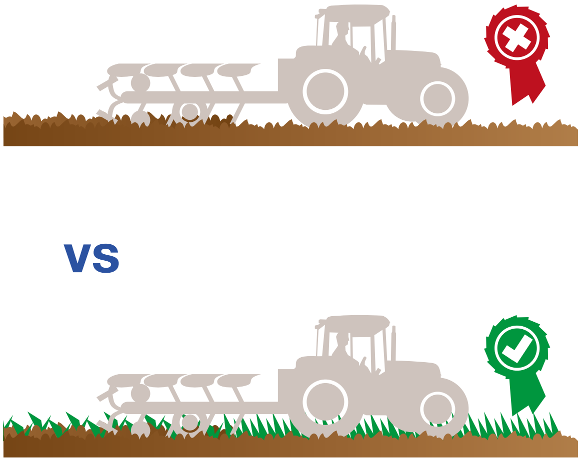
GOVERNMENT OF WESTERN AUSTRALIA
Department of **Agriculture and Food**
Department of **Regional Development and Lands**
ROYALTIES FOR REGIONS

Carbon Farming in WA

Fact sheet No. 7

PRACTICE: **Green and brown manuring as part of carbon farming**

Description of practice



Green manuring and brown manuring are practices where plant material is returned to the soil to improve soil fertility, conserve soil water, reduce weed and disease burdens, and increase soil organic matter. These practices can be included as part of carbon farming, given their potential to increase soil organic matter. Increased stored soil organic carbon would help to offset greenhouse gas emissions, increase farm productivity and potentially create offsets under the Emissions Reduction Fund (ERF). Green manuring has a very long history of managing weeds and building soil fertility in systems where herbicides are not an option or not available, such as in organic farming systems.

The Department of Agriculture and Food, Western Australia has published fact sheets and bulletins (DAFWA 2004, DAFWA 2009a and 2009b) on green and brown manuring, which show a number of benefits and practicalities of these farming approaches. More farmer experiences, research and field trial information are available on the Western Australian No-Tillage Farmers Association (WANTFA) website.

Practicalities to consider include: 1) timing; 2) the crop species used to renovate the paddock; 3) the approach to maximising seed kill; 4) monitoring and managing regrowth; 5) economics; and 6) the long-term benefits to be achieved. Loss of income in the year that the practice is conducted must be considered but this is likely to be offset by yield and quality benefits in the subsequent cropping year.

Outline of procedure

Green manuring incorporates green plant residue into the soil with a cultivation implement, commonly an offset disc plough. It aims to kill weeds and control seedset while building soil organic matter and nitrogen status. More than one tillage pass may be required for a successful kill, and

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For more information please refer to agric.wa.gov.au

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cultivation may lead to losses of soil organic matter and cause soil structure damage.

Brown manuring is a ‘no-till’ version of green manuring, using a non-selective herbicide to desiccate the crop (and weeds) at flowering instead of using cultivation. A follow-up treatment may be required to control survivors. The plant residues are left standing, helping to retain surface cover and soil structure. Soil organic matter is increased.

A variation on brown manuring is mulching, where the crop or pasture is mowed, slashed or cut with a knife roller and the residue is left lying on the soil surface. This maximises soil surface cover to reduce wind erosion and helps to reduce soil moisture loss through evaporation. However, residues may break down more rapidly than during brown manuring because of the increased contact with soil and smaller pieces.

In Western Australia, pulses are generally the preferred crop to grow for green manuring practices as they improve the nitrogen status of the soil, and the potential foregone profit is lower relative to cereals and canola. Green manuring pulse crops, however, carries the risk of increased nitrous oxide (N_20) emissions, discounting increases in soil carbon sequestration (Louise Barton, personal communication). In some locations it may be possible to grow a summer crop—for example, broad-leafed plants such as sunflower and safflower or grasses such as sorghum and millet—for green manuring purposes, especially on sandplain soils and in higher rainfall areas (DAFWA 2004; DAFWA 2009). However, high carbon to nitrogen (C:N) ratios may tie up nitrogen and depress subsequent yields (Hoyle et al. 2003).

Work done to date

The work done to date has investigated these practices as a means to renovate paddocks or improve soil quality to increase crop yields in subsequent years. There is no research targeted at measuring soil organic carbon (SOC) increases with a view to sequestering carbon for carbon credits.

As for all other practices that aim to increase SOC and be part of a carbon trading scheme, green and brown manuring practices require data on the amount of SOC in the soil profile (usually 0 to 30 cm). This is obtained by measuring the concentration of soil organic carbon (% weight) and adjusting for bulk density (weight per unit volume of soil).

An accepted standard of measurement or method for collecting representative samples in a paddock under the ERF is not yet available. These uncertainties and cost make it difficult to establish a defensible baseline for a paddock and subsequent follow-up monitoring events to confirm change. These technical issues are part of ongoing research on SOC farming, and research findings would also apply to measuring changes due to green and brown manuring practices.

Western Australian trials (three sites) have shown soil organic content in the topsoil increasing from an average value of 1.41 to 1.81 per cent, 2.19 per cent and 2.11 per cent after one, two and three years of green manuring respectively (Hoyle et al. 2003). The decline in the third year was due to dry conditions, which reduced the amount of biomass returned to the soil via the third green manure crop. The content of SOC in rain-fed Australian farming systems is influenced (according to Hoyle et al. 2011) by soil type, climate and management factors:

- The potential content is determined by soil type. Clay soils can support higher concentrations of organic carbon than sandy soils. Soil depth, bulk density and mineralogy are other factors.
- The attainable content is determined by climate with best SOC content increases achieved in higher rainfall (that is, receiving > 500 mm per year) and lower temperature areas. In lower rainfall areas (that is, receiving < 400 mm per year), the capacity to increase SOC appears limited. High summer temperatures will lead to faster rates of decomposition.

