PEDAGA INVESTMENTS

MEAT & LIVESTOCK AUSTRALIA

Fertiliser impact on soil carbon project – Results from baseline testing

Soil carbon sequestration has fast become a key talking point in agriculture, stemming from the production benefits of increasing soil carbon levels and the opportunity to sell this increase through Australian Carbon Credit Units (ACCU's). While some strategies associated with increasing soil carbon are well documented in ACCU approved methodologies, others are based primarily on anecdotal reports. There is a need to quantify through evidence-based research which on farm practices will sequester soil carbon in order to better understand these processes.

Biomineral fertilisers, an alternative to synthetic fertilisers, have been promoted as having the ability to improve soil carbon. The project '*The potential of biomineral fertilisers to increase soil carbon sequestration'* is a joint project between Meat & Livestock Australia (MLA) and Pedaga Investments that aims to assess the ability of a biomineral fertiliser to increase soil carbon sequestration, while at least maintaining productivity and profitability in relation to best practice conventional or synthetic fertiliser use. The product being tested is Troforte Cropping as well as a mineral fertiliser product with a polymer coating containing a microbe blend.

The project aims to address the issue of long term soil carbon depletion and assess whether biomineral fertilisers can increase soil carbon levels compared to synthetic fertilisers. The project also addressed a secondary question as to whether there is an impact on production should producers shift to a biomineral fertiliser strategy.

The project has been designed to explore these questions through an Integrated R&D Producer Demonstration Site (PDS) model and is relevant to all livestock producers currently implementing a fertiliser regime. The methodology is comprised of five sites, two trails and three Producer Demonstration Sites. The main trial site comprises of two treatments, best practice synthetic fertiliser and best practice biomineral fertiliser. The paddock is a 40 year old kikuyu/ryegrass and clover pasture under surface irrigation. The surface irrigation site was selected to allow for an extended growing season to speed up assessment of results.

It is proposed that bio-mineral fertilisers will reduce carbon emission through two pathways:

1. By increasing the formation of permanent humus compounds and through an increase in the soil organic matter stability. Consequently, the contribution of the organic matter fractions that are more resistant to decomposition are crucial for increasing soil carbon sequestration. This is achieved by:
    - microbes in biomineral fertiliser colonise roots and drain more carbon to the rhizosphere soil to increase soil carbon pool
    - biomineral fertiliser increases root biomass which are the sources of carbon in the soil over time.
2. Bio-mineral fertilisers will improve soil biological fertility, plant nutrition and reduce carbon emissions by increasing nutrient density of pastures and subsequently increasing weight gain efficiency of livestock. Anti-methanogenic impacts will also be assessed through in-vitro testing.

The carbon footprint of a biomineral and conventional fertiliser regime will be calculated to determine the ability of biomineral fertilisers to be used as a tool for reducing net greenhouse gas (GHG) emissions from an improved pasture system.

Baseline testing

The project commenced in January 2022 and will be completed by the middle of 2025. The initial work over the first 16 months for the project has been focused on generating the baseline data. Data is collected in the winter from winter pasture sites and the in the summer from the surface irrigation site. The following baseline data has been collected and analysed within the project to date:

- Soil sampling completed across the two trials and three Producer Demonstration Sites (PDS's) including:
    - Soil inorganic carbon, organic carbon, total carbon and total N.
    - Soil microbial biomass including microbial carbon and nitrogen plus dissolved organic carbon.
    - Soil chemical analysis – soil pH, electrical conductivity, Colwell P, and Mehlich extraction of a range of soil nutrients including K, P, and S.
- Baseline pasture production and quality/nutrient testing completed across the two trials and three PDS's.
- Anti-methanogenic properties of pasture tested under in-vitro conditions measuring digestibility and methane production.
- Year one yearling calf production/weight gain trial.
- Baseline carbon budgeting completed across the five sites following the national greenhouse gas inventory methodology.

Soil health and carbon status

The baseline testing of soil health and soil carbon were in line with expectations, with the majority of the soil carbon and microbial activity contained within the top 10 cm's (see chart one). The project will examine any change in soil carbon in 10cm increments to the depth of 50cm that results from by changing to a biomineral fertiliser which includes a microbial coating over three years.

