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Agriculture and the Carbon Pollution Reduction Scheme (CPRS): economic issues and implications

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March 2009

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ABARE is a professionally independent government economic research agency.

ABARE project 3372

Acknowledgments

The authors would like to acknowledge and thank the following people for their useful inputs: Mike Hinchy, Don Gunasekera and Hom Pant from ABARE and colleagues at the Department of Agriculture, Fisheries and Forestry, Department of Treasury and the Department of Climate Change.

Agriculture and the Carbon Pollution Reduction Scheme (CPRS): economic issues and implications

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- The Australian Government's Carbon Pollution Reduction Scheme (CPRS) will commence in 2010. Agricultural emissions are likely to be included in the scheme from 2015.
- Before agriculture can be included in the CPRS, a number of issues around the cost-effective measurement and monitoring of emissions abatement in the sector need to be resolved.
- Given that some agricultural industries will be eligible for transitional assistance, the effects of the CPRS to 2020 on Australian agricultural activity levels and costs are projected to be relatively small.
- To 2030, the CPRS will create opportunities for some industries to expand, while growth in other industries will be slower relative to the reference case as consumers switch toward lower emissions intensive food and fibre products.

Introduction

The Carbon Pollution Reduction Scheme (CPRS), a market-based emissions trading scheme to reduce Australia's greenhouse gas emissions, is expected to commence in July 2010 to establish a price for carbon throughout the Australian economy (DCC 2008a). Although emissions from agriculture account for about 16 per cent of Australia's emissions, agricultural emissions will initially be excluded from the scheme because of practical difficulties in the cost-effective measurement of emissions from the sector.

Given that expanding the sectoral coverage of the scheme can reduce the economy-wide cost of meeting a given emissions cap, the Australian Government has proposed to make a decision in 2013 as to whether the CPRS will include agricultural emissions by 2015. Regardless of that decision, the sector will still be required to make a contribution to Australia's emissions abatement task through other measures (DCC 2008a).

A key focus of this paper is to examine the potential economic effects of the CPRS on agricultural production costs and output in the short and long term, using both partial and general equilibrium analytical frameworks. In this regard a range of relevant issues are discussed. Specifically this paper explores: the CPRS and policy positions directly affecting the agriculture sector; agricultural emissions profiles; issues in incorporating agriculture in the scheme; effects of alternative emissions thresholds; and emissions mitigation options.

This paper forms part of the Government's ongoing work program to provide information relevant to policy consideration and consultation processes around agriculture and the

CPRS. It extends the work undertaken for the Australian Government (2008) by the Australian Treasury by improving the representation of the agriculture sector in ABARE's Global Trade and Environment Model (GTEM). A sensitivity analysis of the potential impacts of agricultural abatement options on agricultural costs and production is also included.

The Carbon Pollution Reduction Scheme as outlined in the Australian Government's White Paper

In this section, the key features of the CPRS as presented in the White Paper (DCC 2008a) and those policy positions directly relevant to the agriculture sector will be briefly outlined.

The basic features of the CPRS

The CPRS is a 'cap and trade' emissions trading scheme designed to reduce greenhouse gas emissions in Australia. The government's policy positions on the CPRS have been outlined in the CPRS White Paper released in December 2008 (DCC 2008a). Following public consultation, the government intends to introduce the relevant Bills into the Australian Parliament in mid-2009. The scheme is expected to begin on 1 July 2010. In box 1 some of the proposed key features of the CPRS are outlined.

Policy positions directly relevant to the agriculture sector

Although the government recognises the importance of broad coverage to minimise the costs of reducing emissions, emissions from the agriculture sector will not be covered at the commencement of the scheme because of practical difficulties with the cost-effective monitoring and reporting of agricultural emissions. It is important to recognise that regardless of participation in the CPRS, agriculture will still be required to contribute to the abatement of Australia's greenhouse gas emissions. Specifically, in the White Paper the government indicates that, if the 2013 decision excludes agriculture, mitigation measures should still be applied in agriculture which result in costs of emissions similar to those under the scheme. For example, the government could seek to mandate the use of mitigation technologies or practices in the agriculture sector to achieve a cost of emissions similar to the emissions price under the CPRS (DCC 2008a).

In box 2, key features of the scheme, in addition to those outlined in box 1, which are directly relevant to the agriculture sector, are discussed.

Emissions from the Australian agriculture sector

Before assessing the potential economic effects of the CPRS on the agriculture sector, it is important to have an understanding of the sector's emissions. In 2006, Australian agriculture sector emissions were about 90 million tonnes of carbon dioxide equivalent (million tonnes CO_2-e) or 16 per cent of national greenhouse gas emissions (DCC 2008c). Of the direct production related emissions from the agriculture sector, 65 per cent were from enteric fermentation produced during the digestion process in ruminants such as cattle and sheep;

box 1 Proposed key features of the CPRS

Timing: expected to begin on 1 July 2010.

Greenhouse gas emissions coverage: all greenhouse gases included under the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons).

Sectoral coverage: stationary energy, transport, fugitive emissions, industrial processes, waste and forestry sectors will be covered from 2010. Agriculture may be covered from 2015.

General emissions threshold (entities with facility emissions above this level are subject to scheme obligations): 25 000 tonnes of carbon dioxide equivalent (000 tonnes CO_2-e) per year.

Scope of coverage: approximately 75 per cent of Australia's emissions. Around 1000 entities will initially be subject to mandatory obligations under the scheme.

Emissions trajectory: to be consistent with allowing Australia to reduce its emissions by between 5 per cent and 15 per cent below 2000 levels by 2020 and to 60 per cent below 2000 levels by 2050.

Emissions price: to be set by the market. Drawing on modelling for the Australian Government (2008) by the Australian Treasury, assistance to business and households is based on an assumed initial emissions price of A$25 (nominal) a tonne of carbon dioxide equivalent (tonnes CO_2-e) in 2010. A price cap (maximum price of an emissions permit) of A$40/t CO_2-e, rising at 5 per cent a year, will be in place to 2014-15.

Assistance for Emission Intensive Trade Exposed (EITE) sectors: will be provided to eligible EITE sectors to address competitiveness concerns because of the introduction of an emissions price in Australia before an international emissions price is established (DCC 2008a). Assistance will be provided to eligible entities through the allocation of free permits at the start of each period (based on an individual entity's previous year's level of production) to cover an agreed and declining proportion of emissions. This will include emissions associated with direct production covered by the scheme and scheme-related cost increases for electricity, steam and those associated with the extraction and production of natural gas and its derivatives when used as a feedstock. Eligibility will be decided at an activity level (eg aluminium smelting), based on all entities conducting an activity. To be eligible for assistance an activity must be:

- Trade exposed: trade share (ratio of value of imports and exports to the value of domestic production) greater than 10 per cent in any of the years between 2004-05 to 2007-08, or have a demonstrated lack of capacity to pass through costs because of the potential for international competition, and;
- Emissions intensive: highest level of assistance (90 per cent support in 2010) if entities have greater than 2000 tonnes CO_2-e emissions per $million revenue (or 6000 tonnes CO_2-e emissions per $million value added) on average. Lower level of assistance (60 per cent support in 2010) if entities have between 1000 and 1999 tonnes CO_2-e per $million revenue (or 3000 to 5999 tonnes CO_2-e per $million value added). Estimates of emissions intensity will be based on data over the period 2004-05 to 2008-09.

The rates of assistance will decline each year by a carbon productivity contribution of 1.3 per cent to ensure EITE sectors make a contribution to the national improvement in carbon productivity.

Source: DCC 2008a.

box 2 Additional proposed key features of the CPRS directly relevant to the agriculture sector

Sectoral coverage: Agricultural emissions are initially excluded from the scheme. In 2013, the government will decide if agriculture is to be included. The White Paper indicates that the government is disposed to include agricultural emissions in the scheme by 2015.

Opportunities for offsets: Offsets are emission credits created by reducing emissions below a baseline in sectors not covered by the scheme. Given the complexity of determining offsets in agriculture, the White Paper indicates that there will be no scope for offsets in the agriculture sector prior to 2015. The government will consider the scope for domestic offsets in 2013.

