"Inquiry into Climate Change and the Australian Agricultural Sector"

Senate Standing Committee on Rural and Regional Affairs and Transport.

Submission by Tim Wiley[a] and Bob Wilson[b]

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" The views expressed in this submission are the personal ones of the authors, Tim Wiley and Bob Wilson, and do not necessarily represent the views of either the Department of Agriculture and Food Western Australia or the Evergreen Farming Group Inc. The authors have submitted this document to contribute to, and stimulate the discussion on the effects of Climate Change on Australia's agricultural sector."

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Inquiry Terms of reference

On 19 September 2007, the Senate referred the following matter to the Standing Committee on Rural and Regional Affairs and Transport for inquiry and report by 30 June 2008.

On 14 February 2008, the Committee resolved to recommend to the Senate that the Inquiry be re-adopted with terms of reference unchanged and with a reporting date of 4 September 2008.

i. the scientific evidence available on the likely future climate of Australia's key agricultural production zones, and its implications for current farm enterprises and possible future industries;

ii. the need for a national strategy to assist Australian agricultural industries to adapt to climate change;

and

iii. the adequacy of existing drought assistance and exceptional circumstances programs to cope with long-term climatic changes.

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Issue of Climate Change and the Australian agricultural sector

Key conclusions:

- It is highly likely that there has already been a significant reduction in rain fall in the north east wheat belt of WA due to climate change.
- Yearly rainfall at Lynton (in the Northampton Shire) this decade is 25% below last century. Plant available rainfall this decade is 39% below last century.
- Economic modelling suggests that crop yield improvements, due to better crop varieties and agronomy, will not be sufficient to keep farms economically viable in this region.
- Perennial pastures and the fodder shrub, tagasaste, have proven to be productive and to protect the soil in the extreme drought of 2006.
- Economic modelling suggests that changing from wheat growing to a faming system including winter / spring grazing of station cattle, oil mallees, occasional cropping and carbon trading may be profitable under climate change.
- Managing land solely for producing carbon credits (e.g. oil mallees) will not be profitable, but these enterprises can contribution to profit when integrated into a farming system.
- The farmers will require considerable support in terms of training and R&D to be able to implement these radical changes on their farms.
- Due to drought most farmers now do not have the finances required to implement these changes. Carbon trading could provide the equity to finance the restructuring of these farms.
- Mid West iron ore miners are prepared to invest in R&D to develop ‘carbon farming’ systems. Other companies could also invest <u>if</u> soil carbon is recognised in the ETS.
- There is a widely believed myth that the Kyoto Protocol does not recognise soil carbon sequestration as a Green House Gas sink. In fact the Kyoto Protocol a) requires Australia to include an estimate of changes in soil carbon stocks as part of baseline 1990 accounts (Article 7), and b) makes the reporting of soil carbon mandatory in the second Kyoto Protocol commitment period (Article 3.4).
- Limited soil testing is showing that perennial pastures, ‘pasture cropping’ and tagasaste can sequester carbon at the rate of 5 to 10 CO_2e /ha/year.
- These sequestration rates are substantially above that of traditional farming systems.

- These sequestration rates do not agree with models such as RothC. Either our estimates are wrong or the models must be modified for perennial plant systems.
- Considerable research funds are required to resolve this issue.
- We hypothesise that it is improved soil biology under these perennials that drives the very high sequestration rates.
- Full GHG audits of two farms using perennials and one station using intense rotational grazing show they are net sequesters of green house gasses even with the extra emissions of methane from livestock.
- An extrapolation from this limited soil data suggests that perennial based farming systems have the potential to soak up all of WA's current GHG emissions.
- The cost of reducing emissions using perennial pastures is substantially cheaper than by using wind farms.
- Few research funds have been available for developing innovative farming methods that are drought proof and can sequester carbon.
- The limited agricultural research into soil carbon in Australia is from long term trials with farming methods that are decades out of date.
- A nationally coordinated R&D strategy is required that ensures partnerships between national institutes, state institutes, farmer groups and other resource industries (e.g. mining).
- Soil carbon could be measured and verified for trade through the ETS using a combination of a) modelled changes in carbon pool, b) a 'margin of error' discount based on the uncertainty of the estimate and c) adjustment of the tonnes sold based on periodic soil testing
- Allowing agroforestry off sets (Kyoto Protocol - Article 3.3 sinks), but not soil carbon off sets (Kyoto Protocol - Article 3.4), in the ETS may not give the maximum reductions in greenhouse gasses at the lowest cost. This could also result in Managed Investment Schemes removing large tracts of agricultural land from food production.
- Exceptional Circumstances funds are helping to keep talented farmers on the land in drought ravaged districts. However this is a short term solution to a long term problem.

i. The scientific evidence available on the likely future climate of Australia's key agricultural production zones, and its implications for current farm enterprises and possible future industries;

Climate change for northern wheat belt of WA

The first Global Climate Circulation models were constructed in the early 1980's. There were six models developed by groups of scientists around the world (include a group from the CSIRO). All these models predicted what has come to be known as 'green house gas global warming". These models all predicted that for the south west of Australia winter rainfall would decline and that there will be more extreme weather events. Enough time has now passed to test the predictions of these early climate models.

The weather data for south west of Australia clearly shows that rainfall has been on a declining trend since about 1970. This has been due to much stronger high pressure systems in winter forcing the cold fronts that bring rain further south. The northern wheat belt of WA has been the worst affected as it gets its winter rain from the tip of these cold fronts.

More recent climate models are also predicting 'climate shift'. This is where climate changes occur as a gradual trend until a tipping point is reached where the weather switches, or 'shifts' into a new pattern that is significantly different from the past. It is widely accepted that a climate shift occurred in WA in about 1970. There is now mounting evidence that a second climate shift occurred around 1999. If this is correct then the future climate of the agriculture zone of WA is represented by the weather of this decade rather than of the last century.

What has been happening in the far northern tip of the WA wheat belt may be an indicator of the climate change to come for other parts of southern Australia. The lessons learnt from this region may be the 'canary in the coal mine'. Data from the Lynton weather station in the Northampton shire and results of a project with farmers at Binnu also in the Northampton shire may be illustrative of future challenges to agriculture.

Since 1999 there have been 8 consecutive years of below average rainfall at Lynton. (This could be due purely to chance, but the odds are the same of throwing 8 heads in a row). Rainfall for the decade is 25% below the long term average, with 17 of the last 20 years having below average rainfall (Figure 1 & 2). Modelling by the CSIRO had predicted that the rainfall in this region would fall by 30% by 2050. It appears that this reduction in rainfall may have almost occurred already. Unfortunately the 4th Assessment Report of the IPCC is showing that the measured changes in the world's climate have been at or above the worst case predicted by the global climate models.

Figure 1; Total yearly rainfall for Lynton, Northampton shire which is in the north part of the Northern Ag Region of WA.

