

COGGO

Council of Grain Grower Organisations Limited
ACN 091 122 039

Final Report

COGGO Research Fund for projects finishing at the end of 2015

A project completion report covering the project. The acceptance of a satisfactory report against the objectives of the project, and agreement on the sharing of any commercial returns and/or IP will trigger payment within 4 weeks, by COGGO for any outstanding payments.

This Final Report should be completed with reference to the Research and Intellectual Property Agreement (the Research Agreement) signed between the proponent and COGGO Pty Ltd.

1. Project information

Project title	Incorporating lime to depth on duplex Wheatbelt soils.
Commencement Date	1 st January 2015
Completion Date	31 st December 2015

Name of Proponent	Facey Group Inc.
ACN/Legal Name or ABN	59 136 484 550
Mailing Address	PO Box 129, WICKEPIN WA 6370

Administrative Contact	Bronwyn Dew
Position	Administration Manager
Telephone	08 9888 1223
Fax	08 9888 1295
Email	admin@faceygroup.org.au

Project Supervisor/Principal Researcher	Sarah Hyde and Georgia Oliver
Position	Executive Officer and Sustainable Agriculture Coordinator
Telephone	08 9888 1223
Fax	08 9888 1295
Email	eo@faceygroup.org.au or sac@faceygroup.org.au

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Project Number	
Date Received	

2. Project results	This section provides a final report against the Project Aim and the Planned Outputs for the Project.
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Achievement of the Project Aim	Brief statement of achievement in relation to the aim of the project
<p>The project aimed to reduce the impact of acidic soils on plant growth and test the most practical and economical methods of incorporation of lime on duplex soils in the Central Southern Wheatbelt in comparison with the standard practice of top-dressing lime.</p> <p>In 2015, preliminary results showed plants in treatments of an incorporation method took up a higher percentage of organic nitrogen, in comparison to those treatments top dressed or those with no treatment. Soil samples will be completed pre seeding of 2016, to compare soil pH and other nutrients within the profile and to baseline soil samples taken in 2015 prior to treatments being applied. The yield of the treatments was not statistically different in the first year.</p> <p>An economic analysis was conducted at the end of 2015 harvest, outlining the cost and gross margin for each of the treatments in the initial year of the trial.</p> <p>Through extension and hosting a demonstration of incorporation methods, we have informed members of the Facey Group and growers within the local region; of the lime incorporation methods used and initial findings of the trial. Extension in 2016 will incorporate the delivery of 2015 results to growers and industry through Facey Groups Trials Presentation Event, a field walk after seeding and Spring Field Day.</p>	

Project Outputs	Please provide a report on the achievement, or otherwise, of the project outputs as per the planned outputs provided in the Project Proposal.
1	<p>Output 1 (from Project proposal)</p> <p>Improve data on crop growth and response to lime incorporation methods on duplex soils.</p> <p>Comment:</p> <p>In 2015, data was gathered on soil quality, crop emergence, weed burden, tissue nutrient levels, yield, and grain quality. Preliminary data showed treatments with lime incorporated to depth had a higher nitrogen concentration in comparison to treatments with NIL lime or top dressed lime. The spaded treatment had the highest nitrogen concentration in the plant tissue tests and also had the highest grain protein at harvest. While the plant tissue Nitrogen concentration was statistically different, the protein was not across all treatments. Cultivation increases N mineralisation and availability to the plant, furthermore subsoil acidity can limit the organic nitrogen available to the plant (Davies). The preliminary findings suggest the soil pH has risen in the root zone, and it is likely that a combination of these factors is responsible for the improved N uptake in the incorporated treatments. Soil tests will be conducted prior to seeding in 2016 to assess the movement of lime through the soil.</p>
2	<p>Output 2 (from Project proposal)</p> <p>Report on response to plant growth and yield to different liming methods.</p> <p>Comment:</p> <p>In 2015 the crop establishment and weed burden were monitored after seeding the trial. In the first year the main establishment and weed burden differences between the trial plots were caused by the soil amelioration and seeding depth. The spaded treatments had reduced germination, which were worsened by the seeding bar not being setup specifically for the softer sand, therefore seeding deeper. 2015 has seen very variable emergence in canola crops throughout the state, seeding depth has worsened the emergence. However, the plots with reduced crop establishment had larger and more developed plants; likely due to less plant competition, while there was a trend towards reduced yield in these treatments; it was not statistically different. The top dressed and Calciprill plots tended to have the higher yields and crop establishment, but as stated previously, the yields were not statistically different. The weed burden was decreased in treatments with soil amelioration, shown in Figure 4 below; this is more than likely due to physical burying of the weed seeds.</p>
3	<p>Output 3 (from Project proposal)</p>

