10 Transforming the land sector

GLOBAL FOOD security has been a hot topic since the large spike in world food prices in 2008. Between 2006 and 2008, global food prices rose by 60 per cent. The spike is estimated to have increased by 100 million the number of people considered to be 'food insecure'. Demonstrations and riots occurred in more than 30 countries across the Middle East, Africa, Asia and Latin America, and in Haiti food riots led to the toppling of the prime minister.

Global food prices eased following the Great Crash of 2008. The easing was brief. Prices again surged in 2010 and have risen to new heights in the first months of 2011. They were one factor behind political unrest in the Middle East in the Australian summer of 2010–11.

One long-term source of upward pressure on food prices has been strong growth in demand for high-quality food with economic growth in China and other successful developing countries, recently reinforced by climatic disruption in China and South Asia. The high food prices over the past year have been driven also by an unusual range of other severe climatic events affecting global agriculture: dry conditions in the United States; floods in Australia, Canada, Pakistan and Brazil; dry conditions in Argentina; and high temperatures, drought and wildfires in Russia. Once world grain prices started to rise strongly, the increase was exacerbated by a number of countries, most importantly Russia in the recent episode, seeking to enhance their own food security by restricting exports of grain.

The less successful the reduction of emissions over the years ahead, the more climate change is expected to disrupt global food production. But poorly designed mitigation can also generate large food problems. Significant increases in the production of biofuels driven by government mandates, said to be motivated by climate change mitigation, particularly in the United States and Europe, have contributed to food price increases through recent years. In the United States around 40 per cent of the corn crop and in Europe nearly 40 per cent of canola is now used to produce biofuels. Demand for biofuels is estimated to have accounted for 60 per cent of the global change in demand for wheat and coarse grains between 2005 and 2007. According to a recent study, setting a global biofuels target of 10 per cent of transport fuel would lead to the number of people at risk of hunger rising by 15 per cent, while only delivering significant emissions benefits after 30 to 50 years. When the use of biofuels is mandated, there can be large losses of food production

with minor or no reductions in total emissions—an outcome that would be avoided with economy-wide carbon pricing.

The recent succession of extreme weather events and the associated large losses of food production have focused attention on how future climate change is likely to affect world food production and food security. A major study by the International Food Policy Research Institute estimates that, with the effects of climate change and 'middle of the road' estimates of future incomes and population, prices for wheat, rice and corn in 2050 would be high even with perfect mitigation and much higher without mitigation.

Recent food history

Relative to the prices of other commodities, food prices fell through most of the 20th century. There had been pessimism in the early 1960s about whether the acceleration in population growth that characterised the early years of the second half of the century would overwhelm growth in food production. This was one spur to greatly increased public investment in agricultural research in the large developing countries, which joined traditionally high investments in research in the developed countries. The research yielded what is now known as the 'green revolution', a series of technology developments and transfers around the world that steeply increased global agricultural production.

As a result, food supplies easily outran the rapidly growing population in the last third of the 20th century. The number of people living in extreme poverty (living on less than US$1 a day) fell steadily, and encouraged the development of the United Nations' ambitious millennium development goals, which include accelerated reduction in the number of the world's poor and hungry people. Most important of all, the spreading of modern economic development into the large developing countries and the commitment of the Chinese Government to radical fertility-control policies from early in the reform period in 1980 saw a rapid reduction in fertility rates and population growth. The last of these developments promised permanent victory of food supplies over population.

However, the Platinum Age has taken us into a new, different and bigger race between human requirements for food and its supply. The pressure of modern economic activity on the earth's natural resources and environment is growing far more rapidly and on a much larger scale in the early 21st century than at any time in history. At the same time, rapid economic growth and higher living standards are doing three things that hold

out prospects for humanity's success. The Platinum Age is reinforcing the continued reduction in fertility and population growth. It is widening access to the knowledge and technology that can break the link between growth in living standards and pressure on natural resources and the environment. And finally, it is lifting much of humanity rapidly towards the conditions in which concern for environmental amenity rises in priority alongside consumption of goods and services.

This new race is between humanity's increased pressure on the natural environment on the one hand, and its capacity and will to break the nexus between high and rising material standards of living and pressure on the natural environment on the other. An optimistic view of this new form of an old race suggests that it will be a close-run thing.

