



Significant Increase in Grape Yield Returns from Rock Dust Fertilizer Application

March 2008

Summary:

Since 2005, Fishers Creek Rock Dust (FCRD) has conducted two grape analysis trials to test the effects of FCRD fertilizer on grape yields of different grape varieties grown in different regions. These trials found that FCRD fertilizer application significantly increased Riesling grape yield in the Mintaro in the Clare Valley, while also significantly increasing Shiraz grape yield in Cadell in the Riverland.

Furthermore, the Cadell trials demonstrated that FCRD fertilizer continues to significantly increase grape yield in the second growing season, without further FCRD fertilizer application.

Cost / Benefit analyses were then performed using data obtained from the trials. The data indicated that growers can expect significant financial benefit in both the first and second growing seasons as a result of applying FCRD fertilizer.

From these results, FCRD has formed a new working hypothesis that FCRD fertilizer significantly increases grape yield on a Cost / Benefit basis, regardless of grape variety, grape growing region, or growing conditions such as water availability and soil composition. This hypothesis will be tested in future trials in the 2008/2009 growing season.

Aim:

FCRD aimed to determine the effects of FCRD fertilizer application on grape yields, and collaterally whether these effects consistently applied on different grape varieties from different wine growing regions.

Method:

Trial 1 – Cadell, SA

The first of the two trials was conducted in the Cadell area of the Riverland region. FCRD fertilizer was applied at varying application rates to two Shiraz rows in May 2005. These application rates consisted of a control (0 t/ha), 2.5, 5 and 25 t/ha. In February 2006, a total of 32 grape bunches were then randomly picked from each of the four varied application rates. These 128 randomly selected grape bunches were then weighed and statistical analysis was performed in order to determine the effects of varying FCRD application rates on average grape bunch weight.

The process of randomly picking and weighing 128 grape bunches was then repeated (without further application) in February 2007. Statistical analysis was then performed to determine the effect of varying FCRD application rates on average grape bunch weight, and whether this effect was consistent over two growing seasons.

Due to water restrictions and the results of vine performance in 2008 no measures were taken in the current vintage.

Trial 2 – Mintaro, SA

The second and larger trial was conducted in the Mintaro area of the Clare Valley wine region. FCRD fertilizer was applied at varying application rates to four Riesling grape rows in May 2007. The application rates for this trial consisted of a control (0 t/ha), 2.5 and 5 t/ha. In February 2008, a total of 64 grape bunches were then randomly picked from each of the three application rates. These 192 grape bunches were then weighed and statistical analysis performed to determine the effect of varying FCRD application rates on average grape bunch weight.

Subsequent Analysis

Given statistically significant increases in average bunch weights were identified in both trials, a Cost / Benefit analysis was then undertaken to assess the economic outcome to the grower given grape prices, application rates, and the price of FCRD.

Finally, the results of the two trials were assessed to determine whether statements about FCRD could be made with confidence as they relate to different grape growing areas, grape varieties and growing conditions.

Results:

Trial 1 – Cadell, SA

The Cadell trial was conducted on Shiraz grapes in the Riverland growing region. According to the grape grower, the Shiraz vines that were used in this trial were the oldest on the property, and were pruned to yield a high quantity of grapes at a lower quality. Furthermore, water allocation was decreased due to the current drought, leading to the growers only having 64% of their regular water allocation in 2006, and 40% in 2007. The soil composition surrounding these grape vines consisted of loamy sand over clay, with a reasonably shallow root zone.

Cadell Trial – 2006

As illustrated in Figure 1 and Table 1, average bunch weight of grapes significantly increased when applied with FCRD fertilizer when compared to the control group.