Fuel credits: From 1 July 2010 to 30 June 2013, agriculture and fishing businesses are eligible for a CPRS fuel credit to offset the effect of the CPRS on fuel prices. This measure will be reviewed in 2013. Businesses in heavy on-road transport will also be eligible for a CPRS fuel credit for one year.

Point of policy obligation: The point of policy obligation or emissions liability (the level in the market chain at which entities are required to hold emission permits) has not been decided for agriculture. However, the government is disposed towards an approach where scheme obligations are generally applied off-farm while ensuring there are incentives for on-farm abatement. Determining an appropriate point of policy obligation is a key component of the government's work plan, in consultation with industry, in the lead up to the 2013 decision.

Eligibility for assistance as an EITE sector: If agriculture is included in the scheme, eligibility for EITE sector assistance will be decided in the lead up to the 2013 decision. It is likely activity level eligibility will be decided on a similar basis to that outlined in the White Paper. If agriculture is included in the scheme, the 2015-16 assistance rates will be 84.4 per cent and 56.2 per cent for the two assistance categories.

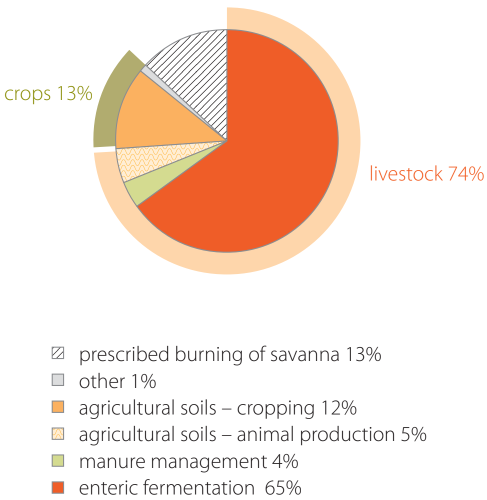
Based on preliminary analysis, some of the agricultural activities which may be eligible for EITE sector assistance are presented in table 1.

1 Potential agriculture activities eligible for EITE sector assistance

emissions threshold	initial rate of assistance in 2015-16 (as % of activity's emissions)	potential activities
≥ 2000 tonnes CO_2-e/$million revenue or 6000 tonnes CO_2-e/$million value added	84.4	beef production sheep production dairy cattle production rice production
1000-1999 tonnes CO_2-e/$million revenue or 3000 – 5999 tonnes CO_2-e/$million value added	56.2	pig production sugar cane production

Source: DCC 2008a, 2008b.

a Composition of greenhouse gas emissions from the Australian agriculture sector, 2006



Source: DCC 2008c.

12 per cent were from agricultural soils associated with the application of fertilisers, crop residues and animal wastes to crop lands and nitrogen fixing crops; 5 per cent were from animal waste to pastures and paddocks; and 4 per cent were from manure management (figure a). Savanna burning accounted for a further 13 per cent; and emissions from rice cultivation and field burning of agricultural residues accounted for about 1 per cent.

Livestock emissions accounted for about 74 per cent of agricultural emissions in 2006 and crops accounted for about 13 per cent. Most of the greenhouse gas emissions from the agriculture sector were methane (77 per cent) from enteric fermentation and manure management, and nitrous oxide (23 per cent) from agricultural soils. In Australia, the vast majority of enteric fermentation emissions are from cattle and sheep. The production of cattle, pigs and poultry account for the majority of manure management emissions.

Further details on Australia's agricultural emissions including a snapshot of the distribution of emissions by agricultural industry are provided later (see table 2 and related text).

Transition to including agriculture in the CPRS

Before discussing the detailed analysis of the potential effects of the CPRS on the agriculture sector, it is useful to review the key issues associated with the inclusion of agriculture into the scheme.

Timing of inclusion

The Australian Government has announced it is 'disposed to include agriculture emissions in the scheme by 2015 and to make a final decision on this in 2013' (DCC 2008a). There are costs and benefits associated with delaying the extension of the scheme to agriculture. Including the sector at a later date will allow for some issues to be resolved. For the sector to effectively participate in a trading scheme, there will need to be cost-effective means of measuring emissions; a clear understanding of which emissions will be covered and where the point of policy obligation will be assigned; and an understanding of which emission accounting rules will be applied.

Delay may allow for more economic and technically feasible monitoring options to become available and could partially defer the compliance costs to the sector associated with inclusion. However, as the cost of emission permits is expected to increase over time as the emissions cap is tightened, the costs faced by operators in the agriculture sector at the time of inclusion are likely to be relatively greater if inclusion is delayed. This will be partially offset if the sector takes action in advance of any inclusion. Some argue that the development of mitigation and monitoring technologies will be accelerated once a credible and specific time for inclusion in the scheme is announced. Ongoing delay may lead to slower development of technologies and changes in production and consumer behaviour.

Coverage of the agriculture sector

The agriculture sector can be divided into a number of industries. When the decision is made about the timing of inclusion of agriculture, the exact coverage of the agriculture sector will also need to be decided. Each of the industries have different characteristics including the source and level of emissions, emissions intensity, size, ease of monitoring emissions and the cost and availability of mitigation options. For example, on average, the livestock industry is more emissions intensive than the cropping industry. If only some industries, such as livestock, are included then compliance difficulties may potentially arise for mixed farms which both raise livestock and grow crops.

Emissions threshold

The White Paper has set emissions thresholds for participation of facilities in the CPRS so compliance costs are balanced with scheme coverage. Thresholds should be low enough to capture most emissions, but high enough to exclude small facilities that are not cost-effective to include (DCC 2008a).

An emissions threshold of 25 000 tonnes of carbon dioxide equivalent (CO_2-e), as outlined in the White Paper, is too high for the agriculture sector as it would exclude most of the sector's emissions (DCC 2008a). If agriculture is included in the scheme a lower emissions threshold will need to be set for the sector. This threshold should be set after taking into account the economic effects of alternative thresholds, including the trade-offs between compliance costs and coverage, and the potential for significant competitive distortions between closely competing farm enterprises on either side of the threshold (DCC 2008a). It could differ from the general scheme threshold and between agricultural industries depending on whether a direct or indirect point of policy obligation is used. The number of entities and volume of emissions captured under a range of illustrative emissions thresholds are explored later in this paper.

Point of policy obligation

The Green Paper (DCC 2008b) outlined three possible options for the point of policy obligation in the agriculture sector. The first is direct obligation, where scheme obligations are imposed on the emitting entity – the farm business. Placing the policy obligation on the farm business ensures that direct incentives are created to reduce emissions through alternative technologies, management practices or production choices. However, this may not be practical or cost-effective given the large number of farm businesses, the diverse nature of emissions and the relatively small volume of emissions from most individual farm businesses.

The second option is indirect obligation, whereby scheme obligations are placed on upstream input (for example fertiliser) producers or downstream food or fibre processing points such as abattoirs, dairy processors and mills. Given the economic costs of estimating emissions at the individual farm level, emissions could be determined using default average emission factors for each activity in different regions, for example, beef cattle by production method in Queensland. This option reduces compliance costs because there would be fewer participating entities. However, moving the point of obligation away from the direct source of emissions and using average default emission factors reduces the efficiency of the price signal to encourage abatement.

The final option is a hybrid approach, where obligations would by default be placed upstream or downstream and farm enterprises would also be given the option of taking on direct obligations (DCC 2008b). This option limits the compliance costs as most of the reporting will be done off-farm, probably using default average emission factors. However, if it is cost-effective for farmers to demonstrate that their emissions are lower than those implied by the default average emissions factors, then they would have an incentive to take on the direct obligation.

The point of policy obligation decision will also need to be taken within the context of other issues, such as the measurement and accounting rules which will apply. Without a system of measuring emissions which takes into account emission abatement from changes in farm management practices or other abatement opportunities, the CPRS will effectively act as an unavoidable additional cost on the production of agricultural products. This means the only way to reduce emissions in the agriculture sector would be to reduce agricultural production, potentially leading to an increase in global greenhouse gas emissions if production is displaced to other countries with higher emission intensities and less stringent emissions constraints. If it is decided that standard activity based emission factors are to be used, without scope for accounting for specific farm level characteristics such as differences in emissions intensity, livestock breeds or management practices, then the difference in effectiveness of the price signal between direct and indirect obligation will be eliminated.

