



Farming Demonstrations Final Report

Response and availability of potassium in wheat
crops to applications of biochar
1512-05-04



Supporting people to support the natural environment



Contents

1.0 INTRODUCTION.....	3
2.0 AIM OF PROJECT	3
3.0 PROJECT MILESTONES.....	4
4.0 DEMONSTRATION SITE/S	5
5.0 METHOD	6
6.0 RESULTS	8
7.0 FINDINGS	9
8.0 PHOTOS.....	12
9.0 DELIVERY PARTNERS	12

1.0 INTRODUCTION

This Document is delivered to you by *Energy Farmers Australia* as part of the Northern Agricultural Catchments Council's Sustainable Agriculture Project. This project has been delivered by *Energy Farmers Australia* and is supported by the Northern Agricultural Catchments Council (NACC), through funding from the Australian Government's National Landcare Programme.

The project started *insert date* and was completed *29 May 2015*.

2.0 AIM OF PROJECT

What was the aim of the project? What did you want to demonstrate to farmers? How could this innovative practice contribute to improved natural resource management?

The primary aim of the project was to demonstrate potassium response to the application of wheat straw biochar to soil in a cereal crop. We also changed the scope and trialled poultry litter biochar at various rates with traditional fertilisers to ascertain yield response.

Poultry litter biochar (PLB), as opposed to wheat straw biochar (WSB) was chosen because of the nutrient content it contains (see table below) and the fact that PLB can act as a slow release fertiliser.

We also chose to use poultry litter biochar because poultry litter can be a problem for the poultry farmer. The current practice is to clean out the poultry litter from sheds every 6-8 weeks. While this represents a large volume of material it is sometimes not enough to make it economic to transport it large distances. Therefore farmers have to stockpile the manure until there is enough to fill a road train. This stockpiling attracts stable flies, produces odours and also produces greenhouse gases. The idea is to process the litter immediately into biochar and eliminate these problems. Energy (i.e. heat) from the process can also be utilised on farm.

The final reason we chose to use poultry litter and not wheat straw is that the economics and logistics of producing WSB at the scale we operate is cost prohibitive. The cost to the farmer to bale, store and transport wheat straw is in the region of \$100/tonne. This does not include processing costs and the transport the biochar back to the farm which we estimate being in the region of \$300-500/tonne. We don't think, (at this early stage) that the benefits of wheat straw biochar are demonstrable enough to encourage farmer uptake.

	pH (CaCl2)	EC (mS/cm)	Total C	CN Ratio	Total N %	P %	K%
Poultry Litter	9	7.7	38.8	10.6	3.7	2.53	2.80
Wheat Straw	10.1	2.4	30.3	54.3	0.6	0.45	0.85

There is a lot of research around the world pointing toward using biochar as a soil amendment and that applications of biochar when blended with fertiliser can improve yield and soil quality.

We also wanted to demonstrate that nutrients such as NPK are tied up in waste such as wheat straw and poultry litter. Many Australian farmers burn crop residue to control chemical resistant weeds. Farmers have the opportunity to capture this residue to produce bioenergy and biofuels. To achieve this outcome it is important to understand how the by-products of the bioenergy process, like biochar will affect our cropping systems.

3.0 PROJECT MILESTONES

Please add additional rows as required

Table 1 Contractual Milestones

#	Milestone	Date Due	Activity completed
1	Completed demonstration design submitted using template which will be provided by NACC	17/12/2014	<input type="checkbox"/> Yes
2	Biochar analysed and produced	31/12/14	<input type="checkbox"/> Yes
3	Small plot trials established at pre-selected sites consisting of a minimum of 3 replications for each of the 4 treatments	29/05/15	<input type="checkbox"/> Yes
4	Site monitored as described in application and Demonstration Design	31/12/15	<input type="checkbox"/> Yes
5	Site harvested	31/12/15	<input type="checkbox"/> Yes
6	Field walk or field day held to extend learnings from the site	31/12/15	<input type="checkbox"/> No
7	Demonstration of pyrolysis kiln processing wheat straw	31/03/16	<input type="checkbox"/> No
8	Soil and tissue tests completed and analysed as described in application and Demonstration Design	31/03/16	<input type="checkbox"/> Yes
9	Project and results promoted through a variety of communication methods	31/05/16	<input type="checkbox"/> Yes
10	Final Report submitted on project results and outcomes using template provided by NACC	31/05/16	<input type="checkbox"/> Yes

If any activities have not been completed please explain why and what is being done.

