The Potential of Biomineral Fertilisers to Increase Coil Carbon Sequestration

Aim

This project aims to assess the ability of Troforte Cropping Plus, biomineral fertiliser, to increase soil carbon sequestration, while at least maintaining productivity and profitability in relation to best practice conventional fertiliser use. It will be explored through an Integrated R&D PDS model and is relevant to all livestock producers currently implementing a fertiliser regime.

It is proposed that biomineral fertilisers will reduce carbon emissions through two pathways:

- 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 locked up in the soil over time.
- Biomineral 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. Possible anti-methanogenic impacts will also be assessed.

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

Delivery

This project will involve a research site based at Bridgetown WA running for 3 years, as well as 3 demonstration sites across the focus region (Picture 1).

The primary trial will be conducted under irrigation to allow an extended growing season in order to increase the rates of soil C sequestration, if it is to be seen. Fertiliser treatments will be applied as best practice applications under both the synthetic and biomineral fertiliser regime, with a small plot trial also included with fertiliser treatments applied by equal weight.

Demonstration sites will be under rainfed conditions and one will be located nearby to provide a control on the influence of irrigation. They will be initiated in year 1, involving 10 core producers and 60 observer producers. Core producers are to become knowledge champions for each region to facilitate adoption project findings and assist other producers through the adoption process. The benefits of operating the trial and demonstration sites concurrently include:

- The extension of the results will be pertinent to a greater number of producers which will expedite the adoption of the change in practice
- Increasing the scope and data capture of the hypothesis over a wider range of conditions delivering a more conclusive verification of the outcomes.

Producers involved in the demonstration sites will build knowledge and skills through being part of the implementation and assessment of practices, as well as attending workshops and field days. Two of the demonstration sites would cross over within the *Uptake Project* regions. The results and findings generated within this project offer a strong linkage with the Uptake Project as an alternative strategy to improve nutrient use efficiency and reduce eutrophication

Background

Troforte biomineral fertiliser is a mineral based fertiliser which consists of a proprietary combination of fine mineral ores, such as micas, alkali feldspars, soft rock phosphate, dolomite, basalt, granite and crystalline silica, that are blended with various sulphates (ammonium, potassium, manganese, copper and zinc). This combination is then blended with a suite of microbes (fungi and bacteria) including phosphate solubilising bacteria and mycorrhizal fungi. The granular form of the above blend in a diameter of 2 - 4mm is then coated in macrocote which is a polymer composition of modified wax, natural additives and with Trace elements. The macrocote polymer creates the targeted slow-release rate of the fertiliser. The microbe blend applied to the biomineral fertiliser is a scientifically balanced blend of up to 24 strains of well researched and trialled Australian cultured, beneficial soil microbes. These include:

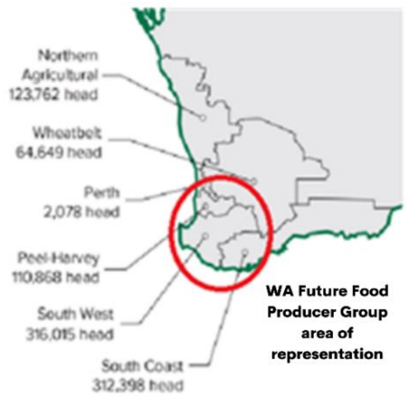
- Bacteria & fungi to carry out wide range of biological activities within the soil such as Nitrogen fixing, nutrient building, producing growth hormones, decomposing organic matter to organic carbon, protecting beneficial bacteria by releasing antibiotics, as well as the conditioning of soils by improving soil structure.
- Species include: Azotobacter, Azosprillum, Bacilli, Cellulosic fungi, Phosphobacteria, Pseudomonas, Saccharomyces, Streptomyces, Trichoderma and VAM.
- Some bacterial species break down minerals and release potassium, phosphorus, magnesium, calcium and iron to make them plant available and other species make and release natural plant growth hormones like auxins, gibberellins and cytokines