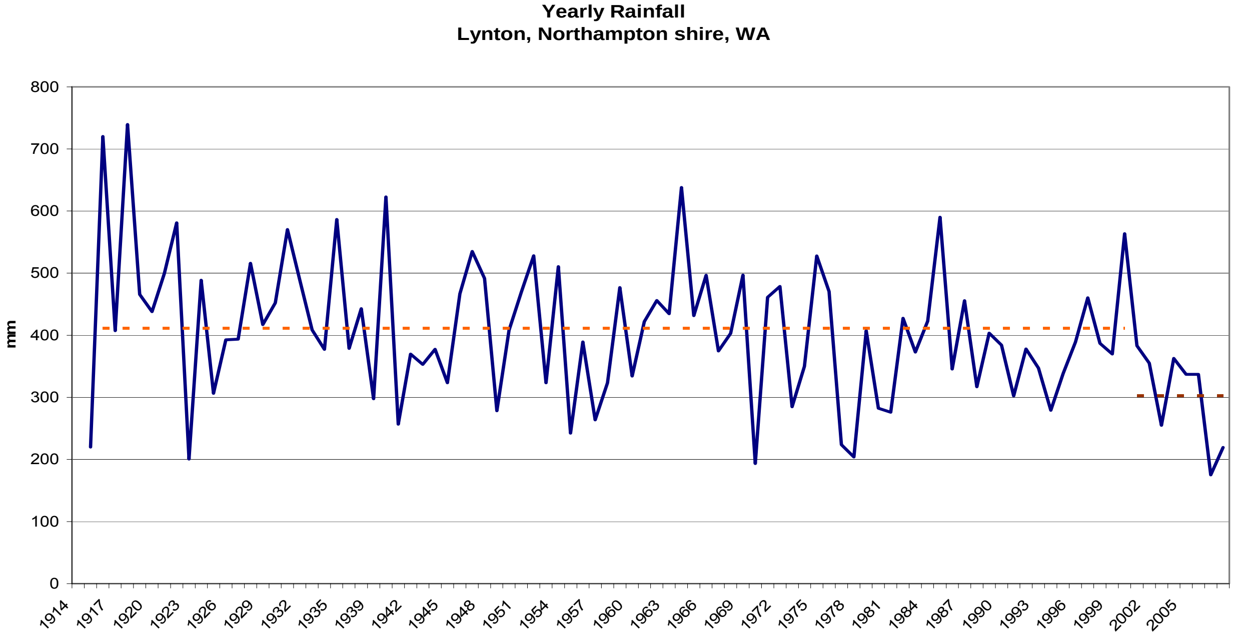
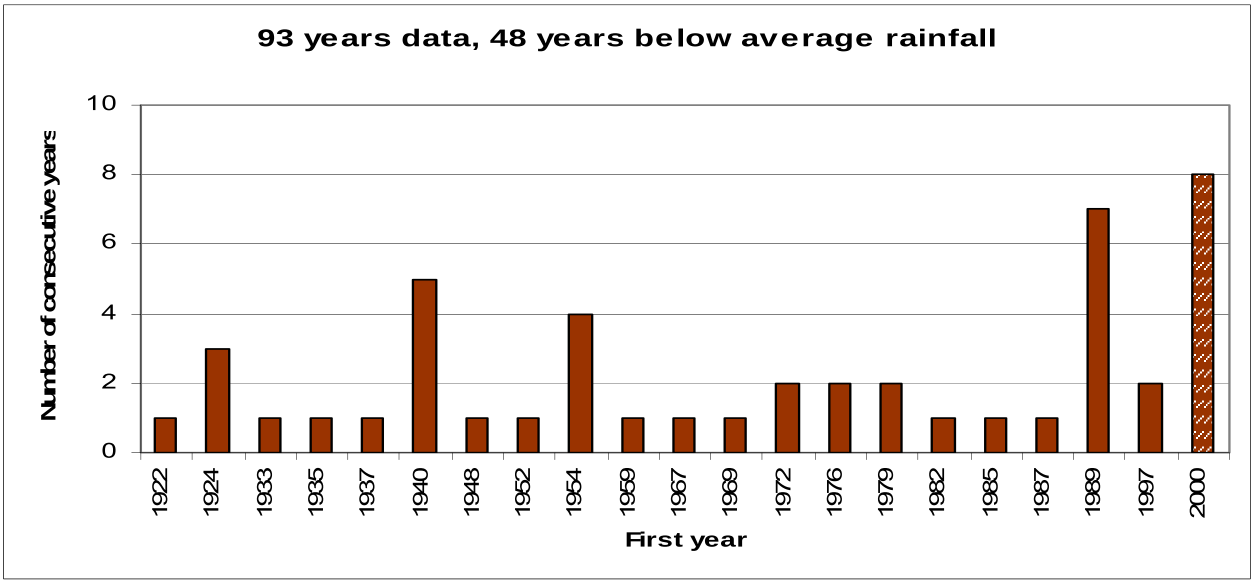
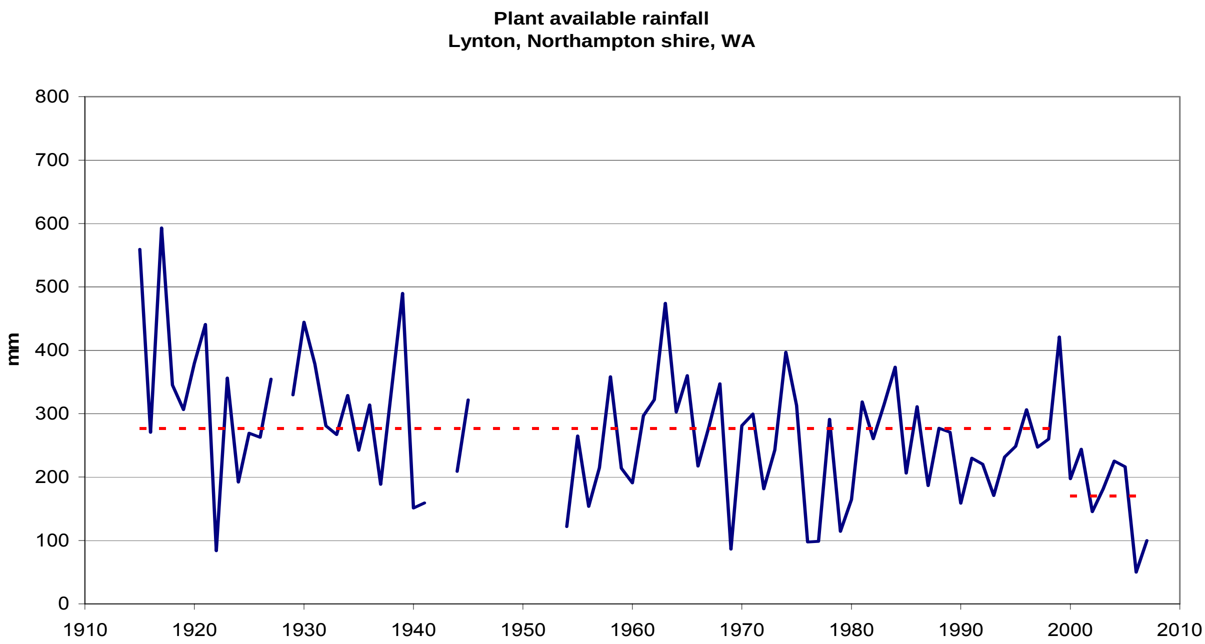


Figure 2; Number of consecutive years of below average rainfall at Lynton, Northampton Shire, WA.



Unfortunately the total yearly rainfall does not give a complete picture of the effects of rainfall on crop and pasture production. Some of the rainfall is lost to evaporation and is not available for crop and pasture production. The 'plant available' rainfall can be estimated by subtracting the like evaporation. This data shows that effective rainfall has fallen by 39% this decade compared to last century (Figure 3).

Figure 3; 'Plant available' yearly rainfall for Lynton, Northampton shire (assuming 100 mm evaporation of growing season rainfall and 50% evaporation of summer rainfall).



The northern wheat belt of WA has also experienced an extreme weather event this decade. This was the drought of 2006 which broke all records. Farmers in the Binnu region received only 90 to 140 mm for the year. There was no grain delivered from any farm, and this district became a net importer of grain for the first time ever. Stock numbers were reduced by 80% and those animals remaining had to be hand fed to get them through summer. Erosion was extreme and wide spread with almost all paddocks being affected.

