Agriculture and GHG mitigation policy:
options in addition to the CPRS

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**Key points**

**Key propositions**

Greenhouse gas policy for agriculture should add to the net value of the Australian Government’s overall climate response strategy and support international engagement while efficiently managing costs and risks.

Policy should emphasise a credible contribution to global abatement rather than just compliance with currently restrictive accounting rules that may, and should, change.

For agriculture, the science is uncertain, institutional arrangements are biased in ways that limit access to abatement options in agriculture, and there is uncertainty about future arrangements. Precise measurements or estimates of GHG emissions and sequestration from individual activities are either missing or prohibitively expensive.

What ultimately matters from Australia’s perspective is the level of abatement and sequestration delivered in aggregate and the associated cost – not emissions from individual farms. This should be inclusive of any leverage of additional international abatement or sequestration.

A sound policy framework needs to be flexible, adaptable and capable of investing in better and earlier information and of anticipating the value of new information. It also needs to pre-emptively signal clear policy intentions and assignment of risk.

The policy purpose strongly favours delivering improved behaviour change incentives on-farm rather than focusing just on charging the sector for its emissions.

Agriculture offers substantial opportunities to lower the costs of meeting Australia’s GHG policy and international engagement objectives. This potential would largely be unrealised using a CPRS mechanism with downstream points of obligation based only on output.

The opportunities offered by agriculture need an approach that encourages input as well as output changes. Without these, abatement by agriculture will be based heavily on reduced production – especially livestock – in ways that are likely to be unnecessarily high cost to the economy.

Particular policy and program approaches to be considered include:

- Reviewing the impact on agricultural emissions of existing policy settings, i.e., drought, water, biodiversity and salinity;
- Maintaining a strong position on separating anthropogenic from non-anthropogenic elements of Article 3.4;
- Considering a 2-part national target consisting of a lower bound on compliant abatement and an additional lower bound on total abatement, inclusive of anthropogenic soil carbon effects;
- Reassessing current emphasis on individually verifiable abatement effects vs. verifiable aggregate abatement. Consider the role of (statistical) portfolio risk management.
- Developing trading mechanisms (eg. CCX-like voluntary exchange) which incorporate systems for establishing farm-level baselines. This could, in time, merge with an evolving CPRS;
- Considering upstream inclusion of selected inputs – possibly including nitrogenous fertilisers, studs and plant breeding;
- Considering using a range of complementary regulatory and transitional assistance measures, recognising the export exposure of the sector; and
- Undertaking strategic investments to extract maximum value from R&D processes.

These approaches also appear to have significant potential to support analogous efforts in a range of other countries.

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- Undertaking strategic investments to extract maximum value from R&D processes.

These approaches also appear to have significant potential to support analogous efforts in a range of other countries.
We have assumed that the purpose of greenhouse gas policy for agriculture is to add to the net value of Australia’s overall climate response strategy. The strategy involves pursuing cost-effective abatement and sequestration and supporting international engagement to influence global greenhouse gas levels while efficiently managing costs and risks.

The primary focus of this study is on national, not agricultural, value and cost-benefit. Sound policy will need to factor in transaction costs, risks of encouraging counterproductive behaviour, costs of correcting unacceptable equity effects and costs of uncorrected equity effects. This implies balancing theoretical nicety against practical reality. Policy should therefore emphasise credible documentable contributions to global abatement, rather than just compliance with currently restrictive accounting rules that may, and should, change.

In relation to agriculture, the science is uncertain, the international rules and measurement protocols are biased in ways that limit agriculture’s access to abatement options, and there is uncertainty about future policy arrangements. Logical responses within agriculture are likely to entail changes in diverse sets of behaviours, interacting within, and across, farms. This reflects the heterogeneity across farm systems and regions. Precise measurements or reliable estimates of GHG emissions and sequestration from individual activities, is currently either missing or prohibitively expensive. But what ultimately matters from Australia’s perspective is the level of abatement delivered in aggregate and its associated cost – not the individual practice or even farm impacts.

A sound framework for dealing with all these features needs to be: flexible; adaptable to new information; capable of investing in better and earlier information; and of anticipating the value of such information. It requires a firm grounding in modern options principles for managing risk. These principles favour progressive, adaptive management of both the risks of not doing enough and of unnecessarily encouraging changes that are counterproductive. They strongly favour working with broad portfolios of interlinked measures, across as well as within farms, rather than case by case measures.

Within this framework we have concluded that agriculture offers substantial opportunities to lower the costs of meeting the policy objectives. This potential would largely be unrealised using the CPRS mechanism, with downstream points of obligation based only on output – abatement might be achieved, but not cost effective abatement and the risks of posting counterproductive incentives are high. The opportunities offered by agriculture need an approach that can encourage input as well as output changes – because of the critical implications of input mix for the intensity of emissions in outputs. It also needs an approach that can deal with uncertainty in a way that still exploits what is known of probable differences in emission outcomes. Without these features, abatement by agriculture will be based heavily on reduced production – especially of livestock – in ways that are likely to be unnecessarily high-cost.

A diverse range of alternative policy packages were considered. In short-listing prospects, the framework strongly favoured either limiting transaction costs or locating higher transaction costs where they offer the greatest value. The policy purpose strongly favours delivering improved behavioural change incentives on-farm, rather than simply focusing on charging the sector for its emissions, a fundamentally different notion. This is likely to require some complexity – and may place strong reliance on early voluntary participation (to better align transaction costs with benefits) and, initially, the use of relatively light-handed regulatory devices. It also needs the flexibility to move to heavy-handed responses. Early
communication of how the policy might evolve, and how the risks of such evolution are to be assigned across sectors, can be used to intensify the incentives for early abatement action, and provide better risk management. It also supports a link, or early movement to a link, with the marginal cost of abatement from the CPRS.

A cost-effective policy process, that manages the risks of intervention failure, as well as tapping the opportunities, is likely to initially emphasise redressing key policy distortions; signalling clear policy intention and assignments of risks, and establishment of a clear baseline and assessment and measurement tools. It would also involve targeting low hanging fruit and responding to constraints in international accounting rules (see Chart 25 on p167).

Overall approaches of particular interest are:

- Addressing a range of specific distortions in the way that other imperfect ‘markets’ – drought, water, biodiversity, salinity, etc. – interact with farm systems to affect emission patterns.
- Australia maintaining a strong position on separating anthropogenic from other elements of Article 3.4 in relation to soil carbon:
  - Strong negotiation for change and an early farm sector strategy predicated on good prospects for success.
  - Possible separation of total abatement/sequestration targets from compliance with the rules, with a 2-part target consisting of a lower bound on compliant abatement and an additional lower bound on total abatement, inclusive of anthropogenic soil carbon effects:
    … This could be used – while still complying internationally – to boost international influence, including in countries not proposing cap and trade arrangements. It would provide an avenue to support higher rewards for constructive on-farm changes.
- Australia reassessing its emphasis on ‘bottom up’ abatement strategy, with heavy reliance on individually verifiable abatement effects rather than verifiable aggregate abatement:
  - Greater openness to the role of (statistical) portfolio risk management - spanning different instruments, farms, regions and even countries - could be more effective in tapping the value offered by agriculture and should offer credible abatement possibilities at much lower cost.
  - The critical value proposition is not by how much it would lower the marginal cost of abatement but rather the economic surplus – the cumulative value of opportunities below this marginal cost – that could be tapped across a wide range of farm-level changes.
- Acceptance of the principle of portfolio-based delivery of abatement and sequestration and support for: the development of mechanisms for trading in the value that proposed parcels of behavioural change offer to the performance and costs of the overall portfolio of measures, and for building a clear link to the marginal cost of abatement in the CPRS:
  - Systems for establishing farm-level baselines, defining current/recent farm systems, and for accrediting packages of changes across groups of farms relative to these baselines.
  - Early, greater, and more efficient abatement could be encouraged if, in addition to recognising immediately a conservative assessment of abatement impact – using statistical portfolio risk management (i.e., the conservatism applies to the whole portfolio, not to individual measures) – access is also granted to any additional value later revealed and verified as a result of ongoing research and accreditation processes. This could take the form of tradable options over future prospects.
- Upstream inclusion of selected inputs – possibly including nitrogenous fertilisers, studs and plant breeding – in the CPRS, for their imputed implications for farm emissions; posting strong
incentives for differentiation, based on emission impacts (e.g. coated nitrogenous fertilisers and tracking of emissions performance in breeding programs).
- This would involve a low transaction cost and would embed strong behavioural change incentives but with a need to address some incentives for ‘perverse’ substitution of inputs.

- Possible use of an evolving CCX-like voluntary exchange, with measures to provide an interchange with the CPRS (supporting higher value), and to allow for: progressive development of an agricultural carbon abatement market, more sophisticated trades, and possibly a long-term merger of the two evolved markets.
  - Within the mechanism for accrediting and rewarding behavioural change, serious consideration could be given to basing rewards and offsets on immediately accessible lower bound valuations of the portfolio contribution. Rights to any further value later determined to have been delivered could also be issued – with such rights potentially tradable earlier via secondary markets.
  - An analogy could be drawn with markets in lower reliability water rights, with exchange rates that reflect the higher volume of nominal rights needed to deliver a specified level of reliability of access, coupled with secondary markets to create value in upside potential.

- Development of readily accessible modelling, monitoring and assessment tools, where feasible in advance of the introduction of policy instruments, to encourage early movers to be consistent and to manage transaction costs.

- Overall policy could be complemented using a range of regulatory and transitional assistance measures when needed, recognising the export exposure of the sector.
  - For example the processes for determining baselines for the accreditation of abatement and sequestration, and the way these are changed over time, might parallel the proposed early assignment of free permits within the CPRS and be used to target EITE challenges.
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Sectoral, national and international responses to climate change trends and threats are complex, with high uncertainty and risks associated with ‘waiting till we can get it right’ before acting decisively. Australia has committed to decisive action based, in part, around target caps on total emissions. The complexity and risks of intervention failure are probably greater for agriculture than for any other significant sector – while the fact that agriculture is a major direct emitter and also a potential carbon sink, cautions strongly against excessive delay in tapping this potential.

There is a range of reasons for caution about forcing agriculture into the CPRS too early, using approaches likely to be currently feasible. Many of these reasons are clearly recognised by the Federal Government. They have underscored the decision to delay inclusion until at least 2015 and, more recently, to establish a Technical Options Development Group to explore policy options, including alternatives to the CPRS.

We have worked on the basis that the primary purpose of greenhouse gas emissions policy for agriculture, should be to make a cost-effective contribution to Australia’s overall climate change policy. The objective should be to implement augmentations to the wider policy strategy that deliver the greatest net benefit to Australia: inclusive of the value of risk reduction; the value of any reduction in the national cost of greenhouse gas abatement; any transition and transaction costs; the net costs of compensating for any adverse equity impacts, for sectors, regions etc.; and the costs of uncompensated adverse equity impacts, where these cannot be compensated cost-effectively. This would also factor in the benefits of any support for international influence in delivering better and more cost-effective global abatement and sequestration – and therefore favour policy settings that support better international response.

This is a complex ask and it explicitly is not focused on delivering the best outcome for Australian agriculture. It assumes that agriculture will have to compete for its logical position in a world in which the opportunity cost of emissions is recognised and factored into strategy and prices.

There are significant trade-offs in bringing agricultural emissions of methane and nitrous oxide within the direct reach of the CPRS, as proposed for other sectors.

Locating the point of obligation downstream (with processors etc.) and with imputed emissions based on ‘one size fits all’, output-centric, emission factors (assumed emissions per kilogram of milk, meat etc), would impose substantial costs on agriculture, and with tightly constrained incentives for sound
behavioural response. Farm-based initiatives to improve the emissions efficiency of production would be difficult to reward.

This approach could be expected to entail unnecessarily high costs – in violation of the assumed policy purpose – and would largely fail to post incentives that would allow the potential of agriculture to be tapped. Indeed, its incentives may well have significant counterproductive elements – forcing costs to be incurred that are likely to prove regrettable and need to be reversed later, as sounder policy options are developed and deliver better signals.

On the other hand, locating the point of obligation on farm, with significant coverage of the emissions of concern, could imply a massive increase in the number of firms in the CPRS and probably very high transaction costs.

We have focused strongly on the opportunities offered by agriculture to contribute via cost-competitive opportunities for abatement and sequestration. These opportunities – for both abatement and sequestration – appear to be large. They are also tightly constrained, in feasibility or attraction, by technical and institutional factors, and often by perverse interactions between these:

- Limitations to current science, combined with large variations in land types, precipitation patterns and detailed aspects of farm systems, commonly preclude any precision in attributing abatement or sequestration impacts to individual farms.

- Actual emission implications commonly involve complex, non-additive interactions across multiple farm decisions – making it difficult and, in an important sense, impossible, to soundly describe the abatement impact of a specific action out of context.

- Article 3.4 of the Kyoto Protocol sets – as a condition of accounting for abatement and sequestration changes in relation to “anthropogenic greenhouse gas emissions by sources and removals by sinks … resulting from … revegetation, forest management, cropland management, and grazing land management”. However, Article 3.4 also extends the accounting to changes to non-anthropogenic emissions from ‘major disturbances’ such as drought and bushfire:
  - While appreciating how it arose (and the risks that need to be managed), we have concluded (in line with the Federal Government view) that this ‘all or nothing’ bundling of two quite distinct classes of emissions is poor policy, globally, and especially for Australia.

  - A key effect is to discourage practical, low-cost initiatives to address anthropogenic emissions, while also encouraging an inappropriate approach to be taken on the non-anthropogenic emissions.

- The assessed quantum of Australian emissions from agriculture has been largely based on emission factors that draw on the propensity of certain land use patterns or outputs to be associated with particular emission levels.
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– relying on statistical averaging of ‘overs’ and ‘unders’ in arriving at an aggregate emissions estimate:

– There appears to be reticence about bringing the same approach – that has drawn on individually poor farm-level precision in arriving at an emission estimate – to bear on accounting for emission reductions. There appears to be an asymmetry of approach that results in costly distortion.

– Individual initiatives, where the level of abatement or sequestration impact is uncertain, appear often to be heavily discounted relative to initiatives where comparatively high levels of precision are possible. This tends to work against the natural opportunities available in agriculture much more than is the case in other sectors.

– Modern principles for managing uncertainty and risk across a wide portfolio of initiatives, strongly suggest that this discounting of the value of agricultural opportunities because of uncertainty is excessive, costly and inefficient.

Given the nature of the uncertainties involved, we have concluded that a sound policy and assessment framework, for developing and comparing policy approaches, must embed suitable principles for efficiently dealing with these uncertainties. They imply that efficient policy will entail ongoing adaptation to emerging information, will incorporate active investment in making better information available earlier to support better decisions; and will favour delaying high cost commitments that may later be regretted, if suitable alternative ‘insurance’ can be implemented.

Efficient policy will also recognise that changes that safely deliver at least a given level of abatement or sequestration can have additional value – an ‘option value’ – if there are real prospects that information to emerge later will reveal that a lot more abatement or sequestration has actually been achieved. It should be worth tapping this value to strengthen incentives for change. This implies a policy approach that incorporates modern options principles, to deal with both scientific and institutional uncertainty.

Within such a framework, the natural ‘changes’ to explore from agriculture involve system changes, designed to increase emissions efficiency – ideally linked to the marginal cost of abatement that has emerged from the CPRS. These system changes will be composed of many individual changes in input structures and output mixes, and can extend across regions and groups of farms. In fact, the aggregation to a ‘portfolio response’ could, in principle, occur across countries and through time. Modern principles for risk management recognise that, even if there are high levels of uncertainty attached to many individual elements in such a portfolio, it may still be possible to assert, with very high confidence that the portfolio will deliver abatement in excess of a threshold and at a competitive cost.
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The type of economic modelling so far used in exploring impacts has an inherent bias towards underestimating the scope for efficient behaviour change – beyond switching product levels and mix – in the face of structural change that is known to be long term, as will be the case with climate change policy.

If agriculture cannot compete by using its areas of competitive advantage, it will face artificially high levels of damage (or artificially high compensation costs) and the resultant climate change policy will be excessively costly from national and global perspectives. We have applied this framework in identifying and undertaking initial assessment of policy alternatives. We have not sought to be prescriptive about individual technical ‘fixes’.

In exploring alternatives using the framework, we have recognised a wide range of levers – both currently available and prospective. Work overseas, and limited work in Australia, strongly suggests that, across this span of possible levers, there is an evolving portfolio strategy that could deliver abatement at more than competitive costs and, in some cases, on a ‘no regrets’ basis. There are serious questions about the impact of transferring some of these levers to specific Australian settings - which underpin a research agenda. However, there is also
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the potential offered by portfolio risk management approaches, to work with conservative assessments of aggregate portfolio impact, along with recognition and rewarding of upside options that could mean an even greater impact has occurred – because they represent options for the whole country.

An important feature of a number of these possible levers – and their underlying science drivers – is the potential for synergies between emission abatement/sequestration and farm productivity. High methane emissions from livestock, indicates inefficiency in feed conversion. Nitrous oxide emissions from nitrogenous fertiliser application, indicates ‘wasted’ fertiliser. Biochar added to soils seems likely, in at least some contexts, to deliver improved crop and pasture production, and binding of nitrous oxide alongside carbon sequestration. These synergies offer scope for cost-sharing across the value of abatement and sequestration services enhancing farm productivity – sound policy will encourage exploiting these synergies. In some cases, as suggested above, this could imply a negative net cost of abatement; in other cases it could imply significant reductions in effective costs of abatement and sequestration.

More generally, it is appropriate to challenge the assumption that sound carbon pricing should necessarily imply reduced farm production in Australia, or even that it should necessarily imply reduced emissions from the agriculture sector. Certainly, it should imply increased emissions efficiency and will probably entail some shift in output mix and some flattening of the trend in farm production.

It is plausible that Australian agricultural production could rise (though probably by less than in a ‘business as usual’ scenario) and it is at least theoretically possible that the growth should be enough to imply increased emissions despite higher emissions efficiency. The final outcome is ideally something to be determined by competition within economy-wide markets that sensibly value emission effects (both priced and unpriced). A policy that sets abatement targets for agriculture separate from the CPRS, and not linked to it, could well risk excessive costs.

Against this background, serious possibilities, as part of a total strategic response, include:

- Inclusion of nitrous oxide emissions from fertilisers in the CPRS via an upstream point of obligation on producers/distributors, and based on imputed emission effects:
  - There are possible perverse incentives to be managed, but this approach, if it imputes different emission levels based on the nature of the fertiliser and any coatings, could make a significant difference.
  - It would allow an approximately ‘efficient mix’ of coated and uncoated fertilisers to emerge, based on the competitiveness of net abatement relative to the CPRS.
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- It would feed behaviour change incentives – in choice of fertiliser and of farming systems – through to farms via prices and price differentials, and a differential scope for targeting nitrogen.

- It may allow a substantial proportion of emissions from cropping specialists to be covered, without triggering the transaction costs of including these farms individually.

- The alternative of regulating to require coating has serious limitations compared to this approach.

• Addressing aspects of a range of other farm-related policies – for drought, water, biodiversity, salinity and farm forestry – to deliver a more coordinated package of measures and to address perverse incentives posted by some of these policies for high emission farm strategies:

  - The consequences of these autonomous corrections to market/regulatory failure should be reflected in greenhouse accounts and translated into measured abatement.

• Concerted efforts to achieve sensible modification to the international rules, at least to the point of allowing separation of anthropogenic from other soil carbon effects:

  - Within the options framework, this has a high option value in its potential for relaxing a high-cost constraint.

• Explicit refocusing of the Australian policy approach, to recognise the opportunity to apply portfolio risk management to portfolios of initiatives within and across farms and to wider land management:

  - With associated value in systems that establish, at the farm level, an accredited baseline farming system and the ability to document and accredit packages of changes in farms and across groups of farms. So that they can be assessed as reasonably offering expectations of a positive impact on aggregate emissions.

  - Institutional support for the development of such accreditation systems.

  - Support for developing systems that could support farms in restructuring in the light of emerging science and marginal abatement costs – noting that these will progressively reshape ‘best practice’ for individual farms.

• Possible implementation of a CCX-style voluntary exchange, as a way of building understanding of possibilities and processes for encouraging abatement and sequestration, and for supporting aggregation of activity portfolios to deliver acceptable risk and value.

  - Progressive development of interchange arrangements with the CPRS, to allow exchanges based on (probably) conservative assessments of abatement value, and to strengthen the link to the marginal cost of abatement emerging from the CPRS.
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Processes set out in draft US legislation recognise these possibilities: the scope they offer to build towards the true value of agricultural abatement options; and to coordinate agricultural emissions price signals with the wider emissions trading scheme in the US.

− Development of a secondary market in the options for the use of conservative emission factors; linked with ongoing R&D to demonstrate the actual (greater) value delivered.

− The distinct possibility that such an exchange could, in time, merge with an evolving CPRS, in a way that addresses the current major concerns.

• Consideration of the possibility of formally separating Australian abatement targets from the international rules, unless and until Australia’s major concerns with the rules are addressed.

− As has been flagged, Australia could declare a commitment to a 2-part target structure, involving: a) a relatively low guaranteed minimum level of abatement within the international protocols; and b) additional (credibly conservative) abatement and sequestration that falls outside the current rules, because of limitations in those rules. Australia could then commit to, and focus primarily on, aggregate abatement and sequestration across these two components.

− This would be fully consistent with recognising and working with international processes, while posting an explicit signal about the consequences of retaining these deficiencies in the rules.

− It could be fully consistent with the proposed policy purpose, both because it would afford access to lower cost abatement and sequestration opportunities – and would allow these to translate to lower costs for the whole economy – and because it could support a constructive role in international engagement.

… Demonstration of approaches to farm emissions in a framework that could be used in other nations not proposing cap and trade arrangements, could have high value for the global response.

• Stopping slightly short of this last possibility, would be commitment to a process that factors in high expectations of the rules being changed (in part because of Australia’s strategy), before 2020.

− It would set a target on compliant emissions based on 2020 rules, and run an adaptive policy process until then.

− Relative to the 2-part target approach, this could imply an elevated risk of failure to meet targets, or of needing to implement high cost measures late in the piece to avoid this.

• As an integral part of these evolving policy processes, undertake strategic investments in extracting maximum value from R&D processes and investing in strategic R&D to plug high cost gaps, where, in the options framework, it appears cost-effective to do so. That is shifting R&D...
emphasis from abatement or sequestration opportunities that are likely to be compliant with current rules to those that offer high abatement or sequestration opportunities but may not at present be compliant. A strategic shift in R&D may also be to widen the research to cover a wider number of abatement options rather than concentrate on a narrower number of highly prospective research areas.

- Again, as contributors to an overall policy approach, make strategic use of regulatory measures where these appear cost-effective.
- Serious consideration of a range of measures to deal with the export exposure of much of the agricultural sector and transition cost impacts;
  - Focusing, where possible, on measures to address equity effects without substantially distorting behaviour change incentives.

Tax instruments may have some role to play in limiting transaction costs. They may also function as an alternative to strategically targeted regulation that allows greater flexibility to ‘opt out’ where the costs of regulation are high. However, tax options still require substantial development and portfolio-level assessment of impacts, to ensure they deliver sensible incentives for behaviour change that extend beyond output level and mix. Taxes determined on the basis of output, applied downstream or on the basis of farm sales and linked to the marginal cost of abatement from the CPRS, would tend to mimic the weaknesses as well as the strengths of including agriculture in the CPRS via downstream accountability.
### Table 1: Summary of range of policy approaches

<table>
<thead>
<tr>
<th>Policy</th>
<th>Description</th>
<th>Examples in agriculture</th>
<th>Likely behavioural response</th>
<th>Transaction costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness, publicly funded R&amp;D</td>
<td>Awareness of options to reduce emissions and publicly funded or matched R&amp;D</td>
<td>Elements of Landcare, weed management, animal welfare</td>
<td>High with those sympathetic to the problem or able to change behaviour at low cost</td>
<td>Very low: R&amp;D program management, monitoring response</td>
</tr>
<tr>
<td>Facilitation of voluntary schemes</td>
<td>Assistance with development of voluntary abatement schemes</td>
<td>Drum muster, organic certification, Chicago Climate Exchange, NSW carbon market?</td>
<td>High for those in the scheme (legally obliged to conform to market specification). Low participation rates likely without other measures.</td>
<td>Very low for the Government. Often high for market participant but related to contract specification and likely market value of the abatement</td>
</tr>
<tr>
<td>Contributions tied to particular outcomes</td>
<td>Subsidise particular actions or inputs that will lead to certain outcomes, such as vaccines, feed additives, fertiliser coating, etc.</td>
<td>Elements of Landcare, fertiliser bounty, pest control, water use efficiency programs, some general R&amp;D programs</td>
<td>Moderate if well targeted. Likely to be dependent on rate of subsidy to total cost of use of input (highly dependent on elasticity of demand of input)</td>
<td>Low, depending on level of monitoring and evaluation required</td>
</tr>
<tr>
<td>Purchasing abatement services on a competitive basis</td>
<td>Purchasing particular services by tendering out a range of service requirements designed to achieve particular outcomes</td>
<td>Bush Tender</td>
<td>High with those that participate in the scheme</td>
<td>Moderate</td>
</tr>
<tr>
<td>Taxes (input or output), with and without appeals</td>
<td>Tax per unit of emission tied to either output (kg of meat, wool, tonne crop or litre of milk) Can also be tied to inputs such as fertiliser, fuel or per cow or ewe Possible (but more complex) to apply to outputs, adjusted for inputs according to an agreed formula or assessment</td>
<td>Land taxes used to fund elimination of invasive plants and animals</td>
<td>Taxing generally has low incentives for change. Can be made higher if appeal mechanism included, as incentive then created to demonstrate lower emissions and reduce tax burden</td>
<td>Low, but higher if appeals process included</td>
</tr>
<tr>
<td>Regulation and mandating, with and without appeals</td>
<td>Banning stubble burning; certain forms of nitrogen fertiliser use</td>
<td>Some animal husbandry practices, agvet chemicals</td>
<td>High behavioural changes but risks substitution with less efficient actions. Appeals mechanism increases incentives to change behaviour</td>
<td>Low but some policing needed</td>
</tr>
<tr>
<td>Cap and trade parallel to the CPRS</td>
<td>Separate trade system applied to Ag, but separate to the CPRS to avoid international compliance</td>
<td>Individual transferable quotas used and total allowable catches in some fisheries</td>
<td>High depending on mandated or voluntary compliance after phase in. Eventual merger with CPRS highly likely</td>
<td>High (additional costs include non compliance with international system)</td>
</tr>
<tr>
<td>Cap and trade within CPRS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point of obligation away from the farm gate</td>
<td>Point of obligation to engage in market at processor level (as considered in NZ)</td>
<td>Some elements of the water market</td>
<td>Low, unless processor can work with suppliers to deliver compliant emissions reductions</td>
<td>Low</td>
</tr>
<tr>
<td>Behind the farm gate</td>
<td>Full inclusion of majority of farm businesses</td>
<td>Some elements of the water market,</td>
<td>High if most enterprises are included</td>
<td>Very high if most enterprises are included</td>
</tr>
</tbody>
</table>

*Data source: ACIL Tasman*
Agriculture and GHG mitigation policy: options in addition to the CPRS

A possible staging of the application of the broad policy approaches identified in Table 6 is outlined in Chart 25. In this chart the evolution moves from light handed to more heavy handed approaches rising in sophistication but also incurring higher transaction costs. This transition relies on a number of factors particularly the development of emissions management R&D and monitoring and management technologies.

**Chart 2**  Possible pattern of staged policy evolution

Source: ACIL Tasman
Agriculture and GHG mitigation policy: options in addition to the CPRS

1 Study Purpose

ACIL Tasman has been appointed by the Victorian Department of Primary Industries and the NSW Department of Industry & Investment to advise on policy alternatives for addressing greenhouse gas emissions from agriculture – notably methane and nitrous oxide emissions that would not be picked up, at least until 2015, by the currently proposed ‘cap and trade’ pollution rights market that the Federal Government is seeking to implement – generally termed the Carbon Pollution Reduction Scheme (CPRS).

This is the report of that study. We explore the background leading up to its commissioning (and the reasons why there is caution about directly incorporating agriculture within the cap and trade arrangements in the short term); set out the policy purpose and assessment framework used, along with the rationale; and then report on its application in developing a short list of policy instruments and packages for further consideration.

The study is predicated on the assumption that CPRS arrangements, broadly in line with the White Paper and with the legislation that is now being considered in the Federal Parliament, will be introduced, though with some current uncertainty as to timing and fine detail. Policy options for agriculture have been assessed as additions to this policy base, and we have not considered any wider reassessment of the broad abatement policy approach of the Federal Government. This approach has been dictated by the study brief, which sought policies for agriculture that would complement the proposed Carbon Pollution Reduction Scheme (CPRS).

We have considered specific impediments within the detail of the proposed arrangements and the detail of the international rules for accounting for greenhouse emissions that might sensibly be modified in the future. Implications for the agricultural sector of pursuing these alternative possibilities are considered.
2 Policy purpose

In developing and comparing policy alternatives, it is important to have clear sense of the purpose of the policy. Without this, it is not meaningful to argue that one policy or set of policies should be preferred to another.

Australia’s overall climate change policy involves a mix of the CPRS and its exemptions, regulation and voluntary engagement measures, strategic investments in R&D and processes to draw value from the R&D, with a clear commitment to a flexible process that will adapt to emerging information. There is a strong emphasis on strategy design to support international engagement and influence; specific measures to adjust for transaction costs and competitiveness impacts in trade exposed sectors; and use of a portfolio of instruments with complementary strengths and weakness. This reasoning appears to translate well to the consideration of agricultural policy options.

We have been asked to develop policies that are consistent with the operation (and presumably purpose and future evolution) of the CPRS. We have assumed that what is being sought are policies that are consistent with, and broadly supportive of, the even wider climate change response strategy – including non-CPRS elements of abatement, climate change adaptation, international engagement to influence the positions taken by other countries, and R&D strategies to support future access to more attractive options.

We have worked on the basis that the primary purpose of greenhouse gas emissions policy for agriculture should be to make a cost-effective contribution to Australia’s overall climate change policy\(^1\). The objective should be to implement augmentations to the wider policy strategy that deliver the greatest net benefit to Australia – inclusive of the value of risk reduction; the value of any reduction in the national cost of greenhouse gas abatement; any transition and transaction costs; the net costs of compensating for any adverse equity impacts, in relation to sectors, regions, etc.; and the costs of uncompensated adverse equity impacts, where these cannot be compensated for cost-effectively\(^2\). This would also

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\(^1\) We note that the Federal Government Technical Options Development Group, recently established to advise on options for agriculture, has been given the overarching goal of assessing “the technical feasibility of policy options that provide the most direct incentives for reducing agricultural emissions at the lowest cost to industry participants and taxpayers.” We interpret ‘industry’ here as being Australian industry, not just agriculture – implying close alignment between our proposed policy purpose and the brief for this group. We have sought to be explicit about the range of factors relevant to assessing costs.

\(^2\) Clearly some of these elements are hard to measure and even hard to define in a non-controversial way. Climate change policy will necessarily have major subjective elements,
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factor in the benefits of any support for international influence in delivering better and more cost-effective, global abatement and sequestration – and therefore favour policy settings that support better international response.

Accepting this places strong emphasis on policy measures that will alter behaviour, rather than simply measures that share the costs of emissions. This approach ensures compatibility and complementarity with Federal Government processes, without building in the risks of focusing on the CPRS itself.

This approach does not imply that we have looked for policies that will be as beneficial as possible for agriculture (though, clearly, benefits to agriculture, in isolation, are highly valued by this approach). It does involve taking into account costs of inequity of treatment across sectors, but the study is driven not from the perspective of agriculture as a ‘client’ but from the perspective of agriculture as a sector, where there are special concerns with its effective and cost-effective inclusion within the CPRS.

We note that probably the best opportunity for limiting unnecessary damage to agriculture from climate change policy development lies in its capacity to contribute constructively to this wider policy. The policy purpose that we have worked with includes valuable safeguards for agriculture, while still subjecting the sector to strong signals to constrain greenhouse gas emissions.

More detailed discussion of policy purpose and process is provided at Appendix A.

and judgments will be made as to whether interventions are justified; in most cases these judgments will be political. This does not detract from the importance of clarity as to what is to be sought through the policy process.
3 Introductory comments

Agriculture is widely seen – across a range of countries looking at aggressive and internationally coordinated policies to address what is now seen as a major threat – as a particularly difficult aspect of such climate change policy planning. At the heart of these perceptions is a harsh reality and there is an associated trade-off. It is almost impossible to imagine policy settings that post reliable signals back to relevant decision makers on the true overall and marginal costs of the emissions they could influence, without requiring substantial transaction costs.

This trade-off flows from the complexity of farm production systems, with actual emissions being very sensitive to the complex interactions between land, variable climate conditions and farm production systems. Even if the science were perfect, there would be significant costs in developing a sound basis to underpin accurate attribution of emissions to those controlling the levers that could vary those emissions.

In reality, the science is far from perfect – making accurate attribution largely impossible in the short term. It is currently more feasible to estimate aggregate emissions from various forms of agriculture (though even these estimates are controversial), than it is to estimate the emissions from individual farms or to predict with accuracy how these would change with changes in farm systems.

Three additional layers of complexity that arise with agriculture stem from its very high export orientation and level of trade exposure; from the regional politics (and associated social values) of agriculture in Australia and, probably even more so, in major competitor countries; and from psychological responses to the fundamental values associated with food production in a world with growing demands for food.

The complexity has tended to favour either: omitting agriculture from playing a serious role in national abatement and sequestration strategy; or use of ‘rough justice’ policy responses (such as largely output-based downstream obligations or output taxes), that post poor incentives for efficient behavioural responses but that can be used to ensure that agriculture, as a whole and perhaps to a reasonable level of approximation across output sectors, pays for its ‘rights to emit’ – while recognising that some will be overcharged, and some undercharged.
It is easy to see why such responses have emerged for serious consideration. However, we have concluded that both the extremes flagged here have serious shortcomings in an Australian context.

- We believe the central proposition that should drive policy development is the strong prima facie evidence that behaviour response in agriculture (and wider land use) can be a major part of the ‘solution’ for Australia:
  - not as a result of what is paid for the rights to emit, but of the potentially large opportunities for more than competitive abatement and sequestration.
- Given this conclusion, any policy strategy that largely leaves agriculture out of the solution, or that focuses on rough justice recovery of the costs of its emissions, rather than on tapping into its potential for cost-effective abatement and sequestration, risks large and avoidable costs for Australia and probably less effective abatement and sequestration internationally.

An element of ‘rough justice’ will necessarily be a part of the short- to medium-term solution, and probably extend well into the longer term. However, in this study we have examined the implications of bringing to bear sound policy principles for working with, and even exploiting, the diversity and complexity of Australia’s agricultural system. If risk management and scope for international influence in attacking climate risks are placed centre stage, alongside demands to meet commitments for abatement and sequestration, what strategy lessons follow? What happens if mechanisms can be developed to favour imposing high transaction costs only where the potential benefits are also high? What can be done to exploit the upside potential (and associated value) of many farm level initiatives, even where there is a lot of uncertainty, to favour early behaviour change that is likely to prove beneficial?

Viewed through this prism, we have tended to favour approaches to policy that are less ‘rough’; while still necessarily ‘averaging’ imputed impacts across multiple farms. These approaches are likely to entail significant transaction costs, but with valuable checks on whether incremental benefits are enough to justify incremental transaction costs. We have also favoured, as a direct result of bringing these policy principles to bear on the above policy purpose, classes of approach that focus strongly on incentives for behavioural change, including changes in production systems that are more radical than simple shifts in output mix.

There is necessarily substantial uncertainty about what can be achieved cost-effectively and over what time period. This strongly favours adaptive policy and a focus on a policy process that is cost-effective in managing both costs and risks over time, in preference to an emphasis solely on cost-effective policy settings.

These elements constitute important threads through the following discussion.
4 Background

4.1 The CPRS

The Federal Government released its policy report: Carbon Pollution Reduction Scheme: Australia’s Low Pollution Future (the White Paper) in December 2008. The CPRS was presented as the ‘central plank’ of Australia’s domestic mitigation response, and described as being “aimed at delivering substantial reductions in emissions while sustaining strong economic growth and securing our future prosperity.” The core of the scheme was a cap and trade market arrangement, to allow targeting of specific and accountable levels of emissions over time – notably based around emission levels in 2020 and 2050. Legislation to implement the proposals has since been prepared, but has yet to be passed by Parliament.

Key elements of the proposals that are directly relevant to the present study include:

• The scheme is designed to cover all emissions classified as greenhouse gases under the Kyoto protocol:
  − Carbon dioxide (CO₂), methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons and perfluorocarbons
  − From an agricultural perspective, the key points of intended coverage are the first three.

• Implementation was planned from 1 July 2010 – a timeline that has since been one of the key sources of resistance; especially, but not solely, in view of severely depressed global financial circumstances. Subsequently, the state date was delayed until 1 July 2011 with a fixed $10/tonne CO₂e price until July 2012.

• Primary emphasis is in application of the obligation to acquire emission rights at the point (the ‘point of obligation’) where direct emission occurs, though with adjustments to make the arrangements more tractable:
  − The rationale for the stated emphasis is to create the clearest incentives for emission reduction.
  − The principle has been applied most cleanly in sectors that include electricity and mining – where most emissions occur at the point of production.
  − For liquid fuels and reticulated gas, the point of obligation in fact lies upstream of the primary emission activity (burning of hydrocarbons in vehicles, homes, etc.):
    … Generally markets where an upstream point of obligation is likely to translate fairly directly into downstream price increases, based on
reasonably predictable estimates of the relationship between upstream production and later downstream emissions.

- **A minimum size of emission load** was specified to define firms for whom participation would be compulsory. The level is proposed to be 25,000 tonnes of emissions of CO$_2$-e, which includes only around 1,200 non-agricultural firms in Australia:
  - The emissions from this small number of firms are dominated by large firms producing energy, minerals and processed mineral products, petrochemical products, other chemical products (including chemical fertiliser) and cement. These firms account for about 75 per cent of all emissions.
  - On the flipside, 1,200 firms would be about 0.01 per cent of all registered businesses in Australia – effectively excluding almost all firms from the direct regulatory demands of the CPRS arrangements.

- **Reforestation** is to be included on a voluntary basis, allowing creation of credits – though only while the trees are standing:
  - There would be little upside in compulsion for a sequestration activity – firms (including farms) can be expected to opt-in if the value of any credits exceeds the compliance costs for participation. Compulsion could discourage carbon sequestration that could be cost effective even without the rights to sell offsets.

- **Fugitive emissions from mines** are included, but not for open cut mines – implying a differential impact on competitiveness across mines, and notably coal mines, and between coal mining sectors in different states:
  - The rationale appears to involve a view that gases associated with near surface deposits of coal are likely to have already been substantially emitted, along with greater difficulty in measurement and attribution.

- **Agriculture is to be excluded from the cap and trade arrangements at least until 2015**, with a decision on its inclusion to be announced in 2013:
  - The reason stated in the White Paper was that its inclusion earlier was not considered ‘practical’; though the Government indicated a disposition towards eventual inclusion, in recognition of the ‘value of broad coverage’.

  … . Also, presumably, reflecting recognition that agriculture accounts for almost two-thirds of the emissions that will initially be excluded from the CPRS.

- **Particular difficulties** were recognised in the case of emissions-intensive trade-exposed (EITE) industries, where the firms are required to participate in the market:
  - This reflects, in part, recognition of the limited scope for passing on cost rises if competitor countries do not experience analogous cost pressures. This could potentially result in high costs to Australia with
little impact on global emissions, if production shifts to non-capped competitor countries.

- It also reflects the recognition that these industries are likely to be hardest hit. Some assistance could help smooth the transition of the economy and address legitimate equity concerns associated with the proposed restructuring process.

- The main mechanism for responding to these concerns is proposed to be *time limited allocation of permits* for a proportion of production needs, with this allocation being wound back over time.

- The provisions appear intended to apply to (and the main mechanism is directed at) firms formally within the CPRS – not to other firms affected indirectly by their inclusion:
  
  ... This would exclude agriculture, at least till 2015 (though it might include meat and dairy firms that operate in export markets).
  
  ... More generally, there is scope for downstream production to be included in the CPRS being EITE firms, while the producer of those inputs need not be within the definitions used.

- Included in a range of measures to lessen impacts for industries and to address welfare concerns, will be arrangements to completely offset the initial cost impact for diesel fuel.
  
  - This implies that every $10 of initial permit price will convert to a $0.027 reduction in fuel tax.
  
  - Petrol users will be more than fully offset at the start of the scheme.
  
  - To compensate for the current fuel tax exempt status of agriculture and fishing, users in these sectors will receive a credit of equivalent value based on fuel purchases.

  - There will be further adjustments to the tax cuts and credits over the following three years if permit prices trend upwards – but not beyond the three years:
  
    ... The arrangement would be subject to review, and possible abandonment; but a likely outcome might be for the excise reduction/rebate to be fixed at the level achieved after 3 years.

  - Because these price compensation measures will be tied specifically to fuel – and not tradeable or transferable to other activities as will be possible with permits – the effect will be to lock in the compensation to fuel users and to hold down the marginal price of fuel:

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3 This long-standing exemption stemmed from a perception that the fuel tax was serving a role as a *proxy for a tax on road usage* – to contribute to construction, upgrade and repair – and the consequential view that fuel use by vehicles away from roads (on farm and water) should therefore be exempt.
… This will limit incentives for behavioural change and associated emission reduction, through reduced fuel use. This point is significant in that it demonstrates a clear willingness in Government to address some concerns for equity and transition costs, through modifications that might be expected to dilute the efficiency of the behavioural incentives.

… The same is not true for the above EITE provisions. These will address equity concerns (about which there are mixed views in the community) but should have limited impact on behavioural incentives because the emission rights will be tradeable.

• There is allowance and hence encouragement for firms and individuals not required to participate in the market to create offsets, in the form of auditable reductions in emissions, that could be sold to market participants to offset their liabilities:
  − However, offsets in the form of the most promising reductions in emissions from agriculture appear to have been excluded from this process so far.
  − Logically, this need not be the case – if a package of measures were accredited with a level of emission reduction within the prevailing rules, agriculture could be granted rights to sell these offsets.

… As is discussed below, this mechanism appears to have significant prospects of being an element in possible future convergence between non-CPRS treatment of agriculture and the formal CPRS.

… While this would exclude soil carbon offsets until Australia signed Article 3.4, or its modified equivalent, other activities could immediately comply.

… Soil carbon and other currently excluded activities could still be traded in a voluntary market.

4.2 Key relevant features of agriculture

4.2.1 Sector structure

The structure of agriculture, in relation to its direct greenhouse gas emissions, is almost the precise opposite of the structure underpinning the CPRS as discussed in Section 4.1.

The CPRS is designed to exploit an industry structure with most of the production of emissions accounted for by a tiny proportion of firms – by imposing responsibilities on a few upstream suppliers of products with fairly scriptable patterns of conversion to greenhouse gases, along with a small number of large direct emitters.
The ‘upstream’ sector directly emitting methane and nitrous oxide is the farm sector. It is composed of many small firms, with high levels of heterogeneity among them – in product mix, in production system and in land characteristics. To account for a high proportion of the emissions, it would be necessary to include a lot of farms – many times more firms than are envisaged for the whole of the CPRS – or to move to a largely downstream point of obligation, but that brings particular issues because the emission patterns are not scriptable. The science underpinning reliable assessment of effective emissions is limited. It is substantially site-specific and would entail very significant transaction costs if reliable, site-specific impact assessments were needed. In agriculture, there are also complex interactions with other ‘externalities’, where poor incentive structures are in place – including aspects of water, forestry plantations, salinity, biodiversity and ecosystems.

4.2.2 Production & climate trends

Farm production, while once a major part of the Australian economy, has been trending downwards for many years and now accounts directly for about 3 per cent of GDP. However, including on-processing and distribution produces a substantially larger share, at around 7 per cent. Agriculture is a significant employer through activities past the farm gate, while it accounts for about 25 per cent of Australia’s merchandise exports. Agriculture, in this sense, remains a key part of the Australian economy.

Agriculture, especially in the southern parts of the country, also appears to face disproportionately high direct threats as a result of climate change. The main threats are: reduced, and more volatile, rainfall patterns; and rising temperatures with implications for production system suitability; pests and diseases; propensity for, and severity of, bush fires, etc.

These trends, suggested by modelling and arguably already apparent in climate trends in some areas, are also notable for being likely to be more severe in Australia. Here there will be a greater impact on established farming systems, than for many of Australia’s major competitors in agricultural markets, including North America and Europe. The market consequences of these may however be shaped significantly by climate change responses in those other countries:

• Possibly beneficial could be strong commitments by these and other agricultural producers to production and use of bio-fuels that may limit their capacity for competitive food production.

