# Biochar…an alternative carbon source

**Facey Group**
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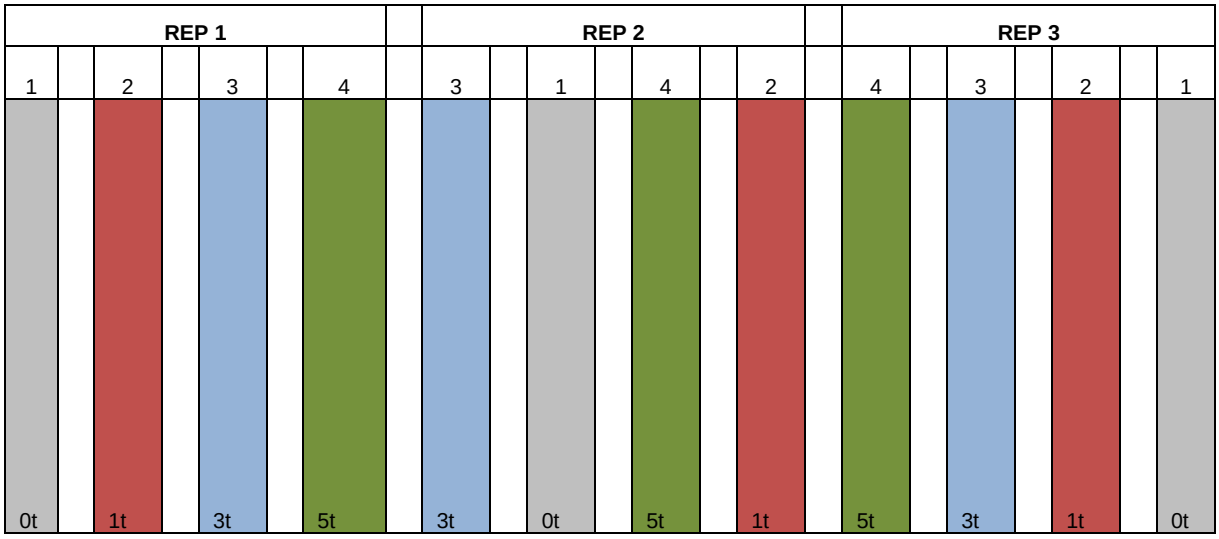
**AIM**
To determine the effectiveness of Biochar on increasing soil carbon and soil stability.

**TRIAL DETAILS**
Initial investigation into the application of Biochar implied that the product itself would be the greatest cost, with this being the most limiting factor for adoption of the practice. Limited knowledge locally was also a limiting factor to the adoption of the practice, with further emphasis on soil carbon at present this proved as a perfect opportunity to establish a site in the local area.

The site was not selected for any particular reason, therefore limiting the potential for a specific response. It was decided after conversations between researchers who had conducted trials previously in the Northern Agricultural Region that small plot trial would be the most effective.

The trial was designed and seeded with the assistance of Kaylx Agriculture, with 3 replications with randomised treatments (see below).




**METHODOLOGY**
Soil testing was completed on the site prior to seeding (2012) and post harvest in 2013 to compare soil available nutrients and in particular soil carbon levels. Randomised sampling of the plots was completed and repeated in same plots at each sampling time.

Plant tissue testing was also completed in season to determine nutrient availability throughout the season.

Following the end of the project in June 2013 ongoing monitoring at the site by the Facey Group will be carried out, with results not expected to be visual or of high impact within the first season of trialling.

## RESULTS & DISCUSSION

Soil tests were completed by contractors and analysed by Summit Fertilizers. Three randomised treatments were samples in each replication, with at least 2 replications completed for each treatment..

