SOUTHERN
MIDLANDS
COUNCIL

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Committee Secretary
Standing Committee on Primary Industries and Resources
PO Box 6021
House of Representatives
Parliament House
CANBERRA ACT 2600

Submission to the Inquiry into the role of government in assisting Australian farmers to adapt to the impacts of climate change

Introduction

The Southern Midlands Council is located in the heart of Tasmania's fine wool producing and dry-land cropping agricultural country. The economy of the municipality is directly dependent upon the ongoing health and financial viability of the agricultural sector. In recent years this sector has been struggling due to a long drought and unprecedented soil dryness. There is growing awareness within the community that the conditions we are currently experiencing in the Midlands are consistent with the predictions for climate change and that conditions are likely to become gradually warmer and drier. This situation means there will be dire consequences for agriculture in the region as most enterprises are currently operating at close to the minimum moisture and rainfall thresholds that enable traditional practices to be viable.

To this end, Southern Midlands Council has given some commitment to addressing climate change. A municipal climate change strategy has been developed, an important part of which is assisting the local agricultural sector to adapt to the consequences of climate change. Early work in this area is relevant to the first two terms of reference of the Inquiry and associated points are made below.

Points made in relation to Terms of Reference 1 (current & prospective adaptations) and 2 (role of government) of the Inquiry

A proven way for farmers to buffer against the drying effects of climate change is to increase the soil's capacity to hold and retain moisture. Adopting techniques that build soil organic carbon can fulfil this function.

Soil organic carbon has a well recognised and important role in agricultural fertility, productivity and moisture retention. For example, in terms of moisture retention:

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- humus (a component of soil carbon) can hold approximately four times its own weight in water;
- increasing soil organic carbon by 1%[1] will allow the soil to hold an extra 144,000 litres of water per hectare[2]; and
- studies have shown that an increase in the organic carbon proportion of soil by 1% is equivalent to having an additional eight inches (200 millimetres) of rain each year[3].

The farm management techniques proven to build soil organic carbon are relatively simple, have worked elsewhere in Australia, have reduced farm costs and improved farm profitability. The techniques for building soil organic carbon form the foundation of Council's approach in working with farmers to adapt to climate change. We believe that widespread adoption of the techniques will build the resilience required in order for agricultural lands to remain productive under warmer, drier conditions.

Technical details in regard to building soil organic carbon and associated 'pasture cropping' are given in the report attached as **Appendix 1** – 'Improving soil health in a drying environment'. This report is currently on Council's web site[4] and is being circulated to Midlands farmers who are willing to consider and potentially adopt the practices.

We believe that the soil carbon building techniques are so valuable in terms of soil productivity, buffering against climate change, and sequestering potentially large volumes of carbon[5] that:

- government resources should be allocated to appropriate rural and regional bodies to set up demonstration sites and disseminate promotional material about carbon farming and pasture cropping; and
- financial incentives should be provided as a mechanism to entice farmers to adopt and maintain the appropriate techniques.

Yours faithfully

Dr Graham Green
Environmental Officer
Southern Midlands Council Landcare Unit

[1] NB – This represents a 25% increase in a soil with an organic carbon content of 4%.
[2] www.peatssoil.com.au/WaterAndCarbon
[3] 'All primed for carbon storage'. Stock & Land January 1 2009, p2.
[4] www.southernmidlands.tas.gov.au
[5] Research has shown that an increase in soil carbon of just 0.5% over 2% of Australia's agricultural land could sequester all of Australia's annual greenhouse gas emissions

