

Innovative Carbon Storage and Nitrogen Management Strategies in the WA Wheatbelt: Green Manuring in Latham

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Fast Facts

- Green manuring gave alternate weed control.
- Green manuring increased yields.
- Green manuring increased soil organic matter from 0.2% to 1%.

Farm Details

FARM NAME	Elserae Agriculture
FARMERS	Brian and Tracy McAlpine
LOCATION	Latham
AVERAGE RAINFALL	340mm
FARM SIZE	Total size - 8500ha Arable - 7200ha
ENTREPRISE MIX	100% cropping – mix of wheat, canola, barley, lupins
SOIL TYPES %	60% sandy loam, 20% gravel, 15% red clay, 5% red loam



Aim

Increase soil organic matter to build and maintain soil health.

Farmers Perception of Green Manuring

The McAlpine's believe that the return of crop residues to the soil is a good way of increasing soil organic matter that has been reduced over time. As a result they adopted green manuring as part of their farming system from 1995 to 2002.

Farmers Prediction of the Future of Green Manuring

"Young farmers should be testing the boundaries and that's what we were doing back then, productivity in the 90's was incredible because we had the opportunity to improve soil health". Today it is more difficult, due to not having a profitable legume crop. "Clearly soil health is still important. It's very important to keep striving to maintain and improve soil health". Brian believes that new technology such as WeedSeeker's, a drying climate and increasing weed resistance will possibly make green manuring economically attractive in the future.

Background

Green manuring is a management strategy that involves the integration of 'green' plant residues into the earth (Peltzer, 2014). This normally occurs at or around flowering through incorporation, most commonly using offset discs. Green manuring can provide very effective weed control (up to 98% seed set control) and can be used when employing a range of strategies to target herbicide resistance (Hoyle et al. 2002). Green manure crops are grown for multiple reasons as they have the potential to improve soil health through increased soil organic matter which in turn provides ground cover from wind erosion and rehabilitates soil structure, improve water holding capacity (WHC) along with depleting the weed seed bank and managing disease (Brockman, 2015). In order to achieve weed control and avoid seedset,

the manuring has to be timed correctly. If green manuring, it should be implemented earlier than brown manuring as the seed will be able to persist in its development, remain viable and add to the following years seed bank (Storrie, A. M. 2014).

Soil quality in many areas of the state has exhibited fertility and structure decline due to agricultural practices (Hoyle et al., 2002). Green manuring is a practice that can potentially help remediate these areas by increasing organic matter inputs to soils. Soil organic carbon is essential to maintain the chemical, physical and biological fertility of soils (Chan, 2008). It aids in the decomposition of important nutrients, improves water holding capacity, gaseous exchange, water infiltration, and root growth as well as providing a food source and habitat for important microorganisms (Chan, 2008). Green manuring is most economically viable and effective in areas that are experiencing continued decline in grain production and viability (Hoyle et al. 2002). Legumes are comparably the most profitable plant type to grow for green manuring due to their contribution to soil nitrogen (Hoyle et al. 2002, DAFWA 2013).

Soil type is an important factor to consider as loamy to clayey ground has an innate ability to sequester carbon due to the clays ability to bind to and slow the degradation of the organic carbon from organisms that lead to decomposition (DAFWA, 2013). It is important to choose the right crop for manuring as higher C:N ratios may lead to the nitrogen becoming tied up and subsequently lead to lower yield gains (Hoyle et al. 2002). Legumes are a commonly used crop for green manuring in Western Australia as they fix nitrogen and the opportunity cost is lower than growing a cereal (DAFWA, 2013).

Adoption process

The McAlpine's had been building their knowledge around soil health, seeking out the information that they needed to help make a decision. "It was before the Liebe Group, so we had to be a lot more active in looking up information and we went to a lot of field days".

