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under the Carbon Pollution  
Reduction Scheme (CPRS):  
an examination  
of some key factors*

Kevin Burns, Jahnvi Vedi, Edwina Heyhoe  
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March 2009

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ABARE is a professionally independent government economic research agency.

ABARE project 1193

## **Acknowledgments**

The authors would like to thank Mark Parsons, Stuart Davey and Richard Thackway from the Bureau of Rural Sciences for data and advice, and Lu Zhang from CSIRO for his assistance with the analysis of water issues. The authors would also like to thank Tim Goesch, Ahmed Hafi and Kenton Lawson from ABARE for reviewing the paper.

# Opportunities for forestry under the CPRS: An examination of some key factors

Kevin Burns, Jahnvi VEDI, Edwina Heyhoe and Helal Ahammad

ABARE analysis for the Australian Government Treasury report *Australia's low pollution future* suggested that by 2050, depending on the price of carbon, the area of agricultural land which potentially could be used for timber plantations may increase up to 4.5 million hectares and the area of environmental plantings could increase up to 21.8 million hectares. As is the case with most analyses of this type, the ABARE analysis was based on a specific set of assumptions.

Some environmental, policy and market constraints which may limit the potential for afforestation in Australia were not fully accounted for in the ABARE analysis because of inherent complex interactions between biophysical conditions and market and policy realities, and, in the case of water interception, the regional specificity. This paper examines some of the key issues affecting afforestation potential.

## Introduction

In recent years the persistence of drought and increasing competition for land has placed pressure on Australia's agricultural industries. One area of concern for some farming groups has been the extent of investment in plantation forestry which has occurred in some regions, and associated concerns regarding the displacement of agricultural production. This land use change has been driven by complex and interconnected market, environmental and policy factors and future land use decisions will require consideration of all these factors.

ABARE has recently undertaken an analysis for the Australian Government of the likely implications of certain carbon price paths on afforestation (Lawson et al. 2008). This analysis fed into the Australian Government's report, *Australia's low pollution future* (Australian Government 2008b). As part of that analysis, ABARE developed a framework to investigate the effect of carbon pricing policy on the economic competitiveness of timber plantations and environmental plantings on agricultural land in Australia. For the analysis, ABARE used spatial modelling techniques and available data including spatially distributed land cover and land use, forest growth and carbon sequestration data, agricultural land values and the distance of forests to timber processing facilities.

However, Australia's potential for afforestation may be limited by some environmental, policy and market constraints. The complex interactions inherent between the biophysical conditions, market and policy realities and, in the case of water interception, the regional specificity need to be well understood before undertaking a robust quantitative assessment of their implications for the future of land use change and forestry.

In this paper, some of the possible implications of environmental and market constraints are explored. The paper begins with an outline of the current and future policy and economic settings influencing the expansion of plantation forestry and environmental plantings. The latter represent forests planted without the intention of being harvested. ABARE analysis for the Australian Government's carbon price scenarios is then presented. The implications of the key assumptions underlying the analysis on the rate of afforestation are explored, with particular focus on key factors including water interception and native vegetation cover. This analysis is intended to provide some useful insights into the complex interactions between different environmental goals and policies.

## Plantation investment and the policy environment

There has been considerable land use change in Australia in recent years. The area of plantation forests has grown by about 60 per cent over the past decade, from around 1.2 million hectares in 1997 to about 1.9 million hectares in 2007 (table 1). Virtually all of the additional area has been planted to short rotation hardwoods (eucalypts), the area of which trebled to 0.9 million hectares over the same period, while the area of softwood (coniferous) plantations increased by about 10 per cent to 1 million hectares. Including native forests, the total forest cover in Australia is about 149 million hectares (MIG 2008).

While the rate of afforestation has been significant, the plantation area remains a small proportion of land use in Australia. The area of farmland in Australia is estimated to be more than 425 million hectares (ABS 2008), and the plantation area in 2007 was equivalent to around 0.4 per cent of this area. The extent of land use change has been regionally significant in some states. Most of the investment in plantations has occurred in Western Australia, Victoria and Tasmania. In Victoria, the plantation area was equivalent to 3.1 per cent of the agricultural land area in 2007, while in Tasmania the proportion was 16.5 per cent (table 1).

The recent expansion of forest areas in Australia reflects both strong economic conditions and government policies over the past decade. Strong world economic growth has spurred the demand for forest products used in construction and for the manufacture of paper products. Importantly for the Australian forest industry, there has been significant investment in Asian pulp and paper capacity over the past decade (Spek 2006), and this has generated strong demand for woodchips. Consequently, pulp and paper prices rose to historic peaks in mid-2008 (UNECE/FAO 2008) and the returns from Australia's woodchips sector also rose. However the recent world economic downturn means the demand for forest products and hence the prices received by forest growers are expected to be much lower than last year's highs over the short term.

A number of Australian Government policy initiatives have sought to improve the economics of forestry by overcoming impediments to forestry investment and providing greater certainty to long-term forest investments. These initiatives included *Plantations for Australia: the 2020 vision* (henceforth, the *2020 Vision*; see Ministerial Council on Forestry, Fisheries and Aquaculture 1997), the National Forest Policy Statement (Australian Government 1995) and the tax treatment of forestry investments.