Economic comparison on different methods of lime incorporation.

Comment:

As there was no significant difference between the treatments yield, the cost of the treatments had the biggest impact on profitability in 2015. Over the long term it is expected treatments that required larger investment will return higher yields, however this effect was not seen in the first year's results. The control treatment had \$0 treatment cost as there was no investment. The Spaded treatment was the most expensive as the plots were deep ripped previous to spading to loosen the soil, making it easier to spade. The costs are shown in Table 1 below; and represent only the treatment costs; not the whole year expenditure per plot.

Table 1: Cost of treatments in year one applied prior to canola being sown in 2015 at Wickepin.

Treatment Id	Treatment	Treatment Cost (\$/ha)
1	Control	\$ 0
2	Calciprill (100kg/ha)	\$ 57
3	Top dress lime (2t/ha)	\$ 86
4	Deep rip Lime (2t/ha)	\$ 126
5	Spade + deep rip + Lime (2t/ha)	\$ 256

As no significant yield difference was determined, treatments that required investment (Treatments 2-5; Figure 2) did not result in a higher gross margin than the untreated control in the year they were applied. Treatments that did not require incorporation; Calciprill and top dressed lime had positive gross margins (\$30.77/ha and \$4.65/ha respectively). When lime was top dressed and incorporated, the gross margins were negative. Deep ripped incurred a \$44.96/ha loss and spaded \$188.43/ha).

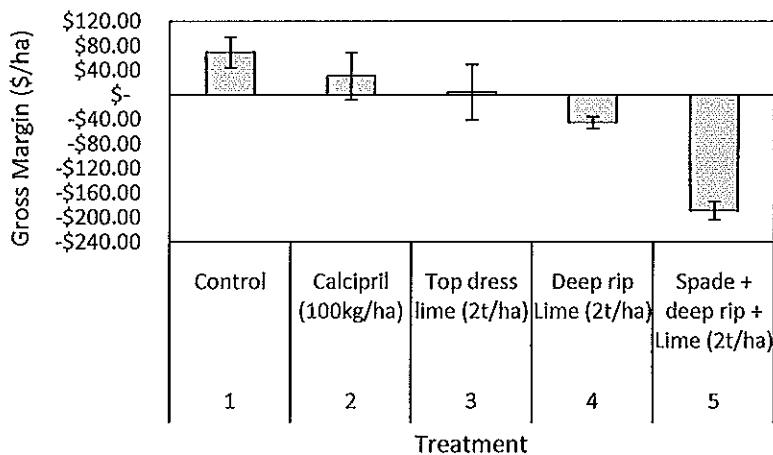


Figure 1: Gross Margins (\$/ha) for soil treatments applied prior to canola being sown in 2015 in Wickepin.

High cost treatments have the potential to increase yield over the longer term, therefore yield and gross margins over a period of time need to be taken into account when considering lime incorporation.

Note; although the variability (standard error) in the gross margins appears high, this is due to the overall low gross margins resulting from a lower than average canola yield.