Climate change is just one of the points of vulnerability of the natural environment in the 21st century. But it seems at this stage to be the one that has by far the greatest potential to trip up humanity in the great race.

The higher food prices are triggered by climate change mainly through lower yields. According to the study by the International Food Policy Research Institute, with climate change, wheat yields in developed countries are 4.2 per cent lower in 2050 and 14.3 per cent lower in 2080, and in developing countries are 4.1 per cent lower in 2050 and 18.6 per cent lower in 2080. Incidentally, declines in production are disproportionately large in Australia, deriving from lower yields and contraction of planted areas.

In the study's optimistic case, climate change increases the number of malnourished children in the world by 10 per cent above what it would otherwise have been in 2050. In its pessimistic case, there are 9 per cent more malnourished children (from a higher base).

The study concludes that good policy and innovative production responses could significantly alleviate the pressures of climate change. But the effects of unmitigated climate change from 2050 to 2080 would possibly be unmanageable. The most important elements in an effective adaptive response would be the maintenance of good policy for broad-based sustainable development; large increases in investment—including public investment in agricultural research—to raise productivity; global free trade in food; and decisive early action on adaptation to and mitigation of climate change. The other items on this list do not look much easier to accomplish than policies to hold climate change within moderate bounds.

Australian consequences

People with good incomes can afford to meet their food needs even when food prices are high, and whether or not their own country produces food. People in Singapore and Hong Kong probably have as much or more fundamental food security than any in the world. They buy large quantities of the best quality food from almost all of the substantial food-producing countries.

A sound economy generating income security provides the first pillar of food security.

Australia is rich enough for all Australians to have incomes that are adequate to purchase their essential needs for good food if policy is set with that objective in mind. It is difficult now to imagine circumstances in which Australians would face shortages of food.

Difficult, that is, until we work through the implications of changes in temperature and rainfall and its variability as a result of climate change, and imagine other countries closing their food markets and banning exports as food prices rise under the influence of difficult climatic conditions. We were given a foretaste of that possibility with the bans on grain exports in many countries during the price spike of 2008, and with the Russian bans on wheat exports in the 2010 drought and wildfires.

An open, rules-based international trading economy, built around maintaining free trade in agricultural as well as other products, is the second pillar of food security. A sound economy and a sound international trading system based on principles of free trade are usually enough to guarantee food security.

The real prices received by Australian farmers declined substantially in the second half of the 20th century, while the real prices paid for inputs remained roughly constant. This resulted in a substantial decline in Australian farmers' terms of trade and a substantial fall in the real net value of farm production in the 1980s and 1990s.

The high global food prices of 2008 and 2010 affected Australians but were not a threat to Australian food security. The high agricultural prices of recent times—which can be expected to rise further in future even with effective climate change mitigation, and further still in its absence—have been a boon to some Australian farmers.

The real value of Australian farm production rose again in the decade to 2011, following favourable conditions in the early 2000s. However, later in the decade, it resumed its downward movement under the influence of prolonged drought.

It may not seem remarkable that Australian farmers' terms of trade have been roughly maintained through the last decade. But the change in trend is of truly historic significance. The huge appreciation of the Australian dollar during the resources boom has crushed the international competitiveness of the services and manufacturing sectors, and in old circumstances would have had a similar effect on the farming sector. This effect would have been exacerbated if the long-term fall in global agricultural prices that reduced Australian farmers' terms of trade by more than half between 1950 and 2000 had continued into the early 21st century.

As the modelling by the International Food Policy Research Institute shows, in the absence of climate change, global food prices (and with them, Australian farmers' terms of trade) could have been expected to rise over the next half century.

With climate change, however, the outlook is more complex, and problematic. World agricultural production will be affected adversely by warming, by more variable weather, and by more intense severe weather events. That will raise global food prices. The price increases in themselves would help Australian incomes. But Australian food production would be affected more than food production in most other countries, and most Australian farmers would be battling to maintain the production that would allow them to take advantage of higher prices.

The 21st century is likely to provide large opportunities for Australian farmers if there is effective global mitigation. It is likely to be deeply problematic without effective global mitigation. The Australian rural economy has an immense interest in the success of global mitigation.

