

PASTURE BIODIVERSITY TO BUILD SOIL HEALTH & RESILIENCE IN THE LOWER BLACKWOOD Farm Demonstration Site Case Studies



Lower Blackwood Catchment
Land Conservation District Committee

Background:

This project has been designed to demonstrate the efficacy of multi species cover crops and perennial pasture plants in the Lower Blackwood as a means to drive various biological soil building processes whilst simultaneously improving the quantity and quality of forage.

The project hinges around spring and autumn seeding of multispecies mixes on sites at three separate farm locations within the catchment – Rosa Glen, Warner Glen & Scott River.



Base Line Soil Assessment Results & Field Observations:

Baseline soil parameters such organic carbon, aggregation/structure and colour, water infiltration, nutrient availability and holding capacity were tested, observed and compared over the course of the project to track progress.

Topsoil samples (0-200mm) were collected and sent to SWEP Analytical labs for analysis in spring 2021, autumn 2022, spring 2022 and a final sample was be taken in later summer 2023.

Dry matter cuts of the control and trial sites were taken for analysis in August 2022, and a further dry matter cut was taken at the Warner Glen Site in November 2022.

In-field observations of the pastures and soil were carried out, and photos were taken from the trial sites and control areas at various stages over the project timeline.

SITE 1: BOLEY PASTORAL, SCOTT RIVER BACKGROUND

Texture / Structure	Dk Grey loamy sand / sand. Sandy fabric, Weak coherence.
Recent History	The paddock was sown to a multi-species mix in late autumn 2021 prior to the project commencing. The cover crop did not fare well due to the late sowing and the water logging that occurred with heavy winter rainfall
Fertiliser History	Super:potash 150kg/Ha every rotation + 100kg/Ha Urea
Ground Cover	60-100% cover
Species Count	Rye grass, flat weed, silver grass, fresh clover
Penetrometer	Hardpan resistance at 150mm. Clear at depth.
Permeability	Permeability: 20 metres / day. This is considered a very high level of infiltration

SITE 2: BLACKWOOD RIVER FARM, WARNER GLEN BACKGROUND

Texture / Structure	Medium to fine grained loamy sand to silty sandy loam
Recent History	The paddock was grazed just prior to seeding. No previous multispecies seeding had been undertaken on the site.
Fertiliser History	4 tons/Ha lime; 1 ton/Ha dolomite
Ground Cover	80-100%
Species Count	Ryegrass and clover
Penetrometer	Hardpan resistance at 100-250mm. Clear at depth
Permeability	3.1 metres/day. This is considered a moderate to high level of infiltration.

SITE 3: EMU CREEK, ROSA GLEN BACKGROUND

Texture / Structure	Medium grained loamy sand to sandy loam. Weak granular structure and slight coherence
Recent History	The paddock was sown to a multi species pasture mix in late Autumn 2021 prior to the project commencing
Fertiliser History	Lime and Dolomite – Autumn 2021 Custom Blend K + Traces – Autumn 2021
Ground Cover	80-100% cover
Species Count	Clover(s), Rye grass, Oats, Barley, serradella, field peas, lupins, canola, brassica, capeweed
Penetrometer	Slight resistance at 150mm. Clear at depth
Permeability	3.1 metres/day. This is considered a moderate to high level of infiltration.

Spring 2021 | Site Preparation & Seeding

All sites were grazed prior to the first spring seeding. The Rosa Glen and Warner Glen sites were seeded without any form of tillage or herbicide application, the Scott River site was surface tilled with multiple passes before seeding. As a result, there was little pre-planting weed control at the Rosa Glen and Warner Glen sites.

The selection of species in the spring summer mix was based on local conditions, the outcomes we were after and the availability of supply. It was comprised of:

- Fabaceae - cowpeas, field peas, vetch, white clover
- Poaceae - Millet
- Asteraceae - Sunflowers
- Polygonaceae - Buckwheat
- Brassicaceae - Turnips

Perennial species **Lucerne**, **Plantain** and **Chicory** were also added to the mix.

Prior to sowing, seeds were lightly coated with a mix of compost extract, Milk, Molasses and Nutri Tech Seedstart.

General Progress:

Initial germination of species such as buckwheat, sunflowers and turnips at the Emu Creek and Warner Glen sites was reasonable but overall germination was poor. This was probably largely because of a lack of suitable tith, seed soil contact and available moisture that, in many ways, could be attributed to the remnant stand of plants from the cool season. Those species that did germinate struggled to grow well, with strong competition from the existing stand of cool species that went into an increasingly demanding reproductive stage of growth as the season warmed up and dried out.

Nonetheless, with minimal soil disturbance and further growth from existing species into spring, the overall impact in terms of soil health at these sites was not obviously negative.