Trial 1. Cadell 2006

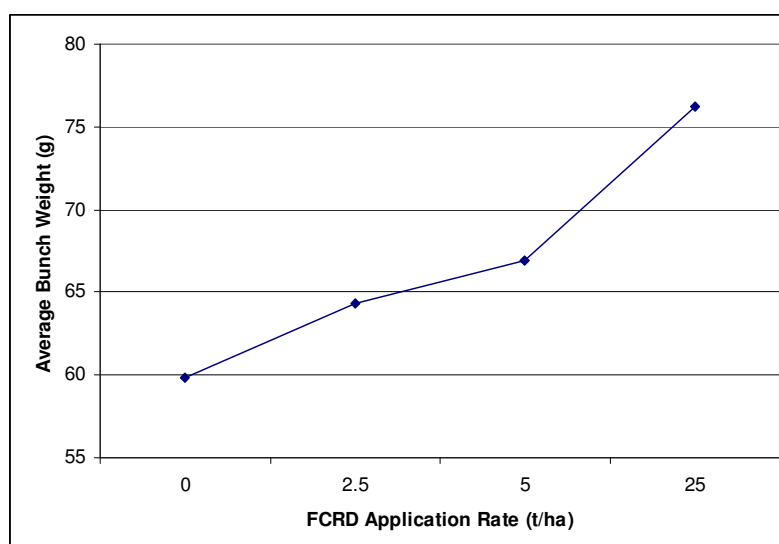


Figure 1. Average bunch weights for each FCRD application rate in Cadell 06 trial.

Trial 1. Cadell 2006

FCRD Application Rate (t/ha)	Average Bunch Weight (g)	Standard Error
0	59.8	3.02
2.5	64.3	1.75
5	66.9	4.25
25	76.2	5.98

Table 1. Average bunch weights for each FCRD application rate in Cadell 06 trial.

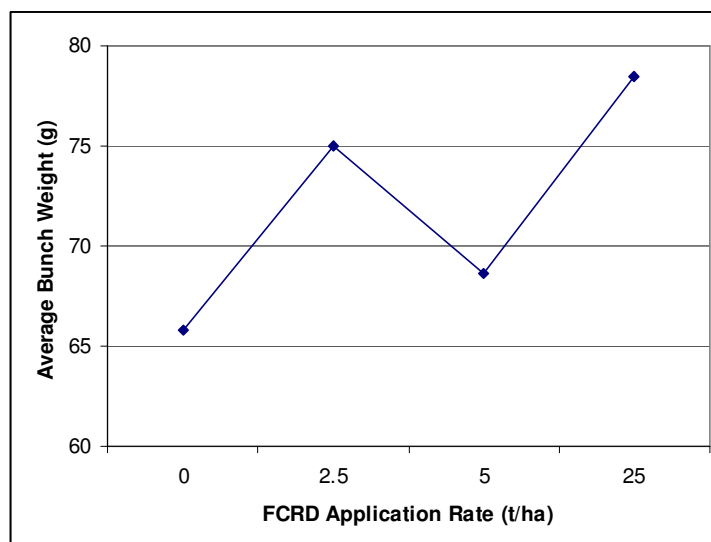
In order to determine if percentage increases in average grape bunch weight were significant, t-tests were performed to calculate the probability that samples from different application rates did not come from the same normally distributed populations. As shown in Table 2 below, bar the 2.5 – 5 t/ha application rates having lower t-test confidence scores, there were significant increases in yield for all other groups at the 90% confidence level.

Trial 1. Cadell 2006

Comparison Between Application Rates (t/ha)	Increase in Average Bunch Weight	T-test confidence level
0 - 2.5	6.99%	89.0%
2.5 - 5	3.88%	75.3%
0 - 5	10.61%	91.5%
0 - 25	21.52%	98.4%

Table 2. Percentage increases in average bunch weight and t-test confidence levels for Cadell 06 trial.***Cadell Trial – 2007***

Like those found in 2006, the results obtained in the Cadell 07 trial also showed a significant increase in average bunch weight of grapes when applied with FCRD fertilizer. However, it is important to note that these significant increases in average bunch weight occurred without any further application of FCRD fertilizer in the 2006/07 growing season. The increases in average grape bunch weights are illustrated in Figure 2 and Table 3.

