A discussion paper on alternative greenhouse emission policies for the Australian Beef Cattle Industry.

Australian Farm Institute

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Executive Summary

The research reported here examines greenhouse emission policy options for the Australian beef cattle industry.

The governmnet has recently announced it will wait until the end of 2012 before implementing an emissions trading scheme. As a consequence of this announcement, there is a great deal of uncertainty about the nature of any future greenhouse emission policy. However, rather than signalling that agricultural industries should ignore the issue, this delay presents an opportunity for the sector to develop policy proposals that are compatible with the needs of the sector, and to advance these to Government. As such it is a critical time for the beef cattle industry to develop preferred policy options.

There are several possible models of engagement for the beef sector (and the agriculture sector more generally) with a national emissions trading scheme (ETS). One involves farm businesses becoming direct participants in an ETS, being required to provide an annual account of farm emissions and to obtain and then surrender emission permits to the Government each year. Available economic and financial modelling of this option indicates it could have a large negative impact on broadacre livestock production in Australia.

A second model would involve agricultural emissions being excluded from a national ETS, and other policy measures being implemented for agriculture in order to reduce emissions from the sector. Among policy options identified as alternatives are direct regulation, consumption-based taxes, emission taxes, offsets for mandatory markets, offsets for voluntary markets, offset markets specific to soil carbon, offset markets specific to forestry, baseline and credit schemes, direct payment for environmental services, policies focusing on research and development, and the Coaltition's 'Direct Action' policy.

While soil carbon sequestration has been included as an alternative, it should be noted that such sequestration is not recognised in Australian national greenhouse emission accounts, and the Government has stated that soil carbon offsets will not be recognised within an emission trading scheme, whilever soil carbon cannot be counted as part of Australia meeting international obligations. It has been assumed for the purposes of this study that soil carbon sequestration is recognised under a national emissions trading scheme. This is not the case at present, and would require either a change in international emission accounting rules, or that Australia ignores these rules as they apply to soil carbon.

The first stage of this research involved analysing these alternative options with specific reference to the cattle and livestock sector more generally. Each option was analysed under criteria which included environmental outcomes, cost efficiency, equity, flexibility, participation and compliance, and risks and opportunities for livestock producers.

Based purely on this evaluation, policies such as environmental services auctions (which involves direct trading between buyers and sellers of environmental services which include carbon sequestration) or environmental stewardship payments (which involve government purchases of environmental services including carbon sequestration) provide the best options for livestock producers. These policies provide opportunities for livestock producers with relatively low levels of risk. The least favourable policies appear to be either direct regulations, an emissions tax levied at the point of production, or coverage under an emissions trading scheme such as the CPRS (given the current lack of available recognised sequestration actions available for farmers under the scheme).

The results of this evaluation are presented in the table below. In the table, each policy option has been given a score with ticks indicating a positive outcome and crosses indicating a negative outcome. The first five criteria were considered from a national perspective, while the last two were considered specifically from the perspective of livestock producers.

Table E1: Analysis of future agricultural emission options based on key criteria.

	National interest					Livestock sector interest	
Model	**Environment outcome**	**Cost-efficiency (national)**	**Equity**	**Flexibility**	**Participation and Compliance**	**Risks for livestock sector**	**Opportunities for livestock sector**
CPRS	✓✓	✓✓✓	✓	✓✓	✓✓✓	✗✗✗	✓
Consumption tax	✗	✗	✓✓	✗✗	✓✓✓	✗	✓
Environmental services auction	✓✓	✓✓✓	✓	✓	✗	✗	✓✓✓
Voluntary offset market	✓✓	✓✓	✓	✓	✗✗	✗	✓
Baseline/Credit	✗	✓✓	✗✗	✗✗	✓✓✓	✗✗	✓
Direct regulation of emissions	✓✓✓	✗✗	✓	✗✗✗	✓✓	✗✗✗	✓
Emission tax	✓	✗	✓	✗✗✗	✓✓	✗✗	✓
Environmental stewardship payments	✓✓	✓✓	✓	✓✓	✗	✗	✓✓✓
Research and development	✗	✗	✓✓	✗	✓	✗✗	✓✓
Coalition 'Direct Action' policy	✗	✓	✓	✗✗	✗	✗	✓✓

To further examine the feasibility of alternative policy options, limited financial analysis was conducted using data derived from ABARE farm surveys to create simple spreadsheet models of a number of different livestock farms. The modelling was conducted before the Government announced a deferral of the CPRS until after 2012, therefore the timeframes used in the modelling are no longer relevant, however the relative impacts of the different policies would remain the same if the policy options wer implemented at a later date.

The models were first used to develop a baseline or business as usual (BAU) projection of farm cash margins over the period from 2011 (assumed to be the first year of a policy) to 2030, using historical rates of productivity growth for each different farm type. The BAU results provide an indication of projected future changes in farm cash margins, in the absence of a CPRS.

A range of different emission policies were then imposed on the models, with the results expressed in terms of the change in projected farm cash margins relative to the BAU projections. Given the static nature of the modelling, (no assumptions were made of likely production responses by farmers) the results are best interpretaed as providing an indication of the scale-of-challenge each of the policies would present to the industry, rather than projecting future farm cash margins.

The projected impact on farm cash margins under three emission reduction scenarios was analysed in comparison to a business-as-usual scenario where no CPRS was implemented. The three scenarios were;

- Agriculture uncovered: No cost imposed on direct agricultural emissions, however an ETS imposed on energy, transport and waste sectors.
- Agriculture covered: Farm emissions covered under the ETS with no free allocation of emission permits for agricultural emissions, and
- Agriculture EITE: Agricultural emissions included in an ETS, with farm businesses receiving an allocation of free emission permits as detailed under the Emissions Intensive Trade Exposed (EITE) proposals.

The results firstly identified that, even in the event that agricultural emissions remain uncovered and at relatively low carbon prices (the CPRS-5 emission price scenario), the projected impact on farm cash margins is a reduction of up to 10 per cent by 2020, compared to BAU. This is solely due to increases in farm input costs, and does not include any cost pass-back from the post-farmgate sectors. At higher carbon prices (such as the CPRS-15 carbon price scenario) projected farm cash margins are up to 20 per cent below BAU projections.

If livestock emissions are covered under the CPRS and livestock emissions are accorded EITE status; the negative impact on projected farm cash margins ranges from approximately 15 per cent (CPRS-5 carbon price) to 22 per cent (CPRS-15 carbon price scenario) compared to BAU projections by 2020. While the impact is significant, it occurs gradually over time, potentially providing farmers with some opportunity to adapt to the changes.

If livestock emissions are covered under the CPRS but not accorded EITE status (and therefore farmers would be required to purchase emission permits for 100 per cent of farm emissions from 2011) the impacts on farm cash margins range from an 80 per cent (CPRS-5 carbon price) to 120 per cent (CPRS-15 carbon price) reduction in projected farm cash margins by 2020, compared to BAU. Clearly, farmers would dramatically modify their enterprises (if possible) or go out of business if presented with challenges of this magnitude.

Current policy proposals incorporate a number of different types of emission offsets. These include offsets for actions that reduce methane and nitrous oxide emissions from farming systems, offsets for forestry plantations, (both included in Government policy proposals) and offsets for soil carbon sequestration (included in Opposition proposals). While some economic modelling of offsets for forestry plantations has been carried out, there has not been similar modelling carried out of the financial impact of soil carbon offsets on farm businesses. The results which follow provide some preliminary results arising from the inclusion of soil carbon offsets as an option available for farm businesses in the high rainfall zone.

The research first involved the development of a model measurement, reporting and verification (MRV) framework that would be sufficiently robust to enable the recognition of soil carbon offsets in a mandatory emission trading scheme.

The framework developed for the purposes of the modelling involved the following assumptions;

- A minimum requirement for twenty soil samples or one sample per four hectares (whichever is greater) to be obtained and tested to establish a baseline level of soil carbon,
- Soil carbon sampling and testing to be carried out on a whole-farm basis to provide confidence that soil carbon leakage is not occurring, and to be repeated every five years.
- Farmers are able to market up to 70 per cent of estimated soil carbon sequestration as offsets, with the remaining 30 per cent acting as a risk buffer for years with poor seasons.

The costs associated with this MRV model were estimated, and incorporated in spreadsheet models of farm businesses in the high rainfall zone, with other relevant data being obtained from the ABARE Agsurf database. The data was sourced from regions of high rainfall, where it is feasible to sow legume pastures, as rainfall is a limiting factor in soil carbon sequestration in all other regions. The farm business information was used to model the financial implications of different emission policies for two model farms from the high rainfall zone. The same models were then used to model the financial impacts of participation in a soil carbon sequestration offsets scheme, with prices for offsets matching those projected for emission permits under the CPRS.

It is most likely that agricultural enterprises would have the opportunity to provide offsets only when the sector remains uncovered under the CPRS - that is where farmers are not liable for direct agricultural emissions. Under a mid-range carbon-price scenario (the Treasury CPRS-15 emission price scenario), the initial high pasture establishment and soil carbon monitoring costs result in farm cash margins for farms providing soil carbon offsets being lower than the BAU case (without offsets) for approximately the first ten years, but then gradually exceeding the BAU case once pasture development has occurred and as the price of carbon increases in the second decade of the modelling.

Under a $5 carbon price scenario (reflecting potential carbon prices in a voluntary market) projected farm cash margins are generally below the BAU projections, meaning that farmers would be better-off not participating in this market. It is possible that the MRV framework detailed in this research is more comprehensive than would be required for a voluntary market, and a less rigorous MRV would assist in making soil carbon offsets more viable in a voluntary market. It is also feasible that efficient soil carbon pooling arrangements may reduce MRV costs for either mandatory of voluntary offset markets. However it should be noted that even with these changes, economic opportunity through soil carbon sequestration will only be realised in high rainfall zones.

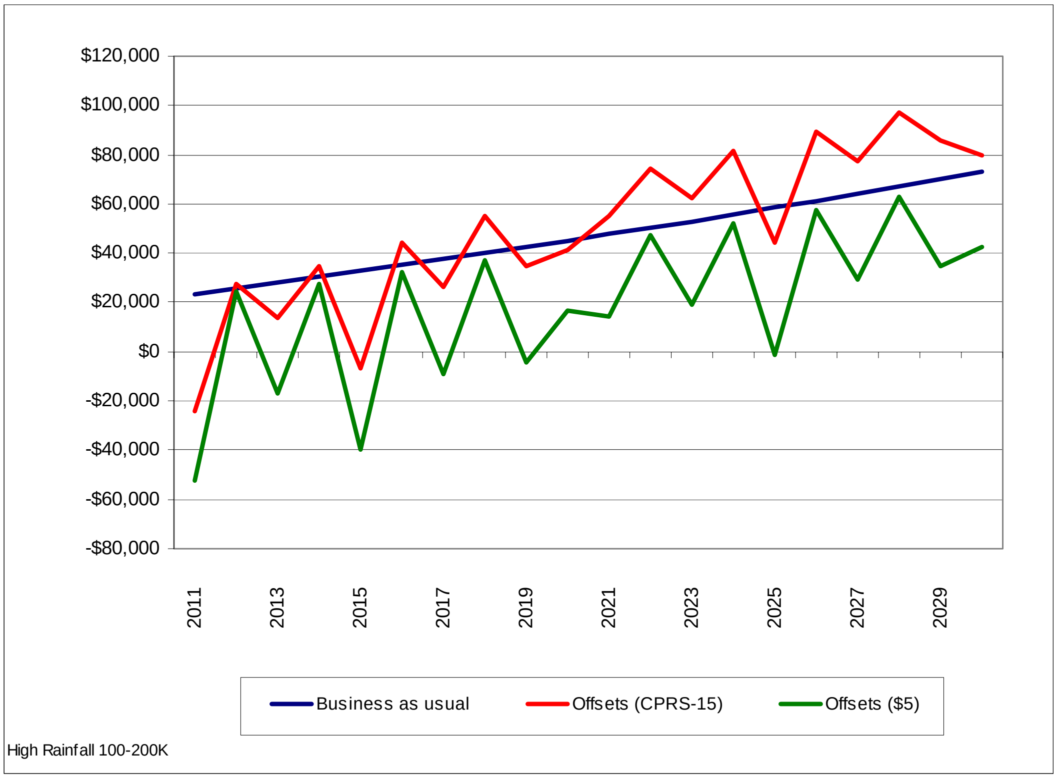

Figure E1: **P**rojected farm cash margins for a model high rainfall mixed livestock farm ($100,000-$200,000 revenue) under the 15 per cent emission reduction scenario, providing soil carbon offsets at either the prevailing carbon price, or a $5 carbon price (reflecting a voluntary carbon market value). Agricultural emissions remain uncovered in this case.

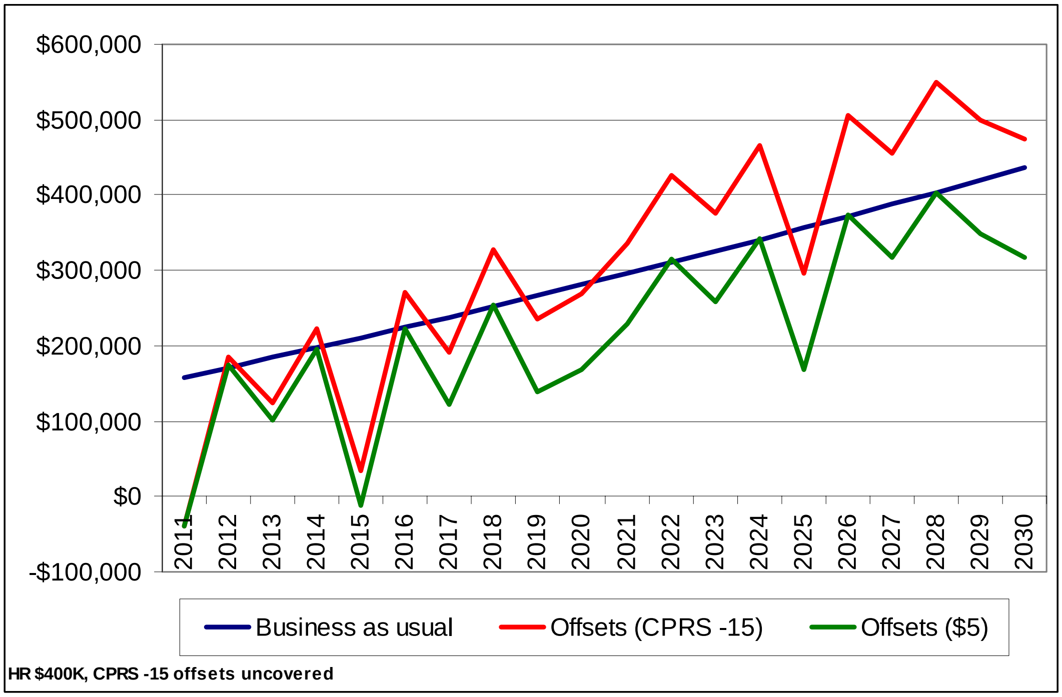

Figure E2: **P**rojected farm cash margins for a model high rainfall mixed livestock farm ($400,000 revenue) under the 15 per cent emission reduction scenario, providing soil carbon offsets at either the prevailing carbon price, or a $5 carbon price (reflecting a voluntary carbon market value). Agricultural emissions remain uncovered in this case.

As a general observation, the potential amount of soil carbon sequestration (under the assumptions used in this research) generally exceeds net farm emissions, meaning that farm businesses providing soil carbon offsets are generally more profitable under higher carbon price scenarios, despite the higher farm input costs that would be experienced.

If direct agricultural emissions were to be included in the CPRS, the sector would not be able to provide offsets for sale; but any mitigation or sequestration would reduce net farm emissions, thereby reducing the number of emission permits that would need to be purchased. If soil carbon sequestration is recognised in the case where agriculture becomes a ‘covered’ sector, it is likely that the same MRV costs would apply in order for the farmer to be able to demonstrate that soil carbon sequestration was occurring.

The research reported here has not attempted to address issues such as carbon sink saturation in soils, the need for 70 – 100 year permanence under current IPCC emission accounting methodologies, and current IPCC soil carbon accounting rules which do not recognise any separation between man-made or natural (drought, bushfire) changes in soil carbon.

Until the full effects farm management practices have on soil carbon across significant depths and ranges of production systems are understood; the risks and costs associated with participating in soil carbon sequestration offset markets appear outweigh the potential benefits.

It also needs to be stressed that the potential revenue from soil carbon sequestration identified in this research would only be available in high rainfall regions where the establishment and maintenance of improved pastures is feasible, and where there is no intention of using the land for cropping at any time in the future. Research to date has shown that long-term soil carbon sequestration is not possible in management systems that involve a cropping rotation, or in lower rainfall or pastoral zone regions.

In situations where soil carbon sequestration is viable, there would be considerable risks for farmers if they became direct participants in carbon markets. An alternative approach which involves either a system of auctions or payments to farmers for providing a 'bundle' of environmental services which include soil carbon sequestration could provide an opportunity for farmers and policymakers to obtain a better understanding of some of these uncertainties without being exposed to high costs of entry and large risks.

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Section I- Literature review and analysis of proposed climate change policies.

Introduction.

The project aims to examine options available to the Australian beef cattle industry for greenhouse gas emission mitigation or abatement given the proposed exclusion of agriculture from the Carbon Pollution Reduction Scheme (CPRS). Despite the government shelving the CPRS until 2013, when the current Kyoto commitment period ends, the agriculture sector has much to consider in terms of its engagement with policies to reduce national greenhouse gas emissions.

The key objective of the report is to develop a clear understanding of the economic and other impacts of the CPRS as it is currently detailed and alternatives to this policy approach; to assist in the development of beef cattle industry policy on greenhouse gas emissions.

The Government's previously stated intention to impose cost-equivalent measures on the agriculture sector, in conjunction with developments in the international political arena, means alternatives to cap-and-trade policies are gaining increasing interest. As such it is a crucial time for agricultural industries to develop preferred policy options. The significant changes to the CPRS design, announced by the government in November 2009, included the commitment to exclude agriculture indefinitely from the CPRS, and also to establish an offset market for livestock and fertiliser emission mitigation that can be recognised under international emission accounting methodologies. A Productivity Commission review in 2015 will assess whether the agriculture sector is at world best emission practice, and will consider potential measures to achieve further emission reductions across the industry.

The expectation that the sector will reduce emissions has significant implications beyond the political. It will also impact on the reputation and brand value of meat products, as consumers are likely to have increased awareness of climate change issues, and the potential exists for low-emission products to gain market recognition via increased value in the future.

There are several primary models for implementation of agricultural emission policies, with the 'benchmark' being economy-wide implementation of the proposed CPRS, including the agriculture sector. Economic modelling examining this approach has been conducted, and will be outlined in greater detail in the report. An alternative is the implementation of the CPRS as detailed in the current draft policy, excluding direct emissions from the agriculture sector (and therefore livestock production) but including processors whose direct emissions exceed the 25,000tCO_2-e threshold. Modelling has also been carried out of this option, and is analysed in this research.

A further alternative involves the CPRS being applied economy-wide, with direct agricultural emissions excluded, and alternative policies applied to livestock production to encourage greenhouse emission mitigation, abatement or carbon sequestration. Alternative approaches which could be applied include regulations, emission taxes, offset markets, direct payment for environmental stewardship, the Coalition's 'Direct Action' policy, or a concerted research and development program to develop new technologies or alternative production practices.

The following report details how each of these policies might work, and examines available research and economic modelling in order to assess their potential implications for the livestock sector. Each option is analysed using six key criteria, which are: environmental outcome, cost-effectiveness, equity, flexibility, participation and compliance; and risks and opportunities. Based on this assessment, those options which appear more probable were further analysed to gain an understanding of their potential impact on farm businesses.

Although the government has stated it will wait until the end of 2012, as at April 2010 there is no information as to which – if any – elements of the proposed CPRS will change. As such the proceeding analysis considers the design of the scheme as currently available, to allow further economic analysis of the potential impact of different policies. The final section of this report details the results of some preliminary modelling of the impacts of different policy options on farm businesses.

1. CPRS applied economy-wide with agriculture included.

The objective of the Carbon Pollution Reduction Scheme (CPRS) is to reduce Australian greenhouse emissions by imposing additional costs on those activities that result in greenhouse gas emissions, and in that way to discourage those activities, or to force businesses carrying out those activities to find ways to produce less greenhouse emissions. Nations that ratified the Kyoto Protocol agreed to act to stabilise greenhouse gas emissions, and accepted legally binding obligations to reduce or limit growth in their greenhouse gas emissions using national greenhouse emissions for 1990 as the 'baseline' or starting point. Australia has ratified the Kyoto Protocol, and the CPRS is the main policy instrument that the Government intends to use to achieve future emission reduction targets.

The CPRS is a cap-and-trade scheme, which works by gradually imposing an increasing cost on activities that result in the release of greenhouse gases. This means those activities will either be discouraged, or the operators of businesses undertaking those activities will have to find ways to reduce the amount of greenhouse gases they produce.

The economy-wide objective of the CPRS is to reduce carbon pollution by a minimum of 5 per cent and up to 25 per cent of 2000 emission levels by 2020. The 5 per cent emission reduction target is the guaranteed minimum target the Government has committed to achieve by 2020. This will be increased to a 15 per cent emission reduction target if most developed nations adopt similar policies, and to 25 per cent in the event that both developed and developing nations commit to robust future emission reduction policies.

Certain businesses that use large amounts of energy or which create significant amounts of greenhouse emissions will be required to prepare an annual greenhouse emission statement based on standard accounting methods, and to submit that to the government each year. These standard accounting methods are important, because very little direct measurement of greenhouse emissions actually occurs. Legislation to implement this requirement (*The National Greenhouse and Energy Reporting Act*) was passed by the Australian Parliament in September 2007.

Businesses that need to participate in the CPRS are those that are in covered sectors of the economy, and that are estimated to produce emissions above a threshold level. The government has generally set the initial threshold at 25,000 tonnes CO_2-e per year (although a threshold of 10,000 tonnes applies to a landfill facility within a specified distance of another such facility). The government will issue a limited number of emission permits (called Australian Emission Units or AEUs) each year and these will be made available to those businesses that require them.

The government has proposed that most AEUs will be sold via regular auctions, but that assistance for businesses likely to be most at risk of losing competitiveness in international markets will be provided in the form of free AEUs. Businesses that meet two criteria – trade exposure and emissions intensity – and that are required to participate in the CPRS will be eligible for this assistance. There are two categories of assistance:

- A 'Highly emissions-intensive' category for activities with emissions intensity of at least 2000 tonnes CO_2-e /$m revenue (assistance commences at 94.5 per cent)
- A 'Moderately emissions-intensive' category for activities with emissions intensity between 1000 tonnes and 1999 tonnes CO_2-e /$m revenue (assistance commences at 66 per cent)

For the first period of the CPRS from 2011–12, an unlimited number of AEUs were to be available at a fixed price of $10. This would puts a firm cap on the market price of emission permits for the initial trading year. From 2012–13 to 2015–16, the cap on emission prices was to continue, however it was to start at $40 and increase at 5 per cent per annum.

Under the changes announced to the CPRS in November 2009, direct emissions from the agriculture sector will be excluded from the CPRS indefinitely. Despite this proposed exclusion, it is useful to understand the potential impact of CPRS coverage on the sector, as a basis for alternative policy comparisons. A range of economic modelling studies have been carried out to analyse the potential impact of this policy on farm businesses. These analyses were conducted by ABARE (Ford et. al. 2009; Tulloh et. al, 2009), The Centre for International Economics (The CIE, 2009a; The CIE, 2009b; The CIE 2009c), and the Australian Farm Institute (Keogh and Thompson, 2008).

The results of these analyses are detailed in Table 1. Despite the variation in magnitude of effect depending on the type of modelling analysis and assumptions made; some key considerations emerge for beef and sheep meat producers.