Most species at the Scott River site germinated well due to the pre-planting weed control but, as it was seeded later in the season, the plants did not put on much growth before they dried out and died.

The success of a warm season cover crop is largely dependent on the termination of existing winter species with herbicide or tillage prior to sowing. However, such measures may have a negative impact on soil health overall.



Autumn 2022 | Site Preparation & Seeding

Any remnant standing vegetation was grazed off over the summer. All sites were seeded after season breaking rain events so cool season weeds had already germinated. The sites were speed tilled to remove surface weeds and then seeded. The seed mix was composed of:

- Reliable and economic soil building annual staples such as oats, ryecorn, vetch, field peas, lupins and linseed.
- Common and reliable pasture species such as ryegrass and clovers.

Other perennial pasture species such as chicory, plantain, cocksfoot, phalaris and tall fescue to test their suitability and potential for increasing pasture diversity. Seeds were coated with compost extract, milk, molasses, liquid seaweed and soft rock phosphate prior to seeding.

General Progress:

Initial germination of Radish, Oats, Vetch, Linseed, Crimson Cover, Field Peas, Lupins, Ryegrass, Plantain, Chicory was good along with a few local weed species. It was difficult to find much, if any, Lucerne, Cocksfoot, Phalaris, Fescue or perennial clover species amongst the other species.

The Warner Glen and Scott River Sites applied a post emergence spray of Biofertiliser, Mn, Fe, B and Co, Fish Hydrolysate, Fulvic Acid and Compost Extract.

All sites made good progress but some cows got into the Scott River paddock and grazed the cover to the ground.



Autumn 2022 Seed Mix:

Plant Group	Family	Species	Annual/ Perennial	Kg in Mix /ha
Grasses	Poaceae	Oats	Cool Season Annual	14
	Poaceae	Ryecorn	Cool Season Annual	6
	Poaceae	Cocksfoot	Cool Season Active Perennial	2
	Poaceae	Everlast Ryegrass	Warm Season Active Perennial	4
	Poaceae	Phalaris	Cool Season Active Perennial	2
	Poaceae	Tall Fescue	Warm Season Active Perennial	2
Legume	Fabaceae	Peas	Cool Season Annual	15
	Fabaceae	Vetch	Cool Season Annual	6
	Fabaceae	White Lupins	Cool Season Annual	6
	Fabaceae	Trikkala Clover	Cool Season Annual	2
	Fabaceae	Crimson Clover	Cool Season Annual	2
	Fabaceae	Balansa Clover	Cool Season Annual	2
	Fabaceae	Persian Clover	Cool Season Annual	2
	Fabaceae	White Clover	All Season Perennial	2
	Fabaceae	Lucerne	Warm Season Active Perennial	2
Tall Non Leguminous Forbs	Asteraceae	Chicory	All Season Perennial	2
	Linaceae	Linseed	Cool Season Annual	5
Short Non Leguminous Forbs	Plantaginaceae	Plantain	All Season Perennial	2
	Brassicaceae	Daikon Radish		1
Counts / Rate	6	19		75

Dry Matter Cuts:

Dry Matter (DM) cuts were taken from the Emu Creek and Warner Glen sites in late July to compare the feed analysis between the trial and control sites. A sample could not be collected from the Scott River site due to a break in by cattle, so substitute sample cuts were also taken from the Witchcliffe Ecovillage (WEV) where a paddock was dry seeded earlier in the season with the same seed mix.

The DM yield was greatest in the WEV paddock simply because it was dry seeded and came up with the first rains early in the season. The overall feed value was greater in the Emu Creek and WEV the trial plots.

The DM yield was lower in the Warner Glen Trial paddock than the control but it was sown later in the season. The forage on this site had the highest percentage of protein.

Site	Treatment	DM yield (kg/ha)	Value (\$/ha) @\$200/t	Energy (MJ/kg DM)	Protein (%)
Rosa Glen	Crop	2212	\$442.40	9.8	14.3
Rosa Glen	Pasture/Control	1953	\$390.67	9.9	16.7
Warner Glen	Crop	1378	\$275.60	10.9	21.3
Warner Glen	Pasture/Control	1963	\$392.50	11	14.2
WEV	Crop	2616	\$532.20	10.5	11.6
WEV	Pasture/Control	736	\$147.20	9.1	13

Spring 2022 | Site Preparation & Seeding

At the Emu Creek and Warner Glen Sites, the existing vegetation was grazed hard, slashed, and then seeded with a Soilkee Renovator.

A different paddock at the Scott River Site was seeded later in the season as there was an overhead watering system in place and it was useful to compare an irrigated and dryland site. That paddock was seeded along with an in-furrow liquid mix of compost extract, fish hydrolysate, humic acid, molasses and seaweed on the 26/11/2022.

In all cases seeds were coated with compost extract, milk, molasses and liquid seaweed.