Project results

Please provide brief statements on the results of the Project

Trial Details:

Property:	Craig Jespersen, Hazeldene, Wickepin
GPS Coordinates:	SW corner -32.785316 117.636913
Plot size & replication:	11m X 180m X 3 replications
Soil type:	Sandy Loam/ Gravel
Crop Variety:	Canola
Application Date (lime and soil amelioration):	7 th May 2015
Liming Rate:	2t/ha
Calciprill Rate:	100kg/ha
Sowing Date:	7 th May 2015
Soil Testing Date:	12 th March 2015
Crop Establishment testing Date:	25 th May 2015
Weed Burden testing Date:	22 nd June 2015
Tissue Testing Date:	17 th August 2015
Harvest Date:	13 th November 2015
Fertiliser (kg/ha):	58kg MAPS, 22kg Potash, 80lirs Maxam Flow at seeding
Paddock rotation:	2014- Barley, 2015- Canola, 2016- Wheat
Rainfall (mm):	302.8

The treatments are:

- Control (NIL),
- Top dressed lime
- Direct drilled Omya Calciprill
- Top dressed lime, deep ripped and then spaded
- Top dressed lime then deep ripped,

The treatments are replicated 3 times. The lime was spread at a rate of 2 tonne per hectare and the Calciprill was drilled at a rate of 100kgs per hectare. The site was seeded on the 8th of May to Canola. The trial is broad acre scale and the plots are 11m x 180m. See Figure 2 for the trial layout.

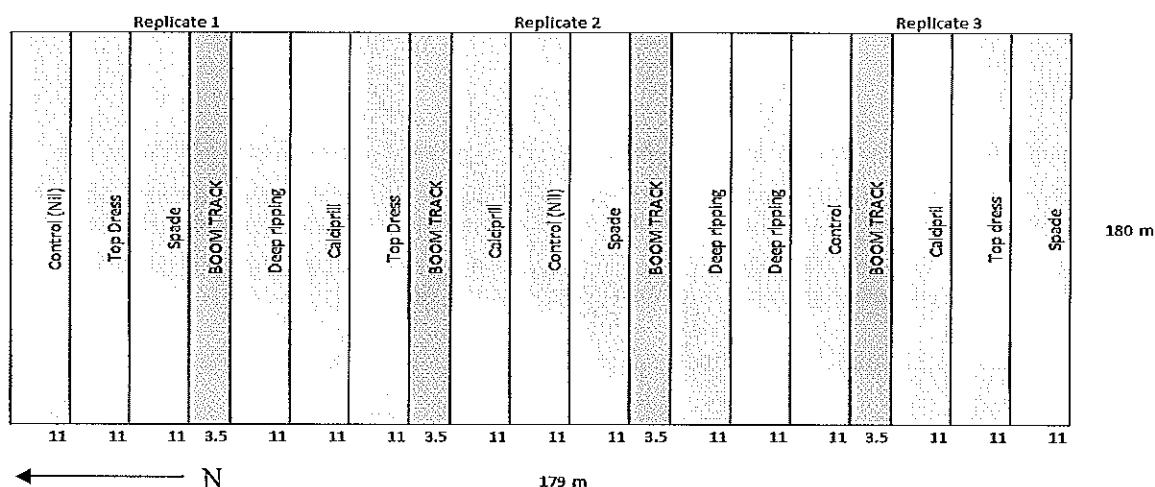


Figure 2: Trial layout of lime incorporation trial set up in East Wickepin.

Pre-seeding Soil test:

Soils tests were taken pre-seeding and pre-treatment on the 12th of March 2015 to a depth of 40cm. 3 samples per plot were taken at increments of 0-10, 10-20, 20-30 and 30-40cm. The analysis was completed by Summit Fertilizers. The average pH for the site was 4.91, though it ranged from 4.4 to 6.0. The soil type is sandy loam and the soil test showed the organic carbon, potassium and sulfur were low, but even throughout the plots. The tests show the top 10cm in the profile had higher levels of organic carbon, nitrates, phosphorus, potassium and sulphur, as shown in Table 2. Lime can take some time to fully react with the acidic soil even after incorporation so more accurate changes in soil pH as a result of liming and incorporation can only be determined after a period of time.

Table 2: Soil test results of whole trial site for 0-10, 0-20, 20-30 and 30-40cm increments.