The actual content is determined by management responses and will depend on the crop or pasture type or density. These will determine the amount of organic carbon inputs into the soil. The starting level of SOC will determine the magnitude of the response; degraded land offers the greatest potential to increase carbon storage towards the attainable limit. Soil disturbance through tillage will encourage SOC loss. Minimum tillage and no-till practices are already conducted throughout much of the cropping areas, mainly for reasons of water availability and the soil's capacity to support farm machinery traffic.

The Western Australian No-Tillage Farmers Association (WANTFA) has ongoing field trials such as investigating the impact of cover crops that are knife rolled, measuring changes over a six-year period (see WANTNA in reference list).

Current level of adoption

There is no adoption for specifically sequestering carbon. The limited data on the current level of adoption of these farming practices suggests ad hoc use when the opportunity presents, often associated with herbicide resistance problems or failed crops. There is increasing interest in these farming systems because of the benefits to soil quality and ecosystem services (Broos & Baldock 2008).

No statistics or information is collected on the extent or location of these practices in Western Australia. Specialists suggest that it is more often opportunistic and not a routine part of the agricultural system. Farmers would decide depending on the requirement to renovate a degraded paddock, to not harvest a poorly performing crop or to break a disease or weed cycle.

Economic analysis for the practice suggests that it is undertaken in years where the foregone income is minimised (that is, in poor yielding years) with only a small yield increase in the following cereal crop required to break even (Moerch & Bathgate 2000). See also reviews by Hoyle et al. (2011).

The practices may be more widely adopted as the goal of increasing SOC improves soil quality and brings economic benefits, without the need to sell carbon credits.

Adoption solely for carbon credits probably is not viable, but green or brown manuring could be one component of the overall farming system.

Carbon benefits

Currently none.

Co-benefits

- Improved soil fertility (largely observed in leguminous green manures) achieved by building soil organic matter and nutrient status, and increasing buffering capacity to moderate changes in pH.
- Reduced weed burdens, particularly when herbicides are not an option or effective, or a break is required.
- Increasing soil organic matter to improve soil structure and provide a protective cover for the soil surface: this increases water infiltration and retention, reduces wind and water erosion, and reduces the impact of extreme temperatures. Conserving soil water and disease control in high rainfall environments are also major benefits.

Opportunities

- Large areas (all cropping soils with loamy to clay surface textures) are more likely to provide greater carbon sequestration benefits because clay inherently in the soil can form aggregates that protect organic carbon from decomposition. the SOC content of soils in Western Australian cropping land is low—between about 1 per cent and 4 per cent with a mean of about 2 per cent (ASRIS 2007). There is limited data on manuring practices to increase SOC. The closest illustration is from conservation tillage studies that retain stubble, reduce tillage or use no-till systems. In NSW, for example, coarse calculations (Chan et al. 2010) show a carbon sequestration rate of 0 to 0.40 t C/ha/yr. Every tonne of carbon in the soil is equivalent to 3.67 tonnes of CO_2. Therefore, conservation tillage would add 0 to 1.47 tonnes of CO_2 equivalent (CO_2-e).

Risks

- There is limited data clearly quantifying the change in SOC linked solely to manuring practices that could be used to calculate a potential carbon sequestration value.
- While most farmers have the appropriate equipment and tools (for example, a tractor, sprayer and some offset disks) to undertake green or brown manuring, others will incur costs when purchasing more specialised machinery (for example, stubble rollers and mulchers).
- There will be a revenue loss from not cropping the paddock in the year of manuring, but this may be offset in future years if improved soil quality increases the performance of subsequent crops.
- These practices will likely be part of rotational cropping management for the paddock, making it difficult to isolate the component(s) of the farming system impacting on soil organic change.
- Green manuring (ploughing in) can result in increased methane production through anaerobic decay.

Case studies

- A demonstration site in the North Stirling Palinup area in 2010–11 proposed to show farmers successful techniques for renovation cropping. The aim was to improve their soil quality, to minimise the risk of soil erosion and increase SOC in the longer term. The gross margin for each technique was also assessed. Analyses and results are available by contacting the North Stirling Pallinup grower group directly.
- A demonstration site in the Albany eastern hinterland area in 2009–10 (using Sustainable Agriculture incentive funds hosted by South Coast NRM Inc. with technical specialist support from DAFWA) proposed to show farmers successful techniques for stubble mulching using an innovative roller design with offset blades to 'cut and pin' heavy stubble cover (as an alternative to burning). The stubble mulching technique was also applied to vetch and long season annual pastures for green manuring. Baseline measurements were collected for SOC and microbial biomass, with the prospect of returning in 2014–15 to evaluate the success of building SOC and microbial activity (Matthews 2011).

Key contacts – Western Australia

- Bindi Ibister, Kevin Wise and Paul O'Meara (North Stirling Palinup grower group)
- Fran Hoyle, Jeremy Lemon and Tim Overheu (DAFWA)
- Dr Ken Flower (WANTFA)
- Private agricultural / agronomy consultants

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