Farmers are naturally anxious about the costs that they will bear as a consequence of Australia doing our fair share in strong and effective global mitigation. Like all Australians, and more than most, they will contribute through higher costs of fuel and transport. Like all Australians, they will be beneficiaries of adjustments to tax and social security that emerge from the allocation of revenue from carbon pricing. The rural community, like all Australians, will be intensely interested in the details of the allocation of increased costs and tax cuts associated with the introduction of carbon pricing.

Australian farmers have no interest in the failure of global mitigation—this would deny many of them the opportunity profitably to expand production and exports in a period of rising global prices.

We will probably have to live through an extended period of transition to global carbon pricing. An initial period, in which farmers can take advantage of the sale of genuine abatement whether or not it complies with Kyoto rules, would provide potentially large opportunities for augmenting rural incomes.

We will only learn how large by introducing the opportunity and observing what use is made of it.

So the world of the 21st century, with Australia playing its part in an effective global mitigation effort—and providing incentives for land-related sequestration at the general carbon price—would be a good world for Australian farming.

Many Australian farmers managed to stay afloat and some to prosper during the long decline in agricultural terms of trade in the second half of the 20th century. Those who remain in farming today have revealed a capacity for innovation based on advanced knowledge, sound management and flexibility in the face of changing opportunity. This same quality will provide the basis for great success in times of expanded opportunity.

If there is no effective global mitigation, success will require a lot of good luck at the farm level. At the national level, Australia would depend on imports for food from time to time, and perhaps much of the time. We would depend on an open global trading system not only for export income, as we do now, but for food security. We may have no choice but to make the most of such a world. But both food security and farmers' income security make it a choice to avoid if we can.

Farming Cancun

Greenhouse gas emissions from the land sector in Australia are affected by patterns of agriculture and forestry as well as by traditional management by Indigenous Australians and nature conservation. The land sector is a source of several greenhouse gases, including carbon dioxide, methane and nitrous oxide. It also provides biosequestration, which is the removal of atmospheric carbon dioxide through biological processes—photosynthesis in plants—and storing carbon over significant periods of time.

The land sector of the economy is a significant part of Australia's emissions profile, because of our large land area and agricultural and forestry resources relative to population. The agriculture, forestry and other land use sectors contributed around 18 per cent of total annual emissions in Australia's most recent Kyoto Protocol accounts. Globally, the land sector accounts for around 26 per cent of emissions. It is the main source of emissions in many developing countries.

The rules for the land sector under the Kyoto Protocol provide limited incentives for countries to reduce emissions and increase biosequestration.

Australia has been one of the countries seeking to broaden the coverage of biosequestration within the international rules. Our objective should be comprehensive carbon accounting, with sound principles for managing emissions due to natural events beyond a country's control. The development of sound principles in domestic coverage of land-based sequestration will be influential in the international discussions.

The negotiations in Cancun in 2010 made progress on some of these issues. If there is international agreement on improvements to the current rules, it could boost the national economic value of Australia's land-based mitigation options.

Australia is exposed to greater risks of damage from climate change than any other developed country. Because of our large land mass and small population, we also have greater opportunities for low-cost mitigation in the land sector than any other country. So we should do what we can to encourage more comprehensive accounting for emissions within the international system. We could advance our interests by adopting more comprehensive accounting ourselves at an early date. This would provide a model for the productive evolution of a global system that provides for appropriately expanded coverage of emissions from the land sector.

Easing into a carbon price

The government has introduced into the parliament legislation to establish the Carbon Farming Initiative, an offset program targeted to begin from July 2011. Under the government's proposal for a carbon pricing mechanism released in February 2011, emissions from sources covered under the Carbon Farming Initiative would be excluded from coverage under the carbon pricing mechanism. Credits for reductions in emissions that count towards Australia's Kyoto Protocol target could be used in the carbon pricing mechanism, or alternative funding arrangements could be adopted for the land sector.

Resolution of accounting rules and estimation issues will open up greater opportunities for emissions reductions and biosequestration in the land sector. Eventual movement toward international acceptance of the full range of genuine land-based sequestration and full coverage of the land sector under a carbon pricing mechanism could substantially reduce the cost and encourage the raising of mitigation ambition for Australia. In the meantime, however, Australian farmers could be disadvantaged if they were forced to

adopt practices that made it more expensive or difficult for them to compete internationally. This is the general problem of the trade-exposed industries, but one that is particularly challenging in this sector.