Milestone's 6 and 7 (Field walk or field day held to extend learnings from the site and Demonstration of pyrolysis kiln processing wheat straw) were not completed.

We had planned to run these two milestones together where we would take the machine to the site, process the straw to demonstrate the technology and explain the trials.

The reason these milestones were not completed was the fact the biochar kiln is still in development and we are continually making changes to the machine. During July– Dec 2015, the kiln was in the workshop a lot and we were not confident of its performance, especially when demonstrating to a group of people.

We were also not confident demonstrating the kiln due to OH&S reasons. The kiln operates at very high temperatures (plus 800°C) and because we have not perfected the design we did not want to run the risk of injuring someone.

Once the kiln is operating at a level where we are confident, we do plan to demonstrate the technology to farmers.

4.0 DEMONSTRATION SITE/S

Please add additional sites as required

Site 1

Location

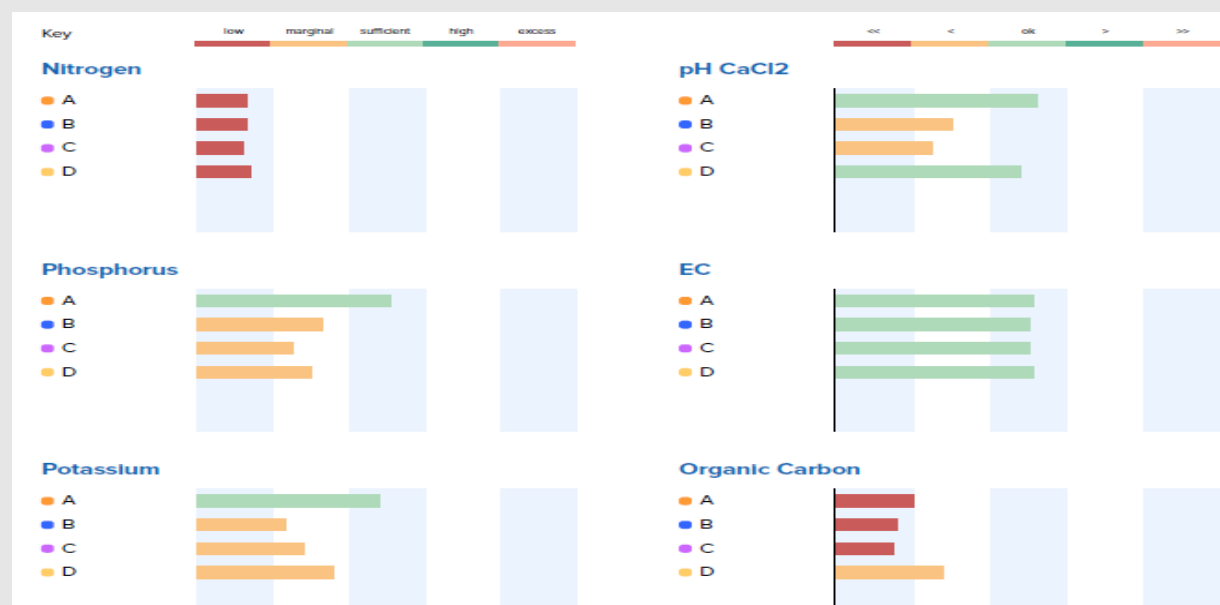
Jib Jib Farm - Chilimony Rd, Northampton.

Industry/farming practices on property

Cropping – wheat, canola and lupins

Why was the site chosen?

The demonstration has been selected for the poor quality soil type and low potassium levels. The soil is a typically, lower performing loamy sand. It is moderately acidic with low levels of Nitrogen, Phosphate, Potassium and Organic Carbon (refer table below).