# 1 Areas of plantations and agricultural land, 1997 and 2007

	softwood plantations <b>b</b>		hardwood plantations <b>b</b>		total plantation area <b>b c</b>	plantation as area of farms <b>a</b>	plantation as % farmland area
	1997 '000 ha	2007 '000 ha	1997 '000 ha	2007 '000 ha	2007 '000 ha	2007 '000 ha	2007 '000 ha
New South Wales	252.6	295.2	33.5	70.6	368.6	58 614	0.6
Victoria	215.5	219.4	54.0	191.0	411.9	13 250	3.1
Queensland	180.8	188.8	7.1	49.4	240.3	143 871	0.2
South Australia	104.7	122.9	9.2	55.0	178.3	50 065	0.4
Western Australia	91.1	106.7	107.2	294.7	403.7	96 742	0.4
Tasmania	71.8	75.0	83.9	199.1	274.2	1 659	16.5
Northern Territory	5.2	2.2	0.7	23.7	25.9	61 202	0.0
Australia	921.7	1 010.2	295.6	883.5	1 902.9	425 449	0.4

**a** ABS Cat No. 7121.0. Includes forested areas. **b** National Plantation Inventory data; Gavran and Parsons 2008. **c** Includes some plantation area not allocated to softwood or hardwood.

The *2020 Vision* was developed by the Australian Government, in conjunction with state governments and the forest industry, to address several market impediments to efficient plantation development. The purpose of the *2020 Vision* was to promote regional development and employment through increased private investment in new timber plantations.

In 1992, the National Forest Policy Statement (NFPS) was developed jointly between the federal, state and territory governments. This statement led to the Regional Forest Agreement (RFA) process in 1995, which sought to integrate the assessment of conservation and sustainable use values of forest resources with consideration of the implications for local communities and industry. These RFAs comprised 20 year plans for the conservation and sustainable management of Australia's native forests. In total, 10 RFAs were negotiated in four states: Western Australia, Victoria, Tasmania and New South Wales. Through these agreements, the tenure of about 2 million hectares of predominantly publicly owned forest was converted from multiple-use forest (which allows timber harvesting) to nature conservation reserve (BRS 2003). In addition to these, in 1999 the Queensland Government negotiated a separate agreement with the Queensland Timber Board and conservation groups, which committed to the elimination of native forest logging on public land in that state by 2024. Since the completion of the RFA process, native timber supply has declined from 10.8 million cubic metres in 2000-01 to 8.7 million cubic metres in 2006-07.

Another important factor affecting plantation investment is the tax treatment of forestry. During the past decade there has been a substantial increase in the role of managed investment schemes (MISs) in plantation establishment, and in recent years MIS companies have undertaken around 80 per cent of plantation establishment in Australia and now own one-third of Australia's plantation estate (Gavran and Parsons 2008).

Forestry MIS arrangements allow companies, which are often vertically integrated with log processing infrastructure, to pool together the investments of individual forestry investors,

thereby allowing these investments to benefit from economies of scale in establishment and management, pooling risk across a large forest estate, and ensuring markets for plantation timber. Under these schemes, individual investors can claim immediate tax deductions for costs associated with 'seasonally dependent agronomic activities' (for the purposes of income tax assessment), provided that these activities are undertaken within the allowed 'prepayment period' (the period of time allowed between the claim of tax deductions for expenses and the time the 'seasonally dependent agronomic activity' is carried out). Currently the prepayment period is 18 months. Recent changes to the taxation arrangements for forestry MISs have capped the amount of the allowable tax deduction and allowed investors to trade their immature plantations.

## Future prospects for land use change

A range of market, environmental and policy developments are likely to influence future land use change in Australia. Slowing global economic growth and changing climatic conditions will have implications for agricultural and forestry commodity production, prices and practices. Over the medium to longer term there may be increasing competition for land resources depending on changes to relative commodity prices and trends in world fuel prices, which will affect the returns from biofuels feedstock production, including biofuels from grains and potentially from forest timber.

Policies associated with climate change mitigation will potentially provide an additional source of income for forestry investments because of the potential for forest owners to be paid for the sequestration of carbon in tree biomass. Climate change mitigation policies are likely to improve the competitiveness of forestry compared with agriculture, despite weak economic conditions in the short term and uncertain environmental conditions into the future. These policies include:

- the introduction of tax deductibility for carbon plantations; and
- the implementation of policies to reduce greenhouse gas emissions.

The former allows investors in carbon sink forests, otherwise known as environmental plantings, to claim tax deductions for the costs of establishing these forests, such as acquiring and planting trees or seeds, but not the costs of purchasing or improving land. The effects of tax deductibility for carbon sink forests are not examined in this paper.

The remainder of this paper will focus on the implementation of policies to reduce greenhouse gas emissions and their potential implications for afforestation and changes to the agricultural landscape in Australia.

## The Carbon Pollution Reduction Scheme (CPRS)

The *CPRS White Paper* (Australian Government 2008a) sets out the Australian Government's policy position to mitigate greenhouse gas emissions. The *CPRS White Paper* commits Australia to unconditionally reduce emissions to 5 per cent below 2000 levels by 2020, with provision

for further reductions of up to 15 per cent below 2000 levels by 2020 if there are substantial commitments from other economies. Australia is also committed to the Kyoto Protocol, which limits national greenhouse gas emissions to no more than 108 per cent of 1990 levels over the period 2008-2012.

The proposed CPRS will operate as a cap and trade scheme, which limits national emission levels and allows for trade in emission permits, such that the price of emission permits is determined by the market. The design of the CPRS includes many provisions specific to particular sectors of the economy. Of importance to this paper are the treatment of the forest sector and the anticipated price of tradeable carbon pollution permits.