This project will take the knowledge from previous MLA funded northern WA research at Gillingarra (Gillingarra Perennial Pastures Project, P.PSH.0977) and translate components of this information to be relevant for the South Western regions. This work primarily examined the use of irrigation to fertigate, produce perennial pastures and background cattle. The project also undertook split fertiliser trials to compare biomineral-based products, which promote soil biology, compared to traditional chemical fertilisers. The results of this work indicated increased soil carbon on the bio mineral based fertiliser applications but similar growth. Further support of this work comes from independent fertiliser trials in Carnarvon on horticultural crops, which have proven that the biomineral fertilisers can replicate plant growth of traditional fertilisers, but with a lower cost and with better plant pest and disease resistance along with improved plant nutrition. Early work on biomineral fertilisers was undertaken by Paul Storer through CLIMA and Dr Zakaria Solaiman from UWA has continued to progress the work. A literature review of previous work examining at the use of biomineral fertilisers in agricultural production has predominantly been focused on grain production. The work has been primarily focused on production and not looked at combatting greenhouse gas emissions in conjunction with maintaining production and profitability. Additionally, the trial designs have generally involved a biomineral fertiliser company and have been designed to favour the outcome. It is imperative to complete this work independently under sound scientific method.

The use of a biomineral fertiliser will potentially increase the formation of permanent humus compounds and act to increase the overall soil organic matter stability. Consequently, this will increase the contribution of the organic matter fractions that are more resistant to decomposition, which is crucial for increasing soil carbon sequestration. The estimation of potential mitigation is an additional 5 – 10 t/ha of carbon stored in the soil in the biomineral treatments over the conventional treatments within the 3 years. While the project is endeavouring to help develop strategies to reduce carbon emissions and increase long term soil carbon sequestration through improved fertiliser practices, it remains important that any new prescribed production system remains as productive and economically viable in the long term as the current best practices. Additionally, any change in practice needs to be practical to implement into existing cattle operations. Changing fertilisers is a very simple and easily adaptable practice, which could result in a significant adoption and associated carbon reduction if the expected results are achieved. Additional to the benefits of carbon sequestration in the pursuit of CN30 goals, increased soil carbon would also provide productivity benefits through increased nutrient cycling and water holding capacity.

Grass fed pasture systems in the Southwest regions of Western Australia need cost effective fertiliser regimes but leaching of traditional synthetic fertilisers often results in poor fertiliser efficiency. Biomineral fertilisers offer improved soil biology and soil carbon that has potential to reduce fertiliser costs without compromising plant growth.

The project will take place within Southwest WA, facilitated through the WA Future Food Producer Group. It will have relevance to all areas where synthetic fertiliser use is common. This region encompasses the area covered by the Great Southern, Southwest and Peel regions of Western Australia and represents the dominant cattle growing districts of Southern WA, representing over 60% or 560,000 head of the cattle in Southern WA and 30% of WA's total herd (Picture 1).



Picture 1: Cattle numbers – as at June 2018 by WA Southern Natural Resources Management Region

Project Outputs

1. Asses the carbon budget output for each of the two fertiliser systems with particular reference to change in soil carbon and cattle weight gain efficiency.
    a. The GHG emissions calculation will be carried out using the Greenhouse Accounting Framework for Beef and Sheep properties based on the Australian National Greenhouse Gas Inventory methodology.
2. Pasture and Cattle production levels under both fertiliser regimes.
3. Cost/benefit analysis of both fertiliser regimes.

Value Proposition

The key value outcome from the overall project for the livestock industry throughout Australia that use fertilisers as part of their production practices is greater soil C sequestration rates. Through adoption of biomineral fertilisers producers can expect the following increases in soil carbon (pers coms Dr Zakaria Solaiman, UWA Institute of Agriculture):

- SW Western Australia, rainfall <450mm soil carbon to increase from ~1.0% to 2.2% in 3 years and to 3 - 3.5% in 10 years
- SW Western Australia, rainfall >600mm soil carbon to increase from ~2.2% to 3.6% in 3 years and to 4.2 - 4.8% in 10 years

The 70 core and observer producers to be engaged in this project represents approximately 140,000 Ha's being managed. Under the above potential impacts (5-10t/ha additional C sequestered, using 8t/ha for this calculation) and the anticipated adoption rate within this project (31 producers), this project would result in 496,000 t of Carbon sequestered above what would occur under a conventional fertiliser regime, as a result of the project.