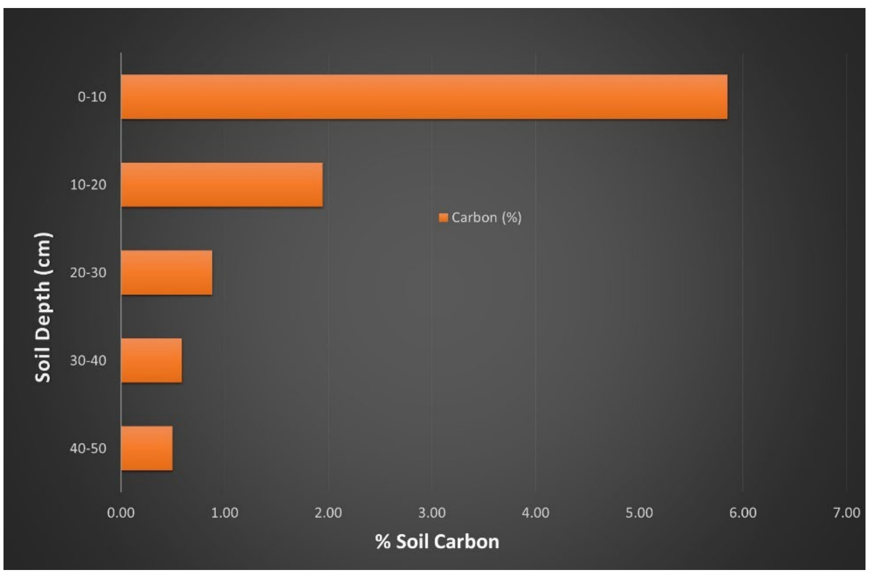


Chart one: Average percentage soil carbon at different depths at the main trial site.

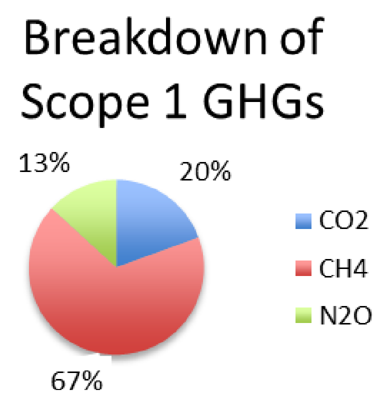
Picture one shows the core of soil which is typical of the main trial site. The dark soil at the top of the core is the soil high in organic matter and soil carbon. With the new fertiliser regime it is hoped this activity will progress deeper in the soil.

Picture one: Core of the typical soil sample to 50cm at the main trial site

Baseline carbon budgeting

Baseline carbon budgeting or greenhouse gas (GHG) emissions was modelled for all the five trial sites. The calculator chosen for determining the baseline GHG emissions was developed by the University of Melbourne and revised by Integrity Ag & Environment Pty Ltd and is intended for use in grazing beef cattle and sheep enterprises (Dunn J, et al, 2020).

The main trial site is located in Bridgetown on a 200 hectare property and operates a 200 cow beef breeder cattle herd. The results from the beef and sheep greenhouse accounting tool show an output of 668 tons of CO_2 equivalent per annum, or 3.34 tons of CO_2 equivalent per breeding cow. Picture two shows the makeup in percentage of GHG emissions in terms of carbon dioxide (CO_2) enteric methane (CH_4) and nitrous oxide (N_2O).



Picture two: GHG emissions breakdown of trial site

Soil organic carbon increase required to offset GHG Emissions

Every one ton of soil organic carbon sequestered is equivalent to 3.67 ton of carbon dioxide equivalent sequestered. Further examining the Bridgetown site property 668 tons of CO_2 equivalent divided by 200Ha gives 3.34 tons of CO_2 equivalent per hectare which needs to be offset each year by an increase in soil organic carbon.

3.34 divided by 3.67 equals **0.91 tons of soil carbon per hectare** which needs to be sequestered per year for the property to become carbon neutral.