APPENDIX 1

Improving soil health in a drying environment

CLIMATE CHANGE PROGRAM – CARBON FARMING

SOUTHERN MIDLANDS COUNCIL

By Graham Green

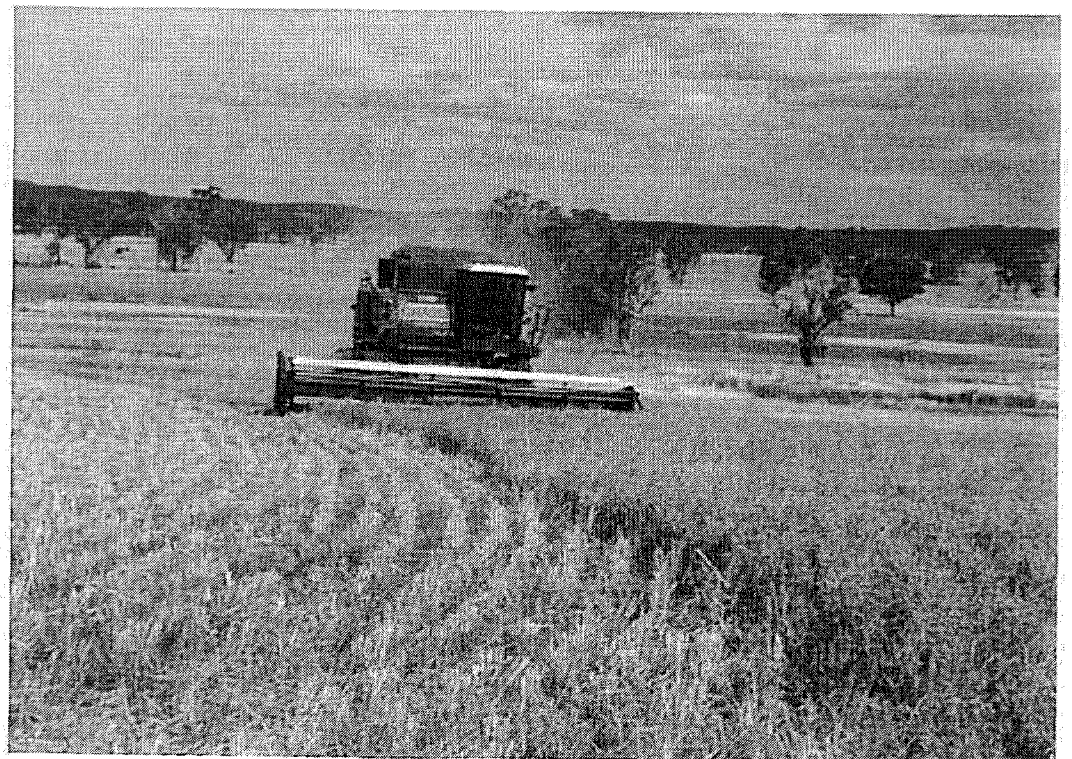

Photo sourced from: www.winona.net.au/farming

For more information and reports in regard to climate change in the Midlands visit the web site www.southernmidlands.tas.gov.au or contact Graham Green on 0422936027

Contents

1.0 Introduction

This report was compiled as part of the Climate Change Program at Southern Midlands Council. The report is aimed at assisting farmers involved in dry land agriculture to remain viable in the face of declining rainfall, predicted increasing temperatures and unprecedented soil dryness.

Statistics show that the average annual rainfall in Tasmania's midlands is in decline and that the soil moisture index is currently at a record low. Rainfall patterns have become random and there is no guaranteed autumn or spring break.

The unprecedented drying of the landscape and occasional complete loss of ground cover has at times led to soil loss. Landscape stress of this kind can lead to the loss of soil carbon to the atmosphere as CO_2. Loss of soil carbon also means considerable reduction in the soil's capacity to retain moisture such that a feedback loop to progressive drying can occur.

Aside from attaining a reliable external source of water, a proven way for farmers to buffer against the drying effects of climate change is to increase the soil's capacity to hold and retain moisture. Building soil organic carbon can fulfil this function. The techniques required to build soil organic carbon are relatively simple and have worked elsewhere in Australia. There is no reason why the techniques can't be applied in the Midlands.

The material presented below highlights the important role soil organic carbon has in agricultural fertility, productivity and moisture retention. The report presents practical ways in which soils may be restored using 'carbon building' and 'pasture cropping' techniques.

2.0 Building soil organic carbon

2.1 Background

Soil organic carbon is one of the largest global stores of carbon. The world's soils hold three times as much carbon as the atmosphere and over four times as much carbon as the vegetation[1].

Soil organic carbon can make up more than 15% of the total soil mass, but in agricultural soils it is usually less than 5%. Healthy perennial pastures can produce some of the most carbon rich soils and may contain up to 350 tonnes of organic carbon per hectare[1].

Agricultural management techniques have a strong bearing on whether soils become depleted in organic carbon (and hence contribute to atmospheric CO_2 concentration) or become a net accumulator of carbon (hence becoming an asset for soil health together with reducing atmospheric CO_2).

