*Chapter 4*

# OECD policy instruments and mixes addressing water quality issues in agriculture

*Policy responses to address agricultural water pollution across OECD countries have typically used a mix of economic incentives, environmental regulations and information instruments. A large range of measures have been deployed at the local, catchment, through to national and transborder scales, across an array of different government agencies. Many measures to control water pollution from agriculture are voluntary. Water supply utilities and the agro-food chain are also engaged in co-operative arrangements with farmers to minimise pollution, such as providing farm advisory services. This policy mix has had mixed results in lowering agricultural pressure on water systems. Over many years these policies, according to OECD estimates, have cost taxpayers billions of dollars annually. For some countries policies to reduce agricultural water pollution have been successful, with a package of input taxes, payments and farm advice. In other cases, despite substantial expenditure on efforts to lower agricultural pollution of a specific water ecosystem, little progress has been made. More recently, some private and public initiatives, for example, water quality trading in agriculture and establishing co-operative agreements to address water pollution are showing signs of success, albeit on a limited scale to date.*

Typically OECD countries have addressed water quality issues in agriculture (e.g. pollution, wetland conservation) by using a mix of economic instruments (*stimulation*), environmental regulations (*regulation*), and information and other persuasive approaches (*persuasion*) (Oenema *et al.,* 2009; Vojtěch, 2010). A large array of measures has been deployed at the local, provincial/state through to national and transborder scales, with many initiatives that emphasise voluntary adoption of farm management practices to enhance water quality encouraged by payments (Shortle, 2012).[1]

Using a mix of policy instruments rather than a single instrument (e.g. pollution tax) has a number of advantages (OECD, 2007).

- Provide a multifaceted approach to water pollution so that not only the amount of pollution, but also where and when the pollution takes place, etc., are relevant.
- Encourage the mutual strengthening of policy instruments between each other.
- Enhance enforcement and reducing policy related transaction costs.
- Address pollution at a much finer scale, targeted to achieve a specific outcome, and achieve these outcomes at lower cost than a single untargeted measure.

There are reasons, however, for restricting the number of instruments in the mix. For example, when several instruments are applied in the mix there could be a danger that one instrument hampers flexibility to find low-cost solutions to a problem that another instrument could have offered if it had been implemented on its own. There are also cases where some of the instruments in the policy mix are redundant and only increase total policy related transaction costs (OECD, 2007, and 2010e)

A survey of OECD countries policy objectives and policy instruments addressing nutrient and pesticide diffuse source pollution, was completed by OECD (2007) in 2004 (Table 4.1). The main findings from the survey responses showed the following.

- Many policy instruments (346) are used to address diffuse source pollution of which 198 (57%) address nutrient pollution, 119 (34%) pesticide pollution, and 29 (8%) address both issues.
- Economic instruments are widely used to address both issues together, with the use of payments much more frequent than application of pollution taxes and charges, with infrequent application of the Polluter-Pays-Principle to diffuse source pollution;
- Regulatory instruments are the most common policy approach used for addressing nutrients and pesticides separately; and that,
- Information instruments and other persuasive approaches are also widely used by countries.

**Table 4.1 Overview of policy instruments addressing diffuse sources of water pollution**

| | National level | | | | State/provincial level | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | Nutrients | Pesticides | Both | Total | Nutrients | Pesticides | Both | Total | |
| Policy objectives | 44 | 35 | 14 | 93 | – | – | – | – | 93 |
| Policy instruments | 137 | 78 | 25 | 240 | 61 | 41 | 4 | 106 | 346 |
| Regulatory instruments | 54 | 37 | 7 | 97 | 28 | 20 | 0 | 48 | 146 |
| Economic instruments, of which: | 37 | 8 | 9 | 54 | 17 | 7 | 1 | 25 | 79 |
| *Taxes* | *2* | *4* | *0* | *6* | *2* | *1* | *0* | *3* | *9* |
| *Subsidies* | *32* | *1* | *7* | *40* | *13* | *7* | *1* | *21* | *61* |
| Information instruments | 32 | 25 | 7 | 64 | 11 | 14 | 2 | 27 | 91 |
| Other instruments | 14 | 10 | 2 | 26 | 5 | 0 | 1 | 6 | 32 |

*Source:* OECD (2007), *Instrument Mixes Addressing Non-point Sources of Water Pollution,* OECD, Paris, www.oecd.org/env.

## 4.1 Economic instruments

### *Pollution taxes*

Application of the *Polluter-Pays-Principle* (PPP) in agriculture, such as by using a ***pollution tax***, can produce efficient and effective economic and environmental outcomes (OECD, 2010e; Weersink and Livernois, 1996). Where taxes or charges have been applied in OECD countries they are usually applied to fertiliser and pesticide inputs (Box 4.1). Such taxes can have desirable effects on water quality by lowering chemical input use and encouraging farmers to switch to nitrogen saving crop varieties. Pollution taxes can also lower transaction costs, by incorporating the taxes into the existing tax system. In **Denmark**, for example, an objective of a 50% reduction in pesticide use was announced in 1986 and reached by the early 2000s, without any loss in national agricultural production of farmers' incomes. The two pillars of the Danish policy to achieve this reduction in pesticides included a high level of pesticide taxes (rising up to 54% of the sale price for insecticides and 34% for all other pesticides), combined with an active farm advisory service (Jacquet, Butault and Guichard, 2011).