By assuming a bulk density of 1.3 g/cm^3 then the percentage carbon increase required within the top 50cm of soil across the 200Ha to become carbon neutral (without accounting for the change in fertiliser) is:

10,000 m^2 in one Ha x 0.5m soil depth x 1.3g/cm^3 bulk density = 6,500t/ha soil

1.0% soil organic carbon = 10g C/kg soil

10g x 6,500t = 65 tons carbon per hectare

1.0% soil organic carbon in 50cm of soil = 65 tons carbon

To calculate the increase required as a percentage of soil carbon:

1.0% = 65 tons

0.91 tons as a % = 0.91/65 = 0.014%

Therefore, to sequester 0.91 ton carbon per hectare requires an annual uplift in percentage carbon of 0.014%. (Edward T, 2021)

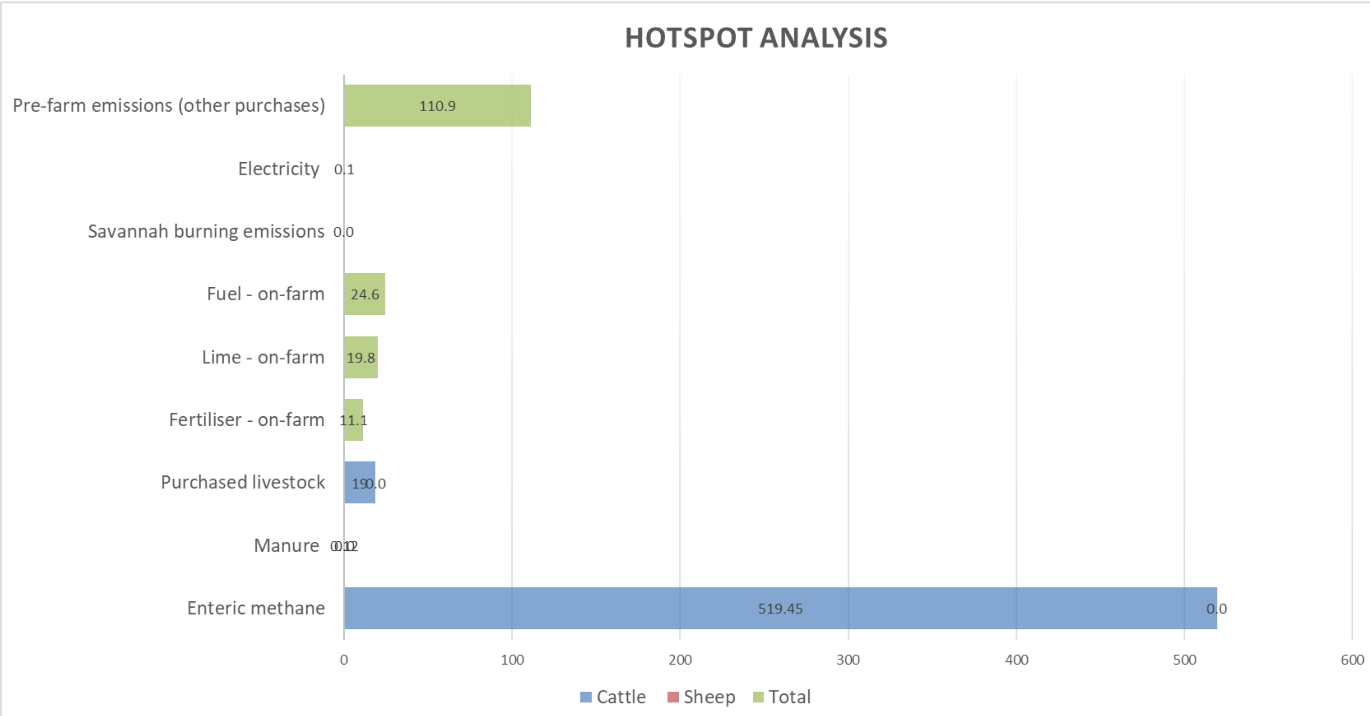


Chart two: GHG emissions by input hotspot analysis for the Bridgetown trial site

Chart two highlights the drivers of the greenhouse gas (GHG) emissions from the model for the Bridgetown operation. The key driver to a cattle operations greenhouse emissions along with operational GHG emissions, is the enteric methane generated from the cattle themselves. Enteric methane is methane is emitted as a by-product of the normal livestock digestive process, in which microbes resident in the animal's digestive system ferment the feed consumed by the animal. This fermentation process, also known as enteric fermentation, produces methane as a by-product.

The process of reducing emissions can be achieved through two key strategies:

- reducing net emissions
- sequestering carbon to offset emissions.