Around 50-80% of the carbon has been lost from the topsoil in many farmed soils, sometimes as a direct result of the loss of the soil itself[1] but more often as a result of the following practices:

- loss of perennial groundcover;
- intensive cultivation;
- bare fallows;
- stubble burning and pasture burning; and
- continuous grazing.

2.2 Types of soil organic carbon

Soil organic carbon can be present in many different forms, both living and non-living. The living forms of soil organic carbon (plants, soil fauna and microbes) facilitate the development and accumulation of the non-living forms (Table 1) which are so important for soil health. Constant growth of root matter and production of crop residues is important because a component of this organic material may be incorporated into the soil and continually broken down into smaller particles. Particulate organic carbon is a building block for the formation of humus which resists further decomposition and is essential to the fertility of the soil.

[1] Jones C. (2007). Australian Soil Carbon Accreditation Scheme. 'Managing the Carbon Cycle', Katanning Workshop March 2007.

Table 1: Some types of soil organic carbon (non-living)

Organic Carbon Category	**Description & properties**	**Longevity**
Crop residues	Plant residues less than 2 mm residing on and in the soil.	Unstable (<1 year) – although the carbon in this material is exchanged readily to the atmosphere as CO_2, some may be incorporated into the soil.
Particulate organic carbon	Individual pieces of plant debris at an early stage of decay that are smaller than 2 mm but larger than 0.053 mm.	Relatively unstable (1-10 years) and may be easily lost to the atmosphere if exposed to sunlight and air through disturbance (e.g. ploughing).
Humus	Decomposed materials less than 0.053 mm that are dominated by molecules stuck to soil minerals. Its chemical structure provides a large surface area for chemical reactions and water holding.	Relatively stable long-term store of carbon (10-100 years).
Charcoals/biochar	Burned organic matter produced naturally or through industrial process (pyrolysis). Resistant to chemical and biological reactions. Extremely high surface area provides great capacity for water holding and habitat for soil microbes.	Very stable long-term store of carbon (100-1000s years).

2.3 Benefits of soil organic carbon

The presence of soil organic carbon provides a number of benefits including:

- improved soil structure and lower bulk density;
- improved infiltration of water;
- significant enhancement of water retention and water holding capacity of soil;
- greater sequestration of nitrogen and sulphur;
- enhanced availability of phosphorus and trace elements;
- provision of energy required to drive microbial activity;
- buffering changes in pH and stabilising positive ions such as sodium[2];
- reduced inputs, reduced costs; and
- increased productivity.

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[2] Baldock J & Broos K. Can we build-up carbon and can we sell it? Australian Grain May-June 2008.

2.4 Moisture holding capacity of soil organic carbon

Dry land farming regions (those with less than 500 mm of average annual rainfall) are particularly vulnerable to the effects of a warming climate as they are already close to the minimum threshold moisture requirements that allow viable farm systems. Maintaining or increasing soil organic carbon can provide the extra moisture buffering capacity required in the face of a drying climate due to the following reasons:

- Soil organic carbon holds water due to its high surface area and ionic exchange properties;
- Humus can hold approximately four times its own weight in water;
- Soil rich in organic carbon is likely to have good structure enabling the holding of water within the spaces between soil particles;
- Increasing soil organic carbon by 1% may allow the soil to hold an extra 144,000 litres of water per hectare[3]; and
- Studies have shown that an increase in the organic carbon proportion of soil by 1%[4] is equivalent to having an additional eight inches (200 millimetres) of rain each year[5].

2.4 Ways to build soil organic carbon

Management options for increasing soil organic carbon include:

- **Maintaining vegetation cover.** Green plants are the link between the atmosphere and the soil and provide the way into the ground for organic carbon. Hence it is important to have large volumes of fibrous roots in the ground at all times of the year, even in cropping enterprises[6]. Permanent ground cover also buffers soil temperature, inhibits weeds, slows evaporation and reduces erosion.
- **Minimising tillage.** Excessive soil tillage increases exposure of organic carbon to the air and sunlight and enhances the processes by which it is broken down and converted to CO_2. Excessive tillage will increase evaporation of soil moisture and enhance the possibility of soil loss by erosion.
- **Retention of crop residues.** Crop residues such as stubble reduce the possibility of erosion and are an important initial building block of soil organic carbon.
- **Rotational grazing.** Large mobs of sheep are used in a rotational grazing method that creates litter and effectively manages weeds and may prepare the ground for subsequent cropping if desired.
- **Use of carbon rich amendments.** Application of fertilisers and soil conditioners such as: organic fertilisers; green manure crops; inoculants that promote the growth of soil