General Information about the site (e.g. soil type, previous activities on the site, any issues such as salinity, etc.)

Previous activities – the paddock is in a wheat, lupins and canola rotation. Canola was grown in 2014 and wheat 2015. The paddock is expected to be sown to Lupins in 2016 and wheat in 2017. No liming was recorded.

5.0 METHOD

Has the method (what has been done or how) changed from the project Demonstration Design? If yes, explain what has changed and why.

Energy Farmers engaged Grant Thompson from Crop Circle Consulting to carry out the trials.

The trial was randomized controlled trial consisting of small plots, each of approx. 2 m x 20 m (0.004ha) for each treatment. Each plot was seeded with a small cone seeder, the biochar was mixed with the fertilisers pre-sowing and deep banded. There was a minimum of 3 reps for each treatment.

Treatments included:

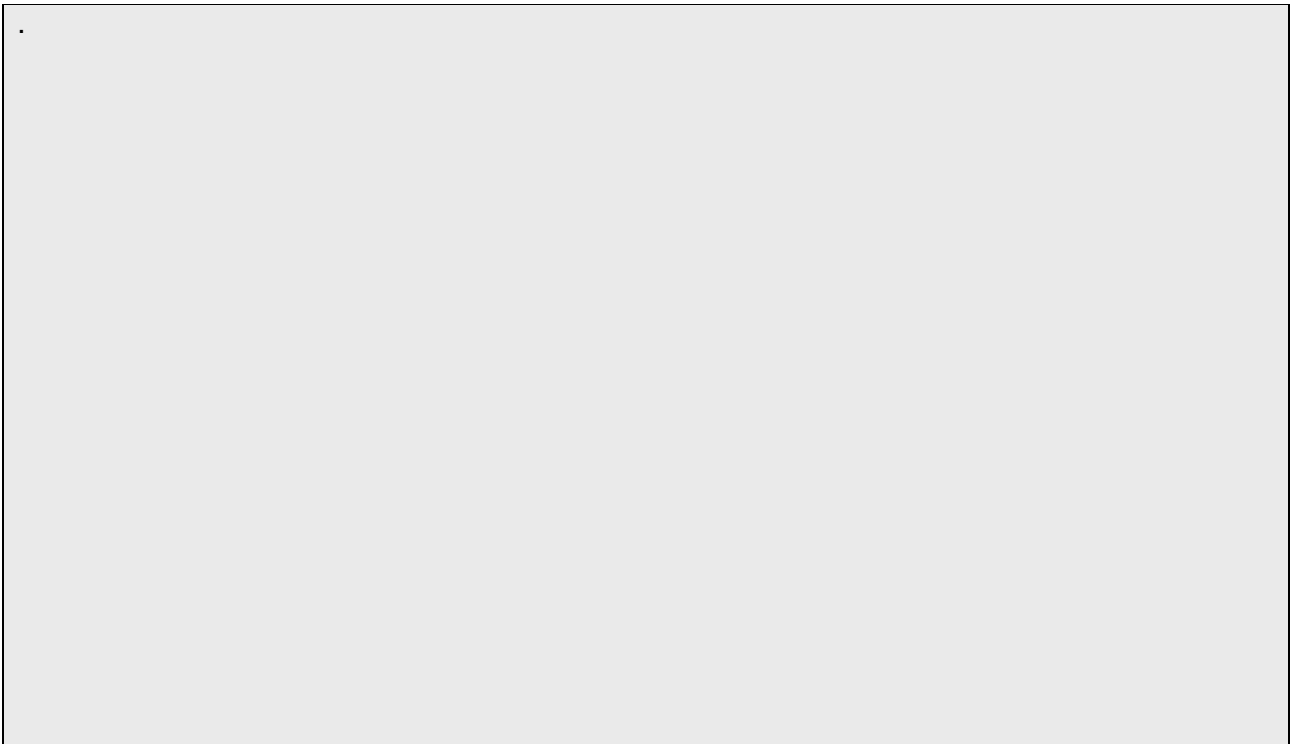
- Treatment 1 - - Control – No fertiliser
- Treatment 2 – Farmer treatment (110kg of Ktill Plus)
- Treatment 3 - Farmer treatment plus 35kg poultry litter (PL) biochar
- Treatment 4 - 50% Farmer treatment plus 35kg PL biochar
- Treatment 5 - AMF 85 Kg/ha (Australian Mineral Fertilisers)
- Treatment 6 - 85Kg AMF – 5% PL biochar
- Treatment 7 - 85kg AMF – 10% PL biochar
- Treatment 8 - 85kg AMF – 20% PL biochar
- Treatment 9 - 85kg AMF – 30% PL biochar
- Treatment 10 - 85 kg EFA Biochar Blend
- Treatment 11 - 100kg wheat straw biochar plus Agras