Establishing credible average emission factors which are based on a variety of characteristics (other than just state based activity choices) such as management practices and breed choice could provide an incentive to reduce on-farm emissions intensity per unit of activity as well as reducing measurement costs.

Coverage of agricultural emissions under different thresholds

The CPRS White Paper indicates that entities with emissions greater than 25 000 tonnes CO_2-e per year will have obligations under the scheme and will be required to hold emissions permits. Analysis by ABARE indicates most farms in Australia emit less than about 2000 tonnes CO_2-e per year. A threshold of 25 000 tonnes CO_2-e will only capture the largest beef farms in the Northern Territory which account for about 2 per cent of total agricultural emissions (table 2). Given this, if it is decided that the point of policy obligation is on farm, it is likely

2 Estimated coverage of different emissions thresholds, by industry a

		threshold (000 t CO_2-e) per year				
		1	2	3	5	25
Beef (17 803 beef farms in total)	farms covered by threshold	7 106	3547	2313	2273	47
	proportion of industry emissions covered	86%	69%	58%	57%	7%
	proportion of agricultural emissions covered b	28%	22%	19%	18%	2%
Dairy (9039 dairy farms in total)	farms covered by threshold	4 441	141			
	proportion of industry emissions covered	71%	4%			
	proportion of agricultural emissions covered b	9%	1%			
Sheep (2305 sheep farms in total)	farms covered by threshold	1 514				
	proportion of industry emissions covered	37%				
	proportion of agricultural emissions covered b	2%				
Sheep-beef (6298 sheep-beef farms in total)	farms covered by threshold	1 838	473	410		
	proportion of industry emissions covered	66%	27%	25%		
	proportion of agricultural emissions covered b	5%	2%	2%		
Mixed crop and livestock (16 570 mixed farms in total)	farms covered by threshold	2 799	346			
	proportion of industry emissions covered	50%	8%			
	proportion of agricultural emissions covered b	6%	1%			
Wheat and other crops (11 035 wheat and other crops farms in total)	farms covered by threshold	686				
	proportion of industry emissions covered	21%				
	proportion of agricultural emissions covered b	1%				
Australia wide (65 359 farms in Australia including 2309 pig farms not included in ABARE surveys)	number of farms covered by threshold	18 383	4 507	2 723	2 273	47
	proportion of agricultural emissions covered b	52%	26%	21%	18%	2%

a For definition of industries, see Hooper et al. 2008. **b** agriculture emissions are taken to be total emissions of 90 million tonnes CO_2-e (DCC 2008c) less emissions from savanna burning (11.5 million tonnes CO_2-e).
Note: The estimated number of farms in this analysis excludes those farms with an estimated value of agricultural operations less than $40 000.

the threshold for agriculture will have to be reduced significantly. In this section of the paper, the number of farms and proportion of agricultural emissions covered by the scheme under different emissions thresholds are estimated. For the purposes of this paper, a bottom up spreadsheet model of average emissions at a farm level has been developed. Data for this analysis has been sourced from ABARE farm survey data for 2006-07 (ABARE 2008) and uses state based emissions factors from the Department of Climate Change (pers. comm.).

Estimating emissions from an average farm

It is currently not feasible to measure the emissions from every farm in Australia. Instead, ABARE farm survey data has been broken up into quartiles of closing capital value, and emissions have been estimated for an average farm in each quartile using state based emission factors.

In other words, four representative farms in each state and industry have been analysed, each representing a certain population of farms within the state and industry which all have similar capital values. If one of these representative farms is found to be covered by the thresholds examined, then the entire population of farms which this farm represents are also assumed to be covered. The ABARE estimates are presented in table 2.

Total agricultural emissions (excluding savanna burning) estimated using the 2006-07 farm survey data amount to approximately 61 million tonnes CO_2-e. The corresponding agricultural emissions estimated in DCC (2008c) for 2006 are 79 million tonnes CO_2-e (excluding savanna burning). The difference between the estimated and published emissions can be explained by two key elements. Firstly, this analysis does not have comprehensive industry coverage because no analysis of emissions from horticulture or sugar farms has been undertaken. Secondly, the estimates of emissions from cropping are incomplete as they exclude emissions from crop residues and soil disturbance because of a lack of detailed data.

Because of this lack of detailed data and the relatively high level of aggregation used, the estimated coverage of total agricultural emissions provided in table 2 is only an estimate and further detailed analysis will be required before any specific farm can be judged as covered or not covered by a particular emissions threshold. A number of online emission calculators exist which can assist farmers to understand the level of emissions on their individual farms (for example, see http://www.greenhouse.unimelb.edu.au/site/Tools.htm). Nonetheless, this study provides an initial broad indication of the types of farms which may be covered under different emissions thresholds.

Distribution of emissions by industry

In table 2, the estimated coverage of agricultural emissions under different emissions thresholds for each included industry is shown. Beef is the most emissions intensive industry, accounting for approximately 32 per cent of agricultural emissions (DCC 2008c). A threshold of 25 000 tonnes CO_2-e per year is estimated to cover only about 47 farms Australia-wide, or 2 per cent of total agricultural emissions (table 2). These 47 farms are all beef farms in the Northern Territory, indicating significant differences in farm characteristics between industries and states.

Industries other than beef are not covered unless the threshold is 3000 tonnes CO_2-e per year or below. A threshold of 3000 tonnes CO_2-e is estimated to capture about 58 per cent of beef industry emissions and about 25 per cent of sheep-beef industry emissions, which together account for about 21 per cent of total agricultural emissions (table 2 and DCC 2008c). The majority of dairy, sheep and mixed crop and livestock farms have been estimated to each emit less than 2000 tonnes CO_2-e per year. It is estimated that the majority of farms in the wheat and other crops industry each emit less than 1000 tonnes CO_2-e per year.

In determining the appropriate threshold level, there is a trade-off between overall coverage and transaction costs, as discussed earlier. For example, a threshold of 1000 tonnes CO_2-e is estimated to cover 52 per cent of agricultural emissions, but would involve significant transaction costs because about 18 400 farm businesses would be required to participate. Increasing the threshold to 2000 tonnes CO_2-e halves the emissions coverage to around 26 per cent but also significantly reduces the number of farms required to participate to about 4500. Determining which threshold is preferable requires weighing up the transaction costs of higher coverage with the benefits of having greater scheme participation.

Opportunities for reducing emissions in agriculture

As discussed previously, the introduction of the CPRS will provide incentives for the agriculture sector to reduce its emissions intensity. If agriculture is included in the CPRS, it will be economic to reduce emissions at the margin if the cost is lower than (or equal to) the permit price (adjusting for any associated transaction and compliance costs). Given this, opportunities for reducing the emissions intensity of output are likely to influence the economic effects of the CPRS on agriculture. In this section, abatement opportunities in the agriculture sector are discussed briefly. Not all of the options discussed here have been commercially proven.

Reducing emissions from enteric fermentation in livestock

The amount of methane produced by an animal depends primarily on the digestive system and the amount and type of feed. Given between 5 per cent and 15 per cent of dietary energy is lost as methane (AGO 2005; Avcare 2003), many farmers will initiate practices to reduce emissions if it is cost-effective to do so. Methane emissions from livestock can be reduced by increasing animal productivity, improving food conversion efficiency, bioengineering and improved livestock and feed management.

Improvements in livestock feed efficiency can be achieved by providing high quality forage, appropriate fats, dietary additives and low structural carbohydrates which can reduce methane production in the rumen. It has been estimated in Australia that using higher digestibility feed such as perennial ryegrass or white clover pasture can increase milk production per cow and reduce emissions per unit of production by up to 50 per cent (University of Melbourne 2008). Australian data also indicate that up to a 40 per cent reduction in methane emissions may be achieved through the additions of unsaturated fatty acids to ruminants (University of Melbourne 2008). The use of rumen modifiers such as specific antibiotics and tannins can reduce methane emissions from the rumen by up to 25 per cent. However, the reductions may be short-lived and it is possible certain regions may ban the use of antibiotics as has occurred in the European Union (University of Melbourne 2008 and IPCC 2007). It should be noted not all of the opportunities for emissions abatement are additive or currently commercially viable. However, some may be complimentary or partially additive (pers. comm. Richard Eckard, November 2008).

