Mixed cover crops for sustainable farming

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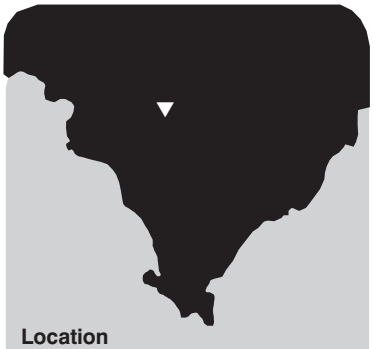

Location
Minnipa Agricultural Centre, paddock S8
Rainfall
Av. Annual: 324 mm
Av. GSR: 241 mm
2019 Total: 254 mm
2019 GSR: 234 mm
Paddock history
2018: Medic pasture
2017: Scepter wheat
2016: Medic pasture
Soil type
Red sandy loam
Plot size
12 m x 1.5 m x 4 reps

Key messages

- **Crop intensive farming systems are running down soil carbon.**
- **Mixed species cover cropping offers a new approach that may address the issue.**
- **Local guidelines need to be developed so that farmers can make informed decisions about incorporating cover crops into their farming systems.**

Why do the project?

Crop intensive farming systems are running down soil carbon, requiring increased inputs to maintain or increase yield without necessarily improving profitability. Mixed species cover cropping offers a new approach to reverse this trend in the Australian context. It is a key component of some farming systems overseas but is yet to be adopted widely in southern Australia. In the context of this project, mixed species cover crops refers to a diverse mix of plant species grown together but often outside the main growing season to build fertile and resilient soils.

Potential benefits of cover crops include improving soil organic carbon, structure and health, while decreasing weed and disease levels for following crops, but these must be balanced against the cost of growing the cover crop and the water and nutrients it will use. Many potential cover crop options exist and while growers are beginning to investigate these, local guidelines are yet to be developed to inform decisions.

A trial at Minnipa is investigating mixed species cover crops grown over winter. The principle behind growing a mixture of species rather than a monoculture is that it mimics naturally occurring diverse ecosystems. Different root systems host different microorganisms, fungi and soil biota that improve the dynamic properties of soil leading to healthier soil that has higher infiltration rates for water and are better able to retain that moisture. This retained water can potentially be used for the following cereal crops. Different root systems also inhabit different parts of the soil profile and therefore access water and nutrients more completely, so no single section is severely depleted. Organic matter is distributed more evenly throughout the soil profile and more carbon is available to soil organisms. The qualities of two or more different species may also improve the overall productivity. Legumes fix nitrogen that can be used by other plants. Tall plants provide shade for emerging seedlings, reducing their exposure to water and temperature stress. Climbing plants such as peas will often use the taller plants as a trellis. The fibrous root systems of many cereals and grasses bind the soil to protect it from wind erosion, particularly under dry conditions. Brassicas can function as biofumigants, suppressing soil pests, especially root pathogens and plant-parasitic nematodes. Leaving residue on the soil surface lowers the soil temperature, reducing soil water loss through evaporation and providing protection from erosion. A diverse cover crop also offers a more balanced diet to livestock.

How was it done?

Ten species were selected as potential components of a winter cover crop based on their suitability for the local rainfall and soil type, seed availability, ability to be included in mixes and existing district practices. The species were also selected to include a range of legumes, brassicas, cereals and grasses. A mix including all ten species in equal amounts, four other mixes composed of subsets of these species and each species as a monoculture were sown. As a control there was a fallow treatment where the plots were left unsown (Table 1). The trial was sown into moist soil on 31 May 2019 with 60 kg/ha DAP.

Table 1. Winter cover crop species sown at Minnipa on 31 May 2019.

Cover Crop Species	Sowing Rate
PM-250 Strand medic	7.5 kg/ha
Volga vetch	40 kg/ha
Field peas	100 kg/ha
Mulgara oats	60 kg/ha
Safeguard annual ryegrass	5 kg/ha
Cereal rye	40 kg/ha
Triticale	70 kg/ha
Stingray canola	2 kg/ha
Tillage radish	5 kg/ha
Narbon beans	120 kg/ha
Ten Species Mix	10% of the sowing rate of each species as a monoculture
Control (fallow)	NA
Jake's Party Mix (oats, vetch & canola)	40 kg/ha oats, 20 kg/ha vetch, 1.5 kg/ha canola
Mandy's Mix (oats & medic)	40 kg/ha oats, 7.5 kg/ha medic
Fluff's Mix (canola & field peas)	2.5 kg/ha canola, 30 kg/ha field peas
Fi's Mix (tillage radish, ryegrass, cereal rye, oats, field peas & vetch)	18% of the sowing rate of each species as a monoculture

PM-250 strand medic was included to represent the common district practice of regenerating medic pastures being used in rotation with cereal crops. As a legume species it fixes nitrogen.