If proved effective, this technology will be relevant for all regions of Australia where fertiliser application is common, providing significant potential for wider adoption.

Objectives

1. Assess the potential of biomineral fertilisers to increase soil carbon, above that of conventional fertilisers.
2. Assess the carbon emissions of a biomineral and conventional fertiliser regime in a pasture fed beef system typical of Southwest WA.
3. Assess the ability of biomineral fertilisers to maintain or exceed productivity and profitability of conventional fertiliser regimes, including a cost benefit analysis

Field Trial Method

The experiment has been designed to apply the best practice fertiliser regime of both fertilisers and measure under each system the impact on carbon emissions that relate to soil carbon sequestration and methanogenic properties of the pasture and cattle production. The trial will be conducted over a 3-year period to determine the time it takes for the impacts of the biomineral fertiliser to be detected in the soil and on production levels.

The paddock selected is a long-term pasture paddock (+40 years) containing a mixture of perennial grasses and annual legumes and grasses that has surface irrigation to provide green feed over the summer. This paddock has been selected to minimise the impact of building soil carbon through establishing perennial pastures and will enable the change in soil carbon to be directly related to each of the fertiliser regimes. It has also been selected for the irrigation, as this will bring forward the impacts of each farming system as pasture is grown 12 months of the year.

The trial paddock, 30 Ha in size, is located in Bridgetown WA, 255 km East South East of Perth in the Southwest region of WA. The long term (125 years) rainfall is 823 mm though this has been declining over recent years (decades) and the length of growing season has also been contracting. The paddock will be divided into 6 x 3 Ha cells to generate 3 replications for each of the fertiliser treatments and cattle production. Within each cell 4 x 25m quadrants will be selected for soil testing (5 depths; 0-10, 10-20, 20-30, 30-40 and 40-50 cm as roots of grasses can extend to depth) to conform with the Australian standards for carbon sampling and a W feed transect will be selected within each cell to allow for more powerful statistical analysis of the pasture production and methanogenic data.

The trial design has been developed in conjunction with Professor Phil Vercoe, Associate Director, The UWA Institute of Agriculture and Dr Zakaria Solaiman, Research Assistant Professor, The UWA Institute of Agriculture. The indicative paddock design is shown below in Diagram 1. The final fencing design, location of quadrants and W transects will be selected during the initial set up phase.

Project outputs assessed under each fertiliser regime will include:

- Carbon budget, following the National Greenhouse Gas Inventory methodology
- Soil Carbon measurement
- Pasture and livestock production
- Pasture nutrient composition analysis
- Anti-methanogenic properties of pastures
- Cost-benefit analysis

<u>Data to be Captured</u>

Carbon budgeting calculated by measuring:

- Soil inorganic carbon, organic carbon, total carbon and total nitrogen.
- Compare the anti-methanogenic properties of fodder grown under each fertiliser regime through in-vitro testing of methane production from pasture samples.
- Measure and compare the change in soil biology in the formation of organic matter fractions that are more resistant to decomposition for increasing soil carbon sequestration.

Soil Health:

- Soil microbial biomass
- Soil respiration
- Grass roots microbial colonisation

Note: The above 3 tests will indicate how much microbial cell biomass is in the soil or measure their activity or presence of microbes in roots. All parameters are related to soil biological health.

- Soil nutrition analysis – soil pH, electrical conductivity, Colwell P, and Mehlich extraction of a range of soil nutrients including K, P, and S.

Pasture Production:

- Pasture growth
- Plant nutritional values

Cattle Production:

- Yearling live weight gain over 120 days recorded monthly
- Calculate operating costs to determine the live weight gain cost of production in $/kg live weight.