The modelling which projected the smallest economic impact of the CPRS on agriculture included an assumption that similar policies would simultaneously be adopted by competitor overseas nations. It is now evident this will not be the case, with New Zealand being the only other country considering including agriculture in a trading scheme. All other modelling research projected quite significant and escalating negative impacts on farm businesses as a result of the CPRS.

For livestock producers there are two cost impacts to consider. The first is the direct cost impact on farm businesses if there is a requirement to purchase emission permits for farm emissions. The second is the indirect of the CPRS as businesses upstream and downstream of farms in the supply chain pass on higher costs in the form of higher prices for farm inputs, or lower prices for farm produce.

Tulloh *et al.* (2009) included both these impacts in an analysis of the impact of the CPRS on the economic value of farm production. The assumptions in the modelling are that both livestock producers and processors are included in the CPRS, and that the carbon price is set at $10/t$CO_2$-e in 2011 and projected to reach $28/t$CO_2$-e by 2015. With processors passing back 100 per cent of costs and agricultural emissions covered, sheep production was projected to decline by 17.3 per cent by 2015, beef production to decline by 21.7 per cent, and mixed livestock (sheep and beef) production to decline by 16.8 per cent.

If agricultural emissions are not covered under the CPRS but 100 per cent of additional costs are passed back by processors, the economic value of production in 2015 was projected to fall by 11.8 per cent for a sheep enterprise, by 13.2 per cent for beef enterprises and by 10.3 per cent for sheep-beef enterprise.

In its analysis, the CIE (2009b) assumed the agriculture sector and processors are included in the CPRS, and that livestock production is an activity eligible for EITE concessions, meaning that initially 90 per cent of required emission permits are provided at no cost. At a carbon price of $25, farm cash income was projected to fall by 9 per cent for sheep producers, by 14 per cent for beef producers, and by 5 per cent for mixed livestock producers.

These two analyses can’t be compared directly as they involve differing assumptions, and The CIE analysis projected changes in farm cash income, whereas the Tulloh *et. al*. analysis projected changes in the economic value of farm production. The economic value of farm production includes changes in the estimated value of capital assets as well as changes in farm cash margins. Despite these differences, the significant potential negative impacts of the CPRS on livestock businesses are a common conclusion in both studies.

The advantage for the livestock sector of being included in the CPRS is that individual producers would have the potential to be recognized and rewarded for emission reduction. However, in the absence of an internationally recognized, practical and easily applied emission reduction activities; the negative outweighs the positive in this model.

This is highlighted by Bray and Willcocks (2009), in their study of the net carbon position of the Queensland beef industry. Using a scientific approach rather than accounting methodologies, the study considered state-wide estimations of various factors including Queensland’s beef grazing area and livestock methane emissions (using a methane emission factor of 1.5tCO_2-e/year for each adult equivalent).

The result, when assuming a continued downward trend in land clearing, was estimated net emissions of 1.2Mt CO_2-e (effectively carbon neutral). There are clear shortcomings with this approach, using state-wide averages and making quite broad assumptions, however it highlights the differences between international emission accounting methodologies and the actual flow of carbon through livestock production systems.

Table 1 Features of CPRS modelling studies regarding agriculture.

	CGE modelling			Farm-level modelling		CGE and case study
	Ford et. al. 2009	**Tulloh et. al, 2009**	**The CIE, 2009a**	**The CIE, 2009b**	**AFI, 2008**	**CIE, 2009c**
Subject	Agriculture, some commodity sub-sectors, processing sector. CGE modelling simulating dynamic sectoral change.	Agriculture, some commodity sub-sectors. CGE modelling simulating dynamic sectoral change.	Agriculture, most commodity sub-sectors. CGE modelling assuming dynamic sectoral change.	A range of typical farm businesses, based on ABARE Agsurf data. Largely static modelling.	A range of typical farm businesses, based on ABARE survey data. Largely static modelling of farm profitability.	GMI model addresses cost changes in farming and processing sectors. CGE model estimates changes in production. Case studies are also used to estimate regional impacts.
Emissions price	2010 - $A 20 2020 - $A 35 2030 - $A 52	2011-$A10 2015- $A28	2010 - $A5 -10 2020 - $A 50 2030 - $A 92.60	$25 $50	2010 - $A 20 2020 - $A 35 2030 - $A 62	2010 - $2.3 tCO2-e 2015 - $14.5tCO2-e 2020 - $26-30 2030 – 81-94
Agricultural coverage within CPRS	From 2015	From 2015	From 2015	From 2015	From 2015	From 2015
Transitional assistance for agriculture (EITE status)	• Sheep, cattle, dairy -84% free permits in .2015, ceasing by 2025 • Other animals – 51% free permits 2015 ceasing by 2025.	Livestock producers receive 89.7% free permits after 2015	100% free permits 2016, declining to zero free permits by 2026 (all commodities)	Different scenarios modelled (see below) but included up to 90% free permits	90% free emission permits from 2015, continuing at that level until 2030 for EITE commodities (mainly livestock). No free permits for grains sector.	90% free emission permits from 2015 under scenario of inclusion for processors and producers, declining at 1.3% each year.
International mitigation activities specific to agriculture	• Developed nations commit to the same reduction in emissions as Australia from 2010. • China, South Africa and	• Developed nations commit to the same reduction in emissions as Australia.	Assumes no equivalent international coverage of agriculture within national ETS	Assumes only Australia and New Zealand adopt similar policies for the agriculture sector	Assumes no equivalent international coverage of agriculture within national ETS	Assumes only Australia and New Zealand adopt similar policies for the agriculture sector

	OPEC implement emissions restrictions from 2015. India, Indonesia and other SE Asia commence in 2020.					
Impacts measured	Changes in farm input costs and production, relative to a business-as-usual scenario.	Changes in farm input costs and production, relative to a business-as-usual scenario.	Changes in gross value of production by sub-sector, relative to a business-as-usual scenario.	Changes in costs and farm cash income	Changes in farm cash margins for individual farm businesses, relative to business-as-usual for those farm models.	Production changes from business-as-usual, exports and gross operating surplus (measure of gross profit)
Productivity in the agriculture sector.	Assumes historical rates of sectoral productivity growth are maintained into the future.	Assumes historical rates of sectoral productivity growth are maintained into the future.	Assumes historical rates of sectoral productivity growth are maintained into the future.	Assumes historical rates of sectoral productivity growth are maintained into the future.	Assumes historical rates of sectoral productivity growth are maintained into the future.	Assumes historical rates of sectoral productivity growth are maintained into the future.
Scenarios	• Scenario 1: in 2010 agriculture faces higher input costs but not covered • Scenario 2: 2015, covered but livestock sector received EITE assistance • Scenario 3: 2015, agriculture	• Rates of cost-price pass-through as a result of processors' being included in CPRS 0,20,60 and 100% • For each of these: 2011 agriculture not included, 2015 agriculture not included, 2015 included	• Scenario 1 – Non-participant • Scenario 2 – Early entry in 2013 as a covered sector, with 90% free permits declining to 0 free permits in 2025. • Scenario 3 – Conservative, entry in 2016 with 100% free permits declining to 0 in 2026.	• Non-participant (agriculture not included in CPRS) • 90% free (included in CPRS) • full participation (included and no free permits) • For each of these, with a $25 carbon price and $50 carbon price	• Non-participant (agriculture not included in CPRS) • 90% free (included in CPRS) • full participation (included and no free permits) • For each of these, with a $25 carbon price and $50 carbon price	• Scenario 1 – meat processing separate and processors included in CPRS but no free permits. Agriculture not included. • Scenario 1A- meat processing separate, processors included and eligible for free permits. Agriculture included and not eligible. • Scenario 2- processors included in agriculture. All of

	not covered by scheme					agriculture covered and eligible. • Scenario 3- processors included in agriculture. All of agriculture NOT included.
Impact on Beef and Sheepmeat sectors	Production costs for beef cattle and sheepmeats under scenario 2 (EITE assistance phased out by 2025): • 2020 decrease by 0.1% • 2030 increase by 19.9% Under the same scenario, production for beef cattle and sheep meats is expected to: • 2020 increase by 0.1% • 2030 decrease by 8%	Economic value of farm production: • Sheep from -0.5% uncovered with no cost-price pass-through, to -17.3% with agriculture covered and 100 per cent cost-price pass-through. • Beef from -0.3% uncovered with no cost-price pass-through, to -21.7% with agriculture covered and 100 per cent cost-price pass-through. • Sheep-beef from -0.4% uncovered with no cost-price pass-through, to -16.8% with agriculture covered and 100 per cent cost-price pass-through.	Production of beef by 2030: To reduce by 1.2% as non-participant, decline by 14% with early entry and 90% free permits. Under conservative scenario to fall by 14% by 2030. Production of sheep meat by 2030: Fall by less than 1% uncovered, to decline by 7% with early entry and 90% free permits, and 7% with conservative scenario.	Change in farm cash income: • Sheep from -5.76% non-participant and $25/t carbon, to -77.85% full participant and $50/t carbon • Beef from -2.69% non-participant $25/t carbon, to -124.54% full participant $50/t carbon • Sheep-beef from -3.99% non-participant and $25/t carbon, to -90.39% full participant and $50/t carbon	Change in farm cash margin under medium emission price scenario: • Beef-sheep enterprises gross farm revenue $100,000 to $200,000: decline by 6.9% as non-participant, 191% covered with no free permits, 25.3% 90% free permits and 23.4% with 10% net reduction in emissions. • Beef-sheep enterprises gross farm revenue $200,000 to $400,000: decline by 4.6% uncovered, 112% covered no free permits, 15.4% 90% free permits, 14.3 with 10% reduction in emissions. Beef enterprise gross farm revenue $400,000 or more: decline of 3.6% uncovered, 56.2% covered, 8.9% with 90% free permits, 8.4% with 10% emission reduction.	By 2030 production: • Scenario 1 fall by up to 12% (grass fed) • Scenario 2 fall by up to 5.9% (grass fed) • Scenario 3- up to 1% (grass fed) By 2030 exports: • Scenario 1 – fall by up to 14% for beef, 8% sheepmeat. • Scenario 2 – fall by 6.6% for beef, 1.8% lamb and 3% mutton. • Scenario 3 – fall by 1-2% for beet and mutton, rise by 1.8% lamb.

2. CPRS applied economy-wide with processors included and the agriculture sector excluded.

Under the changes announced by the Australian Government in November 2009, direct emissions from the agriculture sector were to be excluded from the CPRS indefinitely. However, meat, dairy, horticulture and grain processors whose calculated emissions were above the 25,000t CO_2-e threshold were to be required to participate in the scheme. Those processors would be required to prepare an annual greenhouse emission statement based on standard accounting methods, and to submit it to the government each year. Processors whose direct emissions are under the 25,000t CO_2-e threshold would still face higher energy costs associated with the CPRS. It should be noted that under the policy proposal, processors are unlikely to achieve EITE status.

Benefits may exist for meat processors participating in the CPRS, specifically participants with substantial low-cost abatement opportunities (Price Waterhouse Coopers, 2008). These facilities can opt to bank and sell their additional credits, thus generating income from the system. The potential effects of an emission trading scheme on processors is multi-faceted, as there are several layers of indirect cost that need to be accounted for. Obviously the direct cost of emissions is the first consideration, as permits to cover these emissions are essential for the continuation of the facility.

In addition, under the changes to the CPRS design announced in November 2009, a five-year, $150 million stream of assistance for the food processing sector was to be established within the Climate Change Action Fund (CCAF). This stream was to be dedicated to funding emissions reduction measures within the primary food processing industry, with initial priority given to dairy and meat processing. In addition, a review would examine the impact of the CPRS on the primary food processing industry in 2014 drawing on analysis by the Productivity Commission. The review was to take into account international developments relevant to the impact of the CPRS on the industry, including the assistance arrangements for food processors in comparable countries, in particular New Zealand.

To assess the potential impact of the CPRS on meat processors, Price Waterhouse Coopers (PWC) considered four different types of companies, varying in the species processed, annual throughput; and the State in which they operate. By estimating direct emissions from the facilities, and indirect emissions associated with the operation, the report estimates the carbon value at risk. This is defined as being the sum of exposure from climate change, industry regulatory impacts; physical, recreational and market impacts.

Table 2 Direct and indirect emissions of model meat processing plants.

	NSW	VIC	QLD	WA
COMPANY 1				
Scope 1 (tCO2-e)	30,890	30,890	30,890	30,890
Fossil fuel combustion	30,890	30,890	30,890	30,890
Industrial wastewater treatment	n/a	n/a	n/a	n/a
Treatment of waste solids	n/a	n/a	n/a	n/a
Scope 2 and 3 (tCO2-e)	80,081	95,004	76,058	71,882
Total	**110,971**	**125,894**	**106,948**	**102,771**
COMPANY 2				
Scope 1 (tCO2-e)	10,856	10,856	10,856	10,856
Fossil fuel combustion	10,856	10,856	10,856	10,856
Industrial wastewater treatment	n/a	n/a	n/a	n/a
Treatment of waste solids	n/a	n/a	n/a	n/a
Scope 2 and 3 (tCO2-e)	28,114	33,389	26,730	25,263
Total	**39,000**	**44,245**	**37,586**	**36,119**
COMPANY 3				
Scope 1 (tCO2-e)	4,777	4,777	4,777	4,777
Fossil fuel combustion	4,777	4,777	4,777	4,777
Industrial wastewater treatment	n/a	n/a	n/a	n/a
Treatment of waste solids	n/a	n/a	n/a	n/a
Scope 2 and 3 (tCO2-e)	12,389	14,691	11,761	11,116
Total	**17,166**	**19,468**	**16,538**	**15,892**
COMPANY 4				
Scope 1 (tCO2-e)	192	192	192	192
Fossil fuel combustion	192	192	192	192
Industrial wastewater treatment	n/a	n/a	n/a	n/a
Treatment of waste solids	n/a	n/a	n/a	n/a
Scope 2 and 3 (tCO2-e)	501	593	476	449
Total	**693**	**785**	**668**	**642**

Source: Price Waterhouse Coopers, 2008

Table 2 above shows the estimated emissions for each of the model companies. These emissions were analysed under a $40/t CO_2-e scenario, and 30 per cent exposure to pass through costs arising from Scope 2 and 3 emissions (indirect). The impact of the cost of Scope 1 emissions would be significantly changed in the event processors are allocated emissions-intensive trade-exposed (EITE) status.

The results of the analysis are shown in Table 3 below. It includes a scenario under which the industry received 50 per cent emission permits free as a result of being allocated EITE status.

Table 3 Emission costs for meat processors under the base case (100% liability for Scope 1 emissions and 30% pass through costs for Scope 2 and 3 emissions) and a scenario where 50% of emission permits required for Scope 1 emissions are allocated free of charge.

	NSW	VIC	QLD	WA
Base case				
Company 1	$2,196,068	$2,375,648	$2,148,296	$2,098,184
Company 2	$771,968	$834,908	$755,000	$737,396
Company 3	$339,688	$367,372	$332,212	$324,472
Company 4	$13,692	$14,796	$13,392	$13,068
50 per cent permit allocation				
Company 1	$1,579,288	$1,758,868	$1,531,516	$1,481,404
Company 2	$555,868	$618,808	$538,900	$521,296
Company 3	$245,168	$272,852	$237,692	$229,952
Company 4	$10,872	$11,976	$10,572	$10,248

Source: Price Waterhouse Coopers, 2008

Under the changes announced to the CPRS in November 2009, the agriculture sector would be excluded from the scheme indefinitely, and the carbon price for the first year will be set at \$10/t CO_2-e. These developments have occurred since this analysis was completed, and as such the overall impact of the CPRS can be assumed to be smaller than that shown in Table 2. However, the results provide some key areas of consideration.

It should be noted that the impact of free permit allocation associated with EITE status will be less than would be anticipated, because some facilities operate at or above international average emissions intensity, and revenue from permit auctions will go towards many policy priorities, of which EITE is one (PWC, 2008). As the proportion of free permits will also be reduced over time, there is no long-term comfort in the lower initial impact, although it does provide an opportunity to implement transitional measures.

From an equity perspective definite emission thresholds are necessary, however a processor operating at 1,000 t CO_2-e /\$million revenue will receive free permits, whereas one operating just below at 950 t CO_2-e /\$million revenue will not. As such, the impact across processors will not be equitable during the initial stages of the CPRS. The same could be said for livestock producers if a threshold was introduced at the farm level. Flexibility may be greater under a domestic trading scheme than other approaches by allowing trade of permits and purchase of offsets, however there are many other aspects to consider.

An interesting observation made by Porter (2009), is that the CPRS as it is proposed creates a financial instrument for trade, and the recent financial crisis provides a cautionary tale about risks inherent in unfettered trade in financial derivatives. With a domestic ETS linked to other schemes internationally, the risk is that 'Lax monitoring or enforcement in one country would undermine the effectiveness of the policy not only in that country but in other participating countries as well' (US Congressional Budget Office ,2008). As such, compliance is critical and penalties for non-compliance can be expected to be significant.

3. CPRS applied economy-wide with processors included, and alternative policies applied to agricultural emissions.

The basic assumption in each of the policy alternatives outlined below is that the CPRS is implemented economy-wide; however direct agricultural emissions are excluded from the scheme. Under this approach, different policy options would be introduced to deal with direct farm emissions. Available economic analysis of the potential impacts of these various policy options is examined to provide indications of the potential implications of each approach for agriculture, although it is noted that available research is usually on an economy-wide basis rather than being specific to agriculture.

3.1. Tax measures

According to Schoonbeek and de Vries (2009) taxes are superior to command-and-control regulation in achieving efficient pollution reduction. There is, however, more than just efficiency to consider in examining the implication of an emission tax. The details of two potential tax models are outlined below, and evaluated using a number of key criteria.

3.1.1. Consumption-based tax.

The premise of a consumption-based approach to emission reduction is to target the emissions embodied in the final good when it is ‘consumed’, rather than in the production stages. This translates, in practical terms, to forwarding on the tax to consumers. In the case of the agriculture sector, the way in which this model would work is through estimating the emissions associated with a group of products up to the farm gate, and clearly including the cost of these emissions via a tax levied at the point of final purchase. Emissions generated along the supply chain would not be included in the emissions calculated for the product, because under an economy-wide CPRS, these emissions would be taxed separately. The cost of the product when sold to the consumer includes a carbon tax calculated by multiplying the carbon price by the average emissions intensity of the product.

The way in which the carbon price is generated under this approach is problematic, as it should mirror the permit price in the CPRS market. As such, the tax calculation would need to change over time, complicating the estimation of tax payable on the final product. A consumption-based tax would, however, remove the need for an adjustment to retain export competitiveness, as the tax would be levied on both domestically produced and imported products at the point of sale to consumers.

A criticism often leveled at the production-based approach to emission reduction (as is the case for the CPRS), is that it provides an advantage to imports while penalizing domestic producers, increasing the risk of leakage (Carmody, 2009). Access Economics (2009) assessed the cost-effectiveness of the consumption-based approach across the whole economy, and concluded that for the same carbon price, the consumption approach would lead to about half the emission reduction of a production approach. This is because there is no pressure on domestic producers to find ways to reduce emissions; it is difficult to apply different tax rates to low-emission and high-emission products that are otherwise similar, and there is actually a disadvantage for early-movers who adopt low-emission technologies that are more expensive than conventional production processes.

Access Economics determined that the economic cost of the consumption-based model in terms of gross national income, employment, exports per tonne greenhouse gas; is lower than under a CPRS. However, when compensation is offered to emissions-intensive trade-exposed industries, the results are mixed.

The consumption-based approach is appealing in that imports are subject to the same trading constraints as domestic products. The opportunity associated with this model lies in the ability to tax imports while exports remain exempt, therefore maintaining competitiveness on the international market. However, one could expect products would shift to the international market to avoid the tax, which could have the result of dampening international prices.

The CIE (2009d) analyzed the merits of a consumption-based approach and the CPRS with regard agricultural emissions. The results suggested that to generate the same revenue as the CPRS through permit sales, and to generate sufficient revenue to purchase offsets to achieve the same emission abatement as would occur under the CPRS would require relatively high tax rates. For example, the required tax rate was estimated to be 43 per cent for beef or 26 per cent for sheepmeats with no free permits offered in the CPRS. Under a 90 per cent free permits scenario for emissions-intensive trade-exposed industries, the tax rate required would reduce to 18 per cent for beef and 11 per cent for sheepmeats.

With such a hefty additional tax, domestic consumption was projected to responds by declining by 25 per cent in the case of beef and 14 per cent for sheepmeats (0 free permits) or 12 per cent for beef and 6.5 per cent sheepmeats (90 per cent free permits). The conclusion of this analysis was that the cost-effectiveness of a consumption-based approach is much less than for other policy options.

From a livestock industry perspective, there is a need to consider the long-term implications of such a high tax which would discourage consumers from purchasing beef and sheep meat products. In addition, it would be likely that consumers would be provided with information about the emissions associated with a product in conjunction with the calculated tax, potentially providing a further disincentive for consumers.

Another key issue in the consideration of alternative emission reduction policies is the ability to differentiate between less emission-intensive products and others produced conventionally. The administrative burden of establishing a system under which the emission intensity of various different production methods could be measured and verified for a singular product would be huge. However, in order to accurately provide a price signal for consumers and encourage the purchase of less emission-intensive products, low-emission production practices would need to be recognized.

In the case of offsets, without even further expanding the administrative burden of establishing numerous product classifications, each with an offset 'option', it would need to be left to the producer to cross-subsidize their own produce cost through marketing offsets separately, rather than by including them in the calculation of the net emissions associated with a production system (The CIE, 2009d).

In addition, indirect costs will continue to be imposed on the industry as a result of upstream suppliers and downstream processors paying for their emissions under the CPRS. There is little flexibility for producers under this model, with participation mandatory, and little likelihood of an emission accounting system complex enough to identify low-emissions production systems. When this impact is combined with the indirect costs of the CPRS which will still be imposed on farm businesses; the negative implications of specifically identifying emissions to consumers, and the strong disincentive that a consumption tax would have on consumption of red meat relative to alternative proteins, a consumption-tax model may entail more risks than opportunities for broadacre livestock producers.

3.1.2. Emission Tax.

An emission trading scheme such as the CPRS imposes controls on the quantity of emissions but not emission permit prices; whereas a carbon tax imposes a control on emission permit prices, but not on the total amount of emissions produced. In comparing an emissions trading scheme with an emissions tax, Garnaut stated 'a well-designed emission trading scheme has important advantages over other forms of policy intervention. However, a carbon tax would be better than a heavily compromised emission trading scheme' (Garnaut, 2008).

Under an economy-wide approach, a carbon tax works by imposing a cost per tonne of emissions at each transaction point along a production chain (Porter, 2009). Unlike the consumption-based model outlined above, the carbon tax is calculated along the supply chain, whereas a consumption tax is 'forwarded on' to the consumer (The CIE, 2009d).

Products which avoid using carbon would pay only the 10 per cent GST (as current), but other goods and services would pay additional tax weighted according to the emissions intensity of all stages, carried over until the final sale; in the case it was applied in the absence of a CPRS. The advantage of this approach from the economy-wide perspective is that it is transparent, relatively simple and provides consumers with clear incentives to select products that have been produced with less emissions.

In a policy setting with agriculture excluded from the CPRS, but the emissions trading scheme applied economy-wide (including meat processors); the emission tax would be applied only to the production of agricultural products on-farm. There are two ways in which it could be applied, the first being for each farmer to prepare an annual greenhouse emission statement based on standard accounting methods, and to submit that to the government each year and a per-unit tax would need to be paid by the farmer. Proceeds from the tax could be allocated to research and development, and adjustment assistance for the progression to low-emission production systems. The tax could also be adjusted to create the price incentive needed to reduce emissions to a specified target, in a transparent manner.

It is not only the level of tax per emission unit that can be adjusted to achieve a specific environmental outcome. An emission tax could also be applied only to certain types of emissions. Petersen *et al.* (2003) examined policy options for Western Australian broadacre grazing farms, developing two models under which a price is imposed on emissions. Under one model a tax is assumed to apply to total farm emissions, and under the second the tax applies only to methane emissions.