| Treatment | 1t | | | 3t | | | 5t | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Depth (cm) | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** |
| P (Colwell) | 27 | 18 | 9 | 23 | 13 | 9 | 26 | 13 | 8 |
| K (Colwell) | 105 | 69 | 97 | 92 | 91 | 106 | 116 | 94 | 134 |
| Sulfur (KCl-40) | 5 | 5 | 4 | 7 | 4 | 4 | 5 | 5 | 4 |
| pH (CaCl2) | 5.0 | 4.6 | 5.2 | 5.0 | 4.6 | 5.3 | 4.9 | 4.9 | 5.5 |
| Nitrate N (mg/kg) | 27 | 0 | 0 | 34 | 0 | 0 | 32 | 0 | 0 |
| Ammonium N (mg/kg) | 3 | 0 | 0 | 6 | 0 | 0 | 5 | 0 | 0 |
| Copper (DTPA) | 0.49 | 0.00 | 0.00 | 0.53 | 0.00 | 0.00 | 0.50 | 0.00 | 0.00 |
| Zinc (DTPA) | 0.39 | 0.00 | 0.00 | 0.37 | 0.00 | 0.00 | 0.32 | 0.00 | 0.00 |
| PBI | 23 | 0 | 0 | 23 | 0 | 0 | 24 | 0 | 0 |
| Aluminium (CaCl2) | 0.0 | 1.9 | 0.8 | 0.0 | 1.6 | 0.4 | 0.0 | 1.3 | 0.1 |
| Organic Carbon % | 1.2 | 0.00 | 0.00 | 1.26 | 0.00 | 0.00 | 1.16 | 0.00 | 0.00 |
| E/Conductivity (dS/m) | 0.07 | 0.04 | 0.02 | 0.11 | 0.04 | 0.03 | 0.08 | 0.04 | 0.03 |

***Replication 1: Baseline Soil Testing (April 2012)***

| Treatment | 0t | | | 1t | | | 5t | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Depth (cm) | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** |
| P (Colwell) | 22 | 13 | 8 | 23 | 18 | 9 | 21 | 14 | 9 |
| K (Colwell) | 112 | 72 | 115 | 92 | 85 | 87 | 77 | 48 | 96 |
| Sulfur (KCl-40) | 5 | 4 | 3 | 4 | 3 | 3 | 6 | 3 | 3 |
| pH (CaCl2) | 5.2 | 4.7 | 5.2 | 5.2 | 4.7 | 5.1 | 5.0 | 4.5 | 5.3 |
| Nitrate N (mg/kg) | 36 | 0 | 0 | 23 | 0 | 0 | 38 | 0 | 0 |
| Ammonium N (mg/kg) | 4 | 0 | 0 | 3 | 0 | 0 | 5 | 0 | 0 |
| Copper (DTPA) | 0.40 | 0.00 | 0.00 | 0.16 | 0.00 | 0.00 | 0.46 | 0.00 | 0.00 |
| Zinc (DTPA) | 0.33 | 0.00 | 0.00 | 0.23 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 |
| PBI | 18 | 0 | 0 | 18 | 0 | 0 | 17 | 0 | 0 |
| Aluminium (CaCl2) | 0.0 | 1.3 | 0.3 | 0.0 | 1.8 | 0.6 | 0.0 | 3.0 | 0.5 |
| Organic Carbon % | 1.14 | 0.00 | 0.00 | 0.90 | 0.00 | 0.00 | 1.04 | 0.00 | 0.00 |
| E/Conductivity (dS/m) | 0.09 | 0.04 | 0.03 | 0.07 | 0.03 | 0.02 | 0.10 | 0.03 | 0.03 |

***Replication 2: Baseline Soil Testing (April 2012)***

| Treatment | 0t | | | 1t | | | 3t | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Depth (cm) | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** |
| P (Colwell) | 17 | 16 | 1 | 15 | 14 | 10 | 22 | 15 | 1 |
| K (Colwell) | 83 | 64 | 94 | 5 | 59 | 81 | 87 | 63 | 87 |
| Sulfur (KCl-40) | 5 | 3 | 3 | 6 | 4 | 3 | 6 | 3 | 4 |
| pH (CaCl2) | 5.2 | 4.6 | 5.3 | 5.1 | 4.4 | 5.2 | 4.9 | 4.4 | 5.0 |
| Nitrate N (mg/kg) | 28 | 0 | 0 | 29 | 0 | 0 | 32 | 0 | 0 |
| Ammonium N (mg/kg) | 4 | 0 | 0 | 7 | 0 | 0 | 10 | 0 | 0 |
| Copper (DTPA) | 0.41 | 0.00 | 0.00 | 0.42 | 0.00 | 0.00 | 0.40 | 0.00 | 0.00 |
| Zinc (DTPA) | 0.23 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 |
| PBI | 17 | 0 | 0 | 17 | 0 | 0 | 18 | 0 | 0 |
| Aluminium (CaCl2) | 0.0 | 2.1 | 0.4 | 0.0 | 3.5 | 0.5 | 0.0 | 3.0 | 0.8 |
| Organic Carbon % | 0.90 | 0.00 | 0.00 | 0.88 | 0.00 | 0.00 | 1.05 | 0.00 | 0.00 |
| E/Conductivity (dS/m) | 0.08 | 0.03 | 0.02 | 0.09 | 0.03 | 0.02 | 0.09 | 0.03 | 0.02 |