[3] www.peatssoil.com.au/WaterAndCarbon
[4] NB – This represents a 25% increase in a soil with an organic carbon content of 4%.
[5] 'All primed for carbon storage'. Stock & Land January 1 2009, p2.
[6] Jones C. (2007). Australian Soil Carbon Accreditation Scheme. 'Managing the Carbon Cycle', Katanning Workshop March 2007.

microbes[7] ; or biochar' a manufactured charcoal product that is an excellent soil conditioner with long lasting effect.

3.0 Perennial cover cropping (pasture cropping)

Pasture cropping is a land management method where cropping and grazing are combined into a single technique with each enterprise enhancing each other economically and environmentally[8]. The process of pasture cropping involves direct-drilling an annual grain crop without herbicide into dormant perennial groundcover. The practice enhances plant-microbial associations, vastly improves rates of biological nitrogen fixation, stimulates nutrient cycling, facilitates sequestration of highly stable, humified soil carbon and promotes formation of new topsoil[9].

Perennial cover cropping (pasture cropping) is becoming more widely adopted in Australia and has been implemented in most states with outstanding success. On the mainland a grain crop is largely sown in winter while the perennial grasses are dormant. Additionally, there were good results in Victoria and New South Wales by sowing summer forage crops into winter dominant native perennial pastures. This is likely to be the most effective technique for adoption in Tasmania.

Cropping into dormant perennial groundcover is a one-pass operation that markedly reduces fuel costs and largely eliminates the need for fossil-fuel based herbicides, fungicides and pesticides. Perennial cover cropping has many similarities to annual cover cropping, but brings with it the ecosystem benefits of perennial groundcover. The practice of perennial cover cropping was inspired by the highly innovative integrated cropping and grazing technique of 'pasture cropping' initiated by Darryl Cluff over a decade ago[8].

Large volumes of soluble carbon are fixed in green leaves during photosynthesis, transferred to roots and then to soils via mycorrhizal fungi. After grain harvest, the warm-season native perennial pasture will activate and continue to build soil carbon over the summer period[8].

3.1 Benefits of pasture cropping

A change to farming in a perennial base has many advantages, including:

- same or better yield than chemical fallow or cultivation-style farming;
- fewer inputs, resulting in higher gross margins per hectare;
- less reliance on fossil fuel-based fertilisers and farm chemicals;
- enhancement of natural soil building processes;
- 'reverse' carbon footprint - more carbon sequestered than emitted;
- 'reverse' nitrogen footprint - more nitrogen fixed then emitted;
- increased water use efficiency due to lower evaporative demand;
- improved soil water balance due to hydraulic lift and hydraulic redistribution;

[7] 'All primed for carbon storage'. Stock & Land January 1 2009, p2.
[8] Seis C. (2008) www.winona.net.au/farming.html
[9] Jones C. (2008). Our soils, our future. www.amazingcarbon.com

- no bare soil for weeds to grow - paddocks virtually weed-free;
- reduced financial risk - no expenditure if a crop is not sown;
- additional income stream from harvest and sale of perennial grass seed; and
- little or no requirement for cultivation or herbicide application.

3.2 Pasture cropping case study

The following information is derived from www.winona.net.au/farming.html and highlights Colin Seis' experience with pasture cropping on his property "Winona" at Gulgong in New South Wales.

The idea of pasture cropping was initiated over 15 years ago and since that time Colin Seis, on his Winona property, has spent much of his time perfecting the technique and now also conducts workshops educating other landholders on the methodology. This development of the pasture cropping system over the years has led many different types of winter and summer growing crops being grown without destroying the perennial pasture base.

It may appear that pasture cropping is simply a cropping technique. It is much more than that. Pasture cropping is the combining of cropping and grazing into one land management system where each one benefits the other. The potential for profit and environmental health in being able to do this are enormous and a lot of landholders in many regions of Australia are showing this to be the case.