Using MIDAS (Model of an Integrated Dryland Agricultural System) computer modelling software, the results show that with a total farm emission tax, there is no significant change in emissions under tax levels comparable to tradable carbon units ($10-$50/t), and that the tax needs to increase to $85/t CO_2-e before substantial changes occur in emissions. This research also estimated the emission tax level at which the farm achieves zero-profit, finding that emission restriction policies rather than taxes allow farms to remain profitable much longer than taxation policies.

Emissions included in this modelling were those associated with fuel consumption, which under the current CPRS model will be accounted for at the bulk fuel distributor level, and not allocated at the farm level. However, this research provides a good example of some of the considerations government would need to make in determining taxation levels. It has also been noted that under an emission tax model, the ‘blame’ for the amount of tax levied falls on the Government, and decisions will be driven as much by political considerations as they will be by a desire to achieve emission reductions.

When considering the likely cost burden of verifying emissions across all agricultural businesses, it becomes clear a much simplified model would need to be applied in order to keep administration simple and costs to a minimum. If the tax is set by average industry classifications, as used under current emission accounting methodologies, producers who undertake emission reduction practices won’t necessarily be recognized. In order to recognize and provide price incentives to encourage uptake of low-emission production practices, a system would need to be established whereby various production methods could be recognized and their associated emissions estimated.

This type of tax system would be expensive to establish, and the livestock sector would need to fund significant research to support any claims regarding lower emissions associated with a particular method of production. To ensure equity, any producer or processor who undertook such practices would need to be recognized, meaning the system would require flexibility so that participants could choose emission reduction options.

The second approach that could be taken when applying an emission tax is that it could be applied when the product is sold. This would operate in a similar way to the current research and development levies. For example, when cattle are sold off-farm a certain percentage tax would be applied according to the level of emissions associated with the animal, and this amount would be subtracted from the farmer’s returns. This method would rely heavily on average estimations of emissions, and there would be no facility to recognize emission reduction activities on-farm, and as such no incentive to switch to production practices which were less emission-intensive. Administratively, however, this approach would be much simpler.

Unlike the consumption-based approach, a direct tax on emissions imposed either through annual greenhouse emission statements based on standard accounting methods or applied when the product is sold would not address emission leakage. Australian farmers would face an additional cost that their international competitors would not, and would be disadvantaged in international markets.

Unlike other policy options, an internationally-applied carbon tax model would generally have comparable results in different countries, enabling international linkage; while cap and trade schemes will usually vary between nations (Shaprio, 2009). In fact, a 'harmonized' tax rate could even be agreed between countries which would effectively mean an international agreement to penalize carbon emissions domestically at a common rate (Nordhaus, 2005). This is an excellent model for international cooperation; however the history of climate change negotiations suggests that international implementation is unlikely to be so straightforward. Participation can be 'ensured' through regulation in one country, but not necessarily in other countries. Non-compliance penalties and enforcement systems would also need to be harmonized across jurisdictions, to ensure equivalent participation.

Overall, the only opportunities for livestock producers presented by this model is if research can provide low-emission production options, and these can be recognised in annual greenhouse emission statements submitted to government.

For a tax imposed at the first point-of-sale post the farm gate, little advantage exists for farmers, and all the advantages lie with Government due to the greatly simplified administration that would be required. The risk of this approach for livestock farmers is that livestock production is relatively emission-intensive with few options available to reduce emissions. An increasingly high cost could be imposed on livestock emissions with little or no opportunities available to reduce these costs.

3.2. Market-based measures (auction of environmental services, voluntary offsets, auction of offsets, baseline and credit)

Market-based measures have gradually been developed and adopted internationally to achieve objectives such as biodiversity conservation on farm land. In the absence of large public conservation reserves, governments must rely on private landholders to minimize biodiversity losses; and there are four tools available to achieve this (Young and Gunningham, 1997). These are:

- education and persuasion,
- regulation,
- direct grants and
- market-based instruments.

In the absence of economic incentives, education and persuasion don't necessarily translate to action. Regulation is a commonly-used approach; a key example of which are land-clearing laws or water extraction caps. However, available research shows that market-based measures can offer more cost-effective means by which to achieve environmental outcomes.

Market-based mechanisms can be classified into three broad categories: price-based, quantity-based and market friction mechanisms (Australian Government, 2004). Price-based approaches include subsidies or charges to direct activities. Quantity-based approaches include the cap and trade system. Market-friction measures work by providing more information to the market or encouraging private investment in activities that are viewed to achieve better environmental outcomes. For the purposes of this research, three different market-based approaches have been analysed, including auction of offsets, voluntary offset markets, and a baseline and credit system.

3.2.1. Offset markets- Auction of environmental services

Internationally, environmental services auctions have existed in a number of forms for many decades. The US Conservation Reserve Program, for example, under which in excess of 15 million hectares of cropland have been converted to conservation purposes, has been in operation for over twenty years. Similar programs have also existed in Europe for some considerable time. In Australia, the existence of such auction markets is relatively rare, and there have only been sporadic attempts by Governments to establish these.

An auction system for delivery of environmental services was investigated by Windle and Rolfe (2008), where environmental services are purchased from landholders using public funds. Essentially landholders submit proposals to provide an environmental service, with the proposal detailing the level of financial incentive the farmer would require to perform the activity. Proposals are assessed according to the net environmental benefits and ranked according to cost effectiveness. Potential buyers can then assess the environmental benefit being offered and the associated cost, and under an auction system bids are made by potential buyers for the service.

In Australia, fixed price grant mechanisms rather than competitive tenders are the dominant form of allocation of public funds for landholders delivering environmental services. In comparing the two, Windle and Rolfe concluded that competitive tenders are 30 per cent more cost efficient than a fixed price grant system, as the auction system matches the opportunity costs of activities with environmental outcomes more closely.

Enforcing this conclusion, alternatives to the traditional ‘command and control’ policy approaches were tested in a trial of market based instruments by the Australian and State and Territory Governments in 2002. (Carr, 2005). The results indicated that market based instruments can deliver improved natural resource outcomes at reduced cost when compared with traditional measures such as regulation.

Goven et. al. (2010) set up auctions in the Fitzroy Basin of Queensland to determine the likely participation rates by graziers in a trading scheme. The study used a key management strategy of retention of native vegetation regrowth, and found that landholders would only be induced to participate in an offsets scheme when the carbon price reached \$56/t CO_2-e. Participation rates, even at high prices per tonne of carbon sequestered, were well below 100 per cent, indicating that a significant number of landholders would not participate regardless of price. Uncertainty about the function and risk of offset schemes was a key factor in the large risk premium farmers were putting on their bids in the auction, although one could expect this would reduce when a scheme was started and farmers educated about its rules. Auctions have the advantage of increasing communication between landholder and private business, and may also reduce the demands on public funds, if the private sector is directly purchasing the services from landholders.

Watts (2005) argues that irrespective of the type of conservation program; be it direct payment for environmental services, cap-and-trade programs, or an auction system; all should be complementary to regulation. As noted by Stoneham *et al.* (2003): ‘The use of market mechanisms for environmental management will rely on legislation to define property rights, facilitate the modification of property rights and to specify the rules within which markets operate’. Regulation would detail the duty of care placed on landholders, and set minimum standards of environmental performance, with services in excess of this standard rewarded through market mechanisms. In such a case, landholders could face an increase in operation costs in order to comply with regulation, which would potentially be offset by payment for additional services.

There are limitations to an auction system, firstly in ensuring the value of the environmental services outweigh the burden of establishing the trading scheme and the costs of designing a tender. The major limitation, however, is the identification and inclusion of potential bidders and providers. For highest efficiency, competition is required and may not necessarily be delivered when there is only a small pool of both buyers and sellers. Tender schemes have a limited lifespan in any location (Watts, 2005), as such limiting the market size. Participation of landholders will be limited by the environmental outcomes they can demonstrate will be achieved on-farm. It is expected guidelines would be developed to determine the types of environmental services the auction would accept, but certainly this model is flexible in terms of allowing producers to select the service available on-farm and whether they want to participate.

3.2.2. Offset markets- Voluntary markets and participation

In conjunction with the CPRS, the Australian Government has stated it will promote a voluntary market for non-Kyoto compliant emission offsets, using the National Carbon Offset Scheme (NCOS) which sets minimum requirements for verification and retirement of voluntary carbon credits. Voluntary carbon markets are those markets created by companies or individuals who voluntarily decide to pay for actions (such as planting trees) to 'offset' emissions they have created. Such markets are only lightly regulated, have rules that do not necessarily observe international emission accounting rules, and usually operate at much lower emission prices than mandatory markets. Voluntary markets do, however, provide an opportunity for innovation because they are not constrained by international accounting methodologies; and instead can utilise simplified and novel approaches. (Guigon et al. 2009).

The purpose of the NCOS is to ensure consumers have confidence in the market and the integrity of the offsets they purchase (Australian Government, 2009). Eligible offsets under the NCOS include:

- Carbon pollution permits, including those from forestry projects opting into the Carbon Pollution Reduction Scheme
- Kyoto units recognised and accepted under the Carbon Pollution Reduction Scheme
- Credits issued under the internationally recognised Voluntary Carbon Standard and Gold Standard, where these meet specific requirements
- Credits issued by domestic offset projects that reduce emissions from sources currently not counted towards Australia's Kyoto Protocol target.

The key feature of the NCOS for the livestock industry is that abatement not counted toward Australia's international commitment may be part of this market, including sequestration in agricultural soils, enhanced forest management, revegetation and vegetation management (Eckard, 2010). However, in order to be counted these sequestrations must occur within Australia and be additional or beyond what would be required to meet regulatory obligations, and must also be permanent, measurable, transparent, independently audited and registered.

The standards under which such offsets are to be recognized are currently used in other voluntary markets, and in order to assess the potential risks and opportunities from this approach, it is of value to consider lessons emerging from existing markets.

Internationally, existing voluntary carbon markets can be divided into two types: the Chicago Climate Exchange (CCX) market, and the disaggregated over-the-counter (OTC) market (Hamilton et al. 2008). CCX is a structured and closely monitored market, which organisations join voluntarily. The OTC market features highly fragmented transactions developed on a deal-by-deal basis.

In 2007, Hamilton et al. tracked 42.1 million tonnes of carbon dioxide equivalent ($MtCO_2$-e) offsets transacted on the OTC market and 22.9 $MtCO_2$-e transacted on the CCX; confirming a total volume of 65.0 $MtCO_2$-e transacted in these voluntary carbon markets in 2007. Relative to the volumes observed in 2006, this represented a tripling of transactions for the OTC market, from the 14.3 $MtCO_2$-e traded in 2006, and more than doubling of volumes on the CCX. Companies make up 80 per cent of total voluntary demand for carbon offsets (Guigon et al 2009).

Repeating the analysis for 2008, Hamilton et al. (2009) found that 54 Mt CO_2-e was transacted on the OTC market, 69.2 $MtCO_2$-e on the CCX, for a total of 123.2 Mt CO_2-e. This represented a near doubling on 2007 figures, with CCX trades tripling in 2008 from the previous year. Table 4 below shows the volume and value of transactions in 2007and 2008 on the regulated and voluntary carbon markets.

Table 4 Transaction volumes and values, Global Carbon Market, 2007 and 2008

	Volume ($MtCO_2$-e)		**Value (US$ million)**	
Markets	2007	2008	2007	2008
Voluntary OTC	43.1	54.0	262.9	396.7
CCX	22.9	69.2	72.4	306.7
Other exchanges	0	0.2	0	1.3
Total voluntary markets	**66.0**	**123.4**	**335.3**	**704.8**
EU ETS	2,061.0	2,982.0	50,097.0	94,971.7
Primary CDM	551.0	400.3	7,426.0	6,118.2
Secondary CDM	240.0	622.4	5,451.0	15,584.5
Joint Implementation	41.0	20.0	499.0	294.0
Kyoto [AAU]	0.0	16.0	0.0	177.1
New South Wales	25.0	30.6	224.0	151.9
RGGI	-	71.5	-	253.5
Alberta's SGER(a)	1.5	3.3	13.7	31.3
Total Regulated Markets	**2,919.5**	**4,146.1**	**63,710.7**	**117,582.2**
Total Global Markets	**2,985.5**	**4,269.5**	**64,046.0**	**118,287.0**

Source: Ecosystem Marketplace, New Carbon Finance

Of the OTC transactions in 2008, by volume agricultural methane projects consisted of 3% of the total volume, agricultural soil projects made up 1%, afforestation and reforestation 1% and avoided deforestation 1%. Asia was the most popular project location.

Figure 1 below outlines the registered project types for the CCX in 2007 and 2008.

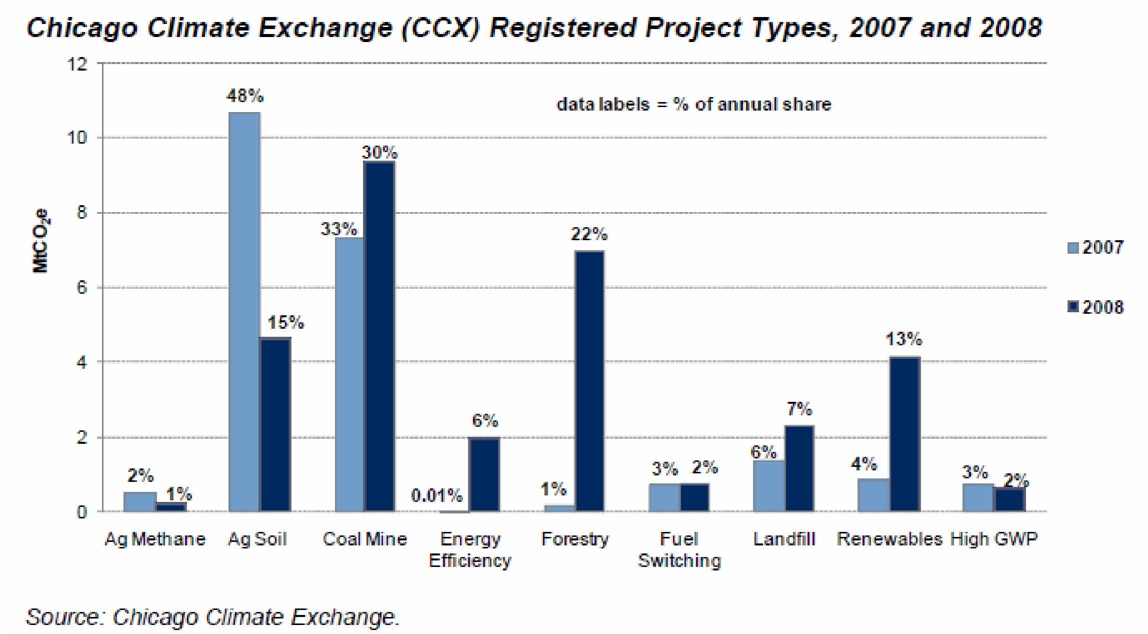

Figure 1 Chicago Climate Exchange (CCX) Registered Project Types, 2007 and 2008

Chicago Climate Exchange

The Chicago Climate Exchange (CCX) was established in 2003 as the first voluntary yet legally-binding trading system for greenhouse gas emission reduction and carbon sequestration. Members are allocated annual emission allowances in accordance with a baseline and their emission reduction schedule. Members who reduce beyond their targets have surplus allowances to sell or bank; those who do not meet the targets must comply by purchasing offsets which are generated by qualifying projects.

Offset projects can include: Agricultural methane
Agricultural soil carbon
Rangeland soil carbon management
Forestry
Renewable energy
CDM projects

Offset-based credits can only be used to offset 4.5 per cent of a member's total emission reduction requirement; therefore the vast majority of credits traded on the CCX are allowance-based. The currency of the CCX is the 'Carbon Financial Instrument' or CFI, which is comprised of Exchange Allowances and Exchange Offsets, and is 100 tonnes of CO2-e. Figure 2 below shows price trends for offsets over the 4 period 2006 to 2010.,

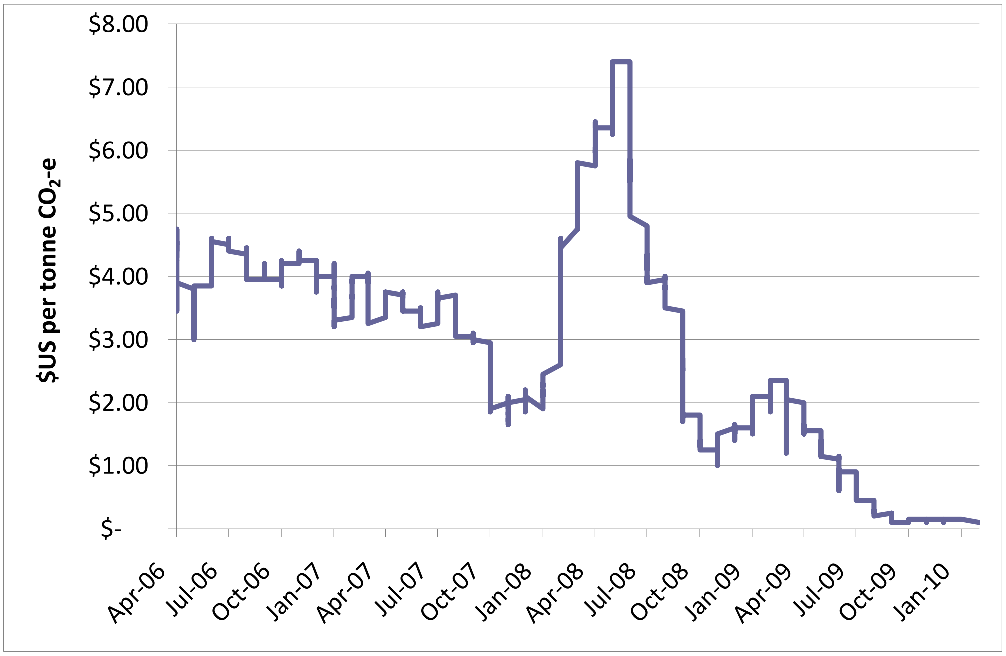

Figure 2 CFI prices for 2006 and 2008 vintages

Source: CCX data

There are 17 identified offset standards that have been developed internationally. The most utilized in OTC transactions in 2008 was the Voluntary Carbon Standard (48 per cent) then the Gold Standard (12 per cent) and the Climate Action Reserve Protocols (10 per cent) (Hamilton et al., 2009).

The Voluntary Carbon Standard is termed a ‘basic carbon standard’ and is aimed at buyers who are focused on carbon accounting, while the Gold Standard is a ‘multiple-benefit’ standard, designed to service the needs of buyers who want a good story to go with their offset. Guigon *et al.* (2009) examined the most utilized standards in 2007, which included the Voluntary Carbon Standard and the Gold Standard. The review concluded that transaction costs under different standards can vary by as much as 100 per cent. For small-scale projects, the average burden of transaction costs was much higher than large-scale projects, at around €2-3/t CO_2-e. This serves as a reminder that in the consideration of participation in an offset market, farmers need to be mindful of administration and verification costs; and also the type of buyer they need to attract.

There has not, as yet, been comprehensive economic studies of the implications of voluntary carbon markets for farm businesses, although some recent research has examined the economic and financial implications of farmers participating in mandatory offset markets. ABARE (2010) analysed the effects of an emissions offset scheme on the agriculture by comparing farm business outcomes under:

(a) a baseline scenario with no CPRS,
(b) CPRS and no offsets, and
(c) CPRS with offsets;

under a scenario where Australia meets it 5 per cent reduction in greenhouse gas emissions by 2020.

There are, of course, assumptions which need to be considered when detailing the results of this study. It is assumed that agriculture is exempted from the CPRS under both scenarios; it is assumed all countries implement domestic emissions trading schemes and face the same world carbon price, and that all countries also implementing the same EITE assistance. In terms of land use change, the rate of conversion of agricultural land from agriculture to forestry is assumed to be the same as in previous research (Lawson et al., 2008). The area of agricultural land that is economically suitable for afforestation between 2007 and 2050 is estimated to be 5.8 million hectares; with about 47 per cent of this area (2.7 million hectares) estimated to be environmental plantings. The simulations included only Kyoto compliant CPRS credits, not offsets that would fall into the voluntary market.

The effect on per-unit production costs, once adjusted for carbon credits, is outlined in Table 5 below, while the change in production is presented in Table 6.

Table 5 Change in production costs relative to reference case, when adjusted for offsets credit, in 2030 (%)

	CPRS with offsets	CPRS without offsets	Impact of offsets scheme
Grains	-0.4	-0.9	0.5
Other crops	-1.0	-1.1	0.1
Beef cattle and sheep meat	-5.7	0.8	-6.5
Other animals	-1.8	-0.6	-1.2
Dairy cattle	-3.3	-0.5	-2.8
Wool	-2.9	0.2	-3.1

Source: ABARE GTEM estimates, 2010.

Table 6 Change in production relative to the reference case, 2030 (%)

	CPRS with offsets	CPRS without offsets	Impact of offsets scheme
Grains	1.1	2.4	-1.3
Other crops	0.6	0.6	Negligible
Beef cattle and sheep meat	1.6	-3.7	5.3
Other animals	-0.5	-1.5	1.0
Dairy cattle	1.9	-0.5	2.4
Wool	-1.7	-3.6	1.9
Processed meat	1.7	-2.0	3.7
Processed other food	Negligible	-0.1	0.1
Processed milk	2.0	-0.4	2.4
Total Agriculture	0.8	-0.3	1.1
Total Food	0.6	-0.5	1.1

Source: ABARE GTEM estimates, 2010.

The impact of an offset market is projected to be largest for the livestock industries because as the most emissions-intensive industry it is forecast to receive larger offset payments as a proportion of the total cost of production. Overall, the conclusion from ABARE (2010) is that with an offset scheme for Australian agriculture, total production will increase and production costs decrease; however ABARE acknowledges that these results could change with the simultaneous introduction of a voluntary market.

This analysis can be considered to provide an indication of the upper bound of the positive effect of an offset market on farm businesses, particularly given the assumption of simultaneous global action. It should also be noted that this analysis is over the long-term, and over the initial stages it could be expected that uptake of mitigation activities (and therefore the positive impact on farm profitability) will be limited.

It should also be recognised that, based on available research, only those farm businesses located in high rainfall areas are likely to be able to consistently achieve positive changes in soil carbon levels, and therefore have opportunity to generate revenue from offsets.

For agricultural processors, an offset market provides greater opportunity to purchase credits and reduce the compliance cost of emission abatement. This introduces flexibility across the entire sector.

Participation, as outlined above in Gowen *et al.* (2010), is a barrier to the efficient operation of this policy option, with producers skeptical about risk and seeking a significant risk premium before opting in. One key concern is also compliance and the possibility of rules changing once farmers have agreed to participate. The government has a significant role to play in this instance, through communicating the function and regulation of the system, and providing assurance that compliance measures won't be changed without due notice.

New offset markets in Australia could include activities that are non-Kyoto compliant (as outlined above) or for reduced or avoided emissions that can be counted toward Australia's international emissions reduction targets (Eckard, 2010). This includes reduced nitrous oxide or methane emissions from changed practices in nitrogen fertilizer use, manure management or feed management. Of course farmers can opt-in to the CPRS to generate CPRS credits via reforestation. While initially the focus has been on CPRS-compliant offset generation through planting trees on farm, another of the offset areas that has been receiving significant interest of late is soil carbon. The risks and opportunities of both these options are outlined in greater detail below.

3.2.3. Soil carbon.

Carbon is constantly cycling through soil, with 'new' carbon being fixed from the atmosphere by plants, and soil carbon also being released to the atmosphere through a range of processes. The amount of carbon in a soil is a consequence of the balance between carbon inputs from plant residues, and carbon outputs as a result of the decomposition or mineralization of plant residues and soil organic fractions.. The amount of carbon in a soil is dependent on the amount of crop and pasture that can be produced. It is limited by solar radiation, temperature and availability of water; which are out of the control of farmers except in the case where irrigation is available (Baldock et al., 2007).

