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Public goods and externalities

AGRI-ENVIRONMENTAL POLICY MEASURES IN AUSTRALIA

David Pannell, Anna Roberts

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Abstract

PUBLIC GOODS AND EXTERNALITIES: AGRI-ENVIRONMENTAL POLICY MEASURES IN AUSTRALIA

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Agriculture is a provider of commodities such as food, feed, fibre and fuel and, it can also bring both positive and negative impacts on the environment such as biodiversity, water and soil quality. These environmental externalities from agricultural activities may also have characteristics of non-rivalry and non-excludability. When they have these characteristics, they can be defined as agri-environmental public goods. Agri-environmental public goods need not necessarily be desirable; that is, they may cause harm and can be defined as agri-environmental public bads.

Public Goods and Externalities: Agri-environmental Policy Measures in Australia aims to improve the understanding of best policy measures to provide agri-environmental public goods and reduce agri-environmental public bads by looking at the experience of Australia. This report provides information to contribute to policy design addressing the provision of agri-environmental public goods including the reduction of agri-environmental public bads. It is one of the five country case studies (Australia, Japan, Netherlands, United Kingdom, and United States), which provide inputs into the main OECD book, *Public goods and externalities: Agri-environmental policy measures in selected OECD countries*.

Keywords**:** public goods, externalities, agri-environmental policies, Australia

JEL classification**:** Q52, Q53, Q54, Q56, Q57, Q58

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The OECD project on public goods associated with agriculture was carried out under the auspices of the OECD Joint Working Party on Agriculture and the Environment (JWPAE), of the Committee for Agriculture and the Environment Policy Committee. This project was led by Tetsuya Uetake (OECD Trade and Agriculture Directorate). The JWPAE endorsed the report for declassification in June 2014.

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Executive summary

Australian agriculture is export-focussed and less reliant on subsidies than many OECD countries. Australia has many important environmental assets and exceptional levels of biodiversity. Impacts of agriculture on the environment have been on ongoing concern. Agri-environmental public goods that have received most attention in recent decades are water quality (salinity, nutrients and sediment), water quantity/availability, farmland biodiversity/native vegetation, soil protection/quality, climate change (carbon storage, greenhouse gas emissions) and air quality.

There has been strong interest in developing market-based mechanisms to address agri-environmental issues. If well-functioning markets for agri-environmental public goods can be developed, decisions about appropriate levels and methods of provision may be made by participants in those markets, rather than by governments. Most progress in this direction has been made in addressing water quantity/availability issues, particularly in the Murray-Darling Basin. Although reforms have been challenging both technically and politically, extensive progress has been made in setting water extraction limits, defining water rights and establishing trading rules. Well-functioning water markets now provide significant public benefits. Relative to water, there has been much less use of markets for other agri-environmental issues. For example, despite successful use of conservation tenders (reverse auctions) to protect native vegetation and biodiversity on private land, these mechanisms remains a relatively small part of the national portfolio of conservation policies.

The decision to use market-based instruments presumes the existence of market failure. However, this assumption is not always justified. Market failure depends on two factors: (a) the existence of at least one characteristic that reduces the effectiveness of markets (non-excludability, non-rivalry, externalities, information failure including asymmetric information) and (b) a benefit-cost test to assess whether the benefits of a government intervention intended to address a market failure exceed the costs. In some situations, agri-environmental public goods are provided incidentally by farmers, as a side benefit of agricultural production decisions made for reasons of productivity and profit. This was the case for adoption of zero tillage, and in such cases minimal government intervention is required, beyond research and development. More commonly, agricultural practices that favour the environmental are not sufficiently attractive to farmers for there to be widespread adoption without government support. In some of these cases, a policy would generate environmental benefits that outweigh the costs to farmers, justifying government intervention – for example, actions to reduce nutrient and sediment movement into water bodies in certain situations. In other cases, the environmental benefits of proposed actions are smaller than the costs to farmers, indicating the absence of a market-failure justification for intervening.

A lesson from Australian experience that is likely to apply to other OECD countries is the importance of spatial heterogeneity. Environmental values, project feasibility, landholder compliance and project costs are all spatially heterogeneous, meaning that carefully targeted environmental investments can generate much greater environmental values than untargeted or poorly targeted investments. The importance of targeting is increased in Australia by the fact that environmental budgets are small relative to the level needed to deal with environmental problems comprehensively.

In the major Australian agri-environmental programs, the predominant methods used for encouraging change in farm management are extension and small, temporary incentive payments, reflecting Australia's usual reliance on low-cost voluntary approaches. This strategy has successfully raised awareness of environmental issues amongst farmers, but for the more challenging environmental issues, translation into on-ground action has been limited.

It is necessary to improve the outcomes from investments in Australian agri-environmental programs. Methods for this include: a more systematic and evidence-based approach to the selection of investments and for the selection of policy mechanisms to be used for particular interventions; improvement in the quality of goals and targets set; greater use of measures to reduce uncertainty prior to final decision making (e.g. high-quality feasibility assessment) and greater efforts to learn from the successes and failures of existing and past interventions (e.g. active adaptive management, enhanced monitoring and evaluation).

1. Introduction

Over 50% of Australia's 760 million hectare land area is devoted to agricultural production (ABS, 2013), although the majority of that area consists of very low-intensity grazing enterprises. The area of cropping land is only 4%, largely reflecting the availability of water, either from rainfall or irrigation. Agriculture in Australia is extremely diverse, ranging from highly intensive to extremely low intensity production, from semi-arid dryland production to irrigated production, from tropical to cool temperate, and from traditional small family farms (small be Australian standards, at least) to large corporate enterprises. From the time of European settlement in the late 18th century to the mid-20th century, agriculture was a major proportion of the Australian economy. It has now fallen in relative importance, currently producing around 3% of Australia's GDP or 12% including related value-adding industries and input suppliers (Anonymous, 2012a). Historically, Australian agriculture received significant levels of assistance, but from the early 1970s to 2010, the effective rate of assistance to agriculture fell from 28% to 5% (Productivity Commission, 2011). Australian farmers do not rely on government subsidies for their profitability. They are highly market-oriented and a large proportion of agricultural produce is exported.

Australia has many important environmental assets, including exceptional levels of biodiversity, with most species endemic to Australia. The Great Barrier Reef is the best known environmental asset internationally but there are thousands of important rivers, wetlands, estuaries, and flora and fauna species. Agricultural production has impacts on many of these assets, so a number of agri-environmental policies have been introduced in recent decades, at both national and state levels. They vary widely in their aims and mechanisms.

Australia has a federal system of government, with different responsibilities falling to state and national governments (Kildea and Williams, 2010). Agri-environmental public goods can be managed by one or both levels of government, sometimes also involving regional bodies (Roberts et al., 2011). Historically, responsibility for environmental management rested mainly with state governments, but over the past two decades the Australian Government has played an increasing role, particularly in addressing water availability issues and has instituted several national agri-environmental programmes.