The original concept of sowing crops into a dormant stand of summer growing native grass, like red grass (bothriochloa macra) was thought to be a very inexpensive method of sowing oats for stock feed. This certainly turned out to be true, however it was quickly learnt that there were many side benefits and that we were only touching the surface of a land management technique that is proving to be revolutionary. The grazing crops performed so well that it was obvious that we could expect to harvest good grain yields as well. Enhancement of the pastures was also another very real and tangible benefit.

Over the years there were more advances with the technique where cereal crops in New South Wales, South Australia and Victoria were sown into winter growing native perennial grass with good results such as oat crops yielding over 3 tonnes/hectare. Additionally, there were good results in Victoria and New South Wales sowing summer forage crops into winter dominant native perennial pastures. As a direct result of the ongoing work and the landholder education these same pasture cropping methods are being used to good effect in places such as Scandinavia, the United States and some South American countries.

It was also learnt that sowing a crop in this manner stimulated perennial grass seedlings to grow in numbers and diversity giving considerably more tones/hectare of plant growth. This produces more stock feed after the crop is harvested and totally eliminates the need to re-sow pastures into the cropped areas. Cropping methods used in the past require that all vegetation is killed prior to sowing the crop and while the crop is growing.

From a farm economic point of view the potential for good profit is excellent because the cost of growing crops in this manner is a fraction of conventional cropping. The added benefit in a mixed farm situation is that up to six months extra grazing is achieved with this method compared with the loss of grazing due to ground preparation and weed control required in traditional cropping methods. As a general rule, an underlining principle of the success of this method is "One hundred percent ground cover One hundred percent of the time".

To illustrate this, below are the details of a 20 hectare crop of echidna oats that was sown and harvested in 2003 on Colin Seis' property "Winona". This crop's yield was 4.3 tonnes/hectare (31 bags/ acre). This yield is at least equal to the district average where full ground disturbance cropping methods were used.

Costs / hectare

Spraying	\$ 5.00
Herbicide	\$14.00
Sowing	\$ 7.19 (own equipment - note contract sowing rates currently valued as \$20/ha)
Fertilizer	\$35.00
Harvest	\$28.00
TOTAL	\$89.19

Yield 4.3tonne/ ha

Value \$150/tonne (value at Dec 2003)

Total \$645 / Ha (\$150 x 4.3)

PROFIT \$555.81/Ha

This profit does not include the value of the extra grazing. On Winona it is between \$50 - \$60/hectare because the pasture is grazed up to the point of sowing. When using traditional cropping practices where ground preparation and weed control methods are utilised for periods of up to four to six months before the crop is sown then no quality grazing can be achieved.

Other benefits are more difficult to quantify. These are the vast improvement in perennial plant numbers and diversity of the pasture following the crop. This means that there is no need to re-sow pastures, which can cost in excess of \$150 per hectare and considerably more should contractors be used for pasture establishment. Even more difficult to calculate are the environmental benefits of leaving a grassland intact by maintaining one hundred percent ground cover one hundred percent of the time.

There is growing evidence, anecdotal and scientific, to support improvement in soil health, improved water use efficiency and general improvement in ecosystem function. Another asset is that these methods lead to a measurable increase in soil carbon levels which may produce both a cash value in future carbon trading schemes as well as playing a role in reducing atmospheric carbon dioxide.

Independent studies at Winona on pasture cropping by the Department of Land and Water have found that pasture cropping is 27% more profitable than conventional agriculture this is coupled with great environment benefits that will improve the soil and regenerate our landscapes.

The CSIRO have also taken pasture cropping seriously investing in a three-year trial project that was conducted by Dr Sarah Bruce *et al* on Winona. Water use efficiency, improved soil health, nitrogen use efficiency and weed control were some of the positive outcomes. Winona now carries more stock using pasture cropping methods than at the height of the "Superphosphate cycle" of the 1960's style of improved pastures with a huge reduction in input costs.

Until this point in time pasture cropping has been practiced with the use of chemicals to control weeds and conventional fertilizers are used to manage soil chemistry, but some crops are being now sown without these inputs. The pasture cropping technique can be used to grow organic crops. This can be done without using a plough or destroying existing perennial pasture.

The benefits of pasture cropping are enormous, way beyond the short-term crop yields. It gives farmers and graziers a tool to effectively manage their properties whilst individually contributing to a healthier environment. It is the difference between the poorly used term "sustainable" and the better objective "regenerative agriculture".

For more information on pasture cropping visit www.winona.net.au/farming and www.amazingcarbon.com

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