Trial 1. Cadell 2007**Figure 2.** Average bunch weights for each FCRD application rate in Cadell 07 trial.**Trial 1. Cadell 2007**

FCRD Application Rate (t/ha)	Average Bunch Weight (g)	Standard Error
0	65.84	5.86
2.5	74.96	4.64
5	68.65	7.11
25	78.43	4.84

Table 3. Average bunch weights for each FCRD application rate in Cadell 07 trial.

As shown in Table 4 below, there were significant percentage increases in average bunch weight between the 0 – 2.5 t/ha, and the 0 – 25 t/ha application rates. These increases were further supported by t-test confidence levels above 94%. However, there was no significant increase in average bunch weight between the 2.5 – 5 t/ha, and 0 – 5 t/ha application rates. T-test analysis showed a much lower confidence level between these application rates.

Trial 1. Cadell 2007

Comparison Between Application Rates (t/ha)	Increase in Average Bunch Weight	T-test confidence level
0 - 2.5	12.17%	92.5%
2.5 - 5	-9.19%	81.1%
0 - 5	4.09%	61.6%
0 - 25	16.05%	95.5%

Table 4. Percentage increases in average bunch weight and t-test confidence levels for Cadell 07 trial.

Cadell Trial Conclusions

As indicated by the results obtained in the Cadell 06 trial, it can be concluded that application of FCRD fertilizer significantly increases Shiraz grape yield in the first growing season. Furthermore, as indicated by the results obtained in the Cadell 07 trial, Shiraz grape yield also increases in the second growing season, without the need for further FCRD fertilizer application. The lack of statistical significance of some of the results may be due to vine quality, sample size, or sampling errors. As a result, FCRD undertook a larger trial elsewhere for the 2008 vintage in another region using more uniform vines, whilst also increasing sample size.

Due to water restrictions and the results of poor vine / grape development, no further measurements were possible in the 2008 vintage of Cadell.

Trial 2 – Mintaro, SA

The Mintaro trial was conducted on Riesling grapes in the Clare Valley wine growing region. According to the grape grower, these were the best quality grapes on his property, and were pruned to yield high quality grapes at a lower quantity. Unlike the Riverland region, water allocation was not reduced in this region, and therefore water was available at all bar one critical watering period in January 2008. The grapes are grown in an area which is characterised by a sandstone base with some areas of clay covered by a shallow brown loam soil. The area is naturally acidic (about 5.5 pH) due to little limestone.

The results obtained from the Mintaro trial in 2008 show a significant increase in average grape bunch weight when applied with both 2.5 t/ha and 5 t/ha of FCRD fertilizer. This is illustrated in Figure 3 and Table 5 below (Note: there was no 25 t/ha application rate tested in this trial).

Trial 2. Mintaro 2008

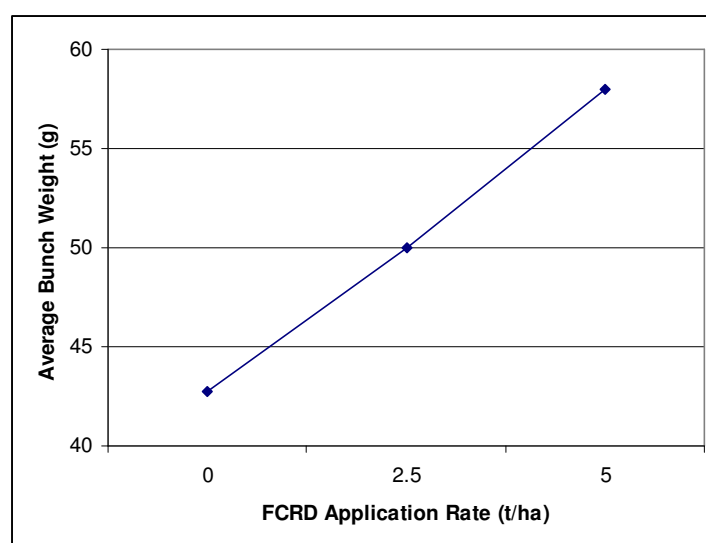


Figure 3. Average bunch weights for each FCRD application rate in Mintaro 08 trial.