AMF was used as a fertiliser in the trial as well as the Ktill Plus which is the fertiliser that the farmers uses. AMF was used as the company has also been using biochar and see a place for it within the fertiliser makeup. It is generally not a fertiliser that is used in the NAR but it may have its place.

Crop Circle Consulting also included (at their cost) 5 extra, more traditional treatments. These were:

- Agras Extra 110kg + 30kg MOP banded
- Agras Extra 110kg
- Agras Extra 110kg + 30kg MOP top-dressed
- Agras Extra 110kg + 60kg MOP top-dressed
- Agras Extra 110kg + 90kg MOP top-dressed

Trials were seeded, on the 28th April and harvested on the 11th of November.



What measurements were taken and/or monitoring was done at each site?

Soil Tests – See above
Tissue Test – See attachment 1
Yield and Gross Margin Analysis – See attachment 1
Biochar Analysis – See attachment 2

6.0 RESULTS

Results from measurements and analysis for site/s (add attachments as necessary)

Due to seasonal moisture constraints, the crop did not perform as well as expected. There was no significant yield variation between any of the treatments. The control, with no fertiliser, yielded 1.46t/ha and returned the highest gross margin at \$379/ha. This is showing that nutrients were not a contributing factor in determining yield in this location for the 2015 season. Treatment 4 - 100kg of wheat straw biochar + 110kg of Agras was the highest yielding biochar/fertiliser treatment which yielded 1.56t/ha. The lowest performing treatment was treatment 16 - Agras Extra 110kg + 90kg MOP top-dressed at 1.39t/ha. There was no significant improvement in tissue % for N, P and K from biochar over straight fertiliser treatments.

While the control returned the highest gross margin overall, what is interesting, is that Treatment 4 with a cost/ha of \$56/ha returned the next highest Gross Margin at \$341/ha. This is consistent with research by the South Australian No Till Farmers Association where half rates of fertiliser plus low rates of biochar are seeing yield improvements with significantly lower costs/ha.

There was no significant difference with quality. The lowest protein of 13.6 was the control, with the highest being Treatment 2 – 110kg or Ktill Plus. There was also no significant difference between grain weight and screenings.

Other results from the site/s (e.g. photo monitoring, farmer observations)

What events/field days/workshops/presentations were delivered as part of the project?

Please add additional rows as required

Event/Activity	Number of Participants	Any significant feedback
No activities		

What communication products were delivered as part of the project? (e.g. fliers, articles, factsheets, case studies, videos)

Please add additional rows as required

Communication Product	Intended Audience (e.g. farmers, readers of x newspaper)
Blog on Energy Farmers Website	Farmers and biochar industry stakeholders
Update on Energy Farmers Facebook page	Farmers and biochar industry stakeholders
Updates through Energy Farmers Twitter account	Farmers and biochar industry stakeholders
Blogs, Facebook and Twitter posts were done throughout the season ie when we got the funding, seeding, tissue testing and harvest	

7.0 FINDINGS

Were the results what you expected? Why/why not?