The purpose of this paper is to review Australian agri-environmental policies to address the following questions:

- What kinds of agri-environmental public goods are targeted in Australia?
- Which agricultural practices and systems lead to provision of these agri-environmental public goods?
- Does supply of these goods meet demand? That is, is there market failure associated with agri-environmental public goods? Is there government failure in attempting to address market failures?
- How does Australia set agri-environmental targets and reference levels?
- What kinds of agri-environmental policy measures are implemented in Australia for different types of environmental issues?

The paper is organised as follows. Section 2 summarises main agri-environmental public goods targeted in Australia; Section 3 describes the provision mechanisms of these public goods; Section 4 examines market failure associated with these goods; Section 5 discusses opportunities to increase the supply of environmental public goods; Section 6 outlines how reference levels and targets are established for agri-environmental outcomes; Section 7 describes a range of existing agri-environmental policies; and Section 8 concludes the discussion.

2. Agri-environmental public goods targeted in Australia

Given its unique physical and biological characteristics, the relatively short history of agriculture, and the relatively small proportion of the national population living in rural areas, the set of agri-environmental issues of concern to Australians is somewhat different to most other OECD countries. The main agri-environmental public goods of concern in Australia are:

- Water quality: salinity, nutrients and sediment.
- Water quantity/availability.
- Farmland biodiversity and native vegetation.
- Soil protection and quality.
- Climate change – carbon storage.
- Climate change – greenhouse gas emissions.
- Air quality.

In addition to the above list there are a number of other issues that are also important but not as yet as widespread or well known (acid sulphate soils and groundwater contamination being two examples). Notable differences with many other OECD countries include that (a) concern for agricultural landscapes, because of the aesthetic and cultural benefits they provide to non-farmers does not feature in the priorities of Australian agri-environmental schemes (reflecting Australia's sparse and highly urbanised population and large land area), (b) concern for biodiversity is mainly focused on the preservation and restoration of remnant natural habitat on farms, rather than on supporting biodiversity within and around farmed fields (Australia still has most of the biodiversity that was present prior to European settlement, although in agricultural areas much of the biodiversity is present in remnant natural areas, many of which continue to degrade), and (c) given the country's large area and low population density, the level of public funding available in public agri-environmental programs is low per hectare of agricultural land. Information about each of the public goods is provided below.

Water quality – Salinity, nutrients, sediment

Dryland salinity has been one of Australia's most costly forms of land degradation – an overview of the problem is provided in Box 1. The National Land and Water Resources Audit (2001) provides a comprehensive overview.

Box 1. Salinity in Australia

Salinity has been a prominent and complex environmental problem associated with agriculture in Australia. In 2001, an estimated 2 million hectares of agricultural land was affected by salinity (ABS, 2002). Large areas of land are yet to reach a new hydrological equilibrium after clearing (Anonymous, 2011), so there is the possibility of further increases in the area of salt-affected land salinity (National Land and Water Resources Audit, 2001).

Salt, mainly sodium chloride, occurs naturally at high levels in the subsoils of most Australian agricultural land. Some of the salts in the landscape have been released from weathering rocks (particularly marine sediments) (National Land and Water Resources Audit, 2001), but most have been carried inland from the oceans on prevailing winds and deposited in small amounts (20-200 kg/ha/year) with rainfall and dust (Hingston and Gailitis, 1976). Over tens of thousands of years, it has accumulated in sub-soils and in Western Australia, for example, it is commonly measured at levels between 100 and 15 000 tonnes per hectare (McFarlane and George, 1992).

Both dryland salinity and irrigation salinity are of concern, although dryland salinity occurs over a much larger area. As a result of clearing native vegetation for agriculture, groundwater tables have risen, bringing dissolved accumulated salt to the surface (Anonymous, 1996).

Salinity causes a variety of negative impacts, including reduced productivity of agricultural land, deterioration in stream and river quality (Hatton and Salama, 1999), threats to environmental assets such as wetlands, woodland communities and native species that are endemic to salinizing areas (Keighery et al., 2004), increased flood risk associated with shallow water tables (Bowman and Ruprecht, 2000), and damage to build infrastructure such as roads and buildings (National Land and Water Resources Audit, 2001).

In response to concerns about these issues, various policy measures have been introduced, most notably the National Action Plan for Salinity and Water Quality from 2001 to 2008 (Anonymous, 2000). However, during the first decade of this century, low rainfall over large areas of Australia resulted in falling groundwater tables and reduced immediate threat from salinity. Partly for this reason, the prominence of salinity as a policy priority has greatly reduced. It is currently not a target for any major policy in Australia. In regions where climate change results in permanent reductions in average rainfall, the long-term threat from salinity will be diminished.

Eutrophication problems have to date received much less attention in Australia than has salinity. Eutrophication problems were formally recognised as an issue in 1992 with development of a National Water Quality Management Strategy (www.environment.gov.au/water/policy-programs/nwqms). Fifteen priority water quality coastal "hotspots" in all of Australia's states and territories are currently designated as being of national significance and under severe threat (www.environment.gov.au/water/policy-programs/nwqms/wqip/hotspots.html), the Great Barrier Reef being the largest and most notable. In reality there are many more rivers, wetlands and estuaries under threat than the listed "hotspots". Most rivers in agriculturally dominated catchments in southern Australia regularly fail to meet water-quality objectives. On a national scale, nutrients and suspended sediment loads are higher than before European settlement in more than 90% of the river lengths assessed, and are substantially modified in at least one-third of the river lengths that were assessed in every drainage division, except Tasmania (Anonymous, 2011; Davis and Koop, 2006). With the exception of some urban catchments, agricultural practices are the dominant contributor of nutrient and sediment pollution of waterways. Grazing industries (dairying in higher rainfall areas and beef and sheep in many other areas), cropping, horticulture and sugarcane production contribute to nitrogen- and phosphorus-induced eutrophication problems in different locations. Gully erosion, often the result of overgrazing, increases phosphorus and sediment delivery to waterways (Vigiak et al., 2011).

Water quantity/availability

Water scarcity, as a result of a highly variable climate, forecasts of adverse climate change and a history of over-allocation of water to users is a strong feature of Australian agriculture (Anonymous, 2011). There is competition for water between irrigation, industry, urban and environmental uses in southern Australia. The Murray–Darling Basin (MDB) remains the major focus of water scarcity issues given its importance in Australia's agricultural production, and as a provider of water to over three million people. It also contains important environmental assets and ecosystems (Anonymous, 2012b; Connell and Grafton, 2011).

Farmland biodiversity and native vegetation

Australia has unique and highly threatened biodiversity, much more so than in many other OECD countries. Many of Australia's species, and even whole groups of species that comprise taxonomic families, are endemic (unique) to the country. As a result, Australia is identified as one of the world's "megadiverse" countries. Myers et al. (2000) identified the south-west of Australia as one of 25 of the world's most important biodiversity hotspots, defined as areas with an exceptional concentration of endemic species undergoing exceptional loss of habitat. It is one of only four of the article's hotspots in developed countries, and one of only five outside the tropics. Protection of biodiversity in this region is therefore of international significance.