<u>Material Required</u>

- Trial area fenced into 6 paddocks between January and May each year of the trial
- Fertiliser products as per protocol
- Machinery to implement project objectives
- Yearling calves for backgrounding
- Cattle yards and weighing equipment

Pre – Experimental Work

- Fence trial site into 6 paddocks.
  - Each of the 6 paddocks will be divided again into two equal paddocks to allow two replicates of calves
  - Including laneway system to allow low stress movement during weighing
- Soil
  - Detailed soil/geology/hydrology report of the experiment site
  - Locate the 4 randomly placed quadrants of 25m x 25m within each of the 6 paddocks
- Pasture
  - Locate W feed transects that represent the pasture in each of the paddocks for sampling during the trial period.
  - Conduct a pasture survey by paddock and W transect including:
    - Pasture species
    - % of each species
- Baseline sampling and testing to be conducted before 15 March (the date for the first fertiliser application) as per below field sampling and testing methodology to generate base data.

Indicative Fertiliser Application Regime

Indicative fertiliser application regimes are outlined in Figure 1. The final fertiliser regimes will be determined by the initial soil testing results. Best practice fertiliser regimes will be recommended by independent agronomic experts in both synthetic and biomineral fertilisers. Applications to be carried out on the same dates each year including the nutrients applied on each application and the total to be applied each year.

Figure 1. Indicative best practice fertiliser regimes

	Fertiliser product	Application rates kg/Ha	N	P	K	S	Cu	Zn
Fertiliser products	Troforte cropping typical analysis		10	7	4.5	4.6	0.00034	0.04
	SulSync N37		37			15		
	Urea		46					
	NKS21		27.8		12.4	6.5		
	Super Phos Extra			8.4		10.5	0.1	0.1
Synthetic fertiliser nutrient application rates	15-Apr - Super	120		10.1	0.0	12.6	0.12	0.12
	15 Aug - NKS21	90	25.0		11.2	5.9		
	15 Oct - Urea	80	36.8					
	15 Dec - Urea	100	46.0					
	15 Feb - NKS21	100	27.8		12.4	6.5		
	Total		**135.6**	**10.1**	**23.6**	**25.0**	**0.12**	**0.12**
Biomineral fert nutrient app. rates	15-Apr - Troforte Cropping	100	10.0	7.0	4.5	4.6	0.0003	0.04
	15- Aug - SulSync N37	80	29.6			12.0		
	15 -Nov - Troforte Cropping	80	8.0	5.6	3.6	3.7	0.0003	0.032
	15 - Jan - SulSync N37	80	29.6			12.0		
	Total		**77.2**	**12.6**	**8.1**	**32.3**	**0.001**	**0.072**

Cattle Production

- Up to 96 southern calves @ 230 - 280kg live weight range divided randomly into 2 equal mobs
- Each mob will be divided again into 2 equal mobs, graze on the same fertiliser replicate, which is divided into 2 paddocks to give two replicates of the live weight gain data.
- Trial entry between 15 December and 15 January each year

- Administer full veterinary protocols and settling period on hay for 5 days.
- Background for 100 - 120 days
    - Target daily weight gain of 0.3% of body weight
    - Total weight gain of 90 to 110kg live weight
    - Exit weight 340 - 390 kg live weight
- Cattle depart property between 1 April to 15 May each year as sale weight is reached
- Cattle production will be monitored by measuring monthly live weight gain

<u>Field Sampling</u>

- Pasture Sampling Plan
    - Sample on
        - 20th of each month during the cattle production trial (5 x January to May)
        - 20th of August and 20th October during Winter and Spring
    - At the start of the trial period a 'W feed transect' will be positioned within each of the 6 paddocks. The pasture samples will then be taken randomly from within these W transects each time using a 1/4m quadrant. From within each W transect 10 samples will be taken at each sample date. Each of the 10 samples will be weighed to measure production. The 10 samples will then be mixed and a sub sample of 0.5kg will be sent to UWA for testing.
        - Total samples each collection date – 60
        - Total tests required from each sampling day – 6
        - Total samples each year – 480
        - Total test results each year – 48
- Soil Sampling Plan
    - Initial Sampling: March 2022 prior to fertiliser application commencement
    - Interim Sampling: March 2024 reduced scale of sampling and testing at the end of year 2 to give an indication of how results are progressing. Ten soil samples will be collected per quadrant.
    - Final Sampling: March 2025 or end of project
    - The sampling plan needs to conform to the Australian standards for carbon sampling and all sampling will occur at the same time of year.
    - Soil samples will be collected from within four randomly placed quadrants of 25 × 25 m within each of the six paddocks (See diag. 1). Within each quadrant, twenty soil samples of fixed volume using a soil auger of 4-cm diameter and 10-cm depth will be collected using random sampling from underneath the pasture stands of perennial/annual grasses and legume. Samples will be taken at five depths (0–10, 10-20, 20–30, 40-50 and 50-60 cm). The twenty soil samples from each depth within each quadrant will be mixed and a 1 kg sub sample sent to UWA for testing.
        - Total samples each collection date - 2,400
        - Total tests each sampling day – 336
        - Total samples for project - 4,800