- Length of trial was not long enough to test theories. The general feel with biochar within the industry is that you may not see a response in the first year and with the low rate system, the benefits are accumulated over a number of years.
- K levels in wheat straw biochar are lower than expected (0.85%) – We thought that because nutrients are concentrated during the pyrolysis process, the levels of K in a wheat straw biochar would be higher.
- No significant improvement in tissue % for N, P and K from biochar over straight fertiliser – we believe seasonal conditions contributed to the fact that nutrient levels were not a large factor in yield determination.
- N (2.27%), P (2.12%) and K (3.18%) in 50% wheat straw and 50% poultry litter biochar is worthy of note. As poultry litter is a limited resource, by blending wheat straw with poultry litter we could effectively double the amount of poultry litter biochar utilised without sacrificing nutrients.
- Biochar has been likened to a [slow release fertiliser](#). Biochar has a very high surface area and provide habitat for soil microbes. These microbes allow nutrients that are bound up in the biochar to be released over a long time period.
- pH of wheat straw biochar is 9.5 (CaCl₂) – Biochar has been proven to have a [liming effect](#) and there may be potential to use wheat straw biochar to reduce soil acidity. More investigation required

Key Learnings

- It was a difficult year to run a trial of this nature. The early timing of seeding combined with a dry spell in the first half of the season reduced the potential of the crop significantly.
- Due to this yield decrease, there were enough nutrients in the soil to maintain a crop of this potential, so it was difficult to determine any significant variation in treatments.
- The fact that half rates of fertiliser plus a low rate of biochar returned the highest gross margin (apart from the control) and consistent yield (1.53t/ha) is encouraging and should be explored further.
- Trial should have had 4 reps for each treatment to reduce the impact that “outliers” had on the trial.

Environmental outcomes of the project

- Potential reduced fertiliser use
 - Lower greenhouse gas emissions (Nitrous oxide)
- Poultry litter disposal
 - Less stable fly
 - Lower greenhouse gas emissions (Nitrous oxide & Methane)

Social outcomes of the project

Most poultry farmers have a disposal issue with poultry litter. Some have to pay to get it disposed of while, some compost the litter and selling it as a fertiliser. Whatever the disposal practice the poultry farmers we have spoken to like the idea of processing the poultry litter on site and value adding into biochar. It represents a solution that gets rid of a problem and potentially may provide a valuable product to sell.

Cropping Farmers are very interested in the prospect of increasing fertiliser efficiency and potentially reducing fertiliser use however, they remain sceptical. They want to see positive results in their own area before they will be convinced.

Economic outcomes of the project

- While the potential needs to be explored further. The fact that half rates of fertiliser plus the addition of biochar showed no yield penalty and returned the second highest gross margin could have significant implications to the farmer's bottom line.
- Value adding a waste resource (poultry litter currently sells for approx. \$20/tonne), poultry litter biochar sells for \$1000/tonne, a 1400% increase.
- Carbon credit potential from methane reduction by the conversion of poultry litter into biochar and carbon storage by the application of biochar to soils.

Any other comments

A trial of this nature needs to be continued over a number of years. There is evidence that the benefits of biochar are not seen in the first year of application and that continued applications over a number of years see the best results.

We will be submitting another proposal to continue the trials in this location for the 2016 cropping year.

8.0 PHOTOS

Please add high resolution photos from the demonstration site and activities as appropriate. Include dates and descriptions as well as any acknowledgement for photographs.

9.0 DELIVERY PARTNERS

What groups/organisations/individuals contributed to the project delivery?

Please add additional rows as required

Name of Group/Organisation/Individual	Contribution <i>(e.g. time, equipment use)</i>
Crop Circle Consulting	<ul style="list-style-type: none">• Coordinate seeding and harvesting of trials• Soil test to determine K levels in soil• Seeding and weed control of trials• Tissue tests throughout the season• Analysis of results and final report
Landmark Trial & Demonstration Team	<ul style="list-style-type: none">• Supply Plot Seeder Plot Harvester• Seed and harvest trails
Dr Zakaria Solaiman, School of Earth and Environment, The University of Western Australia	<ul style="list-style-type: none">• Biochar analysis