Terrestrial biodiversity is under most pressure along Australia's east coast and in southern Australia, particularly the states of South Australia, Victoria, New South Wales and south-west Western Australia (Anonymous, 2011), where the landscape has been highly cleared for agriculture. Despite this, significant biodiversity remains on agricultural land, mostly in remnants of the original native vegetation. Compared with Europe, significant amounts of natural vegetation remain on and around farm land, but degraded to a greater or lesser extent.

Soil protection and quality

Australia has old and fragile soils and land clearing for agriculture has markedly increased soil erosion. Soil erodibility depends on the type of farming system, the degree of bare soil exposure, soil type, rainfall timing and rainfall intensity. Either or both of water or wind erosion occur in differing regions. Australia's State of the Environment Report (Anonymous, 2011) provides an overview of land degradation issues, land condition and management issues.

Naturally occurring chemical limitations also can markedly affect agricultural productivity. In addition to salinity (outlined earlier), sodicity is another major problem. Sodicity may be described as the "obscure cousin" of soil salinity because both involve sodium. In sodic soils much of the chlorine has been leached away. As a result sodium ions attach to clay particles and soils become unstable. Approximately one third of all Australian agricultural soils are naturally sodic. Land clearing and agricultural practices on sodic soils result in reduced water infiltration, surface crusting, erosion and waterlogging. www.science.org.au/nova/035/035key.htm, Anonymous, 2011).

Soil acidity is another major problem. It occurs naturally and can be exacerbated by agriculture. Naturally acidic soils and acidifying soils generally occur in areas where rainfall exceeds 450 mm/year, affecting some of the most productive agricultural land in Australia. Estimates suggest that 33 million hectares of land have a pHCa less than 4.8 (Anon, 1995a). The processes associated with soil acidification are well understood and involve the carbon cycle (loss through product export of organic anions and the accumulation of soil organic matter), and the nitrogen cycle, through nitrate leaching (Helyar and Porter, 1989). Unlike in many other parts of the world, the economic ability to ameliorate some acid soils with lime is constrained by high treatment costs and the low intensity of grazing systems (Scott et al., 2000). The extent of soil acidity and acidification problems are summarised in Anonymous (2011).

Climate change – carbon storage

Historically, land clearing was a major cause of reductions in carbon storage. However, there have been substantial reductions in land clearing in Australia since the establishment of the Kyoto Protocol and regulations are in place to limit further land clearing. Over the decade to 2010, approximately 1 million hectares annually was cleared, but by the end of the decade, the continental extent of annual land clearing was balanced by the extent of annual regrowth (Anonymous, 2011).

With increasing recognition of the importance of climate change, management and monitoring of soil carbon is seen as increasingly important. Soil carbon can be a significant source or sink for greenhouse gas (GHG) emissions depending on how land is managed. However, there are complex trade-offs between reducing GHG emissions and producing food. Soil carbon stocks are low in many Australian agricultural systems, particularly where land is cropped. Conversion from native vegetation to agriculture typically reduces soil carbon by 20–70%. This reduction is often associated with declining soil health and significant GHG emissions.

Climate change – greenhouse gas emissions

In 2010, agriculture emissions amounted to 79 million tonnes of carbon dioxide equivalent, 15% of Australia’s total emissions. Greenhouse gas emissions come primarily from ruminant livestock as methane (68% of agriculture’s contribution) with additional sources from manure management (4%), rice cultivation (0.2%), nitrous oxide emissions from nitrogen fertilisers to agricultural soils (17%), burning of savannas (11%) and burning of crop stubble residues (0.4%) (Anonymous, 2012c). A projected future cause of increased emissions from agriculture is growth in livestock populations due to increased demand from Asia and the Middle East. Emissions from livestock are projected to account for 72% of total agricultural emissions in 2020 (Anonymous, 2012c).

Air quality

The main issue of air quality is the risk of dust storms resulting from wind erosion of agricultural soils. Dust storms may trigger allergic reactions and asthma attacks among susceptible individuals, cause breathing-related problems, contribute to cardiovascular problems and reduce the quality of water in rainwater tanks used to capture and store potable water (Department of Health, 2010). In past decades, dust storms affecting urban areas were more common, but since the widespread adoption of zero tillage and minimum tillage practices in agriculture (D’Emden et al., 2008) they have become rarer. A second issue of air quality is nuisance odour originating from intensive agricultural enterprises (particularly piggeries and poultry farms) close to residential areas. This is managed through regulations on a state-by-state basis (McGahan et al., 2002).

3. Farming practices that provide agri-environmental public goods

A wide variety of changes in production methods and land uses have been promoted to farmers. Key examples include the following.

Water quality – Salinity

For dryland salinity control the dominant management practice is to restore the water balance through planting of perennial pastures (Ridley et al., 2009) and to adapt to increased salinity through growing more salt-tolerant species. Drainage is also used in some cases, particularly in Western Australia, although it can be associated with disposal problems. Planting of perennial pastures can also cause negative externalities, such as by reducing the quantity of fresh water to replenish rivers (Nordblom et al., 2010). For irrigation-induced salinity, improved irrigation management (Hillel, 2000) and management of shallow water tables through groundwater pumping are the major management practices.

Water quality – nutrients and sediment

Management practices for reducing nutrients and sediment in waterways involve a range of agricultural land management practices (such as better nutrient application, effluent collection and management, management of groundcover, gully erosion control) and riparian management (fencing of waterways, buffer strips, wetland restoration) (Cary and Roberts, 2011, Duncan, 2013, Roberts et al., 2012).

Water quantity/availability

Water pricing and reduced levels of rights for water use have led to a wide variety of adaptations by farmers including more efficient irrigation technologies such as drip irrigation (Hillel, 2000), changes to lower-water-using plant varieties, changed enterprises, and, particularly in the dairy industry, substitution from irrigated pastures to purchased feed. Overall, increased prices and reduced water allocations have resulted in a reduced area under irrigation (Anonymous, 2011).

Farmland biodiversity and native vegetation

There are three main measures to conserve biodiversity on farms. These are to avoid further clearing of native vegetation, to conserve or restore existing remnants (removal of livestock, fencing, pest control) and to increase habitat by connecting fragmented remnant patches (Lindemayer at al., 2010).

Soil protection and soil quality

The key to controlling soil erosion by water is to maintain soil groundcover (e.g. living plants, litter, mulch). A range of other soil conservation practices—such as contour banks, filter strips and controlled traffic—are also important, but secondary to the maintenance of cover. Land-management practices have improved significantly during the past few decades, due to better grazing practices and adoption of conservation tillage practices (Anonymous, 2011).

Sodicity can be managed by application of gypsum (calcium sulphate www.dpi.nsw.gov.au/_data/assets/pdf_file/0009/127278/sodic-soil-management.pdf). Avoiding or limiting cultivation of sodic soils to maintain soil structure is also important.

Acidity is mostly managed through lime application and, to a lesser extent, by reducing acidifying practices (Scott et al., 2000). Management of both sodicity and acidity is often limited by the cost of amelioration.