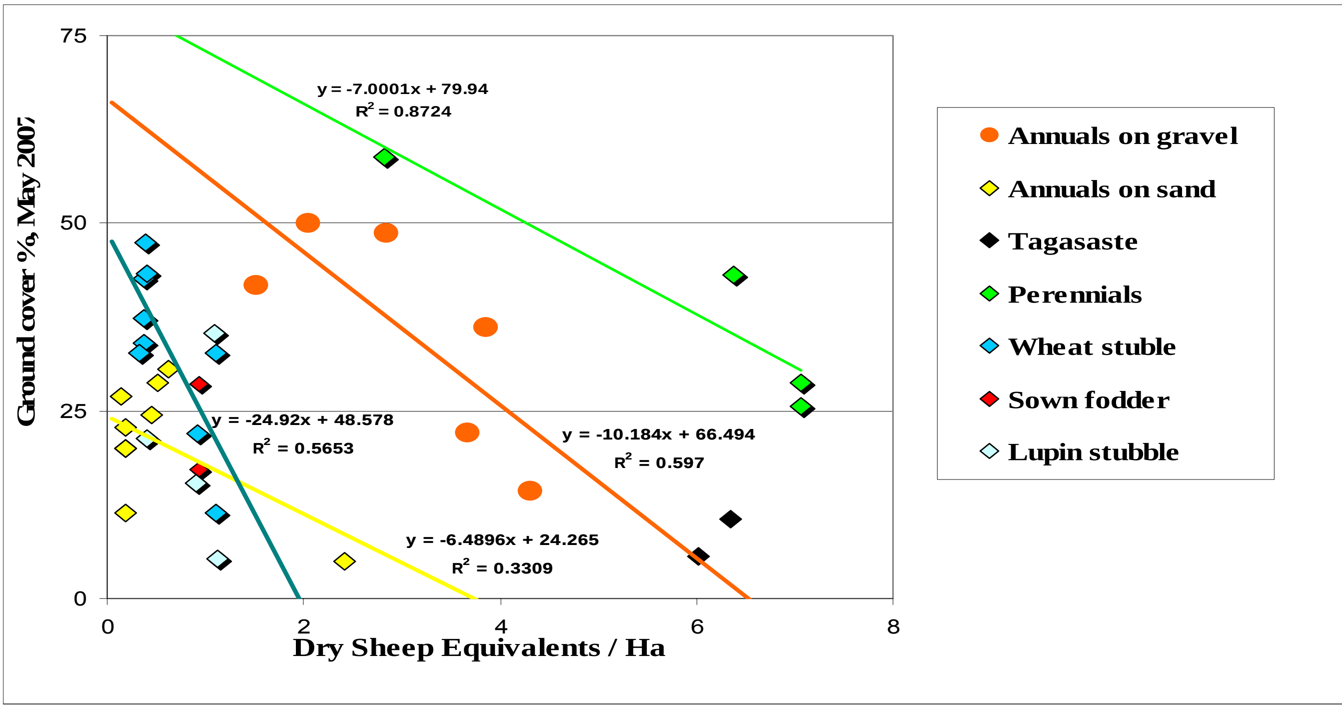
Perennial pasture and fodder shrubs in extreme drought

By chance, a project commenced that year (2006) in the Binnu district to measure pasture production (via grazing days) and ground cover in all paddocks on several farms. These farms were selected because they had adopted some type of innovative pasture system on at least one paddock of the farm. This was a collaborative project between a farmer group, the Northern Agri Group (NAG), and the Department of Agriculture & Food WA (DAFWA), with funds from the National Landcare Program (NLP) through the Northern Agriculture Catchment Council (NACC).

The results from this project showed that erosion was inevitable in 2006/07 with the traditional farming systems based on annual crops and pasture. (To prevent wind erosion there must be 50% of the ground covered with plant material). Even if these farms had been completely destocked for the whole year there would not have been adequate ground cover in any crop or annual pasture paddock. While management decisions did affect how soon wind erosion started, and how severe it was, in the end, erosion was inevitable in this extreme drought with current farming practises.

The exciting outcome of this research was that perennial pastures and fodder shrubs were still very productive and also prevented erosion. The results show that the perennials could have carried 4 Dry Sheep Equivalents per hectare for the year and still had sufficient ground cover to prevent erosion. This stocking rate would be as good as annual pastures in an average season. This project has shown that there are pasture systems that will be viable under reduced rainfall due to climate change. Farmers will be able to adapt their grazing systems to climate change, but their ability to adopt these new systems is currently limited by the large financial losses incurred this decade.

Figure 4; The effect of stocking rate averaged over 12 months on final autumn ground cover in paddocks on two farms at Binnu during the 2006/07 extreme drought (140 mm for the year).



The full consequences of the extreme droughts of 2006 and 2007 are not yet known. While wind erosion has occurred in this region in the past, the form of erosion from this drought was different to any thing seen in the past. Previously wind erosion had been focussed on patches in a paddock, and never from fence to fence. It is not known what the consequence of this type of erosion may be, but production could be reduced for decades to come.

There were also other unusual events during the drought that are unprecedented. On the 19 December 2006 there were two extreme, but localised, thunder storms in the Binnu region. On one farm 75 mm fell in two hours and completely stripped all remaining cover off the paddocks. Summer storms are not unique in this region and they always result in a germination of summer weeds after the rain. This did not occur following the December 2006 rain. The paddocks remained bare all summer despite there being moisture just below the surface. The end result was that a flash flood in the middle of a drought only made the drought worst. Even the oldest farmers of the region said that this lack of summer weeds after rain is unheard of, and they would never have predicted it could happen.

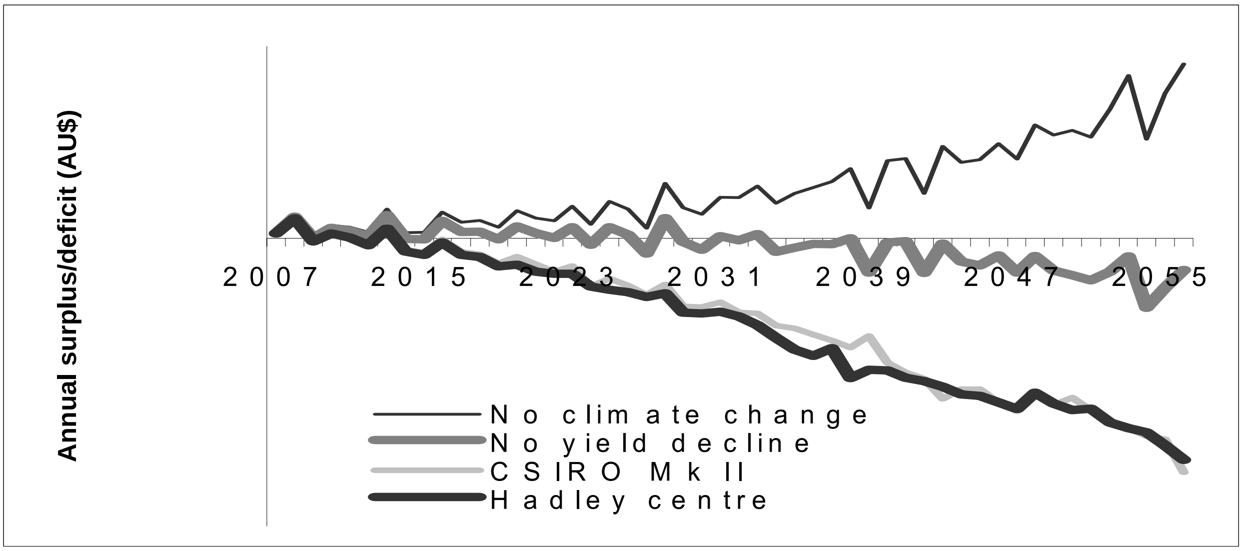
Perhaps the most import lesson from the 2006/07 drought has been that it will not be possible to predict, and therefore plan for, all the consequences of climate change. There will be surprising events for which we will have no capacity to predict in advance.