• However, on the other hand, these countries appear unlikely, in the short-to medium-term, to incorporate agriculture within their emissions trading regimes. This may well support greater competitiveness for their
agricultural sectors, even if at the expense of other sectors in their economies.

Viewed in this context, agriculture has a particularly strong and direct interest in climate change policy and its outcomes – global mitigation, local adaptation and the manner in which adaptation is achieved across sectors in other countries.

Other key features of agriculture that we return to below include:

- High diversity geographically, in farm systems and product mix, and in the size of enterprises.
- A vastly ‘flatter’ size structure relative to sectors that will dominate the initial emissions trading environment – gas, electricity, liquid fuels, chemicals, cement, etc.
- Much greater limitations on scientific understanding of greenhouse gas cycles, in relation to soil carbon and livestock. Possibly even more importantly, a much more limited scope for practical, cost-effective, and reliable measurement and attribution of emission impacts to individual enterprises.

### 4.3 Agricultural emissions and trends

The recently released Australian National Greenhouse Accounts for 2007 ((Department of Climate Change, 2009 a) and b), assessed agricultural emissions of methane and nitrous oxide as accounting for 16 per cent of national emissions of CO₂-e. Of these, 70 per cent, or about 11 per cent of the national emissions, were attributable to methane from livestock, mainly cattle but also sheep. With the farm sector accounting for about 3 per cent of GDP, this makes agriculture a particularly greenhouse gas-intensive sector – 3 per cent of value added in the economy is responsible for an estimated 16 per cent of greenhouse emissions. These figures do not include agriculture’s emissions of carbon dioxide via direct and indirect uses of energy, fuel and other input uses. These are accounted for in other sectors and are already in the CPRS. It does include the direct on-farm nitrous oxide emissions linked to fertiliser use.

Another way of looking at these figures is that agricultural emissions account for about two-thirds of all the emissions not yet included directly in the CPRS.

This intensity and the total contribution, strongly suggest that agriculture is unlikely to have the option of remaining outside mainstream abatement
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Strategy indefinitely\(^4\) – though this does not imply it will necessarily be included within the trading arrangements.

It is also notable that, in contrast to much of the economy, trends in emissions in agriculture have fallen dramatically since 1990 and have been flat since 2000. Chart 3 sets out the major trends, in which agriculture is included within a larger agriculture, fisheries and forestry group.

![Chart 3](source: (Department of Climate Change, 2009))

The major drop in the early 1990s is largely attributable to regulation-driven reductions in land clearing. The fact that agricultural emissions have not risen since 2000 might be seen as a strength of agriculture, though the implications for the sector will depend heavily on the detail of any arrangements – including any initial compensation measures. This pattern is likely to be highly relevant should consideration be given to planning around a separate ‘target’ for agriculture; however, we see serious problems with that policy approach.

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\(^4\) Logically, the fact of agriculture being a major emitter does not imply that it must reduce its emissions and in that sense be part of the abatement ‘solution’ – though it certainly suggests the likelihood that this will turn out to be the case. If agriculture were more competitive, in the sense of extracting more value out of each unit of emissions, than its competitors, and this were true of the most marginal value uses, then it might be efficient for agricultural emissions to remain at current levels or even to rise. The discussion below strongly suggests, however, that this theoretical possibility is extremely unlikely.
Irrespective of any consideration of fairness, the above pattern does not imply that agriculture has a less significant role to play as part of the total solution. The factors driving the above pattern had little to do with livestock and farm soil emissions of methane and nitrous oxide, the gases of most direct future relevance.

### 4.4 Implications for agriculture

The aggregate climate trends mentioned above, almost certainly imply the need for substantial adaptation to climate change by the Australian farm sector – for both technical and market-driven reasons. Australian agriculture has a strong incentive for seeing and supporting an aggressive international abatement response, as a way of limiting its exposure to these developments. This has additional strategic importance if the nature of Australia’s abatement response for agriculture shows the potential to influence responses in other countries.

As so often occurs in policy, Australian agriculture would stand to gain most if the abatement pain could be ‘worn’ by other sectors and other countries; while benefits, in the form of climate change mitigation, could flow through to agriculture. However, it appears that that is not going to happen.

Assuming the CPRS proceeds broadly in the proposed form, there will be direct implications for agriculture’s input costs and for post-farm transport and processing, even if agriculture remains out of the trading arrangements. Also, the impact of the abatement policy will be somewhat more severe for other sectors if agriculture is excluded. It will alter demand patterns across Australia, within overseas markets and amongst overseas competitors.

There is no ‘do nothing’ option on the table, if that is interpreted as preserving the status quo. Agriculture, along with the rest of the economy, is looking at major departure from the status quo in coming years – even if it remains outside the formal emissions market as such.

Exclusion of agriculture – at least in the absence of strong alternative policy measures with a broadly equivalent purpose – means that its direct emissions, of methane and nitrous oxide, will not require emission credits, at least at first. However, it is likely to also mean that agriculture will not be able to sell permits generated via sequestering of green house gases beyond reforestation or reduced methane and nitrous oxide production.

Even more importantly, the decision to delay inclusion of agriculture in the arrangements was based on considerations of practicality in moving early, not by any deeper acceptance that agriculture will be best left out indefinitely. The clear tone in the White Paper, and in most subsequent discussion of the issue,
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has shown a leaning, at the Federal Government level, towards eventual inclusion.

*With appropriate design*, and supported by good science and technical options, this may well prove to be in the best interests of Australia and, quite possibly, Australian agriculture. It is the *current and immediately prospective limitations on these conditions* that underpin the special concern for how best to deal with agriculture.

We have not approached this study as one based in the objective of keeping agriculture out, but rather of making sure that any decision on inclusion has taken into account the best possible information on alternatives – either interim or permanent – that could support a better, more cost–effective, overall greenhouse gas abatement strategy by Australia. These alternatives could include policy approaches that allow for the possibility of, and even facilitate, eventual and sensible inclusion in the market – while delaying formal inclusion until some of the concerns can be addressed.

Against this background, it is useful to ask what can be said about the likely implications of the CPRS, in which agriculture remains outside the trading, and what can be said about the consequences of its relatively early inclusion in the trading arrangements.

Substantial work on modelling likely implications has recently been undertaken, most notably by: ABARE (*Ford et al.* (2009), *Tulloh et al.* (2009)); by the Centre for International Economics (*Jiang et al.*, 2009); and by the Australian Farm Institute, in a series of studies. All use sophisticated modelling tools, in conjunction with a series of assumptions, to draw conclusions. All note serious limitations in the assumptions made – and it is clear that actual impacts are very sensitive to these assumptions. The reality is that confident and precise conclusions about how agriculture (and, indeed, the rest of the economy) will be affected by the CPRS cannot be made.

Arguably, most, if not all, of this modelling work has had a bias towards pessimism, because of the significant constraints allowed in the modelling to reflect scope for restructuring production processes, in response not just to immediate price pressures, but also to *expectations of future price trends*. The Computed General Equilibrium (CGE) models, and indeed any econometric models, relied upon for these studies, have largely been calibrated on the basis of historical data that emerged from price volatility more than the structural shifts in prices envisaged under the CPRS.

Rational response to price volatility can differ from, and be a lot more conservative than, strategic responses to highly credible forward trends in input and output prices and price relativities – especially if there is advance notice.
Capital can be slow to move when there are expectations of a reversal in price movements in the near term – of reversion to historical trends. Restructuring farm systems can entail significant up-front costs that will only be justified where there are strong expectations of persistence in the emerging trends. Such expectations about the introduction of carbon markets will be eminently reasonable. This both adds to the potential financial stress and allows for more radical responses, suited to greater damage reduction. Arguably, the modelling has been better at picking up the extra stress than it has been in taking into account the scope for more radical responses. Most of these studies recognise this – but the point can be lost when the point estimates of impacts on properties are extracted and reported.

The historical data that underpin the modelling effectively exclude application of any technologies, even if technically now available, that were not competitive in the absence of carbon pricing\(^5\). And, of course, the historical data preclude technologies that might now be developed because of expectations of a sustained shift in cost structures.

### 4.4.1 CPRS implications without agriculture’s direct participation

Most CO\(_2\) emissions from agriculture – as a result of its input demands for fuel, electricity, fertiliser, product processing and transport – will be picked up indirectly under the current proposals, that will impose the costs on the large upstream ‘manufacturers’ of these inputs.

Furthermore, major emitters amongst downstream processors – notably large dairy and meat processors – will (without significant changes to on-site practices) also be included within the coverage of the CPRS\(^6\). The resultant costs will be shared back up the value chain, including to their farm suppliers. This will arise as a result of attributed direct emissions – site-based methane emissions from livestock and wastewater treatment, burning of gas and any other non-fugitive gases’.

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\(^5\) Purely as an example, use of coated fertilisers as a device for lowering nitrous oxide emissions could not be expected to emerge from the modelling where such fertilisers do not, in any case, make commercial sense (for example, as a device to regulate timing of release of nutrients.

\(^6\) The extent of such inclusion in the CPRS is unclear. Tulloh *et al* (2009) state that: “…some estimates suggest that it may be only the largest five to 10 processors in each industry. Importantly, in most processing sectors, the largest processors are responsible for the majority of throughput.” The Australian Meat Industry Council has recently released estimates of annual cost implications of $45m for the beef industry and $18.5m for the sheep and lamb industry, based effectively on an assumption of full pass-back to producers.

\(^7\) The concentrated form of these emissions may make them more amenable to significant abatement via capture and conversion – for example, burning of methane vented from wastewater would dramatically lower the CO\(_2\)e emissions. In general, the technical options
Inclusion in the CPRS would not be triggered by high levels of electricity consumption, as those carbon emissions are accounted upstream – but of course all these electricity-linked carbon costs will be reflected in processor operating costs, irrespective of size, and shared back to farms.

It follows immediately from these direct carbon impacts, that agriculture can expect to face changes in key input and output prices, and differential changes across inputs and outputs, as these carbon costs are fed along the value chain. These will result in incentives for modifications to farm production patterns, including both input and output mixes.

There will, however, be some significant buffering, as a result of proposed phase-in and likely long-term arrangements for fuel (Section 4.1), with the benefits applying directly to both on-farm fuel use and the transport content of farm inputs and outputs. Should (as is likely) permit costs rise beyond the initial three years, any consequential increases will not be compensated.

Furthermore, some inputs (such as many fertilisers) are highly traded, with the local price being determined at close to import-parity levels. The scope for local manufacturers to pass through carbon costs is likely to be severely constrained, unless analogous costs arise amongst overseas suppliers. If this happens, and the international price of fertilisers rises, then this would have the effect of offering at least partial compensation for any loss of competitiveness relative to overseas farm sectors.

Nonetheless, while these factors will limit the impact on the farm sector, they will not eliminate it. The CPRS, even with agriculture formally excluded, will place cost pressures on agriculture and will encourage a change in output mix and, to an extent, in input mix. Sector structure strongly suggests much greater relative ‘damage’ to meat, wool and dairy production than to most cropping. This damage is likely to be partially offset by a switch in product mix towards the less severely hit sectors and through modifications in input mix to reflect different relative prices, as well as through reductions in production.

There are significant differences in the assumptions used in the various studies. However, they tend to paint a broadly analogous picture. The recent ABARE modelling has sought to adjust its earlier CGE modelling results for greater limitations on scope for rapid adjustments by the sector to limit damage. It provides an overview of the patterns suggested by this block of work. The results (based on a mid-range assumption that 60 per cent of cost impacts on processors are passed back to farms) can be summarised in terms of net for partial abatement may prove more available (at a price) than is generally the case on-farm.
impacts on the net value of production across different farm sectors, as set out in Table 2.

These figures are driven by higher prices and lower output prices, partially offset by reductions in input quantities. The big difference between 2011 and 2015 is presumably linked heavily to the carbon price being limited to $10/t CO₂e in 2011, in line with stated policy, but subsequently allowed to match market value. This is assumed to fit a line that rises at 4 per cent real from a base position of $20 (AUD2005) in 2010. This involves a carbon price that would spike sharply upwards in 2012, and would rise to $28 by 2015.

Table 2

<table>
<thead>
<tr>
<th>Industry</th>
<th>Recent average value</th>
<th>2011</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$million</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>All broadacre</td>
<td>61,600</td>
<td>-1.2</td>
<td>-8.3</td>
</tr>
<tr>
<td>Wheat &amp; other crops</td>
<td>116,000</td>
<td>-0.8</td>
<td>-6.9</td>
</tr>
<tr>
<td>Mixed livestock</td>
<td>62,300</td>
<td>-1.2</td>
<td>-8.7</td>
</tr>
<tr>
<td>Sheep</td>
<td>27,400</td>
<td>-1.9</td>
<td>-9.9</td>
</tr>
<tr>
<td>Beef</td>
<td>50,800</td>
<td>-1.6</td>
<td>-9.7</td>
</tr>
<tr>
<td>Sheep-beef</td>
<td>46,900</td>
<td>-1.6</td>
<td>-8.0</td>
</tr>
<tr>
<td>Dairy</td>
<td>97,100</td>
<td>-1.4</td>
<td>-6.9</td>
</tr>
</tbody>
</table>

Data source: Extracted from Table 10 of Tulloh et al (2009)

Tulloh et al (2009) note that these estimates do not fully take into account the even greater passing of costs up and down the value chain that full CGE modelling would seek to achieve. They point to evidence (in particular citing Jiang et al. (2009)) that the net impact of making these adjustments would be likely to reduce the severity of the impacts on farm cash incomes and the value of farm production, relative to the above picture. It is important to recognise that, in parallel with these pressures in Australia, there are likely to be analogous pressures in North America and Europe and even greater pressures in New Zealand, affording scope for some additional offsets. ABARE is extending its CGE model to allow it to be applied to these shorter-term impacts, where its current structure is limiting.

The Centre for International Economics has recently completed a study for the Rural Industries R&D Corporation (CIE, 2009) which provides another assessment of direct impacts of the CPRS. Tulloh et al (2009) discuss the comparison of methods and approach between this work and that of ABARE, while noting similar cost impacts but more favourable implications for farm receipts in the CIE work. They also note that in the CIE analysis “the estimated effects on the agriculture sector assume that farmers do not change their input or output mixes, or their farm management practices, in response to the price
Despite this likely upwards bias in the inferred level of ‘damage’ to agricultural industries, these numbers are reasonably modest in comparison to normal variation in the value of farm production as a result of volatility in climate (droughts, etc.), international commodity prices and input costs. Where a 10 per cent reduction in gross income can be devastating if fixed costs hold up – implying a much greater than 10 per reduction in net incomes – the figures above are essentially impacts on net incomes (inclusive of adjustments to trading stocks). The effects are far from trivial but, viewed in single year terms, are probably manageable.

What is different here is the likelihood that these pressures will be sustained. While background volatility has good years to balance against the bad years, that will not be true of these pressures. Unless restructuring of operations (on and/or off farm) can occur to reduce the damage – most obviously through a move to substantially restructure so as to avoid some of these flow through costs – then these reductions in value will persist and be reflected in asset values.

Note, however, that restructuring to ‘efficiently’ avoid these costs from the CPRS, is not the same as restructuring to efficiently reduce greenhouse gas emissions from the economy. While abatement might be possible at much lower cost by reducing methane emissions through changes in land or livestock management, these changes would not offset the loss of value as seen at the farm level. It is certainly possible that these arrangements will post incentives for abatement that favour relatively high-cost changes – and even possible that these could, on some farms, result in increased emissions of methane and/or nitrous oxides and a net increase in greenhouse gas emissions. The incentives are likely to be seriously distorted.

That said, there is likely to be scope for significant amelioration of impacts – by avoiding some of the carbon costs that are being passed through to farms. Earlier ABARE work (Ford et al., 2009) took a longer-term perspective and probed some of the longer-term possibilities alongside a partial assessment of short-term implications of the CPRS. In this latter assessment, the analysis may have been optimistic in not factoring-in the implications flowing from inclusion of some downstream meat and dairy processors. This earlier work

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9 The scope for adjustments to property values to provide a form of equilibrating function is important here – though it does not address the concerns of property owners who have invested on the basis of pre-CPRS conditions. Reductions in land value can allow lower net value of production to remain viable in the longer term – but someone still ends up with a capital write-down. There will, of course, be analogous revaluation consequences across the economy.
lacks some of the modifications (including treatment of downstream processing) introduced in Tulloch et al (2009); notably it fails to include the implications of the large dairy and meat processors being liable for the methane emissions. On the other hand, the earlier comments on likely upwards bias in these methodologies, and on the scope for processors to attack their emissions (at least by 2030), are applicable.

Nonetheless, set in this context, this modelling of the consequences if agriculture is only an indirect participant in the CPRS, should probably be seen as not so scary – though it is unlikely that agriculture would not incur some pain from the proposed arrangements, in aggregate, as well as in some subsectors. The reality is that most sectors of the Australian economy will experience some pain under the broad thrust of current policy. This pain might legitimately be viewed as an investment cost – an investment in risk mitigation – but there will be pain across the economy. The major concern may well lie mainly in the way that this approach would isolate agriculture from the proposed EITE compensation measures.

4.4.2 Effect of including agriculture in the CPRS

Much more worrying for agriculture are, and should be, the implications of modelling scenarios in which agriculture’s emissions of methane and nitrous oxide are included in the CPRS relatively early. The effects of this, based on the same pessimistic assumptions as above, are severe. Livestock production (sheep-meat, beef and wool) is particularly severely affected, because of the costs implied for current patterns of methane emissions from ruminants. However, most sectors are affected adversely.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Recent average value</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>All broadacre</td>
<td>61,600</td>
<td>-12.3</td>
</tr>
<tr>
<td>Wheat &amp; other crops</td>
<td>116,000</td>
<td>-7.7</td>
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</table>

Data source: Extracted from Table 10 of Tulloh et al (2009)
Agriculture and GHG mitigation policy: options in addition to the CPRS

We stress again that, for the reasons outlined above, these estimates are also likely to be pessimistic. They are not estimates of the implications for agriculture of the proposed CPRS. They are indicators of the industry consequences if neither agriculture, nor the rest of the economy, moves so as to take full advantage of opportunities to limit damage.

However, the implications of simply rolling agriculture’s direct emissions into the trading arrangements need to be taken very seriously.

4.4.3 Further comments on short- and long-run effects

The type of modelling that has been done to date is probably most relevant, given the character of its assumptions, to assessing very short-run impacts of the CPRS – with or without agriculture formally included. Even here we would expect that the assumptions are pessimistic, for reasons outlined above. There is some scope for early adaptation of farm systems. The basic shape of the CPRS, without agriculture included, is fairly well specified and there is some time within which planning and modification to this reality can be made. Not all the possible short-run changes require major up-front investment.

With agriculture outside the CPRS, the major implications are likely to be changes in input costs and output prices, with the likelihood of significant sharing of these impacts up and down the production chain – and possible isolation from EITE measures. Adaptation to these effects, if agriculture is not able to respond by trading actual emission changes, may well be largely in line with the production functions underpinning the modelling. The key difference, and potentially a source of significant bias, will be the fact that the price effects will be known with more lead time and will be known to be long-term shifts in relative costs – justifying and encouraging earlier, more decisive and, if necessary, less reversible adaptation than would have been the case with the historical record underpinning the modelling. These effects could be large and could support significant damage reduction.

Meat and dairy processors already face strong incentives to explore ways to manage their emissions to reduce damage – including strategies that may require up-front capital investment, because of the likelihood of facing a lengthy payback period. Many farms could be looking at relatively low cost ‘insurance’ in the certain knowledge that these trends are on the way – irrespective of the longer-term instruments to be used. However, uncertainty as to how agriculture will be handled, and if, when and in what form, against
what baseline, any abatement initiatives will be counted, must weaken these incentives where they would involve up-front commercial costs\(^\text{10}\).

However, Sections 7 and 8 certainly suggest a range of measures, either available or in reasonable prospect, that could allow for significant abatement or sequestration at modest (or even negative) cost – if the incentives are seen by farm-level decision makers. It is against this background that the modelling of the longer term implications of the CPRS by ABARE, the CIE and others, could prove particularly pessimistic – if the mechanisms can be developed to allow farm-level attribution of the benefits of activities that abate – or that are likely to contribute to aggregate abatement.

The modelling impacts are, naturally, heavily driven by the assumed or derived price of carbon – and this is perfectly sensible in modelling a system in which it is assumed there are no direct incentives to abate emissions on farms, other than through responses to cost and price pressures on inputs and outputs.

ABARE assumes a 4 per cent per annum real rise in credit prices – reflecting Treasury assumptions. CIE infers a price for emission credits from its modelling that is broadly comparable, if a bit higher than, this 4 per cent trend. Interestingly, the CIE figures are developed based on the assumption that the abatement and sequestration capacity of agriculture is not tapped, even in the long-run. For this reason alone, the conclusions could be quite pessimistic about the outcome of an evolving greenhouse gas policy that is already focused on how to tap agriculture’s potential. They also suggest that the assumed trend in the price of credits may prove pessimistic – any trapping of the abatement and sequestration capacity should translate to a lower price for emission rights.

However, the level of pessimism is likely to be much further exacerbated by the fact that the modelling has no regard for the likely range of agricultural response options, that could offer abatement and sequestration at very much less than the marginal cost yielded by the CPRS. To model agriculture on the assumption that its emission costs would equate to the marginal cost of abatement, certainly requires heavy discounting of the possibilities suggested in Section 7 and 8, and the indicative Australian marginal abatement curve suggested in Section 7.

For agriculture, the possibility that it could be a major player in addressing Australian net emissions, through its access to the land base, to alternative farming systems, and through contraction in production, is potentially an asset of significant value. With ABARE/Treasury and CIE estimates of the value of credits rising towards $100/t CO2e leading up to 2050, the likelihood of this

\(^{10}\) The possible extent of such discounting can be seen, in part, in the prices emerging from the Chicago Carbon Exchange, as discussed in Section 5.3.
yielding highly cost-effective abatement and sequestration opportunities for agriculture many years in advance of this, would appear extremely high. The questions are, will the right incentives be there for these opportunities to be tapped – and how will the benefits be shared?

Again, we do not want to play down the severity of the pressures that are looming. However, it is crucial to recognise that these adaptation possibilities mean there is likely to be a very big difference between financial pressure and financial damage. These adaptation possibilities seem, based on the discussion below, likely to span a range: from currently available and entailing little downside; through options that will emerge as more than competitive in the medium term if emission prices rise as these models suggest; out to serious possibilities that will require development of technologies and testing, but that could prove highly competitive at prices well short of those being forecast.

4.5 Greenhouse gas mitigation policy

It is crucial to recognise that the proposed greenhouse gas mitigation policy of the Federal Government runs much wider than the cap and trade market proposals – though clearly these form a central plank of the policy and, in some respects, offer a consolidation framework for bringing together different elements of policy.

Importantly, the proposed approach involves a ‘portfolio’ of policy measures. These measures will be adjusted over time. Strategic investments are being made and monitored where these might point to justification for further adaptation of policy settings over time, to tap into opportunities to meet policy objectives at lower cost and/or risk.

• While the cap and trade arrangements can be expected, as the posted carbon price rises, to alter the economics of demand management measures, there is also to be regulation to deliver and lock-in improved ‘energy efficiency’:
  − Examples include the Federal Government decision to phase-out traditional, low-efficiency incandescent light bulbs, and initiatives, that are increasingly being coordinated across states, to impose minimum energy efficiency requirements on new buildings and renovations and on some appliances.
  − Similarly, the Renewable Energy Target Scheme prescribes a minimum contribution to total electricity generation from renewable sources:
    ... The mechanism is a market in renewable energy certificates, with targets specified to almost quadruple renewable energy usage (to 45,000GWh) by 2020 and to hold at least this level beyond.
  − Community education, appliance labelling, etc., is also affecting voluntary energy demand patterns – though sometimes in ways that
imply high effective marginal costs of greenhouse gas abatement, probably well above the prices likely to emerge from the cap and trade market.

- Importantly, these measures will quite fundamentally alter the outcomes from the cap and trade scheme:
  … They will alter the available capital stock for energy generation, shift the economics of dispatch patterns, alter commercial incentives for relevant R&D – and influence the carbon price.

• The Federal Government has made major commitments to parallel investment in R&D that may, in time, deliver access to some less costly strategies to integrate into the response strategy:
  - A central plank of the strategy is the Clean Energy Initiative, with Flagship programs in carbon capture and storage (CCS) and solar energy, and a Renewables Australia initiative:
    … The $2.4b commitment to the CCS Flagship also directly addresses concerns for the future of the coal industry and for some regional economies.
  - The above demand management measures, and broader support for relevant R&D, can be expected to encourage greater investment in a range of other areas.
  - At least arguably, current strategy is already being influenced by the presence of these commitments to R&D:
    … If it is assumed that no new technologies will emerge, then a more sober approach to strategy for coal, coal-powered generation, etc., could well be justified.
    … A key element in our proposed framework below is the recognition that prospects for new technologies can, and should, legitimately shape current strategy.

• The Federal Government is also heavily committed to processes of international engagement, directed at increasing the commitment to abatement by other countries, sharing the costs of R&D to deliver more cost effective options, and influencing the institutional arrangements within which country efforts will be accounted.

• The Federal Government has created a framework to support both:
  - Voluntary participation in the CPRS, where credits/offsets can be recognised within the rules and traded with CPRS participants; and
  - Participation in voluntary emissions markets, where the credits/offsets are not currently recognised within the rules but where there are expectations that the activities will reduce emissions and where there may be commercial advantage or individual satisfaction in having these activities recognised:
Agriculture and GHG mitigation policy: options in addition to the CPRS

... We return later to policy options that could strengthen these incentives by recognising the possibility of later research and rule changes allowing past voluntary credit creation.

• The Federal Government has committed to a process to work out how best to accommodate agriculture within this abatement strategy:
  − This includes the commitment to defer any compulsory inclusion within the cap and trade arrangements until at least 2015, with a decision in 2013.
  − A Technical Options Development Group has just been formed to explore specific policy prospects. The Terms of Reference (Department of Climate Change, 2009) for this group parallel those of the present study, with objectives to:
    1. refine the overarching criteria of creating effective incentives at lowest cost, into a set of specific criteria for assessing policy options
    2. develop a diverse set of options for:
       a) including the agricultural sector in the CPRS, with complementary policy measures to facilitate this, and
       b) alternative policy measures for reducing agricultural emissions, and
    3. evaluating the policy options (2) against the criteria (1).

It is notable that these objectives include the possibility of agriculture being addressed other than through the CPRS.

Of course, the even broader climate change response strategy includes key elements of adaptation alongside mitigation – and almost certainly both will feature prominently and appropriately in future policy.

This recognition that Federal Government policy on climate change involves a portfolio of measures and processes for on-going adaptation is of central importance – as is the fact that current strategy has not been optimised on the assumption that currently available abatement options are the only ones that will be available in the future. The fact is that it is a process, not a static policy position, and it almost certainly needs to be such if it is to avoid large risks of imposing unnecessary costs.

4.6 Scope of policy alternatives

The brief for this study asks that we address policy alternatives to the CPRS for Australian agriculture, with a requirement that alternatives be consistent with the CPRS. It would seem both limiting and dangerous to view the CPRS purely as a stand-alone measure, when the way that it interacts across the portfolio of abatement and even adaptation measures is what will shape the final outcomes.
Agriculture and GHG mitigation policy: options in addition to the CPRS

Background

Agriculture could be included in the narrowly defined CPRS tomorrow – very easily. This could be done by simply noting that virtually all farms have individual farm emissions that fall well below the proposed 25,000 tonne ceiling and that, like other smaller emitting firms in other sectors, there is no formal requirement for participation in the CPRS. This seems totally consistent with the proposed CPRS, but seems also to miss two key points:

• Setting a threshold is about striking a balance between transaction costs and impact:
  - In a highly concentrated sector, in which most production is by a few large firms, high abatement impact may be possible with a moderately high threshold and relatively few firms above the threshold.
  - In a much less concentrated sector, such as agriculture, the same logic will almost certainly not apply.
  - If it is cost justifiable to implement a threshold, the level of the threshold will almost certainly need to vary across sectors as different as agriculture and electricity production, based on sector structure and the scope for effective and competitive abatement.

… This conclusion flows from mainstream, and largely commonsense and non-controversial, economic principles.

- The fact that the Federal Government has implemented a threshold for the sectors it is covering does entail recognition of the need to balance transaction costs against theoretical perfection. However, it does not afford a sound basis for arguing that the same threshold would logically apply to agriculture.

• Agriculture, in accounting for about 16 per cent of measured total Australian emissions (over and above its use of carbon-intensive inputs), and with real opportunities for behavioural change to alter these emissions as discussed below, is most unlikely to be left out of mainstream emissions abatement strategy indefinitely:
  - As was noted earlier, its carbon emissions will already be included.
  - Its methane and nitrous oxide emissions may offer Australia a significant opportunity to lower the aggregate costs of achieving any given abatement target. Can Australia afford not to test this proposition?

This is not a statement about imposing costs on agriculture, but rather a statement about the potential to lower the cost for all of Australia in responding to the greenhouse challenge – and the potential opportunity cost for Australia from not addressing the methane and nitrous oxide emissions. If there is real potential to lower aggregate abatement costs for Australia, then it would seem unwise to walk away from a process designed to encourage this potential to be tested and, if appropriate, tapped – especially in view of the significance of these emissions to the total.
This could be true even if there were an accompanying decision to compensate the sector for any associated cost imposts. This principle is well accepted in other sectors operating under the CPRS, where the assignment of emission rights is being used to deliver compensation for adverse equity consequences, while still providing strong incentives to ensure that emission rights fall to emitting activities where they have the greatest value.

The scope of this study therefore extends to options for incorporation of agriculture within the broad portfolio of greenhouse gas abatement policies and policy processes being developed by governments in Australia, but outside of the formal CPRS. It specifically includes mechanisms for linking the CPRS, and any arrangements outside of the CPRS, to improve the overall efficiency of the abatement strategy. This might, for example, involve feeding the marginal cost of greenhouse gas abatement from the CPRS into the other arrangements in a manner that posts better incentives for cost effective response. If the CPRS does not ‘talk’ to the other measures, to check whether marginal costs of abatement are getting badly out of line, would be a recipe for locking in long-term excessive costs.

The overwhelming majority of firms and households in Australia will not be forced to participate directly in the cap and trade market mechanisms – but will not be immune from the consequences. Almost all will be directly affected by other elements in the overall abatement portfolio. The clear emphasis in this present study has been on methane and nitrous oxide and on the potential for soil as a sink for, as well as a source of, greenhouse gases. Consideration is to be given to policies, groups of policies, and policy processes that could evolve over time as new information emerges.
5 Overview of agriculture

Importantly, NZ is the only country planning to implement a cap and trade emissions regime that includes firm proposals for handling methane and nitrous oxide emissions from agriculture.

It is important to note that agricultural emissions account for over 48 per cent of New Zealand’s gross emissions (probably the highest of all developed countries) – a creation of both the significance of agriculture in the economy and the high proportion of electricity generated from hydro. Furthermore, agriculture accounts directly for 4.6 per cent of NZ GDP. While some commentators have seen such figures (plus the fact that agriculture accounts for over 60 per cent of exports) as reasons to shelter NZ agriculture from emissions trading, the fact is that these figures also point to much higher consequences for costs in the rest of the NZ economy if agriculture is excluded.

The great significance of agriculture in the NZ economy, and the significance of these emissions to its total emissions, has probably made it particularly hard for NZ to contemplate significant emission reduction without bringing agriculture into the process.

Other countries and blocs generally have substantially lower reliance on agriculture, and it tends to be a smaller contributor to total emissions:

- Agriculture accounts for about 10 per cent of European emissions (European Union, 2006):
  - In 2005 it accounted for 1.3 per cent of the GDP of the 25 member states (European Commission, 2007).
- Comparable figures for the US are 6 per cent of emissions (Congressional Research Service, 2007) and less than 1 per cent of GDP (US State department, 2008).
- Comparable figures for Canada are 9.5 per cent of emissions (Canadian Agriculture, 2000) and 2 per cent of GDP.
The fact is that Australia falls between these extremes. Agriculture’s share of emissions in Australia is about a third that of New Zealand’s, but is still substantially higher than Europe, the US or Canada.

With the exception of New Zealand, there is a roughly comparable relationship between share of emissions and share of GDP, with the former being about 5 times the latter. In this sense, agriculture can be seen as emissions intensive across all these sectors. The ratio is much higher again in New Zealand (at about 10).

Based on public indications to date, it seems probable that, for the foreseeable future, major competitors for Australia into export agricultural markets, including the US, Europe and probably Canada, will have excluded agriculture from their cap and trade arrangements – with the sole exception of New Zealand.

An effect for these countries and blocs of not explicitly including agriculture in their cap and trade arrangements – depending on the use and intensity of complementary measures to reduce agricultural emissions – is likely to be higher costs, and a loss of competitiveness, for these countries in other sectors (such as mining and manufacturing), in return for greater competitiveness in agriculture\(^{11}\). This of course offers little joy to Australian agriculture – unless

\(^{11}\) This tendency for strong support to one sector acting as a ‘tax’ on other sectors is well established. It is sometimes referred to, especially in Australia, as the ‘Gregory effect’ and
strong non-trading devices are developed in these countries to reduce their emissions from agriculture. However, it does open questions of possible greater harmonisation of policy responses for agriculture. It may be suggestive of scope for Australia to exert greater global influence if it is able to find a practical and effective approach to dealing with agriculture – in a form that might be adopted by other countries.

We provide here an overview of the approaches of major Annex A countries and blocs, with an emphasis on policy insights. Developments in the US, both in relation to the currently proposed legislation and via the established voluntary market in which farms can trade emissions, are of interest and both are considered here.

5.1 Overview of proposed NZ arrangements

The New Zealand Climate Change Response (Emissions Trading) Amendment Act 2008 came into force on 26 September 2008. It is a price-based trading scheme for greenhouse gases. Forestry has been included since January 2008 and agriculture will be covered by the scheme in January 2013. As has been stated before in this paper, NZ is the only country that has legislated to include agricultural in its cap and trade scheme at this stage. The scheme explicitly includes both nitrous oxide and methane emissions from agriculture.

New Zealand participants can ‘opt in’ their emissions from 2011 and are required to report their emissions by 2012. Payment for emissions will not be required until 2013.

The Act specifies that the point of obligation for agriculture (the point from which the emissions payments will be collected) is downstream at the processor level. However, the legislation enables the point of obligation to be changed to the farm level at the discretion of the Minister, up until 30 June 2010. To assist in making this decision the Minister has established a technical advisory group, which was supposed to report to the Minister in November 2008.
The Technical Working Group’s report was released in February 2009 (Agriculture Technical Advisory Group, 2009). Its recommendations included:

- That the point of obligation be established at the farm level, as this is where the greatest incentives to reduce emissions can be posted.
- The point of obligation for nitrogenous fertiliser should be at the manufacturer (upstream of the farmer), principally to capture horticulture at a very low cost and because it doesn’t compromise the price signal to farmers.

The method of allocation of emissions permits, called New Zealand Units (NZUs), has not been established at this stage. It will depend on the point of obligation chosen.

The Group has suggested consideration of a two-tiered method for farmers to calculate emissions:

- Farmers who opted to be in tier one would determine their emissions using an emissions factor, or factors, applied to simple farm data, such as output and/or animal numbers.
- Farmers who opted to be in tier two would use approved software that uses farm-specific data to calculate emissions.

At this stage, the general assumption seems to be that the system will at least start with the downstream point of obligation – something we have concluded, in an Australian setting, involves substantial risks of intervention failure. Nonetheless, the policy process in train in NZ could still support a switch to a mainly farm level point of obligation – either from the start or as part of an early evolution of the NZ arrangements. It is worth considering the ideas being countenanced in this context.

The tables below are reproduced from the Technical Working Group paper and show the way each tier would calculate and report emissions. Tier one is based on output in much the same way that calculations would be made with the point of obligation at the processor level. This is unlikely to post strong incentives for a farmer to modify farm management practices, leaving only a

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12 Indeed, it might well make sense to allow farms opting for Tier One treatment to transfer accounting responsibilities through to their processors, as a way of further limiting transaction costs. As long as Tier One operates essentially with output quantities this should involve minimal implications for (already blunt) incentives, while offering useful cost savings. You could then think in terms of allowing farms to opt out of a downstream point of obligation, in favour of farm level Tier Two assessment and accountability. The Working Group considered some hybrid systems, but expressed concern that they could add to establishment costs. We question whether these extra costs would exceed the on-going costs of farm level accounting and compliance.
reduction in one or more classes of livestock, or a change in the mix, to effect changes in the emissions produced by the farm.

Table 4  Example of a Tier 1 emissions return for a sheep/beef/deer participant

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Emission factor (per head per month)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef cows</td>
<td>150*12 months</td>
<td>0.176</td>
<td>317</td>
</tr>
<tr>
<td>Rising 1 year old beef</td>
<td>150*12 months</td>
<td>0.091</td>
<td>164</td>
</tr>
<tr>
<td>Rising 2 year old beef</td>
<td>150*12 months</td>
<td>0.221</td>
<td>399</td>
</tr>
<tr>
<td>Ewes</td>
<td>1000*12 months</td>
<td>0.026</td>
<td>311</td>
</tr>
<tr>
<td>Lambs</td>
<td>1500*6 months</td>
<td>0.01</td>
<td>88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>1279</strong></td>
</tr>
</tbody>
</table>

Data source: (Agriculture Technical Advisory Group, 2009)

However, if (as seems likely) the opt in provisions favour farms that expect the more sophisticated analysis to reveal that their emissions are less than average (based on Tier One emission factors). The effect of allowing them to opt in will be to place growing pressure to raise the Tier One emission factors. In time this is likely to encourage more farmers to choose to opt in.

Table 5  Example of Overseer output for greenhouse gas emissions (based on farm emissions software)

<table>
<thead>
<tr>
<th>CO₂ equivalent (kg/ha)</th>
<th>Current</th>
<th>Reduced N fertiliser</th>
<th>Change sample practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane from animals</td>
<td>4473</td>
<td>4271</td>
<td>4473</td>
</tr>
<tr>
<td>N₂O emissions</td>
<td>2875</td>
<td>2117</td>
<td>2509</td>
</tr>
<tr>
<td>Excreta, effluent</td>
<td>1314</td>
<td>1218</td>
<td>1119</td>
</tr>
<tr>
<td>N fertiliser</td>
<td>1151</td>
<td>568</td>
<td>1151</td>
</tr>
<tr>
<td>Indirect</td>
<td>409</td>
<td>331</td>
<td>239</td>
</tr>
<tr>
<td>CO₂ emissions</td>
<td>881</td>
<td>604</td>
<td>881</td>
</tr>
<tr>
<td>Lime</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N fertiliser</td>
<td>528</td>
<td>264</td>
<td>528</td>
</tr>
<tr>
<td>Fuel and electricity use</td>
<td>272</td>
<td>258</td>
<td>272</td>
</tr>
<tr>
<td>Other</td>
<td>81</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>Capital</td>
<td>34</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Processing</td>
<td>1973</td>
<td>1875</td>
<td>1973</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10236</strong></td>
<td><strong>8901</strong></td>
<td><strong>9870</strong></td>
</tr>
</tbody>
</table>

Data source: (Agriculture Technical Advisory Group, 2009)

Tier two calculations appear to offer a much higher level of representation of the farm system, creating incentives for farmers to change practices in ways that deliver lower marginal abatement costs – or at least that are calculated to do so. In effect, opting into Tier Two provides a basis for bringing to account
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input structures to which the modelling tools attribute different levels of expected emissions. The approach is fundamentally statistical in nature – both Tier One and Tier Two will involve attribution based on point estimates, determined in the knowledge that they involve blending a range of possible outcomes. We return to important implications of such a statistical approach in Section 10.

It is likely that the intention of the two tier system is to reduce transaction costs and to allow the higher transaction costs to be incurred only where a judgment has been made that they will be cost justified. However, it also provides a transition from a low incentive system to a higher incentive system for farmers over time. It can be expected to post incentives for farm restructuring, in favour of greater emissions efficiency, ahead of the timing of opting in. This transition would occur when farmers feel that the benefits that could be delivered in more sophisticated abatement reductions exceed the transaction costs involved.

It is also likely that additional tiers of increasing complexity could be introduced and/or the modelling progressively made more comprehensive and discriminating, than the current Tier Two proposals. In effect, the structure offers a framework for absorbing improvements in knowledge into farm level incentives, while continuing to limit transaction costs to those farms where the transaction costs are justifiable – because of relatively low emissions intensity or because of access to practical options to move to relatively low emissions intensity.

The use of two tiers probably would create greater scope for gaming the arrangements, through movements of product and livestock between farms and/or through blending at the processor level – a point recognised by the Working Group. Checks on such behaviour benefitting through artificial changes in imputed emissions would need to be included in these systems.

Under the scheme, agriculture will not be required to pay the full cost of its emissions until 2030. The sector will be allocated a number of emissions units, with 90 per cent of emissions covered by the units between 2013 and 2018, then slowly reducing to zero by 2030. This could be seen as broadly reflecting CPRS EITE provisions in Australia, though with phasing over a very long time period.

The scheme will be reviewed every 5 years and will look at a number of factors, including New Zealand’s trade competitors’ policies and reductions, abatement technology advancements, and also presumably the cost of monitoring the scheme at the point of obligation chosen. Progressive adaptation is clearly envisaged.
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The advice to farmers prepared by the Ministry of Agriculture and Fisheries suggests that mitigation options include:

- Planting forestry on farms otherwise used for livestock production.
- Improving fertiliser use including the use of nitrification inhibitors.
- Reducing the carbon intensity of outputs by improving productivity.

The MAF is also undertaking considerable research and development into methane, nitrous oxide and carbon sequestration options for farmers. The research on methane management and livestock production appears comprehensive and likely to be of great value for Australian livestock producers under certain conditions.

However, it should also be pointed out that New Zealand agriculture includes a higher level of dairying as a proportion of total agricultural output, and sheep and beef production are typically more intensive, although there is considerable range land style animal production on the South Island. Despite these differences it is likely much of the NZ research, development and emissions policy approach would have some applicability in Australia.

Finally – and importantly for some of the options set out below, New Zealand has announced that its abatement targets are to be conditional on (amongst other things) changes being achieved in the rules as they apply to soil carbon. In particular, New Zealand (New Zealand Ministry for the Environment, 2009) has said it is prepared to take on a target for greenhouse gas emission reductions of between 10 per cent and 20 per cent below 1990 levels by 2020, if there is a comprehensive global agreement, and other New Zealand conditions are met. Those conditions include:

1. The global agreement sets the world on a pathway to limit temperature rise to not more than 2°C;
2. Developed countries make comparable efforts to those of New Zealand;
3. Advanced and major emitting developing countries take action fully commensurate with their respective capabilities;
4. There is an effective set of rules for land use, land-use change and forestry (LULUCF); and
5. There is full recourse to a broad and efficient international carbon market.

For reasons flagged earlier, New Zealand is under particularly intense pressures to tap the potential of agriculture.
5.2 Overview of proposed EU approach

5.2.1 EU climate carbon emission commitment

On top of the Kyoto protocol, the EU has adopted a policy to reduce emissions relative to 1990 levels by 20 per cent by 2020. If countries around the world can come to a similar commitment, the EU has stipulated that it will increase its reductions to 30 per cent below 1990 levels. To assist in achieving these targets, the EU has created a European Union emissions trading system (EU ETS). In the 20 per cent reduction model, reductions will be achieved by a 21 per cent reduction in emissions from sectors covered by the EU ETS, compared to 2005 levels, by 2020 and a 10 per cent reduction compared to 2005 levels for those sectors – including agriculture – not bound by the EU ETS.

There has been significant reduction in EU emissions from agriculture\(^{13}\) since 1990, largely as a result of reduction in the beef herd and improved nitrogen efficiency – analogous to the trend in Australian agriculture, but flowing from different factors.

The system is applied on a ‘risk sharing’ basis; this means that less developed countries within the EU, such as Bulgaria and Romania, will be able to increase emissions as part of an overall reduction target.

*The EU ETS*

The EU ETS is the largest multi-country, multi-sector greenhouse gas emissions trading scheme in the world. The EU ETS covers more than 10,000 installations in the energy and industrial sectors; sectors that contribute around 50 per cent of total EU greenhouse emissions. Currently the system covers heavy industry and power installations, meaning agriculture is not bound by the scheme and cannot sell credits into the scheme.

What makes the system unique is its preparedness to acknowledge credits from different countries. It allows companies to buy credits from the Kyoto Protocol’s project-based mechanisms to help them comply. This allows people

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\(^{13}\) The EC Directorate-General for Agriculture and Rural Development has asserted that: “Emissions from agriculture are projected to decrease further – by 23 per cent (EU-27) compared to 1990, and by 15 per cent in the EU-15. This expected trend is due to improvements in farming techniques, continued falls in livestock numbers, the ongoing effects of the 2003 Common Agricultural Policy (CAP) reform measures and environmental legislation. This compares well with other sectors (see figure 5). The EU is the only world region where agricultural emissions are expected to be reduced.” (European Commission Directorate-General for Agriculture & Rural Development, 2008)
from other countries to sell credits into the EU ETS, if their projects fulfil Kyoto requirements.