Climate change – carbon storage

There are a range of practices to increase soil carbon storage. Within cropping systems these include stubble management (avoiding burning), residue retention through reduce tillage and zero tillage, and changes to the crop rotation system (eliminating fallows, increased use of pastures). Where practices provide benefits to farmers (such as productivity and observably reduced soil loss) and do not involve major costs or incompatible system changes, they have become rapidly adopted. Within existing pastoral systems, management actions include changed grazing practices (e.g. rotational grazing) and increasing the perennial plant component (Anonymous, 2011). Overall, whilst the implementation of more conservative land-management practices will lead to a relative gain in soil carbon, absolute soil carbon stocks may still be on a trajectory of slow decline. Analysis by Sanderman et al. (2010) of major management options for sequestering carbon in agricultural soils suggests there is an inevitable trade-off between agricultural production (i.e. carbon exports in the form of crops, fibre and livestock) and carbon sequestration (capture and storage) in soils.

Climate change - greenhouse gas emissions

Whilst research is underway to reduce emissions from ruminants (e.g. through changed diet), the global demand for Australian livestock and climatic conditions (such as drought, floods, temperatures) will be the dominant drivers of livestock emissions. Management actions for farmers to reduce emissions from livestock are currently limited and only feasible in intensive industries such as dairying (feed management, nitrogen fertiliser management) (Eckard and Hegarty, 2012). Technologies to reduce other sources include timing of fertiliser applications, cultivation practices, and reduced burning.

Air quality

The same measures as to protect soil loss mentioned earlier (primarily maintaining groundcover) apply to air quality. Nuisance odour originating from intensive agricultural enterprises (particularly piggeries and poultry farms) is managed largely through planning restrictions by locating intensive animal industries away from human population centres. Intensive industries are also subject to licencing requirements through state Environmental Protection Agencies, such as the Victorian EPA Act (Anonymous, 2010).

Overall there are various management practices that can provide agri-environmental public goods. Only a minority of these are readily adopted by farmers. Many tend to conflict with the personal goals of farmers (Pannell et al., 2006; Pannell, 2008), particularly goals for profit. The vast majority of practices to provide agri-environmental public goods cost farmers money and/or involve large changes to farming systems.

Australia has commonly relied on the provision of small, temporary incentives and extension to promote such practices (Pannell and Roberts, 2010) and unsurprisingly the result has been relatively low levels of adoption, mainly by the minority of farmers who are environmentally motivated and/or have the financial and management capacity to adopt such practices.

4. Markets, market failure and missing markets for agri-environmental public goods in Australia

If well-functioning markets for agri-environmental public goods can be developed, decisions about appropriate levels of provision of agri-environmental public goods may be made by participants in those markets, rather than by governments. Australia has developed water markets and has been exploring the use of markets and market-like mechanisms for other agri-environmental public goods.

Water markets

Australia has made extensive use of markets for the allocation of water amongst agricultural producers (National Water Commission, 2011). While there have been significant challenges in implementing water markets, overall the approach has been very successful. Water markets emerged in response to acute over-allocation of water resources, especially in the Murray-Darling Basin (MDB) of eastern Australia. In response to recognition that farmers' rights to extract water were exceeding the availability of water, granting of new licenses was reduced, and eventually water extractions from the Murray-Darling River system were capped in 1997. Systems of water rights were defined, and trade between holders of rights was allowed. Average turnover of water rights in the MDB market is now AUD 2.4 billion per year (National Water Commission, 2011).

Benefits of Australia's water trading system have been substantial. It has allowed water to be allocated to its most beneficial uses within agriculture. Farmers found the market particularly beneficial during a sustained drought in the first decade of the 21st century, as it allowed water to move to areas of acute need and high benefit, and holders of water rights who were willing to sell benefited from high prices. The market has also been used as a mechanism for governments to purchase water from farmers in order to use it for environmental purposes. The National Water Commission (2011) states that "Trading [of water] generates economic benefits valued in hundreds of millions of dollars annually."

Successful establishment of water markets resulted from changes and reforms that occurred over several decades. Requirements for success included: a secure statutory basis for water entitlements; trading rules that reflect hydrological realities; systems for limiting and managing adverse third-party impacts; and robust trading platforms and accounting systems (National Water Commission, 2011). There were many challenges, including technical, political, social, cultural and managerial challenges. However, water markets are now well established and are broadly supported by stakeholders and governments.

Markets for other environmental resources

Relative to water, there has been much less use of markets for other environmental resources in Australia. Nevertheless, there has been strong interest in the potential for markets to be used for management of issues such as salinity and biodiversity conservation. The Australian Government has supported a series of pilot studies on the use of markets (for development offsets) and market-like mechanisms (conservation tenders or reverse auctions) for natural resource management (www.marketbasedinstruments.gov.au). Initially, the main focus within agriculture was on the use of conservation tenders for management of salinity, as part of the National Action Plan for Salinity and Water Quality. However, over time, the main use of this mechanism has shifted to protection of habitat for biodiversity. Prominent examples include the BushTender programme in the state of Victoria (Stoneham et al., 2003) and the Australian Government's Environmental Stewardship programme for protection of box gum grassy woodland, as part of the Caring for our Country programme.

Despite these successes, the use of conservation tenders remains a relatively small part of the national policy portfolio for protection of biodiversity and native vegetation. Their usage has not grown as much as it was anticipated they might 10 years ago. Possible reasons include that: their application requires specialist skills and knowledge; they require more information than traditional simpler methods for allocating programme funds; they require more time than traditional methods; there is sometimes a shortage of bids to provide effective competition; there is not a history or a culture of government payments to farmers, either for production or for conservation; and there is a fear that paying farmers to undertake conservation actions may crowd out voluntary private conservation actions.

Market failure

The decision to use market-based instruments for protection of biodiversity or native vegetation presumes the existence of market failure. However, this assumption is not always justified. Market failure depends on two factors: (a) the existence of at least one of a number of characteristics that reduce the effectiveness of markets (non-excludability, non-rivalry, externalities, information failure including asymmetric information) (Bergstrom and Randall, 2010) and (b) a benefit-cost test: do the benefits of a government intervention intended to address a public-good issue exceed the costs?

In some situations, agri-environmental public goods are provided incidentally by farmers, as a side benefit of agricultural production decision make for reasons of productivity and profit. For example, zero tillage is widely adopted by Australian crop producers, resulting in public benefits due to reduced soil erosion, but the main reasons for farmers adopting zero tillage related to its economic advantages (D'Emden et al., 2008). Even without ongoing government intervention, it is likely that there is adequate provision of the public goods that arise from zero tillage.

Even if there is under-provision of agri-environmental public goods, given the diversity of circumstances within which they occur, it is likely that they do not pass the benefit-cost test in all places at all times. For example, in the case of dryland salinity, the farm-level economics of addressing the problem are adverse in many situations (Kingwell et al., 2003). Further, the value of externalities generated by many farms is not large, and the technical difficulty of reducing those externalities when they do exist is often high (Pannell et al., 2001). As a result, there are many situations in which the farm level costs of mitigating dryland salinity exceed the external benefits (Pannell, 2001a; Pannell and Roberts, 2010). In these circumstances there is no market failure that justifies a government response.