The *CPRS White Paper* provides for the inclusion of the forest sector in the CPRS consistent with forestry definitions prescribed in the Kyoto Protocol, under which afforestation must occur on land which was clear of forest at 31 December 1989 to be eligible for sequestration credits (which are equivalent to emission permits in a carbon market). Participation by forest owners in the CPRS will be voluntary, such that permits are received and subsequent emissions charged only where the forest owner opts into the scheme. Under the average crediting scheme described in the *CPRS White Paper*, permits are issued to the forest owner for net greenhouse gas removals up to a permit limit, which is based on the 'average cumulative net greenhouse gas removals calculated to the end of rotation (immediately prior to harvest) over the longer term' (Australian Government 2008a). This permit limit may also be reduced by an amount commensurate with the risk of loss of carbon from the forest. Also under this scheme, permits would only be surrendered if forested land is converted to non-forest land use. This crediting scheme applies to both timber plantations and environmental plantings.

Other features of the CPRS including the distribution of emission permits and international participation in an emissions trading scheme are discussed in the *CPRS White Paper*.

## ABARE analysis of land use change for the Australian Government

ABARE was commissioned by the Australian Government Treasury to estimate the potential effect of a carbon price on the economic competitiveness of forestry activities (timber plantations and environmental plantings) on agricultural land. This analysis (Lawson et al. 2008) for the government's *Australia's low pollution future* report included estimates of plantation expansion under a reference case (that is, where no changes to existing policies are assumed) and under certain carbon price scenarios. The introduction of a carbon price under the CPRS will provide payments to participating forest owners for carbon sequestration, providing income supplementary to timber returns, as well as to owners of environmental plantings which are not harvested for timber.

The analysis examined only the potential for afforestation, and did not consider the effect of these policies on the rate of deforestation in Australia.

To estimate the extent of the potential for afforestation in Australia, ABARE developed a spatially explicit modelling framework, using agricultural land value data from ABARE farm surveys, land use and vegetation cover information and data from the Bureau of Rural Sciences

(BRS), and forest growth and carbon sequestration data from the Department of Climate Change (DCC). These data include yields for a range of hardwood and softwood timber plantation regimes and rotation lengths ranging from 10 to 35 years. The yield data also include natural rates of forest growth, which are used here to approximate the yields from environmental plantings. The net present value of potential returns from timber plantations and environmental plantings were estimated in the model at a 1 kilometre spatial resolution across Australia, and compared with the corresponding estimated agricultural land values to determine the economic competitiveness of forest activities and hence the economic potential for land use change. A full description of the methodology and data is provided in Lawson et al. (2008).

The model used in the analysis for the Treasury report estimates returns from afforestation activities and compares these with ABARE estimates of agricultural returns. The model employs spatial data relating to forestry yields, agricultural land use and distances from timber processing centres to provide state and national estimates of land use change potential. Because of the scale of the analysis, a number of simplifying assumptions were used. These assumptions relate to land availability and net returns to agriculture and forestry activities over the projection period.

The key assumptions used in the analysis are outlined below:

- The analysis incorporated non-forested land used for all agricultural activities, including minimally adjusted pastures used for livestock production in remote areas of Australia.
- The model does not consider possible restrictions on forestry expansion for conservation reasons, the potentially negative environmental effects of afforestation such as reduced water run-off and rainfall, regional capacity constraints in timber processing or other factors leading to landholder resistance to land conversion. These considerations may significantly limit the increase in forestry activity.
- There may be some areas of cleared land in the spatial land availability data set that represent land that was cleared after 1990, and as such would not meet the definition of a 'Kyoto forest'. Hence, the projected areas available for conversion to forestry may overestimate the potential afforestation.
- The potential rate of afforestation is restricted for each period, such that approximately 75 per cent of the entire economically suitable area was assumed to be converted into forests between 2007 and 2030. The remaining 25 per cent of economically suitable land is assumed to be converted after 2030.
- The rate of land use change is based on the estimated rotation length of the forests plantations. These rotation lengths vary across regions in terms of the tree species, the timing of forest thinnings and harvesting. The rotation length of timber plantations was assumed to range from 10 to 35 years. In comparison, equal areas of environmental plantings are assumed to be planted over a 45 year horizon.
- All land use change decisions are to be determined by comparing the net present value of returns from afforestation activities to agriculture. The returns from the carbon price were assumed to be received by the landholder on an annual basis. However, no assumptions had been made as to when the returns from agriculture are received by the landholder. Hence, differences in cash flow between the returns with agriculture and forestry were

assumed to not affect land use change behaviour.

- No assumptions are made regarding any commodity or land price changes arising from any policy changes.
- The returns to agriculture are to be unaffected by the implementation of a carbon price. For emission intensive livestock production in particular, returns may be reduced if agriculture is included in the CPRS.
- The value of cleared agricultural land represents the opportunity cost of establishing forests, and data were based on 10 year averages of estimated agricultural land values collected through ABARE farm surveys. The Treasury report modelling has average growth in the land values ranging from 4 to 5 per cent per annum across the states of Australia under all scenarios.
- The carbon accounting provisions of the Kyoto Protocol are to remain unchanged during the course of the 21st century.
- Forestry returns are calculated based on an assumption of even aged development, so that an investor will plant an equal area of forest each year. This means that each investor is assumed to own a forest estate, and as such after the first harvest age is reached for the first plantation, the amount of sequestration in each year exactly matches the amount of emissions for that investor. Hence, the investor does not receive any further carbon credits nor do they pay for emission permits after this time.
- The returns from traditional timber production are estimated using the average mill-door log price receivable in each state. These mill-door prices were assumed to range from \$42/m<sup>3</sup> to \$71.5/m<sup>3</sup> in 2007. The annual increase in returns from timber production in that analysis was derived through the Treasury modelling. These returns from timber production were assumed to increase by around 3 to 6 per cent each year across the Australian states.
- The cost assumptions relating to the establishment, harvesting and transport of timber plantations and environmental plantings were based on data from the New South Wales Department of Primary Industries (Roberts 2007) and ABARE estimates (table 2).
- The potential carbon sequestration implications for the entire area that is economically suitable for afforestation is examined. Therefore the projected areas available for conversion to forestry represent an upper bound of that potential.