The scheme is focused on industries where emissions can be easily quantified with a high level of accuracy, and on large firms within those sectors. This desire for accuracy is replicated in the system’s views on offsetting programs, credits are not granted for land use, land-use change or forestry.

**Agriculture**

The EU aims to reduce agricultural emissions by 10 per cent; however, the industry is not included in the EU ETS. There is considerable commentary on reasons why agriculture should be included in phase III but the EU has not formally specified its position. Originally, agriculture was left out of the system for several reasons:

1. It is difficult to quantify emissions/reductions made by agricultural projects with any level of confidence.
2. The European agricultural sector is one of the most protected in the world and the added cost of compliance would further destabilise the industry.

Critics claim that there is now more research, and consequently greater knowledge, on quantifying emissions, than there was when the system began operation. However, this unpreparedness has meant that countries have to look at other methods to achieve emission reduction in agriculture. In Ireland a cow tax is proposed, charging farmers 13 Euros per cow per year, while Denmark is discussing a levy as high as 80 Euros per cow. Such taxes will allow the country to buy credits to negate the emissions or fund research into emission reduction technology.

Despite difficulties that countries face in handling this problem, there is no mention by the EU that agriculture will be included in Phase III, which starts in 2013. Furthermore, the European commission has stated that livestock taxes are not their preferred options. This will make it very difficult for countries to reduce their emissions by the amount required.

**Policy implications for Australia of the EU management of agriculture**

The exclusion of agriculture in the EU is based on arguments analogous to those raised in Australia: imprecision in measurement and high transaction costs. The linkage into the Common Agricultural Policy and a long-standing policy leaning towards protection of food security and rural economies, perhaps adds an additional layer.

However, the EU has proposed to introduce a separate target for emission reductions from agriculture and other sectors not covered by the cap and trade
arrangements, separate to the rest of economy. It appears to be open to suggestions from member countries as to how this could be achieved on a case by case basis. It is important not to conclude that the EU is proposing to let agriculture off the hook. If it achieves significant reduction in emissions using relatively blunt output levy instruments, as was flagged above, the consequences could well be to place unnecessarily high pressure on the EU to reduce production.

Of course, the commitment does not logically require that agricultural emissions be reduced. They account for about 20 per cent of the emissions not covered by the ETS, so it would be possible for agricultural emissions to fall by less than 10 per cent, and even to rise, while delivering an aggregate reduction of 10 per cent across these activities. However, it seems probable that there will be continuation of the underlying trend towards reduced agricultural emissions and this could be accelerated under plausible modifications to the CAP.

It is possible, and even likely, that the emission reductions achieved by agriculture under a parallel system will eventually receive some recognition in the economy wide system, either directly or through some type of ‘exchange rate’ or interchange with the ETS – all the more so if the US, as is discussed below in Section 0, moves down this certified offsets path.

5.3 The Chicago Carbon Exchange

5.3.1 Overview

The Chicago Carbon Exchange (CCX) is a voluntary carbon trading scheme, which commenced operation in 2003. A growing list of members is voluntarily signing up to a binding contractual agreement, which stipulates certain reduction targets. The CCX cap and trade system currently has more than 300 participants, ranging from electricity providers to county councils. Members are segregated into different classes depending on their reason for involvement.

Market participants who cause greenhouse emissions are given an emission allowance based on their baseline figures. The time at which a company becomes a member will affect their reduction obligations. Phase I runs between 2003 and 2010, members of this phase are to reduce their emissions

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14 The baseline figure is the average quantity of emissions made by the member during an evaluation period prior to becoming a member. For example, Phase I members were evaluated between 1998 and 2001.
by 1 per cent p.a. Phase II runs between 2007 and 2010, subsequent members and Phase I members, are to reduce their emissions by 6 per cent by 2010.

The market consists of numerous different parties who are involved for different reasons. Exchange participants are those who will buy credits and then retire them, either out of goodwill or to offset isolated events. Liquidity providers are professional traders who buy and sell credits to make a profit rather than to offset their carbon emissions.

Emitters who reduce emissions by more than is required are able to sell their surplus or accumulate it for the future. Conversely, if members emit more then allowed, they are required to buy credits from the open market to make up the short fall. They can buy these extra credits from companies that have reduced their emissions by more than required. Alternatively, they can buy them from offset providers. These participants are not necessarily required to reduce emissions but can be granted credits if they: reduce, sequester or destroy carbon dioxide or an equivalent. The prices paid on the market are dictated by supply and demand. A diagram of the system is seen below.
From the above, it can be seen that the system provides clear incentives to farmers to undertake projects to offset carbon emissions. Issues involved with such undertakings are outlined below.
The commodity traded and basis for CCX carbon credit entitlement

The commodities traded on the CCX are Carbon Financial Instrument (CFI) contracts. Each CFI contract represents an entitlement for that company to emit 100 metric tonnes of carbon dioxide equivalent.\(^{15}\) Currently, the government has no involvement with the system. Instead, the CCX grants CFI contracts to market participants in one of two ways:\(^{16}\)

a) Exchange allowances: These are granted by the CCX to emitters, based on their baseline figure of emissions. For example, if company ‘A’ emits 1000 metric tonnes of carbon dioxide equivalent on average during the years proceeding membership, it will be given ten CFI contracts.

b) Exchange offsets: These CFI contracts are granted to those who undertake a project to reduce, destroy or sequester carbon dioxide (or equivalent). Unless the owner of the offsetting project is a ‘significant’\(^{17}\) polluter, owners who are granted such CFI contracts are not required to commit to reducing their emissions as specified under the CCX reduction schedule. These CFI contracts are awarded on a retrospective basis; although the CCX began in 2003, it acknowledges offset projects completed on or after January 1 1999.

Ways in which farmers can become involved.

There are two ways in which farmers may be involved:

1. As emitters using baselines to determine whether they earn or need to purchase exchange allowances
2. As offset providers where they sequester or destroy carbon, eg through increasing soil carbon or methane capture.

The CCX provides incentives for farmers to become offset providers. Provided farmers are not ‘significant’ emitters, they can agree to do one of the following to be awarded CFI contracts, which can be traded on the open market:

a) Conservation tillage: This is a contractual agreement, which requires the farmer to use continuous no-till or strip-till farming practices across the enrolled acres for no less than five years. The offset quantities awarded are issued at standard rates, depending on the project and its location (offsets awarded range from 0.12 to 0.52 metric tonnes per acre per year).

\(^{15}\) Carbon dioxide is effectively the currency that the CCX uses to quantify different greenhouse gases. For example, one metric ton of methane is considered equivalent to twenty one metric tonnes of carbon dioxide.

\(^{16}\) The way in which these CFI contracts are granted does not affect the value of the contract.

\(^{17}\) No meaning of ‘significant’ is provided in the CCX rulebook. Most farmers do not meet the 10,000 metric tonne benchmark (outlined below). Thus, it could be assumed that most agricultural operations would not be classified as ‘significant’ polluters.
Although a standardised CFI is awarded per acre, these projects must be evaluated by a third-party, CCX approved, assessor.

b) *Grassland conservation project*: The CCX will grant CFI contracts to farmers who make a commitment to increase soil carbon stocks by increasing ground cover. Such cover must be planted on or after January 1 1999, on the condition that the grasses remain until 2010. Generally, the amount of carbon dioxide (or equivalent) saved is determined on a rigid basis, depending on the project and its location. However, if a project owner can present evidence contrary to the standardized figures, the CCX may increase the amount of CFI contracts granted to them. Farmers who undertake grassland conservation will be required to place 20% of awarded offsets earned into a CCX carbon reserve pool. This pool is to be used as insurance against natural disasters, such as fire or drought. In cases of extreme drought or fires, the amount of soil carbon lost will be deducted from the reserve pool. At the conclusion of the project, any CFI contracts remaining in the reserve pool will be eligible to be traded on the open market.

c) *Agricultural methane*: This method rewards farmers for the methane that they trap and diffuse, using methods limited to slurry storage, pit storage or anaerobic lagoons. The quantity of credits granted is taken as the lesser of the following:
   i  The theoretical amount that would have been emitted in the absence of the capture system; and
   ii  The amount of methane that is actually captured.

Such a method is most suited to intensive operations such as dairies and feedlots where methane can be captured more readily then on the open plains.

The above operational changes provide farmers with opportunities to increase the profitability of their business. However, for several reasons, farmers are yet to fully embrace the CCX system:

- The low CFI prices indicate that regulations imposed by the CCX are not stringent enough to exert real pressure on the consenting companies.
- Low prices also reduce the incentive for farmers to change their farming practices.
- The CCX advises that those projects that offset less than 10,000 tonnes of carbon dioxide equivalent should register using an aggregator:
  - The vast majority of farmers would not exceed this benchmark and so cannot freely trade on the open market.
  - For example, if one were to use conservation tillage it is estimated that 25,000 acres of cropland would be needed to reduce emissions by 10,000 tonnes. This can lead to one of two scenarios:
    a) Farmers may employ an aggregator who typically charges hefty commissions between 8 and 10%, effectively reducing the profits
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and incentives to farmers (and entailing transaction costs for the farmer); or

b) Farming bodies service their members by acting as an aggregator, such costs would be covered in the membership costs (e.g. Iowa Farming Bureau).

In raising these matters, we do not want to play down the potential value of an aggregation mechanism. Indeed, we argue in Sections 7 and 8 below, that a shift in emphasis onto aggregate abatement performance of a portfolio of measures spanning a range of properties may be essential to sound policy and risk management. There are, however, questions of whether the aggregation is sensibly done from the bottom up, as is the case here, or via commercial incentives at a more concentrated (upstream or downstream of the farms) point.

The process of verification, registration and Ultimately carbon crediting

The CCX provides quite a detailed outline of the process that is involved in crediting a certain offset project. In summary, this process operates as follows:

a) Submit proposal of the project to the CCX, which will review the project and may give preliminary approval, or refer the matter to a scientific technical advisory committee.

b) Obtain independent project verification: External accredited verifiers have to approve the project and determine the amount of carbon offset by it. This is achieved using industry figures, visits to the project and information that is provided by the developer.

c) Register as a CCX offset provider or aggregator: One can join the CCX as an individual or may use an aggregator. Although project owners may register an unlimited amount of projects, each distinct project must be enrolled separately unless they are enrolled by an aggregator.

d) Receive CFI: Upon approval the CCX issues the offset provider or aggregator with CFI contracts equal to the amount they are offsetting. The CFI is given a vintage year, which is the year in which the reduction was made.

The CCX futures market

The Chicago Carbon Futures Exchange (CCFE) is a wholly owned subsidiary of CCX. It is an exchange which offers standardized and cleared futures and options contracts on emission allowances and other environmental products. It appears that the CCX is predicting federal legislation will cover the area by 2012, and so they have developed the futures system based around the date of the futures contract expiration:

• Expiration before 2012:
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- Prices are listed at $0.25 increments, with 8 listed below the money price and 16 listed above the money price.
- Listings are based on a quarterly cycle.
- At expiration of the option, the deliverable commodity is a CFI contract of no less than 100 CFI contracts.

- Expiration after 2012:
  - If the Government has created legislation covering emissions, the deliverable instrument consists of allowances from the registry of the Government-appointed program administrator, equal to 1,000 metric tonnes of carbon dioxide. Initial listings will be January 2013, December 2013 and December 2014, with options listed in $1.00 increments – 8 listed below the strike price and 16 above the strike price.

The options that are in-the-money at the close on the last day of trading will be automatically exercised unless specific instructions have been given. In relation to agriculture, it does not appear that farmers will be granted options for increased, unexpected offsets, which may be realized in the future but not counted in the original quantification of reductions.

Benefits and burdens involved with participation

Benefits to emitters:
- Many companies see the government enforcing emissions regulations in the near future and want to start complying before such legislation is introduced.
- Some companies are required to comply with the Kyoto protocol to trade with other countries. Being involved with the CCX fulfils such a requirement.
- Those companies that can easily reduce their emissions are of the opinion that selling excess credits is a good way of making money.
- Reducing emissions is good for public relations.

Benefits to offset providers:
- The carbon price produced by the CCX is intended to reward innovation and efficiency.
- Encourages investment and risk taking that stimulates development of better environmental technologies.
- Greater marketing options.18

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18 Although there appears to be no specific market for produce that complies with the CCX requirements, an analogy could be drawn with products sold with other forms of accredited
Agriculture and GHG mitigation policy: options in addition to the CPRS

• Allows provider to embrace better yields involved with the conservation system, while benefiting from being able to sell CFI contracts.

Observations relevant to policy formulation

The CCX could be viewed as creating value for holders of certificates now, its main rationale lies, almost certainly, in expectation of the US moving to a more aggressive emissions strategy, in which the capabilities being fostered by the CCX will have elevated value, and through eventual linkage to, and becoming tradable with, a wider cap and trade market. In this sense, the CCX initiative could be seen as securing insurance for agricultural interests – in the form of capability to generate documented credits or offsets, and through the scope for developing baselines for the development of future products. From the perspective of the Chicago Futures Exchange, it could also be seen as securing its options for playing a key role in a future cap and trade market.

The experience also sets out one model for the evolution of agriculture’s capability to contribute to a lower cost abatement capacity. It does not in any fundamental way grapple with the question of long-term ‘rights’ to emit from agriculture although creating a baseline for agriculture on a voluntary basis provides and initial starting point. The baseline could later be treated as equivalent to “free permits” or allowances under the CPRS. If agricultural producers don’t need their “baseline” or initial free allocation of permits due to efficiency gains and abatement activity then they can sell them. If they need more than the allocation they will need to purchase additional permits. The opt in character of the process, and the way it establishes variations in emissions, by-passes this issue, though probably not in a way that could be sustained indefinitely.

5.4 American Clean Energy and Security Bill

The American Clean Energy and Security Act 2009 (‘ACES’ or Waxman-Markey Bill) was passed by the lower house on 28 June 2009. The bill is the first piece of American legislation dealing with climate change; it passed on a tight margin of 219 ‘for’ to 212 ‘against’. Many believe the bill is a step in the right direction; it will give American law makers standing at carbon reduction negotiations. Conversely, conservationists believe it to be too weak, exemplified by a plethora of concessions granted immediately before the vote. Environmental labelling – such as ‘dolphin safe’ tuna, or products that state a proportion of revenues will be donated to an environmental organisation or research body. What is being offered is a product – such as a can of tuna – and a service that some consumers will value, via reduced environmental damage or active environmental good. The presumption is that this will offer commercial returns and/or that the producer will value the knowledge that the production process was better for the planet.
to ensure it passed. Agriculture is a major beneficiary of the bill, as farmers will not be directly regulated by the legislation but will be able to sell credits, as governed by the USDA.

5.4.1 Outline of the bill

The bill is touted to provide millions of jobs, increase national security and reduce carbon pollution. It contains the following cornerstone provisions:

• Reduction in total emissions of 17% by 2020 and over 80% by 2050 compared to 2005 levels.
• Electricity utilities are to ensure that 20% of their electricity demand is serviced by renewable energy sources by 2020.
• $190 billion invested in clean energy technologies and energy efficiencies.
• New energy-saving standards for buildings, appliances and industry.
• Protection of consumers from energy price increases, thus the predicted cost of 50 cents per household per day (by 2020) will be compensated by the state.

Each of the above provisions contains both incentives and disincentives for farmers, some of which are outlined below. However, first it is best to examine the structure of the system and the positives and negatives of the bill.

5.4.2 Structure of the system

Similarly to the CCX, the system will be based on a cap-and-trade structure; 85% of emission allowances will be handed out at the commencement of the scheme. Polluters who pollute more than their allowance will be forced to balance their emissions by purchasing credits from an open market. Offsets provided by agricultural businesses will be evaluated by a greenhouse gas (GHG) advisory committee, which will consist of nine members and be appointed by the secretary of agriculture. The offsets will be equivalent to allowances in the scheme. The way in which the scheme will reduce emissions is shown below.

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19 It is important to note that it does not appear at this stage that the bill will include voluntary markets. This, in turn, may jeopardise, or call for restructuring of, the CCX.
5.4.3 Reactions to the bill

Positives

Analysts have broadly viewed the bill as a positive start, providing good opportunities for improvement in the future. It also augers well for a comprehensive global conversation at the Copenhagen climate change summit later this year.

Negatives

Sceptics believe that the legislation is far too weak in its handling of major polluters, such as gas and coal companies. The bill at conception was strong, however, to ensure it was passed, its architects had to compromise with power brokers within the Parliament. Critics have become disgruntled by the architect’s attitude, which has been to grant concessions to ensure the bill passes parliament. Their primary example is that Barack Obama made an election promise that all allowances would be auctioned to emitters, proceeds being used to compensate American citizens for price increases. However, 85% of allowances are set to be given to relevant stakeholders free of charge.

This has led to many of the underlying goals of the legislation being overshadowed. An example of this is depicted by the outcome achieved by Bobby Rush, a democrat from Illinois. To entice him to vote for the bill, it was agreed to grant his electorate over $1 billion, to fund an inner city ‘green’ job program.

Although there is some clear resentment about the bill, ultimately it is a bill passed by the lower house and is a considerable step forward in reacting to climate change. Thus, it is important to examine how the bill affects agriculture.
5.4.4 The ACES and agriculture

The Agricultural lobby within the US holds a huge amount of power, thus this bill provides favourable outcomes to American agriculturalists.

The agricultural industry is not going to be directly regulated; instead there will be an opportunity to participate through incentives. These incentives will be provided to agriculturalists in the form of emission allowances for agricultural projects that sequester carbon, adapt to climate change or prevent conversion of land that would increase GHG emissions. Incentives will reward acceptable practices, including:

1. altered tillage practices;
2. winter cropping or continuous cropping;
3. reducing the use of nitrogen fertiliser and increasing the efficiency of its use;
4. reducing the duration of flooding of rice paddies;
5. reducing carbon emissions from organic soils;
6. reducing GHG emissions from manure and effluent;
7. cultivation of animal management practices that reduce emissions (e.g. diets);
8. waste aeration;
9. biogas capture and combustion; and
10. field application of manure rather than fertiliser.

This is obviously a very broad list of practices that agricultural operations can use to qualify for credits that can be sold on the open market.

Perhaps the greatest gain for agriculture is that the regulation of credits is left to the US Department of Agriculture. This gives the Secretary of Agriculture the authority to determine what an offset is and the standards and methodologies behind such an offsetting system. It is argued by many that this will create issues, because the Secretary’s allegiance will rest with farmers rather than the environment.

Farmers will be adversely affected, however, because the price of inputs will increase under the scheme. Nevertheless, a range of options are being engaged to minimise possible increases in the cost of resources, such as fertiliser and energy. Such options mean:

1. all electricity companies will be granted allowances, which are to be used to benefit ratepayers; and
2. energy-intensive and trade exposed industries in the US, including pesticides and fertiliser producers, will be granted emission allowances to fully offset cost increases.

The Environment Protection Agency (EPA) believes that the cost of diesel and other fuels will not be greatly affected by the bill.
In another display of the power of the US farm lobby, fossil fuels will be part of the cap-and-trade system, while renewable energies will not. This situation, coupled with a provision mandating the amount of ethanol to be produced annually, leads to a huge opportunity to grow the ethanol industry. This may greatly increase the price of feedstock to livestock producers within the US. It also has implications for US food production, with flow through to Australian agricultural trade.

5.4.5 Implications for Australian farmers

The bill provides clear incentives to the American farm sector. They will not be included centrally in the system and held accountable for their emissions but will be able to sell credits gained in it. In the first instance, this can be expected to have negative ramifications in Australia if agriculture is included in our own carbon reduction legislation, or more generally if Australian farms experience significant pressures without access to analogous facilities to limit damage. Costs of production will be increased in Australia whereas in the US, costs of production will generally remain unchanged. Furthermore, the sale of credits through the system will mean that US farmers will be able to sustain higher costs of production than Australian farmers.

However, further incentives for ethanol production will increase demand for grains and feedstocks with a likely commensurate increase in world prices for these commodities. This will adversely affect US livestock producers more than Australian producers given the greater reliance on extensive pasture based systems in Australia.
6 What is the nature of the problem?

Fundamentally, the problem being dealt with by the carbon abatement strategy, including its application to agriculture, has several elements:

- We now recognise unpriced spillovers, or externalities, associated with greenhouse gas emissions that have not, up till now, been treated as a consideration in investment and resource use decisions:
  - Substantial sunk investment has evolved because of the failure to attribute these spillover costs to those making decisions that affect emissions – these sunk costs almost certainly imply substantial transition costs associated with rapid adaptation:
    - … At the same time, there is a growing body of analysis supporting the view that the opportunity costs of not containing and reducing emissions substantially, and early, could be very high.
  - Incentives to explore alternatives with less damaging emission patterns have been distorted and muted.
  - As with other externalities, the effect can, and probably has been, to cause failures in markets, that are now leading to serious concerns about high resultant costs.

- Information on the marginal cost of additional emissions, or the marginal value of reduced emissions, is subject to very high levels of uncertainty and controversy:
  - Estimates range from close to zero up to very high costs.
  - In this setting, international and national policy development has been based less on posting an accurate price signal, than on negotiating agreement on potential ‘tipping points’ with atmospheric greenhouse gases, and then working back to agreed restraint measures directed at stopping short of such tipping points.

- In relation to agriculture, and wider land use, there is a range of other unpriced, or poorly priced, spillovers where there are distinct risks of unintended and damaging interactions if one set of externalities is addressed through a radical policy change with strong incentives to alter behaviour, without an eye to interactions with the others:
  - Across Australian land and water systems, natural resource management has proceeded with strong elements of trying to move to and maintain a tense balance between conflicting ‘whole of system’ interactions across these poorly priced spillovers. Policy has developed on an adaptive basis, predicated on using a mix of regulatory and market instruments, coupled with monitoring, research and a rolling review of policy settings.
- For example, regulation of water in Australia involves a complex set of measures, including the use of far-from-perfect water markets and active regulation of access, use and transfer of water rights:

  … These controls and incentives have been developed to help underscore informed investment in water using activities and to help limit damage to related systems – including lake, river and estuarine ecosystems, and to address interactions with salinity.

- Similar comments apply to the management of ecosystems and biodiversity. Most jurisdictions are at an early stage in the development of market-based instruments (with governments acting as market participants on behalf of the wider community), alongside a wide range of regulatory and voluntary participation instruments designed to help manage a balance across competing demands on the land and water systems.

  • In moving to redress the greenhouse gas market failures, there is the added complication that these externalities are not directly priced across all countries; in the case of agriculture there are no firm plans for direct pricing in any country other than New Zealand, as was discussed in Section 4.6 above:

    - These circumstances create risks, and even the likelihood, that aggressive action to contain Australian emissions from agriculture could be substantially offset by compensating responses in other countries, where farm production increases as a result of the reduced competitiveness of Australian firms.

    - This is a generic problem for firms with a strong export orientation or trade exposure and specific measures are being developed in response:

      … However, in the case of agriculture, there is a high likelihood that these offsets could come substantially from North America and Europe – traditionally major competitors for Australia – despite the fact that these countries are likely to implement cap and trade arrangements outside of agriculture. These countries will be extremely limited in their capacity to increase their aggregate emissions as a response, but the structure of their policies probably means that they will be able to improve their competitiveness in agriculture, at the expense of other sectors.

      … Where the expansion is in countries not covered by a cap on total emissions, the net impact could be to limit the net reduction in global emissions and, under some circumstances, possibly to increase emissions – if the substitution is into more greenhouse gas-intensive farming systems.

      … These effects can mean that the net impact on global emissions of a unit of abatement by Australia could vary substantially across sectors and across enterprises within sectors.
• In several important areas, there are also high levels of uncertainty that limit the scope for 'jumping' to a sound correction for these unpriced spillovers. These uncertainties appear particularly acute for agriculture relative to sectors such as electricity generation:\(^{20}\):
  - As was noted above, there is fundamental uncertainty regarding the marginal cost of greenhouse emissions – linked to inadequacies and controversy in climate models and poor ability to predict the scope for damage reduction through adaptation strategy.
  - Agricultural emissions of methane and nitrous oxide are highly dispersed; they vary greatly geographically, seasonally and across farm systems. Accurate monitoring at a fine level is difficult, costly and potentially subject to both challenge and gaming:
    … There is also significant uncertainty about potentially offsetting soil carbon effects in agricultural practices, including the role of livestock in sequestering carbon in soil.
• These uncertainties are further complicated by the fact that Government objectives in pursuing abatement targets have multiple facets:
  - Australia, as a small contributor to total (though with high per capita) emissions, can only go so far in lowering global emissions through its own reductions.
  - Perceptions by both Australians and by other countries, that Australia is 'pulling its weight' are important politically and may underpin greater influence in the international engagement processes. Here compliance with current standards for certification, etc. has been of great importance, and ‘leakage’ in the form of offsets from greater emissions overseas, has probably been less important.
• The structure of agriculture – relatively small, highly heterogeneous firms with very different levels of trade exposure, though with a high average proportion of production exported (or subject to import competition) – suggests high transaction costs and/or significant equity concerns, in implementing a system that accurately attributes costs – even if the science is available to do it:
  - Suggesting a particularly intense trade-off between precision of incentives for behavioural change and containment of transaction costs.
• All these considerations imply a complex problem that will probably need a complex solution if the potential offered by agriculture is to be realised:

\(^{20}\) At the same time, it is important to recognise that there are large externality problems other than greenhouse gas emissions. Parts of agriculture and other sectors have in recent years suffered severely from the consequences of major externalities in respect of water interceptions, contributions to dryland and downstream salinity etc. Massive effort has gone into the development of water markets, despite very substantial uncertainties, as a device to encourage scarce water to be moved into higher value uses.
− But in a context where a high premium is being attached to keeping arrangements simple and delivering predictability to support investment.
− It is, of course, logically possible that a solution complex enough to deliver good behavioural incentives may not be cost-effective.

6.1 Reasons for delay in acting on agriculture

The above background outlines major factors that have impeded inclusion of agriculture in the CPRS from the start – and highlights that, initially at least (as indicated in the White Paper), the Federal Government was leaning towards its inclusion, possibly as early as 2015. The terms of reference for the Technical Options Development Group, set out in Section 4.5, certainly suggest there is now clear willingness to consider alternatives in the lead-up to the 2013 announcement.

We are unaware of any suggestions of a shift at the Federal level in the preferred policy approach if it can be made practical and the key concerns can be addressed. We have no fundamental problem with this position.

Whether a cap and trade system was the best general approach has long been controversial, but this decision did emerge out of substantial probing of alternatives and has achieved broad, if not universal support. Appendix B sets out some of the issues in this choice, but probably the most compelling are:
• the capacity of a cap and trade arrangement to ‘guarantee’ an associated level of abatement;
• the consistency of cap and trade arrangements with the approach being adopted by other major developed economies, with implications for both:
  − underpinning international trade on emissions, to encourage discovery of lower-cost ways of delivering a level of abatement across all such countries; and
  − support afforded to Australia’s policy of international engagement and influence.

If the CPRS is to proceed across much of the economy, and if agriculture is to be confronted with at least analogous and linked abatement incentives, then in principle we would agree that it makes sense to look at fitting agriculture into the cap and trade arrangements. It may possibly need other measures to address key concerns, in the longer-term if not earlier. This may well be where the treatment of agriculture will ultimately, and sensibly, end.

However, the requirements for practicality and for addressing key concerns stand as clear impediments to early movement. This has been recognised in the White Paper and in subsequent Federal Government processes.
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In summary, key reasons for delay in inclusion – with the possibility even of long-term exclusion with reliance on alternative mechanisms – include:

- **Severe limitations in available science, on key aspects of how agriculture interacts with global greenhouse gas cycles:**
  - this includes limited understanding of soil carbon interactions with farm systems and implications for net emissions and for options to alternate emissions.

- **Industry structure, including size structure, product mix, production systems, soil and water characteristics that mean, even with perfect science, there would almost certainly be high costs in direct and accurate attribution of emissions to farmers.** This especially constrains the ability to deliver accurate incentives based on output mix. These problems are compounded by the scope for posting incentives to ‘game’ (unintentionally or intentionally) poorly targeted attribution rules, in ways that could be counterproductive:
  - Accepting the principle that the policy purpose is primarily about achieving abatement by Australia at least-cost to the economy, means that these implied transaction costs and the costs of intervention failure linked to poor incentives, are highly relevant.
  - There is also a risk that forcing agriculture into the CPRS could actually impede the efficient use of a range of other measures that might prove more effective in altering behaviour in smarter ways than shrinking production. This could help the whole of the economy to tap the potential of agriculture as a carbon sink and as a major emitter, with substantial potential for medium to longer-term abatement.

- **Addressing greenhouse gas externalities in agriculture with a ‘one size fits all’ cap and trade policy, could exacerbate problems in relation to other externalities that are less than perfectly handled now – including water, biodiversity and ecosystem values.**

- **Partly as a consequence of limitations in the science, the character of the international rules, and Australia’s position in respect of the rules, agriculture risks being confronted with most of the costs of its gross emissions. It also faces being largely isolated from most of the potential capacity for receiving credit for offsets, other than through curtailing production:**
  - This could post incentives for rapid and destructive responses within agriculture that will prove, as the science improves, to have been highly regrettable.

- **The nature of abatement strategy by other countries, including the US, Canada and Europe, suggests potential for significant leakage of the benefits of Australian agricultural abatement to the agricultural sectors and agricultural emissions of these countries:**
While overall emissions by these countries would still be capped, this raises both risks that Australian agriculture could land a disproportionate share of the costs of effective abatement, and that opportunities to harmonise treatment of agriculture across these countries could be lost by pre-emptive Australian introduction of agriculture to the CPRS.

More generally, we argue below that there are serious limitations in the way the international and Australian responses to the climate change threat are managing currently unavoidable uncertainty and transaction costs. They are not exploiting best practice principles for risk management and for establishing a least-cost trajectory, given the uncertainties. This has several consequences:

- It almost certainly implies an excessively costly response strategy. This would effectively cut Australia, and the globe, off from being able to exploit the most cost effective ways of limiting greenhouse gases in the atmosphere over time.
- The spread of pain across countries is highly variable, dependent on industry structure but not in ways that are necessarily linked to emissions efficiency:
  - Countries like Australia, where agriculture is relatively more important, are vulnerable to the bias against sound agricultural abatement strategy.
  - Within Australia, the agricultural sector is exposed to a bias against what appear to be several of its strengths in supporting sound aggregate abatement. Under the CPRS it would be exposed to the downside of its abatement:
    ... This could be viewed as an equity concern, but it is probably even more fundamentally an efficiency problem for the whole of Australia.
- Short-sighted compliance with current rules, and processes for setting targets independent of those rules, risks seriously excessive costs. That could greatly weaken the scope for Australia influencing a change in the rules to deliver sounder incentives globally and allow the Australian economy to better tap the potential of agriculture.

As was stated earlier, we have not sought in this study to defend agriculture, but rather to ensure balanced consideration of where agriculture might best fit into Australia’s abatement response. All of the above points seem relevant to such consideration.

Understanding the limitations of the CPRS, as currently proposed, is also of value in looking to alternatives to deal with the concerns.
6.2 Potential upside from decisive policy

While the points above urge caution in forcing agriculture into the CPRS too early, they also map out a strong case for Australia looking to exploit the opportunities offered by agriculture. It would almost certainly be costly to delay an aggressive policy on agriculture’s current levels of emissions and potential offerings from sequestration. More detailed consideration of specific abatement and sequestration possibilities is provided below. However, the relevant high level picture that emerges includes the following features:

- There is a range of opportunities currently available for reducing emissions from agriculture, ranging from minor modification of farming systems and drought management through to modifications of inputs, such as coating of fertilisers:
  - It is highly desirable that the competitiveness of these measures be assessed against the marginal costs of abatement from elsewhere in the economy.
- There are broadly-based expectations that carbon sequestration in soil, including through possible extensive use of biochar on some cultivated Australian soil, could be significant in lowering Australia’s contribution to global greenhouse gases over time:
  - While the technologies may prove readily transferable to many other countries, including many not proposing to use cap and trade mechanisms.
- There is good evidence of favourable productivity linkages that might be exploited:
  - Reduction in livestock methane emissions might be achieved through more efficient conversion of pasture to meat and wool – as a general proposition methane levels are a pointer to inefficiency in feed conversion.
  - Biochar looks likely to offer joint benefits in carbon sequestration, nitrous oxide inhibition, and crop and pasture productivity improvement.
- Decisive action by Australia in accessing agricultural emission and sequestration opportunities, even if outside current Kyoto accounting, might be valuable in accelerating analogous moves in other countries – including countries that have not committed to cap and trade arrangements.

6.3 International opportunities and constraints

Following on from this last point, it is important to recognise the significance of agriculture, and more generally of land use patterns, internationally as contributors to global emissions. There is also the associated potential for
making a significant difference globally by demonstrating practical and effective ways to limit emissions, while meeting demands for food and fibre. There is a real question as to whether demonstration of sound policy development in Australia, accompanied by the fostering and tapping of improvements in science and technology, could ‘leverage’ some of the wider base of international agriculture and land use to deliver much greater global abatement.

Agriculture, internationally, accounts for about 14 per cent of global emissions (International Food Policy Research Institute (IFPRI), 2009) – broadly in line with the share in Australia, but totalling many times Australia’s aggregate emissions across all activities. Other land use patterns contribute about the same again (Scherr and Sthapit, 2009); at least some of these may also prove amenable to policy instruments suited to agriculture. Furthermore, this total land use sector may offer large opportunities for sequestration as well as abatement – and again policies suited to agriculture could have relevance in tapping any such potential.

IFPRI has recently called for agriculture to be on the agenda of the Copenhagen discussions in December. It has also stressed the need for action to assist poor farmers in adapting to climate change – noting that agriculture provides a living for more than half of the world’s poorest people. Certainly changes to farming systems that exploit potential synergies between emission reduction and productivity rise, could prove of real value. This suggests another possibly avenue of international influence for Australia’s climate change policy – with strong synergy between abatement and adaptation.

Among a range of recommendations, IFPRI suggested allowance of “innovative payment mechanisms and support for novel institutions for agricultural mitigation”, citing as possibilities:

- Land retirement contracts;
- One-time payments for physical infrastructure investments that have long-term mitigation effects; and
- Payments for institutional innovations that encourage mitigating behaviour in common property resources.

### 6.4 Can agricultural emissions rise ‘sensibly’?

It is not unambiguously clear that sound policy should reduce gross emissions from Australian agriculture. The same is logically true of other sectors. Rapidly growing sectors that can deliver high value per unit of emissions may well be able to compete in such a way that their aggregate emissions rise for good reason, even though they will face strengthened incentives to reduce emission levels per unit of production. The CPRS proposes reductions in total
emissions, not reductions in the emissions from every firm or sector. Indeed, it is the potential for the ‘trade’ part of the ‘cap and trade’ arrangements to restructure where the emissions occur – favouring high marginal value uses of the rights to emit and even providing a basis for funding capital investment needed to lower emissions in some firms and sectors – that is among its key attractions.

In the case of agriculture, there are likely to be increasing demands for global food production and for food exports from countries capable of delivering surpluses. These can be expected to arise from a combination of several factors:

- Growth in population numbers and in GDP (and wider measures of capacity to pay) per capita in many countries.
- Global diversion of land currently or recently in food production into biofuels.
- Alienation of some land from agricultural production as a result of climate change and other environmental stresses.
- Development of cost competitive and less emission-intensive forms of production, helping food and fibre compete for its share of consumption expenditure.
- Development of sequestration, CDM and other forms of offsets that may be cost effective relative to shrinking production levels.

It would seem unfortunate to develop a policy approach for agriculture predicated on the need for emission reduction, rather than competitive levels of emissions efficiency. Particularly dangerous would be an alternative arrangement that committed to an aggressive target for reduction in aggregate emissions from agriculture, without the linkages and scope for adaptation to allow a sensible response should some of the above developments emerge as significant.

This reasoning lies in the basic design of the CPRS – there is nothing in the proposed CPRS rules that prevents firms or sectors from growing their emissions, if they can competitively justify the costs. In reality, as targets become more ambitious, such trends become less likely, but not impossible in the context of possibly competitive sequestration – and certainly the levels of reduction by sector are likely, and efficiently, to be highly variable.

6.5 Benefit ‘leakage’ issues

The national abatement strategy, where abatement is viewed primarily as a direct device to lower global greenhouse gas emissions, suffers from risks of ‘leakage’ – of Australian abatement being partially, fully, or even more than fully, offset by market responses to the Australian abatement strategy. These
risks stem from lack of uniformity in approach globally. Policy settings that encourage some industrial activities to relocate to countries not constrained by the same abatement targets, may imply a lower net reduction than the measured gross reduction – and could theoretically, in some cases, deliver a net increase. This is recognised but needs to be interpreted within the international engagement elements of climate change policy.

This is a general problem and not a primary focus of the present study. In some cases, this outcome may well be tolerable as a result of the policy emphasis on international influence. Here, influence is likely to be based, to an extent, on measured levels and rates of abatement, and per capita footprints, with these calculations largely done on a gross basis within countries and blocs. This may well reflect a limitation in current rules and one where Australia would seek to have influence.

Beyond this, and reflecting earlier comments, we restrict ourselves to a few specific points about leakage risks:

- There will be no ‘leakage’ of emissions as a result of agricultural production moving to other countries with cap and trade arrangements – other than via the blunt instrument of their exclusion of agriculture possibly having been a constraint on the targets they have set for their schemes (higher marginal cost of abatement leading to a commitment to less abatement):
  - With agriculture within their cap and trade schemes, they may have faced a lower assessed marginal cost of raising their targets, as a result of a lower marginal cost of abatement, and this could have influenced targets already set and willingness to modify targets in the future.
  - Realistically, for countries and blocs where agriculture is a small part of the total economies, this effect would be small also.

- For these countries and blocs, and in the absence of strong alternative measures applied to their farm sectors, exclusion can be expected to deliver greater competitiveness in agriculture and less competitiveness in other sectors – and they will know this. The reasons were discussed in Section 4.6.

- Exactly the same arguments apply to those countries subsidising their farm sectors – helping these sectors at the expense of the rest of their economies:
  - This has long been recognised, and accepted by the EU and the US, amongst others, as a price they are willing to pay to address such concerns as regional damage, food security and agripolitics.
  - Justification has also sometimes been asserted to be based on keeping pressure on protectionist policies in other countries – a form of ‘international influence’ argument.
• As a general principle, the smaller agriculture is as a share of the total economy, the less costly will be agricultural support as an instrument for addressing these concerns:
  − In these terms, Australia is not competitive with the EC and the US and does not share the EC’s special pressures for food security and managing multi-country regional tensions.
  − Australia is less well placed to incur the cost of subsidies as a way of applying pressure to other countries than the larger, more industrialised economies.
• Australia has long since backed away from a general view that these practices justify complementary protection of Australian agriculture. Instead, Australia operates a 3-pronged approach of:
  − Maintaining pressure for trade liberalisation in international forums and negotiations
  − Recognising reality, and organising the Australia economy to compete, as effectively as possible, with this external reality – rather than incurring the costs of seeking to compensate; and
  − In very selective cases, where Australian response has good prospects for altering overseas policy or strategy, temporary protection measures (such as countervailing duties) may be used as an instrument to increase the strength of the international engagement process:

  ... Such an approach does not conflict with the last point; the scope for altering behaviour in other countries alters the reality and may, sometimes, justify a different short-term strategy because of that prospect.

This last point also has application to concerns for leakage to countries without cap and trade plans. The most effective way to bring them on board in agriculture may well be through demonstration of technologies and policy settings that work in tapping the potential of agriculture – and, in one sense, so much the better if these approaches do not require a cap and trade market.

As a general principle, leakage from the Australian process does not provide support for preventing domestic abatement at an industry or sector level, with two possible riders:
• Rapid early restructuring may not be justified where there are good prospects for early change in the other country (i.e., the leakage problem is likely to be short-lived); and/or
• Australia delaying might reasonably increase the prospects of it beneficially influencing behaviour in other countries.

Finally, it is appropriate to recognise that a decision by a country to exclude agriculture from its formal cap and trade arrangements does not necessarily mean it is to be excluded from strong incentives to lower emissions. As was
flagged in Section 5, the EU and the US are both proposing other measures to apply restraint. This includes the EU proposal to apply a separate ‘cap’ to agriculture and other sectors not directly included in its ETS – however, the trading arrangements in the EU will only directly cover about half of emissions, in contrast to the figure closer to 75 per cent in Australia.

6.6 Not mainly about marginal cost of abatement

There is a strong tendency in the policy discussion surrounding the CPRS and wider aspects of climate change policy and negotiation, to focus on limiting the marginal cost of abatement that is expected to emerge. This is understandable. It is at least intuitively plausible that extending the reach of the CPRS will allow a lower marginal cost to emerge – by tapping alternative sequestration and abatement options at lower cost than the most costly measures otherwise needed to keep within emission aggregates.

This reasoning underpins the view that it could be unfair to the rest of the economy to exclude agriculture. We believe this is true if interpreted as meaning agriculture is not a key participant in the total climate response strategy. However, the same is not necessarily true of the exclusion of agriculture from direct engagement in the CPRS relative to some alternative policy paths.

The fact is that the marginal cost of abatement is only a very crude pointer to the costs implied by the CPRS and wider climate change policy. A high marginal cost of abatement might in fact involve quite low aggregate cost, if almost all of the abatement were achievable at a much lower cost – and the marginal cost is driven by the need for a very small part of economic activity to tap into some high cost measures. This situation could arise if the available ‘abatement curve’ were flat and low cost across much of the needed abatement, but then rose steeply as an abatement target was approached.

It is possible to envisage two very different abatement curves with the same marginal cost of abatement at a specified level of restraint, as is illustrated in Chart 6.

Two stylized abatement curves are displayed in Chart 6. Both entail the same marginal cost for the specified target level of abatement, but in fact would entail very different costs in realising this level of abatement. Abatement Curve 2 is a systematically lower cost for each increment in abatement out to the target, and the blue shaded area shows that aggregate difference in cost of delivering the target abatement – the ‘economic surplus’ available if Abatement Curve 2 can be accessed. Alternatively, the blue shaded area could be interpreted as the opportunity cost of locking into Abatement Curve 1, when Abatement Curve 2 could have been accessed.
Chart 6 is of course highly stylized, illustrating a theoretical concept. The challenge can be viewed as minimising the cost – or maximising the economic surplus – not lowering the marginal cost of abatement for its own sake. Of course, tapping into a whole new block of levers to abate emissions, some of which are very low cost, could be expected to lower the marginal cost of abatement, but this is a consequence, not an objective, of the process that favours one abatement curve over another. And the change in the marginal cost of abatement could be very minor in comparison with the difference in economic surplus, or the value of accessing one curve over another. Most of the ‘action’ in Chart 6, lies in measures with costs of abatement that are well away from the marginal cost of abatement.

While Chart 6 is stylized, the later discussion, especially in Sections 7 and 8, raises the distinct possibility that the picture conveyed may not be too far off the mark. That discussion strongly suggests that the potential for agriculture to contribute to the overall solution may be much greater than is indicated by estimates of the impact on the marginal cost of abatement – because of the value it may offer in abatement options at costs well below the expected...
marginal cost of abatement. Of critical importance then is the distinct possibility that this value may not be accessible to any great extent, unless the measures used post strong incentives for on-farm behaviour change. For example, switching to fundamentally different production systems – rather than relying mainly on changing output mix.

6.7 Equity concerns and baselines

Section 6.1 has already alluded to equity concerns with an early movement of agriculture into a still maturing CPRS. Equity questions are always a challenge in policy development and have been a key feature of the design of the CPRS and of wider greenhouse gas response policies.

What is equitable depends very much on perspective:

- Some see no inequity in moving to penalise emitters, and indeed have argued that the gifting of temporary credits is unfair reward to parties who are a part of the problem:
  - This argument could be applied to agricultural emitters as readily as to coal burners – both are in the business of producing sought after products and services using technologies once considered highly efficient.

- Others would take the view that policy settings that encourage investment in these technologies as a source of growth and wealth accumulation for the nation, need to accept some of the responsibility for a change of mind about the efficiency involved:
  - In this view, it could be seen as unfair that investors should be confronted with a large wealth write-down because of a change in external policy. Added to this is a message to future investors about “sovereign risk” (where investors see Australia as higher risk due to changing government policies)
  - Instead, the community might be seen as both the source of the problem and the beneficiary of the new climate change policies – and might therefore accept the need to bear a reasonable share of the pain.

Key elements of these policies relate to both the transitional credit and EITE provisions to limit the damage to established firms (and their associated workforces etc), and the mechanisms for redistributing the revenues derived from the sale of credits (and, equally relevant, through revenues derived through any carbon off takes that might be considered to complement the CPRS).

