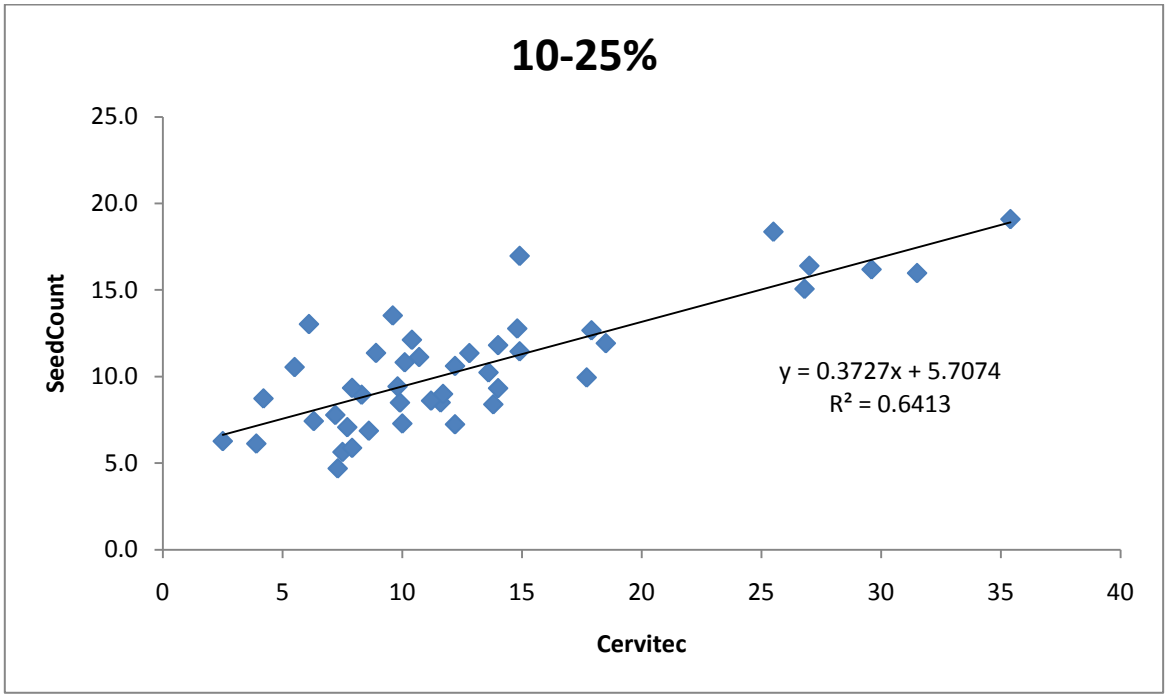

Figure 3 – Percentage of seeds with chalk between 10% and 25% on Long Grain Rice

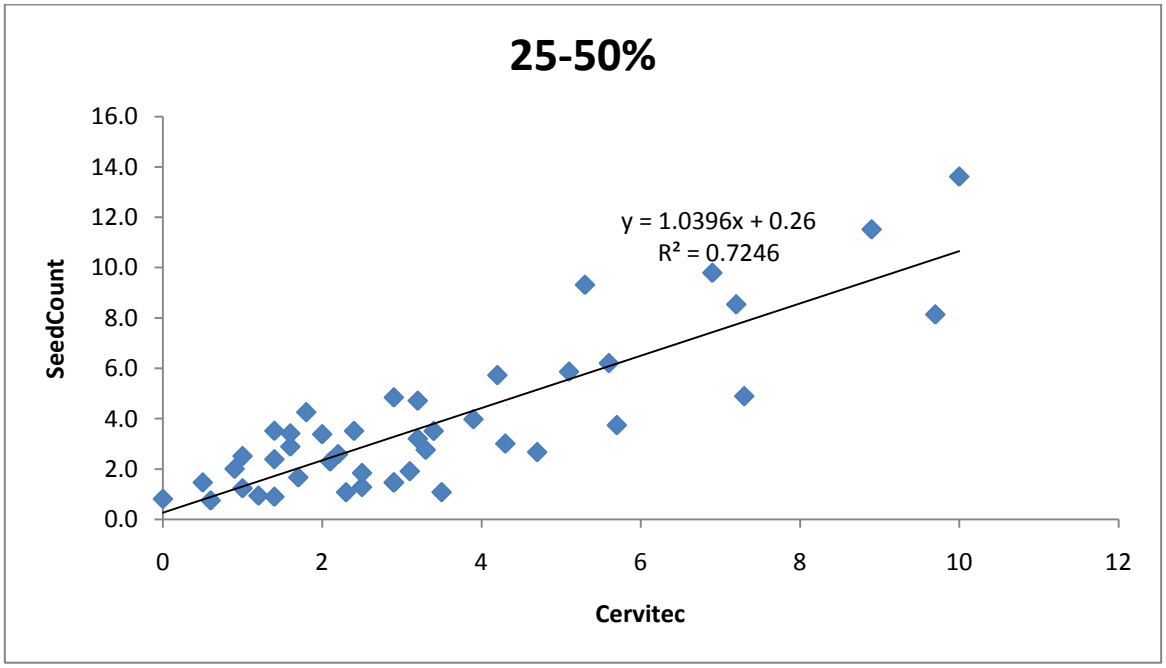

Figure 4 – Percentage of seeds with chalk between 25% and 50% on Long Grain Rice

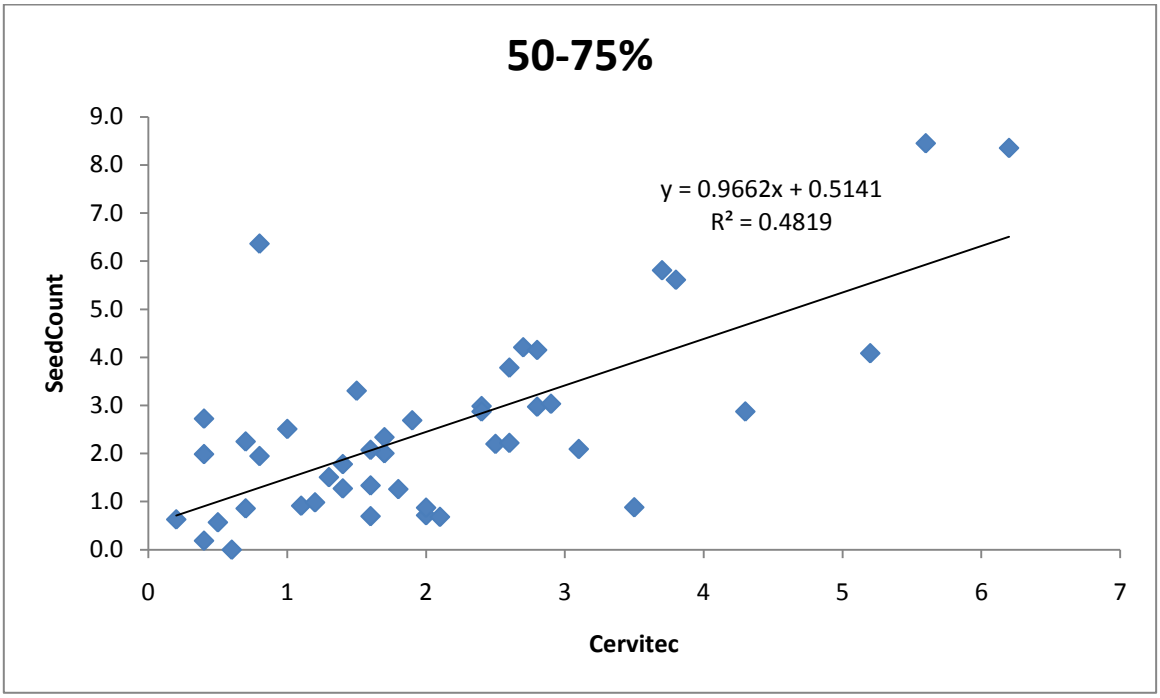

Figure 5 – Percentage of seeds with chalk between 50% and 75% on Long Grain Rice

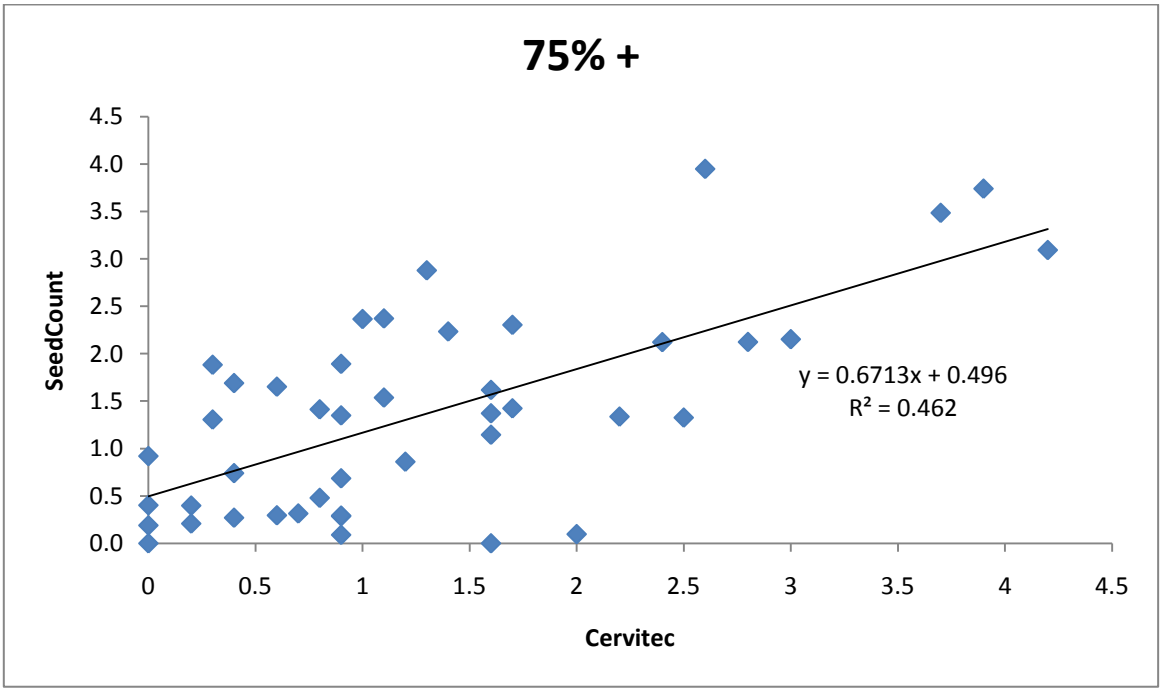

Figure 6 – Percentage of seeds with chalk above 75% on Long Grain Rice

Tables 3 and 4 show the mean and standard deviation for chalkiness as well as the mean and the standard deviation of all the percentages of seeds categorised by each instrument for the 50 studies samples.

	Cervitec					
	Chalkiness	**Chalk 0-10**	**Chalk 10-25**	**Chalk 25-50**	**Chalk 50-75**	**Chalk > 75**
Average	5.88	80.21 %	13.00 %	3.39 %	2.08 %	1.30 %
Std Dev	3.41	11.39	7.59	2.46	1.41	1.07

Table 3 – Means of all the ranges calculated by Cervitec for long grain rice

	SeedCount					
	Chalkiness	**Chalk 0-10**	**Chalk 10-25**	**Chalk 25-50**	**Chalk 50-75**	**Chalk > 75**
Average	5.64	81.77 %	10.55 %	3.79 %	2.52 %	1.37 %
Std Dev	3.47	8.81	3.53	3.00	1.96	1.05

Table 4 – Means of all the ranges calculated by SeedCount for long grain rice

Discussion on Experiment 1:

1) It is important to understand that the Cervitec and SeedCount measure the Chalkiness differently. SeedCount scans the top surface of each seed in the tray and determines the proportion of each seed that exceeds a colour threshold. The software then computes percentage of seeds that fit within each grouping. The Cervitec scans each seed individually and calculates the amount of chalk in an individual grain and categorises it in 5 possible ranges: 0-10%, 10-25%, 25-50%, 50-75% and above 75%. Then the chalkiness is calculated by multiplying the amount of seeds in each range by the mean of each range, e.g., the mean of 10-25 = 17.5. Therefore, the formula is as follows:

$$\text{Chalkiness} = N0*0\% + N1*17.5\% + N2*37.5\% + N3*62.5\% + N4*87.5\%$$

N0 = number of seeds with less than 10% chalk
N1 = number of seeds between 10% and 25% chalk
N2 = number of seeds between 25% and 50% chalk
N3 = number of seeds between 50% and 75% chalk
N4 = number of seeds with more than 75% chalk

This method is not necessarily accurate since it assumes that within each range the chalkiness is normally distributed around the mean. If this is not the case then the score for that range will be skewed.

SeedCount determine the amount of chalk present on each kernel and the chalkiness of the complete sample is the sum of the chalkiness of the individual grains, which should make the measurement more accurate.

2) The first attempt at comparing the SeedCount data and the Cervitec data showed very poor correlation and much higher errors.

It was noticed that with the Long Grain Rice samples, some samples ID's did not match with the spreadsheet received with the samples. There are 2 columns in the result's sheet called "block" and "plot" which suggest that they should match with the ID column (e.g., the sample ID "YRD09 30-08" should have "block" = 30 and "plot" = 8). Around one half of the samples analysed had the Sample ID's which did not match the Block and Plot details.

By rearranging the analysis data to align the Block and Plot with their Sample ID's, the correlations improved significantly.

3) SeedCount uses a dynamic average based on the sample's brightness in order to determine the chalkiness of individual grains since not all the samples necessarily have the same luminance. For extremely chalky samples (at least half of the seeds considered as having chalk) the dynamic average may be higher than expected and the instrument could miss some seeds in the range between 10% and 25%.

4) SeedCount only scans the top surface of the grains. At lower chalk levels, the presence of chalk on the bottom side of the grain would not be detected. As such, SeedCount's accuracy in the lower ranges is dependent on the orientation of the seeds. At higher chalk levels the software detects chalkiness throughout the grain.