For other agri-environmental issues, there is less evidence about whether or in what circumstances a benefit-cost test would be passed. According to its *Best Practice Regulation Handbook*, “The Australian Government is committed to the use of cost-benefit analysis to assess regulatory proposals and encourage better decision making” (Australian Government 2013, p. 81). However, this applies only for high-level policy or program proposals, not to the numerous individual investment projects or interventions within those programs, for which formal Benefit: Cost Analyses are rare. Even if it is difficult to utilise Benefit: Cost Analyses for all projects, it is possible to improve cost-effectiveness of investments substantially through careful targeting.

It is clear that the benefits and costs of environmental interventions have high spatial heterogeneity, so it is very likely that the benefit-cost test would be passed in some situations but not others. Spatial heterogeneity exists in the environmental values under threat, in the severity of environmental threats, in the effectiveness of actions to reduce those threats, in the adoptability of those actions amongst farmers, and in the risks associated with interventions. For example, the benefits of protecting native vegetation in order to maintain water quality in a local water body depend on the location of the vegetation in relation to the water body, local topography and soil types, and climate. Opportunity costs of changing land use vary depending on soil types, climate, distance from market, and the availability of other farm resources such as labour and machinery. This implies the need for careful targeting of investments in agri-environmental improvements to issues and locations where benefits exceed costs. The use of market-based instruments for protection of biodiversity and native vegetation does not in itself address this question of whether the benefits of intervening exceed the costs.

There has been a slow and partial movement in Australia towards recognising the extent of spatial heterogeneity in benefits and costs of environmental interventions. We observe that spatial heterogeneity of benefits and costs from agri-environmental interventions is likely to be high in most countries, but that this seems to be widely under-recognised.

An example where Australian governments were involved in the development of a Benefit: Cost Analysis of an environmental project is the case of the Gippsland Lakes, in the state of Victoria (Roberts et al., 2012). The Australian Government and the State Government of Victoria participated as partners in the Gippsland Lakes Taskforce, working with researchers who conducted the analysis. The analysis considered many different potential management changes across the Lakes’ catchment area, with the aim of reducing nutrient loads into the lakes, the majority of which come from agricultural land. Benefit: Cost Analyses for a range of potential management/policy regimes were conducted. Land use and land management changes were optimised to find the least-cost method of achieving different target levels of nutrient reductions. Results highlighted the importance of accounting for spatial heterogeneity, with the value for money provided by management practices varying markedly across different parts of the catchment, depending on the existing land use, existing nutrient losses, and various other factors. Results also showed that the Benefit: Cost Ratio (BCR) for an agri-environmental policy intervention can be sensitive to the specific design of the intervention. Some of the management/policy regimes examined had favourable BCRs, while for others the BCRs were highly unfavourable. Included in the latter category was the official target of reducing nutrient inflows by 40%.

The main reason for the highly unfavourable BCRs of some management/policy regimes was their high cost. Indeed, the high cost of effective environmental projects poses significant challenges in Australia, given the modest levels of funding for environmental programs in Australia, and the tendency of programs to fund large numbers of relatively small projects, rather than fewer larger projects. For example, Beverly et al. (2012) found that the cost of effective salinity management projects in Victoria would be one to two orders of magnitudes larger than typical projects funded under the National Action Plan for Salinity and Water Quality.

5. Opportunities to increase the supply of environmental public goods

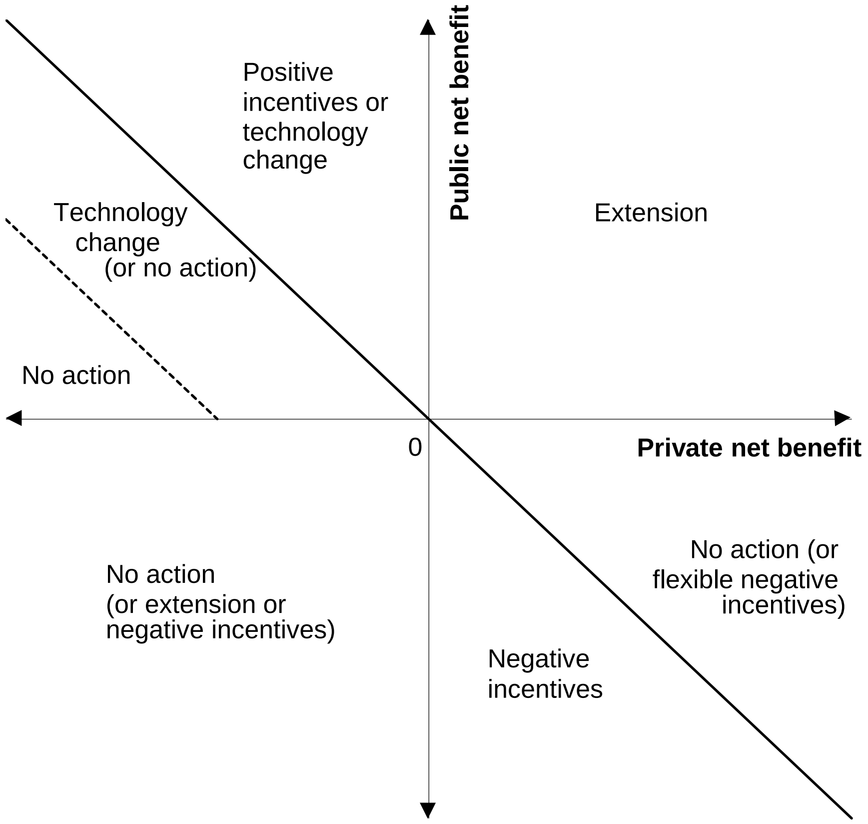
There are opportunities to take a more strongly evidence-based approach to selecting agri-environmental investments to increase the delivery of agri-environmental public goods. Historically, a major emphasis of agri-environmental programs was on maximising community engagement and the participation of farmers. Over time, programs have slowly evolved towards having a stronger focus on the delivery of agri-environmental outcomes through setting clearer targets and strengthening the selection criteria for investments (e.g. in Caring for Our Country). Further developments in this direction are possible. It is important to strike a balance between the transaction costs (including administration costs) of processes used to evaluate investments and set targets, and the benefits generated by those processes. Taking this into account, it appears likely that further moves to strengthen these processes would be beneficial overall.

Pannell (2008) showed that appropriate decisions about the type of policy mechanism to use to address externalities depend on the levels of public and private net benefits resulting from an intervention (Figure 1). Therefore, policy mechanism choice needs to be sensitive to local conditions, the economic and social context, and the general characteristics of a problem. The dominant mechanisms used in Australian programs have been extension and small temporary grants. However, these are not suitable in all cases as they depend on the existence of win-win management options, which are not always available (Pannell, 2001b). Attention to this issue would help to identify policy mechanisms that are most effective for specific projects.