***Replication 3: Baseline Soil Testing (April 2012)***

Plant tissue tests were completed on 25th July 2012 with results shown below. Considering the dry season the results did not present anything significant for immediate management. The paddock was treated with a zinc foliar spray as part of the grower's management practice this season.

| Treatment | 0t/ha | Rating | 1t/ha | Rating | 3t/ha | Rating | 5t/ha | Rating |
|---|---|---|---|---|---|---|---|---|
| Nitrogen (N) % | 3.49 | L | 3.89 | L | 3.65 | L | 3.72 | L |
| Phosphorous (P) % | 0.24 | L | 0.27 | L | 0.24 | L | 0.23 | L |
| Potassium (K) % | 3.19 | A | 3.5 | A | 3.6 | A | 3.96 | A |
| Sulphur (S) % | 0.25 | A | 0.28 | A | 0.25 | A | 0.26 | A |
| Calcium (Ca) % | 0.32 | A | 0.34 | A | 0.25 | A | 0.26 | A |
| Magnesium (Mg) % | 0.18 | H | 0.19 | H | 0.14 | A | 0.14 | A |
| Copper (Cu) ppm | 2.76 | L | 2.92 | A | 2.87 | L | 2.81 | L |
| Zinc (Zn) ppm | 17.9 | A | 19.92 | A | 17.8 | L | 17.58 | L |
| Manganese (Mn) ppm | 102.65 | H | 113.65 | H | 106.55 | H | 87.92 | H |
| Iron (Fe) ppm | 831.73 | H | 460.87 | H | 453.73 | H | 341.57 | H |
| Boron (B) ppm | 3.24 | H | 3.32 | H | 3.2 | H | 3.13 | H |
| Sodium (Na) ppm | 0.06 | H | 0.06 | A | 0.05 | A | 0.04 | L |
| Nitrate (NO3) ppm | 716.18 | D | 940.85 | D | 814.54 | D | 826.22 | D |
| Chloride (Cl) ppm | 1.06 | H | 1.32 | H | 1.19 | H | 1.2 | KH |

***Replication 1 - Hill – Plant Tissue Tests: Wheat Whole Tops (25/07/2012)***
Rating: D = Deficient, L = Low, A = Adequate, H = High

| Treatment | 0t/ha | Rating | 1t/ha | Rating | 3t/ha | Rating | 5t/ha | Rating |
|---|---|---|---|---|---|---|---|---|
| Nitrogen (N) % | 3.59 | L | 3.8 | L | 3.52 | L | 3.71 | L |
| Phosphorous (P) % | 0.24 | L | 0.27 | L | 0.23 | L | 0.24 | L |
| Potassium (K) % | 3.95 | H | 3.96 | A | 3.75 | A | 4.09 | H |
| Sulphur (S) % | 0.27 | A | 0.28 | A | 0.25 | A | 0.27 | A |
| Calcium (Ca) % | 0.29 | A | 0.3 | A | 0.25 | A | 0.3 | A |
| Magnesium (Mg) % | 0.14 | A | 0.14 | A | 0.13 | A | 0.13 | A |
| Copper (Cu) ppm | 3.44 | A | 3.59 | A | 3.02 | L | 3.51 | A |
| Zinc (Zn) ppm | 18.09 | L | 21.23 | A | 17.3 | L | 18.35 | L |
| Manganese (Mn) ppm | 89.79 | H | 90.57 | H | 86.69 | H | 75.12 | H |
| Iron (Fe) ppm | 688.72 | H | 196.4 | H | 694.35 | H | 272.72 | H |
| Boron (B) ppm | 3.44 | H | 3.11 | H | 3.29 | H | 3.43 | H |
| Sodium (Na) ppm | 0.03 | L | 0.03 | L | 0.04 | A | 0.03 | L |
| Nitrate (NO3) ppm | 800.51 | D | 716.38 | D | 763.8 | D | 653.68 | D |
| Chloride (Cl) ppm | 1.28 | H | 1.23 | H | 1.36 | H | 1.19 | H |