## 2 Cost assumptions for timber plantations and environmental plantings

		timber plantations	environmental plantings
Establishment	\$/ha	2 500	2 000
Management	\$/ha	180	0
Harvesting	\$/m <sup>3</sup>	22	0
Transport	\$/m <sup>3</sup> .km	0.123	0

Source: ABARE estimates; Roberts 2007.

### *Timber plantations and environmental plantings: ABARE projections for the Australian Government*

The ABARE analysis for the government's Treasury report incorporated the Green Paper guidelines for the CPRS (and hence is closely related to the *CPRS White Paper* guidelines).

In ABARE's analysis, the following three scenarios were modelled:

- The 'reference case' or 'business as usual' scenario in which no carbon price is introduced;
- The CPRS–5 scenario, where Australia's emissions will be reduced to 5 per cent below 2000 levels by 2020. The carbon price under this scenario was estimated to begin at about \$20 a tonne of carbon dioxide equivalent (t CO<sub>2</sub>-e) in 2010 (in 2005 dollars) (Australian Government 2008b). The carbon price is assumed to rise at an average rate of around 4 per cent annually between 2010 and 2050; and
- The CPRS–15 scenario in which Australia's emissions were reduced to 15 per cent below 2000 levels by 2020. The carbon price under this scenario was estimated to begin at about \$28/t CO<sub>2</sub> in 2010 (in 2005 dollars) (Australian Government 2008b). The carbon price is assumed to rise by an average of around 4 per cent annually to 2050.

In both the carbon price scenarios, Australia's greenhouse gas emissions are set to decline to 60 per cent below 2000 levels by 2050, although the CPRS–5 scenario implies a higher greenhouse gas stabilisation at 550 ppm by 2100 compared with a stabilisation of 510 ppm by 2100 under CPRS–15. For a full description of these scenarios see the Australian Government's *Australia's low pollution future* report (Australian Government 2008b).

Based on the modelling framework and assumptions described above, the ABARE analysis for the *Australia's low pollution future* report estimated that there is economic potential for afforestation on approximately 611 000 hectares of agricultural land under the reference case (table 3). All of these are estimated to be timber plantations, as there are assumed to be no returns available to environmental plantings in the absence of a carbon price policy. The modelling framework did not incorporate the implications of taxation arrangements in land use, and hence the tax deductibility for environmental plantings is not modelled here. Western Australia is projected to have the largest uptake of new forest plantations in the reference case, all of which are short rotation hardwoods. Queensland is projected to have the second highest potential for timber plantation investment, most of which are long rotation softwoods. This potential land use change represents around 0.1 per cent of the 425 million hectares of Australian farm land in 2007.

The introduction of a carbon price in the CPRS–5 scenario is projected to increase the area of agricultural land economically suitable for forestry in Australia to around 5.8 million hectares (table 3). Of this, 3 million hectares are projected to be timber plantations, and 2.7 million hectares are environmental plantings. Most timber plantations are estimated to be short rotation hardwoods, across a range of states, while the economic potential for long rotation softwoods is concentrated in Tasmania and South Australia. In contrast, environmental plantings are projected to be most suitable in the northern states, particularly Queensland, northern New South Wales and the Northern Territory. The area of potential afforestation represents about 1.4 per cent of cleared agricultural land in Australia (table 3).

Under the higher carbon price estimated in the CPRS–15 scenario, the economic potential for afforestation in Australia is projected to increase significantly. While the projected area of timber plantations increases to almost 4.5 million hectares, further expansion of these forests is constrained by the distance to timber processing infrastructure. In contrast, the projected area of environmental plantings increases to almost eight times the potential area under CPRS–5, to be about 21.8 million hectares. Together, the potential area of timber plantations and environmental plantings are projected to account for 6.2 per cent of the area of farm land in Australia. However, this proportion differs markedly across states, and in Tasmania more than 65 per cent of agricultural land is estimated to have economic potential for afforestation.

## Competition for land with agriculture

The above results indicate that the future carbon pricing policies to combat climate change would offer significant opportunities for future forestry investment in Australia. The returns from carbon sequestration are likely to provide a competitive advantage for afforestation over existing activities on more marginal agricultural land. Given the modelling framework and assumptions, the estimates presented in [table 3](#) represent an upper bound for afforestation potential. It is important to recognise the type of agricultural land which is most likely to be subject to afforestation, as well as some of the key factors which will affect returns to both forestry and agriculture into the future. Some of these are discussed below.

### Marginal agricultural land

Australia's agricultural landscape consists of a mosaic of agricultural grazing, cropping and horticultural activities, as well as a significant area of native and plantation forest resources. While there is scope for the integration of agricultural and forestry activities in order to reap the complementary benefits of each, the broad-scale afforestation required for large-scale carbon sequestration implies a direct trade-off between forestry and agriculture. To be eligible for carbon credits under the CPRS, the definition of a forest specifies a minimum area of 0.2 hectares, with tree crown cover of at least 20 per cent and a potential tree height of at least 2 metres, which is consistent with the Kyoto Protocol accounting provisions (Australian Government 2008a).