5) Since good quality rice should exhibit no chalk present, then the number of samples with 0-10% chalk is much greater than the other ranges, i.e., 10-25, 25-50, 50-75 and 75+. Conversely there are fewer samples with higher levels of chalk.

It can be seen from tables 3 and 4 that the amount of seeds categorised in the range 25-50% is, in average, below 4%. For the range between 50% and 75%, in average there are less than 3% of the seeds, and for the last range of seeds with chalk above 75%, they were categorised in average less than 2%. Since only a sub sample is taken from each sample bag, and the fact that there are fewer kernels in these ranges, reduces the probability of selecting and thereby scanning all the grains with chalk at these levels. As such, the correlation between the two instruments becomes less for the higher ranges.

Experiment 2:

The Chalkiness of the medium grain rice samples by both instruments, along with the sample IDs, is presented in table 5.

Chalkiness			
ID	**Cervitec**	**SeedCount**	Difference
YRA09 03-03	**1.06**	**1.10**	-0.04
YRA09 24-10	**1.62**	**1.53**	0.09
YRA09 14-12	**0.79**	**1.47**	-0.68
YRA09 02-11	**3.56**	**2.20**	1.36
YRA09 12-20	**1.82**	**1.92**	-0.10
YRA09 01-04	**2.09**	**2.44**	-0.35
YRA09 04-12	**4.24**	**2.09**	2.15
YRA09 24-06	**1.61**	**2.10**	-0.49
YRA09 02-17	**3.43**	**2.51**	0.92
YRA09 14-11	**1.42**	**2.66**	-1.24
YRA09 12-03	**1.29**	**3.09**	-1.80
YRA09 01-14	**2.92**	**2.57**	0.35
YRA09 10-20	**5.51**	**3.36**	2.15
YRA09 22-16	**6.02**	**3.03**	2.99
YRA09 09-21	**3.96**	**3.68**	0.28
YRA09 28-15	**2.99**	**3.01**	-0.02
YRA09 18-08	**1.74**	**3.12**	-1.38
YRA09 23-18	**4.36**	**4.28**	0.08
YRA09 21-19	**2.61**	**4.28**	-1.67
YRA09 21-14	**3.52**	**4.38**	-0.86
YRA09 13-06	**6.65**	**4.00**	2.65
YRA09 09-12	**2.43**	**4.14**	-1.71
YRA09 28-04	**4.49**	**4.64**	-0.15
YRA09 06-20	**3.99**	**5.17**	-1.18
YRA09 27-01	**5.16**	**5.87**	-0.71
YRA09 08-21	**4.61**	**5.65**	-1.04
YRA09 25-18	**6.44**	**5.61**	0.83
YRA09 13-09	**5.92**	**6.22**	-0.30
YRA09 01-11	**7.53**	**6.97**	0.56
YRA09 19-06	**5.66**	**7.00**	-1.34
YRA09 28-20	**5.82**	**7.60**	-1.78
YRA09 19-17	**9.96**	**7.53**	2.43
YRA09 27-12	**6.55**	**8.38**	-1.83
YRA09 18-07	**5.27**	**8.61**	-3.34
YRA09 20-19	**7.68**	**7.78**	-0.10
YRA09 04-20	**6.35**	**9.84**	-3.49
YRA09 21-07	**4.85**	**9.17**	-4.32
YRA09 25-05	**8.16**	**10.50**	-2.34
YRA09 12-14	**9.57**	**9.97**	-0.40
YRA09 19-13	**12.88**	**11.14**	1.74

YRA09 27-16	**8.89**	**10.45**	-1.56
YRA09 01-09	**9.78**	**10.88**	-1.10
YRA09 19-11	**7.54**	**10.85**	-3.31
YRA09 11-08	**10.43**	**11.67**	-1.24
YRA09 11-10	**11.85**	**13.39**	-1.54
YRA09 09-13	**14.58**	**16.04**	-1.46
YRA09 12-16	**25.10**	**23.06**	2.04