In a number of other OECD countries, the “default” policy mechanism for agri-environmental programmes tends to be payments to farmers. This too is likely to be insufficiently discriminating, resulting, in some cases, in payments to farmers who would have been willing to make the management changes without payment, because of the private benefits generated.

Although target setting has improved within programs, there is scope for further improvements. Ideally, targets should be Specific, Measurable, Attainable, Relevant and Time-bound (i.e. SMART’). The importance of SMART targets has been explicitly recognised by governments (Australian Government 2009). The specific, measureable and time-bound criteria facilitate effective monitoring and evaluation of programmes. The Attainable and Relevant criteria reflect the quality of the outcomes that are being sought, and whether their feasibility has been assessed. Park et al. (2013) examined the targets specified by regional bodies in New South Wales and Victoria since 1997. They found that less that 30% of targets were specific, measurable and time-bound. To improve target-setting and decision making, they propose that there is a need for incentives for good performance by environmental managers and support for capacity building.

Figure 1. Optimal choice of policy mechanisms for environmental interventions to address externalities



Source: Pannell, D. J. (2008), "Public Benefits, Private Benefits, and Policy Intervention for Land-use Change for Environmental Benefits", *Land Economics*, Vol. 84, No. 2, pp. 225-240.

The importance of a strong evidence base to underpin investment decisions is well recognised. Good decision making about priority investments in environmental programmes requires adequate use of information from biological, physical, social, and economic research. The Australian government makes major investments in these types of research, but connecting the most relevant research to policy decision makers remains a challenge. Strategies to improve the evidence base for decisions about agri-environmental programs could include the conduct of high-quality feasibility assessments prior to finalising decisions about funding of major projects, and use of active adaptive management to modify and improve the design of projects in the light of experience with their implementation.

Strategies to monitor and evaluate programmes to support improvements in their performance over time remain a challenge. The Australian Government has invested in and experimented with various approaches to monitoring and evaluation over time as programs have evolved, and efforts to strengthen this area are ongoing. Current efforts are focused on strengthening the monitoring of agri-environmental outcomes, in addition to the traditional approach of monitoring activities and actions.

6. Reference levels and agri-environmental targets of agri-environmental policies

Government intervention may be justified in the case of market failure, depending upon the benefits and costs of intervention. To assist with thinking about where responsibility for environmental management lies and to identify the desired levels of provision of agri-environmental public goods, the OECD (2001; 2010) outlined the concepts of environmental reference levels and target levels. Reference levels are defined as the minimum level of environmental quality that farmers are obliged to provide at their own expense. Environmental targets are defined as the desired (voluntary) levels of environmental quality that go beyond the minimum (mandatory) levels of environmental quality for the agricultural sector (OECD, 2010).

There are four ways in which reference levels and targets are included in agri-environmental policy in Australia: regulated constraints or minimum standards, duty of care, codes of practice and environmental targets (commonly non-binding). The application of these approaches varies between the states, so is difficult to summarise simply.

Environmental reference levels – regulated constraints or minimum standards

Using the state of Victoria as an example, there are a number of Acts and regulations relating to the following agri-environmental public goods:

- Water quantity/availability (e.g. water licencing and construction of dams on waterways);
- Water quality (e.g. prevention of fertilisers or manure entering waterways to maintain beneficial uses of water);
- Farmland biodiversity and native vegetation (shared responsibility between state and Australian governments, with landholders having responsibility to prevent damage to the natural resource base and protect biodiversity);
- Soil protection (e.g. landholders are required to manage and maintain soils responsibly by adopting practices that protect or improve soil resources);
- Air quality. Intensive agricultural industries (piggeries, poultry, feedlots and dairy) are subject to licencing arrangements for pollution regulations (related to nuisance odours and disposal of effluent).

Further details can be found at www.depi.vic.gov.au/agriculture-and-food/farm-management/featured/legal-information-for-victorian-landholders. Overall, landholder agri-environmental responsibilities include avoiding damage to the natural resource base, protecting water for beneficial uses and protection of remaining biodiversity.

With the exception of water availability, where there has been extensive reform and increasingly strong regulatory frameworks in place (see Kildea and Williams (2010) and www.environment.gov.au/water/policy-programs/index.html), for other agri-environmental issues a common problem is that compliance assessment and enforcement is weak even if regulatory minimum standards have been developed. In a recent review of water quality regulations in Victoria, Roberts and Craig (2013) concluded that an effective regulatory regime is impeded by lack of clarity of institutional powers and responsibilities at national, state and regional levels, over-reliance on "soft" policy approaches and a culture of planning. Suggested strategies to improve the effectiveness of the regulatory regime include: improvements in institutional clarity and power (particularly regulatory enforcement), adoption of appropriate metrics (e.g. a source-based approach for water quality), the setting of more effective performance goals, and appropriate legal mechanisms, including mechanisms that would allow the public to hold governments legally to account if they fail to perform mandatory regulatory duties. Conclusions overall were that institutional and regulatory reform, sustained political commitment and outcome-focussed accountability were all lacking.

With regard to biodiversity protection, farmers are subject to state regulations that limit their ability to clear vegetation for production. They may also be affected by the Australian Government's Environment Protection and Biodiversity Conservation Act and state-level threatened species regulations. Historically, farmers in some states were *required* to clear native vegetation as a condition of land ownership. However, as the area of native vegetation remaining has fallen to low levels in many rural areas, broader community wishes to retain that vegetation in a natural state to provide habitat for native species have increased, resulting in new and stronger regulations. In some cases, there has been resistance by farmers to these regulations, resulting, for example, in a review of their impacts by the Productivity Commission (2004). The inquiry concluded that native vegetation and biodiversity on private land are important for many reasons, but that existing regulatory approaches are somewhat ineffective and impose significant costs. Problems included a lack of clearly-specified objectives; disincentives for landholders to retain and care for native vegetation; and the inflexible application of targets and guidelines across regions with differing characteristics such that perverse environmental outcomes sometimes result.

Overall, Australia recognises that minimum regulatory standards are critical to ensure provision of agri-environmental public goods and a number of regulations are already in place. However, with the exception of water availability, where clear rules exist around volumes of water, there is a need for improved clarity around minimum standards, and more strongly enforced compliance measures.

Duty of care

The Duty of Care of farmers for environmental protection has been widely discussed, but not implemented widely in Australia. "An environmental duty of care requires duty holders and responsible persons to take all reasonable and practical steps to prevent harm arising from their activities" (Young et al., 2003). The Duty of Care approach is seen as having the advantage of leaving it to landholders to determine how best meet their duty. However, it suffers from lack of clarity in determining what the duty of care actually is, and from reliance on voluntary agreement by farmers to undertake actions that may be highly costly to them. Only in the state of Queensland does the duty-of-care concept have statutory backing (www.nrm.qld.gov.au/land/management/duty_of_care.html). Farmers in that state can demonstrate that they meet their duty of care by adopting an accepted code of practice.