In the CPRS–5 scenario, the ABARE projections suggest that around two-thirds of potential afforestation occur in the high rainfall zone (based on ABARE agricultural zones). However, the average value of land with economic potential for afforestation in this region was around \$1400 per hectare, compared with an average land value for the high rainfall region of around \$2300 per hectare. This indicates that it is the less productive parts of higher rainfall areas which are likely to be converted to forestry. Reflecting this, more than three-quarters of the agricultural land estimated to be economic for forestry in the CPRS–5 scenario is identified as dryland grazing land, with only around 2 per cent of the additional afforestation projected to occur on irrigated agricultural land.

In the CPRS-15 scenario with higher carbon prices, a marked increase in the proportion of land with potential for afforestation in lower rainfall areas was projected. In contrast to CPRS–5,

### 3 Area of agricultural land economically competitive for forestry – ABARE projections to 2050

	reference case						CPRS-5						CPRS-15						
	timber plantations		environmental plantings		total forest area as a proportion of farmland area		timber plantations		environmental plantings		total forest area as a proportion of farmland area		timber plantations		environmental plantings		total forest area as a proportion of farmland area		
	'000 ha	'000 ha	'000 ha	'000 ha	%	%	'000 ha	'000 ha	'000 ha	'000 ha	%	%	'000 ha	'000 ha	'000 ha	'000 ha	%	%	
New South Wales	12	0	0	0	0	0	293	456	464	1.3	1.3	464	7 945	7 945	14.3	14.3	14.3	14.3	
Victoria	28	0	0	0.2	0.2	491	9	9	3.8	3.8	950	84	84	7.8	7.8	7.8	7.8	7.8	
Queensland	140	0	0	0.1	0.1	447	1 527	1 527	1.4	1.4	293	10 591	10 591	7.6	7.6	7.6	7.6	7.6	
South Australia	26	0	0	0.1	0.1	619	19	19	1.3	1.3	1 031	481	481	3	3	3	3	3	3
Western Australia	379	0	0	0.4	0.4	546	35	35	0.6	0.6	700	1 308	1 308	2.1	2.1	2.1	2.1	2.1	2.1
Tasmania	26	0	0	1.6	1.6	651	1	1	39.3	39.3	1 076	1	1	64.9	64.9	64.9	64.9	64.9	64.9
Northern Territory	0	0	0	0	0	0	692	692	1.1	1.1	0	1400	1400	2.3	2.3	2.3	2.3	2.3	2.3
Australia	611	0	0	0.1	0.1	3 047	2 740	2 740	1.4	1.4	4 514	21 812	21 812	6.2	6.2	6.2	6.2	6.2	6.2

Source: Lawson et al. 2008.

where two-thirds of afforestation potential occurred in the high rainfall region, in CPRS–15 only one-third of afforestation occurred in the high rainfall zone, with 44 per cent occurring in the wheat sheep zone and the remainder in the pastoral zone. Again, this potential tended to occur on more marginal agricultural land, with potential new forests in the high-rainfall zone restricted to land with an average value of around \$1380 (compared with a regional average of around \$2300) and potential in the wheat sheep zone restricted to land with an average value of around \$430, compared with a regional average of around \$790. An average of 85 per cent of potential afforestation in the CPRS–15 scenario is currently used for grazing, with less than 1 per cent on irrigated agricultural land.

In a separate analysis for the Department of Climate Change (DCC 2008), ABARE has also estimated ‘threshold’ carbon prices – the carbon prices at which the estimated present value of net returns from carbon sink forests becomes equal to the corresponding net returns for a representative agriculture farm – for agricultural farms with median returns in several regions of Australia. This analysis, based on slightly different assumptions to those underlying the analysis for the *Australia’s low pollution future* report, suggest that high carbon prices would be required for forestry to compete with agriculture farms earning median returns (table 4). In the case of dairy, the threshold carbon prices were estimated to range from around \$350/t CO<sub>2</sub> to almost \$380/t CO<sub>2</sub>, significantly higher than the market prices for carbon credits projected in the ALPF report (Australian Government 2008b).

## Factors affecting future agricultural returns

As discussed above, the provision of carbon credits to afforestation has the potential to substantially increase the proportion of agricultural land that is economically competitive for forestry, relative to agriculture. However, the implications of the CPRS for returns in the agriculture sector are uncertain.

As set out in the *CPRS White Paper*, agriculture will not be included in the CPRS until at least 2015. However, there will still be implications for the returns to agriculture in the early years of the CPRS because of changes to the costs of some inputs, particularly of electricity, fertiliser and fuel, as well as any cost pass-through from processing industries and changes to global agricultural commodity prices (Ford et al. 2009, Keogh and Thompson 2008, TheCIE 2009).

## 4 Estimation of threshold carbon prices for carbon sink forests on median agricultural land <sup>a</sup>

land use scenario	rainfall zone	agricultural land value \$/ha	estimated net saleable CO <sub>2</sub> -e credits by year 30 t/ha	threshold carbon price \$/t CO <sub>2</sub> -e
Grazing	low- medium rainfall	1 441 – 2 921	61-108	189-362
Broadacre cropping		1 235 – 2 464	56-96	193-367
Grazing	high rainfall	3 500	170	158
Dairy		12 238 – 13 686	148-175	369-399
Sugar		11 000	260	210
Vegetables		14 644	231	295

<sup>a</sup> A threshold carbon price is the price of carbon at which the estimated present value of net returns from carbon sink forests becomes equal to the corresponding net returns from a representative agricultural farm.

Agriculture accounts for a significant share of Australia's greenhouse gas emissions, around 16 per cent of Australia's net greenhouse gas emissions in 2006 (Australian Government 2008a). Accordingly, the inclusion of agriculture within the CPRS is likely to have a significant effect on the profitability of emission and energy intensive activities within agriculture. Livestock production is among the most emissions intensive industries in Australia.