Average	-0.48
Std Dev	1.65

Table 5 – Chalkiness Results for Medium Grain Rice

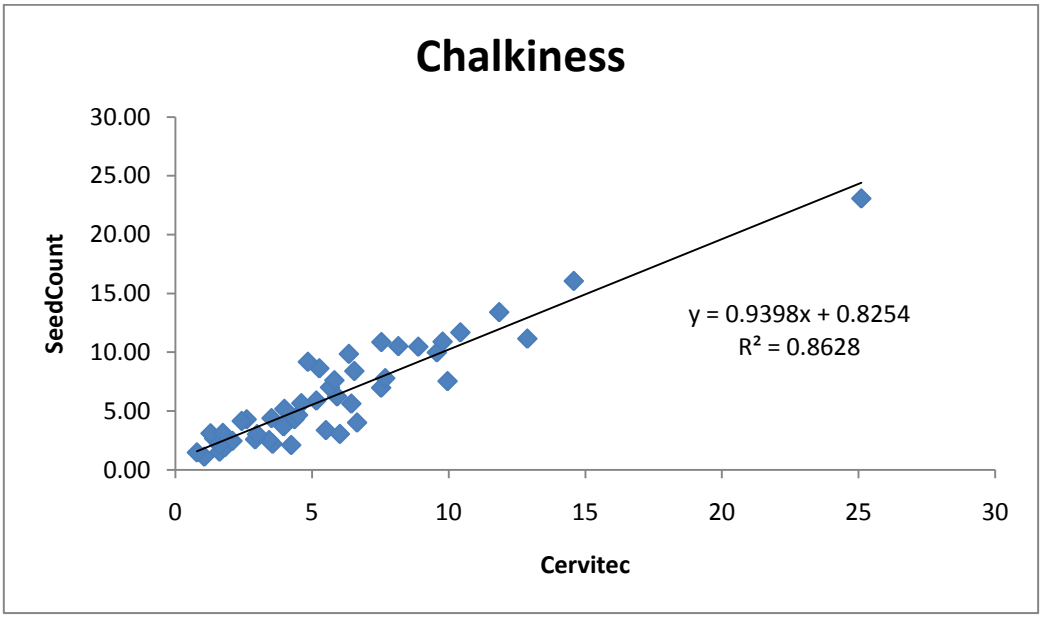

Figure 7 – Chalkiness measured by SeedCount vs Cervitec on Medium Grain Rice

Table 6 represents in percentage the amount of all the kernels categorised as having less than 10% chalk by both instruments.

Chalk 0-10 %			
ID	**Cervitec**	**SeedCount**	Difference
YRA09 03-03	94.7	92.2	2.5
YRA09 24-10	93.2	91.9	1.3
YRA09 14-12	97.1	90.4	6.7
YRA09 02-11	83.1	87.9	-4.8
YRA09 12-20	92.8	89.6	3.2
YRA09 01-04	92.2	86.4	5.8
YRA09 04-12	82.1	90.9	-8.8
YRA09 24-06	92.7	85.8	6.9
YRA09 02-17	88.8	89.6	-0.8
YRA09 14-11	93.5	85.8	7.7
YRA09 12-03	94.2	80.2	14.0
YRA09 01-14	89	86.4	2.6
YRA09 10-20	76.9	83.3	-6.4
YRA09 22-16	71.4	86.2	-14.8
YRA09 09-21	85	80.0	5.0
YRA09 28-15	88.2	82.2	6.0
YRA09 18-08	91.5	84.9	6.6
YRA09 23-18	83.3	78.2	5.1
YRA09 21-19	88.6	73.2	15.4
YRA09 21-14	86.5	74.8	11.7
YRA09 13-06	74.9	80.2	-5.3
YRA09 09-12	89.1	79.0	10.1

YRA09 28-04	81.2	79.4	1.8
YRA09 06-20	85.5	78.6	6.9
YRA09 27-01	81.1	70.7	10.4
YRA09 08-21	82.6	73.0	9.6
YRA09 25-18	73.5	72.1	1.4
YRA09 13-09	77.4	76.2	1.2
YRA09 01-11	71	73.7	-2.7
YRA09 19-06	79.7	73.3	6.4
YRA09 28-20	81.4	69.7	11.7
YRA09 19-17	58.5	67.7	-9.2
YRA09 27-12	78.2	70.9	7.3
YRA09 18-07	82.5	68.8	13.7
YRA09 20-19	65.6	69.1	-3.5
YRA09 04-20	80.9	69.9	11.0
YRA09 21-07	82.2	69.5	12.7
YRA09 25-05	70.6	60.7	9.9
YRA09 12-14	69.9	66.8	3.1
YRA09 19-13	61.4	64.0	-2.6
YRA09 27-16	65	60.6	4.4
YRA09 01-09	67	70.3	-3.3
YRA09 19-11	77	69.9	7.1
YRA09 11-08	71	66.3	4.7
YRA09 11-10	62.9	54.9	8.0
YRA09 09-13	44.5	45.9	-1.4
YRA09 12-16	13.3	21.9	-8.6

Average	3.62
Std Dev	6.92

Table 6 – Non Chalky Seeds Results for Medium Grain Rice

Figures 8, 9, 10, 11 and 12 shows the plots of the SeedCount vs Cervitec data for the medium grain rice samples.