For most agri-environmental issues, the *de facto* reference level is current farmer practice. Provided that farmers do not violate regulated minimum standards, farmers are largely considered to have a right to farm as they have been doing. Even where programs aim to increase farmer adoption of environmentally beneficial practices, the two main policy mechanisms used to encourage change are extension (information provision, persuasion, training, etc.) and small temporary incentive payments that fall far short of meeting farmers' opportunity costs. The only programmes that aim to fully meet farmers' opportunity costs are those involving a market or market-like approaches. Other programs rely primarily on building or engaging farmers' personal motivations for taking environmental actions voluntarily.

Codes of practice

Codes of practice are sometimes used to guide agricultural management practices. An example is management of effluent from dairy farm sheds (Anonymous, 1997). Where codes of practice are commissioned and established by national policy bodies, they tend to be implemented to differing levels in different states and territories, depending on local legislation. Codes of Practice serve as voluntary guides for practices. They may be used to attempt to obviate the need for regulatory enforcement. As such, they are similar to Duty of Care. Overall, their current usage is limited.

Environmental targets

As outlined earlier, environmental targets are defined as the desired (voluntary) levels of environmental quality that go beyond the minimum (mandatory) levels of environmental quality (OECD, 2010). In Australia, environmental targets may be specified in regional environmental plans or in state or federal government policies or plans. For example, there are over 50 regional natural resource management bodies, each of which has a regional plan that specifies a range of environmental targets.

At the national level, the main agri-environmental programme is a component of *Caring for Our Country*. The business plan for this programme includes a number of specific targets. For example, the programme's 2011-2012 business plan includes: "To increase by 10 000 the number of farmers adopting management practices to improve soil health by reducing the risk of soil acidification, soil loss through wind and water erosion and/or increasing the carbon content of soils by June 2013" and "To increase by 3 700 the number of farmers adopting activities that contribute to the ongoing conservation and protection of biodiversity by June 2013."

Other targets are specified in the management plans of specific environmental assets. For example, as mentioned earlier, the target set for the Gippsland Lakes in Victoria is for a 40% reduction in inflows of phosphorus and nitrogen.

Weaknesses in target setting were noted earlier. Few environmental targets are SMART (specific, measurable, achievable, relevant and time-bound) (Park et al., 2013). Many are overly ambitious, given available resources. For example, the Gippsland Lakes target was developed and endorsed by the community, regional bodies, and state and national governments, but without detailed analysis of the technical or social feasibility of achievement and no analysis of the required scale of change in land management or the cost of achieving it (Roberts et al., 2012). Achievement of the specified target would cost an estimated AUD 1 billion over 25 years, whereas the current annual budget for management of the Lakes, if continued for 25 years, would amount to a present value of around AUD 30 million.

In some cases, investments have multiple targets. For example, particular investments in establishment of perennial vegetation may generate benefits for dryland salinity, soil conservation, water pollution and biodiversity. Due to spatial heterogeneity in the bio-physical and/or socio-economic context, the specification of multiple objectives needs to be highly project-specific.

7. Policy measures for agri-environmental public goods

As mentioned previously Australia has a federal system of government, with different responsibilities falling to state and national governments and sometimes regional bodies. The policy mechanisms outlined below are used to some extent by both levels of government.

- Extension and supporting research.
- Small, temporary incentive payments.
- Payments for opportunity costs.
- Markets. The important role of markets (for water) and market-like instruments (reverse auctions or tenders for biodiversity) in Australian agri-environmental policy was described in section 4. Compared to most OECD countries, Australia makes greater use of these mechanisms. The use of water markets, in particular, has been very successful.
- Regulation. There are important regulations for clearing of native vegetation, protection of threatened species, and pollution, as outlined in section 6.
- Technology development.

Some programs rely mainly on a single policy mechanism. For example, the National Action Plan for Salinity and Water Quality predominantly used extension and small-temporary incentive payments to encourage farmers to adopt (or at least trial) new practices (Pannell and Roberts, 2010).

In other cases, a combination of policy approaches is used. For example, measures used to address water scarcity have included underpinning regulations through the Water Act (2007), government purchase of water for the environment, provision of large amounts of money for irrigation infrastructure upgrades and a well-functioning water market (www.environment.gov.au/water/policy-programs/index.html).

Australia pioneered the use of extension and support services to promote uptake of agri-environmental measures, though the National Landcare Program during the 1990s and into the 2000s. The approach was successful in raising awareness of environmental issues amongst farmers, and prompting modest levels of adoption of practices that were not highly costly to farmers. It was less successful for issues involving high costs of management, such as dryland salinity, or for issues for which the ideal response from an environmental perspective would involve extensive changes in land use or land management, such as biodiversity.

The provision of small, temporary incentive payments usually does not compensate farmers for the opportunity costs involved in changing their land management. Rather, it encourages farmers to trial the new practices, in the hope that they will be attractive to farmers and will be adopted permanently. This approach is only successful in cases where the new practices generate sufficient private benefits for farmers to be willing to adopt them. Unfortunately, cases where new agri-environmental practices involve significant opportunity costs for farmers are more usual, and the commonly used approach is not effective in achieving high levels of adoption of these practices.

Notably, the major Australian programmes do not provide payments to cover farmers' opportunity costs. The main cases where farmers can be fully compensated is where environmental services are purchased using conservation tenders (reverse auctions, see

Box 2), which mainly occurs in Victoria and did occur in the national Environmental Stewardship scheme. In these cases, payments are only made to those farmers who are evaluated as having submitted bids that provide the best value for money. Full compensation also occurs in a very targeted way for a small number of specific projects.

Box 2. Reverse auction programmes in Victoria

Reverse auctions (conservation tenders) have been used for a number of years in Victoria to protect biodiversity on farmland. Over 1 million hectares of native vegetation remains on private land, and much of it is small scale, spatially dispersed and of variable conservation significance. Approximately 15 threatened vegetation types remain solely on private land, with another 29 vegetation types occurring largely on private land (Stoneham et al., 2003).

The best-known scheme is BushTender, which was run as a pilot in the early 2000s, evolving into a larger scheme, EcoTender. These schemes aim to enhance habitat conservation on private land. Auction design, contract design and development of a metric to assess the benefits associated with landholder bids to protect biodiversity are crucial design features to help address the information asymmetry issues that exist in many conservation programs. Farmers understand how participation in conservation activities will affect their production and profit motives, whereas environmental experts often have greater knowledge of the value of the environmental assets occurring on private land. The idea of the conservation tender is to reveal the hidden information held by both parties, allowing identification of the most beneficial investment options. The government purchases biodiversity management actions based on the biodiversity significance and the expected improvement in habitat due to landholder management. These biodiversity benefits are divided by the cost: the amount for which the landholder is willing to undertake the management actions. Bids are submitted by landholders and the government purchases the maximum amount of biodiversity benefit at least cost. A description of BushTender is found in Stoneham et al. (2003), with more recent developments accessible at www.marketbasedinstruments.gov.au. Overall, conservation tenders are now well accepted in Victoria, and further potential improvements are possible (Blackmore et al., 2013). They have been used in a range of biodiversity and riparian management pilot programs across the state and are popular because of their voluntary nature.