The problem is more acute in this sector than in manufacturing or mining, where other countries are already applying substantial and costly constraints on emissions. Most individual farm businesses generate emissions on too small a scale for them to be covered by the general carbon pricing system proposed by the 2009 Carbon Pollution Reduction Scheme. Measurement is costly and difficult on a small scale in the present state of knowledge. To date only New Zealand has committed to including agriculture in an emissions trading scheme by 2015. That date is subject to review. New Zealand's commitment is significant for Australian farmers, as New Zealand is Australia's main competitor in domestic and the most important international markets for meat, dairy products, wool and temperate horticultural products.

The 2008 Review recommended that the land sector initially be brought within incentives to reduce emissions through offsets, and brought within an emissions trading scheme once issues regarding emissions measurement, estimation and administration are resolved. The proposed date for inclusion of New Zealand agriculture (2015) is a good time for a review of whether circumstances have changed enough for Australia to have full coverage of the land sector.

The government's proposed Carbon Farming Initiative is an important first step in encouraging abatement in the rural sector. It will provide valuable lessons in Australia and internationally on the administration of land sector incentives. It will also lead to 'learning by doing' improvements in technologies applied to emissions reduction and sequestration in the land sector. The government's proposed design provides some encouragement of new emissions reduction and biosequestration, while constraining the risks of giving credit for activities that do not deliver real abatement.

Under the Carbon Farming Initiative, landholders will be able to submit projects for approval on a voluntary basis. They will be able to sell offset credits from a range of approved activities, so long as legal obligations such as periodic reporting are met. The new scheme covers emissions reductions and biosequestration in agriculture, forestry, other land uses and landfill waste deposited before 1 July 2011. This coverage is likely to break new ground for offset schemes not only in Australia, but internationally. Of all established offset schemes, only the Alberta Offsets Scheme in Canada covers a similarly broad range of emissions offsets from agriculture.

Under the Carbon Farming Initiative, it is proposed that offset credits from biosequestration and emissions reductions will be based on the net emissions or removals each year as measured against a baseline. The baseline represents the emissions that would have occurred in the absence of the incentive provided by the initiative. Originally this proposal included requirements to establish that financial considerations would not have been adequate to encourage sequestration in the absence of the value generated by the scheme. The Review's fourth update paper suggested suggested the exclusion of this consideration, and the government's scheme has been amended to accept the advice. It is important that the setting of baselines should not disadvantage early adopters. The government has acknowledged this issue in consultation papers on the Carbon Farming Initiative.

The design proposed for the Carbon Farming Initiative applies a common framework for crediting abatement that would count towards Australia's Kyoto Protocol target, and non-Kyoto abatement. This approach would provide for broad coverage and, depending on the opportunities to obtain a significant price for abatement, could encourage greater mitigation than an approach that applied different rules to Kyoto and non-Kyoto abatement. It avoids landholders having to interpret Kyoto Protocol rules and provide evidence of, for example, areas of vegetation that met Kyoto forest criteria in 1990. This is a sound approach.

Permanence is a critical issue. Unlike other emissions reductions, the abatement achieved through biosequestration can be reversed by events that are natural as well as by human action. While permanence can never be guaranteed, the risks of an unplanned release of emissions can be reduced through good system design and good management practices. In addition, new insurance products are emerging that are applicable to carbon forests. These may offer forest growers risk management options that complement the management of risks to permanence proposed within the Carbon Farming Initiative.

The government proposes a rigorous but flexible approach to dealing with permanence. Participants wishing to change land use must relinquish credits. A proportion of credits from biosequestration projects would be withheld as a form of insurance against losses. Where unintended losses occur, credits would not have to be relinquished as long as the project was re-established. New credits would not be issued until the previous levels of accumulated sequestration had been reached.