General Progress:

Initial germination at the Emu Creek site was sporadic, probably due to dry conditions following planting and certain species were possibly consumed by rabbits following emergence. Shortly thereafter however, conditions dried out quickly and the existing stand of winter weeds grew over the tilled and seeded Soilkee strips. The few species that remained failed to grow well. Later in the summer In Jan/ Feb, Lab Lab emerged and grew well despite the lack of rain, most likely due to the increase in soil temperature and the lack of competition from Ryegrass. Chicory and Plantain also developed well.

There was good germination of oats, peas, vetch, millet, buckwheat, sunflowers, clover, turnip, chicory, plantain, cowpea, ryecorn and scatterings of other species at the Warner Glen site. They all grew fairly well but were quite young when, at the time, the remnant remaining cool season species went to seed. There came a point where it was decided that the overall benefits would be greater if the paddock was grazed, despite the fact that this would knock out a significant portion of the spring seeded species.

As there was good soil preparation and no actively growing weeds, the best germination and subsequent growth was seen at the Scott River site. This site also received the following inputs following planting.

- 1/12 2.5ha of our own compost was applied.
- 12/12 80kg 3:2 super potash
- 27/12 40kg 3:2 super potash
- 9/1 40kg 3:2 super potash
- 23/1 40kg 3:2 super potash



Spring 2022 Seed Mix:

Plant Group	Family	Species	Annual/ Perennial	Kg in Mix /ha
Grasses	Poaceae	Oats	Cool Season Annual	7
	Poaceae	Millet	Warm Season Annual	5
	Poaceae	Teff	Warm Season Annual	4
	Poaceae	Ryecorn	Cool Season Annual	2
Legume	Fabaceae	Peas	Cool Season Annual	7
	Fabaceae	Vetch	Cool Season Annual	6
	Fabaceae	Sunn Hemp	Warm Season Annual	4
	Fabaceae	Balansa Clover	Cool Season Annual	1
	Fabaceae	Persian Clover	Cool Season Annual	1
	Fabaceae	White Clover	Warm Season Annual	1
	Fabaceae	Lab Lab	Warm Season Annual	3
	Fabaceae	Cow Pea	All Season Perennial	8
	Fabaceae	Lucerne	Warm Season Active Perennial	15
Tall Non Leguminous Forbs	Asteraceae	Chicory	All Season Perennial	1
	Asteraceae	Sunflower	Cool Season Annual	5
Short Non Leguminous Forbs	Plantaginaceae	Plantain	All Season Perennial	1
	Brassicaceae	Turnip	Cool Season Annual	1
	Polygonaceae	Buckwheat	Warm Season Annual	5
Counts / Rate	6	18		65

Dry Matter Cuts:

A dry matter cut was taken from the Warner Glen site in late November for a feed analysis comparison between the trial and control sites. There was insufficient dry matter available for a cut from the Rosa Glen Site.

The DM yield was greater in the control but the spring sown species were still relatively small when the cuts were taken. The available energy and protein levels were greater in the trial forage.

Site	Treatment	DM yield (kg/ha)	Value (\$/ha) @\$200/t	Energy (MJ/kg DM)	Protein (%)
Warner Glen	Crop	2925	\$580.50	9.7	10.4
Warner Glen	Pasture/Control	3275	\$745	8.5	7.8

Pasture cuts for the irrigated site at Scott River were taken in February, it had been grazed in January, the estimated growth rate over this period was 137kg/Ha per day.

Wet wt 1 (kg)	Wet wt 2 (kg)	Sample wt (g)	DM wt (g)	DM (%)	DM yield (kg/ha)
3.3	2.64	660	76.7	11.62	1918



Trial Results

BOLEY PASTORAL, SCOTT RIVER

There was not a significant rise in available nutrients on the trial site over the term of the project.

Soil organic carbon levels improved from 2.97% (Apr 2021) to 3.04% (Sept 2021) jumped up to 3.91% (April 2022) then dropped back down to 2.68% (Sept 2022). A fourth round of soil testing was not carried out on this site as the farmer was not able to seed a spring summer cover crop before the season dried out. As such, he chose to seed an irrigated paddock from which we had no historical reference points.

The fact that the overall soil carbon level dropped during the term of the project could be attributed to the soil disturbance that occurred in combination with the fact that none of the seedings were particularly successful or grew to a stage where you would expect them to markedly improve the state of the soil.

The colour and crumb structure of the soil was less pronounced but deeper in the trial plot. This was probably due to previous tillage passes, where the uppermost soil horizons may have been somewhat mixed together.