In theory, gifting credits to firms should not alter the incentives to adapt to the marginal cost of abatement – provided that the credits are tradable. Those with credits, who also have short-term options for abatement at a cost below
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that marginal cost, should face incentives to sell the credits, while proceeding with ‘efficient’ abatement measures, just as they would without the credits. Those lacking credits but whose marginal uses of credits can support the market price of credits, will face incentives to buy. It should be a pure equity measure.

Potential constraints on this, that might entail efficiency costs in the form of slower than optimal abatement responses, would include:

- Restrictions on where, or how, the gifted credits could be traded:
  - which could prove difficult to enforce if some credits are not gifted and could therefore be ‘substituted’; and
  - which would seem to conflict with our assumed policy purpose.
- Capital market failure that limits capacity to invest in optimal abatement without the cash flow generated by the credits.
- Wealth effects whereby the extra income generated by free credits to some, but not others may influence resource allocation.

A key challenge for agriculture lies in its exclusion from the CPRS in the early stages, and therefore exclusion from main compensation measures – coupled with its strong export focus.

A related concern, with equity and efficiency dimensions, attaches to appropriate baselines for measuring potential future abatement activities. This has elements of transaction costs in it – being heavily influenced by the number and diversity of farms – but could well emerge as an important issue.

What is the status of any investments made now by farms in reducing their emissions or building up soil carbon? These investments, where they occur, can be expected to translate into improved aggregate performance by Australia, as the greenhouse accounts are updated. However, there is a real question as to whether the farmer will be rewarded for such changes.

Suppose a farmer were to switch to a minimum tillage farm system and move to more emission efficient methods for applying nitrogen to crops. There are clear benefits in this, but at present and probably at least until 2015, no commercial reason to do so, if not justified by on-farm productivity gains. Indeed, there may well be a reason to hold off, if there is a concern that abatement requirements will be benchmarked off current or future baseline patterns of farming. There is no systematic recording of current individual farm practices. While national aggregates can be estimated based on sampling methodologies – samples of land, records of national or regional sales of fertilisers by type, etc. – these do not yield a basis for establishing a farm-level baseline.
It might be efficient, given uncertainty as to the future basis for assignment of credits/benefits, for an individual farmer to hold off making changes that would otherwise make commercial sense (immediate productivity benefits and/or insurance against future cost pressures) and deliver abatement or sequestration benefits.

In general, the national interest aligns with sensible abatement and sequestration investments being made early – but uncertainty as to future treatment of agriculture, including the question of baselines, could create distorted incentives for investment in abatement, as well as possible equity issues.

The question of baselines also ties into possible ways of dealing with the trade exposure of agriculture – just as the early allocation of credits to trade exposed firms within the CPRS is being used as a device to deal with equity and some efficiency concerns in other sectors.

### 6.8 Responsibilities across tiers of government

While our clients for this study have come from the states, there has been a clear understanding that the need is for sound alternatives for the CPRS that can operate across Australia. Furthermore, caution should be exercised before applying measures within states that limit the scope for sourcing cost-effective abatement through the effective ‘trading’ of activities across state borders.

The CPRS is being driven strongly at the national level – even though emissions trading arrangements were first introduced in some state jurisdictions. National trading of credits will be encouraged – to deliver lower cost abatement options for Australia. We are arguing that the treatment of agriculture will ideally be of a form that slots into a national greenhouse abatement strategy in a cost-effective manner.

These considerations strongly favour a national policy and national coordination of its implementation. However, a significant role for the states is likely to remain, and a number of considerations are relevant here:

- The national coordination function could, in principle, be guided via a multi-jurisdictional mechanism, with delegations down to state levels – analogous to the National Water Initiative under COAG.
- State-specific differences in agriculture are huge and the government knowledge of the relevant systems is located far more in the states than at the Federal level, mainly in departments responsible for agriculture, land and water. There is also a lot of knowledge and expertise in Landcare groups:
  - Under a range of the policy options considered below, there will be a need for expertise in accrediting systems or activities in ways that may
require reasonably good local knowledge, and that would probably be supported by local expertise.

- We see a **central integrated role for soundly driven and exploited R&D strategy** arising in most of the policy alternatives, as an active investment in delivering options for more cost-effective abatement and sequestration:
  - Again the states tend to have a key role, with capability and processes, in these investments, especially those that are strongly location-specific.
  - Many other institutions also have a lot to offer, including CSIRO, universities and overseas research, that will need to be recognised, assessed for transferability and fitted into strategy options.
- Similar comments apply to communication and extension services to farmers, both directly and via established systems for working with commercial farm consultants, media, etc.
- The need to address possibly adverse and perverse interactions with other externalities, again favours a strong state-specific role:
  - There are substantial differences in water management arrangements and, to an extent, philosophies, across the states (alongside of multi-jurisdictional arrangements that apply to the Murray-Darling Basin).
  - This may well require some tailoring of greenhouse gas strategies to ensure a reasonable balance.
  - Several states are already running forms of markets in ecoservices from agriculture and other land users, where the changed incentives that may flow from greenhouse abatement policy could interact with limitations in these mechanisms, implying a need for careful management.
  - States also have a stronger focus on specific regional implications and the possible need for management of policies with differential impacts across regions.

More generally, the right role for the various jurisdictions will depend on the approach taken to agriculture. At one extreme, placing agriculture into the CPRS on the basis of a downstream point of obligation and ‘swings and roundabouts’ emission loadings defined around outputs, could limit the role of the states significantly, except in addressing socio-economic and regional consequences. The role for the states would tend to arise mainly if farm-level incentives for behaviour change were emerging – either through the design of the scheme or through responses by the downstream firms in changing their purchasing patterns.

At the other extreme, a system based strongly in accreditation of farm systems and associated imputed impacts on emissions, and with strong linkages into water and biodiversity markets, could define a major role for the states. In considering alternatives below, we address implications for different tiers of government.
7 Agriculture emissions & storage - technical levers to respond

We use the term ‘levers’ here to reinforce the view that sound policy will almost certainly need to recognise and look to incentives relating to packages of initiatives, with a range of levers, rather than focusing on the benefits and costs of single instruments viewed in isolation. This reflects both the fact that each farm system involves settings across a large number of individual levers, and the fact that the interactions across these levers may be critical to getting sound policy in place.

The earlier stated policy objective is clearly concerned with net changes in abatement that flow from the combination of levers used, inclusive of any interactions and, of any statistical variation across properties, regions or farming systems. Within the language and policy approach developed in more detail in Section 12 below, it is the performance of the portfolio of measures used that matters.

A further reason for using the term levers rather than ‘options’ is because we have reserved the term ‘options’ for a rather different, and highly relevant, concept as set out in Appendix C.

The levers considered here can be viewed as potential building blocks for composing a policy portfolio.

This section does not set out to replicate the wide range of work already undertaken on abatement levers for Australian agriculture. It is beyond both the scope and the scale of this project to assess every lever currently and prospectively available to Australian agriculture to reduce emissions or sequester carbon. Rather, this section reviews a range of levers viewed through the lens of:

• what is prospective and what is currently available for either, or both, abatement and sequestration; and

• the contribution each prospect might make to policy portfolios that could be developed to help Australian agriculture to reduce greenhouse gas emissions or become more emissions efficient.

Australian agriculture’s mitigation opportunities have, nominally at least, been constrained by a determination to be compliant with Kyoto Protocols, which is

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21 As was noted in Section 6.4, it is at least theoretically possible, if improbable, that greater emissions efficiency could also involve greater emissions from agriculture – if agriculture proves more than competitive for the rights to emit.
Agriculture and GHG mitigation policy: options in addition to the CPRS

Typified in the following quote from a summary of proceeding of the Australian Farm Institute (AFI) Agriculture, Greenhouse and emissions trading conference 2009:

Options available to mitigate agricultural greenhouse gas emissions are limited, especially because any mitigation to be included in the national inventory must be compliant with the emission accounting rules associated with the Kyoto Protocol. The same can be said for sequestration, particularly on the issue of soil carbon. International accounting rules don’t necessarily reflect the reality of mitigation or sequestration activities in a dynamic production system, and in order to get recognition for these practices significant research needs to be carried out. (Australian Farm Institute, 2009)

Importantly, the Kyoto Protocols are to be superseded post-2012, with insights into likely directions of change probably available following the Copenhagen process. The protocols may well be amenable to improvement – while Australia is free to pursue, as part of its response, abatement strategies that do not comply with current protocols. This could be justified on several bases:

- Expectations or possibilities of future change to protocols, possibly supported by on-going negotiation – where these very possibilities can make pre-emptive moves cost-effective.
- Recognition that, even if some measures will never be formally counted, they can still have status and support international influence, if backed up by sound arguments that the set of such initiatives is almost certainly delivering significant abatement and/or sequestration.
  - Australia could, for example, commit to a formal protocol-compliant abatement target, plus a ‘portfolio’ of other measures that will safely deliver additional abatement if assessed soundly. The more credible the second block of abatement, the less pressure there need be on the targets for the compliant reductions – and, potentially, the greater the scope for leveraging analogous measures from other countries.
- Recognition that some non-compliant measures still offer exceptionally cost-effective ways of attacking the source of the climate change concerns – which is not about compliant targets but about levels of, and trends in, measured greenhouse gases in the context of modelling consequences.

Effectively, we are distinguishing here between compliant abatement and additional, highly credible, abatement that is not compliant because of features of the protocols. Given high credibility in the latter, the sum of the two would seem far more relevant to the assumed policy objective than just the former.

Of course, care is needed not to endorse processes, in or outside Australia, designed to circumvent the purpose of the protocols or to ‘game’ their limitations. Nonetheless, it would seem very risky to view the target setting process – where Australia has already expressed a willingness to be flexible
based on the actions of other countries – as independent of any non-compliant measures that can be expected, and soundly argued, to deliver real reductions in global greenhouse gases. Australia has policy flexibility on targets and has already indicated a willingness to use that flexibility. Such a case could be made in parallel with a negotiating stance directed at improving the rules.

Australia already has policy measures designed to encourage other forms of constraint, but the point being made here is that, with a sensible process to accredit abatement implications, Australia could go a lot further with non-compliant measures. Indeed, it may prove very hard to tap agriculture’s potential in the absence of such an approach, or a substantial change in the rules.

This reasoning is central to the discussion in Sections 12 and the subsequent weighting of policy alternatives. This section focuses on the structure of Australian agricultural emissions and on the types of levers that might be accessed, or made accessible, as part of such a response. In doing so, it does consider each lever’s broad compliance with current international rules, but this should be interpreted in this wider strategy context.

7.1 Developing a framework to analyse agriculture’s emissions profile

There are several broad delineations in the agricultural emissions profile and the ability to manage its contributions to abatement policies. It is important that these be understood, as they frame the technical opportunities currently available, and those under development, to assist agriculture to manage emissions.

Creating policy for carbon emissions management and agriculture requires that a distinction to be made between those emissions that agricultural enterprise managers can influence and those they cannot. Many farmers are anxious about being penalised for the emissions that are produced by natural cycles beyond their control. There is, of course, a level of overlap (recognised below) that cannot be ignored – especially given the extent to which man has shaped the landscape and its natural propensity for emissions – but the distinction is still important to sound consideration of policy alternatives.

It also needs to be recognised that agricultural enterprises will have a wide range of emission and sequestration profiles depending on the scale and intensity of the operation. For example intensive agriculture may have higher emissions per ha but cover a relatively small areas of the land mass. Drier and more extensive enterprises may have lower emissions per ha (or the capacity to sequester) but cover a much larger area of agricultural land.
The distinction between anthropogenic non-anthropogenic emissions is important, as incentives to change behaviour need to be directed at those things that land managers and farmers can, or are likely to be able, to influence.

However, given that the target of CO₂e abatement policies is to reduce atmospheric concentrations of CO₂e, non-anthropogenic emissions are relevant to the optimal (most cost-effective) level and timing of desired reductions in anthropogenic emissions. The greater the rate of non-anthropogenic (net) emissions, the higher is likely to be the efficient level of abatement of anthropogenic emissions.

Distinguishing between what is human (in this case farm manager) induced and what is not is not a simple task. Drought is often cited as a major cause of emission from agriculture, as soil organic matter is broken down and not replaced with new growth, and enteric fermentation emits more methane as the quality of livestock diets declines. Rainfall is not influenced by land managers or the farmer, but the rate of emissions caused by drought can be increased or decreased depending on the response of the farmer to the onset of dry conditions.

Another important distinction to be made in agricultural emission abatement opportunities, are those that come from technology improvements (new crops, vaccines, feed supplements, etc.) and those that come from changes to farming practices.

The distinction between the introduction of new technology aimed at reducing emissions or sequestering carbon, and changes to farming systems intended to achieve the same ends, can be blurred at times, but how each of them influences policy choices can be quite different:

• Some of the non-price factors affecting farming practice changes include: awareness, peer practices, management capability, farm adjustment in response to other policies such as drought policy, and the age and experience of farm managers.

• Technology will be influenced by research investment and adaptation of farm systems; technology development is also likely to take considerably longer to implement than farm practice changes:
  − There can be exceptions. New seed varieties, improved vaccines, etc. can achieve very rapid take-up at the farm level, and rates of change can be accelerated using regulatory devices. This has, in the past, been seen in bans on certain chemicals and in requirements for the control of certain pests.


7.2 **Productivity/methane inverse relationship**

When considering the range of levers available to farming to abate emissions or store carbon, the net cost of the innovation or farming system change will be highly relevant. The net cost will drive the rate of adoption and the calculation must also include any spillover effects to the rest of the farming system.

Something of potentially great importance is the strong evidence of a significant and negative relationship between levels of methane and nitrous oxide emissions and levels of traditionally measured productivity in several classes of farming systems.

That such a relationship should exist is not all that surprising. Methane is a high energy product – so a production system that is emitting a lot of the gas could be seen to be ‘wasting’ a lot of energy. It can, for example, be an indicator of incomplete digestion. Similarly, nitrous oxide emitted from farming systems is essentially nitrogen that is not utilised by the plant (crop or pasture), and hence is wasted. In many respects, carbon emitted as carbon dioxide also represents a depletion of a valuable resource of the farming system.

This is suggestive of the scope for initiatives that reduce methane emissions, to also add to farm productivity. It seems just possible that cutting emissions need not involve an increase in costs but rather a reduction – further pointers to the possibility of ‘no regrets’ measures.

Even more likely is that the productivity gains could help to fund, even if they do not fully fund, the costs of limiting the methane emissions. There may be interventions that deliver joint products – carbon abatement and farm production, where the extra farm production can, at least partially, fund the cost of the intervention – making it more competitive as an abatement strategy. Elements of this are built into the earlier charts.

This capacity for joint production is highly relevant from two perspectives:

- The obvious perspective of a device to lower the effective cost of carbon abatement:
  - which could then be supportive of the policy purpose of lowering the costs of Australian abatement, and demonstrating more attractive alternatives to other countries.

- Pointing to ways in which a wider ‘portfolio’ view of policy and strategy could yield different outcomes from focusing instrument by instrument.
7.2.1 Linking emissions and productivity and production

The link between methane, nitrous oxide and carbon emissions from agriculture and productivity has been studied for many years, but only recently in context of the climate related externalities produced by the emissions themselves.

There has been a substantial amount of research undertaken in New Zealand on the relationship between methane emissions and animal production. This is not surprising, given that NZ is the only developed economy to include agriculture in its national emissions reduction scheme, due to agriculture accounting for up to 60 per cent of NZ total emissions.

The research in NZ indicates that the relationship between methane emission and feed intake is positive, but emissions between animals are highly variable (Blaxter & Clapperton, 1965; Kirchgessner et al, 1995; Lassey et al, 1997). An example of this relationship is shown in Chart 7, using data from sheep grazing fresh pasture in New Zealand, where the absolute amount of methane emitted increases as intake increases ($r=0.373; \ P<0.05$) (Lassey et al, 1997). The notable thing about this relationship is that approximately 87% of the variation in methane emission is between animals, suggesting that differences in DM intake per se accounted for about 13% of the variation in methane emission.

Chart 7 Methane emissions versus DM intake in a group of 50 sheep grazed on the same pasture (n=5)

Data source: (New Zealand Ministry of Agriculture and Forestry, 2009)
However, while the relationship between intake and emissions is positive, the rate of emissions per unit of intake declines as more feed is consumed per animal. That relationship is stronger ($r=-0.597; P<0.01$) than that for total intake and emissions ($r=0.373; P<0.05$):

This is a well established relationship for sets of data where animals are fed the same diet at both restricted and ad libitum intakes (Armstrong, 1964; Blaxter & Clapperton, 1965; Johnson & Johnson, 1995). This suggests that for efficient animal production and reduced methane emission it is advantageous to feed animals well above maintenance intake (New Zealand Ministry of Agriculture and Forestry, 2009).

The relationship between feed intake and emissions is also dependant on the quality of the feed consumed. Higher quality feed, measured as apparent digestibility of feed consumed, produces less methane when broken down in the rumen. The relationship between feed intake, productivity of the animal and feed quality is demonstrated in Chart 9. At maintenance, the level of methane emitted rises as digestibility increases. But as feeding exceeds maintenance levels, emissions per unit of feed fall as feed quality rises.

At maintenance levels of feeding, animals are assumed not to be producing meat or milk and only minimal quantities of fibre. Therefore, at this level of feeding, the emissions per unit of product produced are theoretically infinite. As feed intake rises, emissions per unit of production fall dramatically.
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Chart 9  **The relationship between digestibility, methane emissions and different levels of feeding**

Data source: (New Zealand Ministry of Agriculture and Forestry, 2009)

Note: Maintenance is where the animal in only maintaining basic functions and not producing milk, meat or wool.

Similar productivity and emissions relationships have been found to exist in crop production. Most of the emissions from cropping systems originate from the nitrogen cycle, inclusive of the nitrogen applied in fertilisers. As with methane research, nitrogen use efficiency has been the subject of extensive research in agronomy, at least since the introduction of synthetic nitrogen fertiliser use. This research has been undertaken to improve the efficiency of nitrogen use by crops but has not considered the climate externalities associated with the release of N₂O from cropping enterprises.

The results of the net emissions saved from reducing the amount of tillage undertaken in certain US cropping enterprises, conventionally known as minimum tillage farming, are shown in Chart 10. Similar studies have shown possible GHG emissions from controlled traffic farming (CTF) and variable rate farming (where inputs are varied across the paddock according the yield potential).

Zero till, minimum tillage, CTF and variable rate cropping systems have been adopted widely in Australia and overseas. Minimum tillage is now estimated to be practised by 80 to 90 per cent of Western Australian farmers (Agtrans Research, 2009) with slightly lower up-take in the eastern states. Controlled traffic and other more technology-intensive systems are expanding rapidly, as
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upfront and ongoing costs of the technology fall and accuracy increases. These technologies have not been adopted to reduce emissions; they have been adopted because of the net benefits they produce for the farming enterprise.

Chart 10  Changes to CO₂ emissions from a conversion to minimum tillage

Data source: (Bogen, Undated)

7.3  Productivity/sequestration relationships

Carbon sequestration is discussed in more detail, as a ‘building block’, in Section 6.5. However, following from the above observations about the negative relationship between methane and nitrous oxide emissions and productivity, it is worth noting that there is also evidence of potential for a positive relationship between sequestration and productivity. This can arise in several ways:

• Planting of trees and high biomass vegetation can be complementary with other farm activities. Trees can offer shelter for stock and pastures and provide habitats for predators of some crop pests. High biomass pastures can lead to improved porosity of the soil, increasing water infiltration and aeration of soils. Increased biomass is likely to stem from increased perennialisation of pastures, leading to reduced run off and improved dry matter availability across the year.
There is solid evidence that production and application of some forms of biochar can, across substantial cropping country, lock up significant amounts of carbon for extended periods, can inhibit nitrous oxide, and can improve cropping productivity through improved soil structure.

We address these possibilities below. However, for now we note that the logic developed in Section 6.3 about methane and nitrous oxide, applies also to these possibilities. Collectively, they point to a range of potential building blocks where there may be opportunities to offset costs via improvements in farm production and productivity. Technologies that offer abatement or sequestration services as part of a portfolio of economically beneficial outputs, are of particular interest in exploring strategy options that might be competitive as part of the climate change response strategy.

7.4 International analysis of agriculture and emission reduction levers

There is considerable overseas work on emission and abatement levers in agriculture that provides some guidance for Australia, particularly in assessing the likely marginal cost curves for a wide range of abatement options. Of course, large variation is likely geographically, and between farm systems, in some of these levers, but the work is still useful as a basis for assessing the scope for significant beneficial behaviour change that might prove competitive with the marginal options of other sectors.

McKinsey and Company in its report: *Pathways to a Low Carbon Economy* (McKinsey and Company, 2009) examined a range of agricultural abatement options classified into:

- **Land restoration** (34 per cent of abatement potential, 1.6 GtCO₂e per year by 2030). This can be largely achieved by: reducing tillage; reducing rate of acidification; revegetation; improving soil fertility; conserving soil moisture, etc.

- **Pasture land** (29 per cent of abatement potential, 1.3 Gt CO₂e per year by 2030). This is largely achieved by: increased grazing intensity; increased livestock productivity; greater use of irrigated pastures; fire management; and new pasture species.

- **Cropland management** (27 per cent of abatement potential, 1.2 GtCO₂e per year by 2030). Improved crop land management could be achieved by improved agronomy practices (crop rotations, less intensive systems, reduced tillage and reduced biomass residual removal).

- **Livestock management** (10 per cent of abatement potential, 0.5 GT CO₂e per year by 2030). Livestock management can reduce emissions by the use of vaccines, dietary additives and feed supplements. However, McKinsey conclude that these are relatively expensive options.
The McKinsey study also concludes that there is a range of marginal costs associated with the identified abatement options. McKinsey assemble each abatement option, its likely marginal cost, and the quantum of the abatement it may be able to contribute into a margin abatement curve which can be found at: https://solutions.mckinsey.com/climatedesk/cms/default/en-us/contact_us/fullreport.aspx

The McKinsey chart, and the adapted Moran et al chart (see Chart 11) includes possibilities as well as available levers – as illustrated by the anti-methanogen vaccine example used by McKinsey. If the possibilities identified by McKinsey and Moran et al needed to be risk-weighted, then the shape of the curve would change somewhat, pushing up the expected abatement costs of possibilities that are yet to be realised.

Nonetheless, the margin cost curve approach also reflects a range of strategies already available. What is striking is the abatement potential of levers where the study concluded abatement costs were low or, in several cases, negative. Negative abatement costs, if true, would constitute the types of ‘no regrets’ options that are particularly appealing. Of course, as with many changes in farm practices, inertia can be an impediment to rapid take-up.

Reflecting a recurring theme through the present study, the apparent ‘no regrets’ opportunities involve changes that could be expected to improve productivity even as traditionally measured. However, as many farm advisors are aware, expectation of productivity improvement does not always translate into rapid change. Major change in farming systems can involve up-front costs which, even if recoverable in the longer term, may be a major disincentive, or even a barrier, in the shorter term. Older farmers can be slow to commit to major change away from systems they understand well – with such changes sometimes being deferred until the farm changes hands or the children take over the strategy decisions.

Recognising these impediments suggests some possible policy approaches (either or both of carrot and stick instruments) – if the assumptions underlying the chart stand up to closer scrutiny.

This overall pattern is also supported by recent UK work (Moran, et al., 2008), as shown in Chart 11 and Chart 12, which conclude that in the UK there is a wide range of abatement opportunities and a wide distribution of the marginal costs of achieving abatement. This study also assesses the likelihood of adoption and success of new technology.

The results from Moran et al show that there are many technically advanced options for mitigation – such as, cloning and genetic modification of animals, the use of hormones, genetic modification of rumen flora, and some dietary...
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additives – that are possible but unlikely to achieve widespread short- to medium-term adoption, due to the cost of incorporation into the farming enterprise, the early stage of development of the technology, or consumer resistance. The McKinsey study also raises similar issues for the adoption of some of the options for agriculture.

Chart 11  Assessed potential cost effectiveness of measures (£2006/CO2t)

Data source: Adapted from (Moran, et al., 2008)
Similarly, a major New Zealand Ministry of Agriculture and Forestry report concludes that:

A wide range of feed additives have been proposed to reduce methane. These include alternative hydrogen acceptors (e.g. malate, fumarate), halogenated methane analogues (e.g. chloroform, bromoethanesulphonic acid), antibiotics (e.g. monensin, mevastatin), defaunating agents (e.g. manoxol, teric), and probiotics, bacteriocins and naturally occurring plant compounds (e.g. condensed tannins). There are problems with these compounds, such as toxicity to the microbes and the animal, short-lived effects due to microbial adaptation, volatility, expense, and failure to meet consumer acceptance.

With grazing animals, other than dairy cows, a delivery system would be required to ensure regular delivery into the rumen. Delivery by breeding into pasture plants is possible, but the time needed to get a viable plant established in the national pasture should not be underestimated.

Immunisation of animals against methanogens has been suggested by Australian scientists. This is a good concept, but we are still a long way from the delivery of an efficacious vaccine.

There are many possibilities available for manipulating the rumen microbial ecosystem to achieve methane reduction. These include: targeting methanogens with microbial antibiotics, bacteriocins or phage; removing protozoa; and developing alternative sinks for $H_2$, such as acetogenic bacteria. Development of mitigation technologies from this type of research is well in the future because of the need to first understand the complexities of the rumen microbial ecosystem (New Zealand Ministry of Agriculture and Forestry, 2009).
This is not to say that these options are not possible but, as the MAF points out, they are likely to be higher-cost options that require additional research and development to improve the technology and its application to farming systems.

Box 2 sets out an extract from an IPCC report, appearing in a World Bank report on carbon markets (Capoor & Ambrosi, 2009), indicating both the scale and scope of the opportunities for soils used for agricultural production to contribute significantly to abatement options. Like the previous studies cited above, the IPCC indicates that many of these options are technically feasible now and cost competitive, but all but forestry contributions are excluded from Kyoto trading rules.
Box 1  
**Harvesting agricultural soil carbon**

The greenhouse gas (GHG) mitigation potential in the agricultural sector is significant. Agriculture accounts for an estimated 12% of total global anthropogenic emissions of GHGs. Taking into consideration that agriculture is the primary driver of land use change and deforestation, an additional 18% of total human-induced GHG emissions can be attributed to agricultural landscapes. Due to population growth and changing diets, it can be expected that emissions from agriculture will further increase. At the same time, the sector can significantly contribute to GHG mitigation. According to the IPCC, the global biophysical agricultural GHG mitigation potential is estimated to be ~5,500 – 6,000 MtCO2e per year by 2030, soil carbon sequestration being the main mechanism.

Many agricultural mitigation opportunities use current technologies and can be implemented immediately. Opportunities for reducing GHGs in agriculture include: cropland management, grazing land management, management of organic soils, restoration of degraded land, and livestock management. Still, further development and scaling up of testing and application of emerging technologies to support reduced emissions and enhanced adaptation in agricultural landscapes and monitoring, is both achievable and necessary.

Agricultural GHG mitigation options are cost-competitive. The potential gains from soil sequestration are less well-known than those, for example, in the forestry sector, but could be globally of the same order of magnitude. Assuming a price of less than $20 per ton of carbon dioxide, the global economic mitigation potential in the agricultural sector is close to 2,000 MtCO2e per year by 2030. This potential is comparable to, or even above, the economic potential of other sectors, such as: energy supply, transport, industry, and forestry (Chart below). Other studies, for example McKinsey (2009), confirm low abatement costs of soil carbon sequestration.

Under the Clean Development Mechanism (CDM) of the Kyoto Protocol agricultural land management is not eligible (as a stand-alone). Only emission reductions of methane and nitrous oxides from activities other than agricultural land use, are eligible under the CDM. Therefore agricultural soil carbon, which accounts for 90% of the total biophysical mitigation potential in the agricultural sector, cannot be traded within the Kyoto compliance market. This exclusion prohibits farmers from developing payments for emission reductions.

**Global Economic Mitigation Potential for Different Sectors in 2030**

![Graph showing global economic mitigation potential for different sectors in 2030.](source: IPCC 2007.)
Agricultural land management is the “missing link” in establishing functional landscape-level mitigation projects. Afforestation and reforestation are currently the only land uses eligible under the Kyoto Protocol, unless Article 3.4 has been signed. Reduced Emissions from Deforestation and Forest Degradation (REDD) is being considered for inclusion in a future climate regime. Agricultural land management (including grassland management) is the link needed to avoid carbon leakage due to land-use changes, to supplement incomes for farmers (in particular in developing countries), reduce transaction costs and release pressure on natural forests.

**Agricultural carbon sequestration can help to increase agricultural productivity and enhance farmers’ capacity to adapt to climate change.** Carbon is an integral part of sustainable land, water and biodiversity management. Increased soil carbon improves soil structure, with corresponding reduction in soil erosion and nutrient depletion. Soils with increased carbon stocks have better retention of water, thereby improving the resistance of agricultural systems to drought. These positive biophysical impacts of soil carbon sequestration lead directly to increased crop, forage and plantation yields and land productivity.

**Agriculture could deliver charismatic carbon assets, especially if this asset class is included in future compliance markets.** Carbon payments could provide incentives for producers to adopt productivity-enhancing practices and technologies and thereby help, in particular, poor smallholder farmers in developing countries to realize the twin benefits of increased crop yields and climate resilience. Given the key role agriculture plays for livelihoods and economies in developing countries, carbon revenues could be an additional trigger for sustainable rural development. Capacity building and research and development, can help farmers to overcome technical and institutional barriers to benefit from carbon payments.

Many of these studies have been conducted overseas, where farming practices are considerably different from those in Australia. Many of the differences between overseas and Australian farming systems of relevance to this study lie in the level of intensity and the degree of management intervention in daily operations. That is, most developed country farming systems are more intensive than in Australia, are generally on more fertile and younger soils, and the inputs are higher. In these systems there are higher levels of stock management, which allows livestock intakes to be manipulated more easily.

**7.5 International analysis of agriculture and sequestration levers**

Box 2 below sets the sequestration rates and time to maturity for a number of management and land use changes, based on US data.
### Box 2: Representative carbon sequestration rates and saturation periods for key agriculture, land-use change, and forestry practice

<table>
<thead>
<tr>
<th>Activity</th>
<th>Representative Carbon Sequestration Rate in U.S. (Tonnes of CO₂ per acre per year, unless otherwise indicated)</th>
<th>Time Over which Sequestration May Occur before Saturating (Assuming no disturbance, harvest, or interruption of practice)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afforestation</td>
<td>2.2 – 9.5²</td>
<td>90 – 120 years</td>
<td>Birdsey (1996)</td>
</tr>
<tr>
<td>Reforestation</td>
<td>1.1 – 7.7²</td>
<td>90 – 120 years</td>
<td>Birdsey (1996)</td>
</tr>
<tr>
<td>Changes in forest management</td>
<td>2.1 – 3.1</td>
<td>If woody products included in accounting, saturation does not necessarily occur if carbon continuously flows into products</td>
<td>Row (1996)</td>
</tr>
<tr>
<td>Reduced tillage on cropland²</td>
<td>0.6 – 1.1</td>
<td>15 – 20 years</td>
<td>West and Post (2002)</td>
</tr>
<tr>
<td>Changes in grazing management</td>
<td>0.07 – 1.2</td>
<td>25 – 50 years</td>
<td>Lal et al. (1998)</td>
</tr>
<tr>
<td>Cropland conversion to grassland</td>
<td>0.9 – 1.9</td>
<td>Not calculated</td>
<td>Eve et al. (2000)</td>
</tr>
<tr>
<td>Riparian buffers (nonforest)</td>
<td>0.4 – 1.0</td>
<td>Not calculated</td>
<td>Lal et al. (1998)</td>
</tr>
<tr>
<td>Biofuel substitutes for fossil fuels</td>
<td>4.8 – 6.8</td>
<td>Saturation does not occur if fossil fuel emissions are continuously offset</td>
<td>Lal et al. (1998)</td>
</tr>
</tbody>
</table>

Note: Any associated changes in emissions of CH₄ and N₂O or—except for biofuels—fossil fuel CO₂ are not included.

- Values are for average management of forest after being established on previous croplands or pasture.
- Values calculated over 120-year period. Low value is for spruce-fir forest type in Lake States; high value for Douglas fir on Pacific Coast. Soil carbon accumulation included in estimate.
- Values are for average management of forest established after clearcut harvest.
- Values calculated over 120-year period. Low value is for Douglas fir in Rocky Mountains; high value for Douglas fir in Pacific Northwest. No accumulation in soil carbon is assumed.
- Values represent the assumed CO₂ loss avoided in a single year (not strictly comparable to annual estimates from other options). Low and high national annual average per acre estimates based on areas deforested from National Resources Inventory (NRI) data and carbon stock decline from the FORCARB model, from 1990 to 1997.
- Selected example calculated over 100 years. Low value represents change from unmanaged forest to plantations for pine-hardwood in the mid-South; high value is change from unmanaged forest to red pine plantations for aspen in the Lake States.
- Both West and Post and Lal et al. estimates here include only conversion from conventional to no till. Estimates do not include fluxes of other associated GHGs.
- Tillage rates vary, but this value represents a central estimate by Lal et al. for no-till, mulch till, and ridge till.
- Low-end estimate is for improved rangeland management; high-end estimate is for intensified grazing management on pastures, which includes the return of plant-derived carbon and nutrients to the soil as feces.
- Assumed that carbon sequestration rates are same as average rates estimated for lands under the USDA Conservation Reserve Program (CRP).
- Assumes growth of short-rotation woody crops and herbaceous energy crops, and an energy substitution factor of 0.66 to 0.75. Potential for changes in other GHG emissions not included.

Data source: (United States Environmental Protection Agency, 2005) Data source: (United States Environmental Protection Agency, 2005)

A recent briefing paper from the (Congressional Budget Office, 2009) paid particular attention to the potential value of offsets – that could include carbon...
sequestered in soil – as a potential contributor to containing the cost of climate change policy. Chart 13 below draws on that brief, showing a range of estimates of the marginal cost of abatement by 2030, both accessing and not accessing offsets. The picture is fairly stark – though the paper stresses the need to factor in costs of verifying the value of the offsets (while arguing that the indications are, that even with these costs, a range of offsets looks highly prospective.

These estimates are from the US and need to be adapted to Australian conditions. Changes would include:

• soil carbon saturation levels for much poorer Australian soils, which are much lower in organic carbon levels and likely to sequester carbon much more slowly. In addition to poor quality soils, water availability is likely to act as a constraint in SE Australia; and
relative returns from different land uses are likely to change due to agricultural subsidies in the US, suitability for land uses, rates of productivity growth in agricultural enterprises, etc.

However, while sequestration rates and opportunities are likely to vary between jurisdictions (international and domestic), wherever sequestration takes place the rates will vary over time and will reach saturation at some point. Once saturation is reached, additional sequestration will require additional land to be sourced.

Individual claims need close scrutiny and we would not want to suggest that agriculture offers a ‘Magic Pudding’ for solving the climate change challenge. However, uncertainty generally implies a potential upside as well as risk of downside effects. Our proposed risk management framework, stresses the need to manage the risks of missing this upside opportunity, as well as the risks of finding that we are dealing with the downside. Across the portfolio of possible abatement measures, there is a range of types of technical relationship that suggests substantial scope for tapping into portfolio diversity to manage these risks. Australia has, in comparison to many countries, a very large land base relative to its anthropogenic emissions – a land base with option value based on current knowledge. It is important that these opportunities be managed in a sound manner if the policy purpose is to be achieved.

The curves in Chart 14 show how, in a typical forest, sequestration rates accumulate fast per ha in the early years and then decline over time, reaching a theoretical maximum (i.e. a point where there is insignificant gain per year).

Data source: (Australian Greenhouse Office, Department of Environment and Heritage, 2005)
The non-linear shape and theoretical nature of sequestration curves would apply to most sequestration opportunities. However, agrichar is likely to be the reverse of this curve, as all of the carbon is stored up front with some decline over time as the agrichar breaks down, releasing greenhouse gases. In either case, there is a change in the rate of sequestration over time that has implications for the value of the investment.

The investment implications of this curve are quite important, as it raises the question of how credits will be traded over the life of the sequestration. Early, rapid, sequestrations will be more valuable than those accrued later if a discount rate is applied to the investment. Some may argue that a zero or even negative discount rate, should apply as a tonne of carbon saved or stored today is the same or even less important than those in the future.

This view appears to be predicated on the belief that climate change effects today have at least the same values as those in the future, and therefore should not be subjected to discounting.

This view appears to miss several important aspects of the time value of a series of benefits and costs, and the opportunity costs that are incurred even when these benefits and costs are of a climate/environmental nature:

- Discounting infers that returns from an investment with a positive net present value today, achieve returns in excess of the opportunity cost of the funds invested. Thus over time the financial capacity to direct resources to improve greenhouse gas abatement values increases.

- Over time the cost of preserving or improving climate change mitigation is likely to fall, as the technology to achieve this advances and knowledge of the ecological values dependant on stream flows improves.
This section presents an overview of agricultural greenhouse gas emissions, their relationship to production and productivity, and management options in an Australian context. It considers a number of mitigation levers currently being developed to test the general technical capacity of Australian agriculture to respond to mitigation incentives should they be posted in future policies.

Most of the recent modelling of the impact of the CPRS on agriculture, has assumed limited capacity for agriculture to respond to a carbon price. Primary emphasis has been on reducing production and switching output mix within the production functions embedded in the models, which are based on historical patterns. With only limited options for adjustment, as discussed in Section 4.4, this approach tends to be somewhat pessimistic in the inferences for agriculture. Two important points made there are relevant here:

- Historical ‘flexibility’ to adjust to price changes will understate the innate capacity for adjustment:
  - because rapid change that involves significant up-front cost is unlikely to be sensible in response to price volatility of the type traditionally experienced and modelled. Consequently, such radical shifts are not reflected in past data.
  - The situation with a long term policy being introduced to attach a price to emissions, accompanied by stated expectations of rising costs of emissions over time, could well support rethinking more radical options.

- Most of this modelling has been of a CPRS in which the expectations are that inclusion of agriculture is likely to be via some form of downstream point of obligation attached to farm output (with imputed weightings on inputs, averaged across farms). This approach leaves little scope for individual farms to benefit from their own adjustments to levels of emissions per unit of output.

It is worth exploring the extent to which there may be incentives for reduced emissions using other instruments and packages of instruments – or it may be possible to create such incentives.

### 8.1 Australian levers

While this report has recognised that there are likely to be a number of differences in the levers identified overseas and those that are likely to be available in Australia, the principles which underpin the overseas research are:
Methane emissions represent unused energy from livestock enterprises.

Nitrous oxide emissions result from the release of unused nitrogen from the soil; nitrogen that could be utilised by the plant.

Carbon dioxide emissions largely result from a depletion of carbon that would otherwise be sequestered in the soil or biomass.

Therefore the difference between Australian and overseas levers are likely to be variations in the scale of abatements due to differences in farming intensity, climate and soil type, rather than variations of scope, where the range of Australian levers are radically different from those available overseas.

This view is supported by research conducted by the Cooperative Research Centre for Greenhouse Accounting (CRCGA). The notion that there are a number of low (negative and zero) cost options for agriculture, is supported by research being conducted by the CRCGA (Eckard, 2006). The CRC’s research concludes that:

• There is scope to better match crop or pasture demand and N supply. This can be achieved through application of nitrogen-based fertilisers based on accurate assessments of growth potential and identification of factors limiting the expected uptake of applied nitrogen.

• It is best to avoid excessive nitrogen fertiliser rates in any one application. Single nitrogen application rates should be reduced to a maximum of 50 to 60 kg/ha; and split applications applied not less than 21 (39 kg/ha spring) and 28 (50 kg/ha) days apart.

• Nitrogen inhibitors and controlled release agents can be applied to the fertiliser, where the release is matched to the anticipated demand by the plant (in much the same way as anhydrous ammonia is used as a substitute for urea in some crops).

• Crop and pasture management changes to reduce emissions include:
  − Reduced fallow.
  − Using non-leguminous cover crops to use residual nitrogen in some crops, such as cotton.
  − Increase water use efficiency to reduce waterlogging, which leads to elevated emissions of methane.
  − Improve the management of other nutrients to ensure nitrogen use is optimised.
  − Remove subsoil constraints on pasture and crop growth, such as deep ripping, controlled traffic farming and reducing subsurface acidity.

A number of the levers identified by Eckard and others in Australia are supported by abatement and sequestration ventures that have been launched in Australia. Many of these privately funded projects may not prove to be commercially successful, due to the development of new, more efficient...
technologies or from backing the ‘wrong’ carbon price, but the investments do demonstrate that there is significant private confidence in the science at this stage.

Eckard concludes by saying that:

Significant reductions in both methane and nitrous oxide can be achieved within the agricultural industries through the implementation of current best management practices that are entirely consistent with improving the efficiency of agricultural production. These best management practices represent a clear win-win opportunity for Australian agriculture.

8.2 New technologies to reduce transaction costs

The science of agricultural abatements and sequestration appear to offer a number of levers to manage agricultural emissions. Likewise, there have been rapid advances in technology that are likely to play an important role in monitoring the compliance of agricultural emissions and emission policies.

It must also be noted that, as with the marginal costs of the abatement and sequestration technology, there are considerable benefits for farmers that can also be captured by the use of some of the monitoring technologies associated with emissions management.

For instance, if remote sensing is used to monitor land use, considerable additional information on pasture or crop condition can be captured at the same time; which can be of high value to the farm manager. Similarly, information on methane emissions from livestock, if monitored in situ, is likely to reveal useful data on the performance of the animal.

Monitoring and modelling of pastures has improved significantly recently, with internet based tools to monitor and predict pasture growth rates becoming more common.

Chart 15 and Chart 16 depict the outputs of a Meat and Livestock Australia pasture growth rate prediction website. These tools combine regional rainfall records with future rainfall probabilities, to derive potential pasture growth rate curves. They are relatively simple to use, providing a ‘rough justice’ estimate of pasture growth rates. Compared to previous methods, or the lack of any tools, they provide considerably more information upon which to base grazing decisions than was previously available.
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Chart 15  Accumulated rainfall, Yass (Deningullen), Jan-Jun 2008

Chart 16  MLA pasture growth predictor

Chart 16 takes the outputs of Chart 15 and produces a pasture production estimate with upper and lower bounds. These charts are for the Yass area and show the pasture productivity curve for the 10- and 90-percentile rainfall outcomes for the region.

Aimed at improving grazing risk management, it is not hard to envisage this tool being modified to include utilisation of pasture by livestock, the likely
emissions used and the amount of carbon estimated to have been sequestered by the pasture.

The MLA pasture prediction tool is a good example of the developing agricultural monitoring technology. It shows how the monitoring and compliance costs of monitoring emissions and abatement, will be shared between various farm activities and not solely borne by emissions management.

### 8.3 Exploiting the production/emission relationship

Given the above evidence of a negative relationship between productivity and carbon emissions in agriculture, the actual abatements induced by the changes in production modelled by ABARE and others may be significantly higher than a simple average – as has been assumed in the modelling – may suggest. If the relatively higher emitters also tend (as a result of the above correlation and associated causal mechanisms) to be relatively less productive, then pressure to reduce emissions – even if based only on average emissions per unit of production – would tend to favour contraction from the lower productivity, and higher actual emission, activities.

This reasoning applies to activities within a farm, as well as differences between farms. The currently most marginal (in terms of contribution to farm cash surplus and/profit) activities undertaken on farms – possibly including: marginal retention of stock, particularly during drought with associated survival feeding; and cropping margin land (perhaps leading to greater use of variable rate technology to select out marginal yield areas within paddocks) – are the areas most likely to be cut, in response to a new carbon impost on output.

Without accounting for actual differences in emissions, such incentives would be muted, but still real. Any developments that do offer rewards or relief from penalties, for the higher abatement rates per unit of production indicated by these analyses, could be expected to further strengthen the incentives, and the scope for limiting the loss of production per unit of abatement delivered.

This is a statement of logic that stands whether planning for a better CPRS or for alternative measures. It is suggestive of a potentially large capacity to limit damage through greater precision in the targeting of policy. In general, we would expect that increased precision to involve extending from costs and rewards linked only to commodity production levels to also accepting likely differences as a result of:

- the nature of the farming system (covering a range of possible points of intervention/change as discussed below); and
- regional characteristics that influence climate volatility, soil types, etc.
If it were possible to cost-effectively reflect how these additional factors influence expected\textsuperscript{22} aggregate emission patterns, several things would follow:

- It should be possible to encourage more abatement at lower cost\textsuperscript{23} – by encouraging more efficient patterns of behaviour change.
- This should allow national costs of achieving a given level of abatement to be lowered – subject to the extra abatement being measurable and accountable:
  - This might be possible at farm level, with direct attribution to individual farm sector decision makers, or could be done on the basis of rolling reassessments of aggregate farm sector emissions, where the reassessments factor in the changed pattern of farming systems.
- The translation of reduced abatement to a formally accounted reduction against targets could be done in real time or could be accounted retrospectively, as part of reassessing the carbon accounts:
  - This does not imply that the benefits, in terms of lower atmospheric carbon, nor even capacity for international influence, need be delayed. The benefits are accrued at the time of the farm changes and measured and formally rewarded later. In fact, we discuss later mechanisms to reward the activities, based on statistical implications, ahead of the formal measurement – again reflecting the policy principles outlined in 10.3.
- These reassessments could, in principle, take into account both the changed patterns of farming and new science that may support more confident conclusions about aggregate emission consequences of farming patterns:
  - This raises an issue we consider to be of great importance – who ‘pockets’ the potential for later assessment to show that more abatement was achieved than could safely be assumed at the time?