Trial 2. Mintaro 2008

FCRD Application Rate (t/ha)	Average Bunch Weight (g)	Standard Error
0	42.78	2.16
2.5	50.03	2.55
5	57.98	2.86

Table 5. Average bunch weights for each FCRD application rate in Mintaro 08 trial.

[Note: any data points that fell outside three standard deviations of the mean were considered 'outliers', and were subsequently removed from the data set.]

The increases in average bunch weights for both the 2.5 t/ha and 5 t/ha application rates are further supported by t-test calculations that show that these increases in average bunch weights occurred with a confidence level of above 96%. The percentage increases in average bunch weights and t-test confidence scores are illustrated in Table 6 below.

Trial 2. Mintaro 2008

Comparisons Between Application Rates (t/ha)	Increase in Average Bunch Weight	T-test Confidence Level
0 - 2.5	14.49%	96.80%
2.5 - 5	13.71%	98.01%
0 - 5	26.21%	99.97%

Table 6. Percentage increases in average bunch weight and t-test confidence levels for Mintaro 08 trial.

Mintaro Trial Conclusions

From the results obtained in the Mintaro 08 trial, it can be concluded that the application of both 2.5 t/ha and 5 t/ha of FCRD fertilizer significantly increases average bunch weight of Riesling grapes in the first growing season.

Cost / Benefit Analysis:

Cadell 2006/07 Trials – Cost / Benefit Analysis

Using data obtained in these trials, a cost benefit analysis was performed to determine the financial benefits of applying FCRD fertilizer to 10 Ha of vines at the varying applications rates of 2.5 t/ha, 5 t/ha, and 25 t/ha.

Cost / Benefit at 2.5 t/ha application rate

Using the Cadell 06 trial results at 2.5 t/ha, FCRD collaterally suggests the grower would have made a 8% gain on his investment of \$7,083 over 10 Ha of grapes in that year. Furthermore, because the second year did not require further application of FCRD fertilizer and therefore no more investment, the overall gain on investment over two growing seasons increased to 197.54% or \$13,387 profit over the initial cost of \$7,083. This is illustrated in Table 7 and 8 below.

Trial 1. Cadell 2006/07

Cadell 06 Cost / Benefit Analysis		Cadell 07 Cost / Benefit Analysis	
FCRD Application Rate	2.5 t/ha	FCRD Application Rate	2.5 t/ha
Percentage Spread	33%	Percentage Spread	33%
FCRD cost per 10 Ha	(a) \$7,083	FCRD cost per 10 Ha	\$0
% Increase in Yield	6.99%	% Increase in Yield	12.17%
\$ per tonne of grapes	\$1,000	\$ per tonne of grapes	\$1,000
Tonnes of grapes per Ha	11	Tonnes of grapes per Ha	11
Benefit per 10 Ha	\$7,689	Benefit per 10 Ha	\$13,387
Profit = Benefit – Cost	(b) \$606	Profit = Benefit – Cost	(c) \$13,387
Percentage Gain on Investment	8.55%	Percentage Gain on Investment (over 2 years)	197.54%

Table 7. Cost / Benefit analysis for 2.5 t/ha application rate over 10 Ha for Cadell 06 and Cadell 07 trials.

Note: Percentage return on investment = $(b/a) \times 100$
 Percentage return on investment (over 2 years) = $((c+b)/a) \times 100$

Trial 1. Cadell 2006/07

Cadell 06-07 Total Cost / Benefit		(at 2.5 t/ha)
FCRD Cost	\$	7,083
Profit 06	\$	606
Profit 07	\$	13,387
2 Year Profit	\$	13,993
Percentage Gain on Investment		197.54%

Table 8. Total Cost / Benefit for Cadell 06-07 at 2.5 t/ha application rate

Cost / Benefit at 5 t/ha application rate

Using the Cadell 06 trial results at 5 t/ha, FCRD collaterally suggests the grower would have made a 17.62% loss on his investment of \$14,167 over 10 Ha of grapes in that year. However, because the second year did not require further application of FCRD fertilizer and therefore no more investment, the overall gain on investment over two growing seasons increased to 14.14% or \$2,003 profit over the initial cost of \$14,167. This is illustrated in Table 9 and 10 below.