As such, agricultural land values in the future are likely to be affected by economic growth and policy developments in a number of ways:

- under the CPRS, the costs of production in emissions intensive agricultural activities, particularly livestock, will increase. Hence the land values for these activities are likely to be adversely affected;
- lower world economic growth, because of the current global financial crisis as well as the evolving international climate change response policies, is likely to affect the demand for agricultural commodities, lowering agricultural returns;
- low world commodity prices associated with the current global financial crisis and the evolving international climate change response policies, may cause Australia's exchange rate to depreciate, affecting agricultural returns, and;
- competition for land with forestry and reduced availability of land to agricultural activities under the CPRS may put upward pressure on land prices, thus affecting agricultural returns.

Regarding the uncertainties of future land values, another important consideration may be the inclusion of agricultural soils in the CPRS and international carbon markets. If issues relating to the measurement and maintenance of this carbon sink can be resolved, there is significant potential for greater returns to many agricultural enterprises that adopt appropriate land management practices.

All these issues affecting agricultural returns were not explored in the ABARE analysis for the government's *Australia's low pollution future* report, but will influence the economics of future land use change in Australia.

### *Factors affecting the returns to afforestation*

Variations to some of the assumptions used in the ABARE analysis for the Treasury report are expected to affect returns to timber plantations and environmental plantings significantly, and hence, the competitiveness of forestry relative to agricultural activities.

For example, in the ABARE analysis it was estimated that timber plantations would increase by around 611 000 hectares, or around a 30 per cent increase from the current plantation area, under the reference case; by about 160 per cent under the CPRS-5 scenario and about 235 per cent under the CPRS-15 scenario. Any such increase would require significant increases in the capacity to process plantation timber during the projection period. These projections are based on the assumption that the expansion of the timber plantation area would be accompanied by sufficient investment in timber processing infrastructure, and that the returns from forestry commodities such as sawnwood and woodchips are not affected by the increased supply. Significant timber plantings are not assumed to occur until after 2020, and the volume of timber

harvested would not substantially rise until these plantations reach harvestable age. There is, therefore, a significant amount of time for this investment in processing capacity to occur.

There is also uncertainty regarding the additional costs which may be imposed on forest owners in order to qualify for carbon credits. The costs assumed by ABARE for the Treasury analysis are consistent with costs currently incurred in establishing and managing timber plantations, and for regrowth forestry in the case of environmental plantings. However, the costs associated with these activities may be higher than existing regimes because of the need for regular assessment of the volume of carbon sequestered in these forestry activities, and to insure against loss of biomass through fire, pests or drought, and hence the emission of carbon from forests. The *CPRS White Paper* is proposing a 'risk of reversal buffer' which would reduce the carbon credits foresters may obtain from sequestration but provide protection against loss of trees through fire and pests (Australian Government 2008a).

Variations to a number of assumptions relating to the design of the CPRS framework for forestry participation which are modelled may have significant implications for the returns from afforestation. For example, the CPRS proposes the use of the 'average crediting framework', in which carbon permits are issued to the forest owner for net greenhouse gas removals up to a permit limit, which is based on the average cumulative net greenhouse gas removals calculated to the end of rotation (immediately prior to harvest) over the longer term (Australian Government 2008a). This framework allows individual investors in timber plantations to derive returns from sequestration in the first rotation of their plantation, without the threat of having to purchase carbon permits on the harvest of the plantation providing the investor intends to replant immediately after harvest. An alternative accounting framework, based on annual changes to forest biomass, would expose these forest investors to costs whenever forest biomass is reduced, such as through harvest or forest loss through fire or drought. As well, forest investors would be exposed to market risk because of potential fluctuations in the market price of carbon in this framework.

Also, assumptions regarding the volume of carbon dioxide emitted from harvested timber plantations can have a significant effect on the returns. The recognition of the maintenance of sequestered carbon in harvested wood products will significantly reduce the liability of forest investors in harvesting their forests, and hence increase the returns from these investments.

Additionally, assumptions regarding the volume of carbon sequestered in forests can have a significant effect on their returns. The ABARE analysis is based on the assumption that carbon permits are allocated to forest owners for carbon sequestered in forest stems, branches, leaves and roots. The Kyoto Protocol provides for the inclusion of forest trees, roots, leaves, branches, debris and soils under Article 3.3 (United Nations 1998), and the *CPRS White Paper* accounting rules will follow these principles (Australian Government 2008a). The inclusion of soils in particular has the potential to substantially increase the estimated volume of sequestration in forests, and hence to significantly increase the returns to these activities.

## Carbon sequestration and other environmental goals

The extent and type of forestry activities undertaken in a particular region will influence and be influenced by a variety of environmental goals. While climate change mitigation policy has the potential to significantly increase the amount of afforestation in Australia, this may not necessarily improve environmental outcomes. In some cases substantial afforestation may be detrimental to achieving environmental goals, such as the replacement of other native vegetation or the impacts on water availability. Hence, afforestation needs to occur within the context of multiple environmental goals, including the recognition of the effects on water quality and quantity within a catchment, ensuring that afforestation is undertaken in a way to mitigate dryland or stream salinity, and to design afforestation in a manner to maintain or improve biodiversity outcomes.

### Forests and water use

Although water availability concerns have, so far, not contributed directly to restrictions on plantation development in Australia, the recent rapid expansion of the plantation estate in some regions has raised concerns among some land owners and catchment authorities regarding the effects on run-off and groundwater availability in a catchment, and hence the implications for other water users (Duggan et al. 2008). The National Water Initiative recognises large-scale afforestation as a water interception activity, and hence recommends the inclusion of forestry, along with other interception activities, in policies associated with catchment-scale water management (see box 1).