Soil organic carbon (SOC) is equivalent to humus or the organic fraction of the soil, exclusive of undecayed plant and animal residues (Kirkby, 2010). SOC is commonly categorised into three pools, and these are labeled the labile, slow and recalcitrant pools. Carbon in the labile pool is less stable (and therefore easily lost from the soil), but is progressively more stabile in the slow and recalcitrant pools. (Chan et al., 2010).

In order to determine the impact of changes in management practices on SOC, measurement of the all the different forms of organic carbon present is required, not simply a measurement of total soil organic carbon (Baldock et al., 2007).

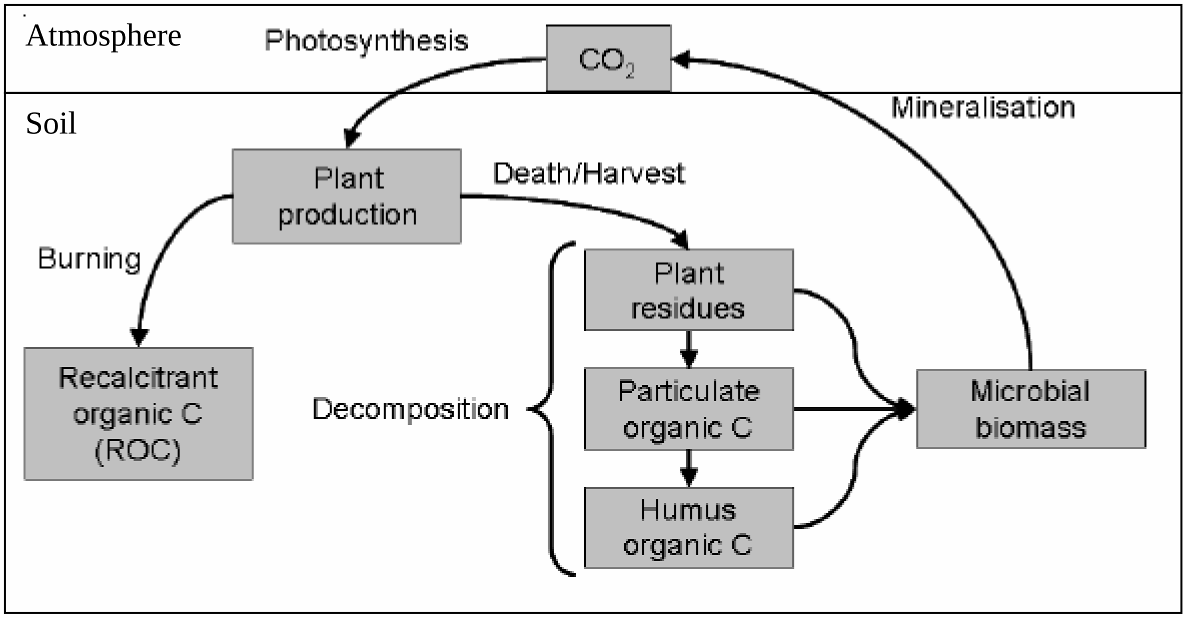

Figure 3 The soil organic carbon cycle
Source: Baldock et al., 2007

There is much interest in soil carbon sequestration because of the perceived productivity and environmental synergies associated with soil carbon sequestration. However, Luo *et al.* (2010) highlight that research quantifying changes in soil carbon as a result of conservation agricultural practices in Australia are inconclusive. For example, while Smith (2004) found no-till agriculture showed the largest potential of conservation practices used to increase soil carbon in Europe, Australian conditions are very different. Chan *et al.* (2010) provides an excellent overview of carbon pool estimates under different management practices, as shown in Table 7 below. The CSIRO (2009) estimates that of the 225 million tonnes CO_2-e that could theoretically be sequestered on rural land annually, only 10 to 15 per cent of that is likely to be achieved.

Research conducted by Meat & Livestock Australia in grazing lands in Queensland studied the effect of soil type and grazing management on SOC, and examined the most appropriate sampling strategy for estimating SOC (Henry and Dalal, 2010). It must be emphasized that the results of this research are preliminary, however the results are worth considering.

Analysing two individual paddocks, each with three soil types (Sodosol, Vertosol and Kandosol), it was found that soil type had a significant relationship with SOC. However, different grazing management systems had no effect on SOC over a twelve year period. These results highlight that before opting into a carbon offset scheme farmers need to carefully consider their farm situation, both financial and physical.

Other research has highlighted that SOC stocks can be extremely variable under pastures, even where pastures are in the same rainfall zone. In field trials conducted by NSW Industry and Investment, average SOC stocks (0-30cm) varied between 29 and 55t C/ha across all sites, and at individual sites within the same rainfall zone, SOC varied by up to 25tC/ha (Chan et al. 2010).

Table 7 Management practices that can increase soil organic carbon and their average sequestration rates

Agricultural activity	Management practice	Carbon sequestration rate (tC/ha/yr)
Cropping	Increase soil fertility	0.05-0.15
	Improve rotations	0.10-0.30
	Irrigate	0.05-0.15
	Eliminate fallows	0.10-0.30
	Use precision agriculture	Not available
Conservation tillage	Retain stubble	} 0-0.40
	Reduce tillage	
	Use no-till systems	
Grazing	Use fertilizers	0.30
	Manage grazing time	0.35
	Irrigate	0.11
	Introduce legumes	0.75
Addition of organic amendments	Add animal manure	0.1-0.6
	Add biosolids	1.0
Land conversion	Convert degraded cropland to pasture	0.8-1.1

Source: Chan et al, 2010; as adapted from Chan 2008

Rainfall is a limiting factor in carbon sequestration, so opportunities to sequester SOC through changes in pasture management or by sowing improved pastures are really only available in the high rainfall zone.

Of the many limiting factors in achieving higher of soil carbon levels, one of the most important is the availability of other critical elements. Eckard (2010) summarises this issue best, outlining that nitrogen, phosphorus and sulphur are all required to build soil organic carbon. There is a stable ratio of carbon to nitrogen, carbon to phosphorous, and carbon to sulphur that plants require in order to build soil carbon. These ratios and implications for the cost of increasing soil carbon are outlined below.

A limited supply of key elements could reduce the decomposition of plant residues and further increase the proportion of greenhouse gases emitted when residues decompose, and as such it is important for landholders to understand these issues if soil carbon trading is to be pursued (Kirkby, 2010).

Table 8 Potential costs associated with increasing soil organic carbon

Stable ratios of elements	1 tonne humus equals	So to build 1 tonne humus you need	Price of Carbon required to pay for elements required
Carbon/Nitrogen = 10 Carbon/Phosphorous = 50 Carbon/Sulphur = 65	60% Carbon 600kg Carbon 2.2t CO_2-e	600kg Carbon 60kg Nitrogen	Price to cover the cost of N only: $38/t$CO_2$-e

Source: Eckard, 2010

Examining soil carbon sequestration from a different perspective, McKenzie (2010) calculated the carbon price necessary to provide financial returns to match existing options for dairy pasture production. Assuming one tonne of pasture contains 45 per cent carbon, and that there is a 50 per cent decomposition rate, this creates 0.23 tonnes of soil carbon. Table 9 below shows the value of the tonne of pasture where it is used for four different outcomes. The results suggest that for soil carbon offsets to be economically attractive the carbon price would need to be at least $200/t$CO_2$-e.

Table 9 Value of different options for the utilization of one tonne of pasture

Uses for one extra tonne (dry weight) of high quality pasture	Approximate gross value of one tonne of pasture
Produce hay bales	$150
Feed to cows to convert to milk (750litres)	$260
Allowed to decompose on the soil surface to produce soil carbon (traded on a one-off basis at $25/t$CO_2$-e)	$21
Allowed to decompose on the soil surface to produce soil carbon (traded on a one-off basis of $250/t$CO_2$-e)	$206

Source: McKenzie, 2010

Research is forthcoming regarding historical rates of loss of organic carbon in soil, however as noted by Walcott *et al.* (2009), more information in required on the impacts of climate variability, its effects on associated greenhouse gases, the effects of farming systems and acidity or salinity on soil carbon, before a full trading system could be developed for soil carbon.

In addition, in order to be able to include soil carbon in a trading scheme there needs to be a means of monitoring, reporting and verifying soil carbon at scales which are meaningful in the context of carbon trading. Trading schemes also need to distinguish between contributions due to management, and those due to environmental change. All soil organic carbon tests detailed by Chan *et al.*, (2010) include measurement of fresh organic residues, so if these are not removed there can be large apparent seasonal and annual variations in apparent soil organic carbon levels. Suggestions as to techniques which could be included in the monitoring of soil carbon for trading (Canadell et al., 2007) include:

- Long measuring periods to accommodation climate variability
- Establishment of specific sites to monitor levels, and development of carbon response curves to management to extrapolate changes in similar sites
- Baseline scenarios or benchmarks, and
- Time-averaged carbon stocks

Lal (2009) also asserts that there is a strong need to measure soil organic matter concentration to a depth of at least 1m, preferably 2m. This is because there are depth-dependent changes in the SOM pool in response to management practices. For example changing to no-till from conventional tillage may increase SOM concentration on the surface soil but decrease it in sub-soil (Puget and Lal, 2004; Baker et al., 2007).

Under the Kyoto Protocol, carbon levels need to be maintained for long periods of time, 70-100 years in most cases. If soil carbon trading systems are to operate within the Kyoto Protocol, soil carbon levels would need to be maintained for this period of time. Unfortunately, none of the carbon pools – with the possible exception of biochar- are permanent over a period of 100 years under a range of Australian conditions (McKenzie, 2010).

Table 10 below summarises a literature review of management practices and reported soil organic carbon sequestration rates associated with these activities.

There are more than just biophysical considerations for farmers when determining the suitability or practicality of participating in an offset market, because participation also implies a competitive financial return. It makes sense that the economic efficiency of soil carbon sequestration depends on the site-specific opportunity costs of changing production practices, and the rate of soil carbon sequestration achieved. This was confirmed by Antle et al. (2001) through an integrated assessment of the potential for carbon sequestration in agricultural soils in the Northern Plains of the US; which extended economic analysis by linking it with ecosystem models which simulated soil carbon dynamics. This approach obtained an estimate of the marginal cost of sequestering soil carbon including the opportunity cost of changed practices; although this technique is entirely limited by the accuracy of the ecosystem model.

In 1997, Izaurralde *et al.* concluded that soil analysis would cost between C$10 and C$30 per sample in Canada. If applied to a 100ha field to measure changes of 1.5tC/ha, this would require prices of $7-21 per tonne of carbon. Chan *et al.* (2010) suggest the Leco test as the most suitable to determine soil organic carbon, though recognizing that this test can overestimate organic carbon present in soil samples. As part of this research, the Australian Farm Institute investigated costs of soil carbon testing for individual farms through commercial providers, and found the average cost per soil sample to be $103, this being for a normal soil carbon test and the Leco test. In addition, there is a further $30 cost for data reporting, although this can be spread over a large number of samples in a single batch. In terms of time for soil sample collection, taking into consideration time for travel between sample sites, it is assumed 4 samples could be collected in an hour. The rate for an accredited sampler is assumed to be $120 per hour or $780 for a 6.5 hour day. This equates to 26 samples in a day, at an average sample collection cost of $30 per sample.

Chan *et al.* (2010) recommend at least 20 soil cores be taken from the sampling area for accuracy. Taking this as a minimum number of samples, and assuming that an additional number would be required for larger areas, an assumption made in this research is that a reasonable soil sampling and testing requirement might be that a minimum of twenty samples is requires or 1 sample per four hectares – whichever is the greater. Using this rule of thumb, for a 100ha area 25 samples would be needed. For a 25 sample batch, the total cost (including sampling, testing and reporting) would be approximately $3,355.

It should not be assumed that farmers would need to test for soil organic carbon each year, however this provides some indication of likely cost for landholders contemplating participation in mandatory carbon offset markets. It is assumed that such testing would need to be repeated every five years in order to meet the requirements of a mandatory trading market (the same timeframe that has already been proposed for forestry offsets.)

There are additional items of cost for farmers to consider when deciding whether to opt into a market which pays them for reduced or avoided emissions, or soil carbon sequestration. The first is the opportunity cost of changing practices, the second is enforcement of contracts, administration and monitoring. Mooney *et al.* (2002) suggests per hectare payments aren't as efficient as per tonne payments, because they (per hectare payments) provide an incentive to change practices regardless of carbon sequestration rates.

The introduction of policies which encourage farmers to market the sequestration of carbon in soil may introduce significant levels of risk to farm businesses unless the upper limits of sequestration are identified, measurement issues addressed and liability due to natural events is understood and incorporated into policy settings.

If in the absence of an emission trading system, best management practices are mandated to achieve emission reductions in agriculture, expectation of mitigation opportunity through soil sequestration needs to be managed, and associated environmental effects understood. As concluded by Walcott *et al.*, there are significant issues for agriculture and forestry associated with soil carbon trading, in that the net benefit of sequestration may not be as large as first expected, and individual land managers will require information and tools to allow them to trade relatively small amounts of carbon. Without further information, the risk of this approach in Australian conditions outweighs the potential benefits.

Table 10 Literature review of management practices and reported soil organic carbon sequestration rates associated with these practices

Category	Management practice	Carbon sequestration (tC/ha/yr)	Reference
Crop management	Irrigation	0.05-0.15	Lal *et al.* 2003; Chan *et al.*, 2010
	Fallow elimination	0.10-0.30	Lal *et al.* 2003; Chan *et al.*, 2010
Conservation tillage	Stubble retention	0-0.4	Lal *et al.* 2003; Chan 2008, Chan *et al.*, 2010
	Reduced tillage	0-0.4	Lal *et al.* 2003;, Chan *et al.*, 2010
	No-tillage	0-0.4	Lal *et al.* 2003; Chan *et al.* 2008, Chan *et al.*, 2010
Pasture management	Fertiliser management	0.30	Conant *et al.* 2001, Chan *et al.*, 2010
	Grazing management	0.35	Conant *et al.* 2001, Chan *et al.*, 2010
	Irrigation	0.11	Conant *et al.* 2001, Chan *et al.*, 2010
	Introduction of legumes	0.75	Conant *et al.* 2001, Chan *et al.*, 2010
	Sown pasture	0.50	Gifford *et al.* 1992
	Average for improved pasture management	**0.55**	**Chan *et al.* 2008.**

Source: adapted from Chan et al., 2008; Chan et al. 2010.

3.2.4. Forestry.

Another offset option for voluntary markets or emissions trading schemes is forestry. The removal of carbon dioxide from the atmosphere by growing trees is recognised as an emission offset in many carbon markets, and the Government has proposed that carbon offset forestry will be recognised as a way of earning emission permits under the proposed CPRS. In its analysis for the Australian Government Treasury report *Australia's low pollution future*, ABARE suggested that depending on the price of carbon, the area of agricultural land that could be used for timber plantation could increase to 4.5million hectares, and 21.8million hectares of environmental plantings (Lawson et al., 2008).

This research was revised in 2008, with Burns *et al.* (2009) considering some of the issues associated with afforestation potential, such as competition for land use and environmental restrictions on land use change. Qualifying the earlier research results as the "upper bounds" of land use change, this later research found that with a carbon price starting at \$20/tCO_2-e in 2010 the area of land economically competitive for forestry between 2007 and 2050 would be 5.1million hectares, and with a price scenario starting at \$28t/CO_2-e it would be 25.7million hectares. This report analyses only the economic factors (such as gross margins per hectare) considered in making a decision to change land use. Obviously there are many other factors that come into consideration for a landholder making such a decision, however the results identify that the introduction of a carbon price could substantially change land use in Australia.

One aspect influencing land use change in the last decade in Australia, is Managed Investment Schemes (MIS). Under these schemes, investors can minimize their tax by deferring tax liabilities until income is received, which for forestry may be more than a decade in the future, by which time the investor's income may be in a lower tax bracket (Ajani, 2010). In 2009 there were 198 registered plantation Managed Investment Schemes (ASIC, 2009), and it is estimated that up to one-third of Australia's plantation estate is controlled by managed investment schemes. (Gavran and Parsons, 2008). In recent times, three corporate collapses have been associated with MIS, these being Environinvest Limited, Timbercorp Limited and Great Southern Limited.

The MIS industry has been criticized for distorting land use decisions in specific regions. Ajani (2010) estimated the gross subsidy to forestry through plantation MIS to be between $0.9 and $1.2billion over the five year period ending 2008. The research considers this a subsidy-driven distortion of land use, and concludes that under proposed climate change policies this distortion is likely to be exacerbated.

The Australian Farm Institute has contracted to GHD Hassall to review existing modelling of potential land use changes in agricultural areas arising from the development of a market for greenhouse emission offsets in the form of permanent plantation trees (GHD Hassall, 2010). The research has not been concluded, however some preliminary findings are interesting to note. The report suggests permanent carbon sink plantations are likely to be established on lower value agricultural land in the low-medium rainfall areas of Queensland, NSW, and northern and SW Western Australia, while commercial timber plantation expansion is expected to continue in traditional plantation areas. The report also identifies that none of the States or Territories has a specific development approval process for carbon sink plantations, although two recognize in their planning legislation there is potential for trees to be planted for carbon benefits.

Under the Kyoto Protocol and its associated rules, for an area to be recognised as a carbon sink forest it must be at least 0.2hectares or greater in size, contain trees which have a potential to reach at least 2metres height, at least 20 per cent of the land area involved must be covered bt the crowns of the trees, and the forest must have been established on land that was clear of trees on 1 January 1990.

In considering the costs associated with the development and maintenance of carbon sink forests, Polglase *et al* (2008) estimated that: upfront carbon management costs, which include registration and lawyers fees, could be in the order of $10 per hectare; while ongoing costs including monitoring and accounting could be $40 per hectare per year; and pooling costs around $2.50 per hectare per year. This is presented in Table 11 below, which considers uncertainty by showing minimum and maximum input values.

Table 11 Assumed costs and revenues resulting from management of environmental plantings in southern Australia with rainfall of >550mm

Assumptions	Minimum	Average	Maximum
Costs			
Establishment ($/ha)	100	800	3,000
Post-establishment ($/ha)	75	150	300
Management ($/ha/yr)	0	40	200
Set up of carbon fund ($/ha)	0	10	100
Annual pooling cost ($/ha/yr)	0	2.5	20
Revenue			
Price of carbon ($/t$CO_2$-e)	2	20	60
Yields			
Yield at first commitment period end (tCO_2-e/ha)	55	338	705

Source: Polglase et al 2008

This analysis was conducted at a national scale and it is difficult to apply these results at the on-farm level, however it provides some indication of cost associated with opting into forestry offsets. The costs will obviously vary year-on-year, as the forest would not need to be established each year, however the yield will also vary year-on-year. Farmers would also need to consider the opportunity cost of converting land to this purpose, in addition to the costs detailed above.

The greatest risk for landholders in opting to provide offsets compliant with the international accounting rules is that if carbon is lost on this land (for example through bushfire) and not replanted, the landholder may be accountable for that carbon. This means a landholder will not be able to decide to change land use after opting into the scheme, without attracting a large financial penalty. If the landholder subsequently decided to sell the land, there is a third-party right to the property which must be recognized which is that of the entity which purchased the carbon in the trees. Conditions between regions, even between paddocks, will vary considerably, and the carbon sequestration rate will in turn change between different areas. Again, landholders will need to consider their individual situation and environmental conditions before opting to provide carbon offsets. There are, therefore, significant risks in this offset option, yet as outlined above the demand for agricultural land as a result of the current policy, will be substantial.

4. Baseline and credit systems.

Baseline and credit schemes involve the establishment of an industry-wide “baseline” level of emissions, and the imposition of penalties for businesses that exceed baseline emission levels, and credits for those businesses that produce less than the baseline level. The baseline may be set in terms of the absolute level of emissions that each participant business is allowed to produce, or the emissions intensity (emissions per unit of output) of the businesses. The baseline is generally set below the business-as-usual emission level, to encourage emission reduction (Price Waterhouse Coopers, 2008). Participants are required to report their emissions over what is termed the acquittal period. At the end of an acquittal period those participants with emissions below the baseline are issued credits and these can be sold to participants whose total emissions are above the baseline.

Some general observations regarding this approach are that an increase in production will result in an increase in emissions, so delivering a specific emission outcome under such a scheme can't be guaranteed. If, for example, there was an aggregate emission reduction target imposed on the livestock sector, this approach would not ensure the goal was reached year-on-year. An increase in livestock numbers would result in an increase in emissions, even if average emissions per head of livestock is decreasing.

As an example of the uncertainty that exists under a baseline and credit approach, Ellerman and Wing (2003) compared the effect of baseline and credit schemes and cap and trade schemes, simulating the effect of each on the European Union countries. To introduce uncertainty, they varied GDP growth rates by 25 per cent around the expected values. The results show that intensity limits are more demanding than absolute limits if actual GDP/output is less than expected. The emission outcome is also much more variable under baseline and credit, and there may be a 'rebound' effect in that less emission intensive activities are effectively subsidized and with more of that activity being carried out overall emissions may increase. In terms of cost-efficiency per emission reduction unit, uncertainty year-on-year because of shifting environmental outcomes means this will vary over periods.

The cost of establishing baselines for facilities would also be significant. One way of avoiding this is to introduce 'average' estimations for activities, which can have the effect of penalizing efficient producers. The issue of averages of emissions estimation is one the livestock sector currently faces, as emission factors used in the emission accounting methodologies are usually state-based averages. Not every farm or every animal will fit the 'average', and the way in which they are determined is critical. There is little flexibility in this approach when averages are used to classify businesses.

Trade amongst participants in a baseline and credit scheme is not as prevalent as is the case under a cap and trade scheme, as the system delays crediting until after the event, so limiting future trade. There is therefore a barrier to participating in trade for participants. Compliance is ensured through the need to pay for emissions above the baseline, which may not be equitable unless production practices which are less emission-intensive are recognized and rewarded. Also international linking of schemes is unlikely under this approach, as a credit in a cap and trade scheme will not be the same as one in a baseline and credit system.

There is a potential advantage for the livestock sector under a baseline and credit scheme. Under such a scheme consumers don't have any incentive to reduce demand for emission intensive goods, as it doesn't necessarily penalize activities or goods to the same level, as each facility will have its own baseline and emission target to reach. As a relatively emissions-intensive product, livestock products may face less reduction in consumer demand as a result of this approach, than might be the case under other emission reduction schemes.

5. Direct payment for environmental services

In meeting the demands of society for environmental services, someone must pay. 'While society as a whole may benefit from preserving biodiversity, someone must pay to provide those benefits.' (Boyd and Simpson, 1999): There are various policy mechanisms by which environment can be protected or enhanced. Regulation is one, which means focusing on setting of standards backed by penalties for non-compliance (Pannell, 2005). In a sense, regulation is similar to the polluter-pays principle underpinning the emissions trading scheme, in that standards are set and variation from those will incur a cost. Regulations often mean landholders focus on compliance, at the expense of looking for less costly options (Industry Commission, 1998). Regulation is often assumed to ensure mandatory participation, however it should be noted that even regulation that sets standards for environmental management can be viewed as voluntary in compliance is not enforced. (Pannell, 2005).

A regulatory approach to achieving environmental outcomes does not reward compliance, and as seen in the case of environmental landuse regulations, the cost burden falls on the landholder. There are opportunities for cross-compliance, such as the requirement for a level of environmental management as a condition of eligibility for other government programs, such as first introduced in the US in 1985 under the title 'conservation compliance' (Davies and Hodge, 2006). However, the cost of compliance isn't removed by this approach, rather it is offset by other payments.

Direct regulation has the advantage of achieving a specific environmental outcome, with little uncertainty for businesses. However there is no opportunity for compensation to limit leakage, and little flexibility in the absence of market mechanisms. As noted by Pannell (2005), policies that are designed without sufficient flexibility are likely to be ineffective and costly.

Support provided to agricultural producers is becoming increasingly conditioned by requirements to follow certain production practices in pursuit of broader objectives, such as preservation of the environment (OECD, 2009). Payments involving the fulfillment of such requirements comprised 4 per cent of OECD aggregate Producer Support Estimates (PSE) in 1986-88, a share which had increased to 32 per cent by 2006-08, with the majority of such payments currently provided in the European Union.