<u>Impacts of climate change on cropping</u>

Wheat yields in the northern wheat belt of WA had been increasing at 4 % per year through the 1980’s and 1990’s. This was despite rainfall declining at 1 to 2 mm per year during that time. Wheat breeding was responsible for about 1 % per year of the total 4% per year improvement. The other 3 % per year was due to improved agronomy packages and better farmer management. Since 1999 there has been a downward trend in crop yields for the first time. If the climate change predictions are right, improvements in crop varieties and agronomy will not be sufficient.

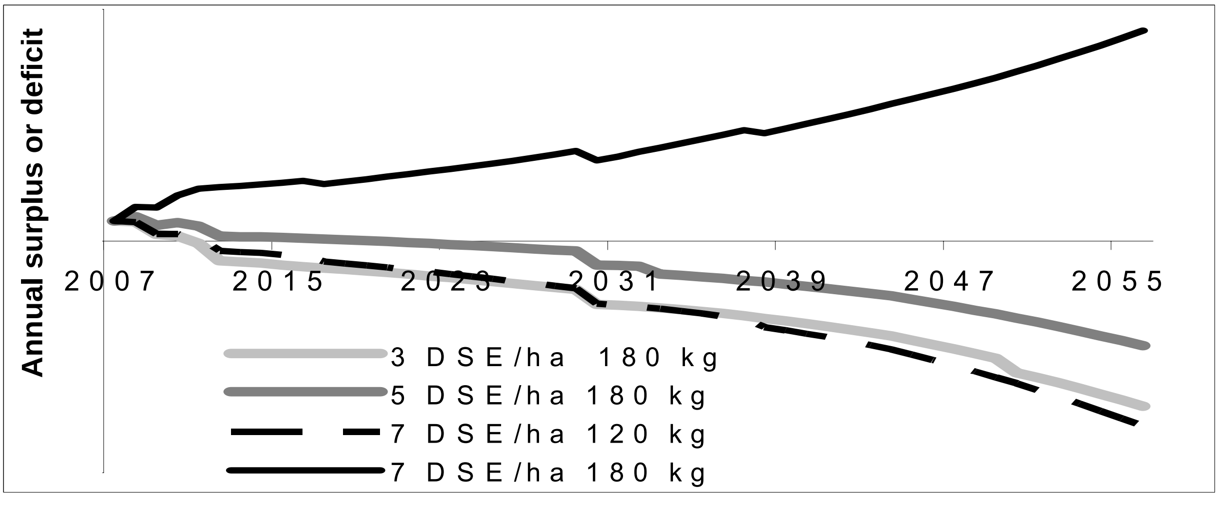
Caroline Peek and Megan Abrahams from DAFWA in Geraldton have been modelling the economic consequences of climate change on a north east wheat belt farm (Abrahams et al 2008). They have used projections of rainfall based on CSIRO and Hadley Centre models that predict a 25% decline in rainfall by 2050 (Note: we may have already reached that point). They find that cropping will not be commercially viable in the near future under the climate change predicted.

Figure 4. Annual surplus or deficit of a north eastern wheat belt farm dominated by cropping under different climate scenarios (from Abrahams et al 2008)



Abrahams et al also considered alternative enterprises that could keep farms profitable. Their modelling suggests that a grazing enterprise based on fattening and trading station cattle could be economically viable if the stocking rate and animal growth rates were high enough (Figure 5). However, their stock assumptions need to be tested in real paddocks. Also, for this significant change in farming systems to occur there will be the need for considerable training and support for farmers who have not run cattle in the past.

Figure 5. Annual surplus or deficit of a north eastern wheat belt farm in transition to a trade cattle enterprise at different combinations of stocking rate and weight gain using the CSIRO II climate scenario (from Abrahams et al 2008).



Abrahams et. al. (2008) also analysed future farming systems that included oil mallees, carbon trading and opportunistic cropping in wetter years as well as station cattle (table 1). All of these enterprises can contribute to improving farm profit. However cattle production is the main driver of profit.

Their findings suggests that managing land solely for producing carbon credits (e.g. oil mallees) will not be profitable, but these land uses can contribute to profit when integrated into a farming system. In more detailed analysis of oil mallees they found that the mallees are only viable when there is a combined income from the oil, biomass for energy and carbon credits. Even then, the timing of the payments of carbon credits was critical. This is because oil mallees are very expensive to establish. However it may be possible to forward sell enough carbon credits to cover the up front establishment costs. Mid West miners have already indicated they a willing to look at this option.

Table 1; Average annual surplus or deficit of the farm over 30 years for different wheat prices, carbon returns and weight gain per head at declining (↓) or neutral terms of trade (T of T) (from Abrahams et al 2008)

	Cattle weight gain/head	120 kg		180 kg	
Wheat price* $/t	Carbon returns $/t CO_2eq	T of T ↓	T of T Neutral	T of T ↓	T of T Neutral
$165	$10	*-$50,000*	*-$33,000*	*-$16,000*	**$1,000**
	$50	*-$40,000*	*-$21,000*	*-$500*	**$16,000**
$204	$10	*-$33,000*	*-$18,000*	**$4,300**	**$21,000**
	$50	*-$23,000*	*-$7,000*	**$21,000**	**$38,000**
$254	$10	*-$13,000*	**$3,000**	**$33,000**	**$50,000**
	$50	**$2,000**	**$20,000**	**$50,000**	**$70,000**

Cattle at 3 DSE/ha, for 4 to 6 months during the growing season.
Surpluses shown in bold, deficits in *italics*. * Farm-gate price

Partnerships with local mining companies

The Mid West region of WA is at the start of a major iron ore mining boom. These mines are just inland from the north eastern wheat belt. Opportunities exist for collaboration between agriculture and mining to make each industry more sustainable. The miners will require 1) labour, 2) carbon off sets, 3) environmental off sets and 4) support from local communities and local government. Farmers will require off farm income to sustain them through drought years. Farmers' working part time on local mines has already made a valuable contribution to both industries through the recent drought.

The supply of labour will limit the growth of the mining industry in Australia. The Mid West miners recognise that farmers in the eastern wheat belt represent a pool of skilled labour on their door step. They are already working with local communities, local government and agencies such as the Department of Agriculture & Food WA to create jobs that suit local farmers. The miners also recognise that if farming does not remain profitable their potential employees will be forced to leave the district. Because of this, plans are being developed for the miners to fund agricultural research in this region.

The miners also recognise that in the future they will need carbon credits to off set the emissions from the mines. As a consequence they are particularly interested in funding research into farming systems that sequester carbon. It is hoped that the first contracts for the research projects funded by Mid West miners will be signed soon. The miners have also indicated that they are keen to contract local farmers to supply them with carbon credits.

Soil carbon and the Kyoto protocol

Farm management methods can change the amount of carbon in the soil. A decrease in soil carbon is accounted for as an increase in a countries green house gas emission (IPCC 2006). While an increase in soil carbon levels is accounted as a reduction in emission for a country. Change in the levels of soil carbon is part of the Kyoto Protocol Article 3.4 sinks. These sinks are optional in the first commitment period of the Kyoto Protocol (2008 – 2012), but are compulsory in the second commitment period of 2013 – 2017.

The methods for estimating changes to soil carbon stocks are out lined in the IPCC 2006 'Guidelines for National Greenhouse Gas Inventories'.