An important implication of significant afforestation is the reduction in water availability caused by water interception (Duggan et al. 2008). This occurs when precipitation over forest areas is intercepted by the forest canopy and ground litter. It is therefore reasonable to conjecture that the development of large scale forestry plantations would not only compete with agricultural production for land, but in some regions foresters would also compete with farmers for water use in bores and for irrigation.

#### box 1 The National Water Initiative (NWI)

The NWI recognises the potential for activities such as harvesting overland flows, farm dams and large-scale plantation forestry to intercept water that would have otherwise been available for irrigation or the environment (Australian Government 2004). In recognition of these risks, signatories to the NWI agreed that entities engaged in significant interception activities will need to acquire water access entitlements if they expand activities beyond an agreed threshold in fully or over allocated water systems. These thresholds are to take into account the entire water system covered by a regional water plan, as well as any positive or negative effects of interception on regional natural resource management outcomes (for example, the control of rising water tables by plantations (Australian Government 2004)).

These institutional arrangements are designed to protect the integrity of the water access entitlement system and water dependent ecosystems. In the absence of these types of arrangements, irrigators and the environment will bear the costs of reduced access to water because of increased interception. The opportunity cost borne by irrigators will be reflected in the market price of water entitlements.

Forests may also extract water from groundwater systems. In some cases this may lower the groundwater table and mitigate dryland salinity. In other cases, groundwater use by forests may mean that there is less groundwater available for other groundwater users.

Evapotranspiration, as defined by BRS (2006), is the sum of water vapour that diffuses into the atmosphere from vegetation, soil and water surfaces. The rate of evapotranspiration along with other factors such as precipitation, ground water response times and soil types, determine the interactions between afforestation and water availability (Heaney et al. 2000). The volume of precipitation not returned to the atmosphere through evapotranspiration will either flow overland or recharge the groundwater system. This in turn can be used for irrigation or maintained for stream flow and environmental benefit.

The rate of evapotranspiration between different vegetation covers may differ markedly across a region. In general, trees use more water than unirrigated pastures or crops because of the greater direct evaporation of rainfall from the leaves, access to deeper soil water stores and greater exposure to drying winds (van Dijk et al. 2006). Native and plantation forests generally have higher rates of evapotranspiration than pasture and crop lands because of more rainfall being intercepted by the forest canopies (BRS 2006).

The nature and extent of the effects of land use change on groundwater will be regionally specific. For example, afforestation on land overlaying local groundwater systems that have shallow groundwater flow may contribute to greater interception of available water, therefore reducing discharge in saline areas and ameliorating dryland salinity (Duggan et al. 2008). In contrast, in regional groundwater systems, significant afforestation of local or intermediate recharge zones may have no influence on the groundwater system and dryland salinity, but will have an effect on available run-off into streams. Afforestation will occur in an environment whereby evolving water policy and a drying climate may both have an effect on its rate of expansion.

Comprehensive modelling of the interactions between water and afforestation at a local scale should include analysis of the hydrology of the region, the effect of interception activities on other water users, the growth rate of the trees and an understanding of the relevant areas of water policy. As the water policy evolves over time, a detailed understanding of potential afforestation within the Murray-Darling Basin and other water constrained regions will improve.

## Environmental restrictions on land use change

The preservation of native vegetation is another environmental goal that has the potential to restrict land use change. Native vegetation preservation is generally imposed within a regulatory framework. The ABARE analysis undertaken for the government's Treasury report did not limit the area available for afforestation because of native vegetation preservation restrictions. This was because of uncertainties surrounding the estimates for these restrictions.

Land use management in Australia operates within a framework of environmental laws and regulations. At the national level, the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) requires approval for activities that may threaten conditions deemed

to be of national environmental significance, including nationally listed threatened species and ecological communities. However, environmental guidelines governing land use are implemented primarily at the state and territory level, where each jurisdiction operates under its own legislation. The states and territories have variable definitions in the legislation they use to manage and protect native vegetation. These legislative controls have evolved over time, as society's attitude to environmental values has changed, and state and territory governments improve systems for natural vegetation identification and management. A brief overview of the Commonwealth and state legislations which directly relate to native vegetation protection is provided in [box 2](#).

The potential of forestry in areas covered by native vegetation may be limited because the intent of the state legislations is to preserve the vegetation existing in the state prior to European settlement. Therefore, forestry plantations would not be acceptable under current state legislation. In the *CPRS White Paper* (Australian Government 2008a), the government has stated its intention to investigate the potential for accepting some biodiversity plantings in the emissions accounting scheme. This change is likely to open up land under native vegetation cover to environmental plantings.

The Bureau of Rural Sciences is currently developing a national estimate of the extent of native vegetation for the 2004 baseline (Personal communication). These data are based on state and

## box 2 Commonwealth and state legislation ensuring the protection of native vegetation

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) came into effect in July 2000. This Act is the Commonwealth mechanism for national biodiversity conservation and environment protection. It provides for rigorous assessment and approval processes for actions that are likely to have a significant effect on a matter of national significance. The EPBC Act 1999 provides for the identification of key threatening processes. In the case of vegetation this may relate to threatened species and communities. A number of threatening processes have been listed so far, with the most relevant being land clearance. Current jurisdictional legislation is designed to promote biodiversity and preserve environmental heritage while issues relating to carbon sequestration have not yet been addressed. Legislation from some states and territories follow:

### ***New South Wales***

The *Native Vegetation Act 2003* provides for the management of native vegetation on a regional basis and prevents broadscale clearing unless it improves or maintains environmental outcomes. This Act is primarily concerned with the legal controls on land clearing. Native vegetation is any species of vegetation that existed in New South Wales before European settlement.