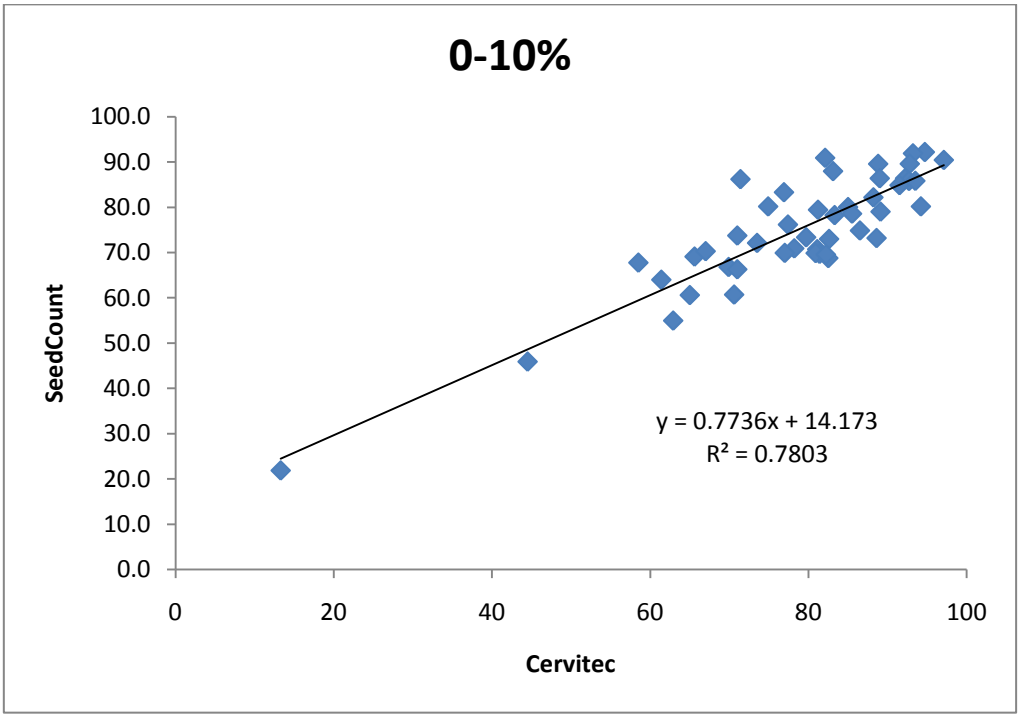

Figure 8 – Non chalky seeds on Medium Grain Rice

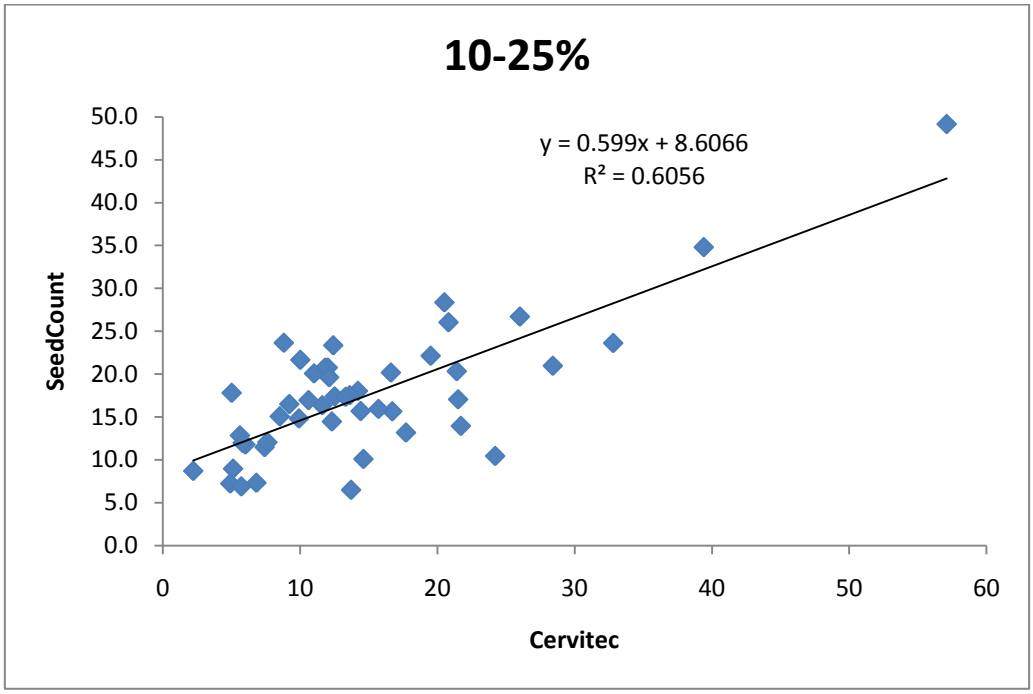

Figure 9 – Seeds with chalk between 10% and 25% on Medium Grain Rice

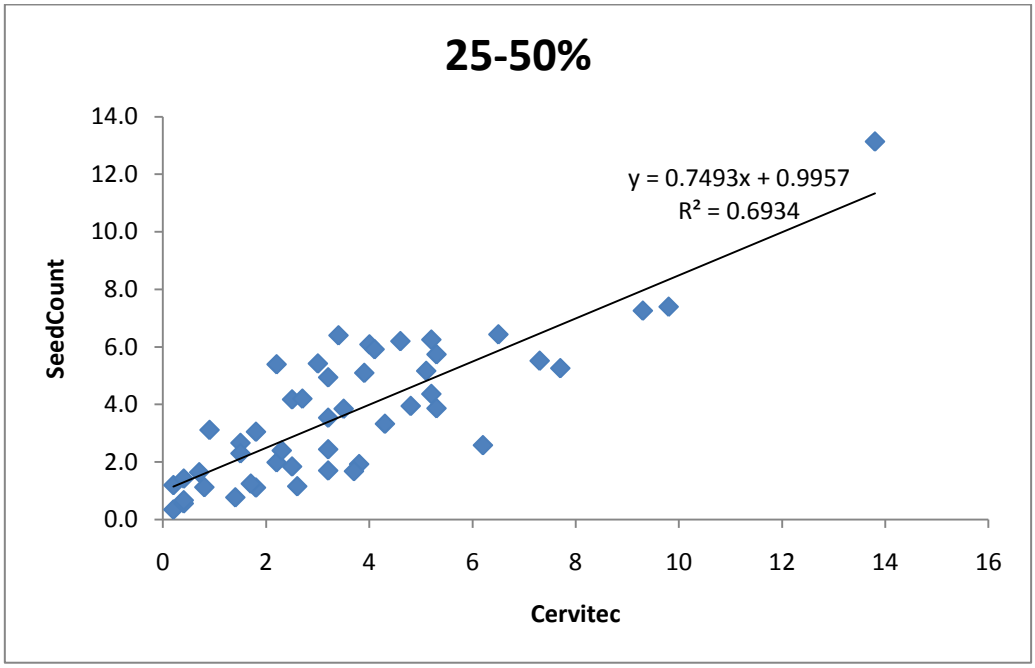

Figure 10 – Seeds with chalk between 25% and 50% on Medium Grain Rice

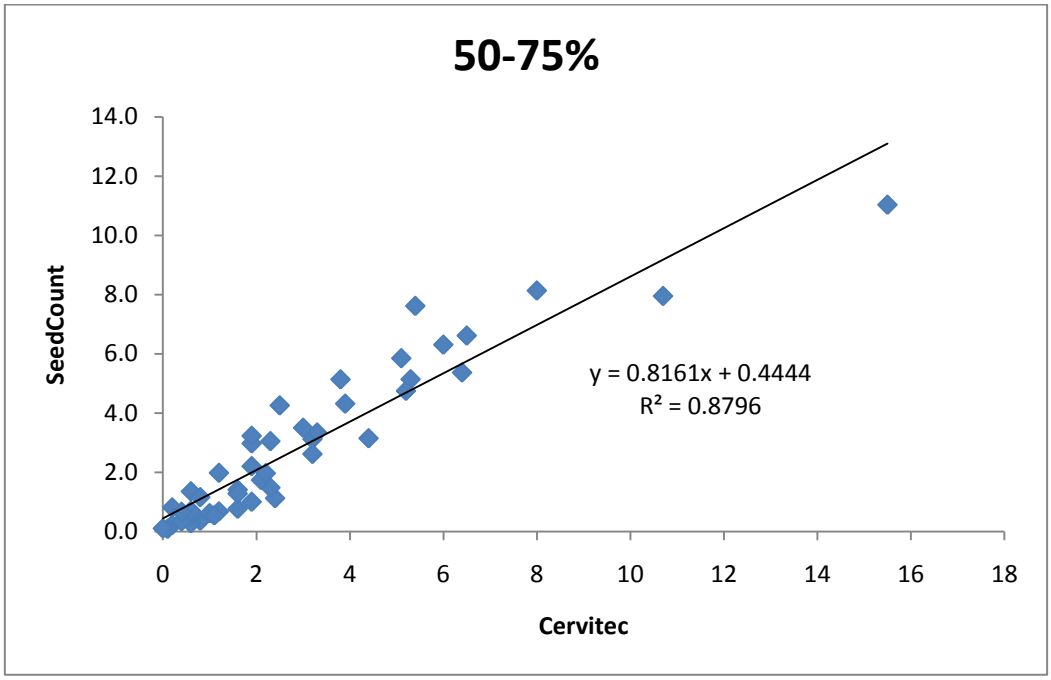

Figure 11 – Seeds with chalk between 50% and 75% on Medium Grain Rice

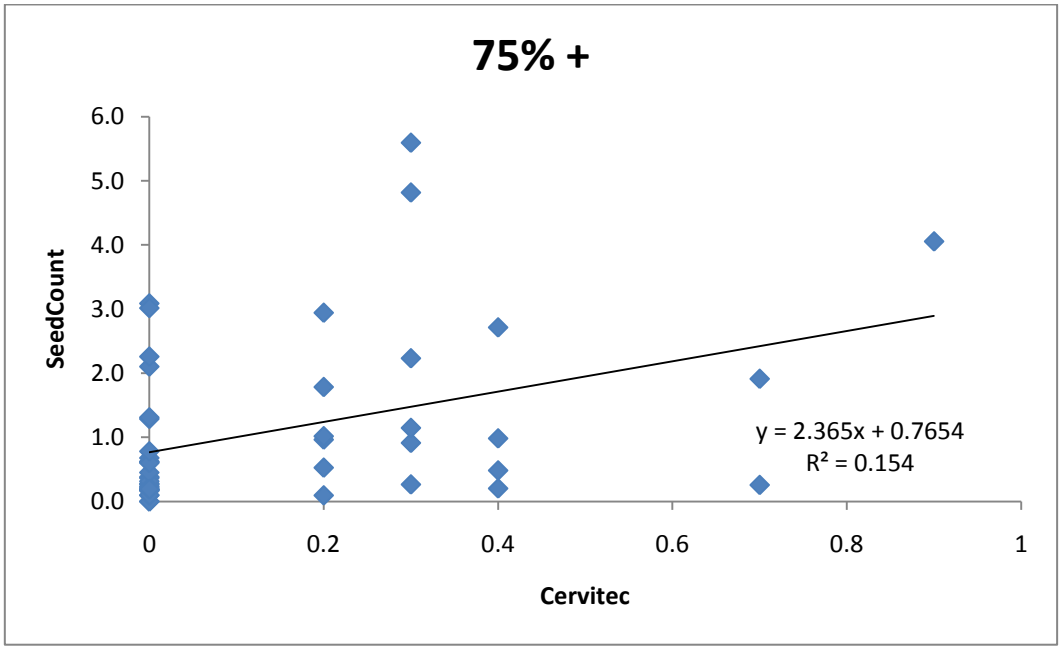

Figure 12 – Seeds with chalk between 50% and 75% on Medium Grain Rice

Tables 7 and 8 show the mean and standard deviation for chalkiness as well as the mean and the standard deviation of all the percentages of seeds categorised by each instrument for the 50 studies samples.

	Cervitec					
	Chalkiness	**Chalk 0-10**	**Chalk 10-25**	**Chalk 25-50**	**Chalk 50-75**	**Chalk > 75**
Average	**5.97**	**77.85 %**	**15.56 %**	**3.61 %**	**2.84 %**	**0.14 %**
Std Dev	**4.39**	**15.43**	**10.95**	**2.73**	**2.97**	**0.22**