Reducing emissions from manure management

The level of emissions from manure management depends on the amount of manure produced, temperature, moisture levels, type of storage and length of storage.

Opportunities for reducing emissions from manure management include reducing the level of manure produced per quantity of output or altering the physical management of manure. Manure per quantity of output can be minimised by ensuring the energy requirements of the animals are met from the highest digestibility feed available and fed only at levels required for the desired animal performance (AGO 2001).

Emissions of methane from managed manure can be reduced through the use of anaerobic digesters, which hold decomposing manure under warm anaerobic conditions to produce biogas which can be piped to an electricity generator or boiler. The digested solids can also be used as a high quality fertiliser. Anaerobic digesters are estimated to reduce methane emissions by about 50 to 75 per cent and can also reduce odours and reduce surface and groundwater contamination (Bates 2001 in DeAngelo et al. 2003).

The scope for mitigating livestock emissions in Australia may be more limited than in other countries because of the greater use of grazing in extensive rather than intensive production systems.

Reducing emissions from agricultural soils

A number of agricultural activities, including fertiliser and manure application and soil disturbance, can increase the level of nitrous oxide (N_2O) emissions from agricultural soils. Emissions of N_2O differ on a seasonal or yearly basis as a result of changes in management practices, crop production, fertiliser application, rainfall and temperature. N_2O emissions from livestock manure applied to pasture or deposited by grazing animals are recorded under soil emissions.

The main focus of efforts to reduce N_2O emissions from agricultural soils is improvements in the efficiency and application level of nitrogenous fertilisers. A more efficient level of fertiliser application can be achieved by better matching the supply of fertiliser to crop demands through soil testing and ensuring appropriate timing of fertiliser applications. More advanced fertilisation techniques such as controlled release fertilisers and nitrification inhibitors can also reduce N_2O emissions. A study by Eckard et al. (2006) found that changes in the application of nitrogen fertiliser to dairy pastures could reduce N_2O emissions by 80 per cent, with a 4 per cent loss in pasture growth.

N_2O emissions from soil can also be reduced through the use of cover crops, plant breeding, improving water use efficiency, reducing tillage and avoiding high stocking rates during high rainfall periods (Eckard 2006; University of Melbourne 2008).

The cost of agricultural emissions mitigation and the need for research and development

As discussed, the loss of methane and nitrogen from managed agricultural systems generally represents sub optimal levels of efficiency as valuable production energy or inputs are lost. Technologies or management practices to reduce these losses may also represent opportunities for efficiency gains and can be considered win-win, neutral or negative cost options.

The cost and potential of agricultural mitigation measures is expected to differ between regions, industries, farms and over time. The cost of mitigation will be influenced by direct costs or benefits associated with increased or decreased levels of inputs. Some mitigation measures such as improvements in the feed efficiency of livestock can result in increased yields, while others may lead to yield declines. The cost of mitigation will also be determined by the current mix of agricultural production and production processes and the current level of emissions intensity as compared with the maximum achievable.

Further research is required in Australia to improve and develop efficient and effective mitigation opportunities in agriculture. Eckard (2006) stresses the importance of 'developing win-win management practices [that reduce emissions and increase yields cost effectively] that integrate into existing processes of continual improvement in agricultural efficiency and sustainability'. The development of these technologies, however, will require a concerted effort and increased funding for research and development.

It is also important that market barriers, such as information gaps concerning available technology and production practices, which may prevent the uptake of economically efficient mitigation technologies are addressed. If market barriers continue to prevent mitigation practices from being taken up, the CPRS will encourage higher levels of production losses to reduce emissions obligations than is economically efficient.

See box 3 for a discussion on how abatement opportunities are represented in the GTEM framework.

The CPRS: a partial equilibrium assessment of the potential effects of increased input costs on total agricultural production costs in 2010 and 2015

If agriculture is directly covered by the CPRS, then production costs will be increased by the requirement to purchase emissions permits or abate emissions. During the transition period to comparable international action, the EITE sectors in agriculture would have access to assistance from the government under the White Paper proposals, potentially ameliorating emission costs in the transition. If agriculture is excluded from the CPRS, then agricultural producers will not have access to EITE assistance and are still expected to face increased input costs for electricity, fuels, energy and potentially emissions intensive products such as fertiliser and chemicals. The following analysis illustrates the additional production costs in the short term which the agriculture sector may face as a result of the CPRS.

Underlying assumptions about input costs

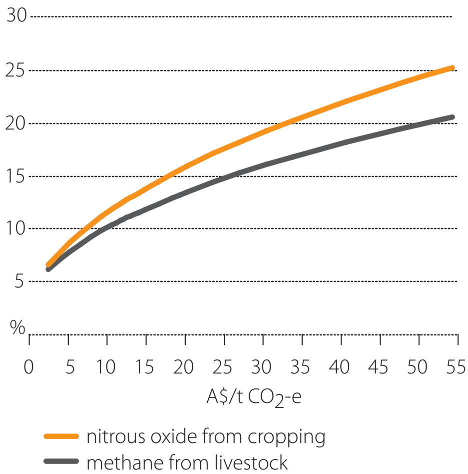
The assumptions used in this analysis are consistent with the government's position as outlined in the CPRS White Paper that:

- electricity prices are expected to increase from the commencement of the scheme;
- a fuel credit will be provided to agricultural producers to offset the increased price of fuel for three years;
- heavy on road transport (freight) will receive a fuel credit for the first year of the scheme;
- the analysis contained in the White Paper suggests fertiliser and chemical producers are among the EITE sectors which will be eligible for government assistance as they are price takers on the international market (as such, it is unlikely that placing a price on emissions in Australia will raise the price paid for fertiliser and chemicals), and;
- under the White Paper framework, free emission permits are likely to be provided to livestock producers for 84.4 per cent of their emissions (including those associated with electricity consumption) in 2015.

box 3 Incorporating agricultural mitigation technologies into the GTEM framework

Opportunities to improve the emissions intensity of production in agriculture are represented in ABARE's global model (GTEM) which has been used in this paper to project the likely effects of the CPRS, through the use of marginal abatement cost (MAC) curves. A MAC curve presents the percentage reduction in emissions per unit of output achievable over a range of given emissions prices. The MAC curves in GTEM are based on information from the Australian Government (2008) CPRS modelling report, the United States Environmental Protection Agency (EPA 2006) and analysis by the Energy Modelling Forum (DeAngelo et al. 2003). In figure b, the MAC curves for methane reductions from enteric fermentation in livestock and for nitrous oxide emissions from cropping are presented for Australia. Given currently available and soon to be available technologies, the greater relative potential for reducing emissions in cropping compared with livestock is reflected in the MAC curves. However, in absolute terms, the potential to reduce emissions in livestock is greater. The MAC curves also contain a time element. This effect has been captured in the parameterisation of the MAC curve parameters.

b GTEM marginal abatement cost curves in Australian agriculture
percentage reduction in emissions intensity



It is important to note that emission reductions achieved by implementing the MAC curves in GTEM are not costed. It could potentially be argued that this causes an underestimation of the costs of the CPRS in the following GTEM analysis. See box 6 for a discussion of the impacts of the CPRS on agricultural production and costs in a scenario without MAC curves. This scenario could be argued to be an overestimation of the costs of the CPRS given current understanding of technological and farm management practice options.

Scenarios

Three different scenarios have been examined to consider the effect of the CPRS on production costs in the agriculture sector in 2010 and 2015.

Scenario 1 In 2010, the agriculture sector faces higher prices for electricity and is shielded from price increases for fuel and freight.

Scenario 2 In 2015, the agriculture sector is covered by the scheme, the price of electricity, freight and fuel increases and EITE sector assistance is provided to livestock.

Scenario 3 In 2015, the agriculture sector is not covered by the scheme but the price of electricity, freight and fuel increases.