Despite their wide trialling, conservation tenders remain at the pilot stage in Victoria and indeed Australia. There are a number of potential reasons for why other policy mechanisms are used. An advantage of the conservation tender approach is that it encourages program managers to account fully for the chain of links from program activities to changes in on-ground management to environmental outcomes. However, this involves elements that conflict with the normal ways of doing business in this sector in Australia. For example, it highlights the need for long-term contracts and on-going stewardship payments to maintain public goods in the long term, whereas projects normally have short-term contracts, and payments, if used at all, are typically small and short-term. The approach reveals that effective biodiversity conservation is much more expensive than typically allowed for in Australian agri-environmental programs. The process is also more demanding and thorough in its use of information for selecting which bids to accept. While there are substantial benefits from this more analytical approach, it is quite different and has higher transaction costs compared to the approaches that program managers are used to. Another potential reason is that not all projects are suited to tenders. For example, for protection of specific habitats where only a small number of landholders are involved, there may be insufficient bids for the auction process to be competitive. In such cases, it may be more efficient to negotiate with individual landholders. There is also concern that conservation tenders (or other payment schemes) may result in 'crowding out' of voluntary landholder actions which would otherwise have occurred (Clayton, 2011). Overall, conservation tenders, when used in appropriate situations and with sound design and metrics, are a valuable tool to improve biodiversity conservation on farmland, but involve a range of potential challenges.

Technology development is often under-recognised as an agri-environmental policy measure. In cases where existing management options are too costly or too ineffective for a benefit-cost test to be passed (e.g. dryland salinity in many cases), an investment in technology development may be made to seek the creation of new management practices that are less costly or more beneficial, either to farmers or to the public (Pannell, 2009). This approach has not often been used in Australia's main agri-environmental programs, but important contributions of this type have arisen from separate research programmes, notably for dryland salinity (the Cooperative Research Centre for Plant-Based Management of Dryland Salinity, the National Dryland Salinity Program) and zero tillage.

Table 1 shows a matrix of policy mechanisms by environmental issues and indicates the current programmes within which particular mechanisms are used.

8. Conclusion

This study reviews policy measures for providing agri-environmental public goods in Australia. It covers a broad range of Australian agri-environmental policies and associated public goods.

This study identifies that Australian agri-environmental policies mainly target 7 agri-environmental public goods: water quality: salinity, nutrients and sediment; water quantity/availability; farmland biodiversity and native vegetation; soil protection and quality; climate change – carbon storage; climate change – greenhouse gas emissions; and air quality.

Agri-environmental concerns and agri-environmental policies in Australia differ from many OECD countries. Agriculture has only been operating for a relatively short time, is largely unsubsidised (although environmental degradation is not factored into production costs) and is highly export-focussed. Many important environmental assets and ecosystems remain, including exceptional levels of biodiversity, with most species endemic to Australia. Addressing issues of water availability (scarcity), farmland biodiversity, soil protection and salinity have been the main agri-environmental public goods historically targeted. Others such as water quality (eutrophication) and climate change (carbon storage and greenhouse gas emissions) have become priorities in recent years.

Australia's record in addressing environmental challenges is mixed. Addressing water availability issues through creation of water markets to address water over-allocation issues and government buy-back of water is a notable success as is protection of soil resources through groundcover management by farmers where it is profitable to do so. Programs to address dryland salinity and biodiversity have been less successful in environmental terms (although somewhat successful at engaging farmers and raising their awareness of environmental issues).

Given the diversity of agricultural systems, bio-physical and socio-economic contexts, and agri-environmental problems, there is a wide range of farm practices that are promoted to provide agri-environmental public goods. Prominent among these practices are: establishment of commercial perennials (for salinity), protection or restoration of native vegetation (for biodiversity), maintenance of groundcover and use of zero tillage (for soil conservation) and various measures to reduce nutrient movement into waterways.

The issue of equating demand with supply has been largely solved for water quantity through the creation of water markets.

Table 1. Policy matrix – Australian case study

AE public goods	Measures									
	Regulatory			Financial incentives						Facilitative
	Regulatory requirements	Environmental taxes/ charges	Environmental cross-compliance	Payments based on farming practices	Payments based on land retirement	Payments based on farm fixed assets	Payments based on outcomes	Tradable rights /permits	Community based measures	Technical assistance/ extension/R&D/ labelling/standards/ certification
Water quality	State-based regulations, e.g. for dairy effluent management in Victoria.			CFOC, Reef Rescue, State programs (small temporary payments in all cases)					CFOC	CFOC
Water quantity/ availability								Water markets		
Farmland biodiversity and native vegetation	EBPC Act. State acts for threatened species. State acts limiting clearing of native vegetation.			CFOC, State programs (small temporary payments). Conservation tenders (reverse auctions) programs in Victoria and National Stewardship Program.				BushBroker market for development offsets (Victoria)	CFOC	CFOC
Soil protection/ soil quality	Soil conservation act (state)			CFOC (small temporary payments)					CFOC	CFOC, Community Landcare grants
Climate change– Carbon storage				Carbon Farming initiative						Carbon Farming Futures
Climate change – greenhouse gas emissions				Carbon Farming initiative						
Air quality	Planning restrictions on locations of farms									

CFOC = Caring For Our Country.

For other agri-environmental issues, there has been modest use of markets and market-like mechanisms, but in most cases it remains unclear whether efforts to increase supply of agri-environmental public goods would provide benefits in excess of costs, because Benefit: Cost Analysis is rarely used to evaluate specific environmental projects or interventions.

In the major agri-environmental programs, the predominant methods used for encouraging change in farm management are extension and small, temporary incentive payments. The latter serve as encouragements to trial new practices, rather than as payments to offset opportunity costs borne by farmers. As such, the approach is essentially a form of extension.

The main methods used for establishing reference levels and targets are regulation and documentation of targets in plans. Secondary methods are use of the duty of care concept and codes of practice.

Overall, the scale of environmental challenges facing Australian agriculture is much larger than can be addressed with existing budgets. Australia’s usual practice has been to rely on low-cost voluntary approaches. This has helped to raise awareness of environmental issues amongst farmers, but the translation into environmental actions has been modest, particularly for salinity management and biodiversity protection.

Delivery of agri-environmental public goods could be increased through greater use of evidence and analysis to target investment to those spatial locations and specific projects that provide the most valuable environmental outcomes for the resources used. This process would need to evaluate and integrate information about environmental values, levels of environmental threat, feasibility of reducing the threats, likely levels of adoption of the required new practices by farmers, probability of project success, and programme costs. There is high spatial heterogeneity in these factors, creating opportunities for substantial increases in value for money from appropriate targeting of investments. This fact is also under-recognised in other OECD countries.

Other methods to improve the outcomes from investments in Australian agri-environmental programs include: a more systematic and evidence-based approach to the selection of policy mechanisms to be used for particular interventions; improvement in the quality of goals and targets set; and measures to reduce uncertainty prior to final decision making (e.g. high-quality feasibility assessment) and to learn from the successes and failures of existing and past interventions (e.g. active adaptive management, high-quality monitoring and evaluation).

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