\textsuperscript{22} The use of the term ‘expected’ here is deliberate and important. We argue in Section 10.3 that a requirement for certainty in attribution of abatement outcomes down to individual activities is not only unnecessary, but almost certainly inconsistent with the assumed policy purpose, given the level of unavoidable uncertainty. Policies that can deal efficiently with the uncertainty are needed. Petroleum companies pursuing a sustainably profitable future do not restrict their drilling to wells that will certainly be commercial, because to do so conflicts with their objectives. A planet seeking a sustainable and affordable response to climate change threats is in a precisely analogous situation.

\textsuperscript{23} Costs here are linked ultimately to capacity to compete, but include dimensions of reduction in output, rising input costs and cost of social dislocation – especially if this might otherwise be linked to early ‘overreaction’ in production adjustment, only to favour restoring some of this production later, as distortions in the policy settings are reduced. Of course, these savings in costs may need to be balanced against transaction costs; here the policy principle of seeking to focus the higher transaction costs on activities where incurring the transaction costs delivers the greatest benefits, is of great relevance. Later we discuss mechanisms for seeking to achieve this.
of such upside potential – with scope for these rights to be important in encouraging earlier, and greater, investment in abatement.

8.4 **Carbon/nitrogen cycles and possible points of intervention**

As agricultural production is based largely on a cycle of carbon sequestration and carbon and nitrogen utilisation and emissions, there appear to be several points of intervention in the carbon and nitrogen cycles. Broad structure is shown in the following three charts.

Chart 17 provides a simplified representation of the carbon cycle for livestock production and Chart 18 does the same for cropping. The effects of minimum tillage on the emissions produced, is shown in Chart 17; where in a US cropping enterprise, GHG emissions are reduced by 273 lbs (124kg) by reducing cultivation. The effects on the carbon cycle of a conversion to minimum tillage in Chart 10, is based on the stylized carbon cycle in Chart 18. Chart 19 then sets out a stylized nitrogen cycle.

It is important to recognise that broadacre cropping is commonly undertaken in cycles with pasture – the activities are not totally separated and there is scope for exploiting synergies in intervening to lower average rates of abatement and sequestration over time. For example, the presence of a cropping cycle within a livestock system opens opportunities for incorporation of carbon (such as biochar) into soils to an extent that would often be more difficult and costly under a pure pasture system. For this reason, the separation is more for simplicity in presentation than as a reflection of a fundamental separation.

Carbon is a nutrient for plants that can be used for commercial crop production or fed to animals to produce animal proteins or fibres. In agricultural systems carbon is absorbed from the atmosphere by plants, stored and eventually released as either carbon dioxide (CO₂), methane (CH₄) or nitrous oxide (N₂O). Collectively these gases are measured as carbon dioxide equivalents (CO₂e). CH₄ has a greenhouse effect about 21 times that of CO₂ and N₂O has an effect 310 times that of CO₂.

This immediately highlights the potential, not just for reducing emissions, but also for altering the form of those emissions. If the balance in carbon emissions could be switched away from methane and into carbon dioxide, this could make a big difference without any effect on the volume of gaseous emissions. In the (almost certainly infeasible) extreme, such conversion would reduce agriculture’s share of assessed aggregate emissions from the current 16 per cent, to less than 5 per cent – the point here is that modest changes could
still have a large impact, and the earlier discussion suggests they could sometimes actually enhance technical productivity.

In this chart it can be seen that carbon sequestration and emission reduction opportunities exist at numerous points in the livestock carbon cycle:

- in *biomass sequestration*, commonly thought of in terms of trees, but also in perennial pastures;
- through *organic carbon stored in the soil* as biomass produced on site;
- in carbon from on- and off-site, that has been stabilised and stored in the soil (e.g. biochar);
- by increasing the capacity of the soil to bind nitrates (with potential for jointly beneficial implications for both N₂O emissions and acidity impacts);
- through modification of pastures to reduce cellulosic content (increase digestibility);
- by intervention in the rumen to modify bacterial activity for reduced greenhouse gas production and more efficient digestion;
- through increased drought tolerance to reduce carbon emissions in periods of low rainfall from pastures and crops;
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• by precision agriculture that matches input use, such as nitrogenous fertilisers, with historical crop yields at resolutions of up to one metre square; and

• by inclusion of enteric CH$_4$ emissions in breeding selection criteria – for example, inclusion in cattle breeding indexes (e.g. many studs could offer an estimated breeding value (EBV) for CH$_4$ emission when selling bulls, assuming reasonable levels of heritability of methane emission levels).

This list is by no means exhaustive but has been included to demonstrate the scale and scope of the opportunities agriculture has to intervene in the management of greenhouse gas abatements – operating within livestock production.

Chart 18  Stylized carbon cycle for broadacre crop production

The diagram in Chart 18 shows that cropping enterprises offer a similar, although less extensive, range of points of intervention, which include:

• retention and management of crop residues;

• minimum tillage;

• reduced fuel use/replacement with biofuels;

• improved nitrogen use efficiency (timing, placement, delivery mechanism, release management, soil retention capacity, fertiliser coating);

• improved soil structure to reduce waterlogging, which leads to elevated methane emissions; and
improving nitrogen use through plant breeding.

Nitrous oxide, \( \text{N}_2\text{O} \), is a potent greenhouse gas emitted from agricultural production systems; but alone it accounts for a small part of total agricultural emissions. The agricultural nitrogen cycle is depicted in Chart 19.

The primary sources of \( \text{N}_2\text{O} \) from agriculture are mineral fertilizers, legume cropping, and animal waste. These losses often are accelerated by poor soil conditions. Some \( \text{N}_2\text{O} \) is also emitted from biomass burning. Improvements in farm technology, such as use of controlled-release fertilisers, nitrification inhibitors, the timing of nitrogen application, and water management, should lead to improvements in nitrogen use efficiency and further limit \( \text{N}_2\text{O} \) formation.

The underlying concept in reducing \( \text{N}_2\text{O} \) emissions is that if fertiliser nitrogen (including manure nitrogen) is better used by the crop, less \( \text{N}_2\text{O} \) will be
produced and less nitrogen will leak from the system. By better matching nitrogen supply to crop demand, and more closely integrating animal waste and crop residue management with crop production, N$_2$O emissions could be decreased by about 0.36 Mt N$_2$O-N or an average of 17% (in a range of 9-26%) of the current emission rate in agriculture (Meat and Livestock Australia, 2008).

However, the importance of the nitrogen cycle extends beyond the release of N$_2$O, as it interacts closely with the carbon cycle – again placing emphasis on the need for a *portfolio of response measures* to extract maximum value from agriculture, while managing risks to agriculture.

### 8.5 The abatement portfolio/abatement curve

Therefore, it appears agriculture is faced with a number of technical options, a wide diversity in the emissions between and within enterprises, and a number of points of possible intervention in the carbon and nitrogen cycles to reduce emissions or store carbon. In options-based policy development processes, where there is significant uncertainty as to the detail and timing of climate change effects, and of carbon policy both domestically and internationally, alongside of technology, this diversity can have considerable value.

The economic and risk management aspects of diverse portfolios of measures are developed further in Section 10 and in Appendix C. However, it is helpful to stand back from the above material and think through what might be implied for the Australian portfolio of abatement prospects.

There is considerable evidence based on comprehensive international research, as discussed above, that agriculture has a range of abatement options. Some of these could be implemented immediately, some require further development and some require significant additional research and development. There does not appear to be the same level of analysis of the abatement curve in Australia, however, it is highly likely that similar options exist.

However, consideration of the types of options identified in that research, alongside the broad structure of Australian agriculture, is suggestive of a potential abatement curve with a structure something like that shown in Chart 20.

As with the international charts on which Chart 20 is based, the charts include some yet to be delivered technologies – such as livestock vaccinations – while, for most, there remains significant speculation as to the extent of the impact – abatement, sequestration and permanence – at the farm level. However, the established greenhouse accounts are drawing strong conclusions about the
aggregate implications for current farming systems – and these have already been translated into policy settings and targets.

As has already been flagged, and is discussed in some detail in Section 10.3 below, certainty as to individual farm or activity impact is not a prerequisite to operate policies that post incentives at the individual farm or activity level.

Of course we can appreciate a level of disquiet with setting out a chart suggestive of a range of low cost, even negative cost, abatement possibilities as a basis for moving forward. Caution will clearly be appropriate. But that caution applies to being cautious about heavily discounting the scope for discovering and testing these possible abatement prospects, as much as it does to not assuming they will all be available tomorrow. What is crucial is that, within the assessment framework and given the policy purpose, these prospects have implications for sound early strategy – even before their uncertainties have been resolved.

It is not efficient, and could be very costly, to wait till the uncertainties have been resolved before factoring these prospects into an adaptive policy process. It would be akin to waiting for a house fire before taking out insurance. It could well lead to a situation in which the value of the developments that do...
occur is greatly reduced, as a result of decisions taken under the working assumption that they will not become available – insurance options can effectively be extinguished.

The science underpinning reasonable expectations of significant opportunities from the range of measures summarised above, is solid. What is lacking is precision in attribution to individual actions and, of course, some of the technologies remain as prospects for the future. Certainly, Chart 20 includes a range of measures that are available today – but failure to factor in greenhouse abatement potential has so far limited their application. Collectively, these measures do suggest significant scope for short-term responses that could offer low-cost abatement and sequestration – but potential that would receive quite limited incentives from the inclusion of agriculture in the CPRS on a basis that does not account for substantial variation in the emission tendencies of different patterns of production.

Another important feature of the possibilities flagged above, is that they probably offer greatest benefits if viewed as a suite of instruments that need to be combined, in a portfolio way, to deliver a significant impact on aggregate emissions and sequestration patterns for Australia.

Tapping into this potential – and managing the risks of forcing very high cost abatement responses to CPRS signals that could be very distorted in the case of agriculture – seems likely to require something approaching a shift in the paradigm used to plan policy and strategy. That shift needs the capacity to plan portfolio responses and to use portfolio-based tools to manage uncertainty that cannot be eliminated at the farm level. Viewed in this way, the broad shape of the stylized abatement curve is likely to be far more stable and robust than the individual prospects offered by some of the elements in the portfolio – in the same way that other investment portfolios can perform with far less volatility than their individual components.

This is likely to be true of policy alternatives to the CPRS, but also of any future evolved form of CPRS, within which the potential of agriculture could be effectively tapped while containing damage from limitations in the design of the mechanism.

It is also possible to use Chart 20 to provide an indication of the potential ‘economic surplus’ – of the size of the prize – that might be offered by effective tapping of the potential of agriculture. This is represented in Chart 21.
The area in red reflects the price times quantity value of accessing agricultural options that are cheaper than the marginal cost of abatement from the CPRS. This is a far better indicator of the size of the potential prize than is looking simply at the impact in the marginal cost of abatement. Note, however, that this surplus is likely to be reduced by unavoidable transaction costs.

Chart 21 includes an additional column to Chart 20. This is a highly stylized column, but is intended to represent the scope for poor agricultural policy to force excessive abatement and sequestration costs on Australia. Indicatively, this could entail a heavy emphasis on reduced production, rather than switching between production systems to better reflect the whole of enterprise economics, inclusive of the scope for offering abatement and sequestration to the economy as a ‘product line’. Any resultant costs in excess of the marginal cost of abatement from the CPRS, are logically a part of the potential economic surplus from policy settings that do tap the full potential of agriculture.

The chart remains as illustrative only – but is suggestive of significant potential value, and of a potentially high opportunity cost, in pushing early with policy settings likely to post significant inappropriate signals for production response.
9 Treatment of LULUCF under international accounting rules

Possibilities for modifying the international rules and interpretations, as they apply to agriculture and land use, are an important part of the policy alternatives developed below. This Section assembles a view of the provisions as a basis for considering these alternatives.

9.1 Emissions accounting under the Kyoto Protocol

Australia’s emissions are reported annually, but at the end of the first five-year period of the Kyoto Protocol (2008-2012), the total emissions for the period will need to be less than, or equal to, five times 108% of Australia’s emissions in 1990.

9.2 Current treatment of LULUCF in Australia

The Marrakesh Accords of the Kyoto Protocol determined that any Annex I party (such as Australia) can claim net emission reductions from activities associated with afforestation, reforestation and deforestation (under Article 3.3 of the Protocol). Parties can also (under Article 3.4 of the Protocol) ‘choose to account for anthropogenic greenhouse gas emissions by sources and removals by sinks … resulting from … revegetation, forest management, cropland management, and grazing land management’. Australia has opted out of Article 3.4 and does not currently have to account for its emissions in these areas.

A key reason for Australia’s decision to opt out of Article 3.4 is the risk that “major natural disturbances”25, which Australia has no ability to control, could completely overwhelm any emission reduction efforts we undertake. Nor is there any ability to create a policy response to address or ameliorate these impacts.

In the first commitment period, LULUCF is included towards Parties’ mitigation commitments as an addition (net removals) or subtraction (net emissions) from their initial assigned amount. This is illustrated in Chart 22.

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24 The term LULUCF refers to Land Use, Land Use Change and Forestry.

25 Major natural disturbances are episodic events that can lead to massive variations in emissions and removals from the land sector. For example, fires, damage due to storms and pest outbreaks.
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Chart 22
Current provisions for how LULUCF emissions/removals adjust Parties’ assigned amount after the mitigation commitment (target) is applied

1. Take base year emissions for Annex A sectors, and deforestation if included. Time five for the number of years in commitment period.

2. Multiply this baseline value by the Party’s percentage mitigation target as per Annex B. The result is the initial assigned amount.

3. Calculate the ‘LULUCF adjustment amount’ as per the Marrakesh Accords (refer Figure 2).

4. Adjust the initial assigned amount by the LULUCF adjustment amount (‘2’ minus ‘3’). The result is the adjusted assigned amount.

5. Take commitment period emissions for Annex A sectors only, plus units transferred or acquired under flexibility mechanisms.

6. Calculate the difference between ‘4’ and ‘5’ to assess whether the target is met.

Data source: Australian submission to the AWG-KP and AWG-LCA on LULUCF, March 2009.

Chart 23
Current provisions for deriving the LULUCF adjustment amount

Before the commitment period:

a. Take base year net emissions/removals from lands subject to elected Article 3.4 activities Cropland Management (CM), Grazing Land Management (GM) and/or Revegetation (RV), time five for the number of years in the commitment period.

b. Take commitment period net emissions/removals for CM, GM and/or RV.

c. Calculate the difference between ‘a’ and ‘b’ (without multiplying by the percentage mitigation target). The result is the net-net accounting quantity for CM, GM and RV.

d. Add to ‘c’ the following amounts from the commitment period:

- the accounting quantity for lands subject to afforestation and reforestation (AR) and application of the credit/debit rule, and lands subject to deforestation (D); and
- the accounting quantity for lands subject to forest management (FM), with application of the FM cap provisions.

The result is the LULUCF adjustment amount (which equates to ‘3’ in Figure 1).

Data source: Australian submission to the AWG-KP and AWG-LCA on LULUCF, March 2009.
Chart 23 illustrates how the amount by which LULUCF adjusts the initial assigned amount is determined.

### 9.3 Tiers

The IPCC methods for estimating emissions and removals are divided into Tiers encompassing different levels of activity and technology detail:

- Tier 1 methods are generally straightforward (activity multiplied by default emissions factor) and require less data and expertise than the more complicated Tier 3 methods.
- Tier 2 and 3 methods have higher levels of complexity and require more detailed country-specific information, on things such as technology type or livestock characteristics.

The concept of Tiers is also used to describe different levels of: key source analysis; uncertainty analysis; and quality assurance and control activities. There is a general expectation that parties will use “robust estimation methods” to ensure confidence in the emissions and removals from LULUCF; also that they should be transitioning towards higher level (Tier 2 and Tier 3) accounting methodologies for emissions.

### 9.4 Post 2012 treatment of Agriculture and LULUCF

There remains considerable uncertainty about the shape of the post-2012 environment for LULUCF. Essentially, the Parties need to decide:

- How land-based emissions and removals are to be included towards Parties’ mitigation commitments and associated baselines.
- Which land-based anthropogenic emissions and removals are covered in the post-2012 outcome, and which parts of the land sector are mandatory or elective.

Broadly speaking, the Australian government’s position is to try to ensure that the mechanisms are sufficiently flexible to allow for all opportunities for mitigation in the sector to be considered.

The Bali Action Plan called for measurable, reportable and verifiable (MRV) mitigation by developed and developing countries.

Australia has argued that MRV commitments and actions should focus on actions capable of achieving quantifiable emissions limitation or reduction outcomes. Furthermore this should include actions for which outcomes are

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not directly measurable, but can be extrapolated or projected, based on agreed methodologies.

The submission goes on to argue that:

...actions that cannot easily be measured in terms of emissions limitation or reduction outcomes should not be ignored.

Possible examples include actions relating to technology R&D, capacity building, education, behaviour change or enabling environments, can all deliver important mitigation benefits. The submission argues that:

In these cases it may be appropriate to consider measurement, reporting and verification as individual concepts (i.e. excluding “measurement” as a requirement) or to consider “measurement” in relation to alternative indicators, such as inputs or implementation.

As a further indication of the desire to maintain flexibility, Australia argued in its submission on the post-2012 arrangements, that:

The flexibility mechanisms should be technology-neutral and not prescribe or proscribe particular technologies. 27

The example provided was that carbon capture and storage (CCS) should not be excluded from the flexibility mechanisms. However, the same argument might equally apply to other measures to limit or remove emissions. The submission went on to state that:

• Australia supports including a broader range of land use, land-use change and forestry (LULUCF) activities in the flexibility mechanisms.

• Australia does not support a cap on eligible LULUCF activities under the flexibility mechanisms. All genuine abatement activities should be included in the flexibility mechanisms without restriction. Placing undue limitations on particular activities will increase the cost of abatement to the global economy.

The submission reiterated Australia’s view that the flexibility mechanisms should be technology-neutral and not prescribe or proscribe particular technologies. Again the example given was CCS. While acknowledging that some countries have concerns about the inclusion of CCS in the flexibility mechanisms, particularly in relation to issues such as long-term liability and monitoring of storage reservoirs, Australia argued that these issues can be satisfactorily addressed.

27 Submission on post 2012 flexibility mechanisms, March 2009
9.5 Policy-relevant observations

Anticipating aspects of the discussion in Section 10, these provisions, in principle, seem to offer a substantial flexibility:

- To use accounting methods that are uncertain, even based on formulae that are not country-specific; though the presumption of transition to higher tiers imposes some discipline:
  - There appears to be scope to apply different tiers of precision to different aspects of abatement and sequestration responses.
- To aggregate impacts across a portfolio of measures.
- It appears that portfolio-based statistical risk management, as is discussed in Section 10.3 to 10.5, would not be precluded. We have seen little evidence of this approach being accepted, but this may stem more from interpretations of the rules than from the rules themselves.

Article 3.4 is restrictive, with its ‘all or nothing’ structure. Theoretically at least, it appears prone to significant inefficiency, as a result of real constraints on flexibility to assess feasible initiatives on their own merits as contributors to a total solution. Australia could stand as a real case study of intervention failure, in the sense that it has led to general opting out, despite the fact that there are a number of highly prospective measures that might otherwise be tapped to deliver greater and/or more cost-effective abatement. The combination of this provision and Australia’s decision to opt out has been to largely exclude soil carbon build-up as a part of agriculture’s response options – if required\(^\text{28}\) to deliver abatement that complies with these rules.

Our impression is that, if the bundling of non-anthropogenic with anthropogenic emissions persists, post-Kyoto, the Federal position is likely to be retained: the risks associated with accepting responsibility for the non-anthropogenic emissions would again be deemed unacceptably high.

That said, the presence of a ‘grey area’ in relation to sources and sinks – where land use patterns have influenced, and could in future influence, the propensity for natural disturbance to cause emissions, does create some issues. There may be legitimate concerns with gaming of the provisions that should be addressed. However, for countries where agriculture accounts for a major share of aggregate anthropogenic emissions, or offers a potentially competitive range of carbon sinks, then the costs of an ‘all or nothing’ structure to these provisions appears likely to be high.

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\(^\text{28}\) Of course, that need not be necessary if instead the focus on agriculture is on tapping cost-effective abatement relative to what would otherwise have occurred – possibly with feedback to targeted levels of emissions abatement within the rules and with links into Australia’s international engagement processes.
We understand that the main enthusiasm for the current bundling lies with a number of developing countries – with their having concerns that unbundling could allow some advanced countries to game the rules as a way of limiting their responsibilities.

Where the bundling results in a decision to opt out of accounting for the anthropogenic emissions, this has the effect of isolating agriculture from a range of its more prospective abatement-reducing strategies – and this strongly favours finding a better way to address the concerns that have led to the present structure of Article 3.4.

The fundamental problem lies in the conflicting incentives that arise. Incentives to walk away from attempts to tap into, and obtain benefit from, the ‘upside’ of land-based intervention possibilities, brought about because of an artificial linkage to risks and costs from events over which Australia may have virtually no control.

In terms of greenhouse gas emissions, droughts and bushfires are largely cyclical – with the uncertainties relating to the timing and severity of abnormal emission events and subsequent re-sequestration into soil. Even if these are to be the focus of sound policy measures, the appropriate instruments are likely to be quite different from point-in-time emission targets that are being pursued in respect of anthropogenic emissions. Appropriate policy would rely on dynamic, adaptive process to deal with the unavoidable uncertainty as to timing and severity of events. This would again involve options-based instruments – focused on cumulative contribution to climate change, not on point-in-time emission levels.

Additional complexity enters if there is a view that climate trends mean the cycles may not be perfect. If parts of Australia are becoming drier, more prone to drought and more prone to bushfire, there may well be an underlying trend in non-anthropogenic emissions. This will be a result of global climate change pressures, far more than it will be a result of specific controllable local actions.

The same will be true, in principle, of rising methane and carbon dioxide emissions from Arctic lands, as the ice cap retreats and permafrost thaws. The world does not want to lock out its access to prospectively low cost abatement options because of the threats from these background trends; indeed, it needs access to these options all the more because of these trends.
Box 3 **The case of the Pine Tree Beetle in Canada**

Australia is not alone in its concerns with assuming responsibility for non-anthropogenic emissions, including where they may be being driven by global climate change.

Canada, for example, is now acutely aware of its vulnerability to pine tree beetle. A recent study has pointed to the scope for dramatic emissions of carbon when this pest develops to a plague stage. The authors assessed that, in the worst single year of plague in British Columbia alone, the resultant carbon emissions from forest destruction approximated 75 per cent of all emissions from forest fires, across all of Canada, over the forty years from 1959 to 1999. The authors argue that climate change is contributing to the severity of the problem, with the current outbreak being by far the most severe on record.

Source: Kurtz et al., 2008

We believe it is crucial to sound global and Australian climate change planning and incentive processes, that a means be found – within the rules or via strategies that fall outside the rules without conflicting with them – to separate the anthropogenic land-based greenhouse issues from the large and crucially non-anthropogenic component that is likely to require a very different policy approach. Failure to do so threatens to severely limit feasible levels of abatement and sequestration and guarantees higher costs for any given level.

The associated biases are particularly acute for countries like Australia, with large land bases relative to the size of their economies, with a likelihood of significant disproportionate climate trends that adversely affect non-anthropogenic emissions, and where agriculture has relatively high significance in the economy and in exports.

Australia set out its views of relevant policy principles in its submission last November to the UNFCCC (Box 4).

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29 Note that we are not arguing for ignoring the potential to influence these non-anthropogenic emissions. Research into biological control of pine beetle in Canada and reduction in forest fire risks globally makes sense. Farming systems can alter drought risks in respect of emissions – and indeed form a key element in the policy levers we have considered. What we need is a mechanism to avoid the perverse consequences of a measure designed to increase abatement efforts actually having the opposite effect, or forcing abatement into higher cost instruments. Policies for non-anthropogenic emissions will almost certainly be needed for both overall policy integrity and for successfully arguing for a separation.
Box 4  **Initial Australian position on Article 3.4**

It is necessary to make changes to the current rules so that only human activities that can practicably be influenced are included in the LULUCF sector, as is the case for all other sectors. Otherwise, large variations in Parties’ accounts from natural events, over which they have no control, can dictate whether a Party fulfils its commitment.

Methods exist to exclude non-anthropogenic emissions from accounts, and Australia submits that these should be made explicit in the LULUCF accounting rules adopted post-2012.

Accordingly, the treatment of the LULUCF sector in a post-2012 outcome should be based on the following set of core considerations;

1. Emissions and removals from anthropogenic sources only, consistent with the UNFCCC objectives and treatment of other sectors. LULUCF is the only sector with accounting rules that extend to non-anthropogenic emissions (for example, from wildfires and drought).
2. Emissions and removals reported and accounted for at the time and place that they occur: reflecting ‘what the atmosphere sees’.
3. A rigorous, robust and comprehensive approach, which strikes a balance between scientific precision, practicality and policy relevance.
4. Cost-effectiveness of policy responses: recognising the need for a comprehensive suite of measures to support mitigation action.
5. Consistency across Parties, while reflecting Parties’ national circumstances, and consistent, mutually supportive, treatment of land sector issues across the AWG-KP and AWG-LCA.
6. Avoidance of perverse incentives that would lead to negative environmental outcomes in developed or developing countries.

Source: Australian submission to the UNFCC: AWG-KP & AWG-LCA. Land Use, Land Use Change and Forestry (LULUCF) Sector.

The fact is that abatement/sequestration of anthropogenic emissions will be of global value, whether counted within the prevailing rules or not. If a credible lower bound can be based on the trend quantum of such emissions, then this will reflect value to global and national risk management. If there is significant upside to those lower bounds, then those upside prospects will also be of value to global climate change efforts. It will be of high cost globally, and especially to Australia, to predicate its climate policy strategy solely on emissions that are compliant with current international rules.

From Australia’s point of view, and from a global perspective, the effect of Article 3.4 and the fact that Australia has concluded that it must opt out of its coverage, is to elevate the costs for Australia of achieving any given target—and this translates to a lower target for overall abatement, whether assessed in economic or political cost-effectiveness.

A key policy question for Australia and especially for Australian agriculture is: what strategy does Australia adopt in respect of the opportunities for
abatement within the anthropogenic part of the land use and land use change, in advance of any change to the rules along these lines?

There are two possible ways of looking at a departure here:

• Recognise that there is a flaw in the rules (which is part of Australia’s current negotiating position) and that this flaw is amenable to change and has good prospects for change by 2020, and all the more so by 2050, and base planning around the recognition of this possibility:
  − Sound options principles would then favour tapping some of the value, in the form of low-cost abatement and sequestration prospects that are not yet compliant, as an integral part of a strategy designed to minimise expected costs for Australia, given these prospects for change.
  − This would sensibly be accompanied by a negotiating strategy designed to boost the prospects for change and by R&D directed at boosting the capacity to take advantage of such change.

• Take a strong position now that the primary purpose of Australian abatement/sequestration strategy, and reason for its willingness to accept costs, is a focus on limiting global emissions, not just those emissions that comply with accounting rules that are artificially restrictive:
  − And to argue that primary targets, etc. will be set inclusive of conservative assessments of abatement, delivered by measures not yet covered by the rules, as well as measures that are covered.
  − Such a strategy could include formal commitment to a lower bound target on compliant emissions, but this setting would be depressed by the (current) artificial character of 3.4, and Australia’s sensible desire to maintain flexibility to expand reliance on verifiable abatement and sequestration not yet allowed under the rules. The ‘headline’ target would sensibly be the sum of compliant outcomes and a verifiable, possibly conservative assessment, of other outcomes not yet compliant.

Neither of these approaches would entail violating the rules. The former is strictly compliant, but applies an options-based approach to cost optimisation to deal sensibly with an unavoidable uncertainty. The latter recognises that the rules are not prescriptive about target levels and in no way preclude a process that commits to a lower bound on compliant emissions and a lower bound on effective emissions, inclusive of soundly-based, non-compliant abatement and sequestration.

The scope for sensibly pursuing either of these paths – with a highly credible contribution to national and global abatement, in a form that might influence other countries to better tap opportunities in their land bases – can be greatly increased through recognition, and exploitation, of the portfolio risk management principles developed further in Section 10.
A further aspect of these accounting processes, that warrants comment in a policy setting, is the demand for permanence. This can be difficult to demonstrate for land-based offsets. Clearly, unambiguously permanent abatement or sequestration is preferable to uncertain or less than permanent commitments. It would be a serious mistake, however, to conclude that abatement that cannot guarantee permanence is worthless as part of a cost effective abatement strategy. There are several factors at play here:

- If there is a social rate of discount, then delaying the need for abatement or sequestration can have value for this reason alone – especially if the costs of later abatement are likely to be no higher than costs of current abatement.

- In the context of rapidly evolving technologies, the prospects for lower cost options emerging in the future would have to be considered reasonably high, so there may be real option value in effective delay if it can be achieved at modest cost.

- Some sequestration methods lend themselves to sequential use, to deal with any leakage that emerges – trees can be replanted after a fire; agrichar could be reapplied (possibly with productivity as well as sequestration benefits), if original agrichar breaks down faster than had been assumed; agrichar might be applied as an alternative to replanting burnt trees should this prove more cost-effective if re-sequestration is needed in the future (an example of a portfolio response to lack of permanence), etc.

- Sequestration now has value even if it is guaranteed to be re-emitted later without replacement – because of the immediate and cumulative effects of atmospheric greenhouse gases today, in building global warming – the warming effects can also be delayed.

If the full opportunities offered by Australia’s land base are to be realised, there is a case for making sure that any provisions on security of abatement and sequestration over time, are not structured in a way that posts inefficient incentives to use what may be highly cost-effective instruments as part of an overall portfolio approach. Reasonable principles could be developed to value sequestration with different levels of ‘life expectancy’ and certainty. Measures implemented now can be constrained by requirements to accept the risks if they must be replaced later – as is done in forestry. If risks are pooled across a portfolio, limited life expectancy, and or certainty, could be reflected in discounting of the value of an individual initiative because of the need to insure the risk across the portfolio.

These concepts of portfolio risk management are developed further in Section 10 and in Appendixes C and D – potentially their implications for permanence requirements are quite profound.
10 Portfolio-based policy prospects

The discussion in Section 7, elements of which are developed further in Section 12 below, flags a wide range of possible contributors to a role for agriculture in supporting overall abatement and sequestration strategy. It recognises that some rely on technologies yet to be developed, proven or commercialised. In other cases, the technologies exist, but the level of impact on abatement, the scale of sequestration, the full extent of possible side-effects, are not well understood or are highly site/farm system specific.

There appears also to be an important group of initiatives where implementation would be possible now and where there are good prospects for useful abatement or sequestration. There is little prospect of any abatement/sequestration effects being seriously negative, nor for major side-effects (beyond commercial cost and productivity interactions, at least some elements of which may be positive). This seems true, even though accurate prediction of the magnitude and duration of abatement and sequestration impacts is, at least in some cases, significantly constrained.

Included here, as examples, would be some potential modifications to herd and flock management, especially in response to drought; use of coated nitrogenous fertilisers in some applications; and the application of some forms of biochar to at least some cropland. This is not to say these technologies are cost effective, but they do offer strong prospects for abatement and sequestration impacts, with at least the option of early application if the incentives are in place.

In this Section, and in Appendix C, we look in more detail at policy and strategy insights that flow from taking a true portfolio view of opportunities of this suite – with different instruments, to which different levels of confidence can be attached as to availability, timing, impact and implied abatement costs, and, as a key part of soundly managing such a portfolio, with a strategic investment in a suite of R&D programs and processes to attack, where feasible, the most limiting elements of the uncertainty that currently exists.

It turns out that a number of the insights that flow from this appear to have particular application to the opportunities offered by agriculture – much more so than for most other sectors. These insights and policy/strategy principles do challenge aspects of the currently emerging general approach across countries committing to cap and trade arrangements. We argue below that they also point to ways to improve such arrangements – potential both to
lower costs of greenhouse gas abatement and sequestration and to reduce the concerns with introducing agriculture into the CPRS.

This section is somewhat abstract – relying heavily on analogies within other risk management problems and stylized examples to establish principles and illustrate their possible significance. The section would make a good appendix, were it not for the fact that an understanding of these principles really is a prerequisite to understanding our subsequent discussion of policy alternatives. We set out here what is, in some respects, a paradigm shift in approaching the climate policy problem with the types of opportunities offered by agriculture.

### 10.1 Lessons from mining and petroleum

Drawing on lessons from the mining and petroleum sectors to inform better greenhouse gas abatement policy might seem a little perverse. However, these sectors have extended histories of managing portfolios of strategic investments, opportunities and risks in the presence of very high levels of uncertainty. A central challenge for companies with a long-term vision is to engage with investment in information, as well as production, to support sustainable performance despite these uncertainties.

#### 10.1.1 Balancing the present against the future

Consider the case of a diverse mining company. This company has a number of operating mines across different resources; a number of active exploration programs; a backlog of completed and advanced exploration that has identified further prospects, with varying levels of confidence; exploration rights over further areas; and a body of background geological and production cost/product value data. It may also have investments in R&D to deliver more cost-effective extraction and processing technologies – and these days that may well include research into better management of emissions.

The challenge for the company is to plot a way forward, which, in some sense, supports the *shareholder objectives* that the company be sustainably profitable, that risks to profitability be managed, and that opportunities to improve performance be identified and accessed as appropriate – and that, subject to these considerations (and institutional constraints), the company seek to deliver as much value as possible.

A short-sighted response would proceed to ‘milk’ the existing mining operations and the known reserves already identified as commercially viable. This would minimise the risks of ‘wasting’ money on exploration or on production that subsequently proves unprofitable. However, it would seem likely to conflict with shareholder objectives in a number of ways:
Agriculture and GHG mitigation policy: options in addition to the CPRS

- The direction of company equity and debt solely at these opportunities may well involve lower profits than might be possible by exploiting some of the other prospects, even though they are not yet proven:
  - It might make sense to defer some of the activities with the most marginal profitability, to test the ‘competitiveness’ of the alternatives.

- Minimising the risks of wasting exploration funds also has the effect of minimising the prospects of tapping a potential ‘bonanza’ within the exploration portfolio or, indeed, within the strategic investments in processing R&D:
  - The strategy can be expected to constrain growth prospects.

- The strategy is not sustainable – a mining company cannot survive indefinitely on existing known reserves and production processes. It needs either, or both, of:
  - on-going renewal of the ‘next cabs off the rank’ through successful exploration (that will almost always entail some unsuccessful exploration); and
  - improving technology to allow continuing commercial production from harder to access or lower yielding ores/tailings, etc.

- Some already commercial viable developments may have good prospects for being even more attractive in the future – because of trends in commodity markets or prospective improvements in the technologies to access or process the reserves:
  - It may well be rational to hold off on some of these developments and instead direct resources at exploration with high prospects, and at other R&D – or at developing even faster reserves where trends may be in the opposite direction.

In short, the company faces the challenge of balancing the evolution of its portfolio of opportunities, with the right balance having elements of risk management, creating options to access upside opportunities and maintaining adequate cash flow and trend profitability. In general, the larger, long-established companies have evolved sophisticated tools for achieving this balance. Reflecting the above concerns, these tools are about balancing the portfolio – across currently available production options and between those options and potential future options – to secure sustainable and competitive performance.

Paralleling the abatement policy imperative of delivering ‘adequate’ abatement over time is the imperative to also sustain adequate cash flow and profitability. Paralleling the abatement policy concern for doing this at least cost is the pressure to maximise the access to upside opportunities, subject to the requirement to manage downside risk. The ‘solution’ for mining is not to look only at what could be done today and do only those things that definitely will deliver profitably – this would be unsustainable and could seriously threaten
company competitiveness. The optimal response is to defer some of these possibilities while testing others.

### 10.1.2 Balancing across current uncertain prospects

There is another relevant example – which only develops in more detail an element of the above portfolio strategy, but accentuates the point that a portfolio can perform well and sustainably, even if no single element can be guaranteed to work.

Petroleum companies sustain their long term production with a strategy that drills a lot of wells – with each well costing many millions of dollars. Commonly (away from a few rather special areas, such as are found in parts of the Middle East), far fewer than 10 per cent of these wells end up delivering access to commercially recoverable petroleum. Some yield nothing; some yield reserves that are not commercial or at least not yet commercial. Nonetheless, this portfolio approach to production – tapping into numerous individually unlikely possibilities – has for many companies managed to underpin profitable, competitive production over many years. The risk profile of an individual prospect is far scarier than the risk profile of a portfolio of investments in such prospects.

Of course, the commercial wells need, on average, to be sufficiently commercial to cover not just their own costs, but also the costs of the unsuccessful wells. For this reason, a higher ‘strike rate’ is highly desirable and justifies companies investing heavily in more accurate resource modelling and exploration planning tools. Nonetheless, any strategy that would refuse to drill unless the reserve was guaranteed to contribute to company profits would almost certainly prove fundamentally unsustainable and uncompetitive.

We believe there are strong analogies here with the portfolio of uncertain prospects offered by agriculture. Even if every individual prospect were uncertain, collectively these possibilities may support a sustainable and competitive abatement strategy – even one that is essential to the assumed purpose of Australian greenhouse policy, given its emphasis on cost as well as targeted abatement.

### 10.2 Forestry rules as a ‘sub-portfolio’ approach

As has already been noted, planting trees has been accepted as a way of creating offsets that can be traded into the CPRS. We endorse the concept. However, it is worth looking at what is actually involved in this policy.

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30 We do so while noting that tree planting can involve many of the complex interactions with other externalities in natural resource management that were discussed in Section ### – with
Planting trees does offer reasonably predictable carbon capture under certain assumptions. These include such things as assumptions about growth rates, life in the ground and ‘fate’ post-harvesting if they are harvested. Life in the ground is rendered uncertain by both prospects for harvesting and risks of unintended loss – most notably through bushfires.

Recognition of these risks has resulted in the emergence of a form of portfolio risk management as part of the treatment of forestry. To ensure that tree planting is not ‘over-compensated’ through credits issued, a range of complementary measures have been included to hedge this risk:

- **Credits are extinguished by harvesting**, though they can be recreated through planting:
  - This approach is highly conservative – not all harvested trees are immediately returned to the atmosphere as greenhouse gases – but it does allow a key risk to be managed, at the expense of under-compensating tree planting for average patterns of harvested timber use.

- In the event of fire, the trees have to be replanted to protect the credits:
  - This is effective, but possibly restrictive and unnecessarily costly relative to other ways of acquiring enough offsets to cover the effect of the fire.

In effect then, the key risks in tree planting are managed via a larger portfolio approach, in which tree planting now is hedged via options to extinguish credits in the event of harvesting or fire and possibly with contractual requirements to exercise options to replant. These hedge instruments look likely to be significantly biased towards discouraging the initial tree planting – by underestimating expected sequestration and by constraining the possible ways of replacing lost sequestration in trees. Nonetheless, they do combine with initial tree planting to deliver a ‘sub-portfolio’ of tree-based sequestration options, that are seen as sufficiently certain to allow their recognition and trading within the CPRS.

This study is not about advising on improvements to the design of the forestry provisions. Here we focus on this as an example of how individually uncertain (as to sequestration impact) activities can, as part of a strategic commitment across several instruments and across time, deliver a sequestration outcome that is acceptable within the rules. This demonstrates an important principle that we believe is sound and that may well warrant generalisation in the case of agriculture. Agriculture offers a wide range of instruments. Is it necessary that they be technically linked (such as planting trees if trees burn down) for the aggregate effect to be acceptable within the rules?

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major concerns having arisen in recent years over the impact of increased forestry plantations on other water users and for associated ecosystems.
10.3 Managing risks ‘statistically’

Appendixes C and D set out some further detail on risk management principles and portfolio effects. Here we concentrate on some specific aspects that appear to have special application to agriculture. Could a large number of individually uncertain measures be implemented to deliver abatement and/or sequestration with much less uncertainty – and could any residual uncertainty be better hedged, as with forestry, via a form of insurance that has a low premium, even if a higher excess is payable in the low likelihood event of a ‘claim’ being needed.

The discussion in the Appendix looks at the way that a portfolio of R&D measures can combine to greatly limit risks. The same logic applies to the use of multiple instruments, each uncertain in their abatement impacts.

To keep things simple for a moment, suppose there are two possible changes to Australia’s farming, each with a chance of lowering aggregate abatement. Assume they are totally independent. One might entail a change to drought management in WA and the other to applying biochar to a property in south east Australia. They rely on different science and are being applied to different land. This is just to keep the key argument as clear as possible – these assumptions can be relaxed.

We also assume that both measures can be implemented for a cost of $5 per tonne, and that in both cases the hope is that the investment will capture or abate one tonne of CO$_2$-e. Success is not guaranteed, with an estimated 50 per cent chance of success, and a 50 per cent chance of failure with no impact on atmospheric carbon.

Policy makers worrying about being able to guarantee they reach a target level of abatement would be understandably suspicious of each measure in isolation. What if they back the changes and they do not deliver – there would be a 50 per cent chance of not making the assumed contribution. In general, and presumably largely as a result of this reasoning, and a view that the climate change threat is big enough to support some form of precautionary principle – such measures are not in general recognised.

Note, however, this conclusion flows from a strong policy emphasis on targets – which are a policy means not a policy end. If we stood back and said that we can deliver a 50 per cent chance of taking a tonne of CO$_2$-e out of the atmosphere for $5, and assessed this in the same ‘doomsday’ context that supports the precautionary principle, the measure might look like good insurance. This would seem particularly true in a world in which we are moving to a CPRS that will encourage abatement actions that cost well over $20/tonne of CO$_2$-e, and could rise towards $100/tonne (based on Treasury
estimates and other modelling). Statistically, each of these actions offers an ‘average’ half a tonne of abatement for $5 – or a marginal cost per tonne of expected abatement of $10. Yes, the abatement is uncertain, but to an extent that uncertainty is factored into this $10 figure.

But what happens if both actions are performed. At best, we achieve two tonnes of abatement for $10 – $5 per tonne. At worst, there is no abatement – despite spending $10. In between, there is the chance of one delivering and not the other – one tonne of abatement for $10.

The probability of each outcome can be mapped out here – it is a simple binomial problem:

• 25 per cent chance of 2 tonnes of abatement @ $5/tonne
• 50 per cent chance of 1 tonne of abatement @ $10/tonne
• 25 per cent chance of no abatement, costing $10
• Averaged across both possibilities, 1 tonne of abatement @ $10/tonne.

Already, the combination of measures looks better than each individually. The risks of not delivering abatement at all have been halved. The prospect of delivering abatement at a price competitive with the CPRS marginal cost of abatement has been increased by 50 per cent (from 50 per cent to 75 per cent). The ‘shape’ of the distribution of possible outcomes is being squeezed – both away from zero and away from the most optimistic abatement cost. Importantly, the chances of real abatement have risen.

Of course, a 25 per cent chance of failing to deliver might still be considered unacceptable. What if there were three such changes that could be used. It is again possible to work the arithmetic and conclude:

• 12.5 per cent chance of abating 3 tonnes @ $5 per tonne
• 37.5 per cent chance of abating 2 tonnes @ $7.50 per tonne
• 37.5 per cent chance of abating 1 tonne @ $15/tonne
• 12.5 per cent chance of no abatement at a cost of $15
• Averaged across all possibilities, 1.5 tonnes of abatement @ $10 per tonne.

As the number of such activities rises, the trend continues – shrinking risk of no abatement, increasing the likelihood of tonnes of abatement close to half the number of such changes31. What if there were 100 such changes, costing $500. The chance of no abatement is miniscule – (1/2)^100, or about 10^-30. The average level of abatement would be 50 tonnes, at an average cost still of

31 This conclusion is actually true even if the changes are not all independent – provided they are not perfectly correlated. Even if perfectly correlated, the same ‘average’ result applies, but the reduction in the risk of no abatement would stay at 50 per cent.
$10 per tonne. Not all possible outcomes that deliver abatement would be judged as cost effective. For example there is a tiny chance (about $10^{-29}$) only one would deliver abatement, and at a cost of $500 this would be expensive. There is of course a matching chance that it would deliver 499 (and even 500) tonnes of abatement for $500 and this would look extremely cost-effective.

However, given the uncertainties, this backward looking perspective has little relevance. The fact is that, under the above assumptions, 21 of the 100 chances would have to work out to deliver an abatement cost of no more than $25/tonne – used here as a crude indicator of ‘break even’. The probability of this not happening can be calculated as approximately three chances in a billion. For an abatement cost of $50, the chances of this not being achieved would be about $10^{-15}$.