Data sources

The analysis uses ABARE's farm survey data on input costs by industry, averaged over the years 2004-05 to 2006-07 (ABARE 2008). The analysis undertaken here assumes an emissions price of A$20/t CO_2-e (in 2005 dollars) in 2010 which is consistent with the Australian Government (2008) CPRS modelling report. The emissions price is assumed to increase along the path projected in the government's report and reaches A$28/t CO_2-e (in 2005 dollars) in 2015.

The different cost shares of each industry are shown in table 3.

3 Percentage share of input costs in total production costs in Australia, average over 2004-05 to 2006-07, by industry a

	all broadacre industries	wheat and other crops	mixed livestock–crops	sheep	beef	sheep-beef	dairy
Electricity	0.9	0.8	0.9	1.1	0.8	1.1	2.6
Freight	3.2	4.3	3.1	2.5	2.8	2.7	1.0
Chemicals	6.0	12.8	7.4	2.9	0.8	1.9	0.6
Fertiliser	9.2	14.4	11.8	8.2	3.1	6.6	7.2
Fuel	7.9	10.0	8.9	7.1	6.1	5.8	3.8
Other expenses	72.7	57.7	67.9	78.1	86.4	81.9	84.8

a For definition of industries, see Hooper et al. 2008.

4 Estimated emissions price and percentage increase in Australian farm input costs relative to the average over 2004-05 to 2006-07

	2010	2015
Emissions price (in 2005 A$/t CO_2-e)	20	28
Electricity (%)	17	24
Freight (%)	n.a	1.8
Fuel (%)	n.a	11

Note: No cost increases for other inputs are assumed.

The estimated increase in the cost of farm inputs in response to the emissions price, assuming no other changes, is shown in table 4.

Based on the above assumptions and a partial equilibrium framework, the estimated increase in production costs because of the introduction of the CPRS are shown for the years 2010 and 2015 in table 5.

Key insights from this partial equilibrium analysis

The effect of the CPRS on the agriculture sector in 2010 is expected to be relatively minimal, at between a 0.1 and 0.5 per cent increase in production costs. This is because the sector will only face the increased price of electricity, with the price increase of fuel and freight shielded in the initial years of the scheme and the price of fertilisers and chemicals being set on international markets. Compared with the other industries, the greater use of electricity by the dairy industry leads to a higher increase in production costs for the industry.

In 2015, if agriculture is not included in the scheme, production costs are projected to increase by between 0.9 and 1.3 per cent with the greatest increase expected in the wheat and other crops industry because of their relatively high use of fuel and freight. If fertiliser and chemical

5 Percentage increase in total Australian agricultural production costs on an average farm because of the CPRS, relative to the average over 2004-05 to 2006-07

scheme coverage	agriculture not covered 2010	agriculture not covered 2015	agriculture covered 2015
Accounting for increased price of:	electricity	electricity, freight, fuel	electricity, freight, fuel, EITE assistance to livestock
Emissions price (in 2005 A$/t CO_2-e)	20	28	28
Industry			
All broadacre industries	0.2	1.1	2.8
Wheat and other crops	0.1	1.3	3.6
Mixed livestock–crops	0.1	1.2	2.4
Sheep	0.2	1.1	2.6
Beef	0.1	0.9	3.8
Sheep-beef	0.2	0.9	3.1
Dairy	0.5	1.1	2.5

prices were to increase, despite the internationally traded nature of these goods, there would be a further modest increase in agricultural production costs of around 0.1 percentage points for the wheat and other crops industry, with a smaller increase for other industries.

If agriculture is included in the scheme at 2015 then the effect of the scheme is expected to increase for all industries to between a 2.5 and 3.8 per cent increase in production costs. The industry facing the highest increase in production costs is the beef industry, despite receiving EITE assistance, because of the higher emissions intensity of beef. The wheat and other crops industry experiences a comparable increase in production costs despite having a lower emissions intensity as they do not receive any transitional EITE assistance.

This analysis is intended only to be illustrative of the extent to which the agriculture industry may be affected by the introduction of the CPRS. It is based on historical input costs and activity levels. The introduction of the CPRS and the resulting changes in input costs are expected to lead to agricultural producers changing their input mixes and activity levels, none of which was accounted for in this partial equilibrium analysis. Producers may also seek to reduce emissions and the associated cost of emission permits by adopting abatement technologies or management practices. The scenarios and analysis presented above only accounted for the ceteris paribus effect of the increased cost of the specific inputs on the agriculture sector. No allowance for flow-on effects of increased costs on inputs was made other than those discussed nor were any price interactions between the inputs considered. Also, no consideration of the effects of trade or international climate change policies on prices or production levels was given. The analysis undertaken using ABARE's Global Trade and Environment Model (GTEM) and presented in the following section, accounts for these general equilibrium interactions.

The CPRS: a general equilibrium assessment of the potential cost and production effects on agriculture to 2030 using GTEM

Using ABARE's Global Trade and Environment Model (GTEM), a computable general equilibrium model of the global economy, the potential effects of the CPRS on Australian agriculture are assessed by developing a policy scenario in which the CPRS is assumed to be implemented in Australia in the context of a gradually evolving international emissions trading scheme. These results are compared against a GTEM reference case or business as usual scenario. A brief overview of GTEM and its reference case is provided in box 4 and box 5 respectively.

The Australian Government (2008) recently released a comprehensive analysis of the CPRS on the Australian economy. The Australian industry results highlighted in that report, including for the agriculture sector, were obtained from the Monash Multi-Regional Forecasting (MMRF) model. The bulk of the assumptions used in this analysis are consistent with the government's report.

The effects of the CPRS on the agriculture sector are dependent on a range of factors. One key factor which remains largely outside the government's control is the extent of international mitigation action, which will drive the Australian emission price. The extent of mitigation across regions will also potentially influence the competitiveness of the agriculture sector, as it is highly trade exposed. However, trade competitiveness effects can be minimised by providing transitional assistance to offset the cost of the CPRS. The development and uptake of emissions abatement technologies and opportunities for terrestrial sequestration (forestry) will also have a significant influence on the effects of the CPRS on agricultural costs and production.

Results in this analysis are presented for the years 2020 and 2030. For the period to 2020, key design features of the CPRS scenario are consistent with those outlined in the CPRS White Paper and the Australian Government's (2008) CPRS modelling report. Beyond 2020, the EITE sector assistance is gradually removed as all economies are assumed to employ emission constraints from 2025.

The CPRS scenario

Australia

The CPRS is assumed to be implemented in Australia from 2010 and is consistent to 2020 with the policy positions outlined in the CPRS White Paper and the Australian Government (2008) CPRS modelling report. In this analysis it is assumed that Australia has a commitment to reduce its greenhouse gas emissions, relative to 2000 levels, by 5 per cent in 2020. Although the Australian Government has not committed to a 2030 emissions reduction target, in this paper it is assumed that Australia commits to reducing emissions by 20 per cent below 2000 levels by 2030. This is consistent with allowing Australia to reduce its emissions to 60 per cent below 2000 levels by 2050.

box 4 The economic framework – GTEM

GTEM (Pant 2007) is a recursively dynamic general equilibrium model of the world economy developed by ABARE to address policy issues with long-term global dimensions, such as climate change mitigation. The advantage of using a global general equilibrium model is that it captures interactions within and across sectors and countries, which is particularly important when analysing trade exposed sectors such as agriculture.

The version of GTEM used in this paper is largely consistent with the version used in the Australian Government (2008) CPRS modelling report. However, a number of additional model developments have been undertaken to improve the analysis of the agriculture sector. These are described here.

For the analysis in this paper, the agriculture and food processing sectors of GTEM were expanded from three broad industries (livestock, crops and food processing) to seven agriculture industries (grains, rice, other crops, beef cattle and sheep meat, other animals, dairy cattle, and wool) and three food processing industries (meat, milk and other food). Furthermore, within the meat and food processing industries, substitution among inputs in response to relative price changes was enabled.