Trial 1. Cadell 2006/07

Cadell 06 Cost Benefit Analysis		Cadell 07 Cost Benefit Analysis	
FCRD Application Rate (t/ha)	5	FCRD Application Rate (t/ha)	5
FCRD Spread Rate	33%	FCRD Spread Rate	33%
FCRD Cost per 10 Ha	\$14,167	FCRD Cost per 10 Ha	\$0
% Increase in Yield	10.61%	% Increase in Yield	4.09%
\$ per tonne of grapes	\$1,000	\$ per tonne of grapes	\$1,000
Tonnes of grapes per Ha	11	Tonnes of grapes per Ha	11
Benefit per 10 Ha	\$11,671	Benefit per 10 Ha	\$4,499
Profit = Benefit – Cost	-\$2,496	Profit = Benefit – Cost	\$4,499
Percentage Gain on Investment	-17.62%	Percentage Gain on Investment (over 2 years)	14.14%

Table 9. Cost / Benefit analysis for 5 t/ha application rate over 10 Ha for Cadell 06 and Cadell 07 trials.

Cadell 06-07 Total Cost / Benefit		(at 5 t/ha)
FCRD Cost		\$ 14,167
Profit 06		\$ -2,496
Profit 07		\$ 4,499
2 Year Profit		\$ 2,003
Percentage Gain on Investment		14.14%

Table 10. Total Cost / Benefit for Cadell 06-07 at 5 t/ha application rate

Cost / Benefit at 25 t/ha application rate

Using the Cadell 06 trial results at 25 t/ha, FCRD collaterally suggests the grower would have made a -66.55% loss on his investment of \$70,833 over 10 Ha of grapes in that year. However, because the second year did not require further application of FCRD fertilizer and therefore no more investment, the overall loss on investment over two growing seasons was -41.66% or -\$29,506 over the initial cost of \$70,833 (illustrated in Table 11 and 12 below).

Although these results do not show a positive return for investment like the other application rates due to the cost of applying such a high rate of FCRD fertilizer, future measurements on these vines may illustrate the longer term effects of applying high rates of FCRD fertilizer. As noted above, growing conditions in 2008 did not allow for further measurements this past vintage.

Trial 1. Cadell 2006/07

Cadell 06 Cost Benefit Analysis		Cadell 07 Cost Benefit Analysis	
FCRD Application Rate (t/ha)	25	FCRD Application Rate (t/ha)	25
FCRD Spread Rate	33%	FCRD Spread Rate	33%
FCRD Cost per 10 Ha	\$70,833	FCRD Cost per 10 Ha	\$ -
% Increase in Yield	21.52%	% Increase in Yield	16.05%
\$ per tonne of grapes	\$1,000	\$ per tonne of grapes	\$1,000
Tonnes of grapes per Ha	11	Tonnes of grapes per Ha	11
Benefit per 10 Ha	\$23,672	Benefit per 10 Ha	\$17,655
Profit = Benefit – Cost	-\$47,161	Profit = Benefit – Cost	\$17,655
Percentage Gain on Investment	-66.58%	Percentage Gain on Investment (over 2 years)	-41.66%

Table 11. Cost / Benefit analysis for 25 t/ha application rate over 10 Ha for Cadell 06 and Cadell 07 trials.

Trial 1. Cadell 2006/07

Cadell 06-07 Total Cost / Benefit	
	(at 25 t/ha)
FCRD Cost	\$ 70,833
Profit 06	-\$ 47,161
Profit 07	\$ 17,655
2 Year Profit	-\$ 29,506
Percentage Gain on Investment	-41.66%

Table 12. Total Cost / Benefit for Cadell 06-07 at 25 t/ha application rate.**Mintaro 2008 Trial – Cost / Benefit Analysis**

Using data obtained from the Mintaro 08 trial at 2.5 t/ha, FCRD collaterally suggests the grower would have made a 268% gain on his investment of \$5,313 over 10 Ha of grapes in that year. Furthermore, using data obtained from the Mintaro 08 trial at 5 t/ha, FCRD collaterally suggests the grower would have made a 233% gain on his investment of \$10,625 over 10 Ha of grapes in that year. This is shown in Table 13.