	0-10cm	10-20cm	20-30cm	30-40cm
Soil pH (CaCl ₂)	4.9	4.9	4.9	5.0
Organic Carbon (%)	1.1	0.7	0.4	0.3
Nitrate N ppm (mg/kg)	14.6	6.0	4.0	3.0
Phosphorus ppm (mg/kg)	32.8	28.3	18.9	11.4
Potassium ppm (mg/kg)	24.1	17.7	15.0	14.5
Sulphur ppm (mg/kg)	11.8	4.1	3.9	4.7
Aluminium (CaCl ₂)	1.7	2.9	2.7	1.6

Crop Establishment:

Treatments that encompassed soil disturbance as a lime incorporation method generally had reduced crop establishment than other treatments as seen in Figure 3. Crop establishment was completed on the 25th of May when the canola crop was at 2 leaf stage, nine 1metre rows were counted per plot.

In 2015, the spaded treatments had the lowest crop establishment with 25 plants per m², while those top dressed had the highest crop establishment with 50 plants per m². A visual observation made was the plots with lower germination rate had larger, more developed plants, while the plots with higher germination rate had smaller plants. There was no link to a difference in yield at the end of the season.

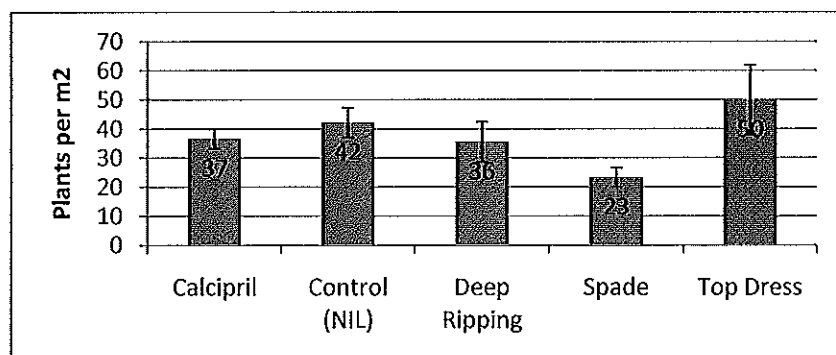


Figure 3: Crop establishment, measured as plants per m², of all treatments from 25th May 2015 when canola crop was at 2 leaf stage.

Weed Burden:

The weed count results showed similar trends to crop establishment. Nine weed counts per plot were taken along a 10m transect with weed species recorded as well as the total number of weeds. The two main species of weeds recorded were Capeweed and Ryegrass. The results showed the trial plots with the highest level of soil disturbance had the lowest weed burden. This is due to the physical burying of the weed seed bank.

Annual Ryegrass was similar throughout the treatments with Deep ripping having the lowest burden with an average of 4 weeds per treatment, as shown in Figure 4. Top dressing, Deep ripping, Control and Calciprill all had similar averages per treatment with 7, 8, 8 and 9 respectively.

Capeweed was variable between the treatments, the weed seed bank was affected by the Spaded treatment due to the physical burying of the weed seeds. The Spaded treatment had an average of 2 plants per treatment. Calciprill, Control and Deep ripping all had averages of 8 Capeweed plants per treatment. Top Dressing however had a very high Capeweed burden, with an average 19 plants per treatment; this is shown in Figure 4.