The key components of the new GTEM broad industries are: grains: wheat, corn, barley and other cereals; other crops: oil seeds, vegetables, fruit, sugar cane, cotton; beef cattle and sheep meat: beef cattle, sheep, goats, horses; other animals: poultry and pigs; wool: wool and other animal materials used in textiles and milk: dairy products.

In addition, various land types and switching possibilities between them were modelled, reflecting agronomic conditions and differences in returns to various land types. In this analysis, some agricultural land is assumed to be converted to forestry in response to changes in relative profitability associated with the introduction of an emissions price. The conversion of agricultural land to forestry differs across agriculture industries. The majority of agricultural land converted to forestry is from the grazing industries.

The GTEM results presented here, as with any simulation modelling results, should only be taken as indicative projections of the potential effects which can occur under the CPRS. This is because economic models are only an approximation, or simplified version, of the real world. Over time, this analysis can be improved as additional information and data become available, however, model results will always be an approximation.

box 5 ABARE's GTEM reference case scenario

ABARE's GTEM reference case is a set of projections of economic growth, population, industry growth, productivity improvements and greenhouse gas emissions to 2030. The reference case aims to reflect a world in which technological development and government policies progress along their expected pathways in the absence of any major regional or global climate change initiatives and without any significant technological breakthroughs. GDP growth, population and economy-wide productivity improvements are consistent with those used in the Australian Government (2008) report. The CPRS is not implemented in the reference case and climate change impacts are not explicitly accounted for in either the reference case or CPRS scenario in this analysis.

ABARE's Australian reference case projections of agricultural production and emissions are generally consistent with the most recent analysis by ABARE's agriculture analysts. The emission projections for the agriculture sector are lower than contained in the Australian Government (2008) modelling report because of changes in assumptions around productivity, emission intensity and preferences for Australian agriculture exports. Reference case production and emission projections for Australia are presented in the results section.

Agriculture is assumed to enter the scheme in 2015 and eligible EITE sectors across the economy receive transitional assistance in the form of free permit allocations. The rate of assistance for agricultural industries assumed in GTEM is detailed in table 6. EITE sector assistance is assumed to be phased out between 2020 and 2025 as all economies are assumed to employ mitigation constraints by 2025.

6 Rate of transitional assistance in the agriculture sector (%)

	2015	2020	2025
Beef cattle and sheep meat, dairy cattle, wool	84.3	79	0
Other animals	51	48	0
Grains, other crops	0	0	0

Note: The assistance rate is measured as a percentage of an activity's emissions using emissions intensity in 2007 and current production levels. The rate of assistance to other animals accounts for the mix of industries within this category some of which are not eligible for EITE sector assistance. The rate of transitional assistance beyond 2020 was not detailed in the White Paper. In this analysis it is assumed that transitional assistance is reduced and removed between 2020 and 2025 given that in the CPRS scenario all economies are assumed to employ emissions constraints by 2025.

Free permit allocation is implemented in the model by giving a subsidy to eligible industries to partially cover the cost of the emissions price on direct emissions and indirect emissions related to electricity consumption. The subsidy in each year is based on the rate of transitional assistance and the emissions and electricity intensities of production in 2007 and the previous years production levels.

Mitigation commitments globally

Much uncertainty surrounds the timing and scope of emission allocation commitments internationally, particularly in developing countries. In this analysis the same international assumptions as those employed in the CPRS-5 scenarios contained in the Australian Government (2008) CPRS modelling report have been used. It is assumed that from 2010 other developed economies will employ emission allocation constraints which decline at the same rate, relative to the reference case, as in Australia. Developing countries are assumed to begin to employ emissions allocation constraints between 2015 and 2025. These regional emission allocation constraints are consistent with a global emissions pathway which would allow stabilisation of greenhouse gases at 550 parts per million CO_2-e toward the end of the century.

Emissions price and international emissions trading

The implementation of an international emissions permit trading scheme allows a uniform global emissions price to be established across all participating regions. The Australian price starts at A$20/t CO_2-e (in 2005 dollars) in 2010 and increases to A$35/t CO_2-e (in 2005 dollars) in 2020 and A$52/t CO_2-e (in 2005 dollars) in 2030.

Forestry and sequestration

The implementation of an emissions price provides an incentive to sequester emissions through afforestation and reforestation in Australia and in other regions throughout the world. Drawing on ABARE analysis for Australia (Lawson et al. 2008) a proportion of agricultural land in each industry is assumed to be converted into forestry. Grazing land accounts for the majority of the agricultural land converted reflecting differences in returns.

In table 7, a summary of the key features of the CPRS scenario is presented.

7 Summary of key features in the CPRS scenario

Emissions price	The international emissions price increases from US$21/t CO_2-e (in 2005 dollars) in 2010 at about 4 per cent a year to about US$44/t CO_2-e (in 2005 dollars) in 2030. The Australian price increases with the international price because of international emissions trading, subject to exchange rate movements. The Australian price starts at A$20/t CO_2-e (in 2005 dollars) in 2010 and increases to A$35/t CO_2-e (in 2005 dollars) in 2020 and A$52/t CO_2-e (in 2005 dollars) in 2030.
Emissions commitments in Australia	5 per cent below 2000 levels at 2020.
Emissions commitments in developed countries	From 2010 developed countries participate in an international emissions trading scheme and commit to the same percentage reduction in emission allocations, relative to the reference case, as in Australia.
Emissions commitments in developing countries	Developing countries participate in an international emissions trading scheme and commit to emissions constraints between 2015 and 2025. China, South Africa and OPEC enter the international emissions trading scheme in 2015. India, Indonesia and other South East Asia enter in 2020 and the rest of world enters in 2025. Emission allocations reduce in developing economies at the same rate as in developed economies consistent with the emission allocation rule used in the CPRS scenarios in the Australian Government (2008) report.
Sectoral coverage in countries with emissions commitments	Consistent with the CPRS White Paper. Agriculture covered from 2015.
Mitigation technologies in agriculture	Marginal abatement cost curves allow opportunities to reduce emissions intensity in the agriculture sector using mitigation technologies or changes in management practices.
Forestry sequestration and land use change	Some agricultural land is converted into forestry.
Transitional assistance for Emission Intensive Trade Exposed (EITE) sectors in countries with emissions commitments	Assistance provided to covered sectors consistent with that outlined in the White Paper to 2020. Assistance is withdrawn between 2020 and 2025. For simplicity, all participants within the international emissions trading scheme employ the same rate of assistance as applied in Australia. The rate of decline of EITE sector assistance is consistent with the White Paper, and is slower than that used in the Australian Government (2008) report which was based on the proposed assistance scheme contained in the Green Paper.
Fuel rebate in countries with emissions commitments	Rebate to offset the increase in fuel prices as a result of the CPRS to 2013.

Effects of the CPRS on the Australian agriculture sector

In this section, the potential effects of the CPRS on production costs, output and emissions are presented for the Australian agriculture sector at 2020 and 2030.

Agricultural production costs

Earlier in this paper, the immediate and short-term effects of the CPRS on agricultural production costs were estimated using a partial and static analytical framework. In this section medium to long-term effects are presented using GTEM, a dynamic general equilibrium framework.

In table 8 the implications for Australian agricultural production costs in the CPRS scenario at 2020 and 2030 are presented.

At 2020, the effect of the CPRS on production costs in all agricultural industries is projected to be relatively low – less than a 2.4 per cent increase relative to the reference case across all industries. This occurs because the EITE sector assistance offsets nearly all of the direct costs of the CPRS. The proposed EITE sector assistance does not occur without redistributional consequences through the reallocation of capital, labour and income for other sectors of the economy. The introduction of the agriculture sector into the scheme, and expansion of EITE assistance to cover this sector, is likely to add to the redistributional aspects of the assistance. Importantly, the structure of the proposed EITE assistance maintains the incentives for abatement activity to occur and lessens the aggregate economic implications from shielding.

The projected increases in costs at 2020 are even lower than those presented previously for 2015 using the static and partial analysis, despite the higher emissions price. These production cost estimates are not strictly comparable. The GTEM measure of production costs incorporates the cost of primary factors (land, labour and capital) which in aggregate tend to grow slightly more slowly in the CPRS scenario, relative to the reference case. This is associated with the slower growth in the global economy which results from the global emissions constraint. GTEM also captures resource reallocation and changes in the production mix in response to the emissions price. In particular, GTEM allows farmers to adjust their production choices and technology and management practices in response to the emissions price, thus reducing its effect.