The Article 3.4 of the Kyoto Protocols also states that *"....each Party included in Annex I shall provide, for consideration by the Subsidiary Body for Scientific and Technological Advice, data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years*".

Also, Article 7 of the Kyoto protocol states that "*Those Parties included in Annex I for whom land-use change and forestry constituted a net source of greenhouse gas emissions in 1990 shall include in their 1990 emissions base year or period the aggregate anthropogenic carbon dioxide equivalent emissions by sources minus removals by sinks in 1990 from land-use change for the purposes of calculating their assigned amount*". The IPCC 2006 accounting methods for the 'Land use change' also includes the changes in soil carbon stocks as this is part of the '*removals by sinks'*.

IPCC 2006 guidelines recognise that countries may not have all the data needed to give an accurate estimate of emissions / sequestration for a sector. When that is the case the IPCC supplies assumptions to be used in place of detailed local data (i.e. Tier 1 assessment). As there has been so little research on soil carbon in Australia we are using the Tier 1 assumption from the IPCC which is no net change in soil carbon, or 0 tonnes of CO2e emissions/sequestration.

As a result of these factors many people wrongly assume that the Kyoto Protocol does not recognise soil carbon sequestration (or emission).

<u>Farm methods and soil carbon sequestration</u>

Valzano et al (2005) have conducted a review of all published literature on long term trials in Australia where the soils have been sampled for carbon under a range of different management practices. This review shows differences in soil carbon due to farm management practices. They found that productive pastures had the highest levels of soil carbon. Generally cropping resulted in lower levels of soil carbon than grazing (except in some situations where pastures were heavily overgrazed). With cropping, the more the soil was tilled the lower the soil carbon stocks. The review suggested that when cropping, changing from 'multiple cultivation' to 'one pass seeding' could increase soil carbon stocks by 25%. The Valzano review demonstrates that it is possible for farmers to impact on soil carbon stocks through their management decisions.

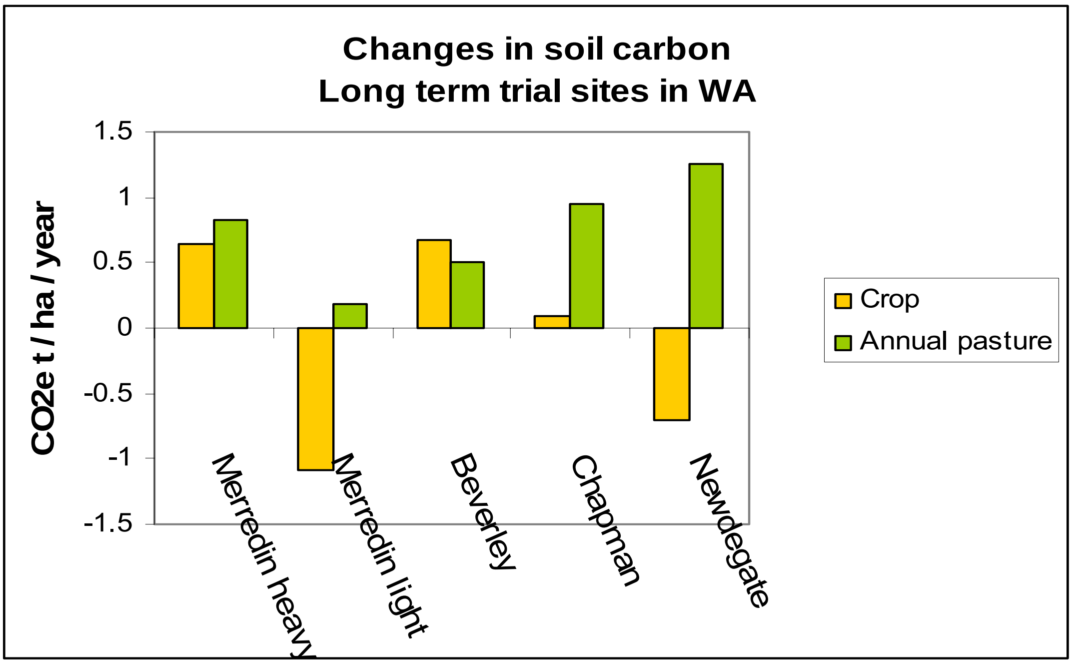
The trials in the Valzano et al review where almost entirely on annual crops and pastures. The limited research with perennial pastures showed soil sequestration rates even higher than the annual pasture. However there were no trials on sub tropical perennial grasses or any trials with perennial pastures in WA.

Recently DAFWA researchers have been taking soil samples from old perennial pasture trials and farmer paddocks in the Northern Agriculture Region of WA. We are estimating the sequestration rate by comparing the soil organic carbon under the perennials with that under traditional annual crops and pastures. The results are showing sequestration rates of, between 5 to 10 tonnes of Carbon dioxide equivalents per hectare per year (t CO2e /ha/year). This is way in excess of the sequestration rates reported for annual pastures and crops. The six long tem trials in WA reported by Valzano el at had sequestration of less than 1.5 t CO2e/ha/year (Figure 6).

Our data on the sequestration rates of perennial pastures and tagasaste have created vigorous debate in the scientific community. There is a valid criticism that there has not been sufficient numbers of samples taken for a rigorous scientific comparison. This is because we do not have an official project to fund more testing. While our data is limited, it is unfortunately the best available.

Similar rates of sequestration under perennial pastures are being found with soil testing by Dr Christine Jones in the eastern states. She also is being restricted by limited funds. Despite the intensity of sampling it is encouraging that very similar rates of sequestration by perennial pastures are being measured in a wide variety of sites across Australia.

Figure 6. Changes in soil carbon content (t CO2-e/ha) after land use change to either continuous cropping or pasture for five sites in south-western Australia (from Harper et al, 2007; data from Skjemstad and Spouncer, 2003).



Debate is also being fuelled by the fact that our results with perennials do not agree with the predictions of the RothC model. RothC is the internationally recognised model for predicting changes in soil carbon stocks for a range of environments, soil types and land uses. It was originally built to model the changes in soil carbon for a trial at Rothamsted in England that has been running for 160 years. CSIRO researchers have modified the RothC model based on some long term annual pasture and crop trials in Australia. They then tested the Australian version of RothC by seeing how accurately it could predict soil carbon levels at other trial sites. They found that RothC was accurate in predicting soil carbon levels under annual crops (Skjemstad et al 2004).

The sequestration rates being measured under summer active perennials do not agree with that predicted by the RothC model. This means that either the soil measurements are wrong or that RothC needs modifying for this class of pasture.

If the sequestration rates are as high as being suggested, this raises the question as to why. It has been suggested that perennial pastures change the soil biology in a way that increases the amount of fresh plant material that is converted into very stable humus compounds. Again there is considerable debate on the importance of soil biology in effecting soil carbon sequestration rates. Soil tests from farms using 'biological' methods of cropping and grazing are also showing exceptionally high sequestration rates. It is possible that the significance of soil biology may have been vastly under estimated. If so, then there are real opportunities to increase sequestration on Australian soils.

Increased or Decreased Farm Emissions?

While perennial pasture may be sequestering carbon in the soil there are other Green House Gas emissions from the farm. Live stock produce methane which accounts for 10% of all of Australia's emissions. Perennial pasture will increase the number of stock run, and therefore increase the emission of methane.

Whole farm Green House Gas emission budgets have been calculated for three properties that are using innovative perennial pasture and grazing systems.

Colin Seis at Gulgong in NSW has pioneered 'pasture crops' where annual grain crops are grown over the top of his native perennial grasses in a one in four year cropping rotation. Colin also uses an intense rotational grazing system (Holistic management). An audit of Colin Seis's was calculated based on the whole farm production.