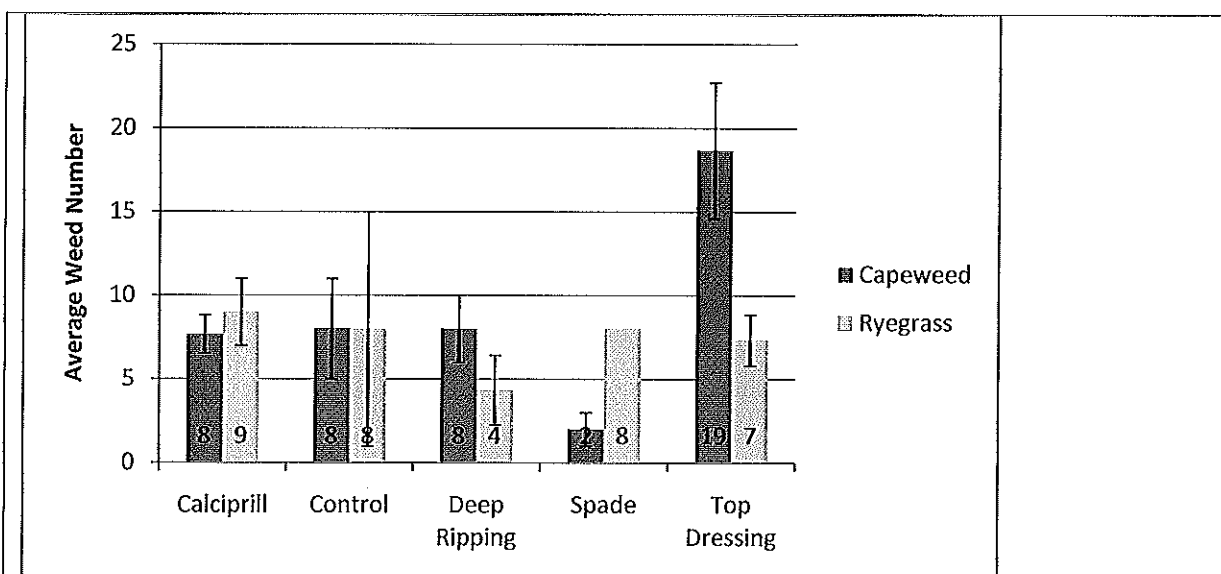


Figure 4: Weed burden, measured as number of weeds per 10m transect, for each treatment.

Tissue Test:

Tissue testing was conducted at growth stage 50-59 at bud formation on the 17th of August 2015 and the samples were analysed by Summit Fertilizers. Nine samples per plot were taken. The tissue tests showed the spaded treatment had the highest concentration of nitrogen in the shoot green matter, followed by the deep ripping plots, 4.071% and 3.484% nitrogen respectively as shown in Table 3. The top dressed and control plots had the lowest percentage of nitrogen in the plant with 2.937% and 2.869%. The increase of nitrogen could be attributed to a number of factors. Acidic soil reduces the availability of organic nitrogen to the plant, as the pH increases so does the availability of nitrogen. The other factors that may have influenced the plants uptake of organic nitrogen are increased mineralization from cultivation and reduced compaction due to soil amelioration. Soil tests in 2016 will help determine which of these factors had the greatest effect on nitrogen concentration.

Grain quality showed the spaded treatment had the highest grain protein level, though there is no statistical difference between the treatments, there is a strong correlation between available soil nitrogen and grain protein. At this point the correlation between the two results is an observation, but they will both be tested in 2016 when the trial is seeded to wheat to see if the correlation is stronger.

Table 3: Nitrogen percentage from green shoot matter tissue test.

Treatment	Nitrogen %
Control	2.869
Top Dress	2.937
Spade	4.071
Deep Ripping	3.484
Calciprill	3.236
LSD (P=0.05)	0.3355

Yield and Grain Quality:

The trial was harvested on the 13th of November using farmer machinery and weighing each plot in a weigh trailer. The results show that the Top dressed and Calciprill plots yielded the highest, an average of 735 and 730 Kg/ha respectively, as shown in Table 4, though they are not statistically different to the other treatments.

Grain analysis was completed by Wickepin CBH. While there are small differences between the plots, they are not significantly different.

Table 4: Yield (Kg/ha), protein (%), oil (%) and moisture (%) from canola grain samples taken at harvest for each of the treatments.

Treatment	Yield (Kg/ha)	Protein (%)	Oil (%)	Moisture (%)
Control	698.33	21.40	45.03	5.167
Top Dress	735.00	22.07	44.77	5.200

Spade	695.00	22.30	44.10	5.367
Deep Ripping	718.33	21.63	44.77	5.267
Calciprill	730.00	21.40	45.03	5.233
LSD (P=0.05)	107.7	0.997	1.061	0.254

Economic Analysis:

An economic analysis was conducted after harvest and grain analysis by Planfarm Narrogin. As there was no significant difference between the yields of the treatments, the Gross margin is determined heavily by the treatment cost for all the treatments. Since the trial was seeded to canola and a below average year, the gross margins were low for 2015. 2016 will be seeded to wheat, which will hopefully recuperate some costs.