In the case of dairy cattle, production costs in the CPRS scenario are actually projected to grow more slowly than in the reference case, to be 1.2 per cent lower at 2020, as the improvement in emissions intensity (per unit of production) between 2007 and 2020 allows the transitional assistance to offset more than all of the direct cost of the CPRS. This is because the transitional assistance is based on 2007 emissions intensity. The majority of emissions intensity improvements in the dairy cattle sector between 2007 and 2020 in the CPRS scenario are also achieved in the reference case through expected increases in production efficiency. Dairy cattle emissions intensity declines by 13 per cent and 18 per cent between 2007 and 2020 in the reference case and CPRS scenario respectively.

8 Implications for Australian agricultural production costs in the CPRS scenario at 2020 and 2030, percentage change relative to the reference case

	2020	2030
Grains	1.7	1.0
Other crops	1.1	0.2
Beef cattle and sheep meat	–0.1	19.9
Other animals	1.5	4.0
Dairy cattle	–1.2	6.7
Wool	2.4	15.8

The projected increase in production costs in 2020, relative to the reference case, in grains and other crops is also projected to be relatively low at about 1.7 per cent and 1.1 per cent respectively, even though these industries do not receive any transitional assistance. This is because the emissions price has little affect on costs in the short term as they are relatively low emissions intensive industries.

After 2020, production costs in agriculture are projected to increase further in the EITE industries as the emissions price increases and transitional assistance is reduced and removed. At 2030, the rise in production costs is projected to be largest in those industries which have the highest emissions intensity and thus largest emissions obligations under the CPRS. For example, production costs in 2020 relative to the reference case are projected to increase by about 20 per cent in beef cattle and sheep meat and 16 per cent in wool. The effects on dairy cattle and other animals production costs are significantly lower as they are less emissions intensive on a value basis. The cost increases in the other crops and grains sectors are projected to be lower in 2030 than in 2020 as farmers in these sectors are assumed to have greater access to emissions abatement technologies which are able to significantly reduce their emissions obligations.

Total Australian agricultural production

Assuming continued improvements in crop and livestock yields, Australian agricultural production is projected to expand by about 36 per cent between 2005 and 2030 in the reference case (table 9). The majority of the increase in production is driven by increases in demand for Australia's exports by developing economies.

In the CPRS scenario, total Australian agricultural production is projected to remain largely unchanged to 2030, relative to the reference case. This result is consistent with the findings in the Australian Government (2008) report. This result occurs because agriculture is excluded from the CPRS (with the exception of energy inputs) to 2015 and when agriculture becomes a covered sector, the most emissions intensive agricultural sectors are given transitional assistance to 2020 which nearly covers all of the increase in costs generated by the CPRS. To 2030, declines in some agricultural industries are expected to be offset by increases in other industries. Australia's total agricultural production is still projected to increase by about 35 per cent between 2005 and 2030 in the CPRS scenario (table 9).

Agricultural production by industry

In table 9, the projected production effects of the CPRS in 2020 and 2030 for various Australian agricultural industries are presented. In the short to medium term (to 2020), production effects in Australia are projected to remain relatively small because transitional assistance to emissions

9 Implications for production of Australian agriculture by industry

	% increase in production in the reference case		% increase in production in the CPRS scenario		% change in the CPRS scenario, relative to the reference case	
	2005-2020	2005-2030	2005-2020	2005-2030	2020	2030
Grains	29	49	33	56	3.3	5.3
Other crops	20	37	20	37	–0.6	0.0
Beef cattle and sheep meat	15	30	15	20	0.1	–8.0
Other animals	26	48	24	46	–1.6	–1.1
Dairy cattle	30	44	30	40	0.4	–3.0
Wool	–4	6	–6	4	–1.4	–2.1
Total agriculture	19	36	20	35	0.1	–1.0
Processed meat	15	30	15	23	0.0	–5.8
Processed other food	42	70	42	72	0.0	0.6
Processed milk	37	57	38	52	0.5	–2.8

intensive agricultural industries offsets nearly all of the cost increases associated with the CPRS, enabling trade competitiveness to be maintained.

Although the other animals industry continues to expand to 2030 in the CPRS scenario, it has the largest declines in output in 2020 relative to the reference case at nearly 2 per cent. The other animals industry declines by more than higher emission intensive sectors such as beef cattle and sheep meat and wool because the former receives a lower rate of transitional assistance in 2020 than the other agricultural EITE sectors. Grains production is projected to increase by about 3 per cent in 2020, relative to the reference case, despite not receiving any transitional assistance and its cost increasing. This is because grains are used as an input into biomass electricity generation which expands significantly, relative to the reference case. This is associated with the Renewable Energy Target. It should be noted no additional biomass is assumed to be used in the transport sector as biofuels are not represented in the analysis.

After 2020, production effects are projected to vary significantly across agricultural and food processing industries because of varying emission intensities, land supply responses and the assumed availability of abatement technology options.

The emissions price leads to changes in demand for final food and fibre products and this influences the level and composition of agricultural production. In particular, final consumers change their food consumption in response to price changes and switch away from emissions intensive meat products to other lower emissions intensive food products which use inputs such as grains, vegetables and fruits.

There is also some substitution away from higher emissions intensity meat products such as red meat to lower emissions intensive white meat. As a result, the largest declines in agricultural production are projected in beef cattle and sheep meat (down 8 per cent at 2030, relative to the reference case). It is important to note, however, all agricultural industries are still projected to grow between 2005 and 2030 under the CPRS scenario (table 9). Despite the switch away from meat products, production of other animals remains relatively unchanged, declining by only 1 per cent at 2030 relative to the reference case, as consumers are projected to switch away from red meat to white meat including poultry and pigs.

Grains production is projected to increase by about 5 per cent relative to the reference case at 2030 as its low emissions intensity drives substitution away from higher emissions intensive foods such as red meat. Grains demand also increases as a result of rising biomass electricity generation.

The broad direction of industry movements obtained in this analysis is consistent with the Australian Government (2008) report. However, because of the more detailed disaggregation of the food processing sector, some differences are observed for the direction of effects on the dairy and other animals sectors. In the MMRF results, the Australian dairy sector is reported to grow slightly faster in response to a CPRS, relative to the reference case, as demand for other food increases. The GTEM results reported here allow for differentiation between milk and other food, resulting in a slight slowing in dairy output, relative to the reference case, in response to the CPRS. Similarly, differences in the substitution possibilities between other food and meat production result in other animals slowing slightly relative to the reference case rather than growing slightly faster in the MMRF results. The separation of the wool industry from the beef and sheep industry in GTEM compared with MMRF also results in slight differences in effects.

Share of Australian agriculture in world exports

Under the CPRS scenario, Australia is likely to maintain or improve its international competiveness. At 2020 in the CPRS scenario, Australia's trade competitiveness and thus share of world agricultural exports, remains relatively unchanged relative to the reference case. This is because developed economies, including Australia, are given transitional assistance which offsets nearly all of the effect of the CPRS in 2020. At 2030, Australia's share of agricultural world exports increases by around 4 per cent in the CPRS scenario, relative to the reference case. The increase in the share of Australia's agricultural exports can primarily be attributed to an expansion in exports of grains and other crops because they are less emissions intensive compared with grains and other crops in key competitor economies.

Emissions in the Australian agriculture sector

Based on projections of agricultural activity levels, emissions from the Australian agriculture sector (excluding savanna burning) are expected to increase by about 11 per cent between 2005 and 2030 in the reference case, to around 91 million tonnes CO_2-e in 2030 (figure c). In contrast, Treasury projected that agricultural emissions would increase by about 63 per cent between 2005 and 2030.

Once agriculture is included in the CPRS from 2015, agricultural emissions are reduced as consumers and producers respond to the market signal. By 2020, Australian agriculture emissions are projected to decline by about 13 per cent relative to the reference case. By 2030, Australian agriculture sector emissions are projected to be reduced by about 20 per cent, relative to the reference case, to a level about 11 per cent below 2005 levels at 73 million tonnes CO_2-e.