Bob Wilson at Lancelin in WA has a grazing only farm. Half his farm (i.e. 1,000 ha) is established to the fodder shrub tagasaste. Bob is now in the process of replacing the other half of the farm previously planted to annual pastures with sub tropical grasses. A full carbon audit was conducted on a per hectare basis for the tagasaste and perennial grass paddocks.

Changes in soil carbon pools have been estimated for these farms using paired paddock soil sampling. For the tagasaste paddocks estimates of the carbon build up in the wood and roots was based on direct measurements of the carbon in tagasaste from another trial site. The emissions of methane were estimated from the number and class of livestock.

A web based model was used to estimate other CO2 emissions from fuel and chemical use for both farms. The net carbon emission / sequestration were then divided by the produce sold off the farm to calculate the true foot print of their farm produce. The results of the calculations are given below

Table 2; Green House Gas budget for Colin Seis, Gulgong, NSW. Native perennial grass, rotational grazing, 'pasture cropping' over native grasses 1 year in 4.

Carbon balance for whole farm	**CO2eq**	
Sequestration - Increase in soil organic carbon	-7,200 t	based on comparative soil sampling over the fence with brother using a traditional grazing systems with sheep on native perennials with occasional full cut cropping
Total farm emissions	2,200 t	based on a whole farm audit using a web based calculator
Net sequestration	**-5,000 t**	

Produce sold off farm	
Animal live weight	50 t
Wool	20 t
Grain	100 t
Total	**170 t**

It is not possible to allocate the net sequestration and emission between the different farm products, so an analysis is done on the combined farm 'produce'.

CO2eq per kilogram of product sold = net emissions (or in this case, sequestration / total produce sold

29 kg CO2eq sequestered / kg of product sold

Table 3; Green House Gas budget for Bob & Anne Wilson, Lancelin, WA. Beef production from tagasaste (1,000 ha), perennial grasses (200 ha) and annual pasture (800 ha)

Carbon balance for perennial & tag paddocks	**CO2eq**	
Sequestration - Increase in soil organic carbon	- 7.7 t/ha	based on comparing soil samples in adjoining paddocks of perennial grass & tagasaste compared with the traditional annual pasture
Paddock methane emissions	0.7 t/ha	extra methane emissions from extra stock on perennial and tagasaste paddocks
Other farm emissions	2.0 t/ha	ball park estimate
Net sequestration	**- 5 t/ha**	

Produce sold off farm	
Animal live weight	0.2 t/ha
Total	**0.2 t/ha**

CO2eq per kilogram of product sold = net emissions / total produce sold

25 kg CO2eq sequestered / kg of product sold

The ‘pasture cropping’, tagasaste and perennial grass grazing systems were calculated to be net sequesters of carbon. Consumption of food produced from these two farms would ***help to reduce*** the global warming problem, rather than contributing to it, as now being widely promoted in the public arena.

Even Pensini at ‘Cheela plains’, Paraburdoo in the Pilbara has converted some of his station from conventional set stocking on very large paddocks to intensive rotational grazing on very small paddocks. He now has 22,000 ha divided into 50 paddocks. Cattle are rotated through these paddocks based on the ‘Grazing for Profit’ method. Some paddocks are as small as 200 hectares and have been grazed with mobs of up to 1,000 head of cattle.

The intensive grazing cell was started in 1998 and paddocks have been progressively subdivided since then. Over this time there have been substantial changes in the vegetation despite mostly below average rainfall. Originally the plains had very few shrubs or trees, sparse perennial grass and large bare areas. Today there is much smaller bare patches, greatly improved perennial grass cover, many shrubs and a dense layer of litter on the soil surface. The carbon pool in the soil, litter and plants have increased significantly compared to the traditional grazing.

There has been a very substantial investment in infrastructure to enable the rotational grazing. While an investment analysis suggests this will ultimately be profitable, the up front cost will prevent many pastoralists adopting this. If payments for carbon credits were allowed this would be a much more bankable option.

Table 4; Economic and Green House Gas budget for Evan & Robyn Pensini, Paraburdoo, WA. Intense rotational grazing on fertile soil compared to set stocking the whole station.

	Set Stocked	**Rotation grazing**
Cow numbers	700	1,200
Extra CO_2e sequestered in soil & litter in top 10 cm t/year (22,000 ha)		-6,459
CO_2e emissions (methane) from cows t/year	1,260	2,160
Net CO_2e t/year	**1,260**	**-4,299**
Beef cost of production at farm gate $/kg	0.81	0.43
Beef gross margin at farm gate $/ha	1.30	2.40
Total beef Gross Margin (without Carbon payments)	**$244,693**	**$451,740**

Extra infrastructure costs of rotation grazing		$1,144,000
Net Present Value of the rotation grazing investment (no carbon payment)		$615,565
Internal Rate of Return of rotation grazing (no carbon payment)		11.9%
Net Present Value of the rotation grazing (with carbon payment @ $20 t CO2e)		$1,950,760
Internal Rate of Return of rotation grazing (with carbon payment @ $20 t CO2e)		52.8%

While these calculations are crude (but unfortunately the best currently available), they indicate that meat production under appropriate agricultural systems could be a critical part of the cure for global warming rather than the cause.

<u>Estimate of potential for soil carbon sequestration</u>

How much carbon could we sequester if these innovative 'carbon farming' systems were adopted by all farmers? We have made an estimate of the potential amount of soil carbon sequestration for the agricultural zone of WA. This is based on the major soil types of the region and by extrapolating from the limited data we currently have. While it is a crude estimate it does indicate the scale of importance that soil carbon could have.

The National Carbon Accounts for 2004 have total net emissions for WA of 68.5 million tonnes of CO2e (AGO 2006). Our estimates suggest there is the potential to sequester almost all of this in the states agricultural soils. While the full potential may not be realised however, the figures do indicate soil carbon sequestration could play a major role in reducing Australia's emissions.

There are 470 million hectares of land in Australia that come under the 'grass land' and 'crop land' categories for Kyoto Protocol accounting. If there was an average of 0.5 tonne CO2e per hectare per year of emission from a loss of soil carbon, then Australia's total emission would increase by 41%. An average of 0.5 tonne CO2e per hectare per year sequestration of soil carbon would decrease Australia's total emission by 41%.

Table 5; The potential to sequester carbon in the soil if all farm land was converted to 'carbon farming' systems in WA.

Soil Super Group	Hectares	Estimated Sequestration rate t CO2e /ha/yr	Total CO2e/year
Wet or waterlogged soils	2,275,000	5	11,375,000
Rocky or stony soils	868,000		
Ironstone gravel soils	3,937,000	2	7,874,000
Sandy duplexes	6,574,000	2	13,148,000
Shallow sands	658,000	1	658,000
Deep sands	4,347,000	5	21,735,000
Sandy earths	1,640,000	2.5	4,100,000
Loamy duplexes	2,068,000	1	2,068,000
Shallow loams	758,000	1	758,000
Loamy earths	1,915,000	1	1,915,000
Cracking clays	302,000	-	
Non-cracking clays	476,000	-	
Miscellaneous soils	842,000	-	
Total	26,660,000		63,631,000

<u>The cost of reducing Green house gas emissions</u>

Australia has a target to limit its green house gas emissions to 108% of the 1990 level during the current Kyoto Protocol commitment period. If we exceed that limit the Federal government will have to buy off sets from another country. Australia is likely to be close to that target only because of the reductions due to land clearing bans. With out that off set we would be 30% to 40% over the target. Policies that result in lowering emission will have a direct financial benefit for the Australian federal government.