I suggested in March 2011 that genuine land sector abatement should be rewarded with a credit that was equal in value to the carbon price within the formal scheme. For activities that are currently recognised for Australia under

the international rules, credits could be sold to parties that were liable under the scheme. For other genuine biosequestration, the regulator of the carbon pricing scheme would purchase credits at the carbon price. Sales of land-based credits under these arrangements would be placed under generous quantitative limits. Sales of credits that complied with current international rules would be limited to 4 per cent of permits in the first year of the scheme, rising to 10 per cent in 2020. Credits that fell outside current international rules would be limited to 2 per cent of the value of scheme permits in the first year, rising to 4 per cent in 2020. These quantitative limits would be removed when there was full coverage of land sector emissions under the scheme.

These limits would allow for high values of sales of credits from the land sector. If the limits were fully utilised, the total value of sales of credits in 2020 would be in the vicinity of $2.25 billion, or roughly the value of Australian wool production in the most recent full year.

The land and farm management practices that would generate credits under the recommended arrangements could have substantial additional benefits to farm productivity and the environment. The build-up of carbon in soils is helpful to retention of moisture and therefore for the maintenance of farm production in times of drought. It assists productivity by improving the availability of nutrients needed for plant growth. Restoration of woodlands can have benefits for stock management and, if accompanied by appropriate incentives of other kinds, for biodiversity.

The land sector could make a large contribution to the reduction in Australian emissions. Analysis by CSIRO indicates that technical potential (the upper limit of what could physically be possible) is about twice the total level of current Australian emissions. The realisation of a small percentage of that potential would make a significant difference. Let's take a look at the opportunities.

Deforestation

Deforestation is undertaken for agricultural purposes, as well as for mining, urban development and infrastructure such as roads and powerlines.

Since 1990, there have been large reductions in deforestation rates in Australia, and therefore emissions, due to economic, technological and climatic factors as well as government regulation. In regions such as semi-arid Queensland, where there has been extensive clearing for livestock grazing since the middle of last century, regrowth of woody vegetation following clearing is common. Landholders clear regrowth once it has reached an extent that

reduces livestock production. Since 1990, the amount of clearing of regrowth has increased relative to the area of first-time clearing.

Further abatement could be achieved by reducing the rate of deforestation and retaining or promoting regrowth vegetation on land that has already been deforested.

The greatest opportunities for reducing deforestation and for maintaining and promoting regrowth are in Queensland, and, to a lesser extent, in New South Wales.

CSIRO's analyses indicate that a carbon price or an offset credit at around $15–25 per tonne of carbon dioxide equivalent would encourage landholders to retain substantial areas of native vegetation that might otherwise be cleared. Landholders would make decisions based on carbon price levels, possible impacts on agricultural production and ecosystems, and risks of loss of stored carbon (for example, due to fire or drought). In some instances, decisions will also be influenced by the need to adapt to climate change.

Livestock

When cattle and sheep digest their food, they produce methane emissions, which account for about 10 per cent of total national emissions. These emissions have declined by 14 per cent since 1990, largely because of a fall in sheep numbers due to the combined effects of the extensive drought and a fall in the price of wool relative to other agricultural products.

Several abatement options are available. These include changes in animal breeding, diet and management.

Improving emissions estimation methods to allow assessment of the impacts of emissions reduction options will be essential for further developing and realising abatement strategies for cattle and sheep and other livestock.

Soil

Compared to northern hemisphere soils, many Australian soils have naturally low soil carbon levels due to their old, weathered nature and the effects of a warm and dry climate. Large losses of soil carbon have occurred since the conversion of native vegetation to agricultural land started in the 1800s.

Over recent decades, Australian farmers have progressively adopted practices that reduce soil disturbance and reduce losses of soil carbon, such as no-till and conservation farming practices. These practices also reduce production costs and land degradation in cropping systems. Adoption levels for these practices have reached 90 per cent in many regions, and there

have been rapid increases in the last five to ten years in some regions where adoption had previously been relatively low.

As well as reducing losses, the amount of carbon in soils can be increased, for example through establishing pastures using perennial species and adding organic matter such as manure and green wastes.

There are risks that increases in soil carbon can be reversed, for example in drought. Drought caused a significant spike in national emissions from croplands during 2002 and 2003.