Pasture growth and pasture quality

Pasture production on the main trial site was measured while under surface irrigation for the period between the 17 January to 22 April 2023. Three cuts were recorded over this period with the production results detailed in Table three. The pasture spread with synthetic fertiliser grew on average 0.151 ton/ha/day, slightly faster than the pasture spread with biomineral fertiliser which grew at 0.145 ton/ha/day. Over the 95 days of the trial the biomineral fertiliser grew on average across the plots, 13.8 ton of dry matter compared to the synthetic fertiliser plots which grew on average 14.4 ton/ha of dry matter.

There was no significance difference in pasture production between the two treatments.

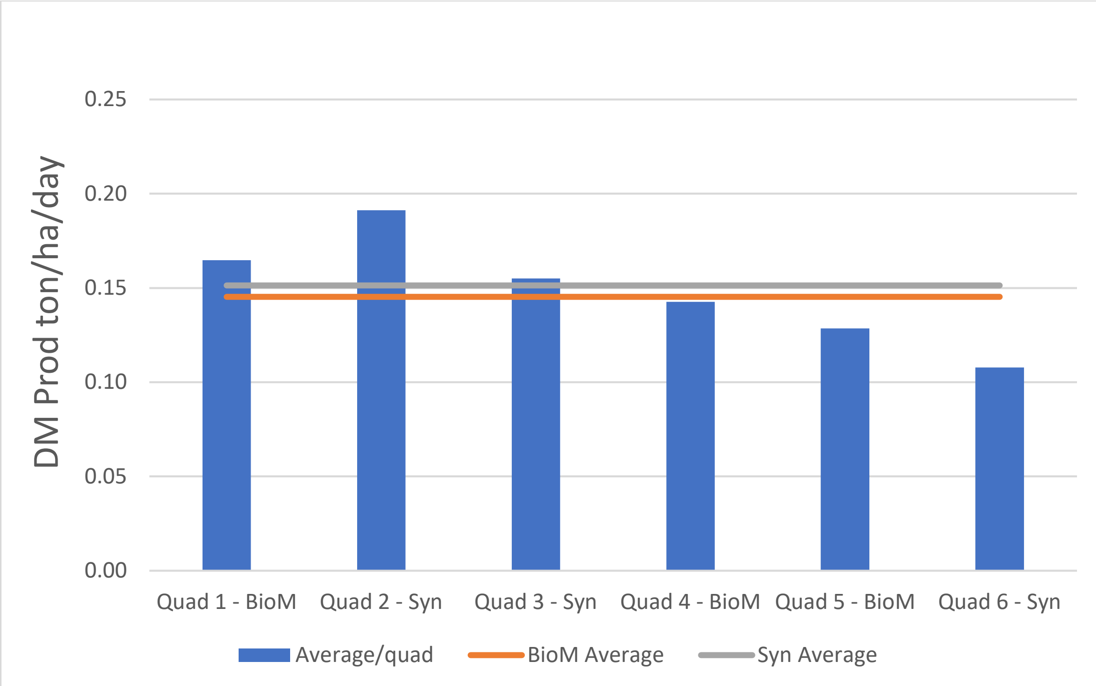


Chart six: Average quadrant pasture production in ton/ha/day of DM and the average across the two types of fertiliser.

Picture three: Pasture cage in place on main trial site surrounded by grazing calves to measure pasture production.

Cattle production trial – main trial site

The methodology for the cattle production trail involved:

- Selecting 96 southern calves @ 250 - 300kg live weight range divided randomly into two equal mobs.
- The calves entered the trial on 7 January and exited the trial on 4 May as sale weight was reached.

- Cattle production was monitored by measuring live weight gain every six weeks. This allows the full benefit cost analysis to be determined in calculating the margin per kilogram of live weight sold for each treatment.

Over the 117-day production trial the calves were weighed three times post their initial weight. The change in weight between the entire mobs of cattle grazing pasture spread with different fertiliser was very even for the first period. The average of both groups on Biomineral fertilisers was 19.3kg compared to the cattle grazing the synthetic fertiliser who gained 19.25kg. For the second period the calves grazing the biomineral fertiliser gained 12.05kg compared to the cattle grazing the synthetic fertiliser who gained 9.00kg.

The change in weight during period three was 6.6kg for the cattle grazing the biomineral fertiliser plots compared to 17.25kg for the cattle grazing the synthetic fertiliser plots. The differences in weight gain or rate of weight gain per day is outlined in Chart seven.

The average weight gain for each group across the entire period was 44.75 kg or 0.38 kg/hd/day for the cattle grazing the synthetic fertiliser plots and 35.85 kg or 0.31 kg/hd/day for the cattle grazing the biomineral fertiliser plots. There was no significance difference between each group.