In brief, a large number of initiatives can combine to deliver very high probability of delivering significant, and cost-effective, abatement. The same principles could place a statistical lower bound on the level of abatement. In the above example, accepting a one chance in a million risk of failing to at least meet a proposed quantum of abatement, would allow the combination of the 100 activities to be associated with abatement of at least 26 tonnes. Each in a thousand would increase this to 34 tonnes. Each of these abatement levels would be associated with a portfolio strategy with an expected cost of $10 per tonne.

The same logic applies if the probabilities are different – as long as each initiative has an individually risk-weighted cost that would be competitive if it could be guaranteed. As was noted before, correlations can alter the calculations, but would not cut across the core principle – that weighing risks initiative by initiative can be seriously misleading relative to taking a whole of portfolio approach.

### 10.3.1 Policy pointers

Suppose now that we knew that Australian agriculture is characterised by 100 feasible initiatives that satisfy the above assumptions, except that now instead of tonnes and dollars, we talk about millions of tonnes and millions of dollars. Each individually is considered too uncertain to ‘count’; collectively they would, with near certainty, deliver about 50 million tonnes of abatement annually – with a ‘value’ of the order of over $1 billion annually (valued at a likely marginal cost of abatement from the CPRS), or an amortised value to Australia of about $8-10 billion. That would be the cost of trying to absorb the extra 50 million tonnes of abatement within the CPRS, assuming the marginal cost of abatement is not escalating. It would also be about the cost of forcing agriculture into the CPRS but in a manner that did not provide incentives for these on-farm behaviour changes.
Perhaps it would be too big a step to accept the expected abatement of 50 million tonnes – but what about 34 million tonnes (99.9% certain), or 26 million tonnes (99.9999% certain):

- What price insurance against the remaining ‘gap’ – perhaps in the form of more aggressive regulation if the gains are not realised – given the incredibly low probabilities of this outcome emerging:
  - An alternative or complementary approach would be to require extra credits/offsets to be purchased in the event of under-delivery – extending the concept behind a requirement to replant trees in the event of loss to fire.
  - As with other insurance against a very low probability event, it could be quite rational to accept this tiny chance of triggering a relatively high cost ‘excess’, rather than forcing a higher cost premium up front, in the form of measures with greater certainty but also much greater expected costs of abatement.

10.4 Is statistical hedging practical

There are a lot of simplifying assumptions above. Is it practical to think of translating these principles into Australian climate change policy? Remember we are really talking of extending and deepening existing principles, characterised by the forestry portfolio example.

This is a really important question. If Australian agriculture offers, as is at least hinted at by Error! Reference source not found. to Chart 12 and the wider discussion in Sections 7, options for abatement that are more of this form than in the form of large, lumpy and largely deterministic levers (as might be the case with a switch from brown coal to gas fired generation, for example), then there is an important policy challenge – and significant dollars and major implications for national competitiveness could be at stake.

We see the need for examples like the above, of pooling initiatives to manage portfolio risk while tapping the potential of existing initiatives, coupled with mining/petroleum-like portfolio management tools that balance short-term prospects, given what is known now, against longer-term opportunities, given what might become known in the short- to medium-term.

A corollary of statistical hedging is that you could find you have rewarded actions that did not deliver abatement – but complaining would be like complaining that you paid to insure your house for the past year and got nothing back from the insurance company. In an options view of risk management, what you buy from each of the actions in the portfolio is risk management services – a non-zero prospect for adding to the total in a way that, statistically, is cost effective.
More generally, we accept that insurance companies hedge risks statistically when they offer companies discounts for group insurance, when older people and smokers are charged higher premiums for term insurance or travel insurance, and when young motorists face higher excesses – and when they enter reinsurance markets to further diversify their portfolios.

Commercial risk management is handled via propensities for some groups to perform differently from other groups. This can be perfectly rational and cost-effective as an approach to risk management where it is not knowable (or too costly to find out) in advance who, within a group, is actually the greater risk. Insurance companies base their model for sustainable business around the statistical characteristics of large groups – and to allow this they run an adaptive portfolio risk management strategy.

Of course, it is easy to trot out probabilities and precise abatement outcomes in a stylized example. The reality is that the uncertainties cannot be confidently quantified with precision, and that there will almost certainly be a continuum of levels of abatement of sequestration for most initiatives. Exactly the same is true in the mining sector about rolling exploration and production programs and the associated need for portfolio management. Certainly, it appears even more complex for greenhouse gas abatement than for mineral resource development, but the stakes also appear higher.

This is not a problem that requires an exact solution – the challenge is to do the best to manage risks and limit costs, given the unavoidable uncertainties. In this context, the question of whether the best that can be done is to limit strategy only to those levers that individual offer high certainty of impact becomes very important. It would seem highly plausible, based on the above reasoning, that even a fairly crude approximation to the ideal portfolio statistical hedging strategy could prove much more cost-effective than would a strategy limited to high certainty individual levers.

Devices available to support approximations to the ideal strategy could involve incentive structures that:

- reward individual measures based on safe lower bound estimates of their expected value to the strategy – but, subject to acceptable safety, pitched as high as possible
- complement such incentives with ‘call options”, over the value of any later demonstration that the impact was greater than these lower bound figures, possibly redeemable in tranches, as the estimate is pushed progressively higher
- build accreditation and reward (and or penalty) systems around portfolios of farm system measures spread across a ‘portfolio’ of farms.
In what follows, we seek to outline possible approaches within agriculture for tapping into at least some of this potential.

10.5 Portfolio risk management in R&D

Precisely analogous principles apply to R&D investments. Appendix E provides a specific sequestration example, where diversity in the R&D portfolio can substantially increase the precision with which outcomes can be assessed – and can significantly hedge the risks that the R&D does not deliver a ‘breakthrough’.

In the same way, a portfolio with both specific actions and R&D, and an adaptive process that will influence which actions are used when depending on how the R&D investments are performing, can offer dramatic improvements in cost-effectiveness over exploitation of currently available tools. As has already been noted, the presence of the R&D prospects can alter the optimal early abatement initiatives, because of the preference in an options setting for limiting the risks of regret. Early initiatives that make robust good sense whether the R&D works out or not, will tend to be favoured subject to the requirement of ensuring the ability to meet targets.

Australian strategy is clearly based on a portfolio that includes major investment in geo-sequestration – and such an approach can be interpreted and tested within this sort of a portfolio risk management framework.

10.6 Transaction cost considerations

As the portfolio is extended and diversified, it is likely that the transaction costs in monitoring, and accounting for the collection of changes and their statistical impacts, will rise. Almost certainly these transaction costs will still be dramatically less than those that would arise if there were a requirement for accurate attribution of abatement impact to each change in a farm system on every farm. The use of statistical propensities for abatement, possibly expressed as a lower bound and upside possibilities, will generally be a lot less onerous.

This is not however a reason for shrinking from higher transaction costs, if they are likely to create substantially better incentives to ‘discover’ more cost effective abatement possibilities.

New Zealand’s short-term proposals for including agriculture in its CPRS fall towards one end of the possible spectrum here. Low transaction costs in ‘rewarding’ changes across farms and farm systems will be achieved by assuming a constant level of abatement for given classes of farm outputs, even
where the outputs may stem from quite different farm systems, with quite different emission intensities.

The incentives for individuals to look for and implement abatement-increasing strategies, other than by contracting production or changing to quite different outputs, provide little incentive to encourage a shift in production of a particular output towards those farms offering, or prepared to offer, greater emissions efficiency. Indeed, it may well be that this encourages greatest contraction in production from those farms with the greatest flexibility to adapt – when these may in fact be the very farms that would ideally be most effective in competing to supply, under an ‘ideal’ greenhouse gas regime that was posting sound incentives through to individual farms.

Of course, these very limitations are a reason why the New Zealand arrangements are likely to evolve over time – and probably fairly rapidly. The portfolio principles discussed here could have great relevance to that evolution, as well as to development of appropriate policy for Australia. One of the key risks, and transition costs, that will ideally be dealt with effectively in Australia, is the risk of posting seriously inappropriate incentives for changing the farm sector and its land use patterns ahead of developing arrangements with enough soundly-based differentiation to be reliable statistically in encouraging improved emissions efficiency. Failure here could entail very high costs to the sector and to the Australian economy.

We see the core policy challenge as being to drive an evolving set of policies, in ways that protect against the extremes of these risks, while still allowing the upside opportunities offered by agriculture to be tapped early rather than later.

Provided that there is scope for differentiating the statistical propensity for emissions across farm systems, then it is possible to start to post incentives that extend beyond contracting production and that favour those systems, within, as well as between, classes of output, that are most emissions-efficient. This would not require great precision, though clearly greater precision is desirable if it can be achieved cost-effectively.

Distinguishing crops based on forms of cultivation, fertiliser regimes, soil types, etc. could allow the introduction of a range of ‘classes’ of propensity for emissions. Similarly, distinguishing meat or fibre production, and more generally mixed production, on analogous criteria should deliver analogous capability and scope for accrediting output with a statistical propensity for causing emissions. A capacity to certify the class contributing to specific production, and to track this certification through to point of obligation, or more generally a point for accounting/rewarding and/or penalising emissions, would imply scope for attaching differential assumptions as to emissions content. That
would translate into incentives for behaviour to move towards those classes that have been judged to have the lower propensity for emissions.

The challenge is to find a sensible balance between transaction costs and quality of incentives for change. Striking this balance should take into account likely scope for increased precision in the future, and look to policy settings suited to progressive adaptation to exploit these improving opportunities. As in the earlier discussion of options principles, basing policies on the assumption that current capabilities will not change, may not be optimal. Certainly there will be implications for parallel commitments to research, and adaptation of research, but there may also be implications for the structure of any processes for accreditation – to provide the flexibility for smooth evolution over time, with modest transition costs.
11 Agriculture as a portfolio of abatement options

It is against the background of the principles and the levers discussed previously that we now turn to exploring in more detail the opportunities for bringing portfolio tools to bear on agricultural emissions and emissions policy.

In looking at portfolio prospects, it is important to recognise the time dimension of the portfolio opportunities. Many of the opportunities offered by agriculture lend themselves to rapid implementation and do not require large and irreversible investments of capital. This relates to a range of farming practices – including patterns of cultivation, of drought management, fertiliser application, etc., and possibly to such things as biochar application. This flexibility has value in the potential it offers for early abatement, without large irreversible commitments to costs that could later prove seriously regrettable. It has value as a way of demonstrating clear progress, in underscoring Australian international influence. And it has value because abatement and sequestration applied now are inherently valuable to climate response:

- Emissions that are not abated early can never again be abated (though they might later be sequestered). The emissions are a net increase to atmospheric greenhouse gases that feeds into an accumulating global liability for the future – a ‘legacy cost’.
- While extra greenhouse gases are in the atmosphere, they are contributing, effectively irreversibly, to climate change. A tonne of CO2e emitted this year, implies higher costs than a tonne emitted next year, and cannot be fully compensated for through a tonne of sequestration in 2020.

These points favour early action but do not compel it. Good prospects for more cost-effective elements emerging later, could justify a more measured early response. However, early access to initiatives that are likely to entail low costs and little likelihood of serious regret does, as a result, offer real value. The emphasis in target setting on point-in-time abatement levels, does not fully recognise the value of earlier abatement – however, the policy objective of supporting delivery of the most cost-effective climate change response does.

There is a range of characteristics of farm businesses that supports the development of a portfolio of abatements and sequestrations.

As with any investment portfolio the choice of investments to include in portfolios will depend on the objectives of the investors and their attitude to risk. In financial markets, portfolios will generally be constructed on the need to balance expectations of growth and yield (returns) against risk. Portfolio
Diversification proves of great value here, because of the scope for the diverse portfolio to exhibit much less volatility than its individual components – allowing higher growth and yield expectations to be pursued with still acceptable risk. Similar principles, as outlined in earlier, apply in the construction of a portfolio of abatement and sequestration activities and investments.

Farmers will therefore look to balance their portfolio across a wide range of levers, considering the risk / reward profile of each. More generally, climate change policy will have an interest in pursuing even greater diversification and balance across multiple levers and multiple farms, regions and farming systems. Here, the heterogeneity that has underpinned concerns for the viability of many farm-level initiatives as components of meeting abatement targets, can actually become a strength (of sorts) by allowing diversification across different systems with abatement and sequestration patterns that are not perfectly correlated.

Another important aspect of an agricultural emissions management portfolio will be the time value of the emissions and who bears the technology risk (the risk that planned emissions management commitments or targets are not met) and the price risk – and how these risks will be managed.

Taking these features into consideration, farm portfolios are likely to be constructed:

- within the enterprise
- across enterprises within the farm
- across farms
- across farms and across regions
- with variations in the time profile of the abatements or sequestrations; and
- between initiatives that can viably be implemented in the short-term, and a range of possibilities likely to emerge in the future.

Australian agriculture has a long history of collective investments, both compulsory and voluntarily. Wheat pools have been a major selling method in grain markets for years, and there are numerous cooperatives through which farmers procure inputs and sell produce.

It is important to note that each farm will have access to a unique range of abatement options, depending on a range of factors including the:

- geographic location of the farm
- the enterprise mix
- sunk investment in plant, equipment, fertiliser banks, livestock breeding, etc.
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Agriculture as a portfolio of abatement options

- management capability and
- the ability to access capital to invest in new technology.

It is likely that, for most portfolios, a key determinant of its characteristics will be the attitude to risk by the farm manager. This is important because the way that risks are assigned can have strong policy consequences. Incentives to manage risks can be strong motivators for change.

The following is a list of examples of the types of portfolios that could be constructed by a farm manager. This is not exhaustive, as the portfolio options are large even with a small number of abatement levers being compliant with the policy instrument(s) used.

For a farm manager who is strongly risk averse, the portfolio options may include:

- Participating in a scheme with the point of obligation upstream (with the input supplier). This might be conducted on a single abatement lever such as purchasing stud bulls bred (conventionally or genetically altered) for greater emissions efficiency:
  - The stud might then accumulate the abatement credits on behalf of the farmer, and reflect them in the value of the animals, or the credits could be pooled with all of the stud’s customers and allocated to clients periodically.
  - Alternatively the credits could calculated as a present value, to be recognised in the purchase price of the bull as a present value of the stream of credits that the bull is likely to generate. The farmer may undertake to continue to purchase bulls from this stud for a number of years, until the genetics of low emission has spread across the herd, and participate in continued stud improvements.
  - Similarly a farmer might purchase a particular pasture seed manipulated to produce less methane when consumed by livestock, or might purchase coated nitrogenous fertiliser, or a proportion of coated fertiliser, with imputed credits being accumulated upstream.
  - These forms of upstream obligation have low transaction costs but may entail relatively limited flexibility for the farmer to alter management practices in response to new carbon price signals.
  - Reflecting the principles set out in Section 7, the upstream point of obligation may be well placed to deliver a high credibility portfolio of farm changes, even though there would be substantial variation across farms in the associated abatement/sequestration effects:
    … Greater sophistication in tracking where, and how, the inputs are used across farms, could support the ability to safely infer greater abatement/sequestration. If this tracking information is recognised as a component of credit value, then there would be commercial
incentives for contracts to allow such tracking, and for the encouragement of more tightly targeted use of these technologies.

• In a concept similar to pooling of grain, a farm manager may elect to have the point of obligation downstream (where to do so is permissible under the policy instrument used):
  − In this case, the farmer may decide to elect that a bulk handling company (in the case of grain) or the dairy processor (in the case of milk) be the point of obligation for accounting for emissions based on units of output and verifiable features of supplier production systems.
  − The farmer may then elect, as part of a grower group attached to the processor, to implement certain practices to lower aggregate emissions:

    … The farmer is not confronted with the direct emissions of his or her farm but will assume an average level of abatement that can be modified through collective action and / or through greater scope within the downstream handler/processor, for classing product by emissions intensity.

    … Decisions on the level of classing and tracking could then be made on a commercial basis and underpinned by a form of supply contract that embeds responsibility for auditable features of the production system.

Less risk-averse growers may seek to establish a portfolio with some collective activity and some individual emission management options:

• A farmer may decide to invest in some genetics and seek credits and investment in feed technologies that can be altered in response to the emission price. This requires more active management and monitoring of the management practices, which some farmers would be willing to take on if they believed the margin costs of the abatements they are committing to are less than the price achieved by trading the credits and complying with the rules.

• A less risk-averse farmer would consider the full range of options available under the policy instrument used to construct a portfolio tailored to minimise the marginal abatement costs for the farming business. In this situation, the farmer would seek to have several abatement options.

Growers who seek large opportunities and have the scale to undertake them efficiently, are less likely to act collectively but may seek one or more higher risk investments, such as: early large-scale adoption of biochar, new varieties of pastures, large scale conversion to variable rate technology (although much of the risk of these investments is mitigated by the positive productivity benefits inherent in the technology). In this scenario, the farm manager may seek to establish an option (call or put) over the any sequestrations that are proven to have been in excess of those credited. Call or put options over the abatement that are possible but unverified at the time of the investment. A call option
could be sold by the farmer to someone willing to buy the credits at a predetermined price if they eventuate. A put option could be established by the farmer to sell the credits if they eventuate.

What would emerge is a wide range of portfolios, the sum of which would match the risk aversion profile of farm managers. Farmers would have strong incentives to understand and manage the risk of the levers they have the opportunity to invest in, which would establish a strong market signal about the relative merits of a range of abatement and sequestration options.

11.1.1 Development of secondary markets

The development of secondary markets is likely to alter the way risks can be bought and sold by farmers and will alter the way a portfolio of abatements would be developed on farm.
12 Possible policy approaches

12.1 General policy principles

In considering alternative policy settings, and especially in assessing and comparing alternatives, there are also a number of more general policy principles that are highly relevant, including:

- A paramount principle that policy should offer benefits in excess of costs (with both defined broadly to include community values, opportunity costs, transaction costs, transition costs and attitudes to risk), and net benefits greater than feasible alternatives;
- where possible, risks should be assigned to those best placed to mitigate the risks or limit the damage;
- where possible, transaction costs should be assigned where the transactions have the greatest potential to deliver benefits; this can sometimes be best achieved using either, or both, voluntary ‘opt in’ provisions and provisions to appeal ‘one size fits all’ policy settings.
- strong focus on risks of intervention failure alongside concerns for market failure;
- risks should include risks of gaming behaviours and competitor responses;
- explicit recognition of the value of ‘insurance’ against high risks – and the clear indications that the community is prepared to act pre-emptively to ‘buy’ insurance, even where expected claims are less than the costs of the insurance;
- where supported by new information, policy should be changeable – and the scope for making such changes should be factored into decisions on early strategy;
- recognition of the value of information and the risks in needing to make commitments ahead of full information – imply strategic value for investments in better, and earlier, relevant information;
- simpler is generally better – however, simplistic can be risky; a trade-off is involved, and here the cost-effectiveness principle should be paramount;
- the management of equity concerns through complementary instruments should be carefully considered, before judging equity impacts unacceptable and a reason for rejecting a policy that offers substantial benefits.

12.2 General policy approach

Determining a policy approach is essentially a balancing act:

- Balancing rising prospects for reducing market failure against rising risks of substantial intervention failure:
Possible policy approaches

- Balancing the value of better incentives against higher transaction costs.
- Balancing the value of possibly better incentives against the risks of inducing counterproductive responses.

• Balancing early action based on limited information against delayed action that might access better information:
  - Sound early responses have value because the benefits of abatement and sequestration in any given year persist, accumulate and have long-term implications for climate outcomes and costs:
    - The value of reaching a target by 2020 or 2050 is not independent of the abatement/sequestration path that led to the target being achieved.
  - But delay may deliver the capability to substantially lower the costs and risks of some early action.
  - Hence, balancing the benefits of early abatement against the risks of later realising this has entailed unnecessarily excessive cost.

• Balancing optimising response to current ‘official’ international positions against investing in supporting capacity to beneficially alter aspects of those positions, and to increase the global, as well as Australian, capacity to extract benefit from such changes:
  - Including international influence on the rules and the strategies adopted by other countries.

• Balancing investment in exploiting what is currently available, against investment in improving what will be available in the future:
  - With scarce resources, an opportunity cost of funding R&D may be to constrain other action.
  - However, present-day R&D expenditures are simply part of the costs of pursuing a policy that emphasises minimising the long-run costs of delivering beneficial abatement and sequestration.

For reasons flagged earlier, and developed in more detail in Appendixes C and D, sound balancing will almost certainly require an approach that is flexible, dynamic and designed to invest in better information, to adapt to the better information as it emerges and to anticipate and secure options over areas with good prospects for improvement – limiting exposure to high risks under plausible future developments. We also envisage that it will be necessary to approach agriculture’s opportunities and threats with a portfolio approach – spanning ranges of interventions across groups of farms, with a sound R&D overlay and a sound international negotiating strategy that is capable of exploiting future capability to emerge from the R&D – if the particular features of agriculture and land-based opportunities for abatement and sequestration are to be tapped efficiently.
12.3 Broad instrument types

Abatement of agricultural emissions and/or tapping opportunities for sequestration might be pursued, using instruments drawn from one or more broad classes of approach:

1. Attacking possibly perverse incentives flowing from other established policy settings – drought, water, forestry, biodiversity, salinity, etc.

2. Allowing flow-through effects from the CPRS to impact on farm input costs – fuel, electricity, fertiliser, some downstream processing, etc.:
   - With or without measures to compensate for EITE characteristics.

3. Regulation in respect of allowable farm inputs and systems, with the determination of settings factoring in estimated emission impacts:
   - An example would be regulation to require coating of some nitrogenous fertilisers.

4. Implementation of an upstream point of obligation for some additional inputs with significant imputed on-farm emission effects:
   - e.g., nitrogenous fertilisers, via inclusion of manufacturers or distributors on the basis of imputed N₂O emissions, with emission factor adjustments for nitrification and/or urea inhibitors coatings.

5. Systematic negotiation efforts to address constraints imposed by the international rules and their interpretations:
   - to open broader opportunities for more cost-effective abatement and sequestration, by Australia and globally.
   - this could, we believe, include significant reinterpretation by Australia, even in advance of international agreement, without undermining Australia’s cooperation with international processes.

6. Linkage of targets and international negotiating positions to a combination of abatement/sequestration within the rules, plus lower bound estimates of additional demonstrable abatement/sequestration:
   - With or without also recognising upside value to climate change of options for further abatement/sequestration, that is likely to occur but is not yet definitively provable.

7. Integration of at least some of the agricultural sector into the CPRS cap and trade market:
   - Point of obligation at farm level:
     … With or without size trigger.
   - Point of obligation downstream of farms, based on imputed emission content of products supplied:
     … Emissions accounted purely on basis of farm output.
     … Emissions adjusted for accredited input/farm system characteristics.
… Possible issue of options over abatement/sequestration in excess of assumed levels demonstrated later.

8. Voluntary access to the CPRS for purposes of trading *accredited* offsets:
   - Offsets based on activity-specific, verifiable lower bounds on abatement/sequestration which is additional and permanent (i.e. above some pre-agreed baseline):
     … With or without tradable *options over future upside possibilities*.
   - Offsets based on verifiable abatement/sequestration and on accredited *lower bounds on portfolio value* (possibly much higher value than lower bounds on individual emission reductions, for reasons flagged in Section 10):
     … With or without tradable *options over future upside possibilities*.
   - Offsets based on statistical risk management across the cross-sectional portfolio (with possible need for modification to rules), reflecting the increase in the safe lower bound on portfolio sequestration and abatement (and possibly a much higher value than the activity-specific estimate):
     … With or without tradable *options over future upside possibilities*.

9. Development of a logically separate (but not necessarily independent) cap and trade market covering agriculture or land-based sectors:
   - Voluntary (cf. CCX) or compulsory:
     … If voluntary, might allow ‘opting out’ of some regulations – substituting a ‘market test of appropriateness and competitiveness’ for emissions of inputs and farm systems.
     … If compulsory, with or without size trigger; with or without institutional arrangements for aggregation.
     … If aggregation is used, either aggregation prior to application for accreditation, with responsibility for aggregation lying with the farms, or use of measures of impact on portfolio value to allow the aggregation to be managed after the fact at the portfolio level.
   - With or without *early* establishment of baseline:
     … For all farms/regions.
     … For farms/regions based on submission.

10. Development of an interface between such a separate market and the formal CPRS:
    - Most promisingly, based around the marginal cost of abatement revealed by the CPRS over time.
    - With *exchange rate mechanisms* to deal with timing and uncertainty differences (e.g. credits in the separate market may trade at half the value of a CPRS permit):
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… Again, scope for use of lower bounds, coupled with options over upside, that could be traded into the wider CPRS and for use of statistical risk management attached to bundles of measures.

11. Convergence over time between the markets, with the potential for eventual merging.

12. Strategic R, D and E at the farm level, especially where these target emissions and productivity synergies, and undertake strategic investments in extracting maximum value from R&D processes.

Many of these measures would not be mutually exclusive and the earlier discussion (Section 10) of sound portfolio risk management, would strongly favour use of a mix of measures within an evolving policy context. We take as virtually given that there will be downstream flow-through effects from the main CPRS; key input prices will be affected.

There might be EITE or other measures to help compensate for some impacts, but, in most cases, it would seem sensible to try to sustain the marginal price signals emerging from the CPRS, even if measures are in place to mitigate the net impact on total costs or earnings. For reasons flagged in Section 6.5, this position might be modified if there are expectations of influencing an early change in the nature of international competition and climate policy settings, but policy settings that weaken the incentives to move emissions to their highest value uses nominally cut across the policy purpose and limit access to the upside potential offered by agriculture.

Heavy and light handed policies are best described by the level of Government intervention and impact. Light handed approaches are characterised by minimal regulation where incentives are posted to encourage behaviour change rather than mandate it. Light handed intervention in agriculture includes financial incentives to protect remnant vegetation or threatened species. Heavy handed interventions include mandating certain behaviours such as regulating chemical use or even banning some practices such as exclusion from some fisheries. Heavy handed interventions pose less risk of not achieving a particular outcome but increase the risk of over correcting the behaviour where the costs or achieving the outcome exceed the benefits.

That said, the early introduction of heavy handed interventions, such as the inclusion of agriculture in an economy wide cap and trade system from day one of the introduction of the scheme, could be expected to largely extinguish the options to use the range of light-handed intervention options and seems likely

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32 Balancing these would tend to favour assignment of credits of some form in relation to ‘baseline’ emissions, but would probably set the assignments below current emission levels and/or permit trading of the credits. This type of arrangement is that proposed for the CPRS, but the concepts could have wider application.
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Possible policy approaches

to risk significant intervention failure if the early incentives that can feasibly be delivered via the heavy-handed instruments are likely to badly distorted. We consider the likelihood of this being true to be very high, for the reasons developed earlier.

Nonetheless, maintaining the option of, without committing to, progressing to more heavy-handed approaches by moving more slowly is not costless. The premium that has to be paid for early use of light-handed methods, with scope for later ramping up if required, is the delay of the more certain greenhouse gas reductions that could be delivered by the heavy-handed approaches\(^3\). The issue is not primarily that heavy-handed measures might fail to limit emissions but rather that the limitation could come at very high cost – and at a cost that is neither cost-effective nor necessary, for any of a range of reasons:

- A lower level of emissions actually mitigated than anticipated, due to poor estimation of direct effects or failure to adequately account for substitution of behaviours that entail offsetting emissions.
- Transaction costs that prove much higher than was allowed for, but that are necessary to manage the other sources of intervention failure.
- Much more cost effective ways of delivering the emission reductions being developed (increasing the opportunity costs) – or that would have been developed had the above transaction and opportunity costs been redirected to R&D, etc.

Early heavy-handed intervention has the potential to deliver a modest reduction in the nominal marginal cost of abatement from the CPRS. If this were the objective, it might make sense. However, as was argued in Section 6.6, this is not the most important performance indicator. The value of agriculture to climate change strategy lies in the indicators of potentially large economic surplus – reduction in costs to the economy as a whole – that might be accessed with the right strategy. This is both the reason for being cautious about how agriculture is treated (lest its potential be destroyed) – and the reason for making sure it is treated as part of the solution (lest its potential be overlooked).

Stating a clear intention to intervene and a transparent process of increasing the level of intervention creates considerable incentives for adaptation and mitigation, well in advance of the intervention if, or when, it is introduced. Sound communication of the process to be followed could tap into some of

\(^3\) As was flagged earlier, emissions not abated this year are effectively emissions never abated and climate change impacts never avoided – with the option to avoid these specific emissions being surrendered forever. Climate change policy imperatives are driven by the cumulative character of greenhouse gases on global climate. Later action can limit emissions of that type, but early abatement keeps open both sets of options while delayed abatement only keeps open the option of later abatement.
the potential early – and do so in a way that favours high value and low, or at least competitive, transaction costs.

Just as important as signalling an intention for more aggressive intervention is undertaking research and development into the effects and monitoring of proposed intervention options. For example, comprehensive modelling of the agricultural carbon cycle may be developed in anticipation of a cap and trade policy but these models could be used by those responding early in voluntary schemes. A significant advantage of making this capacity widely available is that it will standardise some of the work undertaken outside the government agencies, reducing possible future transaction costs.

A central issue being dealt with in this approach is dealing with the tradeoffs between creating incentives for individual enterprises to modify behaviour to reduce emissions and the transaction costs of the intervention.
13 Possible ways forward

Sections 8 to 12 of this report have developed a number of building blocks that could be drawn on to form the basis of a policy development process.

These building blocks can be summarised as:

• The Australian agriculture abatement profile can be characterised as a portfolio of abatement and sequestration options. There is good evidence that that portfolio has:
  - a number of low cost, low risk options with scope for early implementation. Some such measures are already being implemented, based mainly on complementary productivity effects.
  - a significant proportion of abatement options that appear technically feasible but may require further scientific verification and development to firm up their individual abatement impacts:
    … however, it is likely to be possible to be far more confident earlier about the aggregate impact of implementing a range of such measures across a range of farming systems.
  - a number of additional abatement options where the scientific pathways are well understood but require considerable additional research and development and, in many cases, are likely to be more costly to adopt:
    … though some may still prove to be competitive compared to the marginal cost of abatement in the coming years.

• Greenhouse gas emissions are positively correlated with increases in production but in many instances are negatively correlated with improvements in productivity as traditionally measured\(^{34}\), particularly for livestock production:
  - there may be significant synergies available for exploitation and cost containment.

• Agriculture, operating in open ecological systems has a long history of managing the externalities it produces, such as salinity, water, invasive pests and diseases, biodiversity, etc. Management of these externalities has created a rich experience of adaptation, voluntary action and government intervention. This experience provides some indication of the likely success of prospective emissions policies:
  - Some of these policies also impact on emissions management, such as drought, water, and R&D policy.

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\(^{34}\) This qualifier is potentially of great significance. Measuring productivity exclusive of the value of abatement services is partial and potentially misleading in a world that is starting to price emissions. However, without a mechanism for rewarding the abatement impacts, lower productivity as measured traditionally is likely still to be a pointer to lower farm profitability.
There are a number of policy options that appear to offer some scope for managing agricultural emissions. They can be characterised as:

- Ranging from minimal intervention (light-handed) through to heavy-handed regulation.
- Ranging from low to high transaction costs.
- Ranging from low to high capacity to create incentives to modify behaviour and encourage adaptation.
- Ranging from low to high levels of intervention failure, such as incurring high, irreversible, costs prematurely.
- Delivering increasing risk of delaying certain emissions reductions that could be delivered by heavy-handed intervention.
- Having varying levels of compatibility with international accounting standards.
- Interventions that can be applied to inputs or outputs of production, based on imputed CO$_2$e emissions of the production process.

The major trade off with most of the policy approaches discussed above is transaction costs and the ability of the intervention to influence behaviour (after any substitution has occurred). As a rule, transaction costs rise with how much the intervention recognises individual business or enterprise emissions, and over time.

However, the more these variations are recognised by the intervention, the stronger can be the incentives posted for individuals to modify behaviour. As lower emission activities are recognised and accounted for, the emission factors attached to remaining activities will need to be adjusted upwards, implying progressively stronger incentives to shift to farming systems producing lower emission levels. The more the calculations are focused on broadly homogenous units – individual farms or groupings of similar farms – the stronger can be the incentives posted to individuals.

Transaction costs will also be dependent on the extent to which they can be shared across the farming enterprise. Many monitoring technologies that are likely to be employed by farming for greenhouse gas management, will also contribute to improvements in farm productivity as discussed in Section 8.3.

### 13.1 Policy approach

The following sections detail the policies that could form the basis of an adaptive policy approach. They can be summarised as:

- Reducing, as much as possible, indirect policy distortions from drought, biodiversity, environmental and water management:
Possible ways forward

- Moving to limit these perverse incentives ahead of posting strong incentives to modify behaviour.

- Pre-emptive signalling of clear policy intentions and assignment of risks:
  - by providing information about how the process will work and who will be responsible for managing the risks that policy settings will need to be changed to provide incentives for farms to bring forward emissions efficiency improvements to manage those risks.

- The establishment of a clear baseline of agricultural GHG management from which the adjustment process will commence.
  - Providing a base for recognising and certifying early contributions to abatement and sequestration and encouraging farm participation, because of the risks associated with delay in establishing these baselines.
  - Using these to encourage and support accreditation of *portfolios of behavioural changes* that offer safe abatement/sequestration, where this can be done cost effectively.
  - Potential winding back of the baselines over time – allowing alignment of the financial imperatives with the scope for rapid change.

- Progressive calibration of signals via linkages to the evolving cost of abatement elsewhere in the economy (or internationally):
  - Likelihood of direct engagement with the CPRS via offsets markets, possibly evolving to later convergence of the two sets of arrangements.

Section 13.2 summarises a series of more specific policy instruments that will evolve as circumstances change and more information becomes available on the science of agricultural GHG management and transaction costs.

### 13.1.1 Do nothing

Any contemplation of policy options should include ‘do nothing’ or more precisely ‘no intervention is required at this time’. In an important sense, these two ‘definitions’ are quite different. In an important sense, there is no ‘do nothing’ option for agriculture. The CPRS – or indeed any aggressive climate change policy, even where agriculture is not explicitly included, will reshape agriculture through its upstream and downstream impacts. Compensatory measures might be possible, but they will not be costless and they will not deliver perfect compensation. Agriculture will be affected by international responses that are now certain, as well as by Australian responses. Of course, there is also the question of how agriculture is to be affected by climate change that is already locked in and that will emerge despite international measures.

As used here, ‘do nothing’ applies to an approach that does not look to agriculture-specific climate change policy measures and that continues to exclude agriculture from the CPRS. Even interpreted this way, it would seem that ‘do nothing’ is unlikely to be possible in a practical sense. Agriculture is
already changing as a sensible way of managing risks, there are expectations that markets will become more discerning in respect of environmental credentials, because of government initiatives already in train and because farmers share the concerns and desire to help address a major challenge, that is already underpinning substantial voluntary activity across the economy. It is probable also that we are already seeing significant responses to actual climate change in many areas of Australia – with evidence of structural change in rainfall patterns now dating from the mid-1970s in South-Western Australia and with growing likelihood of structural change now across much of the remainder of the country.

The effects of such a ‘do nothing’ policy will, based on recent modelling work, translate into significant reductions in production for various enterprises, where this is the most cost effective option. What is not known is the marginal effects of these cost rises and the capacity of each enterprise to adjust? What is known is that the effects will fall disproportionately to enterprises where these inputs are used more extensively, such as broad acre cropping. Perverse substitution effects seem likely. Livestock could substitute for cropping – to limit fuel and fertiliser demands, but in effect to substitute methane for N₂O. Substitution may be with higher emitting inputs, such as: increased stubble burning to reduce tillage costs (fuel); greater use of legumes or pastures in the crop rotation where N₂O emission may be higher, as the use of nitrogen in these situations is far less precise and controllable. These are all classical symptoms of incomplete regulation – allowing the problems to pop up in a different, and possibly even a more intense, form.

While this option may have near-zero transaction costs at the farm level, it posts few incentives for agriculture to adjust behaviour to reduce emissions directly. That is, direct CO₂e emission opportunity costs are not considered in farm management decisions.

### 13.1.2 Indirect policy approaches

Many policies currently in place for reasons other than emission management, affect (positively or negatively) the emissions from agriculture as a whole or those of individual farm enterprises. Any policy approach formulated will need to take these into consideration to avoid creating conflicting incentives for farm business operators.

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35 This alone is a pointer to probably perverse incentives, given that livestock emissions of methane constitute the bulk of the perceived problem, but would not be addressed, even indirectly, under the ‘do nothing’ strategy.
This suggests a whole of agricultural policy approach will need to be developed in advance of more interventionist policy approaches being introduced.

Policies and processes of particular interest for their scope for modifying emissions include:

- Drought policies
- Water policy and water markets structure and operation
- Biodiversity protection through both regulation and eco-market mechanisms
- Rural research, development and extension (particularly with the development of the Primary Industries Ministerial Councils National Research, Development and Extension Framework) and
- Forestry policy.

The propensity for a negative relationship between production intensity and CO₂e emissions means that drought and RD&E policies have a significant impact on carbon emissions.

Some elements of drought policies are directed at, and generally successful in, retaining stock numbers during drought, at higher rates than would otherwise be commercially attractive or feasible, with the animals progressing increasingly towards survival rations – and the associated rising emissions intensity. This has long been seen as sound investment in retaining the capability to bounce back after the drought breaks, and this value should not be underestimated.

However, getting the balance between reducing demands for feed and retaining this capacity for recovery has always been hard, given the uncertain depth and duration of droughts – harsh trade-offs need to be addressed with limited information. Given the uncertainties regarding intensity and depth of the drought and the costs of rebuilding herds and flocks, a level of retention of some stock will usually be efficient. However, judgments as to what level of retention, with what level of feed supplementation is efficient, would ideally factor in the emission costs as well as current on-farm economics. Animals retained on drought rations move to very high levels of emission relative to meat production. Current policy settings favour a balance that is tilted towards greater retention and greater emissions than would otherwise be justifiable.

The same policies probably also support the competitiveness of ‘less efficient farms’ relative to more efficient farms – where efficiency is defined as inclusive of capacity to manage drought risks. This could well support the retention of less productive animals and higher emitting farming systems – again reflecting the propensity for a negative correlation between emission levels and production/productivity. Similar principles apply to cropping systems where drought effects, and in most cases greenhouse gas emissions, can be exacerbated on less efficient farms, inclusive of their capacity to manage drought risks.
Box 5  Insights from management of water externalities

Parallels exist here with the evolution of farm policies with an eye to other externalities. Early evolution of water usage patterns was largely predicated on ignoring externalities. Growing usage and increasing conflict between uses led initially to a range of regulatory measures and then supplementation with increasingly sophisticated market mechanisms to manage the scarcity costs of water. These have included elements of recognising both the finite nature of the resource and the desirability of ensuring that there is encouragement to minimise the costs of that constraint, by directing the water at higher value uses.

There are still significant limitations in these policy settings. There is a glaring gap between the management of river and groundwater and the management of water before it ‘officially’ enters the rivers and groundwater. These weaknesses have translated into increasing attention being paid to these prior water ‘interceptions’ – especially but not solely as a result of growth in timber plantations or other deep rooted crops. It is even commonly the case that water can be extracted from groundwater via planting of trees with no requirement for an access right, where drawing the same water by other means to apply to higher value crops would require an access right.

Even amongst irrigation uses the arrangements can be weak in their capacity to handle different patterns of farm use with different impacts on return flows. There remains a tendency to define efficient water use on farm in terms of maximising the value extracted on the farm – with little if any recognition of the externality costs of reduced return flows to the environment and downstream uses. Increasingly, policy is being forced to recognise that efficiency in use of a scarce resource does not equate to maximising the value extracted on an individual farm.

The NWI requires that mechanisms be established to bring significant interceptions into overall management of the resource and similar concepts might reasonably attach to ‘on-farm efficiency’ in respect of all water.

A key issue has been the limitations in the available science. However, increasingly sophisticated hydrological models, that infer impacts down to small area levels across alternative land uses, have provided the basis for increasingly sophisticated adjustments to the water management regime. These models are far from perfect, but judgments are being made that the system cannot afford to wait for perfection. Individual land users are being charged and rewarded for changes in land use patterns based on commonly crude assessments of the individual impacts of these changes – but also commonly with much greater confidence in assessments of the aggregate implications of a large number of such changes.

Urban water planning and management has also provided some valuable insights. Many of Australia’s urban water systems and planning processes have been challenged by recent drought conditions and by the impact of still uncertain climate change patterns that have reduced confidence in planning based on historical in-flow patterns.

A range of responses has been emerging, which has involved fundamental change in planning paradigms. Historical supply planning has been based heavily around dams and groundwater systems that need to be in place well before droughts begin to offer effective management of drought risks. In recent years, desalination and recycling technologies have emerged to play a growing role – in part because of their capacity to operate independently of rainfall. In this setting, options-based planning methods, working across the ‘portfolio’ of supply sources, supply options and demand management instruments, have been refined, looking at the most cost effective ways of delivering system security, rather than just the least cost ways of producing water. Individual elements in the portfolio cannot in general be guaranteed to deliver a given quantity of water, but a dynamic, portfolio-wide options process can be used to ensure supply certainty across an evolving portfolio of measures. Desalination plants are no longer being assessed on the basis of continuous operation, because intermittent operation can be much more cost-effective, especially if dams are near full. The flexibility of desalination technologies – to switch off and even to defer commitment until deep into a drought – has real value in managing the climate change risks. Under broad conditions it has emerged that water supply cannot be managed cost-effectively using only pre-emptive investments in new supply infrastructure and drought restrictions.
Agriculture and GHG mitigation policy: options in addition to the CPRS

Other externalities dealt with by farmers include: animal welfare, invasive pests and diseases, biodiversity management, and nutrient runoff. This is not an exhaustive list but it does demonstrate the extent to which farmers have had to deal with the unpriced (or inappropriately priced) spillovers from their farm businesses and these processes have encouraged a range of policy settings – some have further encouraged spillovers, while others have been directed at reducing damage from the spillovers, but in most cases the link through to cost of emissions has not been made. Carbon management policies may also make some policies that deal with the externalities cited above redundant.

13.1.3 Pre-emptive signalling of clear policy intentions and assignment of risks

Current farm enterprises have been built up on the basis of no restrictions on, or charging for, the emission of greenhouse gases. ‘Rights to emit’ have been assumed and capitalised into the value of the land, in much the same way as land is priced and purchased on the basis of the rainfall it receives and an implied right to use this water. Any restrictions on emissions will ultimately be reflected in land values, as assets are adjusted to the returns that can be generated from agricultural enterprises faced with the opportunity cost of the greenhouse gases they emit – exhibiting as reduced emissions that constrain production, or as extra input costs as rights to emit are acquired from elsewhere.

The earlier enterprises and agricultural investments take account of a possible opportunity cost of the greenhouse gases that land uses emit, the lower the adjustments are likely to be.

An important first step in the policy process is to signal the policy development process, the key decision points and how they will be made, what information the decisions will be based on, etc. This will signal early what the likely risks will be and to whom they may be assigned. The purpose of early signalling of the scale and scope of the risks of possible future policies is to affect the nature of investments being contemplated now to avoid larger adjustments in future.

The policy principles set out in Section 12.1 clearly include the ‘mainstream’ principle of assigning risks to those best placed to minimize the associated damage. In relation to future risks that farmers will be ‘charged’ for their

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36 An analogy could also be drawn with industrial plants that once assumed a right to emit waste gases or discharge waste water but that have since been forced to manage these emissions via processes that usually entail higher costs. Historical presumption of a right to emit does not translate automatically into a perpetual right to emit, especially in a context where Australia is committing to reductions in aggregate emissions.
emissions, directly or indirectly, it is the farmers who are best placed to minimise the damage. Governments may be able to spread the damage differently, but ultimately it is the farmer’s investments in production and production systems that will allow cost-effective containment of these risks. Cost-effective strategy should not wait till a risk is realised before trying to buy insurance. In making choices as to product mix, farm system, plant and livestock gene pools, investments in cultivation equipment, etc., farmers are steadily altering their options to deal with future changes of this type. Encouraging strategies that are robust enough to deal with plausible patterns of policy evolution makes good sense and lines up strongly with the policy purpose as set out in Section 2.

Furthermore, the more that farmers responding to climate change and climate policy change their exposure to risks with sound risk management tools, the more accessible will be a growing range of portfolio options for Australia to better contain its abatement/sequestration costs and to adapt agriculture to contribute cost-effectively.

For these processes to work efficiently, it is important that farmers share in the insights that government has as to likely patterns of policy development. However, we stress that the major rationale for this early assignment of risk is an efficiency one – to allow efficient risk management across farms.

A logical consequence of this is that investments in improving what can be said of likely future developments, and conveying this information to farmers, could prove highly cost-effective. Of interest here would be strategic investments, discussed in more detail in Section 12.3, in the development of assessment tools such as models, common exchange rates, etc. Long before the results of this work are reflected in formal policy settings, knowledge of what is emerging, and what could be done, will influence sound assessment of risk and planning of pre-emptive risk management.