There is also considerable interest in the potential for incorporating biochar into soils to increase soil carbon. Biochar can be produced through a combustion process at high temperatures from sources including wood, agricultural crop residues and green waste; gas produced in its creation can be used to generate electricity or converted to liquid fuels. Biochar has greater stability than the material from which it is made, and can therefore provide a long-term carbon store. It can be added to soils, and may improve soil fertility, which could in turn provide biosequestration benefits through enhanced plant growth.

Recent studies have confirmed earlier indications that some types of biochar can significantly increase crop yields, and some are stable in soil for decades, although these qualities vary with the feedstocks and production processes used. Crop yield responses to addition of biochar are also variable, ranging from a 30 per cent reduction to a 200 per cent increase, and can vary with soil type. The introduction of financial incentives for increases in soil carbon allows farmers to take up the opportunity in those places where it is profitable for them to do so.

CSIRO estimated that building soil carbon, combined with nitrous oxide emissions reductions, on cropped land had a national technical abatement potential of 25 million tonnes of carbon dioxide equivalent per year from 2010 to 2050. This assessment assumed adoption of practices to improve crop productivity and reduce tillage across 20 million hectares of annually cropped soils.

Rangelands

Arid and semi-arid rangelands, which include grasslands, shrublands and woodlands, make up about 70 per cent of Australia's land mass, or about 550 million hectares. Rainfall in these rangeland areas is highly variable.

Over many years, marginal sheep and cattle grazing has caused considerable degradation of some of these rangelands, including shrublands and woodlands dominated by mulga.

The most likely way in which rangelands will be rehabilitated is through reducing grazing intensity. Other possible ways to rehabilitate rangelands and increase carbon levels include introducing or re-establishing palatable shrubs such as saltbush, tagasaste or other perennial shrubs, and fire management.

Recent studies have indicated substantial, but widely differing, technical abatement potential from rehabilitating degraded rangelands. Most studies apply similar sequestration rates of less than one tonne of carbon dioxide equivalent per hectare per year through rangeland rehabilitation. The differences in technical potential arise primarily from differences in the land area considered by each study. Some of the differences in area derive mainly from differences in definition.

CSIRO estimated that rehabilitating 200 million hectares of overgrazed rangelands could have a technical potential to sequester 100 million tonnes per year of carbon dioxide equivalent between 2010 and 2050.

Fire management in northern Australia

Tropical savannas cover the northern third of Australia and are largely owned and managed by Indigenous Australians. They include grasslands and woodlands and are used by Indigenous peoples for traditional purposes, and for grazing and conservation. Fires are common in savannas, especially in the late dry season, when fuel loads are highest and have dried out. Strategic burning earlier in the dry season can help reduce fuel loads so that late dry season fires are smaller and less intense. Intense, hot fires late in the season burn more completely, and damage trees and native fauna in ways that controlled early season burning does not.

Savanna burning is the major source of emissions in the Northern Territory. Australia's total emissions from savanna burning have declined since 2001. Emissions are heavily influenced by climate factors from year to year.

Improved management of savanna fires has been estimated by CSIRO to have the technical potential to reduce emissions by 13 million tonnes of carbon dioxide equivalent per year, or around 90 per cent from the average level over recent years, between 2010 and 2050.

Another assessment of abatement options on Indigenous land estimated that strategic fire management had the potential to reduce emissions by 2.6 million tonnes per year. The West Arnhem Land Fire Abatement Project is operating successfully across 28,000 square kilometres. The cost of implementing the project has been estimated at between $7 and $30 per tonne of carbon dioxide equivalent. Commercial viability will vary across regions and depend on the carbon price.

Plantation forests

Australia's plantation forest estate has expanded significantly since 1990. An average of about 64,000 hectares per year was established from 2002 to 2008. Within this average, there was a decline from 72,000 hectares in 2008 to 50,000 hectares in 2009.

CSIRO assessed the technical abatement potential of plantations established since 1990 to be 400 million tonnes of carbon dioxide equivalent per year between 2010 and 2050, with a carbon price of $20 per tonne and an average carbon sequestration rate of 9 tonnes per hectare per year.

CSIRO cautions that this estimate needs to be considered as an upper limit once market demand, processing capacity and transport costs are taken into account. Other constraints on expansion include willingness by landholders to convert agricultural land to forest, regulatory restrictions on forest establishment, the transaction costs of carbon market participation, and impacts of climate change on land productivity for forestry.