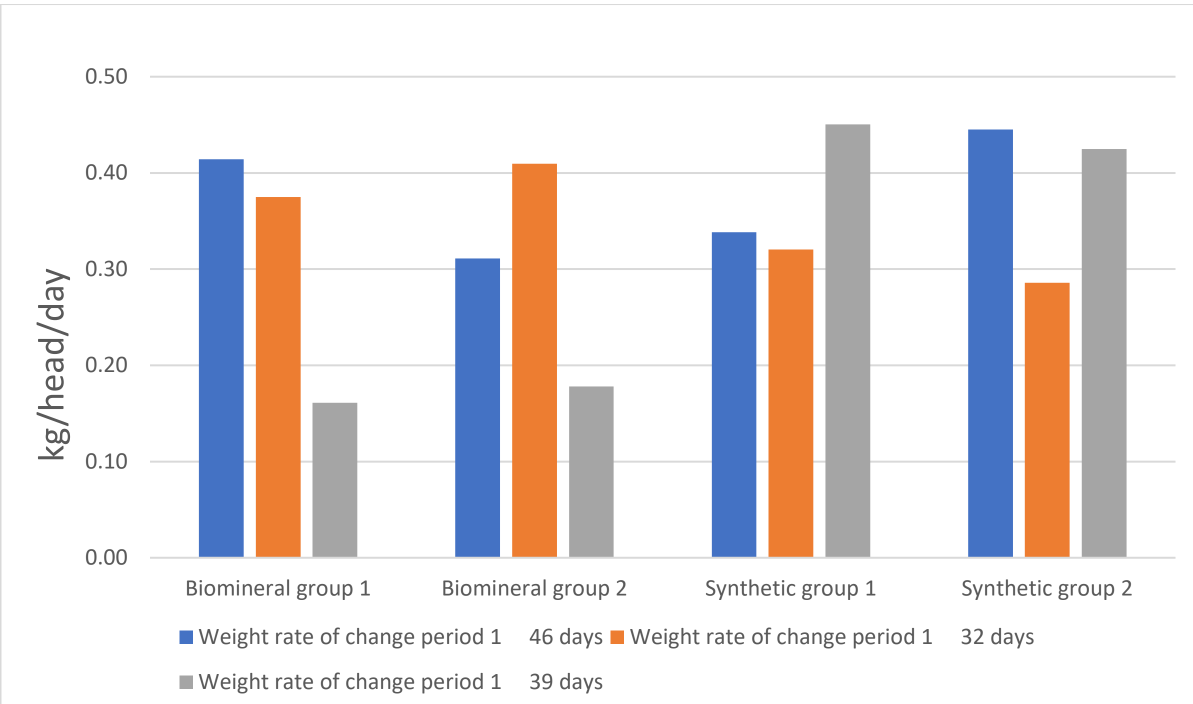


Chart seven: Average daily weight gain between periods for the reduced cattle line

Key take aways from baseline testing

- The key driver for GHG emissions for a cattle operation in the south eest region of WA is from the cattle themselves.
- A very minor increase in soil organic carbon of **0.014%** to a depth of 50cm is required each year to offset GHG emissions and make an operation carbon neutral.
- The soil test results are in line with expectations with the majority of the plant and microbial activity being contained in the top 10 cm.
- The soil results highlight that there is considerable room for increased biological activity in the soil profile below 10cm which is encouraging for the project to meet the overall targets.

Baseline testing benefit cost analysis results

- The benefit cost analysis has been determined through the MLA's cost of production calculator. Under synthetic fertilisers for producing beef, the cost of production is $2.83 ($/kg lwt) and the profit (benefit) margin is $0.77 ($/kg lwt sold). Under biomineral treatments for producing beef, the cost of production is $3.52 ($/kg lwt) and the profit (benefit) margin is $0.08 ($/kg lwt sold).
- The poor benefit cost analysis for the biomineral fertiliser was expected as high rates of biomineral fertiliser were applied in the first year of the project with the aim of speeding up the process of improving the microbiology in the soil. The biomineral fertiliser rates will be reduced over the next two seasons of the project which will work to bring the costs back in line with the synthetic fertiliser cost structure. Any benefit cost analysis will then be driven by changes in production.

Acknowledgement

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