Due to having no expenditure for the control treatment this was reflected with the highest gross margin of \$69.49/ha. Of the four applied treatments, Calciprill and Top dressed had positive Gross margins; this was due to low cost to apply the treatments. Due to the cost of soil amelioration, in the first year, both the deep ripping and spading plots had a negative gross margin, as shown in Table 5.

Table 5: Treatment cost (\$/ha) and Gross margin (\$/ha) for each treatment from economic analysis conducted by Planfarm.

Treatment	Treatment cost (\$/ha)	Gross Margin(\$/ha)
Control	\$0	\$69.49
Calciprill	\$57	\$30.77
Top Dress	\$86	\$4.65
Deep Ripping	\$126	-\$44.96
Spade	\$256	-\$188.43

Difficulties encountered:

We had difficulties locating a suitable tractor to pull the spader. A spader was borrowed from a local grower, but we had to supply our own tractor. A tractor was supplied by Greenline Agriculture and a demonstration for both the tractor and lime incorporation methods was held.

The trial was seeded immediately after the soil treatments. The soil was very soft and the seeder was not calibrated for it. As a result the spaded plots were seeded slightly deeper than the other plots, which could account for the lower establishment rate in the spaded plots.

In 2015, one of the biggest issues faced from growers around the district was a low germination rate due to non-wetting soils. The trial was seeded to canola which was the worst affected crop. Sporadic rainfall and low soil stored water exacerbated the impact of the non-wetting soils, reducing the germination rate for all the treatments.

Conclusions:

The germination and weed burden have been affected by the soil amelioration treatments; the high level of soil disturbance has decreased the weed burden and the crop germination in the first year. This was not reflective of the yield which was not significantly different between the treatments. As it was a below average year and the trial was planted to canola, a low yielding break crop, the Gross margin for the soil amelioration treatments was negative. There was a high cost to set up the treatments and this was reflected in the gross margins. How this changes over time in conjunction with the limes movement through the profile will be documented in years to come.

We recommend that this trial continue in 2016. Preliminary results from the tissue test show there has been an interaction between lime incorporation methods and nitrogen uptake by the plant but this was confounded by the cultivation effect and further evidence could be collected from a cereal crop in 2016. Soil tests in 2016 will show how the lime is moving through the profile and whether it has significantly improved the soil pH. From previous research, the affects of soil amelioration decrease in the second year as the soil settles. The soil amelioration may not have as great of an impact on the germination as it did in 2015.

This section should cover aspects identified in *Section 7.3* of the Research Agreement

- the results of the Project, including discoveries made and other achievements (including any Project IP and Project Confidential Information);

- the potential application of the outputs of the Project to the Western Australian grains industry and broader community;
- the actual or potential economic benefits flowing to the Western Australian grains industry and broader community from the Project;
- the difficulties encountered;
- the conclusions reached;
- the Researcher's recommendations for any further research;
- a list of scientific papers or publications resulting from the Project; and
- attach copies of any photos, diagrams or other artworks (including, if requested by COGGO, negatives, bromides or the like) which the Researcher has and which may be of assistance to COGGO in the dissemination of information concerning the Project to COGGO's stakeholders.

3. Project resources	This section describes use of the funding listed in the initial plan and any refunds due to COGGO
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Expenditure of funds requested from COGGO	\$ Total funds budgeted	\$ Total funds expended (actual)	\$ Total funds requested from COGGO*	\$ Total COGGO funds expended	\$ Refund due to COGGO of any unexpended COGGO funds
Salary/Contractors	15,000	15,000	15,000	15,000	0
Operating costs	20,000	20,000	20,000	20,000	0
Capital	0	0	0	0	0
TOTAL	35,000	35,000	35,000	35,000	0

*Funding provided by COGGO.

IMPORTANT: Return of unused funds to COGGO is required as per *Clause 3.3* of the Research Agreement.