Trial 2. Mintaro 2008

Mintaro 08 Cost Benefit Analysis		Mintaro 08 Cost Benefit Analysis	
FCRD Application Rate (t/ha)	2.5	FCRD Application Rate (t/ha)	5
FCRD Spread Rate	25%	FCRD Spread Rate	25%
FCRD Cost per 10 Ha	\$5,313	FCRD Cost per 10 Ha	\$10,625
% Increase in Yield	14.49%	% Increase in Yield	26.21%
\$ per tonne of grapes	\$2,000	\$ per tonne of grapes	\$2,000
Tonnes of grapes per Ha	6.75	Tonnes of grapes per Ha	6.75
Benefit per 10 Ha	\$19,562	Benefit per 10 Ha	\$35,384
Profit = Benefit – Cost	\$14,249	Profit = Benefit – Cost	\$24,759
Percentage Gain on Investment	268.22%	Percentage Gain on Investment	233.02%

Table 13. Cost / Benefit analysis for 2.5 t/ha and 5 t/ha application rates over 10 Ha for Mintaro trial.

[Note: The percentage spread rate of FCRD differed between the two trials due to the fact that the Mintaro vines were 4m apart, while the Cadell vines were 3m apart. FCRD is applied in 1m wide strips along the vines, and therefore the percentage spread rates per Ha differed between the two trials.]

Cost / Benefit Summary

Cost / Benefit analysis of each of the application rates across both trials indicates that there are significant financial gains in applying 2.5 t/ha, 5 t/ha, and 25 t/ha of FCRD fertilizer. Results indicate that growers can expect at least a minimum of 27% return for investment in the first growing season and a minimum of 76% return for investment over two growing seasons (in the case of the Cadell 2006/07 trial at 5 t/ha application rate). However, results from other application rates in both the Cadell and Mintaro trials suggest that growers could expect significantly greater return for their FCRD application investment.

Overall Conclusions:

Based on the Cadell 06 and Mintaro 08 trials, FCRD believes it is reasonable to state that growers should expect to see a significant increase in grape yield in the first growing season after FCRD fertilizer application.

Furthermore, based on the results obtained in the Cadell 07 trial, FCRD believes it is reasonable to state that growers can expect to see significant increase in grape yield in the second growing season, without the need for further FCRD fertilizer application.

Finally, based on the results obtained in both the Cadell and Mintaro trials, FCRD believes it is reasonable to hypothesize generally that FCRD fertilizer application significantly increases grape yield regardless of grape variety, grape growing region, or growing conditions.

The analysis of these trials suggest that growers can expect a significant financial return on an investment in applying FCRD fertilizer to their grapes at both the 2.5 t/ha and 5 t/ha levels. These returns appear to be at least 27% in the first year and over 76% over two years.

Some may query the use of FCRD fertilizer and its effect on grape quality. As part of the 2006 Cadell trial, Provisor* undertook an anthocyanin analysis to determine grape quality (notably the colour of the juice). This analysis was performed by the Australian Wine Research Institute (AWRI), and it was found that there was no significant change in anthocyanin levels in grapes that had been exposed to different application rates of FCRD fertilizer. According to these results, it could be concluded that FCRD fertilizer significantly increases grape yield, without affecting grape quality.

The results of the Mintaro 2008 trial being undertaken on a larger scale and on more uniform vines may help support the low confidence levels of certain outcomes in both the 2006 and 2007 Cadell results.

**Provisor assisted FCRD in the implementation of the Cadell 2006 trial.*

Future Directions:

These results suggest that grape growers can use FCRD with confidence in at least the Riverland and Clare Valley regions. Further trials will now be undertaken in other regions and on other grape varieties to test FCRD's working hypothesis. In addition, extensions of the current trials in Cadell and Mintaro will be undertaken (subject to water availability) to assess the impacts on longer term and broader application bases.