Volga vetch is a legume so has the benefit of adding nitrogen to the soil. It can be grown in the lower rainfall areas of southern Australia where no other legume crops perform consistently well. It can also be grazed or cut for hay. Its dense, spreading structure provides shade to the soil.

Field peas are legumes so fix nitrogen. They can be grown in most cropping regions of southern Australia.

Mulgara oats are a hay variety that we had available, which can produce a highly competitive crop canopy that can compete well with weeds when sown early. Oats were included as a treatment to represent a common district practice of sowing oats to provide grazing and ground cover, with the option of later cutting for hay or harvesting the grain.

Safeguard annual ryegrass can mature rapidly in drought conditions, producing abundant winter forage in marginal areas. It has no herbicide resistance and is resistant to annual ryegrass toxicity.

Cereal rye is suited to infertile, sandy soils and is drought resistant. It has the ability to produce a soil-binding cover on land where other cereals grow poorly.

Triticale can make good use of land that is marginal for other cereals and is adapted to alkaline soils. It has an aggressive, fibrous root system that binds light soils reducing erosion and builds soil organic matter. It also provides excellent residual ground cover and can be grazed.

Stingray canola is a brassica commonly included in crop rotations in low rainfall southern Australia.

Tillage radish is a brassica bred specifically for its large tuberous taproot, which is claimed to reduce soil issues such as compaction. It is drought hardy with the ability to access subsoil moisture and nutrients. It also produces very palatable feed.

Narbon beans (*Vicia narbonensis*) are a legume suited to low rainfall and alkaline soils, with resistance to aphids. They can be grazed, cut for hay or used for green manure.

Jake's Party Mix was included because this same mix was sown on the MAC Farm by Jake Hull in 2019 to provide grazing for the MAC sheep.

Mandy's Mix was included because oats and medic produced the most dry matter of the mixes included in Amanda Cook's 2018 trial 'Maximising dry matter production for grazing systems on alkaline soils'.

Fluff's Mix was suggested by Ian Richter as canola and field pea had the greatest benefit to subsequent cereal crops in Suzanne Holbery and Roy Latta's 2011-2014 'Crop Sequences' trial.

Fi's Mix was selected to represent a balance of species from cereals/grasses, legumes and brassicas. Retrospectively I would have replaced Safeguard annual ryegrass with canola to provide an extra brassica species.

Table 2. Dry matter measurements at Minnipa 13 September 2019.

Cover crop species	Shoot dry matter (t/ha)
PM-250 Strand medic	0.48 de
Volga vetch	0.89 d
Field peas	1.15 cd
Mulgara oats	2.94 a
Safeguard annual ryegrass	1.24 cd
Cereal rye	2.44 ab
Triticale	2.52 ab
Stingray canola	1.50 cd
Tillage radish	1.41 cd
Narbon beans	1.14 cd
Control (fallow)	NA
Ten Species Mix	2.24 b
Jake's Party Mix (oats, vetch & canola)	2.42 ab
Mandy's Mix (oats & medic)	2.40 ab
Fluff's Mix (canola & field peas)	1.57 c
Fi's Mix (tillage radish, ryegrass, cereal rye, oats, field peas & vetch)	2.60 ab
LSD (P=0.05)	*0.62*

What happened?

Plants began to emerge and establish vigorously two weeks post seeding. The performance of PM-250 Strand medic was compromised by being sown too deep and struggled all season with low plant numbers. Dry matter cuts were taken on 13 September 2019 (Table 2) at early grain fill, as a measure of maximum biomass.

Despite triticale and Jake's Party Mix producing the best early vigour, Mulgara oats produced the most dry matter of all treatments by the end of the season; 2.94 t/ha at early grain fill.

Of the mixes, Fi's Mix produced the most dry matter with 2.60 t/ha. As expected the PM-250 Strand medic produced the lowest amount of dry matter with 0.48 t/ha.

The trial was terminated with glyphosate on 2 October 2019 to prevent seed set and further water use.

What does this mean?

Whilst some species were shown to grow more vigorously and/or produce more biomass, this is only one measure of the effectiveness of cover crops. The most important factor to consider is their benefits to the following crop. Cover crops can improve soil health, nutrient cycling, organic carbon, and soil moisture; decrease weed populations and increase the population of beneficial insects, however these benefits may not be measurable after only one phase.

The trial will be sown to wheat in 2020 to evaluate the impact of each cover crop option on crop performance. The amount of crop residue and ground cover will be assessed prior to seeding, as will soil moisture, organic carbon and chemical fertility.

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