Some of these constraints could be addressed by growing native tree species on low productivity land for carbon sequestration as well as harvesting for timber or biomass energy production. Research suggests that there are some prospects for growing low rainfall plantation eucalypt species.

Native forests

The area of forests and wooded lands per person in Australia greatly exceeds that of other developed countries. Native forests cover around 147 million hectares, or almost 20 per cent of Australia, including 23 million hectares held in conservation reserves and 9.4 million hectares of public land where timber production is permitted. The remaining area comprises public land used for other purposes, and privately owned land. The area of native forest harvested has declined over time, and totalled about 81,000 hectares in 2009.

There is limited information on carbon sequestration in native forests, and current estimates are subject to significant uncertainties. Taking these uncertainties into account, CSIRO has estimated that if native forest harvesting were to cease, there is a technical potential for abatement of 47 million tonnes of carbon dioxide equivalent each year from 2010 to 2050.

There has been considerable recent discussion among forest industry and union representatives, environmentally focused non-government organisations and governments on greatly reducing harvesting of trees in native forests on government-owned land. The sequestration benefits of

such developments are considerable. Where arrangements are negotiated for reduction of native forest harvesting and a financial settlement is made, future claims on the carbon scheme revenue should be excluded.

More comprehensive carbon accounting could open up opportunities for carbon markets to provide a source of revenue for forest managers. Emissions reductions and biosequestration in harvested native forests could be achieved by reducing the area harvested, or potentially through changes in harvesting practice. Forests that are subject to minimal human influence are likely to be either mature or regrowing following fire or other natural disturbance, and therefore provide limited opportunity for active management to increase carbon storage.

Carbon forests

Carbon forest plantings are grown for the purpose of biosequestration, and are a relatively new activity. They include plantings of mixed native species as well as single species such as mallees, and are often designed to provide other benefits for biodiversity, natural resource management and farm productivity. Plantings may be established in blocks, widely spaced rows or in ways designed to provide specific environmental benefits, for example along stream banks or as corridors for native species. Australian companies that are managing new forest plantings to provide emissions offsets commonly use locally native species.

As carbon prices rise, establishing forests in regions with lower rainfall and lower land values becomes economically viable. Carbon plantings are more likely to be suited to these growing conditions than timber plantations. CSIRO has estimated that, with a carbon price of $20 per tonne carbon dioxide equivalent and incentives for biodiversity benefits, establishing biodiverse carbon forests could have a technical biosequestration potential of 350 million tonnes of carbon dioxide equivalent per year between 2010 and 2050. At a large scale of activity, some carbon forest establishment could replace growing of forests for wood production.

In recent years at least 20 businesses and not-for-profit organisations have been reported as offering carbon forest offsets in Australia. New agreements between carbon forest growers and companies with large emissions profiles for extensive plantings to offset energy emissions indicate expanding capacity and readiness in the carbon forest industry ahead of a carbon price.

Bioenergy

Using bioenergy (liquid biofuel, electricity and heat) instead of energy derived from fossil fuels can deliver mitigation benefits if emissions over the lifecycle of production of the biomass feedstock and energy are lower than for fossil fuels. The biomass feedstocks can be sourced from purpose-grown agricultural and forestry crops as well as waste material. Biofuel can also be produced through gasification of biomass. Biofuel production supplies less than 1 per cent of Australia's total transport fuels.

Biomass feedstocks for heat and electricity in Australia currently comprise by-products or residues from agriculture and forestry production systems. The major feedstocks for heat and electricity are sugar cane waste and wood and wood waste. Biomass energy contributes around 1 per cent of Australia's total electricity generation.

Biomass electricity is financially competitive with other renewable technologies where the fuel costs can be kept relatively low. Unlike some other prospective low-emissions technologies, current industry estimates do not envision significant potential for capital cost reductions or significant increases in the scale of operation for power generation using biomass only. There are opportunities in the transition to a low-carbon economy for biomass to be used with coal in power generation to lower emissions.