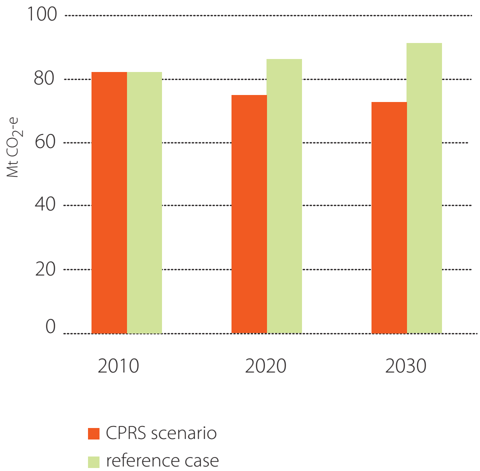
In the CPRS scenario, emission reductions to 2020 are achieved primarily by improving emissions intensity through the uptake of new technologies and management practices, rather than by reducing production. This is because until 2020, production of individual agriculture industries remains largely unchanged from the reference case because transitional assistance offsets most of the cost and eases their transition to a low emissions economy. As a result, carbon leakage, in terms of both production leakage and emissions leakage is insignificant from the agriculture sector. This result is consistent with the findings of the Australian Government (2008) analysis.

Beyond 2020, substitution in production away from emissions intensive agriculture industries, such as livestock, to production from lower emissions intensive agriculture industries, such as grains, also contributes to emissions abatement. Specifically, in 2030 emissions in the Australian agriculture sector are reduced by about 15 million tonnes CO_2-e, relative to the reference case, as a result of the uptake of lower emissions intensive technologies and management practices, with an additional reduction of 4 million tonnes CO_2-e, relative to the reference case, as a result of substitution away from livestock production towards grains (figure d).

Although at 2030 the highest level of abatement is projected in livestock industries (given their larger level of emissions), proportional emission abatement are expected to be slightly higher in the other crops and grains industries reflecting greater low cost abatement opportunities.

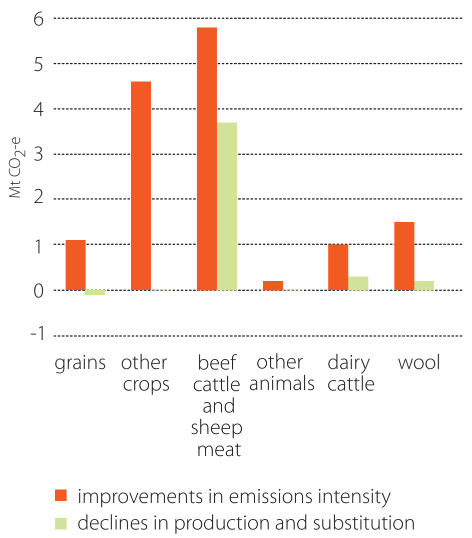
The development and global uptake of lower emissions technologies and management practices in agriculture is expected to contribute to reducing the global emissions price by expanding the opportunity for lower cost abatement. In box 6, a sensitivity analysis is undertaken to assess the effect of having no access to such options.

c Greenhouse gas emissions from the Australian agriculture sector



d Reductions in Australia's agriculture sector greenhouse gas emissions in the CPRS scenario

relative to the reference case at 2030



Conclusion

The CPRS is Australia's key policy to reduce greenhouse gas emissions. Given agriculture's contribution to Australia's greenhouse gas emissions, the sector will be required to make a contribution to Australia's abatement task. However, before agriculture can be included in the CPRS, a number of issues surrounding the cost-effective measurement, monitoring and achievement of emissions abatement in the sector need to be resolved. The point of policy obligation also needs to be decided. If the obligation to hold permits is placed on farm, the emissions threshold will also need to be adjusted to increase coverage, while keeping monitoring and compliance costs low.

box 6 The potential effects of having no access to low emissions technologies and management practices in agriculture

There is a great deal of uncertainty surrounding the future development and uptake of mitigation options in agriculture. In order to assess the effects of additional abatement options in agriculture, relative to the reference case, a CPRS no technology scenario is developed. This is compared against the CPRS scenario which incorporates opportunities for emissions abatement through the use of the (non-costed) MAC curves discussed previously. Effects on key variables are discussed here briefly.

Effects on the Australian emissions price

In the CPRS no technology scenario, which represents a sensitivity scenario with no technological abatement options (other than those embedded in the reference case) available to the global agriculture sector, the global emissions price is projected to increase. In 2005 dollar terms, the Australian emissions price is projected to be A$23/t CO_2-e in 2010, around A$2/t CO_2-e higher in the alternative scenario than in the CPRS scenario discussed earlier. By 2030, the Australian emissions price is projected to be about A$58/t CO_2-e in the alternative scenario, around A$6/t CO_2-e (in 2005 dollars) higher than when abatement technologies were assumed to be available.

Effect on Australian agricultural production costs and output

The lack of access to abatement technologies in agriculture slightly increases the cost of agricultural production, relative to the CPRS scenario, as agricultural producers are projected to purchase more emission permits. The projected increase in Australian agricultural production costs at 2030, relative to the reference case, is between 0 and 24 per cent in the CPRS no technology scenario compared with 0 and 20 per cent, in the CPRS scenario (table 10).

The higher costs of the scheme lead to a small amplification of effects on agricultural production. For example, there is greater substitution away from emission intensive livestock products to relatively lower emission intensive products such as grains and other crops.

Effects on Australian agricultural emissions

Despite only having a small effect on production and prices, the lack of mitigation technologies in agriculture significantly reduces the ability of the sector to contribute to the cost-effective reduction of Australia's emissions. By 2030, Australia's agricultural emissions are projected to be about 84 million tonnes CO_2-e in the CPRS no technology scenario compared with 73 million tonnes CO_2-e in the CPRS scenario.

10 Effects on Australian agricultural production costs and output, relative to the reference case, at 2030

	% increase in production costs, relative to the reference case		% increase in output, 2005-30			% change in output, relative to the reference case	
	CPRS no technology	CPRS	reference case	CPRS no technology	CPRS	CPRS no technology	CPRS
Grains	1.4	1.0	49	59	56	6.9	5.3
Other crops	0.4	0.2	37	38	37	0.2	0.0
Beef cattle and sheep meat	24.0	19.9	30	18	20	–9.4	–8.0
Other animals	4.7	4.0	48	46	46	–1.0	–1.1
Dairy cattle	8.5	6.7	44	38	40	–3.9	–3.0
Wool	18.9	15.8	6	4	4	–2.2	–2.1
Total agriculture			36	35	35	–1.0	–1.0

Once agriculture is included in the CPRS, the short to medium-term (to 2020) effects of the scheme on Australian agricultural activity levels and costs are projected to be relatively small. This is primarily because the transitional assistance as outlined in the White Paper eases the transition of industry to a low emissions economy and is projected to offset nearly all of the effect of the CPRS and maintain trade competitiveness.

If major developed and developing economies agree to effective mitigation efforts and the government removes EITE sector assistance post 2020, the effects on individual industries in the agriculture sector are projected to be greater. However, total Australian agricultural output is expected to be relatively unaffected by the CPRS to 2030 as declines in some agricultural industries are expected to be offset by increases in other industries relative to the reference case. Livestock industries are projected to be most adversely affected by the CPRS, however, the industry is still projected to grow relative to 2005. Conversely, the CPRS will create opportunities for some agricultural industries to expand, with production of grains projected to increase as consumers switch away from higher emissions intensive foods and demand for biomass energy increases.

The implementation of the CPRS provides a signal throughout the economy to reduce emissions. In the CPRS scenario, significant reductions in Australia's agricultural emissions are expected to be achieved primarily through the assumed development and uptake of advanced technologies and management practices and some switching toward lower emissions agricultural products such as grains. This highlights the ongoing need for research and development into technologies which allow reductions in emissions and increases in yields. Such technologies can reduce the potential effects of the CPRS on agricultural industries and contribute to ongoing productivity improvements.

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