Figure 3. Field sampling plan

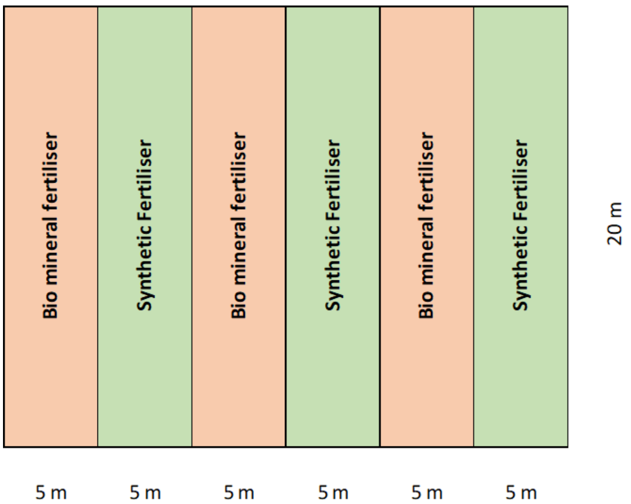
Year	Test	Paddocks	Quadrants	Depths	Total Samples	Comments
Mar-22	Soil inorganic carbon, organic carbon, total carbon and total N	6	4	5	120	5 depths x 4 quadrants
	Basic soil analyses	6	2	5	60	5 depths x 2 quadrants
	Mehlich all nutrients including trace elements	6	2	5	60	5 depths x 2 quadrants
	Particle size analysis	6	2	5	60	5 depths x 2 quadrants
	Soil health (soil microbial biomass	6	2	3	36	3 depths x 2 quadrants
Mar-24	Soil inorganic carbon, organic carbon, total carbon and total N	6	4	2	48	5 depths x 4 quadrants
	Basic soil analyses					
	Mehlich all nutrients including trace elements					
	Particle size analysis					
	Soil health (soil microbial biomass	6	2	2	24	2 depths x 2 quadrants
Mar-25	Soil inorganic carbon, organic carbon, total carbon and total N	6	4	5	120	5 depths x 4 quadrants
	Basic soil analyses	6	2	5	60	5 depths x 2 quadrants
	Mehlich all nutrients including trace elements	6	2	5	60	5 depths x 2 quadrants
	Particle size analysis	0	0	0	0	
	Soil health (soil microbial biomass	6	2	3	36	3 depths x 2 quadrants

Plot Trial Method

Within the small plot trial, the nutrient application rates of the biomineral fertiliser and the synthetic fertilisers will be applied at equal rates. The synthetic fertiliser rates will be reduced to match the biomineral fertilisers. The objective of the small plot trial, by applying equivalent nutrient rates, is to assess the impact of the microbe blend applied to the biomineral fertiliser and how it impacts soil micro-biology and pasture production. This trial within the whole the project will allow the data to assess the impact of biology above the effect of different nutrient application regimes has on production. It is acknowledged that the application of biomineral fertiliser at the unit rates equivalent to conventional fertiliser systems is cost prohibitive and contrary to production system bio mineral fertilisers are aiming to generate, however this trial is of value in isolating the effect of biology away from nutrient application.

The small plot trial will be carried out on the same property on which the main trial is being conducted. This removes the impact of different environmental conditions and property history. The small plot trial will be 2 treatments, bio mineral and synthetic fertilisers with 3 replications as per Figure 4.