The government will implement an Emissions Trading Scheme as the core policy to reduce increase in emission in the future. The challenge for government is to ensure that reductions in net emissions are achieved at the lowest cost to the economy.

A simple comparison has been made between the capital costs of a wind farm at Geraldton and the capital costs of converting annual pasture to perennial pastures or fodder shrubs (table 6). This analysis indicates that net emissions can be lowered at far lower cost using by perennial plants than by renewable wind energy.

Much more detailed economic analysis is required to compare sequestration on agricultural land with a range of other potential options

Table 6: A comparison of the capital cost of reducing Carbon Dioxide (CO2e) emissions between a) wind towers and b) perennial fodder plants in the Mid West of WA.

a) Individual wind tower at Walkaway, WA*		
Power generated (megawatts/tower)	1.67	
CO2e avoided each year (t/tower/year)	7,407	
CO2e avoided over 20 years (t/tower)	148,148	
Capital cost of a wind tower ($/tower)	$3,888,889	
Capital cost per total tonne CO2e avoided over 20 years	**$26.25**	

b) Perennial pasture & tagasaste on sand plain		
Net CO2e sequestered each year (t/ha/year)	5**	2***
Net CO2e sequestered over 20 years (t/ha)	100	40
Capital cost of establishment ($/ha)	$200	$200
Capital cost per total tonne CO2e sequestered over 20 years	**$2.00**	**$5.00**

* Figures are from the Alinta Wind Farm at Walkaway.

** Trial data to date is showing sequestration rates in the region of 5 to 10 t CO2e /ha/year, with an average of 7 t CO2e /ha/year. The sequestration rates of tagasaste and sub tropical perennial pastures have been very similar. There will be emission of methane from stock on the perennial paddocks, and from other activities on the farm, estimated at a total of 2 t/ha/year. This gives an estimate of a net 5 t/ha/year of CO2e sequestered in the soil and woody vegetation.

*** Calculations are also done on a much more conservative estimate of a net 2 t/ha/year of CO2e sequestered in the soil and woody vegetation.

ii. ***The need for a national strategy to assist Australian agricultural industries to adapt to climate change***

Government needs to support research into adaption and mitigation at the national, state and local levels. All the R&D effort needs to be coordinated as part of one integrated national strategy. This will require a dramatic improvement in communication and collaboration between the many players in Australia. The initiative by Land & Water Australia to develop a truly national strategy is an excellent start, but there is still a long way to go.

Our concern is the research and development dollars will be concentrated into only a few key research agencies. This approach ignores the fact that much of the break through innovations actually originate in the paddock.

The Northern Agricultural Region of WA has a culture of innovation and improvement. The potential threat from climate change has been recognised, and agriculture in this region is already working actively to respond to that threat. Farmers, agribusiness, researchers and community in this region have a history of working together in true partnerships.

A wide range of farming systems are being developed in this region that can adapt to and mitigate climate change. Central to this effort is recognition of the potential of farm systems to sequester carbon in the soil and woody vegetation. Unfortunately, there have been almost no funds to support this research. Nor has there been any research by city based research groups to measure the sequestration rates of farming systems in WA. However DAFWA staff, based in Geraldton,have been able to conduct a limited amount of sampling to compare soil carbon under perennial pastures and tagasaste with the traditional annual crops and pastures.

<u>A ‘Catch 22’ situation</u>

The results of the soil testing in the NAR is suggesting soil carbon sequestration rates far in excess of what had been thought possible. Rather than create excitement in city based experts, these results have only generated criticism of the methods used. There is no doubt that the sampling we have done so far does not meet the high standards required for rigorous science, but this is due to the lack of adequate funding. A ‘catch 22’ has developed. As a result of some experts challenging the concept that these new farming systems can sequester large amounts of carbon, the funders will not support research to accurately measure the sequestration rates of these systems.

Some experts also challenge the possibility of measuring and verifying soil carbon for trading purposes. Commercially viable methods of measurement and verification have not yet been developed. Again funds to overcome this barrier have not been available. There needs to be a change of thinking from 'whether' we can adapt to and mitigate climate change, to 'how' we can adapt and mitigate.

The federal government can play a key role in changing the approach of the research community. Currently most of the federal funding seems to be targeted at the impact of climate change on current farming systems. Only a small percentage of funds are for developing new ways of farming. The lessons from the northern wheat belt of WA suggest radical changes will be required, rather than gradual refinement of existing farming systems.

The speed of climate changes in some regions has surprised everyone. The past approach of farming systems steadily evolving over time may be too slow to be effective. Research now needs to deliver a 'revolution' in farming systems rather than 'evolution'.

Soil sequestration and the National Emissions Trading Scheme

Whether or not the agricultural sector is to be included in the nations Emissions Trading Scheme is yet to be decided. It would simply not be possible to include agriculture as a fully 'covered sector' when the ETS starts in 2010, as the accounting procedures have not been developed. However, agriculture could become a 'covered sector' at a later date. (Being a 'covered sector' means that each agriculture businesses would have to submit a Greenhouse Gas budget. Farmers would then either have to buy credits if they are a net emitter or could sell credits if they are a net sink).

With full carbon accounting farmers could off set their emissions from live stock and energy use through the sequestration of carbon in vegetation and soil. Sequestration in trees and tall shrubs (Kyoto Article 3.3 sinks) is already being accepted under the limited NSW carbon trading scheme. However this scheme excludes soil carbon sequestration (Article 3.4 sinks). There currently is considerable debate about whether, and how, soil carbon should be included in the national ETS.

Unfortunately most tree crops are not commercially viable (even with carbon credits) in the low rainfall regions that will suffer the most from climate change. So to exclude soil carbon from the ETS would mean that many farmers will be hit with the costs of their emissions without the ability to lower the financial burden through implementing more sustainable practise.

An alternative to being fully covered would be for agriculture to sell 'carbon offsets' into the ETS. This is already occurring with the limited NSW emission trading scheme. However this scheme only recognises carbon sequestration from agroforestry projects that meet the Kyoto Article 3.3. Soil carbon sequestration has been specifically excluded.

It is possible that if agriculture is not covered under the ETS and is only allowed to sell off sets from agroforestry but not from soil carbon sequestration then this scenario could have serious effects on some rural economies.

It has been announced recently that Woodside will buy $100 million worth of carbon credits from CO2 Australia. These credits would come from planting oil mallees on broad acre agriculture land. It is rumoured the CO2 Australia will buy farms and plant them completely to oil mallees, effectively taking them out of producing food. If large areas of land in a district were used solely for oil mallees this could make local business that support farmers unviable and therefore impact on other farms.

It is also likely that Managed Investment Schemes would make similar investments in agroforestry projects in traditional farming districts. So the net result of allowing Article 3.3 sinks but not Article 3.4 could be the collapse of farming industries and local populations in some rural areas.

A better option would be to support the integration of oil mallees and other trees into existing farming systems under share farming arrangements. Alley cropping allows farmers to plant rows of trees and continue to crop and graze in the inter row.

If the purpose of the ETS is to maximise carbon sequestration at the lowest cost it is critical that both agroforestry sinks and soil sinks are included. Farmers and local researchers will work out the best mix of enterprises given a level playing field in terms of the ETS and Managed Investment Schemes.

Agricultural research required on carbon sequestration

Valzano et al (2005) reviewed all of the Australian research that has been published in scientific journals. Only 50 papers had sufficient data to do a complete calculation of the Total Carbon stocks in the top 30 cm of the soil. Of these papers 79% came from NSW and Queensland, with only 21% from the rest of Australia. Of the papers reviewed, 88% were published prior to 2000. With most of these being long term trials, the initial farming methods investigated would have been selected decades ago. These farming methods would not be representative of conservation cropping systems widely used in Australia today.