***Replication 2 - Hill – Plant Tissue Tests: Wheat Whole Tops (25/07/2012)***
Rating: D = Deficient, L = Low, A = Adequate, H = High

| Treatment | 0t/ha | Rating | 1t/ha | Rating | 3t/ha | Rating | 5t/ha | Rating |
|---|---|---|---|---|---|---|---|---|
| Nitrogen (N) % | 3.71 | L | 3.81 | L | 3.82 | L | 3.67 | L |
| Phosphorous (P) % | 0.25 | L | 0.27 | L | 0.26 | L | 0.26 | L |
| Potassium (K) % | 3.46 | A | 3.68 | A | 3.82 | A | 3.76 | A |
| Sulphur (S) % | 0.26 | A | 0.28 | A | 0.28 | A | 0.27 | A |
| Calcium (Ca) % | 0.28 | A | 0.33 | A | 0.31 | A | 0.3 | A |
| Magnesium (Mg) % | 0.14 | A | 0.16 | A | 0.15 | A | 0.14 | A |
| Copper (Cu) ppm | 3.09 | L | 3.28 | L | 3.32 | L | 3.13 | L |
| Zinc (Zn) ppm | 18.12 | L | 20.86 | L | 19.87 | L | 20.42 | A |
| Manganese (Mn) ppm | 95.74 | H | 89.88 | H | 91.36 | H | 90.98 | H |
| Iron (Fe) ppm | 223.7 | H | 233.94 | H | 172.36 | H | 185.1 | H |
| Boron (B) ppm | 3.06 | H | 3.12 | H | 3.44 | H | 3.01 | H |
| Sodium (Na) ppm | 0.04 | L | 0.04 | L | 0.04 | L | 0.05 | A |
| Nitrate (NO3) ppm | 441.58 | D | 679.74 | D | 669.9 | D | 580.93 | D |
| Chloride (Cl) ppm | 1.29 | H | 1.21 | H | 1.5 | H | 1.41 | H |

***Replication 3 - Hill – Plant Tissue Tests: Wheat Whole Tops (25/07/2012)***
Rating: D = Deficient, L = Low, A = Adequate, H = High

Harvest was completed by Kalyx Agriculture on 7th December 2012 with yield weights recorded in Table 1, measured in tonne per hectare. Farmer yield data for the remainder of the paddock, with no treatment of Biochar averaged 1.05t/ha, a significant difference between the nil (0t/ha) application of Biochar within the trial, further investigation is required to quantify the harvest results within the trial plots.

| Treatment (Biochar) | Rep 1 – Yield | Rep 2 – Yield | Rep 3 - Yield | *Average Yield* |
|---|---|---|---|---|
| 0t/ha | 2.925 | 3.022 | 3.314 | *3.087* |
| 1t | 2.830 | 2.724 | 2.866 | *2.806* |
| 3t | 2.584 | 2.866 | 2.768 | *2.738* |
| 5t | 2.818 | 2.684 | 2.912 | *2.804* |

***Table 1:*** Harvest Yield Results per treatment (December 2012)

Follow up soil tests were completed in January 2013 to compare any changes in soil available nutrients. Results are shown below. Initial interpretation of the results indicates the level of organic carbon has decreased in most sample plots rather than increase – further investigation and soil testing will be completed over the next few years to determine any significant changes within soil organic matter.

| Treatment | **1t** | | | **3t** | | | **5t** | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Depth (cm) | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** |
| P (Colwell) | 26 | 18 | 17 | 27 | 17 | 14.0 | 26 | 20.0 | 19 |
| K (Colwell) | 102 | 73 | 89 | 108 | 107 | 110 | 103 | 96.0 | 114 |
| Sulfur (KCl-40) | 6.7 | 5.5 | 5.8 | 6.2 | 4 | 5 | 6.2 | 4.2 | 5.1 |
| pH (CaCl2) | 5.0 | 4.6 | 4.9 | 4.7 | 4.4 | 4.9 | 5.1 | 4.7 | 19 |
| Nitrate N (mg/kg) | 21 | 9 | 9 | 21 | 8 | 9 | 22 | 9 | 2 |
| Ammonium N (mg/kg) | 5 | 1 | 2 | 6 | 1 | 1 | 5 | 2 | 5.1 |
| Copper (DTPA) | 0.24 | 0.30 | 0.28 | 0.24 | 0.29 | 0.56 | 0.24 | 0.25 | 0.45 |
| Zinc (DTPA) | 0.38 | 0.25 | 0.26 | 0.32 | 0.14 | 0.40 | 0.43 | 0.15 | 0.29 |
| PBI | 22 | 26.2 | 19 | 13.6 | 28.2 | 24.9 | 23.7 | 25.7 | 23.9 |
| Aluminium (CaCl2) | 1.29 | 1.54 | 0.73 | 1.3 | 1.87 | 0.61 | 0.76 | 0.88 | 0.41 |
| Organic Carbon % | 1.0 | 0.76 | 0.81 | 1.24 | 0.75 | 0.71 | 0.99 | 1.03 | 0.67 |
| E/Conductivity (dS/m) | 0.078 | 0.030 | 0.036 | 0.070 | 0.00 | 0.006 | 0.085 | 0.038 | 0.06 |