Figure 4. Small plot trial design



Fertiliser Treatments

Fertiliser applications or nutrient applications will be matched to the final biomineral fertiliser rates applied in the main trial site. The synthetic fertiliser applications rates will be reduced to apply the equivalent kilograms of each nutrient as the bio mineral fertiliser. Similar to the main trial the final application rates will be determined after the results of the initial soil testing have been completed and analysed.

Figure 5. Indicative fertiliser application rates of the plot trial

	Fertiliser product	Application rates kg/Ha	N	P	K	S	Cu	Zn
Fertiliser products	Troforte cropping typical analysis		10	7	4.5	4.6	0.00034	0.04
	SulSync N37		37			15		
	Grazing plus		5.2	7	5	6.1	0.00052	0.00057
	Urea		46					
	NKS21		27.8		12.4	6.5		
	Super Phos			8.4		10.5		
	Super Phos Extra			8.4		10.5	0.1	0.1
Synthetic fertiliser nutrient application rates	15-Apr - Super	100		8.4	0.0	10.5		
	15 Apr - NKS21	45	12.5		5.6	2.9		
	15-Aug - Super Extra	65	0.0	5.5	0.0	6.8	0.1	0.1
	15 Aug - NKS21	30	8.3	0.0	3.7	2.0	0.0	0.0
	15-Dec - NS31	63	29.0					
	Total		**49.8**	**13.9**	**9.3**	**22.2**	**0.065**	**0.065**
Biomineral fert nutrient app. rates	15 -Apr - Troforte Cropping	120	12.0	8.4	5.4	5.5	0.0004	0.048
	15 - Aug - Troforte Cropping	80	8.0	5.6	3.6	3.7	0.0	0.0
	15 -Dec - SulSync N37	80	29.6			12.0		
	Total		**49.6**	**14.0**	**9.0**	**21.2**	**0.001**	**0.080**

Testing Regime

Soil Testing (Figure 6):

- Soil samples will be collected from within each of the 5m x 20m plots with samples taken randomly from over the entire plot. Within each plot, twenty soil samples of fixed volume using a soil auger of 4cm in diameter and 10cm depth will be collected using random sampling from underneath the pasture stands of annual grasses, legumes and perennials. Samples will be taken at 3 depths 0 – 10cm, 10 – 30cm and 30 – 50cm. The twenty soil samples from each depth within each plot will be mixed and a 1 kg sub sample sent to UWA for testing.
    - Total samples each collection date
        - Mar 2022 - 1,800
        - Mar 2024 – 720
        - Mar 2025 – 1,440
    - Total soil samples for small plot trial – 3,960.

Plant Testing:

- Pasture growth
  - 2 pasture cages per plot
  - 12 cages in total for small plot trial
- Plant nutritional values
  - 1 test per plot per testing time
  - 3 testing times per year coinciding with main trial times
    - 20th October
    - 20th February
    - 20th April
- Pasture anti-methanogenic properties through in-vitro testing of methane production
  - 1 test per plot per testing time
  - 3 testing times per year coinciding with main trial times
    - 20th October
    - 20th February
    - 20th April

Figure 6. Plot trial soil testing regime

Year	Test	Paddocks	Plots	Depths	Total Samples	Comments
Mar-22	Soil inorganic carbon, organic carbon, total carbon and total N	6	1	3	18	3 depths x 4 quadrants
	Basic soil analyses	6	1	3	18	3 depths x 2 quadrants
	Mehlich all nutrients including trace elements	6	1	3	18	3 depths x 2 quadrants
	Particle size analysis	6	1	3	18	3 depths x 2 quadrants
	Soil health (soil microbial biomass	6	1	3	18	3 depths x 2 quadrants
Mar-24	Soil inorganic carbon, organic carbon, total carbon and total N	6	1	3	18	3 depths x 4 quadrants
	Basic soil analyses					
	Mehlich all nutrients including trace elements					
	Particle size analysis					
	Soil health (soil microbial biomass	6	1	3	18	3 depths x 2 quadrants
Mar-25	Soil inorganic carbon, organic carbon, total carbon and total N	6	1	3	18	3 depths x 4 quadrants
	Basic soil analyses	6	1	3	18	3 depths x 2 quadrants
	Mehlich all nutrients including trace elements	6	1	3	18	3 depths x 2 quadrants
	Particle size analysis					
	Soil health (soil microbial biomass	6	1	3	18	3 depths x 2 quadrants