In the case where environmental stewardship is viewed as an alternative to the CPRS, it is assumed that payments would be for practices which reduce or avoid greenhouse gas emissions or sequester carbon. The core of this model is the concept that external parties pay for environmental services through direct, contractual and conditional payments (Wunder, 2005). Through the basic concept of paying for conservation, restoration or changed practices, there is a recognition that trade-offs exist between land use pressures and this model seeks to reconcile these trade-offs through compensation. It also needs to be remembered, however, that other trade-offs also exists in the case of environmental payments. For example, providing payments for carbon sink forests could lead to the establishment of plantations of fast-growing trees that have a negative impact on biodiversity.

A direct payment approach, applied only to the agriculture sector, could work through various models, but the primary principle is that financial incentives are introduced to encourage delivery of environmental services. An example of this is direct payment by government to landholders who can prove they provided environmental services which comply with predetermined guidelines or standards. In this case, it could be expected landholders would need to provide annual statements detailing the actions they have undertaken that are producing environmental services, and could expect verification to be required at regular intervals. A less tangible model for this policy approach would be development of technology, with direct payment to encourage uptake on-farm. This is a longer-term option, however it could include new management practices developed and verified as delivering an environmental benefit. Another example could be an accreditation program, where production practices are audited and reviewed according to industry standards. Once accredited, the producer may be able to access additional premium markets, which provides a direct financial incentive for adoption of environmental services as part of a production system.

To be counted toward the national greenhouse gas inventory, environmental services provided by landholders would need to include activities that are counted under international greenhouse accounting methodologies, and as such these are currently limited. It could be assumed the government would be the primary buyer in this case. If the services do not fall under the current accounting methodologies, it can be assumed they would be paid for by individuals or companies voluntarily paying for these services.

Creating a reputable and profitable market requires a significant pool of buyers and sellers, and for that clear verification, monitoring and payment systems need to be developed. As stated by Wunder (2005), the willingness of buyers to pay will only increase if schemes can clearly demonstrate additionality from well established baselines. To ensure the link between environmental outcome and land management practices is robust, significant research must be carried out. Voluntary systems of payment for environmental services have been established (see above), however for historical information on the uptake and attitudes of farmers to adoption of new land management practices, the system of best management practice (BMP) provides an example.

Prokopy *et al.* (2008) produced the first paper synthesizing adoption literature on BMPs to apply consistent methodologies to assess their success, looking at 55 studies over 25 years (from 1982 to 2007). The focus of the study was narrow, being only US-based systems, however it was found that land area was positively correlated with BMP adoption, education was more likely to have a positive influence on adoption, yet farm income was not correlated with adoption. However, the review also found that farmers who perceive a practice will be profitable are more likely to adopt than others. What this shows is that education for landholders regarding the system and the method of payment for services is critical to participation, and clear financial incentives are crucial.

Comparing voluntary and regulatory approaches to natural resource conservation, Brant (2000) found that many landholders wanted to adopt conservation but were hampered by high social and/or economic costs, stressing the importance of adequate monetary compensation to ensure benefits outweighed costs. However, voluntary and regulatory approaches to BMP are not mutually exclusive. A system could be developed by which regulation is imposed with voluntary programs included to attract the attention of landholders and encourage adoption. This is particularly the case as government policies have an important role to play in influencing farmers' receptivity to land conservation programs by legitimizing the programs (Kabiii and Horwitz, 2006).

The Australian beef industry has significant experience in the process of implementing quality assurance and best practice programs. The nature of the product being sold by the industry means that quality and food safety standards are crucial; without them consumer confidence both domestically and internationally may erode. The Australian National Livestock Identification System was implemented for this reason, but may also have a role in greenhouse gas mitigation by making it possible to track animals moving between properties, and providing a national database through which production details could be retained.

A direct payment approach is flexible in terms of producers being able to both opt in, and also to choose which BMP or activity is best suited to their production system. It is equitable in that participation is by choice, however participation will, by necessity, be limited to businesses which can deliver environmental outcomes. For processors, there is significant opportunity and flexibility in being able to select suppliers who carry out BMPs, to reduce the indirect emissions associated with their business. For processors to want to be involved in this model, producer compliance would need to be regularly verified and measured.

For livestock producers, the opportunities arising from a system of environmental stewardship payments is the potential to obtain financial return from activities that also have productivity benefits. There has been shown to be synergies between the two by Westra (2003), who evaluated effects on net farm income and water quality of specific BMPs. That research found that the cost of not implementing the BMPs was smaller than the negative impacts of BMP adoption on net farm income.

There is a risk associated with changing land use or management practice with the sole aim of being paid for the environmental service, when the market in Australia is largely untested. It is critical to ensure one goal isn't pursued to the detriment of another. Also there is the potential for property rights to be eroded by the sale of outcomes, as it sets up an additional claim on land. For instance, land that is going to be planted to trees may be leased from the landholder under an agreement whereby the right to the trees on that land belongs to the leasee. If the leasee sells the carbon in those trees, there are essentially three different sets of property rights associated with that land which need to be considered in future management decisions.

6. Research and development

Most policy models to address climate change use greenhouse gas emission reduction targets and timelines for their completion. The way in which these targets are reached is different, but the underlying principle remains the same. Another way to address the issue is to create incentives for new technologies and management practices through a concerted greenhouse emission research and development policy. Barrett (2002) suggests this, in an approach that includes a protocol for collaborative research and common standards for technologies. The clear advantage of this model is that it would reduce the cost of developing new technologies, and these could be disseminated through technology transfer facilitated by the protocol, making the approach equitable across industry.

Canes (2006) proposes continued research and development in new technologies, with supporting policies such as federal government agencies experimenting with the technologies to expedite the process of adoption, and encourage government agencies to publicly report their emissions and plans to reduce them. Canes states this policy approach will not constrain GDP growth, which may occur where models sacrifice other goals in pursuit of emission reductions.

Another, similar, approach is that of Benedick (2001), who also suggests incentives for technology innovation and diffusion, with a small carbon tax used to fund new technology research. The two models are relatively similar, and both present the same issues. The first issue is that research would essentially need to lock in to technologies early on that were perceived to be ‘winners’, removing an element of flexibility that is will undoubtedly be needed in future to look at emerging challenges or to respond to new information. The second issue is that this approach won’t necessarily prove to be cost-effective in the long term, unless a technology can be developed that can be adapted to many production systems, industries and countries. Of course this can’t be guaranteed, and disseminating such technologies to many countries, some of whom may be competitors, will reduce the domestic benefit of this approach.

Policymakers may be skeptical this approach could work on a broad environmental issue, however, there are examples of international protocols whereby the development and dissemination of technology enabled an environmental agreement to reach its goal. For example, over 60 countries participated in the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol). The main focus of this Protocol was on chlorofluorocarbons (CFCs); which were understood to be depleting the ozone layer in the atmosphere.

With the development of hydrochlorofluorocarbons as a replacement for CFCs, the results of the Protocol have been nothing less than spectacular. As of 2006, the 191 Parties that had ratified the Montreal Protocol had, in aggregate, reduced their use of ozone-depleting substances by approximately 95 per cent, with developing countries also reducing their use by 72 per cent. The Montreal Protocol demonstrated that the availability of suitable technology is a critical incentive to encourage developing countries to accept such commitments (Benedick, 2001).

The issue for livestock producers and processors is in many ways much more complex, because of the multifaceted interaction between the carbon cycle and agricultural production. The challenge agriculture faces in this regard was clearly stated by Shellenberger *et al.* (2008), who said that in order to free energy and food production from the issue of climate change, they must be separated from greenhouse gas production. To do this, new technologies must be developed. For the livestock industry, research and development has been a key to driving productivity improvement and reduce emissions associated with production and processing. However, expecting government to rely only on research which by necessity will be long-term, is not a sound approach. The sector will be expected to address emissions in the short and long term, therefore research and development is an important element of a policy proposal, but cannot be its only ingredient.

7. Coalition 'direct action' policy

The Coalition's recently announced direct action policy package to reduce greenhouse emissions is a hybrid of a number of the above policy measures. The 'Direct Action' policy outlines an intention to deliver about 85 million tonnes per annum of CO_2-e abatement through soil carbon sequestration by 2020. In addition, the policy aims to re-establish "green corridors" and urban forests to facilitate the planting of an additional 20 million trees by 2020. These abatement activities will be supported through an Emissions Reduction Fund, based on the National Greenhouse and Energy Reporting Scheme (NGERS).

The estimation of the carbon sequestration potential of Australian soils contained in the 'Direct Action' policy is based upon the findings of the Garnaut Review[1], the CSIRO[2], the Wentworth Group[3], State Governments[4]; and other groups[5].The policy proposal states that 'submissions to the Coalition from farm groups support the potential for a minimum 150 million tonnes of CO_2-e per annum to be captured in soil carbons by 2020 and beyond, with a payment to farmers of approximately $10 per tonne.'

The CSIRO (2009) estimates that of the 225million tonnes CO_2-e that could potentially be sequestered on rural land annually, only 10 to 15 per cent of that is likely to occur. In addition, Gowen *et al.* (2010) conducted experimental auctions and found that significantly higher than breakeven prices for carbon would be required before landholders would participate in carbon offset markets, putting a significant risk premium on the activity. Luo *et al.* (2010) conducted an extensive review of research on carbon change as a result of cultivation worldwide and in Australia. The conclusion from combining data of over 20 published studies across Australian agro-ecosystems was that cultivation has led to significant loss of soil carbon. Luo *et al.*, found that specific farm strategies could be developed to generally increase soil carbon, but the same strategies could have different results on soil carbon with different climatic and soil combinations. This research also concluded that no consistent trend of increases in soil carbon was found over the period during which specific farm strategies were employed.

Based upon the general costs of increasing nitrogen, phosphorous and sulphur to the levels required for soil carbon sequestration (noted earlier), the price paid for soil carbon would need to be much higher than $10 per tonne in order to make this policy proposal attractive for farmers. In deciding to opt in to a system such as is proposed by the Coalition, farmers would also need to be aware that once the rights to carbon in soil are sold to another person, there is a responsibility on the seller to maintain those soil carbon levels indefinitely, and not to adopt

[1] Ross Garnaut, The Garnaut Climate Change Review Final Report, (2008).
[2] CSIRO, "Analysis of Greenhouse Gas Mitigation and Carbon Biosequestration Opportunities from Rural Land Use," (2009).
[3] Wentworth Group of Concerned Scientists October, Optimising Carbon in the Australian Landscape, (2009).
[4] Access Economics, Report Prepared for the Council for the Australian Federation, (May 2009).
[5] Including the Bio CCS Consortium of Australian companies, comprised of MDB Energy, Ignite Energy Resources, Soil Carbon, Plantstone Technology, Ocean Nurishment and Environment Business Australia. Email to the Shadow Minister for Climate Action, Environment and Heritage, (20 and 31 January 2010).

any management practices (such as cultivation or increased grazing pressure) that would result in soil carbon levels being reduced.

Given the natural variability of soil carbon under Australian climatic conditions, the environmental outcome from pursuing such high levels of abatement through soil carbon is questionable. As identified by Walcott *et al.* (2009), measuring organic soil carbon directly is currently difficult and expensive, and uncertainties in measurement mean it's difficult to bundle soil carbon into tradable units. Luo *et al.* (2010) also identify that the long-term impact of conservation agriculture practices on soil carbon change is still inconclusive. All these factors combined mean the risk for landholders in selling rights to verifiable and permanent soil carbon which is expected to be permanent in the landscape seems at present to be too high.

With regard to the carbon sink forestry proposal, 20 million hectares is approximately the upper bounds of economic suitability of land conversion from agriculture to forestry with a carbon price starting at \$28/tCO_2-e, according to Burns *et al.* (2009). The area of plantations in Australia at 2007 is about 1.9million hectares (*Ibid.*), which provides an indication of the amount of land use change that would be expected under the Coalition policy.

There is a significant lack of flexibility under both sequestration options available through the Coalition policy, as each is required to be a permanent sequestration. As such if the landholder wanted to convert land from forest they would need to pay for the loss of carbon, and if there was a reduction in soil carbon levels a similar loss would occur, leaving the farmer liable. There are certainly opportunities available; however the level of technological support and further investigation of the soil carbon cycle required is quite substantial, as is the need to find ways to separate natural and human-induced changes in soil carbon.

The cost of compliance, administration and verification would be relatively high (compared to returns) under a voluntary offset scheme which included soil carbon, and this would also apply to the Coalition policy (given the projected carbon price that would apply). With increasing awareness and education about the risks involved with this approach, it is unlikely the participation rates among farmers would be very high, unless new technologies for measurement are developed and there is a significant growth in knowledge about the factors that impact on soil carbon levels.

8. Conclusions.

No single policy approach satisfies all criteria while offering substantial opportunities and minimizing risk for landholders. This reflects the fundamental tension between some of the criteria against which different policy approaches need to be evaluated. For example, cost-effectiveness and environmental outcomes usually involve a trade-off, as do flexibility and compliance. Table 12 below provides a summarised assessment of each of the policy options against six evaluation criteria, from the perspective of the livestock industry.

Based on this assessment, it appears that policy approaches that utilise either an environmental services auction system, or provide payments for environmental stewardship actions provide the best option for livestock producers, with least risk. It is assumed that under either of these options, landholders would have the option of voluntary participation in a scheme. Ideally, the scheme would involve the development of a ‘package’ of different actions available for landholders, who would be able to choose to adopt the elements of the package that best suits their production system. Under the scheme, landholders would receive payments for actions recognised as generating environmental benefits, some of which would include actions to sequester or abate greenhouse gas emissions.

Having a scheme that provides payments for a variety of environmentally-beneficial actions in addition to carbon sequestration would be an advantage for several reasons. The first is that it would avoid the potential distortions in landholder decisions that would arise in having payment available for just one specific environmental service (carbon sequestration), but not for any other. It is not difficult to envisage situations where a decision to maximise revenue from carbon sequestration could have negative impacts on other environmental values, especially over the longer term, and this needs to be avoided given the anticipated timeframes that will be involved.

A second advantage in packaging carbon sequestration with other environmental services is the efficiencies in measurement, verification and reporting that are likely to be available in the case of a multi-faceted system, as opposed to one with a narrow focus. A key cost in any system is likely to be the cost associated with a visit by an auditor or verifier, and that cost is likely to be much higher during the initial stages of a scheme if adoption rates are low. Having a scheme with multiple income streams available for a range of environmental services should speed initial rates of adoption, but also mean that participation costs are low, relative to potential income.

Involvement in a scheme which includes income streams from a range of different environmental services should mean that individual landholders are exposed to less risk than would be the case with a scheme focused solely on carbon sequestration. Even if measurement or verification identified that rates of carbon sequestration (in soil or by trees) were not as high as anticipated initially, the income stream arising from other environmental services included in the package of services contracted by the landholder should still make participation financially viable.

There should not be any disadvantage in the inclusion of carbon sequestration or abatement in a package of environmental services provided by landholders from the perspective of Governments. The nature of international and domestic greenhouse emission accounting methodologies is such that specific actions that modify emission or sequestration rates can be recognised, and the change in emission arising from the adoption of that action can be incorporated in national emission inventories.

In effect, this would mean that Governments could ‘pool’ the aggregated net change in emissions arising from the environmental services scheme and recognise Kyoto Protocol compliant changes in the national greenhouse emission inventory. This would mean less risk for individual landholders and for Governments, in that seasonal or other factors that may affect emission or sequestration rates in a particular region would normally not be affecting all regions of the nation simultaneously.

Table 12 provides a summary of the assessment of alternative policy options, from both a national and a landholder perspective.
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Table 12 Summary of the implications of each policy approach under six criteria (risks and opportunities presented separately).

Model	Environmental outcome	Cost-efficiency (national)	Equity	Flexibility	Participation and Compliance	Risks for livestock sector	Opportunities for livestock sector
CPRS	✓✓	✓✓✓	✓	✓✓	✓✓✓	✘✘✘	✓
Consumption tax	✘	✘	✓✓	✘✘	✓✓✓	✘	✓
Environmental services auction	✓✓	✓✓✓	✓	✓	✘	✘	✓✓✓
Voluntary offset market	✓✓	✓✓	✓	✓	✘✘	✘	✓✓
Baseline/Credit	✘	✓✓	✘✘	✘✘	✓✓✓	✘✘	✓
Direct regulation of emissions	✓✓✓	✘✘	✓	✘✘✘	✓✓	✘✘✘	✓
Emission tax	✓	✘	✓	✘✘✘	✓✓	✘✘	✓
Environmental stewardship payments	✓✓	✓✓	✓	✓✓	✘	✘	✓✓✓
Research and development	✘	✘	✓✓	✘	✓	✘✘	✓✓
Coalition "Direct action' policy	✘	✓	✓	✘✘	✘	✘	✓✓

Section II – Limited financial modelling of farm-level impacts.

1. CPRS applied economy-wide, including agriculture.

Since the economic modelling analyses outlined above in Section 1 were completed, there have been additional changes announced to the CPRS. The Australian Farm Institute has conducted a subsequent analysis of the potential financial implications of the CPRS, as it was designed at March 2010 for livestock producers. The modelling starts in 2011, projecting out to 2030. It is now evident the earliest the scheme will be introduced is 2013, however it is still prudent to consider the policy as it is currently designed.

The analysis reported here has examined the implications of the CPRS for the Australian livestock sector, using eight model farm businesses, three future greenhouse emission price scenarios, and three potential modes of engagement for the agriculture sector with the CPRS. While it is now known agriculture will be excluded indefinitely from the scheme, it is important to model the potential implications of full engagement by agriculture in the CPRS, as a baseline for comparison with other emission reduction policy options.

The assumptions underlying the following analysis need to be carefully considered, and the outcomes need to be qualified by stressing that they represent the potential impact of this particular policy measure and associated assumptions when considered in isolation; rather than as part of a dynamic and interrelated economic system. The modelling is relatively static, in that no change in producer behaviour, enterprise mix or farm activity is accounted for. As such the results provide an indication of the potential scale of challenge that each policy option presents to agriculture, rather than a projection of likely future farm returns under each model.

1.1. Major assumptions

During the initial stages of the CPRS, it is proposed that those direct emitters of greenhouse gases in the stationary energy, fugitive emissions and waste sector, which produce net emissions in excess of 25,000 tonnes CO_2-e per annum, will be required to become participants in the scheme. As CPRS participants, these businesses will first be required to use standard calculation methodologies to estimate their annual greenhouse emissions, and then will be required to purchase government-issued greenhouse emission permits equivalent in number to the net tonnes of greenhouse emissions generated by their business each year. A progressively decreasing number of emission permits will be made available for purchase by the government each year, which will result in an increase in emission permit prices, creating greater incentives for participants to reduce their net emissions.

Major fuel distributors will be required to be participants in the CPRS, and will need to purchase emission permits each year, equivalent in number to the tonnes of emissions it is estimated the fuel they distribute has created. The government has announced that existing excise rates applicable to fuel and the rebate rate applicable to off-road fuel use will be adjusted over the first three years of the CPRS so that there will be no net impact on fuel prices during that period.

Three different scenarios were modelled in this research, and these scenarios are compared with a base-case (business as usual) which assumes that no CPRS is introduced. These scenarios are summarised as follows;

- BAU - Business as usual, assuming that no ETS is introduced.
- Uncovered - The CPRS is introduced but agriculture remains an uncovered sector.
- ETS - Agriculture is a covered sector in the CPRS post 2011, with farm businesses required to purchase emission permits equivalent to their estimated emissions.
- ETS (EITE) - Agriculture as a covered sector post 2011 with Emissions-Intensive Trade-Exposed (EITE) status. EITE assistance rates will commence in 2011-12 at 94.5 per cent for highly emission intensive activities and 66 per cent for moderately emission intensive activities and decline at an annual rate of 1.3 per cent per annum. The government's 'global recession buffer' will be integrated into base assistance rates and will not be removed after 5 years.

Timeframe
The modelling commences in 2011, and projects forward to 2030.

National emission reduction targets
Three national emission reduction scenarios were modelled; the first where emissions are reduced by 5 per cent of 2000 levels by 2020, the second by 15 per cent and the third by 25 per cent. The modelling uses emission and electricity prices under each of these scenarios as reported in modelling by Treasury for the Australian Governments' White Paper on the Carbon Pollution Reduction Scheme (Australian Government Treasury, 2008).

Emission prices
A key variable in modelling the impact of these policy measures is the potential price that will apply to greenhouse emissions, as reflected in the price paid for permits by those businesses required to participate in the CPRS. The emission prices used in this modelling have been taken from Treasury modelling for the two emission reduction scenarios of 5 per cent and 15 per cent, and the Garnaut Report modelling for the 25 per cent emission reduction scenario. Since Treasury modelling was completed, the government announced that for the first year of the trading scheme (the 2011-12 financial year) the price of emission permits will be capped at $10. As a result, the modelling reported here holds the carbon price at $10/tCO$_2$-e for the first year of the scheme, and then from the 2012-13 financial year, the emission price follows that projected by Treasury and Garnaut. The projected carbon prices are shown below in Figure 4.

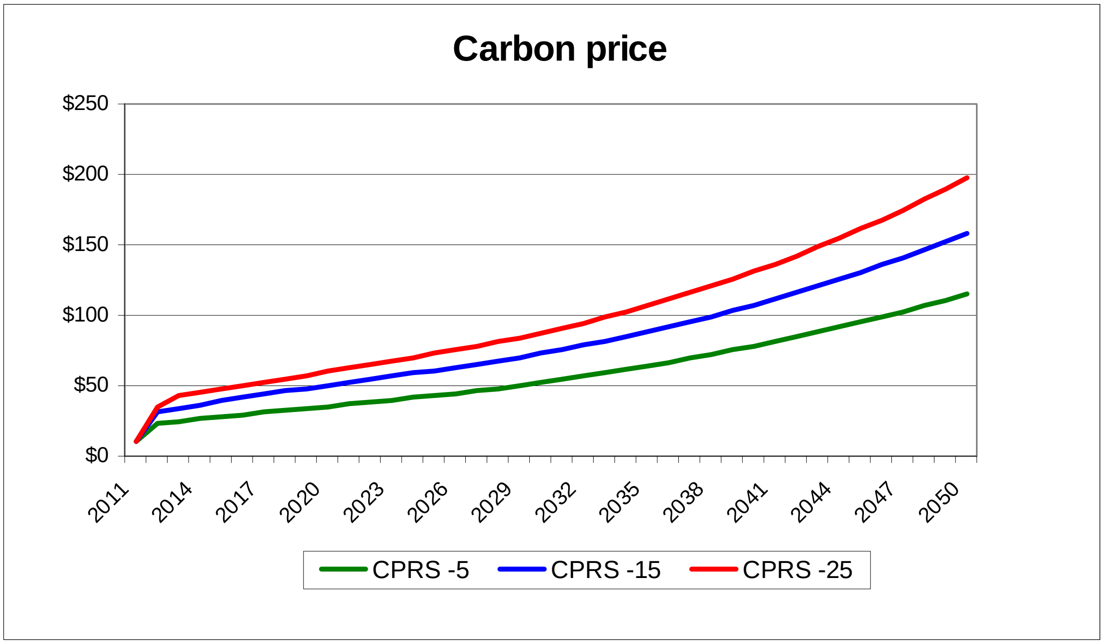

Figure 4 Carbon price under three emission reduction scenarios

Electricity and fuel price increases
The results of earlier Treasury modelling have also been used as the basis of projected fuel and electricity prices, although also incorporating specific Government announcements that have subsequently been made, such as the pledge to reduce fuel taxes by an equivalent amount to CPRS-induced increases over the first three years of the CPRS.