***Replication 1: Follow Up Soil Testing (January 2013)***

| Treatment | **0t** | | | **1t** | | | **5t** | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Depth (cm) | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** |
| P (Colwell) | 17 | 15 | 11 | 14 | 16 | 1.00 | 14 | 14 | 11 |
| K (Colwell) | 138 | 117 | 148 | 129 | 100 | 135 | 105 | 80 | 108 |
| Sulfur (KCl-40) | 4.2 | 3.5 | 3.5 | 3.4 | 3.4 | 3.1 | 3.9 | 3.7 | 2.9 |
| pH (CaCl2) | 5.3 | 4.8 | 5.2 | 5.4 | 4.8 | 5.3 | 5.1 | 4.7 | 5.1 |
| Nitrate N (mg/kg) | 15 | 10 | 14 | 14 | 13 | 6 | 12 | 10 | 1 |
| Ammonium N (mg/kg) | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 |
| Copper (DTPA) | 0.26 | 0.26 | 0.43 | 0.21 | 0.27 | 0.38 | 0.24 | 0.23 | 0.25 |
| Zinc (DTPA) | 0.28 | 0.23 | 0.32 | 0.23 | 0.25 | 0.25 | 0.22 | 0.14 | 0.19 |
| PBI | 20.1 | 22.6 | 22.4 | 21.5 | 10.4 | 22 | 16.9 | 20.8 | 21.6 |
| Aluminium (CaCl2) | 0.36 | 0.64 | 0.32 | 0.39 | 0.65 | 0.30 | 0.49 | 0.93 | 0.35 |
| Organic Carbon % | 0.84 | 0.79 | 0.58 | 0.43 | 0.74 | 0.69 | 0.73 | 0.59 | 0.68 |
| E/Conductivity (dS/m) | 0.05 | 0.036 | 0.043 | 0.042 | 0.041 | 0.029 | 0.051 | 0.037 | 0.032 |

***Replication 2: Follow Up Soil Testing (January 2013)***

| Treatment | 0t | | | 1t | | | 3t | | |
|---|---|---|---|---|---|---|---|---|---|
| Sample Depth (cm) | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** | **0-10** | **10-20** | **20-30** |
| P (Colwell) | 19 | 19 | 15 | 16 | 16 | 12 | 22 | 15 | 17 |
| K (Colwell) | 92 | 70 | 111 | 91 | 67 | 78 | 108 | 76 | 98 |
| Sulfur (KCl-40) | 4.4 | 3.6 | 3.5 | 4 | 3.2 | 3.6 | 4.6 | 4.2 | 3.6 |
| pH (CaCl2) | 5.1 | 4.6 | 5.2 | 5.4 | 5.0 | 5.1 | 5.5 | 4.9 | 5.1 |
| Nitrate N (mg/kg) | 14 | 10 | 12 | 10 | 7 | 9 | 3 | 11 | 10 |
| Ammonium N (mg/kg) | 2 | 1 | 1 | 1 | 1 | 2 | 0 | 1 | 2 |
| Copper (DTPA) | 0.22 | 0.21 | 0.36 | 0.24 | 0.21 | 0.37 | 0.28 | 0.28 | 0.27 |
| Zinc (DTPA) | 0.29 | 0.15 | 0.30 | 0.26 | 0.40 | 030 | 0.52 | 0.11 | 0.22 |
| PBI | 15.3 | 19 | 22.3 | 19 | 14.30 | 15.00 | 16.2 | 21.4 | 25 |
| Aluminium (CaCl2) | 0.63 | 1.32 | 0.39 | 0.41 | 1.57 | 0.48 | 0.51 | 1.17 | 0.56 |
| Organic Carbon % | 0.75 | 0.75 | 0.75 | 0.78 | 0.55 | 0.62 | 0.90 | 0.57 | 0.57 |
| E/Conductivity (dS/m) | 0.055 | 0.038 | 0.044 | 0.045 | 0.030 | 0.33 | 0.094 | 0.038 | 0.037 |

***Replication 3: Follow Up Soil Testing (January 2013)***

## CONCLUSION

Carbon is generating plenty of interest at present and the project aims to answer questions around increasing organic carbon in agricultural soils through the addition of carbon source. It would be expected that the results will show minimal impact on soil carbon levels in the first year of trialling however will to be tested by the Facey Group in continuance to the project. Harvest results however require further investigation with such variance between the remainder of the paddock and the treatments within the trial.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