Development of these tools, and the research that supports them, is likely also to assist in developing a common, and more widely accepted, approach to measuring and monitoring agricultural emissions and sequestration – that may reduce transaction costs and ensure consistency in policy development for those making investments based on the policy process.

The strengths of assigning risks early are:

- Stronger compliance with policy principles of risk assignment, and deferral of costs that might later be regretted.
- Improved management of avoidable risk and assignment of liability for risks that are unavoidable (to those best placed to manage them).
• Signalling the possibility of needing to move to more heavy-handed policies at some point – and building the capability early that both lowers the likelihood and reduces the consequential damage of needing to do so.

• Allowing a clearer separation of policies that manage equity and efficiency, affording substantial flexibility and robustness for dealing with equity effects of future policies:
  − A decision to assign risks does not rule out complementary measures to compensate for some or all of the costs – as long as this is not done in a way that mutes the incentives to better manage the risks.

• Establishing a sound policy framework, improving transparency and highlighting gaps in current science and technology.

There are also some ‘weaknesses’ in signalling policy development early, though these are presentational rather than substantial:

• Signals explicitly the possibility of needing later to take controversial decisions – bringing forward policy debate and possibly political costs that may never actually become necessary:
  − This is almost an innate consequence of sound risk management – including identification of ‘worst case scenarios’ and climate change policy must be capable of working in such a context.

• This will highlight serious limitations in knowledge of technology and the tools currently available to monitor and measure greenhouse gas emissions from many farm enterprises (not dissimilar to the controversy surrounding the application of the CPRS and agriculture now):
  − Again, approached positively, this should be for the good, but may entail some controversy that needs to be managed.

• There are initial costs in establishing transparent policy process and development of measurement and monitoring tools (such as whole of farm models, etc.):
  − Though all would be subject to an assessment that they are cost-justifiable.
  − Definitive and rigid policy settings might avoid these costs, but only at the risk of locking in intervention failure.

From the point of view of addressing the problem at source, a clear option would be to look at clarifying early the nature and scale of emission rights presently bundled into farming activities (and hence included in asset values, such as land) that will be assumed in the future – and to clearly assign risks to any parties using, or planning to use, in excess of these ‘rights’ and the risks that the assessment will be changed by new information. This may involve pre-emptive benchmarking, and agreement on the principles that could apply to future determinations of rights relative to these benchmarks, including
possible progressive adaptation of benchmarks to a form that is less strongly linked to historical farming patterns.

This last point is important – to what extent will the fact that a property has been operating on a high intensity basis historically, secure lasting access to elevated rights to emit? It seems likely – as with emissions from factories – that such a basis for future rights would prove increasingly unacceptable to the wider community, while recognition of sunk costs might support some gradualism in transition. For the CPRS, it is proposed that the long-term ‘benchmark’ be zero, but with a process of transition via temporary credits. Should agriculture expect a different approach to be taken to its long-term rights? There is no ‘natural benchmark’ (as there might be in respect of rights to intercept rainfall) short of looking to net emissions from land that is effectively not farmed.

In theory, measures to ‘reward’ agricultural behaviour change could operate with a benchmark of zero provided that there are mechanisms – such as rights to sell sequestration or rights to enter the CPRS to buy credits – to allow additional rights to be acquired. In the long run, this may well be the position policy moves to, along with significant restructuring of asset values. The process could be seen as somewhat akin to the unbundling of water rights from land, which has occurred across recent decades – commonly resulting in substantial write-down of land values, though usually compensated by provision for ownership and trading rights in the separated water rights.

With such provisions, benchmark determination is more about equity than efficiency and a zero level (at least relative to some defined ‘natural use pattern’) would be possible. The lower any benchmark, the more farmers would need to acquire from other sources – and presumably would choose to do so if and only if they had a more than competitive use for the rights. Similarly, a benchmark set at a higher level would not necessarily, or desirably, lock out the rights to reduce emissions below that level – or to move to negative emissions via a sequestration strategy.

Accepting this, a process that allows the benchmark to reduce over time could be judged to be equitable – at least in the context of the whole of the economy needing to reduce emissions and if timing lined up reasonably with practical access to the natural instruments for farms reducing their emissions and/or delivering sequestration. A natural analogy exists with the temporary rights envisaged under the CPRS, to be phased-out in most cases, or indeed to such measures as the proposed fuel subsidies that could either lock in a fixed level of support indefinitely or be phased-out over time. A feature of fuel subsidies is that there is no facility for someone willing to lower their fuel use to trade the subsidy to some other emission activity, even if this would be cost effective. The rigid form of the equity measure has efficiency costs.
Examples of approaches to the establishment of a baseline that could be considered include:

- The baseline could be built on an assessment of recent historical emission patterns, based around the enterprise characteristics and region:
  - The baseline could be set at the assessed historical level or at some proportion (say 90 per cent) of this – with this proportion possibly being reduced over time.
- The baseline could be developed broadly as above, but built around an assessment of ‘best practice’ for the type of enterprise involved, with best practice defined as inclusive of imputed costs of greenhouse gas emissions:
  - Acceptable substitutions and acceptable rates of substitution between alternative uses would probably emerge from such a process (essentially establishing a series of exchange rates between enterprises and land uses)
  - Again the baseline could be subject to phasing-down over time, either in concert with the evolving best practice models (that would change naturally as the marginal cost of abatement changes) or in accordance with a timetable. The latter is simpler and more predictable, but entails a different assignment of risks.
- Linked to either of the above, the baseline could be a variant on modelled emissions using a whole of farm model – in one sense or other, a whole of farm or a model for a group of farms, is probably largely unavoidable:
  - Either the model would be used to assess the baseline or to assess the change relative to the baseline.
  - It may be easier, and involve much lower cost, to develop the model across a group of farms in a region, though, in time, the more emission-efficient farmers could be expected to place growing pressure on the models to take into account their competitive advantage:
    … This would be another example of incentives to locate the transaction costs where they are likely to be cost justifiable.
- Rights could be specified as actual emission amounts, with models providing one means of assessing compliance – but with scope to appeal on the grounds that the models have a bias and the potential for technologies now being trialled to be brought to bear on direct measurement:
  - Rights might be specified initially as estimated emissions, and moved later to measured emissions (i.e. regularly monitored).

There are likely to be strong pressures, as with the CPRS, for initial rights or benchmarks to reflect current capital structures, probably as reflected in current enterprise mixes. Again, the case is essentially based on equity and political in nature, but the equity concerns could be very real. However, it would be important that the equity provisions do not unnecessarily lock in inefficient emission practices. Here, the ability to be rewarded for operating
below the benchmark is important and appears to be the natural mechanism to use in the short term. In the longer term, evolution of benchmarks towards levels more naturally linked to the fundamental capability of the land, rather than past usage patterns, would seem to allow for moving away from any remaining linkage.

In either case, there is the underlying concept of an ‘emissions pool’, used as a device to either limit the level of emissions, or to force commercial discipline, including the need to face the cost of offsets, on decisions to move beyond assigned levels.

These benchmark concepts have been developed in relation to the early assignment risks of future policy change. However, exactly the same principles could apply to suitable benchmarks to work with some form of voluntary market, or even eventual convergence with the CPRS. In the CPRS setting, the analogy with temporary credits, and the proposed transition towards a zero baseline, is particularly relevant.

13.1.4 Application of a base line or notional cap

There are two critical elements to consider when considering the establishment of a greenhouse gas emission and sequestration baseline for agriculture: timing and level of precision. Notional caps or base lines have been used in other resource management policies, such as when land clearing has been banned, and is an instrument currently under consideration for managing water interceptions in the landscape. It is therefore not a concept foreign to most of agriculture.

It is important to note that the establishment of a baseline should not be viewed as conferring the right to emit or maintain stored carbon at the baseline level. Rather, the establishment of a baseline establishes a point from which future emissions or sequestrations can be assessed.

The establishment of a baseline also recognises that there have been investments made in land, plant and stock based on the notion that the emission of agricultural GHGs have not generally been constrained in the past. Therefore, some adjustments need to be made over time if farm managers are confronted with the opportunity costs of emissions.

Establishing a base line year early in the process, reduces the scope for gaming of future potential caps and encourages consideration of emissions of farm level investments from the nominated date. The risk of gaming of a baseline is driven by the amount that can be gained and the cost of seeking advantage from greenhouse gas policy on other aspects of the farm business. This will largely be determined by the anticipated price of carbon emissions, as seen by
agriculture, net of transaction costs times the level of emissions abatement or sequestration possible.

If, as anticipated, agriculture has significant low-cost ‘no regrets’ options it means that there is likely to be the potential for fairly high levels of gaming risk, as farmers may seek to claim significant abatement practices, such as reduced tillage and farming management changes, incurred after the introduction of the base line. Equally, they may delay changes to bring them to account in more valuable ways – even where earlier action would have greater benefits for climate change and could be cost effective viewed in a wider context.

There are serious policy problems with any process that allows farmers to determine a point in the future when they will be ‘benchmarked’, based on the structure of the farm at that time. Equally, there would be high transaction costs in seeking to establish definitive benchmarks for all farms as of yesterday.

The decision as to whether to determine a benchmark as a given level of emissions or as the outcome of a given assessment process, that might produce different numbers over time, is an important one. As models improve and as monitoring capability advances and becomes more affordable, it would be quite feasible for benchmarks to be reassessed. This issue pervades greenhouse gas policy. Within the risk paradigm, it is probably most constructive to view the choice as one of assignment of the risk of a re-assessment being made on the basis of improved information. Such re-assessments will be made – the question is, who wears the risks of a downwards revision and who banks the benefits of a possible upwards revision? Reflecting the discussion in Section 13.1.3, it is probably more efficient if these risks are assigned through to landowners.

There are also risks associated with setting the base line too early. For example, technologies such as remote sensing used to collect past data were not as advanced and this could lead to over or underestimation of baselines.

Setting the baseline too early may also affect the calculation of whether GHG emission reductions are additional, particularly where there are strong relationships between emission management productivity and production. For example, if the baseline is set too early a great deal of the emission reductions from the rapid expansion of reduced tillage farming would be included (see chart below). Similarly, large changes to stock numbers or drought effects could make the assessment of changes more complicated, if a base line were set which preceded large changes in farming practices.
The farming sector is constantly changing, so elimination of the risk of setting the baseline where large trend changes are included cannot be totally avoided, but the risks can be reduced if the baseline is chosen with these issues in mind.

While these emissions are real they would have occurred irrespective of the GHG emission policies and if they occurred after the introduction of a baseline the eligibility could be tested. But this level of complexity and the risk of gaming could be reduced by careful consideration of the timing of the baseline.

Establishment of a notional cap or base line of emissions does not require a high level of precision of measurement, as lower bound estimates could be used where reasonable levels of certainty of emissions currently exist. A notional cap can also be refined over time prior to the introduction of abatement policies.
The level of precision of a base line will largely be determined by the available information and the costs of acquiring it at certain levels of precision. The more precise the level of the baseline and the earlier it is introduced, the more costly it will be to establish. There are several ways to reduce the cost of establishing a base line:

- Accepting a lower level of precision.
- Making it relatively recent.
- Shifting the establishment of the base line to those who can measure it most efficiently.

The level of precision required for the baseline will largely be set by precision required in ongoing monitoring and compliance.

Shifting the level of responsibility for the establishment of the baseline can be done by introducing a period of voluntary inclusion (opt in) and/or an appeals process. Both cases create the incentive for those who believe that they have more to gain by acting early, or demonstrating they are different from the average, to invest in an analysis of their individual baseline emission levels.

A period of voluntary opt in has been included in the NZ emissions policy, for one year prior to mandatory reporting.

The establishment of base-lines will require the use of a range of information sources. If based on output, a baseline calculation could be relatively simple and rely on a combination of tax accounts and delivery records maintained by processors. However, relying on output measures alone as a form of assessment is likely to be a blunt instrument, which has been emphasised in previous sections of this report. It is likely that the baseline will, at least, have the requirement to capture some inputs, such as: stock numbers, area of crop, fertiliser used, tree crop and pasture cover, drought status, tillage practices, stubble management, etc.

There is considerable information collected about agriculture that could be used to assess average regional, or even farm level, base lines. These information sources include:

- The National Resource Audit (and the DAFF Signposts project where the resource condition of a number of industries have been assessed already).
- Considerable remotely-sensed information has been collected for public and private projects over the years.
- ABARE farm survey reports.
- Regional exceptional circumstances assessments.
- A long history of soil and vegetation mapping.
- Comprehensive stock inventory information is contained in tax accounts.
Establishing a base line on inputs was assessed in a recent report commissioned by the Victorian DPI by Firecone (Firecone Ventures Pty Ltd, 2008). In the report the CPRS with the point of obligation at the farm level is seen as requiring a basic set of readily available information:

Under the farm-level option, each farmer would be required to provide, at a minimum, the following data:

- “land area
- “animal numbers by type and age class
- “animal weights
- “diet (feed system and total supplementary food intake)
- “average levels of output produced per animal.

This core data list would allow for a relatively accurate farm-specific estimate of enteric methane emissions – the most important single emissions source. Ideally, most of this data would be collected and reported monthly. However, to reduce compliance costs less regular reporting could be allowed, and monthly figures estimated through the application of ‘typical’ birth, death and growth rates.

All of the data listed by Firecone are central to farm management accounts and could in most cases be largely derived from farm tax accounts.

Assignment of rights and risks of emissions provides the bases for developing a range of policy options discussed in the following sections, particularly those involving more market-based approaches, where offsets can be traded between those covered by the cap, or within a wider cap and trade system under the CPRS.

### 13.2 More specific prospective policies

Once the ‘policy ground work’ has been established by:

- Ensuring indirect policy distortions, such as water, biodiversity, drought and environmental management are reduced as far as practically possible.
- Pre-emptive signalling of clear policy intentions, and assignment of risks.
- The establishment of a clear baseline and the development of widely available assessment tools (such as carbon and nitrogen accounting methods and models).

There is a wide range of policy tools that could be employed. These policy options can be characterised in a number of ways, such as moving from light-handed to more heavy-handed interventions; high incentives for behavioural change and transaction costs to lower incentives and lower transaction costs.

Table 6 outlines a range of specific policy options that should be the subject of more detailed analysis as part of a policy implementation process.
The policy options are mostly ones that have been used to manage a range of other agricultural externalities. They have a range of strengths and weaknesses and specific applications discussed in the following sections. It is likely that they will be applied in response to particular GHG abatement events and situations consistent with an adaptive policy response.

It is also highly likely that each of these policy options will be used at some point and many will be used concurrently as should be assessed in a cost benefit framework as part of an over-arching policy approach.
### Table 6  Summary of range of policy approaches

<table>
<thead>
<tr>
<th>Policy</th>
<th>Description</th>
<th>Examples in agriculture</th>
<th>Likely behavioural response</th>
<th>Transaction costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness, publicly funded R&amp;D</td>
<td>Awareness of options to reduce emissions and publicly funded or matched R&amp;D</td>
<td>Elements of Landcare, weed management, animal welfare</td>
<td>High with those sympathetic to the problem or able to change behaviour at low cost</td>
<td>Very low: R&amp;D program management, monitoring response</td>
</tr>
<tr>
<td>Facilitation of voluntary schemes</td>
<td>Assistance with development of voluntary abatement schemes</td>
<td>Drum musters, organic certification, Chicago Climate Exchange, NSW carbon market?</td>
<td>High for those in the scheme (legally obliged to conform to market specification). Low participation rates likely without other measures.</td>
<td>Very low for the Government. Often high for market participant but related to contract specification and likely market value of the abatement</td>
</tr>
<tr>
<td>Contributions tied to particular outcomes</td>
<td>Subsidise particular actions or inputs that will lead to certain outcomes, such as vaccines, feed additives, fertiliser coating etc</td>
<td>Elements of Landcare, fertiliser bounty, pest control, water use efficiency programs, some general R&amp;D programs</td>
<td>Moderate if well targeted and likely to be dependent on rate of subsidy to total cost of use of input (highly dependent on elasticity of demand of input)</td>
<td>Low, dependent on level of monitoring and evaluation required</td>
</tr>
<tr>
<td>Purchasing abatement services on a competitive basis</td>
<td>Purchasing particular services by tendering out a range of service requirements designed to achieve particular outcomes</td>
<td>Bush Tender</td>
<td>High with those that participate in the scheme</td>
<td>Moderate</td>
</tr>
<tr>
<td>Taxes (input or output) with and without appeals</td>
<td>Tax per unit of emission tied to either output (kg of meat, wool, tonne crop or litre of milk) Can also be tied to inputs such as fertiliser, fuel or per cow or ewe Possible (but more complex) to apply to outputs adjusted for inputs according to an agreed formula or assessment.</td>
<td>Land taxes used to fund invasive plants and animals</td>
<td>Taxing generally has low incentives for change. Can be made higher if appeal mechanism included as incentive created to demonstrate lower emissions to reduce tax burden</td>
<td>Low but higher if appeals process included</td>
</tr>
<tr>
<td>Regulation and mandating with and without appeals</td>
<td>Banning stubble burning, certain forms of nitrogen fertiliser use</td>
<td>Some animal husbandry practices, agvet chemicals</td>
<td>High behavioural changes but risks substation with less efficient actions</td>
<td>Low but some policing needed</td>
</tr>
<tr>
<td>Cap and trade parallel to the CPRS</td>
<td>Separate trade system applied to Ag but separate to the CPRS to avoid international compliance</td>
<td>Water market Individual transferable quotas used and total allowable catches in some fisheries</td>
<td>High depending on mandated or voluntary compliance after phase in. Eventual merger with CPRS highly likely</td>
<td>High (additional costs include non compliance with international system)</td>
</tr>
<tr>
<td>Cap and trade within CPRS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Point of obligation away from the farm gate</td>
<td>Point of obligation to engage in market at processor level (as considered in NZ)</td>
<td>Some elements of the water market</td>
<td>Low unless processor can work with suppliers to deliver compliant emissions reductions</td>
<td>Low</td>
</tr>
<tr>
<td>Behind the farm gate</td>
<td>Full inclusion of majority of farm businesses</td>
<td>Some elements of the water market, High if most enterprises are included</td>
<td>Very high if most enterprises are included</td>
<td></td>
</tr>
</tbody>
</table>
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handed to more heavy handed approaches rising in sophistication but also incurring higher transaction costs. This transition relies on a number of factors particularly the development of emissions management R&D and monitoring and management technologies.

### 13.3 Applications, costs, benefits and risks of the approaches

Item by item evaluation of the costs, benefits and risks of the approaches set out in Table 6 can be seriously misleading. Within our framework, it is the packaging of combinations of measures, with complementary strengths, offsetting costs and cross-portfolio risk management that is crucial. Evolution of a policy package taking these interactions into account will be fundamental.

Nonetheless, it is useful to look at the main approaches as a basis for exploring the types of packaging that could be most promising.

#### 13.3.1 Awareness raising

Raising awareness of the risks of climate change has already been a prominent feature of many publicly funded research programs in recent years. However, further awareness could be raised in the farming community of the low cost changes that each business could implement to reduce emissions.
Costs could be open ended but there are numerous agriculture extension channels that could be followed. A critical question of awareness building is the additional investments that would be required and what additional behavioural changes that they would induce.

General raising of awareness, is likely to be relatively high risk, as farmers have numerous productivity, environmental, and other messages conveyed to them every day. Could be more effective if part of the Landcare or productivity extension investments. Extension is also mostly undertaken by the State Departments.

It is likely also to be particularly potent as part of a wider policy portfolio in which risks of future policy becoming more aggressive have been assigned through to farmers. If this has been done, then messages directed at raising awareness of the need for ‘insurance’, through strategic farm planning and development could prove more effective.

### 13.3.2 Facilitation of voluntary schemes

Voluntary schemes are developed to capture the value of differentiating a product on its greenhouse gas emissions profile. This may be done in anticipation of consumers expressing a willingness to pay for products with demonstrably lower emissions profiles – paralleling at least some of the drivers in demand for organic produce and free range chicken and eggs.

They may be as simple as enabling a marketing claim, supported by a simple verification system accredited by a third party. Voluntary schemes may become more sophisticated, involving the development of secondary markets in the carbon credits generated by changes to farm business practices, such as is done by the Chicago Climate Exchange.

The basis of voluntary schemes tends to be more certification of process rather than measuring outputs. That is, credits are claimed when a particular process is used, rather than the actual emission measured, in much the same way as organic produce is produced and sold.

Policies that might facilitate the development of these options include assistance with research and development; and accreditation services (such as mandating of standards, enforcement provisions under the Trade Practices Act).

Costs and benefits will be dependent on the type of entitlement established. If a voluntary scheme were the only measure in the portfolio, participation rates would probably be quite low. Again, however, in a wider portfolio setting, participation could be recognised as valuable insurance for those well placed to demonstrate relatively high emissions efficiency, or well placed to change in
ways that increase emissions efficiency. Details of the policy settings in relation to the determination of baselines for farms opting into such a scheme later, could post significant incentives for early entry.

A major component of the value of a voluntary market lies in the capability and other options that would be created for progressively expanding into offset creation and exchange with the CPRS. These option values are of crucial importance. The fact that the voluntary structure would allow farmers to opt out where transaction costs appear high relative to benefits, is one way of managing transaction costs for greater efficiency. There is a ‘self-hedging’ character to the risks of transaction cost blowout.

If the entire value is derived from prices increased due to meeting the demand from consumers for greenhouse gas friendly products, then the benefits are likely to be low – if previous branding exercises using credence labelling are used as a guide. However, if benefits are low then the costs are likely to be low also, as the monitoring and reporting requirements and participation rates will be adjusted accordingly. If the entitlement (the abatement or sequestration) is, or could be, recognised at some point in the wider scheme, then it would become efficient to incur greater costs to access the greater value. Pre-emptive incurring of higher costs by a group of farms, to secure an early competitive position and ability to service an offsets market, could also make sound commercial sense, even if current values are low.

There are a number of ways that a Government could facilitate a voluntary trade: removing inefficient incentives in other policies (drought, etc.) that might impede natural development of such a market; setting up a market (like the CCX, and as an entity that might later be sold); ensuring that trade practices and competition policy provide some recourse for market participants; and/or underpinning the credibility of potential offset packages through establishment or monitoring of standards and through engagement in processes designed to agree interchange standards.

Other costs of facilitation of voluntary markets would include the development of modelling and other technology, to ensure reporting, accounting and monitoring consistency between participants.

Risks are largely likely to be managed by how, and at what point, abatements in a voluntary market would be tradeable with the CPRS. Some of the obvious risks have been mitigated by experience of the CCX – but some sophistication will be needed to deal with the diversity of Australian systems and the current and near-term quality of available information.
13.3.3 Contributions tied to particular outcomes/carbon services

Bushcare and Landcare are examples of where public funding is provided to create incentives for particular actions to be undertaken by farmers. In most instances, the benefits are only partly internalized so public funding is offered to match private funding, to induce a particular behavioural change.

However, these subsidies are not entirely directed at supporting farm production but are tied to particular verifiable behavioural changes to reduce externalities. They could be viewed as mechanisms for the community to purchase environmental services from landowners.

Landcare and Bushtender would provide good estimates of costs if this system were to be implemented and show how risks could be managed. These systems also have the capacity (Landcare actual and Bushcare theoretical) to include third (i.e. private purchases) participants in the markets. Risks can be managed effectively through the contract between the supply of services and the buyer. However, unless the processes can be substantially ‘automated’ with good predictability by those considering an involvement, the reach of such schemes is likely to be fairly limited – while allowing specific targeting of particular issues. Development of submissions without a good understanding of what is likely to be accepted would entail a substantial culture shift for many farmers.

There is a rich history globally of Governments creating financial incentives to alter farmer behaviour.

Due to criticisms of the consumer burden and international trade distortions associated with the forms of protection used, in recent years, in common with much of Western Europe, Switzerland has been slowly replacing its intrusive agricultural price support policy with budgetary provisions that, unlike traditional price support, are not directly proportional to output. The process is known in international trade policy circles as “decoupling,” so-named because the new intervention is targeted at farm entities rather than in a blanket way across product revenue.

Often the newer mechanisms are criticised for being as protectionist as the old mechanisms they have replaced - in the sense that, to a significant degree, they still artificially promote domestic agriculture and continue to discourage imports of cheaper product from elsewhere. The official rationale tends to have become agriculture’s so-called multi-functionality, or the provision by agriculture of a range of non-agricultural services deemed valuable to society, such as decentralisation, scenic beauty and environmental sustainability.

In Switzerland the contracting parties for farmers are typically environmental authorities at the canton or federal level. The following statement from a
survey of Swiss agricultural policy by OECD’s agricultural secretariat illustrates the point (Phan-huy et al 2004):

“The concept of multifunctionality enjoys a broad political and social acceptance in Switzerland, as its integration in the Swiss Constitution (1996) and regular polls (UNIVOX) show. Although participation in the programmes is voluntary, more than 90% of Swiss farmers receive direct payments that are conditional on proof of ecological achievements (“Ökologischer Leistungsnachweis”). The farmers’ economic situation is quite stable. Satisfaction in the existing situation is rather high among farmers, although they express concern about the future with the ever increasing pressure on agricultural markets. Some farmers, especially older ones and those in favoured zones, express reservations about the change from a production-oriented agriculture to multifunctional agriculture with financial compensation for the supply of public goods” (pp25-26).

The community acceptance in Switzerland of contractual payments to farmers for performing an environmental stewardship role appears striking.

In Australia, the covenant incentives offered by governments for farmers to preserve environmental assets on their farms are similar in principle to the Swiss contracts outlined above. The Australian covenanting schemes are administered by state governments but involve the Commonwealth also, because approved schemes can be income tax deductible and free of capital gains tax. The schemes offer a wide range of possibilities particularly for carbon emission reduction and storage.

Formally, a conservation covenant is a voluntary agreement made between a landholder and an authorised body (such as a Covenant Scheme Provider) that aims to protect and enhance the natural, cultural and/or scientific values of certain land. The owner continues to own, use and live on the land, while the natural values of an area are conserved by the landholder in partnership with the Covenant Scheme Provider. Covenant Scheme Providers can be not-for-profit organisations, government agencies or local Councils, that can enter into conservation covenants with landholders to protect land with conservation values.37

It is understood that conservation covenants are accepted on a few thousand hectares of private land in Australia each year. It is hard to say how they are affecting farming or conservation, but their impact is probably fairly benign.

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13.3.4 Broader offset provisions for agriculture

A policy option receiving considerable attention at the moment is broadening the sequestration opportunities that can be carried out on farm. Broadening the offset provisions for agriculture would also add considerable depth to carbon offset services markets and voluntary markets.

Biochar is one technology that, some have argued, offers considerable potential for sequestering relatively stable forms of carbon for some time in soils.

However to be considered within current institutional arrangements, any offset will have to demonstrate that it is:

- Additional
- Quantifiable
- Verifiable
- Permanent
- Monitored.

The transaction costs associated with meeting these principles are considered to be significant and at present may exceed the value of the offsets derived from the offset investment made by most individual farmers.

There are several aspects of the standards that need to be tested further.

Where there are public or private funds purchasing the offsets there will be questions about whether the sequestration opportunities are additional ones. In agriculture there are significant spillovers from management practice changes that sequester carbon or reduce emissions. For example, increasing soil carbon levels usually:

- is achieved by reducing tillage, saving machinery, labour and fuel costs
- improves water holding capacity and soil structure and
- increases microbial activity and releases nutrients to plants.

Base line carbon cycles need to be established to measure the additional quantity of carbon being stored or emissions reduced. Net carbon emissions are likely to change over time in the absence of carbon pricing, as land use and management practices change in response technology changes. For instance, there have been substantial increases in minimum tillage of soils by farmers to reduce machinery and labour costs and improve soil structure (added incentives will also come from price rises for these inputs from other sectors being covered by the CPRS). Minimum tillage also increases soil carbon levels as it suppresses organic matter decay.
The technical capacity to undertake this level of evaluation and monitoring is at present limited and the cost where elements are possible is well beyond the capacity of most small farms.

The definition of permanence is also open to interpretation. There appears to be a considerable consensus that biochar is likely to persist for at least 100 years in most Australian soils if treated appropriately, but the scientific consensus falls away after 200 to 300 years.

However, these uncertainties should not be a reason for not acting. In most instances high levels of confidence could be attached to abatement impacts exceeding a specified lower bound. This confidence also comes at lower cost as there is likely to be an exponential relationship between verification and monitoring of carbon sequestration as the precision increases. As has already been flagged, mechanisms could be developed to assign value in relation to potential for later establishment and certification of longer duration. These mechanisms could be used to improve incentives now to start sequestering carbon, where it would not be justified based on productivity impacts and lower bound values alone.

Within a dynamic policy paradigm, with evolving technologies, deferring the return of carbon as atmospheric carbon dioxide has high value, even if it may not be permanent. In relation to biochar, it:

- ‘buys’ a fairly substantial period in which atmospheric carbon dioxide is confidently lower, along with associated lowering and delaying of adverse consequences, such as ice melt
- retains the option to reapply biochar later as a device to deliver permanence without locking into incurring costs that might later prove to be excessive
- ‘buys’ time, and therefore options, to tap into emerging alternative and more competitive technologies, or to tap the value of research that demonstrates that the lower bound estimate was substantially less than the actual duration of the sequestration
- delivers complementary productivity benefits that might help defray the learning and other transaction costs of the technology, bringing forward and expanding the efficient size of such investment.

Logically, conversion of methane to carbon dioxide – through more efficient digestion or through capture and burning, could be viewed as a form of sequestration – taking high impact molecules and ‘locking’ the carbon up in a lower impact form and storing it in the atmosphere. We are not suggesting that it should be accounted for this way, but the observation provides insights into what is really intended by permanence provisions. The commonly cited global warming potential of methane, of about 21 times carbon dioxide, is in fact based on calculations over 100 years, factoring in the relatively short
seven-year half-life of methane molecules that are subject to natural oxidation in the atmosphere.

Requirements to be recognised as additional for such things as storage in soil, also invites comparison with what is to be allowed within the CPRS and elsewhere. The proposed EC measures for containing agricultural emissions are clearly built around some trends that are already in train. Australia had a clear trend towards greater reliance on gas relative to coal in electricity generation, ahead of planning for the CPRS; any generator moving into gas as replacement for coal will, in any case, be ‘rewarded’ by the CPRS in the form of lower costs of emission rights per unit of electricity supplied. Care is needed not to post an artificial barrier to agricultural measures based around these objectives of additional quantities and permanence. At the same time, care will be needed to avoid counterproductive ‘gaming’.

Widening the sequestration opportunities is likely to lead to a market for carbon offsets, in much the same way that other environmental, amenity and biodiversity markets currently operate, here and overseas – though the requirements for sophistication may be substantially greater. This is particularly true because of the substitution issues flagged earlier.

Realistically, a level of confidence in the ability to draw safe inferences at the level of a farm, group of farms or region, seems necessary – though not necessarily all three. Sound accounting at the region or group of farms level, may well support recognition of offsets, even if attribution down to the level of individual farms is not safely possible.

Analogous issues have arisen in recent years with the focus on water interceptions as a result of changing land use patterns, and where governments have made substantial investments in regional modelling capabilities; even though safe attribution of impacts to individual farms is often not possible. Analogous issues can also arise with the accounting for return flows from irrigation use.
Box 6  Likely impacts of Federal regulation on existing and upcoming state-based and regional initiatives

STATE-BASED AND REGIONAL INITIATIVES

A number of state-based and regional initiatives have emerged in North America over the past few years, with the goals of implementing emissions trading programs and influencing any federal scheme. The future of these schemes – and interest in carbon instruments issued by them – will largely depend on their treatment in upcoming legislation at the Federal level.

RGGI MARKET

Market activity in the Regional Greenhouse Gas Initiative (RGGI) gathered steam in 2008, in preparation for the official 2009 start of operations, and interest has grown significantly during the first half of this year. Prices of RGGI Allowances (RGGA) are now reported around US$3.90 per short tonnes of CO2e (€3 per short tonnes of CO2e) in a market that is likely to be long in emissions in its first years. Analysts consider that likely fungibility of RGGI Allowances into the federal system, along with the possibility of banking to later RGGI phases, has possibly helped keep the price above the US$1.86 auction reserve price.

CHICAGO CLIMATE EXCHANGE (CCX)

Members of the Chicago Climate Exchange (CCX) had made voluntary, but firm commitments to reduce GHG emissions by 6% below a baseline period of 1998-2001 by 2010. CCX continued to see record breaking activity in 2008, tripling transacted volumes at 69 MtCO2e for a value of US$309 million (€211 million), more than quadrupling 2007 values. America’s Climate Security Act, sponsored by Senators Lieberman and Warner, was introduced in October 2007 and reported by Committee in December 2008, before a closure vote halted further debate on the bill. The sharp rise in 2008 values is related to particularly high prices in the first part of the year, following a perception that passage of the bill would result in favourable treatment. The Chicago Climate Exchange Carbon Financial Instrument (CCX-CFI) skirted above US$7.00 per tCO2e in early May 2008, before plunging to less than US$2 by mid-September, when it became clear that the Lieberman-Warner bill would not become law. The CCXCFI is currently trading in the US$1-2 price band, as the market perceives that a U.S. federal market is unlikely to recognize the value of CCX-CFIs.

CALIFORNIA GLOBAL WARMING SOLUTIONS ACT

The passage of Assembly Bill 32 (California Global Warming Solution Act AB32) in August 2006 sets economy-wide GHG emissions targets as follows: Bring down emissions to 1990 levels by 2020 (considered to be at least a 25% reduction below business-as-usual) and to 80% of 1990 levels by 2050. Covering about 85% of GHG emissions, a cap and trade scheme (still under design) would be a major instrument, along with renewable energy standards, energy efficiency standards for buildings and appliances as well as vehicle emissions standards. Allowances issued by California and other states before 2012 could also be exchanged for Federal carbon allowances under the proposed W-M draft legislation.

CALIFORNIA CLIMATE ACTION RESERVE

The prospect of fungibility with federal law, among other reasons, has stimulated a domestic offset market, through the California Climate Action Registry (now known as the Climate Action Reserve). This new market generates Climate Reserve Ton (CRT) units, which currently comprise project types from livestock and landfills across the U.S. and forestry project offsets in California. Early transactions for one to 10 year terms forward have been reported with prices ranging between US$5.00 and US$14.00, depending on the location, project type and volume of supply guaranteed in contracts. The primary buyers of these CRTs have been pre-compliance buyers with an eye to California’s law AB32, the emerging Western Climate Initiative (WCI), and a potential Federal U.S. program.

Source: (Capoor & Ambrosi, 2009)
Taxation – measured or imputed – offers another broad set of policy options, where agriculture is charged for the estimated opportunity cost of the emissions it produces. Taxing may offer significantly lower transaction costs, particularly when the point of collection is downstream from the farm gate. This is a key differentiation from cap and trade schemes.

Taxation does not offer significant incentives to change behaviour when applied at an average rate, unless it includes some form of appeals mechanism where those being taxed can demonstrate that they emit less than the average. However, the application of a tax is more likely to occur when the cost effective behavioural change is unlikely or not possible.

In this, it shares the weakness of a downstream point of obligation under the CPRS. Some form of appeals mechanism could help focus higher transaction costs on those farms/regions/systems where incurring these costs would be justified because of the value on offer. Under some circumstances, this could result in greater cost effectiveness, without the requirement that all farms incur the higher transaction costs.

Taxation rates can be linked to market prices, but tend to be less flexible, as the process to alter the rate in response to variations in the cost of CO₂e would tend to be more cumbersome than some market based approaches.

The classical objection to use of taxation relative to a cap and trade market, lies in the unpredictability of a given level of abatement – as is discussed in Appendix B.1. However, tax levels that are responsive to the marginal cost of abatement emerging from the CPRS, coupled with variation in the cap that is sensitive to inferred (and accounted) changes in the level of emissions from a sector covered by the tax, could still be more efficient while delivering certainty as to targets. There is no certainty, under the CPRS, as to the level of abatement from any other sector – and it would seem poor policy to seek to impose such certainty. One of the key reasons for using incentives, rather than regulatory measures, is to encourage discovery of where the cost-effective abatement and sequestration options lie – and to allow for growth in emissions from some sectors within an aggregate limitation across all sectors 38.

38 It seems probable, for example, that emissions from the renewable energy manufacturing sector could, and should, rise under the CPRS, for the good reason that its growth will enable cost-effective abatement elsewhere. As was flagged in Section 6.4, it is not, and should not be, a given that aggregate emissions from agriculture should fall – even though such an outcome seems likely, given the discussion of abatement prospects earlier and given the marginal cost of abatement estimates being suggested for the longer term. What does seem certain is that the emissions efficiency of agriculture should rise.
It is important to distinguish taxes that, with reasonable precision, correct for an unpriced spillover (unpriced emission rights) and those that simply recover revenue. In designing revenue measures, it is normal to try to eliminate behavioural response and ‘distortions’ from the taxes. In correcting for an unpriced spillover, a primary objective is to encourage behaviour change. We assume the emphasis will be on correction of unpriced spillovers, but that the taxes will need to be levied fairly bluntly on purchased inputs or outputs.

The lack of precision will imply deadweight losses, though a judgment is needed as to whether these are greater than might flow from other measures necessarily adapted to make them practical.

At one extreme, you could imagine a high transaction cost system that requires each farm to develop a set of emission accounts – possibly using something like the New Zealand Overseer software, to report on the basis of these accounts and to pay a levy reflective of the assessed net emissions. This could work a little like an income tax system, could create a growth sector in farm accounting and consulting, and could probably, at least after a development phase, post useful incentives, though probably with high transaction costs and the need to address the alignment between this system and the CPRS.

At the other extreme would be a set of taxes on volumes of products and specific inputs. It seems very hard to target these effectively, and perverse incentives (analogous to including agriculture in the CPRS on a largely downstream basis) could be expected – but probably at much lower transaction cost than with the CPRS. The tax rates could be calibrated to the marginal cost of abatement emerging from the CPRS – and it would be possible to address equity concerns via some form of tax threshold.

In contrast to voluntary offset provisions, a tax regime would offer little scope for managing transaction costs by opting out where transaction costs are high in relation to benefits – though use of some form of default rates to apply in the absence of active involvement could go some way in this direction.

The choice of taxes is made less attractive – though not ruled out – by the decision to support cap and trade arrangements in the rest of the system. The chances of progressive convergence to an integrated system seem substantially less with this approach.

### 13.3.6 Regulation

Regulatory measures in general face real difficulties in ensuring that the incentives strike a sensible balance between delivering abatement that is competitive and not locking in very high cost abatement. For example, a regulatory ban on uncoated nitrogenous fertiliser could probably reduce
emissions significantly. By pushing up the cost of all nitrogenous fertiliser, it is likely also to encourage substitution into farm practices that may offset some of the direct benefits.

Compare this to a strategy that allows both coated and uncoated fertilisers to be sold, but with coated fertiliser having its higher costs partially or fully offset by access to a credit, based on the imputed value of resultant reduced emissions. This might be achieved through upstream incorporation of fertiliser manufacture, inclusive of imputed nitrous oxide emissions, in the CPRS. Substitution remains an issue, as was discussed in Section 8, but this arrangement would allow the market to determine the competitive mix of coated and uncoated fertilisers, reflecting relative production costs and the marginal cost of emissions from the CPRS.

13.3.7 Cap and trade in parallel with CPRS

Establishing a separate cap and trade market for agricultural emissions involves some significant risks – unless seen as part of a strategy likely to lead to convergence with the CPRS. The process of setting a cap risks getting that setting wrong – and the right level can probably only sensibly be found through active exploration of interchange possibilities. These processes can mature within a voluntary offsets market without introducing the risks with a full cap and trade arrangement before these mechanisms have been developed.

Allowing a voluntary offsets market to move to compulsory coverage of a proportion of agriculture as part of such an evolution would make greater sense – provided that the offsets systems had developed to the stage where they could permit sensible management of the risks of posting perverse behaviour change incentives.

If the agricultural cap were to be kept separate from the information emerging from the CPRS, it would probably render the option of having agriculture expand its emissions politically very difficult. As was flagged in Section 6.4, this may be an efficient outcome, but the politics and economics would be very difficult without a formal mechanism to test the true competitiveness of agriculture’s demand for emission rights. This would seem to require a fairly close linkage into the CPRS.
14 Concluding comments

The purpose of this study has been to assemble and provide a reasoned, qualitative assessment of alternatives to the CPRS for agriculture — not to recommend a specific policy. From the start it was recognised that further planning and consultation would be needed to come to a landing on policy — and that this study would be just one input to those processes.

Serious limitations in the available science and in scope for reliable farm level attribution have been raised by some as reasons for largely leaving agriculture out of the ‘carbon market’ response strategy. Others have seen this as a reason for using blunt instruments that we believe risk posting seriously perverse incentives and potentially locking in excessive costs. We see the same insights as posting strong caution against either of the strategies that could seriously limit Australia’s ability to access the opportunities for cost-effective use of its land base as part of a sound policy response. High uncertainty exists in parallel with strong prima facie evidence that a behavioural response to agriculture and the wider land base, may be able to make a major contribution to lowering the costs and improving the effectiveness, nationally and internationally, of Australia’s climate response strategy.

At the end of this study, it seems fair to conclude that, as a logical consequence of the assumed policy purpose and the characterisation of the key problem and issues, our reasoning strongly suggests both the existence of promising policy paths and scope for substantially narrowing the set of such paths.

It strongly suggests that a soundly managed policy process that invests in improving information and that adapts policy settings over time in the light of new information is almost certainly necessary to deliver on the policy purpose — because of the scope this approach offers for addressing the key concerns and soundly managing the competing risks of failing to do enough and of incurring unnecessarily excessive costs. While policy certainty for the future has a superficial appeal, it really must be viewed as infeasible and undesirable, given the characteristics of the problem:

- It is not inconceivable that improving knowledge of climate change trends, implications and sensitivity to changes in anthropogenic emissions, will compel international decisions to alter the rate of abatement and sequestration being sought, well within the 2050 limit of targets.
- It is not inconceivable that emerging technologies, or better understanding of the full implications of existing technologies (including agricultural technologies), will result in substantial reassessment of the costs of
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abatement and lead to international revision of the optimal rate of
abatement and sequestration over time.

• Australia, New Zealand and Europe and others have already committed to
‘flexible targets’ that are conditional on the willingness of others to adopt a
more aggressive approach:
  − This implies that Australia should value, and probably should cultivate,
an adaptive emissions strategy, which offers the flexibility to ramp up
its rate of abatement at modest cost – and that it could well be worth
paying a premium for such flexibility. For reasons developed in this
study, agriculture could be an important element in this flexibility.
  − New Zealand has gone so far as to make its targets conditional on
improved treatment of land – one of the key areas of concern in the
present study.

• Even if Australia were to commit to a deterministic policy approach, it is
unrealistic to assume that the settings would remain immutable in the face
of clear evidence that they entail on-going and excessive costs, or that
substantially greater abatement and sequestration could be achieved at
similar cost:
  − Structuring the economy for flexibility in emissions makes sense, even
if the formal policy settings are, nominally, deterministic.

Of course, many businesses would like certainty – but not at any price and,
given the characterisation of the problem, it is appropriate to ask whether they
would also like the certainty of being locked into an unnecessarily costly path
for the economy. The major uncertainties that make treatment of agriculture
hard cannot be eliminated through policy settings. Policy settings influenced
by a desire to deliver greater certainty can reassign and exacerbate the
associated risks, could change the form of some uncertainties, can severely
mute the incentives to plan proactively to limit damage and can drive or
discourage investment in reducing uncertainty over time. Only some of these
seem desirable.

Sustainable businesses – farm businesses more so than most – are in the
business of managing risks alongside pursuing rewards. Agriculture has long
been subject to climate volatility and even reasonably long cycles as evidenced
by the marked shift from drier to wetter conditions between the first and the
second halves of the 20th century. It has evolved in the face of both trends and
volatility in commodity markets and input prices – in part driven by strong
trends in technological innovation. Australian agriculture’s success in building
competitiveness over many decades attests to its skills in working with high
levels of uncertainty, with managing the associated risks and with investing in
and exploiting new technologies.
This does not, of course, mean that extra uncertainty is welcome (while recognizing that it is possible to extract value from uncertainty through the delivery of risk management services). However, it is arguable that skills in dealing with climate variation and with commodity market uncertainties are probably greater – and more competitive – in Australia than in other production regions, where climate variation has traditionally been less and where policy settings have tended to shelter agriculture more from market volatility and reality.

Structural climate change trends and associated policy responses have resulted in significant reshaping of the uncertainties and risks faced by agriculture. A decision to exempt agriculture from the CPRS, without strong and well-founded alternative measures – may well add more uncertainty than it removes.

We would predict that any such exemption would quickly become the subject of frequent policy review, in the same way that historical agricultural subsidy measures were the subject of frequent review and were eventually wound back, with the ultimate adjustment commonly being traumatic.