Table 7 – Means of all the ranges calculated by Cervitec for medium grain rice

	SeedCount					
	Chalkiness	**Chalk 0-10**	**Chalk 10-25**	**Chalk 25-50**	**Chalk 50-75**	**Chalk > 75**
Average	**6.33**	**74.86 %**	**17.58 %**	**3.70 %**	**2.76 %**	**1.11 %**
Std Dev	**4.35**	**12.81**	**7.59**	**2.45**	**2.58**	**1.31**

Table 8 – Means of all the ranges calculated by SeedCount for medium grain rice

Discussion on Experiment 2:

From figure 7, it can be seen a better correlation in this experiment than in experiment 1, obtaining a gradient of 0.939 and a higher R-square value. Again, both instruments calculate the chalkiness in different ways, which explains the differences between the measurements.

It can be deduced from figure 9 that the highest percentage of missing seeds from figure 8 again comes from the kernels with chalk between 10% and 25%. Despite this fact, the gradient presented on figure 9 is 61% higher than the gradient of this chalk range for long grain rice. Therefore it can be concluded that SeedCount is more sensitive to chalk recognition in medium grain rice than in long grain rice for the range between 10% and 25%.

Conclusion

Due to the fact that with SeedCount, the amount of chalk can only be seen on one side of the seed when it is a low level of chalk present, SeedCount may give a lower percentage of seeds considered to have chalk between the range of 10% and 25% because they could be laid flat with the chalky side down. This nuisance is seen more with the long grain rice samples than the medium grain rice samples.

Also, the low R-squared values present in the plots for high chalk seeds (above 50%) are affected by the low amount of these types of kernels contained in the samples.

It is very difficult to compare the SeedCount and Cervitec systems since they measure the seeds in different ways and use different algorithms to compute the level of chalk present in a sample. The only real way of assessing SeedCount is to use samples that have been assessed manually.