Fuel prices are assumed to be $1.30 per litre in 2011, and for the first three years of the scheme will remain unchanged. For electricity, earlier Treasury modelling provided projections of wholesale electricity prices. Wholesale electricity prices are approximately half the price of electricity for retail consumers, with the other 50 per cent of retail prices being the costs associated with electricity distribution. For the purposes of this modelling, projected future retail electricity prices have been calculated by doubling projected wholesale electricity prices under each of the three carbon reduction trajectories. Projected fuel and retail electricity prices under the three emission reduction scenarios are displayed in Figures 5 and 6 respectively.

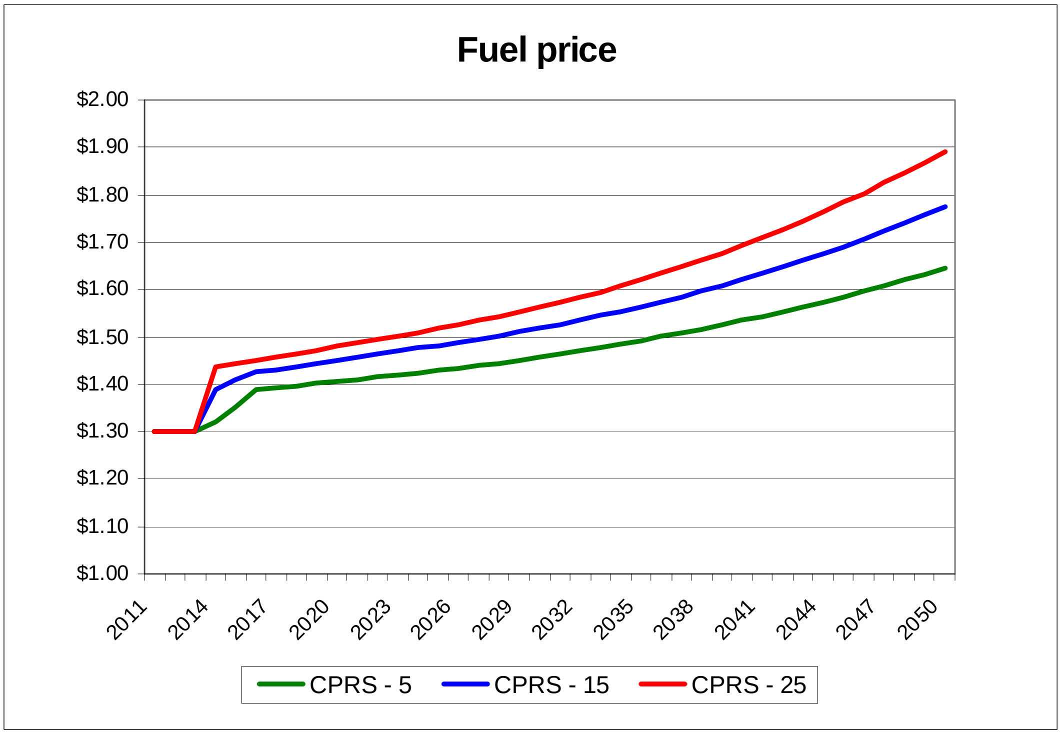

Figure 5 Fuel prices under the three emission reduction scenarios

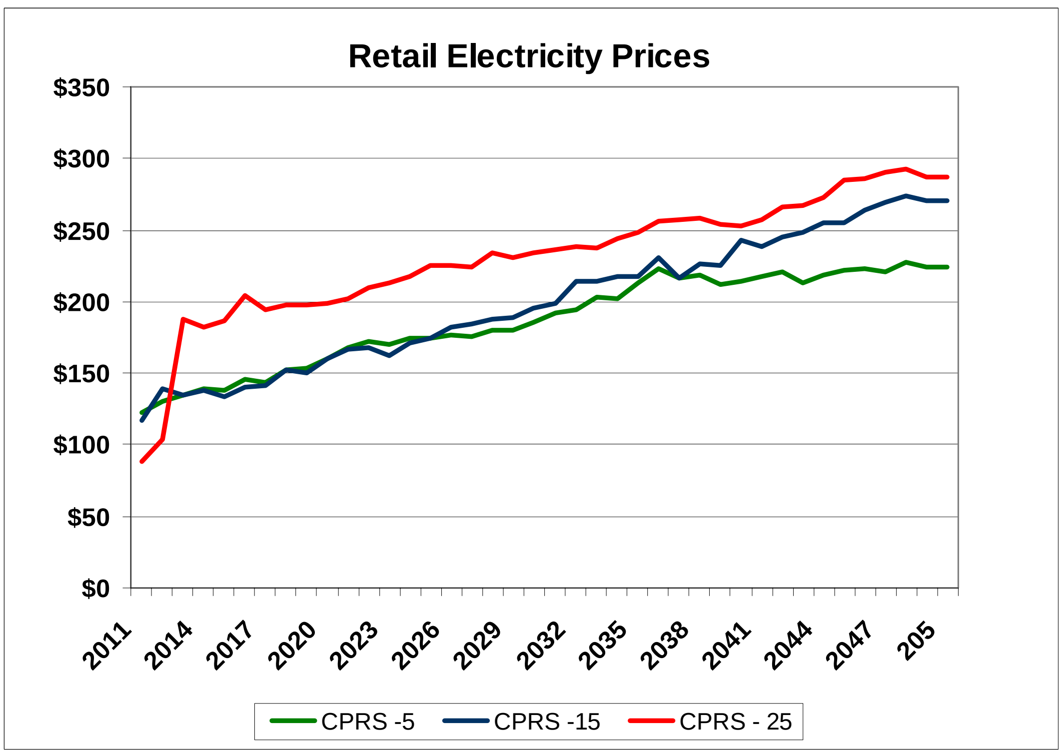

Figure 6 Retail electricity prices under the three emission reduction scenarios

Model farms.

The modelling reported here assesses the impact of the CPRS at the individual farm business level, for eight different livestock enterprises. Two sizes of enterprise were selected, those with gross income between $100,000 and $200,000 and those with gross income in excess of $400,000 per annum. Data available from the ABARE Agsurf database (ABARE 2010) was used as the basis of the financial models developed for each farm type. The first six farms were selected because they represent specialist livestock producers, either beef, sheep or mixed livestock. The Agsurf data for these farms is taken as an Australia-wide average, so is not specific to a rainfall or production zone. The final two farm models were developed using Agsurf data which is specific to the high rainfall zone. These additional two farms were chosen because of assumptions regarding soil sequestration potential. As outlined earlier, rainfall is a limiting factor in the sequestration of soil carbon. For soil carbon sequestration rates to be maintained over a 20 year period, it is assumed that improved pastures would need to be established with high legume components, and that the pasture would have to be maintained by the regular application of fertilisers over that period. Such an approach is not feasible in lower rainfall regions.

The modelling approach used does not attempt to incorporate some of the inevitable flow-on impacts of the CPRS in either the wider economy, or within the agriculture sector. More comprehensive modelling studies that include these impacts are outlined above in Section 1.

To estimate the potential impact of the ETS on the prices farmers pay for farm inputs, itemised annual cash revenue and expenditure data was obtained for the eight different farm types, using statistics sourced from the Agsurf database. The Agsurf database provides itemised average farm input revenues and expenditures (all expressed in 2007-08 dollars) based on details of actual farm revenues and expenditures obtained through annual surveys of a sample of Australian farms. To negate seasonal variation, data were obtained from the Agsurf database for the years from 2004 to 2008 inclusive, and the results averaged to provide a single-year model for each of the farms included in the study.

Given the twenty-year timeframe of the projections, there was a need to incorporate productivity growth for each of the farms involved. It was assumed that each of the farms would achieve productivity growth rates equivalent to the long-term rates estimated by ABARE for each of the sub-sectors of Australian agriculture.

Details of each of the eight farms are outlined below in Table 13 below.

Table 13 Characteristics of the eight model farms

Physical characteristic	Beef		Mixed livestock		Sheep		High Rainfall	
Farm scale	$100,000-$200,000	More than $400,000	$100,000-$200,000	More than $400,000	$100,000-$200,000	More than $400,000	$100,000-$200,000	More than $400,000
Gross revenue	$143,698	$1,339,463	$160,335	$941,722	$159,981	$713,596	$149,403	$840,607
Gross costs	$124,603	$1,186,299	$148,572	$738,294	$137,376	$614,884	$128,304	$694,985
Total farm area (ha)	3,698	64,485	1,114	4,706	3,847	13,316	815	3,872
Beef herd at June 30	459	3,415	62	256	-	-	247	839
Sheep flock at June 30	-	-	1,226	3,469	2,143	7,167	937	3,748
Productivity growth (% pa)	1.5	1.5	1.4	1.4	0.3	0.3	1.5	1.5
Estimated greenhouse gas emissions (tCO_2-e)	563	4381	364	1190	450	1519	620	2477

Farm greenhouse emissions

In order to obtain a more complete picture of potential options for the engagement of agriculture with the CPRS, the greenhouse emissions arising from each of the farms included in this analysis were calculated using the FarmGAS Calculator. The FarmGAS Calculator estimates 'farm-created' greenhouse gas emissions under the methodologies used by the Department of Climate Change in determining Australia's National Greenhouse Gas Inventory (NGGI) which is in accordance with the Intergovernmental Panel on Climate Change Guidelines. The methodology as applied to agriculture contains both Australian-specific and IPCC default methodologies and emissions factors. The FarmGAS Calculator has enterprise-specific calculators for beef production, sheep production, intensive livestock production (feedlot and piggery) dryland and irrigated cropping, horticulture and environmental plantings on farm.

In order to generate an estimate of emissions for each enterprise, some general assumptions about farm operations were made, and available physical information about each farm was obtained from the ABARE Agsurf database. Greenhouse emission calculation methodologies don’t vary significantly between states for the same enterprise, and as such all six model farms were assumed to be in NSW for the FarmGAS Calculator estimation.

In the Agsurf database, some of the enterprises generated income from cropping, and as such greenhouse gas emissions from fertilizer application needed to be included in the farm emission estimate. However, there is limited data available on nitrogen application for each enterprise type from the Agsurf database.

In order to estimate nitrogen fertilizer use for emission estimates, Agsurf data detailing returns from different crop types for each model farm were divided by average return per tonne of grain, obtained from NSW Industry and Investment gross farm budgets. This provides an estimate of the number of hectares cropped, which divided by average yield gives an estimate of the area cropped. Using average fertilizer application rates from NSW Industry and Investment gross farm budgets, the volume of nitrogen fertiliser used was estimated. All crops are assumed to be dryland, with stubble grazed not burnt (burning stubble generates emissions).

It was assumed that in each case there are no greenhouse emission offset tree plantings on the farm, and emissions arising from fuel and electricity use are not included in the farm inventory (because fuel and electricity will be sourced from CPRS-covered sectors and these emissions will be accounted for at the point of generation or at the point of bulk distribution, rather than at the point of final consumption). The farm greenhouse emissions calculated for the farms included in this research are displayed in Table 13 above.

1.2. Impacts

Farm input items which are likely to have their prices impacted by an increase in energy prices were identified. For each of these farm input items, an estimate was made of the potential flow-on price impacts of increases in fuel or electricity prices, based on an approximation of the significance of fuel or electricity in the provision of those goods or services. For example, for crop contracting (including contract sowing and harvesting) it was assumed prices paid for these services by farmers will increase by 50 per cent of the percentage of CPRS-related fuel price increases, recognizing that while fuel is a major input in crop contracting, labour and machinery are also significant inputs.

Table 14 provides a summary of the farm input items, the price of which is likely to be impacted by increases in fuel and energy prices, and an estimate of the percentage flow-on effect of increases in fuel and energy prices that will be reflected in the future prices farmers pay for these inputs. For example, if fuel prices are estimated to rise by 10 per cent as a result of the CPRS, then contract cropping prices are estimated to rise by 5 per cent (i.e. 50 per cent of 10 per cent).

Table 14 Estimated flow-on impacts of increases in fuel and electricity prices.

Farm Input	Linked to: (fuel or electricity)	Percentage flow-on cost impact
Contracts- cropping	Fuel	50%
Contracts- livestock	Fuel	20%
Crop and pasture chemicals	Fuel	50%
Electricity	Electricity	100%
Fertiliser	Fuel	50%
Fodder	Fuel	30%
Fuel oil and grease	Fuel	100%
Water charges	Electricity	10%
Repairs and maintenance	Fuel	20%
Shearing/crutching	Fuel	20%
Stores and rations	Fuel	10%
Vet fees	Fuel	20%
Handling/marketing	Fuel	30%
Shire and PPB rates	Fuel	10%
Total freight	Fuel	80%

For future years, it was assumed that the prices paid by farmers for all other (non-energy related) farm inputs will remain constant, with no inflation factor being applied. This approach was adopted not because it is assumed that farm input prices will remain constant in the future, but because the critical issue for farm businesses is changes in the relative prices paid for farm inputs and the prices received for farm outputs. The focus of this research is to assess the impacts of the CPRS on farm businesses, all other things being equal. By holding non-energy related farm input prices and future farm revenues constant (aside from productivity growth), the results provide a picture on the relative impact of the CPRS on farm businesses as emission prices change.

Productivity growth

For the purposes of this research, total farm revenue for each of the model farms was projected to grow annually by an amount equal to historical rates of productivity growth for that particular sub-sector of agriculture, as estimated by ABARE (Nossal and Gooday, 2009). This approach assumes historical rates of productivity growth in the sector will be able to be maintained into the future and is limited to an extent in that it is assumed that rates of productivity growth are equal within a farm enterprise type, irrespective of the scale of the business. Research suggests that this is not the case, and that larger-scale enterprises are more likely to be able to invest in additional capital which will enhance productivity. The assumption that historical productivity growth rates will persist in the future is also dependent on a range of factors, not the least being the extent to which public investment in agricultural research and development is maintained or increased.

Total factor productivity measures as estimated by ABARE compare total output with total inputs used in production, and include land, labour, capital, materials and services (Nossal *et al.,* 2009). Introducing a 0.3 per cent productivity growth rate for sheep enterprises has a significant impact on the ability of the enterprise to absorb increases in input costs as a result of the CPRS.

Table 15 Average annual input, output and total factory productivity (TFP) growth in broadacre industries 1977-78 to 2006-07

	TFP growth (%)	Output growth (%)	Input growth (%)
Total broadacre	1.5	0.8	-0.6
Cropping	2.1	3.1	1.0
Mixed crop-livestock	1.5	0.1	-1.5
Beef	1.5	1.7	0.1
Sheep	0.3	-1.4	-1.8

Source: Nossal et al., 2009

Figures 7, 8 and 9 below show the projected percentage change in farm cash margins under the different CPRS scenarios, when compared with the 'business-as-usual' case. This table displays projected results for 2030, under the three different emission reduction scenarios of 5 per cent reduction, 15 per cent reduction and 25 per cent. The 'ETS uncovered' item shows the projected impact of the CPRS on farm cash margins, expressed as a change from the business as usual result. In effect, these results reflect the indirect effect of the ETS on farm businesses, in the event agriculture remains an uncovered sector.

The 'ETS covered' results provides a projection of the impact on farm cash margins of agriculture becoming a covered sector, and farm businesses having to pay for 100 per cent of required emission permits as well as experiencing the indirect impact of the ETS.

The 'ETS-EITE' item provides a projection of the effect on farm cash margins of agriculture becoming an ETS covered sector, but with farm businesses receiving a significant number of emission permits free, rather than having to purchase them. This rate of free permits starts at 94.5 per cent in 2011, but declines to 73.7 per cent by 2030, reducing by 1.3 per cent each year.

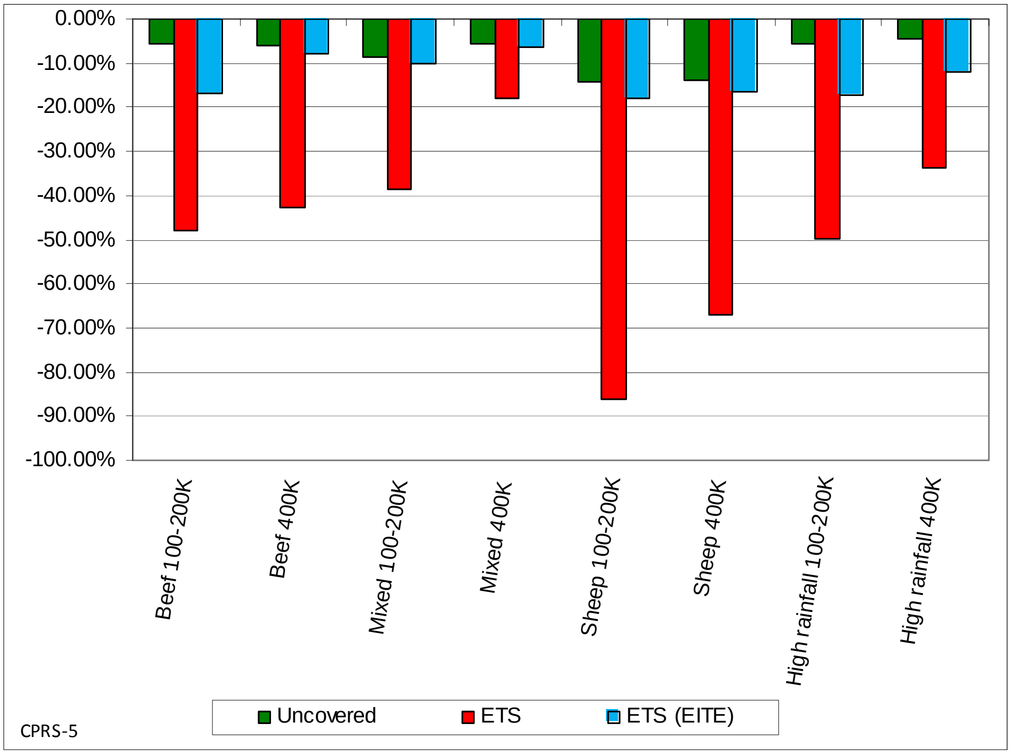

Figure 7 **Projected change in farm cash margins in 2030 under the CPRS-5 emission reduction scenario.**

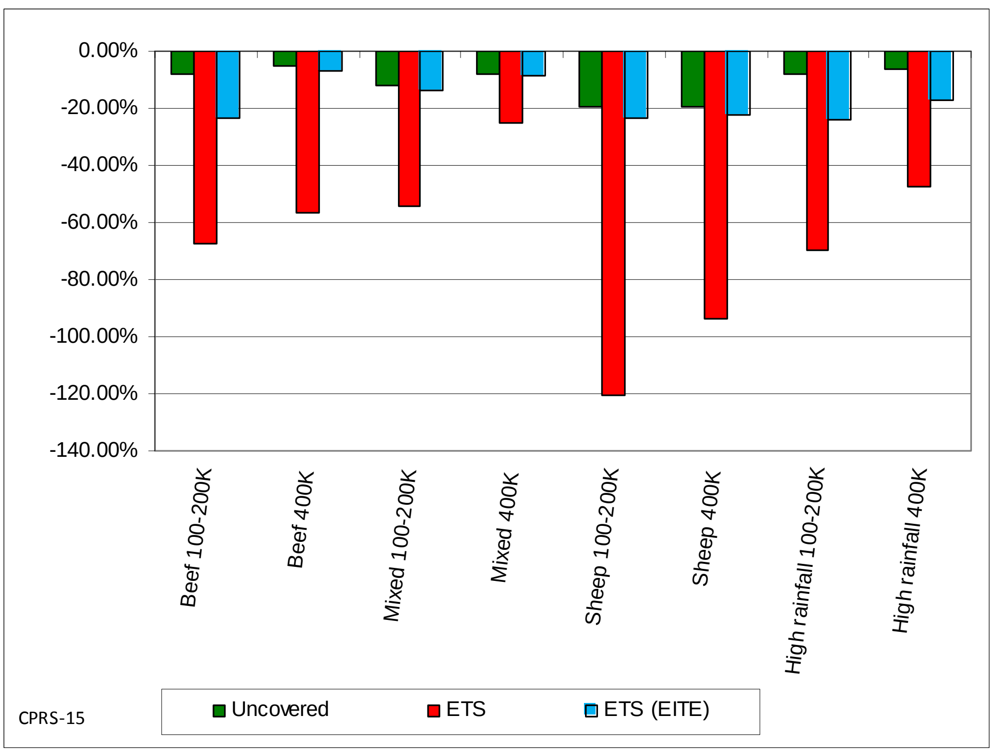

Figure 8 **Projected change in farm cash margins in 2030 under the CPRS-15 emission reduction scenario.**

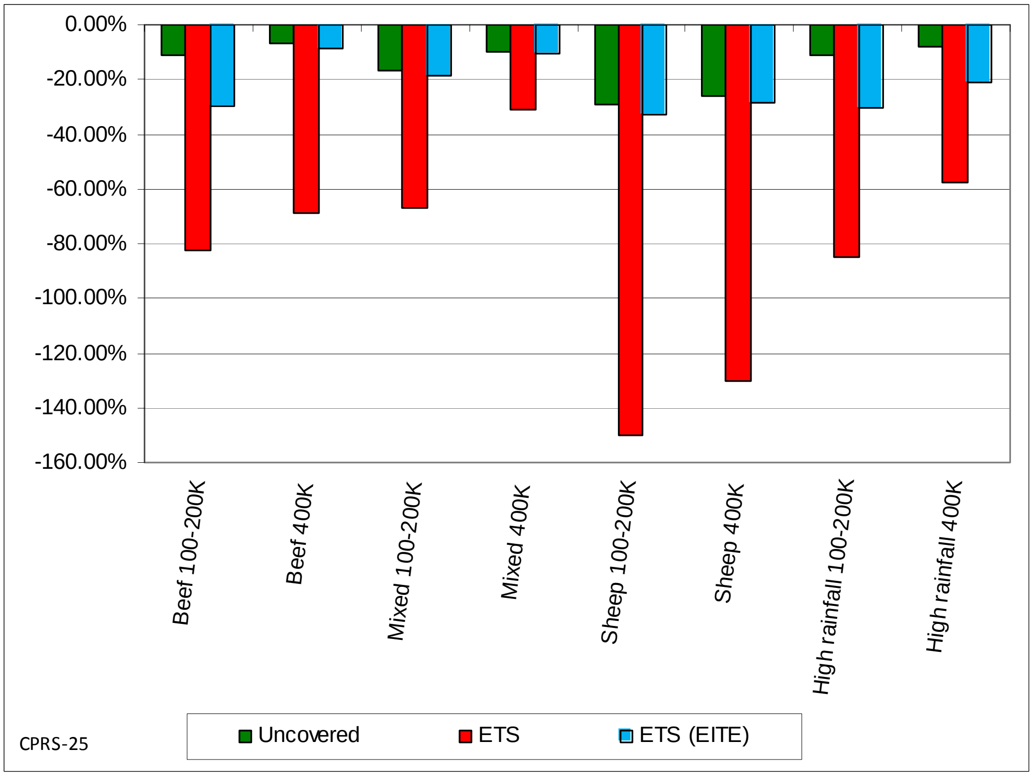

Figure 9 Projected change in farm cash margins in 2030 under the CPRS-25 emission reduction scenario.

It should be noted that the modelling reported here does not incorporate changes such as enterprise substitution, which would undoubtedly arise if the projected impacts of the CPRS on farm businesses were as significant as is projected in this research.

The modelling also does not incorporate switching landuse out of agriculture into forestry, which would also be the case in the event that emission prices reached the levels indicated, and there was not a very substantial rise in the prices received by farmers for agricultural products. As would be expected, under the 25 per cent emission reduction scenario a very large impact on farm cash margins is projected in the event agriculture becomes a covered sector under the CPRS.

Given the exclusion of agriculture from the CPRS indefinitely, the results for the 'Uncovered' item are of importance, showing the indirect effects of the CPRS. The two model sheep farms included in this research show significant reduction in farm cash margin under all emission reduction scenarios, which reflects the very different assumed rate of productivity growth. For the sheep enterprises, according to Nossal et al., (2009) the historical productivity growth rate is 0.3 per cent per annum, while for beef enterprises it is 1.5 per cent per annum. This difference in assumed productivity growth rates has a large impact on the ability of the enterprise to absorb future cost increases in farm inputs.