Even if the basic policy setting holds, the pressures to use regulatory and other measures to constrain agricultural emissions and to be seen to be making agriculture ‘pull its weight’, will be substantial and will risk forcing high-cost change because of the limited scope for ‘sensibility testing’ the impact of the regulatory measures against the value to the economy of restraint. These pressures and risks will come from the nature of agricultural emissions and their significance as a contributor to total emissions. As the CPRS bites, and abatement is delivered across other sectors, the significance of agricultural emissions, if not limited by other means, could well rise, without supporting the defence (recognised in Section 6.4) that they are rising in response to fair competition for the limited rights to emit.

Crucially, agriculture may offer a real opportunity to the rest of the economy, in the form of substantial offsets that are particularly cost competitive – the opportunity to limit the constraints climate change policy implies (in the short term) on economic surplus, or net performance of the economy in delivering value. In the long term, we assume there will be expectations that climate change policy will limit the costs of climate change – but this would not justify locking in early costs that are unnecessarily high for the levels of abatement and sequestration offered, or relative to the marginal value of investment in adaptation.

This opportunity could come through a combination of significant opportunities for low cost abatement and real prospects for substantial sequestration – if fostered with the right incentives and research underpinnings. A major concern throughout this study has been with the risks.
that policies would emerge that strike a ‘rough justice’ accommodation of transaction costs and concerns for historical emissions, in ways that greatly limit access to these opportunities. This is a challenge for the whole of the economy, not just for agriculture.

All these considerations are reasons why we believe agriculture actually has a strong interest, shared with the rest of the economy, in being inside a soundly based policy process, designed to tap into its potential with soundly structured incentives within a sustainable set of principles and policy processes (but not fixed policy settings). Rather than being outside and subject to the indirect impacts of the CPRS, to the less structured and predictable processes of regulatory and other measures likely to follow, and to the ongoing uncertainty as to whether policy will shift, with its transitional costs, to closer integration. These transition costs are likely to rise with the rising marginal cost of abatement from the CPRS.

Sound structure almost certainly involves linkage to – at least in the medium term – the value of emission rights emerging from the CPRS. This might be managed through periodic analysis, review and recalibration of ‘best practice’ guidance and nominally independent accreditation processes – but we doubt that this could remain efficient over time. Growing evidence of inefficiency and misalignment of policy is likely to be one of the triggers for reassessment of the policy approach.

Even if agriculture is to be managed indefinitely through a process distinct from the CPRS, there is a lot of appeal in having sensible inter-linkages and trading – of offsets if not permits – to allow ongoing testing that the costs being incurred within agriculture are not moving too far from efficient levels and to support sound progressive decisions as to the sensible future level of alignment between the two policy processes. These inter-linkages and trading activities would be a key source of information within an adaptive policy framework. The same inter-linkages could underscore strong commercial incentives for innovation and deliver more cost-effective solutions over time.

From this reasoning follows our view that a sensible policy approach for agriculture is likely to place increasing emphasis on market mechanisms and commercial incentives that relate logically to the evolving structure of the CPRS. There is logically a lot of room for movement here as to timing and detail – but there is also likely to be a high opportunity cost on unnecessary delay, given the potential for reducing costs within a steadily tightening CPRS, and the fundamental option value in avoiding emissions and delivering sequestration early.

We have heard many suggestions that there is little that farmers can do, short of cutting back on production – especially ruminant livestock production.
That appears not, in fact, to be true – there are a lot of things that could be done, many of which offer very good prospects of delivering lower emissions intensity and synergistic benefits to productivity. The problems lie more with incentives and recognition/reward – and this is tied up with difficulties in measurement and attribution.

Certainly, there are prospects for far more powerful options emerging, with sound underpinning research, over the next several years – and greater confidence that these developments, where successful, would be rewarded would improve prospects and bring down the mean times till these options are available.

There is legitimate controversy about the actual form of a realistic abatement curve for Australia – but little controversy about the view that there are genuine opportunities for the agriculture sector to make a significant contribution towards abating its and Australia’s overall level of emissions.

We do not want to overstate the potential, but we do believe that a paradigm has been applied to the assessment of these opportunities that is seriously biased towards underestimating their potential value, and to under-realising their translation into real benefits. A key message to emerge from this study is the view that these biases should be attacked at their foundations – that an appropriate, risk-based portfolio paradigm is needed, to ensure that the value offered by agriculture is tapped cost-effectively.

The insurance market sells risk management services based on actuarially sophisticated tools to assess the portfolio cost of issuing a new insurance policy – but with very poor capability to predict the level of claims on individual policies in individual years. Available science is tapped to inform assessments of likelihood – with older people paying more for life insurance and younger people paying more for car insurance – but the viability of the sector is predicated on tapping into the far more predictable performance of the portfolio. As major events occur, and sums get recalculated, insurance premiums and products evolve and portfolio structures change, to support sustainable long-term profitability and access to cost-justifiable risk services. Sophisticated reinsurance markets have emerged to further tap into this principle for separating insurer risk from insured risk.

We believe there is potential for a lot of value to be derived from the transfer of these same principles into the structure of incentives to address climate change risk – internationally, nationally and at the level of the agricultural sector.
Chart 26 sets out a broad representation of some of the key decisions needing to be taken, reflecting the perspectives developed through this report. Particularly pivotal is the choice between a process, assumed to be largely deterministic and using classical cost-benefit principles for comparing alternatives, to an approach based on the principles of adaptive management and the value of an adaptive policy process. Given current tools and knowledge, the choices in the former case come down to an ‘either-or’ – that approach will almost certainly underutilise the potential of agriculture or will extract that potential at excessive cost. The options approach, on the other hand, offers serious prospects for relaxing this apparent trade-off – with a dynamic path that should provide joint access to cost-effective potential and limitation of the risks of locking into excessive costs.

However, there would remain important decisions to be taken as to the approach to limitations in the rules. The more conventional approach – of planning largely within the rules, while maintaining pressure for change – has limitations in the way that it would defer access to potentially high-value measures that could have early and real impact on global greenhouse gases. Alternative strategies range from an adaptive strategy that secures options over the possibility of a change in the rules, through the New Zealand approach of making target levels conditional on changes to the rules, or use of a two-part target structure. The third of these is arguably the most radical, but also the one most closely aligned with the policy purpose.
There is probably no need, and potentially some risk, in locking in now to a firm response as if conceding that appropriate changes to the rules cannot be achieved. There is scope over the next few years for building the case, for posting incentives for useful change within agriculture, and for addressing the detail of what would be done if the rules cannot be changed later – though in sufficient time to allow a serious choice to be made as to whether the emphasis will be on accounting within the rules, or accounting on a wider basis while also reporting within the rules.

It seems sensible to think in terms of a phased policy development process. Given that we see it as an adaptive process that will respond to information generated over the next several years, it is important not to view the detail of this phasing as tightly scripted – the further out you proceed, the greater the range of plausible forms of policy, as reflected in the widening bands of possibilities set out in Chart 25.

Even beyond the growing range of possibilities as we move out in time – and as the policy is adapted to the emerging information – Chart 25 is far from being prescriptive. It embodies the risk management framework as developed in this report, but leaves open substantial choice as to the initial packaging of measures, as well as the evolution in that package.

Specific elements will require more detailed assessment before locking into an initial strategy. This will require engagement with the scientists, farm sector stakeholders and farm advisors, as well as with the policy makers. As was noted earlier, individual elements cannot readily be rated usefully on a stand-alone basis. A process is needed to pull together a package that is self-hedging in respect of the major risks, while securing access to the more promising longer term options. What is important is that, within the proposed framework, there is a lot more room to move because of the presumed adaptation process, the integration of risk management into the strategy and the recognition that the early processes, even if flawed and unsustainable, will yield powerful new information and will build experience that later policy settings can exploit.
15 References


References


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A Some comments on policy process and purpose

A.1 Policy purpose

We have assumed in this study that the primary purpose of greenhouse gas emission policy in respect of agriculture should be to make a cost effective contribution to Australia’s overall climate change policy. The objective should be to implement a policy strategy that delivers the greatest net benefit to Australia – inclusive of the value of risk reduction, the value of any reduction in the national cost of greenhouse gas abatement, any transition and transaction costs, and the costs of any adverse equity impacts, in relation to sectors, regions etc. where these cannot be compensated cost-effectively. Accepting this places strong emphasis on policy measures that will alter behaviour rather than simply measures that share the costs of emissions.

To assert that a policy or policy process is preferable to another only makes sense if linked to a clear understanding of what is meant by the term ‘better’. The need is made even more intense in considering an array of potential policies and processes.

There are different ways of viewing the policy options and possible interventions delineated between defensive, where agriculture pays for its emissions and reductions are made through reductions in production, or posting clear opportunity costs to agriculture of the costs of its emissions whereby farmers can make reductions where the marginal costs are lower than other emitters abatements or reduce production where they are not.

Given the diversity of emissions and emission abatement possibilities across agriculture by enterprise, management capability and geography, a more prospective primary perspective may be value with risk management (see Chart 27).
It would certainly seem highly desirable that the objectives set for agriculture be compatible with those driving the wider greenhouse gas abatement and even wider climate change response policy agenda, and desirable that they be mutually supportive. This could be expected to reduce the risks of policy conflict, to improve the scope for convincing the Federal Government processes to take seriously an agriculture-specific policy position and possibly provide access to valuable policy synergies that could allow for substantial cost avoidance.

Here aspects of the earlier commentary are important. Government objectives in relation to abatement appear to be significantly about perceptions, and the creation of leverage to seek to influence the global outcome, inclusive of the responses of other countries. Just how much influence Australia has is debatable, but the notion that Australia stands to benefit not just from the direct effects of its own abatement but also from consequential changes in international abatement seems sound. Perceptions may also be important in providing insurance against other countries penalising Australia for perceived inadequacies in response.
We noted earlier the potential for significant ‘leakage’ of actual Australian reductions in emissions – as some of these emissions are replaced following responses to the changed circumstances from competitors. At this stage, we make no judgments about how real and significant such effects might be. We understand the logic and can imagine a range of factors that could limit the scale of such effects. Nonetheless, there may be a real effect.

If Government objectives are focused on direct reduction in global emissions as a result of Australian abatement, these effects are potentially important. If the objectives are dominated by seeking to affect perceptions, these effects could be quite minor. The truth probably falls in the middle.

This does not, of course, mean that improvements in the international rules that allowed better accounting for net abatement would not be desirable – and could potentially work strongly in Australia’s and agriculture’s interests.

It seems reasonable to assume that broader greenhouse gas response policy is being developed with an idea to delivering a package of policy measures that is, in the broad sense suggested there, cost-effective and more so than any of the alternatives. This might be restated as seeking a policy package that offers the greatest net benefit, inclusive of the values associated with economic and financial performance, risk management protection of the environment, etc.39

39 We are not asserting that the proposed policy settings, including the CPRS, deliver fully on this objective – this will necessarily be subject to judgment and currently stands as somewhat controversial. We are purely making an observation about likely intent. Most policy development is also constrained by a range of considerations, including political constraints, that influence the set of feasible policy options.
Sometimes the terminology ‘triple bottom line’ is used to cover the dimensions of economic, social and environmental outcomes, but it does seem crucial to recognise the critical role of values attached to risk and to risk mitigation. Current climate change policy is substantially about buying insurance to mitigate risk – failure to recognise this in the objectives set for the associated policy in agriculture could lead to serious misalignment of objectives. This is to be pursued largely through international engagement to deliver substantial abatement and through domestic and international work designed to deliver lower cost abatement and adaptation options.

Australia, and indeed the states, have committed to a response to climate change pressures, including a wide range of measures, covering mitigation, adaptation and international engagement to influence global responses. The proposed ‘cap and trade’ greenhouse gas market is a central part of this response but must be seen as only part of the response.

Although it is yet to be passed by the Senate, the broad market approach as a central plank of greenhouse gas containment strategy appears to have the support of a substantial majority in both Houses. Debate is centred on details of targets, timing and aspects of equity measures to deal with particular concerns. Major developed economies around the world have implemented, or are planning implementation, of analogous market mechanisms – though so far with limited formal inclusion of agriculture.

The formally proposed structure and targets for this market embed elements of both emissions mitigation and influence over international policy response. The latter is most clearly reflected in the proposal that Australia’s reduction targets would be varied upwards if there is a strong enough international commitment – which might be seen as supporting an objective for global mitigation.

Reflecting the above discussion, this policy flexibility could be rationalised in more than one way:

- Offering to raise Australian targets in response to higher targets from the rest of world posts direct incentives for stronger global mitigation, with Australia standing to gain from this:
  - In effect, Australia could be seen as seeking to ‘buy’ matching restraint in some other countries – though clearly a reasonably sober assessment

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40 A range of measures, such as the regulated phase-out of most incandescent light bulbs and regulation of housing standards for energy efficiency, will constrain greenhouse gas emissions while falling outside (but influencing the carbon price within) the cap and trade arrangements. The fact that other measures can alter the cost of abatement within the market, without being formally part of the market, opens a range of policy options for agriculture other than direct participation in this market, while still allowing a contribution to lowering costs of carbon mitigation across the economy.
of the ‘purchasing power of Australian willingness to reduce emissions’ would need to be taken in the light of Australia’s low absolute contribution to global emissions.

- Australia appears to be heavily and even disproportionately exposed to the risks and already apparent trends, of climate change. This reflects its: industry structure (including agriculture); natural resource base; established investments in key energy and water infrastructure assets; and specific aspects of climate modelling, with implications for generally adverse movements in rainfall patterns in our most heavily populated, and farmed, areas.

- Stronger mitigation by other countries, especially major competitors in international trade, has implications for the level of loss of competitiveness Australia may experience in established sectors, for any given level of mitigation in Australia – the *opportunity cost of commitment to a stronger target* would be reduced by this stronger international commitment:
  - In general, the greater the restraint delivered by other countries, the less will be the loss of competitiveness experienced by Australia.
  - As a result of this shift, a *higher level of mitigation by Australia could itself prove cost-justifiable* as a response to overseas policy change – because the incremental costs to Australia of greater restraint would be lower.

- There may be scope for synergistic responses by Australia and other countries, based on potential developments where Australia is making a major commitment to R&D:
  - Most notable here is the very heavy Australian commitment to (and reliance on) technology development for carbon capture and storage:
    - While Australian industry could benefit directly from this technology, the largest benefits for all – including the Australian coal industry – almost certainly lie with large-scale take up of the technology in countries, characterised by China and India, where there are expectations of massive new investment in energy production.
    - Success in delivering the technology could again shift the costs of higher rates of global mitigation, while shoring up Australia’s competitiveness in both domestic industries with strong energy dependence and as an exporter of coal.

Also highly relevant is the fact that current proposals for the cap and trade arrangements involve application of the policy to ‘large emitters’, with a threshold of 25,000 tonnes of CO₂ equivalent emissions annually being proposed. This certainly suggests *clear recognition that transaction costs are an issue*, and that some emitters might be better off not being brought directly into the market arrangements, because the benefits may not exceed the costs.
It so happens that in relation to major upstream emitters of carbon dioxide, this approach effectively captures most emissions – the costs in leaving smaller firms out are modest.

Fundamentally, Australia is using a flexible, adaptable policy process as a central plank of its response to climate change threats – with the policy having multiple prongs. The rationale for the approach would appear firmly grounded in looking to Australia’s contribution to global outcomes as a means of protecting Australia’s interests.

The choice of a cap and trade mechanism, despite its relatively high transaction costs, reflects a strong commitment to posting incentives to discover and adopt lower cost ways of delivering the level of abatement considered necessary. The mechanism emphasises the desire to post incentives for behavioural change and a focus on ensuring a level of emissions reduction, more so than would other mechanisms, such as a tax. This approach also seems more likely to ensure ready compatibility with the developments occurring in other countries – and might, as such, be viewed as limiting the risks of the Australian policy being judged to be out of step, with possible adverse trade consequences.

The target setting process, focusing on point-in-time gross emissions within country, seems less than ideal given these objectives – except for the fact that the objectives could be seriously undermined by a failure of Australia to operate within the international rules, or by a failure to establish perceptions that Australia is making a big enough contribution within the existing measures of emission levels.

Agreeing to operate within the rules does not, of course, preclude a commitment to seeking to improve the rules over time. From an Australian perspective, this could especially involve working to remove anomalies that will distort responses in ways that are particularly disadvantageous to Australia. Here there are a number of areas of quite legitimate concern, including:

• Treatment of forestry and soil carbon.
• Emphasis on widely-spaced point-in-time targets, as opposed to impacts on the ‘area under the curve’ – cumulative emissions up to points-in-time (net of offsets):
  − This includes treatment of discrete/lumpy and finite sequestration opportunities.
• Failure to incorporate formally into the rules modern principles for handling the value of flexibility and uncertainty, including in respect of future R&D outcomes.
The decision to allow some activities to fall outside the cap and trade scheme reflects a level of pragmatism and an approach to cost-effectiveness of policy that includes transaction costs.

It is against this background that we look at the objectives that might underpin decisions on policy for agriculture.

We have concluded that the primary emphasis should be on ensuring that Australia derives maximum value from the opportunities offered by agriculture to contain the costs and boost the effectiveness of its climate change response. These costs include transition and transaction costs that vary across enterprises and sectors, and costs and benefits that flow through via impacts on the competitiveness of the economy.

They include costs associated with exposure to risks:

- Risks of inadequate abatement creating much larger costs later.
- Risks of incurring excessive costs and loss of competitiveness for inadequate gain in international abatement.
- Risks of incurring large and irreversible costs from hasty response, only to learn later that these costs could have been substantially avoided with emerging technologies or changing institutional arrangements.
- Risks of future changes to rules and targets (possibly done for sound reason) leading to regret about aspects of the responses undertaken:
  - For example, is there a risk that 2050 targets may be altered in magnitude or redefined in coverage as a result of new science, possibly revealing a need for an even more intense response globally to avert an underestimated threat? Or vice versa?

They also include a range of potential costs and benefits associated with the fact that there are other imperfectly priced spillovers and market and regulatory failures in the Australian economy – and these may be affected by changes in policy in relation to emissions. Several of these tie strongly into agriculture:

- Water: markets in water and water reliability are far from perfect and are also under stress from climate change and climate change policy trends:
  - Extending into current concerns for water interceptions as a result of land use changes, including forestry.
- Salinity and desertification threats where the pressures and controls do not lie solely at the level of individual properties threatened.
- Ecosystem threats where native ecosystems have already been reshaped by land and water patterns.

This approach does not fully imply a commitment to helping minimise the costs of achieving current 2020 and 2050 targets. This is because it incorporates potential for changes to the rules and allows for consideration of
possible international responses that limit the level of global abatement flowing from Australian abatement. These potentially have large implications for agriculture. Of course, we are not arguing that we proceed on the assumption that the anomalies will all be addressed soundly – we assume that a key objective should be development of a policy approach that is quite robust, given the uncertainties about the international rules and response to Australian engagement.

This statement of objective is complex and leaves a lot of room for debate and discretion. The alternative of assuming a simple objective that bears little relationship to the realities of the processes that will be rolling out, appears to entail very high risks. This broad interpretation should align well with actual processes; provide substantial scope for analyses to probe the relative strengths of different policy approaches; while still ultimately leaving significant room for discretion in what will remain a complex trade-off question.

### A.2 The policy process and options - flexibility and uncertainty

The uncertainties are large and will not go away fast. A key element in our approach has been to recognise this and to work through the logical consequences, including drawing on modern principles for managing investment strategies in the presence of uncertainty.

These principles came to the fore, starting in the late 1970s, with the emergence of Real Options theory as an approach to dealing with increasingly apparent serious distortions and weaknesses in classical discounted cash flow methods, for planning and managing strategic investments.

Common practice before the development of these tools (and still common practice!) was to deal with uncertainty by working with best estimates of outcomes and largely optimising strategy based on the assumption that the investment is deterministic. Stress testing for extreme departures was often undertaken – but under the unrealistic assumption that the deterministic strategy would hold, but outcomes would be affected by these extreme circumstances. This approach is fundamentally flawed. An example that works through the reasons is set out in the Appendix C. In particular, we would stress the following points:

- Uncertainty can be priced in an options setting, by exploring the value, in terms of change to expected net returns and related measures, from a reduction in key uncertainties.
  - This can be done (as is illustrated in the Appendix C) by, for example, modelling the impact of resolving an uncertainty before a key commitment is made, as against resolution after the event.
Planning that optimises a strategy ignoring the possibility of future R&D outcomes that could offer lower cost/higher value strategy, is biased towards locking in excessive cost:

− It can be rational, in terms of both reducing expected costs and managing risks, to adopt a short-run policy stance that will turn out to have been high cost if none of the R&D in fact delivers better options. We believe this principle is implicit in current Federal Government strategy on coal-fired generation.

Planning that assumes a worst case scenario and minimises the expected costs of coping with that scenario, will generally be biased towards excessive expected costs – sometimes dramatically raising expected costs.

Strategies that allow for adaptation to new information, and that may well make investments in gaining new information before major commitments are needed, can prove dramatically more cost-effective than deterministic strategies:

− In contrast, virtually any form of planning for a deterministic strategy – one that would be buffered by the forward uncertainties, but without allowing for change in strategy in response to those uncertainties being resolved – will almost always be biased towards lower net value and higher risk:

… The risks can be either or both of poor performance and failure to take advantage of upside opportunities.

These forms of reasoning generally favour an approach that looks to maximising the expected net gains from a strategy, subject to constraints that ensure that the consequences of the ‘worst case scenario’ for planning purposes are manageable.

Strategy to deliver on this will almost always incorporate the following elements:

− It will involve a dynamic, adaptive process that responds to emerging information and that buys ‘insurance’ in recognition of possible future outcomes on key uncertainties:

… Strategic investments in getting better access to information earlier, and investments in flexibility to allow damage reduction through adaptation are common forms of cost effective insurance.

− It will look to flexibility as an asset, again seeking to build flexibility to provide greater scope for managing the uncertainty, both proactively and reactively.

− It will almost always involve a range of complementary investment elements, so that weaknesses in one element can be covered by strengths in others – it will involve an evolving portfolio of measures.

As we have noted, policy is an investment. The CPRS will involve imposing costs on the economy in the expectation of future benefits for Australia,
sufficient to justify these costs. For some enterprises and sectors, the costs are likely to be high; for others, scope for damage mitigation may lower the costs, while actually supporting greater future benefits. The same could be said of most other policy elements under consideration – certainly including commitments to relevant R&D and international engagement.

In probing packages of policy measures that might apply to agriculture, we are proposing invoking this sort of reasoning to explore areas of risk exposure and bias from deterministic application, exploring the scope for incorporating the measures within an adaptive policy process and working through the consequences.

In saying this, we recognise that there is demand for greater certainty. Investors want to know the arrangements that will be in place, and even the effective cost of abatement, for years forward. Of course, if uncertainty can be eliminated without cost, then this will almost certainly permit more valuable policy and strategy. However, many uncertainties are just not amenable to elimination, though clearly they can be moved and transformed. Governments can deliver uncertainty as to carbon price, but not without increasing other forms of uncertainty, such as the level of abatement to be achieved. Governments can assume risks, but in doing so will typically remove risks from those best placed to reduce the damage.

In a flexible policy setting, uncertainty can sometimes be engaged and exploited in powerful ways. If there is uncertainty about the level or permanence of sequestration using an existing technology, this might be addressed in various ways:

- Given the uncertainty, it might be ignored from the perspective of recognised abatement.
- A cautious estimate of a lower bound on the abatement might be recognised.
- A cautious estimate of a lower bound on the abatement might be recognised immediately, along with the issue of an ‘option’ over the non-zero prospects for on-going research leading to an upwards revision to this estimated lower bound;
  - If such revisions were to occur in the future, then the holder of the entitlement might be eligible to be awarded credits for the past history of under-rewarded sequestration.
  - Note that such an option has value at the time of issue, and should alter the incentives for investment in the technology, even in advance of the revision occurring.

We are not here proposing such an instrument, but using it to illustrate how the potential value of R&D can be engaged to alter current behaviour in a
manner that could, in fact, be quite efficient. If Australia is seeking to maximise the expected net benefits of its carbon abatement strategy, then failing to recognise and reward the current value of future R&D possibilities, can certainly translate into inefficient and high risk patterns of behaviour.
B Greenhouse gas management - some observations

This is not the place to roll out a full assessment of options for managing greenhouse gas emissions. The broad structure of Australia’s abatement strategy has been mapped. However, in relation to the debate about how best to manage agriculture, a range of assertions have been made that warrant closer consideration. This attachment is designed to collate a number of observations that are relevant to exploring alternatives. It addresses some ‘myths’ that have arisen in support of particular lines of argument, but does not seek to be comprehensive.

B.1 Market vs. tax?

Climate change policy choices, at least amongst developed countries where there has been a presumed need for significant abatement in the future, has sometimes been represented simplistically as a choice between a cap and trade market or a ‘carbon tax’. This is simplistic, as is evidenced by the discussion in Section 4.5, setting out the breadth of Australia’s policy response that includes, but is certainly not restricted to, a cap and trade market.

However, it may be sensible to view the choice of a market or tax mechanism as establishing the central accounting and consolidation point for managing emission incentives. These mechanisms are designed to post explicit incentives to factor in a cost of emissions when choosing patterns of behaviour and the level of such incentives will be influenced by other elements on the policy package.

For example, regulatory constraints as additional elements in the policy package could be viewed as mechanisms to adjust the marginal cost of abatement as posted through the tax or market mechanisms. Phasing out incandescent light bulbs could be seen as lowering the demand for credits in a cap and trade market – and lowering the costs to the market participants of meeting an overall target. Of course, it would only lower the overall cost of abatement if the issue of the alternative lighting solutions offered competitive abatement – raising the question of why the market would not have resulted in the same outcome. In reality, regulation might be used to accelerate change that is desirable – but can be blunt in accounting for the transition costs and the wider value of any differences seen in service quality. Interim arrangements in respect of agriculture could be viewed in a broadly analogous way – as complementing the cap and trade mechanism and delivering benefits
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through the scope offered to lower costs to market participants (indirect as well as direct) in delivering a prescribed level of aggregate abatement.

The choice between cap and trade arrangements and a tax has been the subject of extensive discussion in the literature.

From a theoretical perspective given full information, and if viewed in terms of single country abatement independent of any links to the rest of the world, the ‘least cost’ choice is an empirical one – it depends on the nature of the economy. It is linked into how rapidly the marginal cost of abatement is changing in the region of quantity cap or tax level likely to be needed. In practice, this result is likely to have limited value as a guide, in a context where the marginal cost of abatement and the necessary levels of cap or tax, are unknown, and likely to need to change substantially over coming decades.

There are two major attractions in choosing the cap and trade over the tax approach:

• Broad compatibility with the direction being taken by other major developed countries, and the likelihood that consistency will expand the opportunities for international trade in emission rights, as a way of accessing lower cost abatement options globally.

• The fact that a cap and trade scheme can build in a cap – can directly underpin a targets-based strategy with an ability to prescribe the level of abatement to be delivered:
  – It is not practically possible to also provide high predictability as to the marginal cost of abatement – that will emerge over time.
  – A tax, on the other hand, can (in theory) deliver confidence as to the cost of abatement if there is a willingness to allow the level of abatement to be uncertain:
    … In practice, an international process based around targets probably means this option is not available to Australia – had it used a tax, the rate of tax would have been subject to variation over time to ensure Australia’s capacity to deliver on targets.

For the purposes of this study, we have taken as given a commitment to the cap and trade mechanism as a central plank of the climate response strategy. At the time of writing, this is broadly official policy for the major parties (though with a lot of contention as to policy detail). US moves towards a cap and trade mechanism strengthen the case for this approach.

Again, however, this will not be all there is to Australian climate change policy. For now at least, agriculture and agricultural emissions are not included and there is a range of regulatory and incentives measures in addition to the cap
and trade market already in place and being envisaged. This includes alternatives for agriculture beyond 2015.

Some commentators have argued for use of a tax instrument for agriculture, even where a cap and trade market has been created for most emissions. The rationale for such a split would lie largely in the transaction cost arguments, given the sector structure of agriculture as discussed in Section 0, compounded by the current uncertainties. For a tax to address the behaviour response biases considered in this study, would still require an ability to translate incentives back to patterns of farm behaviour. A broad-brush tax on outputs would have essentially the same problems in accessing the potential of agriculture that would accompany including agriculture in a CPRS based on outputs. Addressing these matters will require broadly analogous instruments. Again, failure to address these problems would risk both substantial bias against agriculture – by isolating it from its natural means of limiting damage, while confronting the cost of emissions – and substantial intervention failure, in the sense of failing to tap into the potential of agriculture to limit the costs to Australia of delivering a level of abatement and sequestration.

If the means could be developed to build input structures soundly into the tax base, then most of the work is likely to have been done to allow the emergence of offset markets and probably to allow ultimate convergence. If a tax were to be used, the natural rate would be the value of credits emerging from the CPRS. This would allow incentives to be posted to source from agricultural abatement and sequestration if, and only if, it is competitive, in cost terms, to the marginal opportunities available elsewhere in the economy. Doing so would, however, eliminate the ‘emissions price certainty’ argument that some have used to support a tax mechanism. If the tax rate is to be set, and not allowed to adapt to the information emerging from the CPRS, then over time this can almost be guaranteed to become increasingly inefficient and in conflict with the assumed policy purpose.

It is also relevant to recognise, given the assumed policy purpose, that looking at choice of instrument as though the sole purpose is to limit the cost of abatement, could get it wrong. Correspondingly, an approach to ‘efficient policy’ that fails to take in wider objections and dimensions of value could prove misleading. The international influence element of Australia’s climate change strategy is also important and, arguably, far more relevant to real impacts on climate. Here credibility is important – and the natural way that a cap and trade arrangement defines a minimum level of abatement and allows for predictable reductions over time, should not be underrated; nor should the value of broad consistency of approach across major developed countries.
B.2 Should everyone face the same carbon price?

The point has been made to us many times in the course of this study that what is needed is a mechanism to ensure that everyone faces the same cost of emissions – because that is efficient. In practice, it would seem likely that a good policy process will progressively reflect the system cost of marginal emissions through to decision makers. However, the assumption that economic theory requires this is not quite so clear cut – and this may offer scope for better managing equity and efficiency concerns during the transition period.

In the lead up to the introduction of a GST, the argument was widely mounted that there should be a flat rate of GST across all consumption because this was efficient. Any departures in the interests of equity would necessarily imply an economic cost.

Certainly, departures create transaction costs and can lead to some of the same equity outcomes. However, the theory of efficient taxation does not show that a flat rate of tax is necessarily more efficient than one that varies across consumption items. In fact, ignoring transaction costs, it implies a highly variable rate structure, with actual rates dependent of the sensitivity of demand to price changes, as the efficient structure (though it would be an administrative nightmare). The theory suggests that higher rates of tax should apply to items with lower rates of demand sensitivity.

The reason here is that efficient tax theory is largely concerned with limiting distortion of consumption patterns – as a way of limiting the economic costs of raising revenues. You therefore tax most heavily those activities that will be least distorted by a price rise. A real problem with this approach is that it implies taxing most heavily the necessities – when the push to vary tax rates is driven by those who want to tax the luxuries more heavily, as an equity device. In this setting, a flat rate might be seen as a compromise rather than a theoretically pure position.

Shifting to emissions policy, the objective is reversed. The aim is not to minimise ‘distortion’ but in a sense to maximise it, if interpreted as the level of abatement achieved per unit of ‘cost’. But the same economic principles apply. This does not, from a theoretical perspective, necessarily imply that everyone need face the same emission cost. The rationale is more pragmatic.

What is needed is that activities that lie close to the marginal cost of abatement for the system really should see a cost on emissions close to that marginal cost – so sound decisions can be taken as to whether to change behaviour or not. Activities whose emission costs are well away from this point need not
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necessarily be confronted with this marginal cost to encourage efficient behavioural response.

The practicality of managing a process that seeks to exploit this flexibility is the reason why moving towards a single price on emissions is attractive. Such an arrangement is likely to be far more flexible in dealing with the reality of an evolving and imprecisely predictable marginal cost of abatement and probably allows reasonably certainty to be conveyed to markets as to the policy process, if not the outcome in terms of an emissions cost.

It should also be recognised that economic efficiency does not require, in any practically useful sense, that prices be certain – and does not underpin a case for governments acting to deliver predictable prices. Price regulation is generally seen as implying loss of efficiency, not efficiency. Efficient policy will generally favour allowing markets to allocate and manage risk and uncertainty – within constraints – whether this be in relation to the price of carbon emissions or the price of wheat.

B.3 Efficient responses to uncertainty

Flowing from the above discussion, care is needed to ensure that sound principles are applied to strategy in the presence of uncertainty. While an Economics 1A text book might show that lack of information is a source of market inefficiency – in the sense that economic surplus could be increased if the uncertainty could be eliminated without cost, this hardly underpins a case for policies designed to shift the risks of unavoidable uncertainty from markets to governments. The general policy principle is that the uncertainty is best located with those who control the instruments to minimise the damage – and in the case of emissions costs that will generally be those emitting or those deciding whether to buy goods and services that require emissions.

Efficiency in the presence of uncertainty that is effectively unavoidable, temporarily or permanently, needs to factor in that reality – and strategy needs to use tools that work with the uncertainty rather than those that are predicated on ignoring it. This concept pervades the present study.

B.4 Value of unproven prospects

This leads into the final observation. Prospects, even where they are unproven, have value. Any strategy that is prepared to work only with absolutely certain outcomes can constrain itself into a very high cost position – and can render a solution to a problem effectively unavailable.
Stock market prices reflect an assessment of forward prospects with some
adjustment for perceptions of risk. Few stocks could guarantee that they will
be worth more than zero 12 months out. Anyone seeking to invest for their
future on the basis of absolutely guaranteed value would avoid equity
investment and, given the experience of the financial sector over the past 12
months, would probably also avoid debt investment. Diversified portfolios of
investments can, however, deliver much better returns over time than ‘keeping
the money under the bed’, with high levels of reliability.

R&D ventures can have high value. The value paid for equity in Amazon.com
and Google as they developed their commercial models – before they ever
turned a profit – points to this. Large investments are made in resource
exploration, in technology development (including in renewable energy, 4th
generation nuclear power, etc., with no guarantees of commercial return) – yet
economies continue to develop off the backs of such investments, people live
longer by accessing medical technologies that have emerged, etc. The R&D
portfolios of large pharmaceutical companies, of mining companies, etc. are all
valued ahead of confirmed delivery.

Failure to recognise and exploit the value of prospects, using appropriate risk
management tools, would entail very high costs over time for societies. It is
almost certain that the same will be true of dealing with climate challenges.
The strategic position Australia has adopted in relation to carbon capture and
storage reflects this reasoning. The same logic can be applied to farm sector
R&D or to the implementation of prospective farm technologies ahead of
proving the level of outcome at the farm level. Again, sound risk management
tools are needed, but value in recognising the potential, alongside the
uncertainty, and adapting strategy to both can be very high.

These matters are developed further, and demonstrated, in Appendix C.
C Example of risk-based strategy

The framework used in this study is far more about thinking through the possibilities within the framework than it is about building and solving models. However, working through a relatively simple model does provide a better feel for some of the underlying concepts.

We start with a very simple example – where a decision between two approaches needs to be taken now, but the outcome will not be determined till later, when a key uncertainty is resolved.

This can be represented as a simple decision tree.

Chart 28 Structure of simple decision tree

- A green circle denotes an uncertainty – used here to include uncertainty as to R&D outcomes at various stages and uncertainty as to the effective carbon cost implications of the carbon regime that was still being mooted at the time of the study:
  - Note that uncertainties have been stylized as a finite set of discrete possibilities, each with a probability (shown underneath the relevant branch). This is a simplifying assumption, and some other options tools do not require this assumption, but it can be easily represented graphically.
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- A blue square denotes a decision to be made between alternatives at a point in time. Again, we assume a finite number of possible decisions – and again this assumption can be relaxed.

- A red triangle denotes final calculation of the result.

Choosing to follow D2 rather than D1 entails higher upfront costs. However, this buys insurance against a poorer revenue outcome (it might, for example, entail extra investment to diversify the market opportunities) but it also clips the upside opportunity (perhaps because the more general product is less suited to the high upside opportunities).

Which decision is better depends heavily on trade-offs between potential and risk. This model can be ‘solved’ in terms of risk-weighted profit as follows:

Chart 29  ‘Solution’ to the simple decision problem - risk-weighted values

The $25 figure against the top right uncertainty node is simply a 50/50 weighting of the two outcome possibilities if the decision is to back D1. Similarly, the $38 is the weighted average of the two possibilities if D2 is backed. On this basis, D2 is preferred, indicated in the chart by the pink line. However, this is not the best possible outcome under all possible circumstances. Maximum profit is clipped by $50 relative to a D2 decision – just as you immediately reduce maximum ‘returns’ from your house or car for the year the moment you renew the insurance.
Of course, it would be easy to disagree over whether the chances are 50/50 or something else. To help in dealing with this problem, it would be good to know the value of the probabilities where the expected values break-even. This is easily estimated within the model as shown by the following chart:

**Chart 30 Illustration of analysis of sensitivity to different uncertainty assumptions**

![Chart 30](image)

Much more complex probing would be possible – for example probing combinations of this probability and the assumed impact of the different outcomes on revenues. The key point for now is these types of analysis, coupled with the information on the distribution of possible outcomes, provided by the right hand side of Chart 2, can underpin serious discussion of which decision offers the best risk/reward trade-off.

We turn briefly now to another example that is more realistic and energy-related.

In 2006, ACIL Tasman undertook a study for the CRC for Coal in Sustainable Development, examining the case for continued coordinated industry commitment to research into carbon capture and storage technologies. Clearly, there have been a lot of developments since then – so that the work today would require significant updating – but it does provide some feel for how a strategy problem could be cast in an options setting.

While substantial analysis underpinned the work done, it had a relatively simple ‘front end’ in the form of a decision tree that captured stylized versions of the major uncertainties and potential decisions. The structure of the tree is set out in Chart 31.
The Chart uses a highly compact form of representation, relying on the fact that a lot of the structure of uncertainties and decisions is stable, though key parameters might change. This keeps the chart of manageable size, without detracting from its ability to represent the logic of the model:

- ‘Clones’ are used to represent this repeated structure, such that “Clone 1: Regime Outcome” is a shorthand way of saying: Repeat all of the structure starting at “Regime Outcome” in the top line and moving to the right”.

As with the simple example, in a time sense, you move from left to right, following only one path – as dictated by the decisions taken and the chance outcomes. Computationally, it works the other way. If you happen to find yourself at the end of one of the branches, you can work out how ‘well’ you did – based on the costs you will have incurred along the way and the benefits obtained. Every possible path from the left to the right will have an associated value.

Given these values, you can move left back through the system. We have allowed for 4 possible regime outcomes, each with a probability. So you need to look at the risk-weighted value of where you are at just before the regime outcome is determined – a weighted average across the 4 possibilities. These values can in turn be ‘rolled back’ through earlier uncertainties to provide a risk weighted value for each of the possible initial investment decisions.

Doing these calculations for each possible path through the tree yields a ‘solved’ version of the model – in this case solving for a measure of
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performance consisting of the gross value of production less R&D costs. A range of performance measures were developed and compared in undertaking this analysis.

The results are shown in Chart 32. We have retained the compact presentation format, so not all results are clear, but the following can be seen:

- Commitment to another 4 years of major research emerged as offering the highest ‘risk-weighted’ value – $741m above the abandonment options, though other analyses are clearly relevant to taking a final decision.

- The two statistical distributions within the chart show the extent to which a different distribution of possible outcomes is delivered by the major research commitment versus just maintaining the established skill set (to allow rapid adoption of an overseas technology).

- The spread of possible outcomes under the R&D strategy is huge compared to the alternatives – with small but non-negligible prospects for accessing a very large upside.

Again we stress that the overwhelming proportion of the effort and value in the final product from this process did not lie with this type of modelling. However, it does provide a powerful way of assembling the results of a much wider assessment of options, flexibility, risks and uncertainties.

Now, what does all this have to do with options? Quite a lot in fact:
The decision to commit to the major R&D effort can be viewed as a decision to buy options to use the information that would emerge from that investment. The other two strategies essentially ‘extinguish’ these options, though maintaining skills does still secure options to more rapidly deploy possible technologies that emerge from elsewhere, and perhaps to restart the program later. Under some assumptions, it could have been competitive. Of course, committing to the R&D extinguishes options to use the money differently and this needs to be factored in – usually, and in the case of this study, via an explicit cost of capital calculation.

The value of these options can be reflected in the differences in the forwarded expected values attached to the three initial branches – though commonly several performance measures will be calculated, and the statistical spread of possibilities (as represented in Chart 32) would be taken into account in reaching a final position.
D  Example of structured adaptive decision process

Recent work done by ACIL Tasman in relation to management of the water interception impacts of changes in land use included some analogous framework elements. Chart 33 is drawn from that work as an example of how a policy process can be established that starts out light and low on key information and evolves from there in ways that may rely on increasingly sophisticated devices, justified by increasingly better information and management of intervention risks.
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Chart 33  Broad structure of intervention choices, interceptions

Example of structured adaptive decision process
## Abatement options: prospects and likely effects

### Table 7 Abatement options, an assessment of prospects, and likely effects

<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-category</th>
<th>Measure</th>
<th>Ranking</th>
<th>Effects (+ denotes emission reduction or enhanced removal)</th>
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<tbody>
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<td>2012</td>
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<tr>
<td>Livestock mgmt</td>
<td>Increased nutrient use efficiency and improved feeding practices</td>
<td>Feeding more concentrates (replacing forages)</td>
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<td></td>
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<td>Increased concentrate in diet – dairy</td>
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<td>Increased concentrate in diet – beef</td>
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<td>Analysis of forage and fodder</td>
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<td>Target specific livestock nutrient requirements</td>
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<td>Balance diet for energy and protein (e.g. reducing protein, increasing carbohydrates, increasing condensed tannins)</td>
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<td>High fat diet – dairy</td>
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<td>High starch diet (maize) – dairy</td>
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<td>High starch diet (maize) – beef</td>
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<td>Increased protein quality (balanced essential AA comp.)</td>
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<td>Increased milking frequency</td>
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<td>bST – dairy</td>
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<td>Estimating potential CH₄ production from feeds</td>
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<td>Mechanical treatment of feed</td>
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<td>Chemical treatment of low quality feedstuffs</td>
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<td>(Multi) Phase feeding</td>
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<td>Improved feed conversion (increasing energy content and digestibility) – beef</td>
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<td>Improved feed conversion (increasing energy content and digestibility) – dairy</td>
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<td>Use of antibiotics – beef</td>
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<td>Continuing conventional dietary improvement</td>
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<td>Improved diets for pigs</td>
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<td>In general</td>
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<td>Adding certain oils to the diet</td>
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<td>Ionophores and natural extracts to modify rumen microbial fermentation</td>
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<td>Pro-biotics (e.g. yeast products)</td>
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<td>Promoting acetogens</td>
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<td>Genetic modification of rumen microflora</td>
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<td></td>
<td>Vaccination against methanogens</td>
<td>Naturally occurring plant compounds (new species/GM)</td>
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<td>Adding certain enzymes to the diet</td>
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<td>Vaccination against methanogens</td>
<td>Antimethanogens</td>
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<td>sheep</td>
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<td>beef</td>
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<td>Structural and management changes</td>
<td>dairy</td>
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<td>Structural and management changes</td>
<td>sheep and goats</td>
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<td>Structural and management changes</td>
<td>Reduction in the number of replacement heifers/Improved fertility management</td>
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<td>Structural and management changes</td>
<td>Multi-use of cows (milk, calves and meat)</td>
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<td>Structural and management changes</td>
<td>More feed production on farm scale or local level</td>
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<td>Structural and management changes</td>
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<td>Selection for reduced methane production</td>
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<td>Animal breeding and genetics</td>
<td>Selection for longevity, fertility, and other non-productive traits</td>
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<td>Selection for higher yield</td>
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<td>Cloning</td>
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<td>GM livestock</td>
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<td>Planned selection of male/female at insemination (embryo and sperm sexing)</td>
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<td>Twinning</td>
<td>3 3 3</td>
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<td>Animal breeding and genetics</td>
<td>Transgenic manipulation – dairy</td>
<td>5 5 4</td>
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### Example of structured adaptive decision process

<table>
<thead>
<tr>
<th>Category</th>
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<th>Measure</th>
<th>Ranking</th>
<th>Effects (+ denotes emission reduction or enhanced removal)</th>
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<th>2017</th>
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<td>CO₂</td>
<td>CH₄</td>
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<td>Anaerobic digestion and CH4 capture</td>
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<td>Transgenic manipulation – beef</td>
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<td>On-farm – dairy</td>
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<td>High-tech digesters – dairy</td>
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<td>Low-tech digester – dairy</td>
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<td>Complete-mix digester with engine – dairy</td>
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<td>Plug-flow digester with engine – dairy</td>
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Data source: (Moran, et al., 2008)