Assessment	April 2021 (Pre Project)	September 2021	April 2022	October 2022
pH (1:5 Water)	5.6	6.1	5.5	6.02
Total Organic Carbon	2.97%	3.04%	3.91%	2.98%
CEC	9.76	8.34	12.34	9.71

Comments on visual assessment of irrigated site February 2023:

We carried out visual assessments of the seeded area in comparison to an adjacent area on the same paddock which was not seeded. At the time of observation, the paddock had already been grazed once but had somewhat regrown and seeded area had significantly more, and better growth, than the unseeded area. What is more, existing species such as crabgrass, growing amongst the cover crop, appeared to be much healthier and more palatable. The soil in the seeded area was darker, had better crumb structure and moisture levels below the surface, all indicators of a more functional soil.

BLACKWOOD RIVER FARM, WARNER GLEN

Soil profiles were dug in winter 2022 and the observed colour and crumb structure in the trial site did not differ much from the soil in the control. Because of the late autumn sowing, the cover crop had to play catch up which may explain why there was not more improvement in the soil at that stage.

Assessment	April 2021 (Pre Project)	September 2021	April 2022	October 2022	Feb 2023
pH (1:5 Water)	6.6	5.7	5.5	6.6	5.98
Total Organic Carbon	3.33%	3.2%	3.03%	3.33%	2.94%
CEC	11.6	11.7	12.6	11.6	11.4

The levels of most nutrients as shown on the soil tests decreased between October 2022 and February 2023. Lime and dolomite had been applied beforehand which may account for slightly higher initial readings. Available soil tests don't indicate what is in the soil bank, only what's plant available at that time and this can vary with seasonal conditions and other factors. In addition, the timing of the final test also makes a direct comparison void.

The soil carbon levels dropped over the course of the project. This may be attributed to oxidation from the cultivation that occurred in both autumn and spring to prepare the ground for seeding and the lack of longevity with the 22/23 spring cover crop, essentially leaving strips of the paddock bare over the summer.



EMU CREEK FARM, ROSA GLEN

The levels of most available nutrients on the trial site as shown on the soil tests improved significantly but this may be partially attributed to the range of inputs applied in autumn 2021 at seeding.

Soil carbon levels improved initially but dropped significantly in the last year. Again, this may be due to the oxidation that occurred with the cultivation both in autumn and spring and the lack of establishment with the 22/23 spring seeding, leaving strips of the paddock bare over the summer.

There was a slight upward trend in cation exchange capacity over the term of the project.

In winter 2022, some soil profiles were dug and there was a recognisable improvement in soil colour and crumb structure of the area with a successful cover crop when compared to the control area.

Assessment	April 2021 (Pre Project)	September 2021	April 2022	October 2022	Feb 2023
pH (1:5 Water)	6.1	6.6	6.4	6.77	6.61
Total Organic Carbon	3.31%	3.54%	4.33%	3.59%	2.36%
CEC	13.4	15.7	12.6	13.7	16.2



Conclusions

A number of conclusions have been drawn from the observations made and the data collected over the course of the project:

- The sowing of cover crops and establishment of diverse pastures has been shown to build soil structure and fertility, improve supply and quality of forage and align with favorable environmental outcomes. The costs and benefits associated with such practices, however, are very much dependent on when and how you go about it, what species you choose to sow and success with establishment.
- Seeding a multispecies cover crop in early autumn with cheap staple species offers the most reliable short-term return on investment in terms of soil building and generating forage. The earlier in the season it is seeded the better, as the weather conditions are more conducive for good growth. If seeded before the seasonal rain break, there is no need for soil cultivation and/or herbicide use.
- The seeding of cover crops in spring must be done in conjunction with good pre-planting weed control. The use of tillage and/or herbicide can have a negative effect on the soil which may negate the proposed benefits of a warm season cover crop - which may not grow very well anyway due to lack of moisture in a dry time of year. Unless irrigation is an option, it may be better to manage the existing cool season species so that they stay vegetative and remain longer into the dry season with succinct grazing.
- The perennial species that did well included chicory, plantain, ryegrass and some clovers. They were best off sown in early autumn so that they had time to grow deeper root systems in order to survive during the hot, dry season. Other pre-requisites for the establishment of perennial species include ensuring there is little competition from annual species during the first season of growth, and having a soil with the capacity to retain moisture for longer into the dry season.
- In poor fertility and low biology soils, the use of compost/vermicast extract, bio-stimulants and some nutrition at planting and/or early in the growing season can help to give multispecies plantings a good start, increasing their capacity to effectively improve soil function and fertility and raise the quality of production.
- The establishment of a multispecies pasture may take a number of seasons. In low fertility and poorly functioning soils, more reliable and cheaper species can be used initially for soil improvement and weed control. This sets the scene for better establishment of the more challenging dry season and perennial cover crop species.

This project received funding from the Australian Government's Future Drought Fund.



Australian Government
Department of Agriculture,
Fisheries and Forestry



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