This is highlighted in Table 16, which displays projected future farm cash margins under two different rates of productivity growth. By increasing assumed future productivity growth rates to 1.5 per cent (the same as that for beef production) for the $100,000 -$200,000 sheep enterprise, the projected impacts of different CPRS scenarios are considerably reduced. The figures highlight how critical rates of farm productivity growth will be for farm businesses, irrespective of the nature of the sectors engagement with the CPRS.

Table 16 Effect of productivity rate on projected changes in farm cash margins for a $100,000-$200,000 sheep enterprise.

Emission reduction scenario	Scenario	Change in farm cash margin, 0.3% productivity growth	Change in farm cash margin, 1.5% productivity growth
-5%	Uncovered	-25%	-10%
	ETS	-95%	-39%
	ETS (EITE)	-29%	-12%
-15%	Uncovered	-40%	-16%
	ETS	-137%	-57%
	ETS (EITE)	-43%	-18%
-25%	Uncovered	-59%	-25%
	ETS	-196%	-82%
	ETS (EITE)	-63%	-26%

Given the trade exposed nature of Australian agriculture, this will have an impact on Australian agricultural competitiveness, especially relative to developing nation agricultural exporters in South America, Asia and Eastern Europe, where farmers will not experience farm input cost increases associated with national greenhouse emission policies for some considerable period, if ever, and where farmers are also protected from international competition by trade barriers.

In either a covered or uncovered scenario, the impacts of the CPRS may be able to be reduced if the agriculture sector is able to implement farm management and greenhouse mitigation strategies, however this will effectively require very high future rates of agricultural productivity growth.

2. The CPRS applied economy-wide, with soil carbon offset opportunities for agriculture.

There has been a great deal of discussion about the sequestration potential of Australian agricultural soils, and the benefits and disadvantages associated with farm businesses entering into contracts to provide soil carbon offsets as part of national climate change policy. Australia opted not to include changes in soil carbon in its national greenhouse emission inventory, because of the risks associated with international emission accounting methodologies that do not separate natural and man-made changes in soil carbon. As a result, changes in soil carbon are not part of the national emission inventory that Australia prepares to report on progress in achieving its Kyoto Protocol emission target, and the Australian Government has stated that only emissions and sequestration that can be counted in Australia's national emission inventory will be included in the CPRS.

In contrast, the Direct Action climate change policy proposed by the Opposition relies heavily on soil carbon sequestration to achieve the stated target of a 5 per cent national emission reduction by 2020. In adopting this policy, it is assumed that the Opposition proposes ignoring international emission accounting rules, and adopting an approach that is similar to that proposed by the USA, whereby the 'rules' about what can or cannot be counted will be set by a national technical panel.

Given the prominence that soil carbon sequestration is now playing in debates about future climate change policies, it is appropriate to carry out some preliminary modelling of the financial implications of a soil carbon offset market for farmers.

There are two broad strategies available for increasing soil carbon levels. The first involves adopting management strategies that optimise plant growth and the retention of soil organic matter. The second involves adding extra carbon to the soil, using additives such as imported biological material or biochar. The following analysis focuses primarily on the first option, due to the large number of uncertainties surrounding the costs and outcomes associated with the use of imported carbon.

Chan et al., (2008) estimate that total carbon sequestration potential from pasture land, cropping land and rangelands in Australia amounts to 4.9 million tonnes of carbon, or 18 million tonnes CO_2-e per year. The 'Direct Action' policy proposed by the Opposition envisages soil carbon sequestration delivering about 85 million tonnes per annum of CO_2-e abatement from soil carbon sequestration by 2020. Various results in Australia, including that conducted by Meat & Livestock Australia (Henry and Dalal, 2010), suggest that soil carbon sequestration is highly variable between regions and between paddocks, so the uniform SOC increase modelled here should be considered as an informative example rather than practical reality.

In order to assess some potential implications of soil carbon offsets on the livestock sector, limited farm-level economic modelling was carried out on two of the model farms outlined above, estimating soil carbon sequestration costs and benefits. In each case, it was assumed additional soil carbon sequestration would be achieved by progressively sowing improved, pastures with a high legume content, and then regularly applying fertiliser to these pasture areas. The two farms selected were both located in the high rainfall zone, the reason being that it would be uneconomical to implement actions such as the sowing of improved pasture or the regular application of fertilisers in lower rainfall regions.

There is little detail available about how this policy approach would work in practice, and as a consequence many assumptions were necessary; all of which are detailed below. The carbon prices used in this analysis are the CPRS-5, CPRS-15 and CPRS-25 emission price scenarios developed by the Australian Treasury, and a carbon price of $AU5 per tonne CO_2-e, to reflect likely carbon prices if soil carbon offsets are only able to be sold in to voluntary carbon markets.

2.1. Major assumptions:

The CPRS is assumed to be applied economy-wide, with agriculture providing offsets in the form of soil carbon. Three scenarios are considered, where agricultural emissions are not covered by the CPRS, where agricultural emissions are included in the CPRS, and finally where agricultural emissions are included in the CPRS with EITE status. The same major assumptions outlined above for the CPRS modelling are applied, for instance, direct emitters of greenhouse gases in the stationary energy, fugitive emissions and waste sector, which produce net emissions in excess of 25,000 tonnes CO_2-e per annum will be required to become participants in the scheme. A progressively decreasing volume of emission permits will be made available by the government for purchase each year, which will result in an increase in emission permit prices, creating greater incentives for participants to reduce their net emissions.

It was assumed that AEUs for direct agricultural emissions must be purchased by the model farms in order to cover emissions under the two scenarios where agriculture is a covered sector within the CPRS. To simplify the analysis, soil carbon sequestration offsets are assumed to be sold by farmers into the carbon market, not used to offset direct on-farm emission liabilities. This simplifies the modelling exercise, but makes no practical difference in terms of projected outcomes.

Involvement
The modelled scenarios are summarised as follows;

- BAU - Business as usual, assuming that no ETS is introduced.
- Uncovered - The CPRS is introduced but agriculture remains an uncovered sector, and generates soil carbon sequestration offsets.
- ETS - Agriculture is a covered sector in the CPRS post 2011, with farm businesses required to purchase emission permits equivalent to their estimated emissions. Soil carbon sequestration provides offsets for sale into the carbon market.
- ETS (EITE) - Agriculture is a covered sector post 2011 with Emissions-Intensive Trade-Exposed (EITE) status. EITE assistance rates will commence in 2011-12 at 94.5 per cent for highly emission intensive activities and 66 per cent for moderately emission intensive activities and decline at an annual rate of 1.3 per cent per annum.

> The government's 'global recession buffer' will be integrated into base assistance rates and will not be removed after 5 years. Soil carbon sequestration provides offsets for sale into the carbon market.

Timeframe
The modelling commences in 2011, and projects forward to 2030.

Emission prices
In this modelling, Treasury emission price projections are used for each of the three national emission reduction targets that have been foreshadowed. In the case of offset prices, this modelling assumes the price for offsets matches the prevailing price of emission permits.

Electricity and fuel price increases
Treasury projections of changes in fuel and electricity prices under each of the three different 2020 emission reduction targets were used in this analysis.

Farms modelled
Two model farms are used in this analysis. These were a High Rainfall zone farm with an annual turnover of between $100,000 and $200,000, and a High Rainfall zone farm with an annual turnover in excess of $400,000 per annum. Farm size, area of grazing land operated and itemized annual expenses and receipts were all sourced from the ABARE Agsurf database, averaged over a 5 year period 2004-2008. The high rainfall zone is necessary because the scope for sowing improved pastures is limited by rainfall, so this strategy may not be viable for landholders in lower rainfall regions.

Carbon sequestration
Assumptions made in relation to soil carbon sequestration are very important in the analysis of this modelling. Without direct measurement of soil organic carbon levels under various climatic, environmental and management changes, it is extremely difficult to estimate soil carbon sequestration rates. As outlined in Table 10 above, various ranges of sequestration rates are estimated for different management practices. Given the model farms are livestock related; grazing management is assumed to be the practice changed to generate soil carbon offsets.

For the modelling it is assumed that legume-based improved pastures are introduced gradually on the grazing area of each farm, to a maximum of 50 per cent of total grazing land. The reason for this limit is that the cost of improved pasture establishment is restrictive, at $175/ha, as estimated by NSW Industry and Investment (2005). For cash flow purposes, it has been assumed that 10 per cent of grazing land is sown to improved pastures in the first year, and the area of improved pasture is increased by 10 per cent every 2 years after this, until 50 per cent of available grazing land has been sown down.

It is assumed that single superphosphate is applied every 2 years on the grazing land that is sown to improved pastures, to enable soil carbon sequestration levels to keep increasing. Superphosphate is assumed to cost $400 per tonne delivered to the farm, and is applied at a rate of 100kg per hectare. In addition, it is assumed the farmer does not increase stocking rate despite having established improved pasture, in order to enable a buildup of soil carbon to occur.

The average soil carbon sequestration rate for pasture management activities was estimated by Chan et al. (2009) to be 0.55tC/ha/pa (2.02 t CO_2-e/ha/pa), and Chan states that this rate of increase could be maintained for fifty years, assuming that the improved pasture was initially established on an area of relatively degraded soil.

For the modelling exercise, it was assumed that soil carbon sequestration is only occurring on the area that has been sown to improved pasture, and that on the rest the land soil carbon is being maintained, but not increased. Soil carbon offsets are therefore only assumed to be generated from the area of land that has been sown to improved pasture. The area of land sown to improved pasture over time, and the subsequent soil carbon offsets generated from that land are shown in Table 17.

Table 17 Area sown to improved pasture, and associated soil carbon sequestration for the two model farms..

	$100,000 - $200,000 annual farm turnover.		**$400,000 + annual farm turnover.**	
Year	Area sown to improved pasture (ha)	Carbon sequestration (tCO_2-e/yr)	Area sown to improved pasture (ha)	Carbon sequestration (tCO_2-e/yr)
2011-12	77	156	356	719
2013-14	154	311	713	1439
2015-16	231	467	1069	2158
2017-18	308	622	1425	2877
2019-20	385	778	1782	3597
2021-22	385	778	1782	3597
2023-24	385	778	1782	3597
2025-26	385	778	1782	3597
2027-28	385	778	1782	3597
2029-30	385	778	1782	3597

Costs and receipts associated with soil carbon offsets.
There are additional costs associated with opting to sell soil carbon offsets into an emissions trading scheme, such as accreditation, compiling annual statements, insurance and verification.

The Australian Farm Institute has attempted to estimate these costs, which are detailed in Table 18 below. The cost of soil testing was estimated based on quotations provided by several soil testing organisations. According to Chan *et al.* (2010) the Leco soil test is the most accurate, and this was confirmed in discussion with Dr Yin Chan (NSW Industry and Investment, *pers. comm.* 16 March 2010). It was considered unlikely that any landholder would need to have estimated soil sequestration verified with direct soil sampling every year. Rather, verification is assumed to only take place every 5 years. The accreditation, reporting and insurance costs were estimated based on industry experience with initiatives such as the Best Management Practice program operated by the Cotton industry.

It was assumed for the modelling exercise that soil testing would need to be carried out over the entire farm area, to avoid the possibility that one area of a farm was being conservatively managed to achieve soil carbon sequestration, while the remainder of the property is overstocked and soil carbon is being lost. It's unlikely a scheme would allow farmers to register paddock-size areas as sequestration units, but would instead require them to include the entire property in any scheme. The rate of soil sampling required every five years is assumed to be a minimum of 20 samples, or 1 sample per 4 hectares; whichever is greatest. This may be a conservative figure however. Research by Meat & Livestock Australia (Henry and Dalal, 2010) recommended within homogenous grazing management, 10 samples throughout one soil type, on a grid with random origin; is the minimum requirement. No assumptions regarding soil type variation is made in this modelling.

Table 18 Assumed costs associated with registering to provide offsets

Item	Cost
General soil test	$75 per sample
Leco soil carbon test	$28 per sample
Result reporting	$30 per batch
Initial accreditation	$3,000 one-off cost
Legal advice (contract)	$2,000 one-off cost
Annual statement preparation	$1,000 per year
Annual insurance	$500 per year
Soil sampling	Assume $780 per day labour costs, with operator collecting 4 samples per hour and working 6.5 hours per day. Total = $30 per sample.

For modelling purposes, it was assumed that a risk buffer would be applied of 30%, meaning that participating landholders would only be able to sell offsets equivalent to 70% of the estimated rate of soil carbon sequestration. The use of a risk buffer should ensure that landholders would not face the risk of 'overselling' offsets in years where rainfall is lower than average.

2.2. Impacts:

The results arising from the modelling are displayed in the following figures and tables. In general, the option to market soil carbon offsets provides the model farm businesses with an opportunity to generate extra revenue and thereby negate some of the negative impact of the CPRS, but during the initial years (when the area developed for soil carbon sequestration is limited, and pasture establishment costs are being encountered) the net effect of soil carbon offsets is negative. It is only after approximately ten years, when all pasture development expenditure has occurred and the return for soil carbon offsets is beginning to increase that projected farm cash margins begin to consistently exceed the BAU projections, even in the case where agricultural emissions remain uncovered.

In the case where agricultural emissions are covered under the CPRS and agricultural emissions are eligible for EITE concessions, the opportunity to market soil carbon offsets enables farm cash margins to generally be maintained at a level comparable to the BAU case, although with fluctuations arising from pasture development, fertiliser and MRV costs having a negative impact in some years.

In the case where agricultural emissions are covered under the CPRS but are not eligible for EITE concessions, projected farm cash margins consistently remain below the BAU case despite the income from soil carbon offsets.

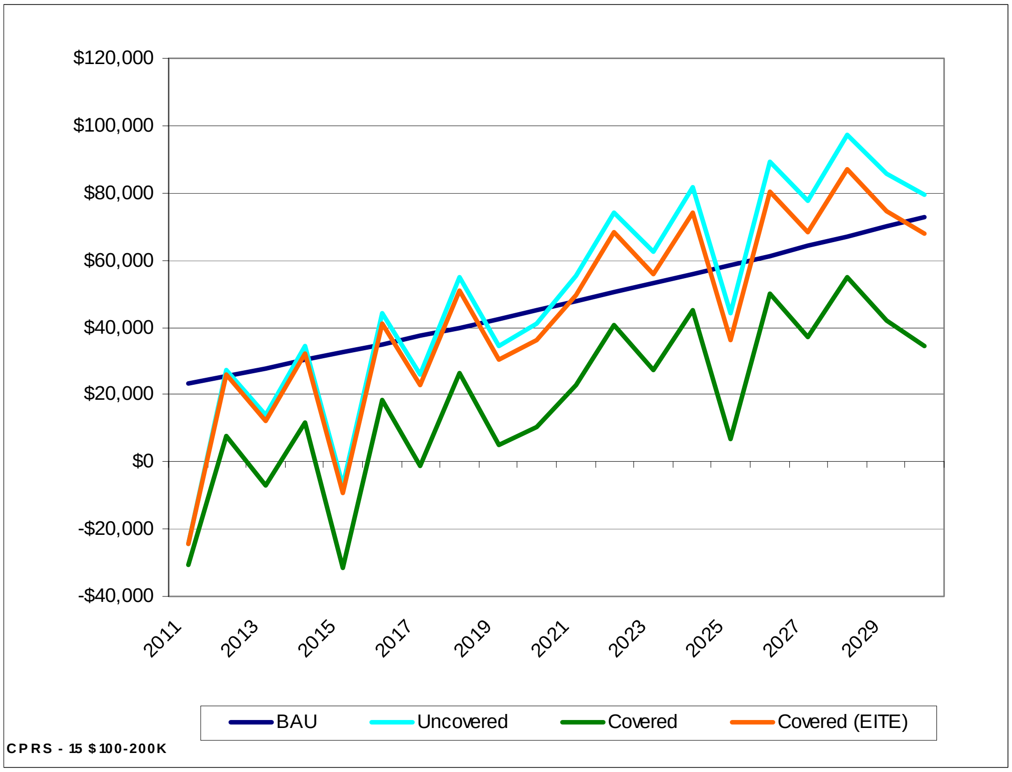

Figure 10 Farm Cash Margin for High Rainfall zone farm with $100,000-$200,000 annual turnover, under the CPRS-15 emission price scenario.

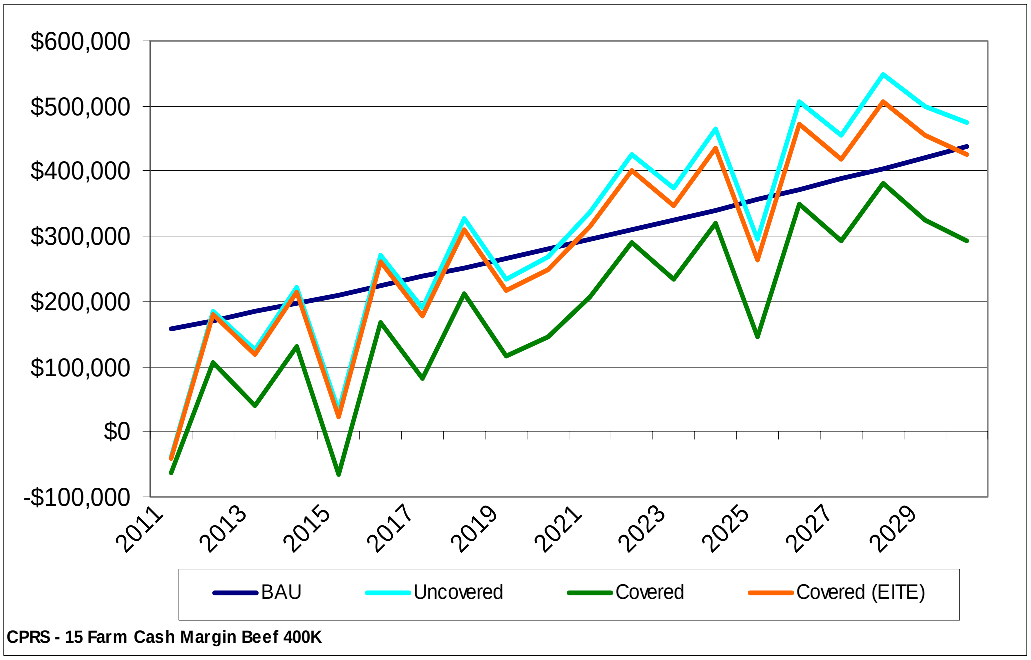

Figure 11 Farm Cash Margin for High Rainfall zone farm with $400,000 annual turnover, under the CPRS-15 emission price scenario..

It is noteworthy that the negative impact of any of the scenarios considered in the above analysis is less (in proportional terms) for the larger scale farm than for the smaller farm. This probably arises because larger-scale farms generally achieve higher gross margins per head or per hectare, and also in the case where soil carbon offsets are an option, the larger farm has more land available to sow to improved pasture, and therefore has a greater number of soil carbon offsets available to sell.

These results should be considered only in the context of the assumptions outlined above. Most important to consider is the assumption that soil carbon sequestration will continue in a linear manner across all 20 years, at 0.55tC/ha/yr. In research outlined in Table 10 above, it is assumed this rate of sequestration can be maintained year-on-year for 50 years or more. However, practically this relies on numerous environmental and climatic factors, and implies that the starting point is a soil with depleted levels of carbon. If the land in question had been subject to improved pasture establishment and conservative management for an extended period prior to the introduction of the CPRS, it would be unlikely that these soil carbon sequestration rates could be achieved for even a short period, let alone consistently over a twenty year period.

It is also important to note that the modelling not only relies on the above assumptions, but also does not factor in risks such as natural variation or climatic change. Soil carbon can decline as a result of natural events, irrespective of farm management decisions. This risk cannot be included in modelling, however for all the increases in farm cash margins estimated below, if soil carbon was to fall by a similar amount then a proportionate liability would be faced by the landholder. It should also be noted that under international emission accounting rules, in order for carbon sequestration to be recognised it must be capable of being maintained for between 70 and 100 years. This modelling only shows farm cash margin changes over the initial 20 years. For the subsequent 50-80 years, rates of soil carbon sequestration can be expected to significantly slow, reducing income from offsets, but landholders would still face the same expenditure on pasture management in order to maintain soil carbon levels.

Finally, this modelling shows the impact when market prices for offsets increase over time. As seen in the Chicago Climate Exchange (see Figure 9 above) this is not always the case. There is significant risk in pursuing soil carbon sequestration and incurring the associated costs every year, when income cannot be guaranteed. This is not to say there are no opportunities associated with soil carbon sequestration, but if costs could be reduced through, for instance, a less expensive MRV framework; the risk would be much reduced. Research and development has a critical role to play in making offset markets a viable option for landholders.

Table 19 **High rainfall $100-$200,000 change in farm cash margin with and without offsets, under three emission reduction scenarios. Both with and without offset scenarios are being compared with business as usual without the implementation of a CPRS.**

				2011	2015	2020	2025	2030
CPRS -5	Uncovered	No offsets	$ change	$0	-$1,283	-$2,762	-$3,434	-$4,173
			% change	0%	-4%	-6%	-6%	-6%
		Offsets	$ change	-$47,619	-$42,042	-$10,719	-$22,663	-$2,987
			% change	-204%	-129%	-24%	-39%	-4%
	ETS	No offsets	$ change	-$6,200	-$18,581	-$24,586	-$29,970	-$36,413
			% change	-26.56%	-56.92%	-54.53%	-51.24%	-49.94%
		Offsets	$ change	-$53,819	-$59,340	-$32,543	-$49,199	-$35,227
			% change	-231%	-182%	-72%	-84%	-48%
	EITE	No offsets	$ change	-$341	-$3,068	-$6,253	-$9,091	-$12,653
			% change	-1%	-9%	-14%	-16%	-17%
		Offsets	$ change	-$47,960	-$43,827	-$14,211	-$28,320	-$11,467
			% change	-205%	-134%	-32%	-48%	-16%
CPRS -15	Uncovered	No offsets	$ change	$0	-$2,643	-$3,843	-$4,733	-$5,777
			% change	0%	-8%	-9%	-8%	-8%
		Offsets	$ change	-$47,619	-$39,517	-$3,800	-$14,220	$6,730
			% change	-204%	-121%	-8%	-24%	9%
	ETS	No offsets	$ change	-$6,200	-$27,319	-$34,781	-$42,367	-$50,913
			% change	-26.56%	-83.68%	-77.15%	-72.44%	-69.82%
		Offsets	$ change	-$53,819	-$64,193	-$34,738	-$51,854	-$38,406
			% change	-231%	-197%	-77%	-89%	-53%
	EITE	No offsets	$ change	-$341	-$5,190	-$8,793	-$12,756	-$17,649
			% change	-1%	-16%	-20%	-22%	-24%
		Offsets	$ change	-$47,960	-$42,063	-$8,749	-$22,243	-$5,142
			% change	-205%	-129%	-19%	-38%	-7%
CPRS -25	Uncovered	No offsets	$ change	$0	-$4,707	-$5,710	-$6,969	-$8,074
			% change	0%	-14%	-13%	-12%	-11%
		Offsets	$ change	-$47,619	-$38,935	-$170	-$9,924	$12,271
			% change	-204%	-119%	0%	-17%	17%
	ETS	No offsets	$ change	-$6,200	-$34,405	-$42,910	-$52,043	-$62,138
			% change	-26.56%	-105.39%	-95.18%	-88.98%	-85.21%
		Offsets	$ change	-$53,819	-$68,633	-$37,370	-$54,998	-$41,793
			% change	-231%	-210%	-83%	-94%	-57%
	EITE	No offsets	$ change	-$341	-$7,772	-$11,662	-$16,578	-$22,294
			% change	-1%	-24%	-26%	-28%	-31%
		Offsets	$ change	-$47,960	-$42,000	-$6,122	-$19,533	-$1,949
			% change	-205%	-129%	-14%	-33%	-3%

Table 20 High rainfall 400K, change in farm cash margin with and without offsets, under three emission reduction scenarios. Both with and without offset scenarios are being compared with business as usual without the implementation of a CPRS.