### ***Victoria***

The *Planning and Environment Act 1987* provides the legislative mechanism for planning activities related to timber production and harvesting on private land. With regard to native vegetation, under the provisions of all planning schemes, a permit is required to harvest native vegetation as part of a timber harvesting operation. Under the recent (2002) Victorian native vegetation management policy document ('A framework for action') clearing of native vegetation may be permitted. However, specific offset requirements must be met. Currently the exemptions to the native vegetation protection regulations are being reviewed.

*continued...*

box 2 **Commonwealth and state legislation ensuring the protection of native vegetation** *continued*

**Tasmania**

The Tasmanian Government made commitments in 2005 under the Tasmanian Community Forest Agreement to phase out broad-scale clearing and the conversion of native forest to plantations. The aim of this agreement is to reverse the decline of Tasmania's native vegetation and conserve biodiversity.

**Queensland**

The *Vegetation Management Act 1999* makes clearing on freehold land assessable under the *Integrated Planning Act 1997*. The *Land Act 1994* applies to leasehold land. Objectives of the *Vegetation Management Act* include regulating the clearance of native vegetation to maintain or increase biodiversity.

**South Australia**

The *Native Vegetation Act 1991* is specifically designed to protect and enhance plants native to South Australia and control the clearance of native vegetation.

**Western Australia**

Native vegetation legislation Regulation 4 of the *Soil and Land Conservation Regulations 1992* was repealed and replaced by amendments to the *Environmental Protection Act 1986* in 2004. Under this legislation, clearing is not generally permitted where the biodiversity values, land conservation and water protection roles of native vegetation would be significantly affected.

**Northern Territory**

Native vegetation clearing in the Northern Territory is controlled by various legislations with the principal ones being either the *Planning Act 1993*, *Pastoral Land Act 1992* or the *Planning Act Clearing of Native Vegetation Development Provisions 2004*. The commercial harvesting of native vegetation is controlled under the *Territory Parks and Wildlife Conservation Act*.

A *Native Vegetation Management Act* for the territory will be developed to ensure all land clearing across the territory takes place in a sustainable manner. The legislation will include caps on total clearing and will provide the basis for climate change effects to be included in land clearing decisions.

territory measures of the extent of native vegetation consistent with their own jurisdiction's legislated definition of native vegetation. Comparing native vegetation extents across state boundaries highlights the many limitations to the use of these estimates for national applications. Accurate estimates of the actual extent of native vegetation across Australia needs the harmonisation of various methods. Where it is assumed that the 2004 native vegetation dataset reflects only structurally intact vegetation communities, the estimate of native vegetation extent will over estimate the extent of native vegetation. Hence, use of these data to determine the level of afforestation in Australia may underestimate the area of land available for that purpose.

Overall, based on preliminary BRS data, 88 per cent of Australia's land area is classified as native vegetation, with the proportion ranging from 47 per cent of the land area in Victoria to

99 per cent of the land area in the Northern Territory. The proportion of New South Wales land classified as native vegetation is also significant, estimated at 87 per cent.

Compared with the analysis for the Treasury report, the area of agricultural land in Australia potentially available (but not necessarily estimated to be economically competitive) for afforestation may be reduced because of relevant legislations. The effect of these regulations on potential land use change in each state will depend on the extent of land covered by these restrictions and the productivity of this land for forestry. For example, a significant proportion of land in the high and low rainfall regions of New South Wales is classified as native vegetation, and hence precluded from afforestation. However, a significant part of this land in western New South Wales is not productive for forestry, and hence the native vegetation restrictions have no implications on potential afforestation in these areas. Similarly, the significant area of land classified as native vegetation in Queensland is mainly in the low rainfall areas of the state, and hence not suitable for afforestation.

Landholders and government manage land for multiple environmental goals. While environmental plantations will achieve set goals, they may hinder biodiversity and water availability but improve salinity outcomes.

## Conclusion

Land use change will be an ongoing process in rural Australia as land owners respond to various market and policy stimuli. Market conditions and policy changes have spurred the rate of afforestation in Australia over the past decade, and upcoming policies, such as the CPRS, are likely to provide further impetus for change.

ABARE analysis for the Australian Government's Treasury report, *Australia's low pollution future*, suggested that a carbon price could generate significant levels of afforestation in Australia. However, there are large variations in the projections depending on the level of the carbon price. Hence the factors that determine the carbon price, such as Australia's abatement target, will be critical in determining the actual level of afforestation.

In addition to the future carbon price paths, the ABARE analysis was based on a range of other assumptions likely to affect the future returns to forestry and agricultural activities. Given the modelling framework and assumptions, ABARE's projections should be considered as an upper bound for afforestation potential.

In particular, ABARE has not yet quantified the effect of environmental factors on afforestation. The relationship between land use and natural resource systems is complex. Some of the complexities of the relationships between land use change and different environmental goals are explored in this paper. It is clear that, because land is managed for multiple environmental goals as well as economic activities, expanding the scope of the earlier ABARE analysis to incorporate environmental issues would significantly improve understanding of the potential for land use change in Australia's rural sector.

Overall, it is apparent that the existing and emerging market and environmental factors discussed in this paper will have far reaching implications for Australia's agricultural industry and natural resources. While there will be competition for land and other resources across various sectors, the analysis in this paper has shown that afforestation is not likely to replace high value agricultural activities. Importantly, as the competition for scarce resources intensifies, and the value of environmental services rises, it will be critical to integrate these factors into land use decision making in Australia.

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