The research reviewed certainly does not include more recent innovations which are being developed and adopted today. These innovations include 'pasture cropping', intensive rotational grazing, fodder shrubs and sub tropical perennial pastures in temperate environments. The limited range of the trials in the review indicates that there is a serious deficiency in the research effort on soil carbon sequestration in Australia. While agriculture could play a very large role in reducing Australia's GHG emissions there is a need for very significant investments into long term farming trials on 'crop land' and 'grass land' carbon sequestration.

To improve the accuracy of Australia's Nation Carbon Accounts, research is required on…..

a) Net sequestration/emission rates for the major farming method for each region
b) The area of each farming method for each region

Specific research is required for soil and vegetation carbon sequestration to be traded as Green House Gas off sets. To support trading, research is required on…..

c) The most cost effective farming methods to sequester carbon in broad acre agriculture
d) Cost effective methods for measuring, accrediting and auditing net carbon sequestration

Government does not have to carry the full financial burden for this research. There has been considerable interest from the mining industry to support research on farming systems that sequester carbon. If soil carbon is not included in the ETS that source of funds could disappear.

A cost effective method of measuring and marketing soil carbon

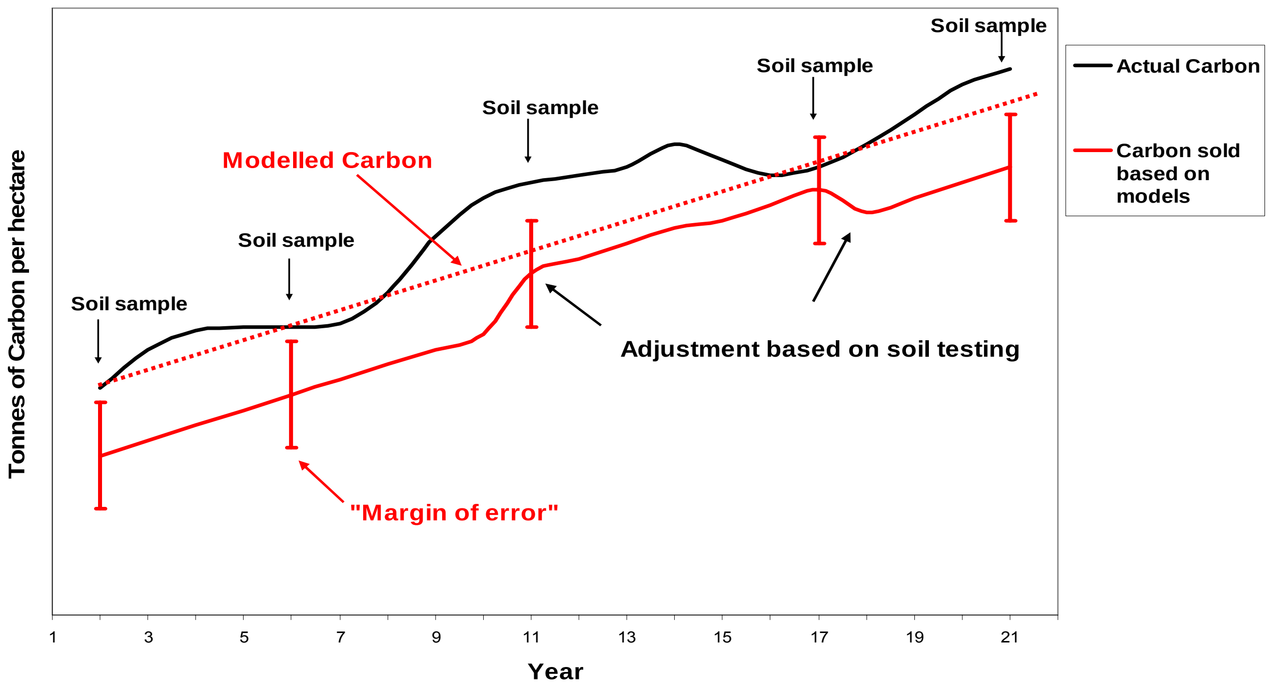
Direct measurements of changes in soil and vegetation carbon pools using scientific methods will be too expensive for commercial trading of carbon credits. This fact is being used as a reason for not allowing the trade of soil carbon. Soil carbon can be estimated at lower cost by using indirect methods that are calibrated and validated at research sites using detailed methodologies.

The simplest approach to estimating sequestration rates is to base it on farming practices. This approach is being used to sell soil carbon off sets through the Chicago Climate Exchange (CCX). Farmers are paid for contracting to use specific farm practice on a specific parcel of land for a fixed contract period. Acceptable farm practices are 'zero till' cropping and improved pasture. The contract period may be for as little as four years. The rate of sequestration is estimated from the findings of a series of long term trials in the region. As there can be considerable variation between the actual trial sites and a specific farmer's paddock, farmers are only paid for a proportion of the estimated sequestration rate. There is a large margin of error used as there is considerable 'uncertainty' from a) extrapolating from the research sites to farmers paddocks and b) a lack of soil testing to verify that the soil carbon in the contracted paddock has actually increased at the rate predicted.

Scientists would struggle to accept the large experimental 'error' of the estimates used in the CCX scheme. However business can, and must deal will large uncertainties. Businesses deal with uncertainty by adjusting prices for 'risks'. In a mature and open market 'risk' discounts are built in to trade prices. The key for business is a realistic estimate of the size of the risk when they make purchases. The IPCC requires that all estimates of Green House Gas emissions and sinks come with a statistical measure of the 'uncertainty' or 'error' of the data. Article 3.4 sinks could also be sold with an estimate of the measurement error. The size of the error would then become an indicator of the quality of the carbon off set being sold. Or a 'margin of error' could be subtracted from the tonnes of carbon being sold, with the margin based on the statistical error of the estimate.

Estimates of carbon sequestration based on farm practices will always have a high degree of uncertainty. Direct measurement will be the most reliable indicator of sequestration, but will be too expensive for commercial trading. A trading system based on carbon pool models should reduce the estimate uncertainty and be cost effective. The risk from models would be reduced by periodic direct measurements of the carbon in the paddocks marketed. The data from paddock sampling could be then fed back to refine the models. This iterative approach would progressively reduce the uncertainty over time.

Figure 7; A model for trading Article 3.4 sinks ('crop land' and 'grass land') in an Australian Emissions Trading Scheme.



iii. The adequacy of existing drought assistance and exceptional circumstances programs to cope with long-term climatic changes.

Currently farmers in many parts of Australia are receiving federal assistance through Exceptional Circumstances funding. This EC assistance is helping good farmers stay on the land through extreme droughts. Unfortunately this may be a short term solution to a long term problem.

There needs to be a gradual change from the concept of drought assistance to industry restructuring. An abrupt change in funding could results of the loss of talented farmers who will be needed to develop and implement radical changes to agriculture. The hardest hit regions, such as the north eastern wheat belt of WA, face the immanent threat of the collapse of whole rural communities. Farmers in these regions will require on going support to give them time to restructure their farms.

The scale and the cost of the changes required are massive. It is unlikely that government would have the funds or political will to be the major financier of agricultures restructure. Traditionally the banking sector has financed change on farm. However the current prolonged drought will reduce farm land values and therefore the equity that banks borrow against. A new source of funding will be required.

Carbon trading could provide the finance for agriculture restructure. If soil carbon (Kyoto Article 3.4 sinks) was recognised under the proposed national Emissions Trading Scheme (ETS) a new equity in agricultural land will be created. Farmers will then be able to borrow against their carbon sequestered or forward sell enough to finance the changes to their systems.

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