4. Commercialisation	<p>Insert details of the proposed commercialisation process, as applicable, with reference back to the planned commercialisation plan in the project proposal) for any outputs from the project.</p> <p>This should include recommendations for the commercialisation of the results of the project and the registration or other protection of Project IP and Project Confidential Information as per the Research Agreement.</p>
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This project is 'public good' research, the aim is to increase growers knowledge of lime incorporation methods and return to growers investment over specific time periods.

The trial brings new soil acidity management strategies to the district and through extension will inform farmers of the options available. As there are 5 different management strategies being tested, there are many different ways for growers to adapt our research to best fit their management practices. Our findings and economic analysis will be made available to growers at the Facey Groups Trials Presentation Event in March 2016 and at Spring Field Day 2016.

In 2015 an economic analysis was conducted after the results were collected and it showed due to the high cost of setting up the trial the treatments with soil amelioration had negative gross margins. At the end of each year an economic analysis will be conducted and will be compared to the previous year to show the economic trends throughout time. The economic analysis will be available to growers and industry as it will show the cost of setting up the trial and the gross margins for each year. We are hoping to provide information on all aspects of the trial and allow growers to be fully informed before using the treatments.

It is understood that this may require further discussion and agreement with COGGO via its' agent GIWA, as per the undertakings given and terms agreed, in the project proposal. This can be the subject of an appended letter

and attachments. In all cases such discussion and subsequent agreements need to be governed by *Section 8 Project IP, Improvements and Project Confidential information* of the Research Agreement.

5. Communication/ Extension	Insert details of how the communication and extension of the project outcomes has been achieved to date and recommendations for future activities to disseminate and promote adoption of the results of the Project.
<p>A field walk and spading demonstration was conducted prior to seeding the trial on the 8th of May. 12 farmers and industry members from the region came and watched the treatments being deep ripped and spaded while being involved in discussions surrounding liming.</p> <p>An article featuring the trials treatments, progress and future was included in the Facey Groups June newsletter. The article promoted both the trial and COGGO. This newsletter is distributed to all of the members and features updates on events, trials and industry news. The newsletter is sent to all members, which includes 90+ farming entities, sponsors, and local industry and is also posted on the Facey Group website. The article is attached.</p> <p>A mid season write up detailing the trial plans and results up until early September was published in the trial booklet released at our Spring Field Day on the 16th of September. The Field day was attended by over 70 individuals, with the majority being growers. The report included the trial aim, trial layout, germination rate, weed count scores and trial updates. The article is attached.</p> <p>A trial report will be completed with the economic analysis included and will be included in the 2015/16 Trials & Demonstrations Booklet. This event will be held on March 10 2016.</p> <p>In 2016 the trial will be featured at our main trial site, which features a number of soil trials. A write up showing 2015 results and 2016 preliminary results will be submitted into the Spring Field Day booklet, and the trial will be featured and presented during the day.</p>	

Note: As per *Clause 7.3 (b) (ii)* of the Research Agreement COGGO may require the Researcher to produce an edition of the Final Report in a form suitable for general distribution. If so required by COGGO, the Researcher must produce a non-confidential version of the Final Report within 28 days of receiving a request to that effect from COGGO.

6. Certification

The Project Supervisor and the Research Organisation certify that all information contained in, and forming part of, this final project report is complete and accurate. The project supervisor and research organisation further warrant that the project complied with all the relevant guidelines affecting the conduct of research, for example in relation to ethics, bio-safety, environmental legislation, GMAC or National Health and Medical Research Council Codes.

Project Supervisor's signature



Name (in Capitals)

GEORGIA OLIVER

Date: 15.2.2016.

Research Organisation signature



Name and title of authorised signatory (in Capitals)

SARAH HYDE

EXECUTIVE OFFICER

Date: 15.2.2016.

Completed Final Project reports

Email to coggoresearchfund@giwa.org.au or mail to
COGGO Research Fund, GIWA, PO Box 1081, Bentley DC, WA 6983

For any further enquiries please email questions to coggoresearchfund@giwa.org.au
Or phone (08) 6262 2128

COGGO representative

For the purpose of this Project agreement contract, COGGO will be represented by Grains Industry Association of Western Australia (GIWA), or such other representative that is nominated by COGGO as authorised to operate on behalf of COGGO.