Adoption Pathway

A comprehensive adoption pathway has been developed to complement the research component of this project. It involves 3 commercial demonstration sites as a vehicle to enable producers in the Southwest, South Coast and Great Southern regions to build knowledge, awareness and skills. This will involve strategies to improve soil carbon levels while maintaining production plus operational carbon accounting methodologies by participating in the workshops, field walks and field days.

The three producer demonstration sites are each to be carried out for three years in the below districts

- Bridgetown Boyup Brook region – Great Southern
- Nannup, Scott River region – South Coast
- Manjimup, Pemberton – Southwest

Each site will involve:

- 2 paddocks of similar soil type, side by side.
- 15 – 20 Ha in size
    - 1 treated with synthetic fertilisers
    - 1 treated with biomineral fertilisers
- Both to be grazed over winter/spring and into summer if perennials are being grown with stock present on property (sheep or cattle).
- 2 x PDS designs will allow for replicated data, though with reduced sampling, to be generated for all the information being captured including soil carbon, carbon budgeting, soil health, pasture production and animal production.
- The 2 above PDS's will be located in the Southwest and South Coast regions.
- The 3rd PDS will be located on the same property as the main trial site and the small plot trial
    - Within this PDS the sampling and testing regime will be increased to match that of the main trial site.
    - This site being next to the main trial will act as a non-irrigated control site, which will allow for the effects of the fertiliser to be separated from the effects or impacts of irrigation.
- The final fertiliser regimes to be applied to each PDS site will follow those outlined in Figure 1 and be determined after the soil test results have been completed and analysed. The recommendations will be provided by an independent expert in each field.

<u>Testing Regime</u>

PDS Soil Testing (Figure 7):

- Soil samples will be collected from within 3 randomly placed quadrants of 25m x 25m within each of the 2 paddocks. Within each quadrant, twenty soil samples of fixed volume using a soil auger of 4cm in diameter and 10cm depth will be collected using random sampling from underneath the pasture stands of annual grasses, legumes and perennials. Samples will be taken at 3 depths 0 – 10cm, 10 – 30cm and 30 – 50cm. The twenty soil samples from each depth within each quadrant will be mixed and a 1 kg sub sample sent to UWA for testing.
    - Total samples each collection date
        - Mar-22 360
        - Mar-24 360
        - Mar-25 360
    - Total soil samples per PDS – 1,080.
    - Total soil samples for both PDS - 2160

PDS Control Site Soil Testing (Figure 8):

- Soil samples will be collected from within 3 randomly placed quadrants of 25m x 25m within each of the 2 paddocks. Within each quadrant, twenty soil samples of fixed volume using a soil auger of 4cm in diameter and 10cm depth will be collected using random sampling from underneath the pasture stands of annual grasses, legumes and perennials. Samples will be taken at 3 depths 0 – 10cm, 10 – 20cm, 20 – 30cm, 30 – 40cm and 40 – 50cm. The twenty soil samples from each depth within each quadrant will be mixed and a 1 kg sub sample sent to UWA for testing.
    - Total samples each collection date
        - Mar-22 600
        - Mar-24 600
        - Mar-25 600
    - Total soil samples for project – 1,800.

PDS Site Plant Testing:

- Pasture growth
    - 3 pasture cages per treatment
    - 6 cages in total per PDS Site
- Plant nutritional values
    - 6 tests each site annually
    - 18 tests per PDS
- Pasture anti-methanogenic properties through in-vitro testing of methane production
    - 6 tests each site annually
    - 18 tests per PDS
- Plant testing to be completed early spring of each year (2022/2023/2024)

PDS Livestock Production:

- The short graze time within trial plots will not allow for animal weight gain measurements to be taken with any validity. Alternatively, plant growth and nutritional measurements will be compared to that of the main trial site where subsequent animal performance is known. This will allow animal performance and cost benefit within demonstration site conditions to be considered.

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