The use of planted mallee eucalypts as a biomass source for energy and other products has been investigated for a number of years, and has been demonstrated in a pilot bioenergy plant in Western Australia. Unlike some agricultural sources of biofuels, the ratio of energy output in biomass to energy inputs in production is highly positive. Commercial viability of growing mallee for bioenergy would be enhanced by innovation to reduce growing, harvesting and transport costs. Cost reductions of 50 per cent are expected within ten years.

Combining sequestration with biodiversity

There is increasing recognition in Australia of the value of biodiverse forests and woodlands. Incentives for carbon sequestration will incidentally encourage biodiverse development in some circumstances, and work against it in others. While establishing or restoring a native forest or woodland might support a rich and diverse ecosystem, the mass planting of a single species of tree would not.

If carbon pricing is combined with separate incentives that recognise the value of biodiversity, market decisions will generate combinations

of sequestration and biodiversity that have maximum value. The ideal arrangement is for separate funds to be established for rewarding investments in biodiversity, and for landowners to be able to draw both on these and carbon pricing arrangements. Established state and federal schemes to encourage biodiversity could form the basis of the required arrangements.

Land and water

Reducing emissions and increasing biosequestration in rural Australia will involve some changes in land and water management. Many changes will be positive: improved soils, restored habitats and new sources of regional income. There could be negative impacts, not just on biodiversity but also on water resources and agricultural land use.

In our market economy, landholders should be free to use their land as they judge best for themselves unless there are good reasons for the community as a whole to constrain private choices. Carbon pricing will cause farmers to substitute some sequestration activities for conventional farming simply because it is profitable to do so. On the other hand, rising food prices could favour food production over forests. In many cases the changes will be new mixes of activity rather than complete changes in land use; farmers in the Western Australian wheat belt have been planting rows of mallee trees since the 1990s to reduce land degradation while maintaining crop production.

There are roles for regulation, as well as market-based approaches, in helping to avoid unintended negative impacts. Land-use planning requirements already apply to plantation forestry. Decisions on whether to constrain changes in land use are best made at a local level, and should aim to achieve a balance between land uses that is appropriate in each local community.

Conclusion

The land sector is greatly affected by climate change and has a large part to play in its mitigation. This is true for the world as a whole. It is more powerfully true in Australia than in any other developed country.

The world has entered a challenging period of rising food prices in the 21st century, after a long period of decline. This presents problems for global food security. These challenges can be met, so long as the higher food prices are not compounded by the effects of weakly mitigated or unmitigated climate change.

In themselves, higher food prices represent opportunities for the Australian rural sector.

The Australian rural sector is set to do well in these new circumstances if the world is effective in mitigating climate change. The measures that reduce emissions in the rural sector will add considerably to rural incomes once they are rewarded within carbon pricing arrangements. Some will confer substantial benefits for farm productivity and for adaptation of farm management to more intense drought and other extreme weather conditions that are associated with climate change.

In the absence of effective global mitigation—in which Australia will have to do its fair share—the 21st century will be deeply problematic for global and even Australian food security, and for the income security of rural Australia.

The international rules developed within the Kyoto process overlook many potentially important areas of land sector mitigation. The omissions are especially important in Australia. Australia has a major role to play in developing alternative and economically and environmentally more efficient rules governing incentives for mitigation in the land sector. Demonstration of their suitability in Australia can lead to their adoption in other countries, including our developing country neighbours with their large forestry sectors.

The land sector, especially through biosequestration, has immense technical potential for reduction and absorption of emissions. Realising a small proportion of that potential through providing incentives commensurate with the sector's mitigation contribution would transform the Australian mitigation effort. It would also greatly expand the economic prospects of rural Australia. Complementary incentives for biodiversity would help to ensure that the potential for carbon and biodiversity efforts to assist each other is realised.

We are a long way from knowing how much of the technical potential can be realised economically. The linking of the proposed Carbon Farming Initiative with the carbon pricing scheme would open the way to realisation of that potential. This is an essential modification of the proposed Carbon Farming Initiative. Once it was linked to the carbon pricing scheme, the Carbon Farming Initiative would reveal the potential and define the extent to which it is economically relevant; it does this by providing for the emergence of an offset market for land sector abatement.

In time, as the world shifts towards pricing carbon in farming, the Carbon Farming Initiative can be merged with the broader carbon price and fulfil its full mitigation potential.