				2011	2015	2020	2025	2030
CPRS -5	Uncovered	No offsets	$ change	$0	-$5,872	-$12,607	-$15,628	-$18,992
			% change	0%	-3%	-4%	-4%	-4%
		Offsets	$ change	-$196,700	-$188,972	-$43,978	-$99,137	-$8,067
			% change	-124%	-90%	-16%	-28%	-2%
	ETS	No offsets	$ change	-$24,770	-$74,981	-$99,798	-$121,644	-$147,796
			% change	-15.65%	-35.61%	-35.57%	-34.17%	-33.81%
		Offsets	$ change	-$221,470	-$258,080	-$131,168	-$205,152	-$136,871
			% change	-140%	-123%	-47%	-58%	-31%
	EITE	No offsets	$ change	-$1,362	-$13,004	-$26,557	-$38,229	-$52,869
			% change	-1%	-6%	-9%	-11%	-12%
		Offsets	$ change	-$198,063	-$196,103	-$57,927	-$121,738	-$41,944
			% change	-125%	-93%	-21%	-34%	-10%
CPRS -15	Uncovered	No offsets	$ change	$0	-$12,214	-$17,587	-$21,623	-$26,331
			% change	0%	-6%	-6%	-6%	-6%
		Offsets	$ change	-$196,700	-$12,214	-$17,587	-$21,623	-$26,331
			% change	-124%	-27%	-6%	-7%	-5%
	ETS	No offsets	$ change	-$24,770	-$110,799	-$141,190	-$171,977	-$206,656
			% change	-15.65%	-52.61%	-50.32%	-48.31%	-47.27%
		Offsets	$ change	-$221,470	-$275,923	-$135,551	-$210,421	-$143,365
			% change	-140%	-131%	-48%	-59%	-33%
	EITE	No offsets	$ change	-$1,362	-$22,387	-$37,362	-$53,676	-$73,759
			% change	-1%	-11%	-13%	-15%	-17%
		Offsets	$ change	-$198,063	-$187,511	-$31,724	-$92,120	-$10,468
			% change	-125%	-89%	-11%	-26%	-2%
CPRS -25	Uncovered	No offsets	$ change	$0	-$20,888	-$25,433	-$31,012	-$36,077
			% change	0%	-10%	-9%	-9%	-8%
		Offsets	$ change	-$196,700	-$173,777	$5,633	-$39,244	$63,467
			% change	-124%	-83%	2%	-11%	15%
	ETS	No offsets	$ change	-$24,770	-$139,537	-$174,053	-$211,090	-$252,071
			% change	-15.65%	-66.26%	-62.03%	-59.30%	-57.66%
		Offsets	$ change	-$221,470	-$292,425	-$142,987	-$219,322	-$152,527
			% change	-140%	-139%	-51%	-62%	-35%
	EITE	No offsets	$ change	-$1,362	-$33,132	-$49,210	-$69,402	-$92,887
			% change	-1%	-16%	-18%	-19%	-21%
		Offsets	$ change	-$198,063	-$186,020	-$18,144	-$77,635	$6,657
			% change	-125%	-88%	-6%	-22%	2%

3. Soil carbon offsets only able to be sold into voluntary carbon markets.

@@@
In the event international greenhouse accounting rules are not changed to differentiate between natural and human-induced changes in soil carbon levels, soil carbon offsets are unlikely to be counted in Australia's international greenhouse gas inventory. In this case, soil carbon offsets will only be able to be marketed into voluntary carbon markets, and it is unlikely these offsets will be priced at the same level as emission permits. The modelling outlined below assesses the potential impacts of soil carbon offsets only being able to be marketed into voluntary carbon markets.

3.1. Major assumptions:

All the major assumptions in this modelling are all the same as those that applied in the preceding analysis. Under this scenario the price of soil carbon offsets is set at \$5/tCO_2-e.

Voluntary carbon markets are not necessarily constrained by international emission accounting methodologies, but voluntary carbon markets do involve legally-binding commitments for participants. In general, voluntary carbon markets require that the activity creating the offset must occur within Australia and be additional or beyond what would be required to meet regulatory obligations, as well as being permanent, measurable, transparent, independently audited and registered. As a result the assumed costs associated with improved pasture establishment and management outlined above are also assumed to apply in this modelling. The \$5 price for soil carbon offsets has been chosen to reflect a potential voluntary carbon market price, although there is little information available about prices in voluntary carbon markets when a mandatory market is also operating. The experience of voluntary carbon market prices in the USA is that with the potential of a mandatory market commencing, voluntary carbon market prices have dropped to very low levels.

In conjunction with the CPRS, the government has proposed to introduce a voluntary offset market using the NCOS. Eligible offsets under the NCOS include:

- Carbon pollution permits, including those from forestry projects opting into the Carbon Pollution Reduction Scheme
- Kyoto units recognised and accepted under the Carbon Pollution Reduction Scheme
- Credits issued under the internationally recognised Voluntary Carbon Standard and Gold Standard, where these meet specific requirements
- Credits issued by domestic offset projects that reduce emissions from sources currently not counted towards Australia's Kyoto Protocol target.

The key feature of the NCOS for the livestock industry is that abatement not counted toward Australia's international commitment may be part of the market, including sequestration in agricultural soils.

3.2. Impacts.

Figure 11 below shows the farm cash margin for a $100,000-$200,000 annual turnover farm in the High Rainfall zone under the 15 per cent emission reduction scenario. Despite receiving payments for soil carbon offsets, there is no CPRS scenario under which farm cash margins are equivalent to the BAU case. It is also evident from the graph that the expenditure patterns associated with participation in the soil offset market introduce considerable instability into projected annual farm cash margins. It seems likely there would be systems introduced (for example by soil carbon aggregators) to smooth these fluctuations in an operating market, although the costs would still need to be borne somewhere in the system.

The other consideration, which cannot be modelled here, is that this carbon sequestration must be permanent, or maintained for 70-100 years. According to Chan *et al.* (2010), rates of carbon sequestration estimated in Table 10 above can be maintained for up to 50 years. This does seem the upper end of sequestration potential for Australian soils; however it must be considered that beyond 50 years, the same or improved pasture management options must be employed to maintain soil carbon levels; and all associated costs paid. There is no doubt that over such an extended timeframe, new research or technologies will emerge which offer cheaper verification or sequestration potential, and perhaps novel technologies to enhance the carbon sequestration potential of different soils.

Tables 21 and 22 below show the results across all emission reduction scenarios for the High Rainfall farms of sizes $100,000-$200,000, and the $400,000 turnover farm. Farm cash margins in this modelling are not significantly improved by the inclusion of soil carbon offsets, because the income from offsets at a price of $5/t$CO_2$-e is not as high. However, all the same risks apply in terms of costs and liability. This demonstrates the reliance a soil carbon offset system has on carbon price, in order to be a viable option for landholders.

An alternative to achieving soil carbon sequestration via enhancing pasture growth is the use of ‘imported’ carbon, via the use of biological additives such as manure, or through the use of a product such as biochar, which is a stabilised form of carbon. Biochar is a charcoal-like substance produced by pyrolysis of biomass, and is being considered as a means of storing carbon for long periods, potentially as a soil amendment. In the analysis of the economic value of biochar, Galinato et al. (2010) conclude that it may be profitable to apply biochar under some conditions, but it depends heavily on the market price for biochar and the price of carbon offsets; and the affect the application has on crop yield. Given the uncertainties associated with the cost and impact of biochar, the research reported here has not investigated biochar application as a mechanism to enhance soil carbon sequestration.

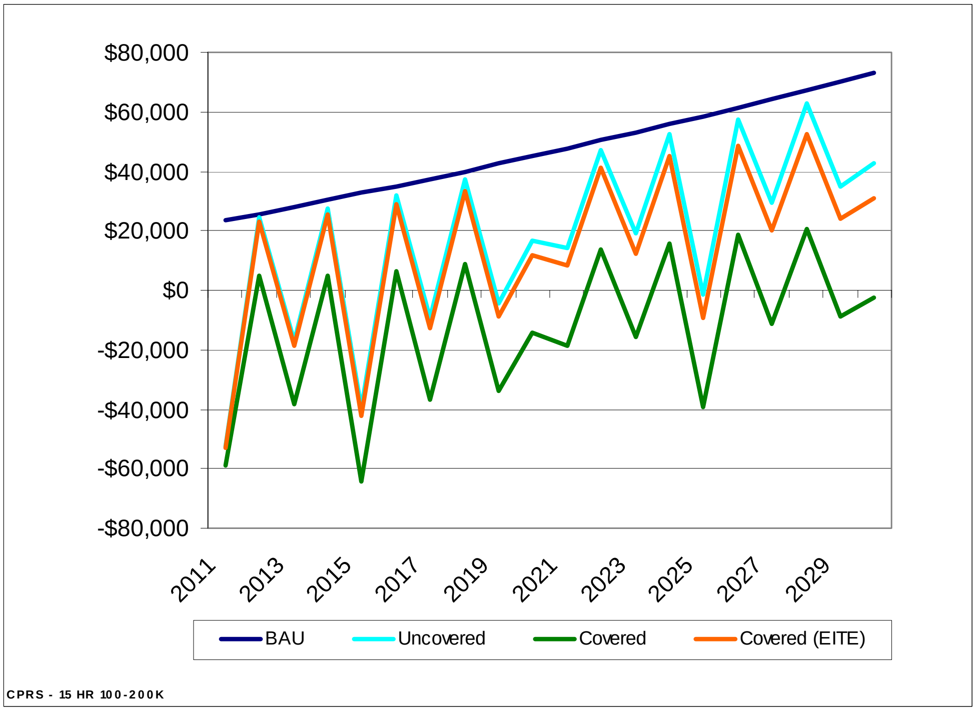

Figure 12 **Farm Cash Margin for High Rainfall zone farm with $100,000-$200,000 annual turnover, with voluntary carbon market offset prices fixed at $5 per tonne CO_2-e, under the 15 per cent emission reduction scenario.**

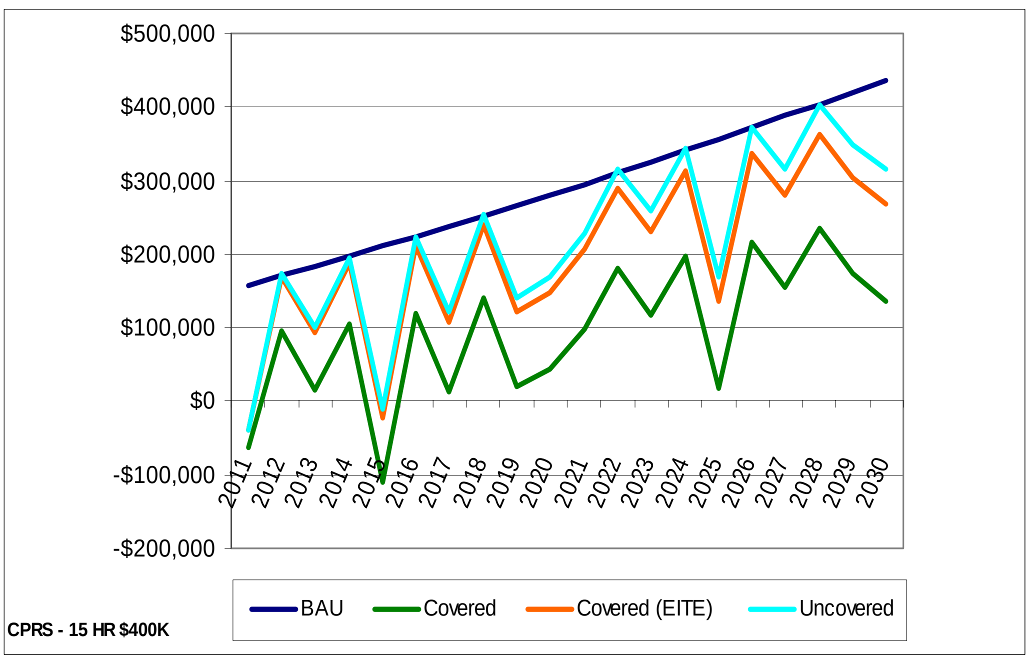

Figure 13 **Farm Cash Margin for High Rainfall zone farm with $400,000 annual turnover, with offset prices fixed at $5 under the 15 per cent emission reduction scenario.**

Table 21: High rainfall 100-200K, change in farm cash margin with and without offsets, under three emission reduction scenarios. Both with and without offset scenarios are being compared with business as usual without the implementation of a CPRS. In this modelling, offsets are priced at $5 over the 20 year period.

				2011	2015	2020	2025	2030
CPRS -5	Uncovered	No offsets	$ change	$0	-$1,283	-$2,762	-$3,434	-$4,173
			% change	0%	-4%	-6%	-6%	-6%
		$5 offsets	$ change	-$75,897	-$71,092	-$27,156	-$58,645	-$28,568
			% change	-325%	-218%	-60%	-100%	-39%
	ETS	No offsets	$ change	-$6,200	-$18,581	-$24,586	-$29,970	-$36,413
			% change	-26.56%	-56.92%	-54.53%	-51.24%	-49.94%
		$5 offsets	$ change	-$82,097	-$88,390	-$48,980	-$85,181	-$60,808
			% change	-352%	-271%	-109%	-146%	-83%
	EITE	No offsets	$ change	-$341	-$3,068	-$6,253	-$9,091	-$12,653
			% change	-1%	-9%	-14%	-16%	-17%
		$5 offsets	$ change	-$76,238	-$72,877	-$30,648	-$64,302	-$37,048
			% change	-327%	-223%	-68%	-110%	-51%
CPRS -15	Uncovered	No offsets	$ change	$0	-$2,643	-$3,843	-$4,733	-$5,777
			% change	0%	-8%	-9%	-8%	-8%
		$5 offsets	$ change	-$75,897	-$72,452	-$28,237	-$59,943	-$30,172
			% change	-325%	-222%	-63%	-102%	-41%
	ETS	No offsets	$ change	-$6,200	-$27,319	-$34,781	-$42,367	-$50,913
			% change	-26.56%	-83.68%	-77.15%	-72.44%	-69.82%
		$5 offsets	$ change	-$82,097	-$97,128	-$59,175	-$97,577	-$75,308
			% change	-352%	-298%	-131%	-167%	-103%
	EITE	No offsets	$ change	-$341	-$5,190	-$8,793	-$12,756	-$17,649
			% change	-1%	-16%	-20%	-22%	-24%
		$5 offsets	$ change	-$76,238	-$74,998	-$33,187	-$67,966	-$42,043
			% change	-327%	-230%	-74%	-116%	-58%
CPRS -25	Uncovered	No offsets	$ change	$0	-$4,707	-$5,710	-$6,969	-$8,074
			% change	0%	-14%	-13%	-12%	-11%
		$5 offsets	$ change	-$75,897	-$74,516	-$30,105	-$62,179	-$32,468
			% change	-325%	-228%	-67%	-106%	-45%
	ETS	No offsets	$ change	-$6,200	-$34,405	-$42,910	-$52,043	-$62,138
			% change	-26.56%	-105.39%	-95.18%	-88.98%	-85.21%
		$5 offsets	$ change	-$82,097	-$104,214	-$67,305	-$107,253	-$86,532
			% change	-352%	-319%	-149%	-183%	-119%
	EITE	No offsets	$ change	-$341	-$7,772	-$11,662	-$16,578	-$22,294
			% change	-1%	-24%	-26%	-28%	-31%
		$5 offsets	$ change	-$76,238	-$77,581	-$36,056	-$71,788	-$46,688
			% change	-327%	-238%	-80%	-123%	-64%

Table 22 High rainfall 400K, change in farm cash margin with and without offsets, under three emission reduction scenarios. Both with and without offset scenarios are being compared with business as usual without the implementation of a CPRS. In this modelling, offsets are priced at $5 over the 20 year period

				2011	2015	2020	2025	2030
CPRS -5	Uncovered	No offsets	$ change	$0	-$5,872	-$12,607	-$15,628	-$18,992
			% change	0%	-3%	-4%	-4%	-4%
		$5 offsets	$ change	-$199,218	-$223,564	-$120,009	-$194,302	-$126,394
			% change	-126%	-106%	-43%	-55%	-29%
	ETS	No offsets	$ change	-$24,770	-$74,981	-$99,798	-$121,644	-$147,796
			% change	-15.65%	-35.61%	-35.57%	-34.17%	-33.81%
		$5 offsets	$ change	-$223,988	-$292,672	-$207,199	-$300,317	-$255,198
			% change	-142%	-139%	-74%	-84%	-58%
	EITE	No offsets	$ change	-$1,362	-$13,004	-$26,557	-$38,229	-$52,869
			% change	-1%	-6%	-9%	-11%	-12%
		$5 offsets	$ change	-$200,580	-$230,695	-$133,958	-$216,903	-$160,271
			% change	-127%	-110%	-48%	-61%	-37%
CPRS -15	Uncovered	No offsets	$ change	$0	-$12,214	-$17,587	-$21,623	-$26,331
			% change	0%	-6%	-6%	-6%	-6%
		$5 offsets	$ change	-$199,218	-$12,214	-$17,587	-$21,623	-$26,331
			% change	-126%	172%	-10%	-12%	-8%
	ETS	No offsets	$ change	-$24,770	-$110,799	-$141,190	-$171,977	-$206,656
			% change	-15.65%	-52.61%	-50.32%	-48.31%	-47.27%
		$5 offsets	$ change	-$223,988	-$328,490	-$248,591	-$350,651	-$314,058
			% change	-142%	-156%	-89%	-99%	-72%
	EITE	No offsets	$ change	-$1,362	-$22,387	-$37,362	-$53,676	-$73,759
			% change	-1%	-11%	-13%	-15%	-17%
		$5 offsets	$ change	-$200,580	-$240,078	-$144,764	-$232,350	-$181,161
			% change	-127%	-114%	-52%	-65%	-41%
CPRS -25	Uncovered	No offsets	$ change	$0	-$20,888	-$25,433	-$31,012	-$36,077
			% change	0%	-10%	-9%	-9%	-8%
		$5 offsets	$ change	-$199,218	-$238,580	-$132,835	-$209,686	-$143,479
			% change	-126%	-113%	-47%	-59%	-33%
	ETS	No offsets	$ change	-$24,770	-$139,537	-$174,053	-$211,090	-$252,071
			% change	-15.65%	-66.26%	-62.03%	-59.30%	-57.66%
		$5 offsets	$ change	-$223,988	-$357,228	-$281,455	-$389,764	-$359,473
			% change	-142%	-170%	-100%	-109%	-82%
	EITE	No offsets	$ change	-$1,362	-$33,132	-$49,210	-$69,402	-$92,887
			% change	-1%	-16%	-18%	-19%	-21%
		$5 offsets	$ change	-$200,580	-$250,823	-$156,612	-$248,076	-$200,289
			% change	-127%	-119%	-56%	-70%	-46%

4. Conclusions

The modelling reported here confirms the results of earlier modelling which concluded that the implementation of a CPRS in Australia will have a significant negative impact on the future profitability of Australian farm businesses.

From a farm business perspective, the worst-case scenario would be one under which farm emissions were covered under the CPRS, and farmers were required to purchase emission permits equivalent in number to estimated annual farm emissions. Modelling of this scenario identifies that farm businesses are projected to experience immediate and sustained declines in profitability, and without major changes to production systems it is doubtful if most livestock farm businesses would remain viable.

Under a scenario where agricultural emissions are covered but eligible for EITE concessions, farm cash margins are still projected to be significantly negatively impacted, although the impact is more gradual and would provide livestock farm businesses with some opportunity to adapt. Longer-term, livestock farm viability under this scenario would depend heavily on the emergence of emission-reduction technologies, and the adoption of common policies by both developing and developed nations internationally.

Even under a scenario where agricultural emissions remain uncovered (as the Australian Government has now proposed) the indirect impacts associated with energy and energy-related cost increases are projected to have a marked effect on farm cash margins, ranging from a 5 per cent to a 15 per cent reduction in farm cash margins relative to the BAU case by 2030 under the lowest emission price scenario (CPRS-5). Higher emission price scenarios result in a larger negative impact.

The opportunity to utilise soil carbon sequestration to generate offsets that can be sold to emitters provides a means of reducing the negative impacts of the CPRS, although the net result under most scenarios is that the revenue from soil carbon offsets at best negates the negative impact of the CPRS on farm cash margins. Given the variability between regions, farms, paddocks, it is unrealistic to expect every farm to be able to access this option. High rainfall zone landholders may find it economic to participate over the medium-term, but this is not likely for all livestock producers.

Only in some limited cases does projected soil carbon offset revenue result in farm businesses being more profitable. Even in these cases, farmers would be required to undertake considerable investment during the early years to establish a soil carbon baseline and develop areas of improved pasture, and the revenue associated with this investment lags this expenditure by a considerable period. Nevertheless, soil carbon offsets could at least provide an opportunity for some farm businesses to retain farm profitability under a scenario where agricultural emissions remain uncovered by the CPRS.

It should be noted that this opportunity appears limited to farms located in higher rainfall zones where establishing legume-based improved perennial pastures is feasible. There are

probably also strategies available to increase soil carbon in lower rainfall areas, although these are likely to involve reduced stocking rates, and therefore reduced livestock revenue.
There are significant risks and trade-offs associated with reliance on soil carbon sequestration by farmers that have not been incorporated into this modelling. These are sink saturation; permanence; displacement and verification.

Rates of soil carbon sequestration could be anticipated to be greatest in the first few years after changes are made to farm management (such as sowing improved pastures), with the gains declining over time. Soils tend to reach an equilibrium carbon level over timeframes that may be between 20 and 100 years, after which major changes in the production system are required to sequester more carbon. As such the soil carbon baseline from which a farm business starts will have considerable bearing on the carbon sequestration that can be achieved before saturation, and the length of time that elapses before saturation or equilibrium is reached.

Permanence of soil carbon sequestration is another major issue for soil carbon, because it is closely associated with environmental and climatic factors over which farmers have no control. It is pertinent to recognise that climate records reveal notable changes in ‘average’ weather patterns in specific regions of Australia over the past forty years. Given the timeframes over which soil carbon levels are likely to be required to be maintained, regional weather changes such as have been experienced in the past represent an important risk factor that needs to be considered. The potential liability which this could create would be equal to the possible benefits arising from the sale of soil carbon offsets in the modelling reported here.

It also needs to be recognised that participation in soil carbon offset markets may restrict the future flexibility of farm management decisions. Once involved in the market, farmers will not as easily be able to adjust landuse in response to commodity market changes, and especially to increase cropping intensity. All the available research to date indicates that it is extremely difficult to achieve long-term increases in soil carbon under conventional crop-pasture rotations.

As is highlighted by this modelling and analysis, the price of carbon heavily influences the viability of soil carbon offsets as part of a farm enterprise. Participating in offset schemes can be uneconomic when the costs of achieving and verifying increases in soil carbon levels are greater than the value of the offset that can be sold. It can also become uneconomic if the cost of change in management practice outweighs the return. In a market system, it is difficult to be sure receipts will cover the costs of involvement in this market, especially given the fluctuations in the price of carbon that have been experienced in existing markets.

It was noted above that an increase in soil organic carbon in the top layers of soil can be associated with a decrease in soil carbon content in the lower layers of soil (Puget and Lal, 2004; Baker *et al.*, 2007). The displacement of carbon from one part of the soil profile to another is not an increase in total soil carbon. In a similar vein, changing

management practices to increase soil carbon in favour of increased production, will also have risks and liabilities.
Until the full effects of farm management practices on soil carbon levels throughout the soil profile are well understood, it appears that the risks associated with participation in soil carbon offset markets are too significant in comparison with the potential rewards.

As noted in earlier analysis and confirmed by the limited economic modelling reported here, the development of environmental services markets or land stewardship schemes that reward farmers for delivering a package of positive environmental outcomes, one of which may be soil carbon sequestration, seems to provide the best opportunities for farmers to develop a better understanding of the implications of participation in soil carbon offset markets, without exposing them to considerable risks.

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