As Brian learnt more about soil health and began to understand the science behind green manuring, he became convinced that it was the correct option to replace sheep in their rotation. They were in the process of destocking 1,500 breeding ewes. Over the years the McAlpine's have tried sheep, green manuring, chaff carts, cattle and export hay as ways to complement their cropping system. Brian believes that you are "unsustainable when continuous cropping and always have to have something different in the system".

Brian began green manuring back in 1995 and jumped on board right from the start, putting one fifth of the farm aside for this rotation. This increased each year for two reasons, a) as he grew in confidence with the decision and b) as the farm expanded (approximately 300ha in 1995 to 1,200ha by 2002).
Rotation at the time: Green manure, canola, wheat, lupins, wheat.

Why?

There were a number of limitations on the farm that were coming to light with the advancement of soil testing analysis and their greater understanding of the whole system. Acidity and subsoil compaction were big issues which were having a negative impact on the organic matter levels (soil tests were showing organic matter levels of 0.2-0.3 %). Brian and Tracy were in transition from livestock and they saw green manuring as a viable inclusion in their rotation.

From Brian's increased understanding of soil health he knew that organic matter can increase the water holding capacity (WHC) up to six times that of soils that had low organic matter levels. Yields weren't at their water use efficiency (WUE) potential and Brian and Tracy saw green manuring as a way to improve

their soil health. Legumes with pasture grasses were the quickest way to increase the organic matter and the fact that they are nutrient fixing added to their advantage as nutrient levels were also a concern. "All I needed to do was get an increase of 0.2 t/ha of canola the following year and 0.1 t/ha increase in wheat the year after, to justify the green manure investment".

Benefits

- Increased organic matter.
- Alternative weed control.
- Increased water holding capacity (WHC).
- Increased water use efficiency (WUE).
- Increased yields.

Disadvantages

- Opportunity cost.
- Can increase acidity when green manured if nutrients leach.
- Water recharge.

How?

Paddock Action Manager was used to run the economics - \$100/ha in variable costs (fuel, depreciation, repairs, fertiliser and herbicides) however no opportunity cost was included in the analysis. At the time lupin's were one of the McAlpine's most profitable crops so the opportunity cost was significant. Brian and Tracy also went to the expense of purchasing a 22ft tandem disc plough.

The McAlpine's sowed lupins at 70 kg/ha in the paddocks that were to be green manured. Prior to seeding they spread 100 kg/ha of super copper, zinc and molybdenum. Lupins were grown to late flowering which occurred at the end of August, allowing time for nodulation and therefore provided an added nitrogen benefit. To combat the risk of leaching bringing down the pH they applied 1.2 t/ha of lime before ploughing it in.

Why did they stop?

There were two main factors that influenced Brian and Tracy to stop green manuring in 2002. This period was when drought really started to come into play and they had also hired a new consultant. Their consultant brought it to their attention that they had not taken the opportunity cost into consideration when working out the cost/benefit analysis of green manuring. Given the droughts, they were not making a return on investment (ROI), so 2002 was their last year of green and brown manuring.

The McAlpine's found it difficult to keep the summer weeds under control after green manuring a paddock. This was a side effect from the green manuring that they hadn't anticipated. Radish in particular was a problem, as it was germinating after the paddock had been ploughed in and had access to the nitrogen that had been released and the big moisture bank.

Results

The McAlpine's were able to raise their organic matter levels to approximately 1%. Four to five tonnes of biomass was produced on average each year. They had higher yielding crops following green manuring due to increased WHC and WUE.

Other practice change came out of the green manuring such as increased deep ripping and liming along with using soil tests to get a good indication of their farms soil health.

Comments/Summary

Brian and Tracy believe that they have made a ROI but they acknowledge that given the years they were green manuring they would have made a bigger ROI if they had harvested the lupins, given the pricing of lupins at the time. "Through the 90's it was wet, so we didn't benefit as much as you could now in the dry years". Now that soil health has improved, cereals are yielding better than lupins.

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