But application of the PPP in agriculture is difficult and not widespread across OECD countries, mainly because diffuse source pollution from agriculture into water cannot be measured at reasonable cost with current monitoring technologies (this does not generally apply to point sources of pollution in agriculture), and also due to property right, institutional and other barriers (Blandford, 2010) (Chapter 1). Some studies have also shown that a nitrogen tax, for example, may induce a shift to cropping systems that use less nitrogen fertiliser but lead to higher groundwater nitrogen pollution (Randhir and Lee, 1997). Research in **Ireland** revealed that in view of the inelastic demand for inorganic fertiliser a tax of over 260% would be required to achieve compliance under the European Union *Nitrates Directive,* while other research has also pointed to the political problems of attempting to enforce very high taxes on farmers (Weersink and Livernois, 1996). Also regulatory limits on nitrogen fertilisers compared to a tax could achieve compliance more effectively and equitably for those farms already in compliance (Lally, Riordan and van Rensburg, 2007).

### Box 4.1. Environmental taxation of pesticides and fertilisers in OECD countries

Only a few countries levy taxes on pesticides and nutrients (inorganic fertilisers and manure) as a means to reduce their use. The Box Table below shows the different approaches countries have taken in this area. The revenues derived from taxes also vary significantly, in line with the different tax rates that countries have imposed.

**Sweden**, for example, imposes the same per unit tax on the active ingredients for all pesticides, thereby levying the same rate on rather benign products as those which are more toxic. A percentage tax is used by other countries, which is dependent on the price of the pesticide, hence, a major user of pesticides will pay a smaller amount of tax on each unit of pesticide purchased than smaller users. **Norway** moved away from a system of percentage taxes on imports of pesticides in 1998, in favour of an approach that categorises each pesticide based on its negative human health and environmental effects. In doing so, it makes specific the value of the potential environmental and health damage, instead of relating the tax just to the price of the pesticide. Not only does this encourage more careful use of pesticides in general, it also provides incentives to substitute to less damaging products, as the price among pesticides are differentiated. The Norwegian system of pesticide taxes, however, can present a significant administrative burden, both for regulators and industry. While in Norway this is less of an issue as only 188 pesticides are approved for use, in the **United Kingdom** by contrast, for example, 3075 pesticides are registered for use.

**Box Table. Environmental taxes related to water pollution from agriculture**

| | Description of tax rate as at January 2010 | **Total annual tax revenue** (mill. USD) |
|---|---|---|
| Belgium | Flanders manure tax and water pollution tax | Not available |
| Canada[1] (British Columbia) | Pesticides: EUR 0.7568 per litre of pesticides | Not available |
| Denmark[2] | Pesticides: 35% of retail value for chemical products for disinfection of soil and insecticides; 25% of retail value for chemical deterrents of insects and mammals, chemical products for reduction of plant growth, fungicides, and herbicides; and 3% of retail value for deterrents against rats, mice, moles and rabbits, and fungicides for wood protection.<br>Fertilisers: EUR 0.67 per kg of nitrogen | 80 USD (2007) |
| France | Pesticides: Seven pesticide categories with rates ranging from EUR 0.38 per kg to EUR 1.68 per kg | Not available |
| Italy | Fertilisers: Tax on fertilisers and pesticides | Not available |
| Netherlands | Nutrients: Tax on surplus nitrogen and phosphate in excess of approved farm nutrient budget.<br>Levy on water pollution; and tax on pollution of surface waters | Not available |
| Norway | Pesticides: Tax per kg or litre of agricultural pesticides = (base rate*factor)*1 000/standard area dose. Standard area dose is the maximum application rate in kg or litres per hectare for the main crop for which the particular pesticide is used. The base rate is set by the government and is the same for all products (was EUR 3.12 per kg or litre in 2005). The factor is a weighting based on the relative risk level of the | 11.5 USD (2007) |
| Sweden[4] | Pesticides: EUR 3.11 per whole kg active constituent<br>Fertilisers: Tax | Not available |
| United States[5] | Fertilisers: EUR 0.001-EUR 0.004 per kg tax in Louisiana | Not available |

1. Earmarked for the residuals stewardship programme.
2. Exports are exempted. Earmarked for the environmental and agricultural sector. Only applies to nitrogen used outside the agricultural sector. Denmark also applies a DKK 4 kg-1 tax (EUR 0.54) on mineral phosphorus in animal feed (Box 5.1).
3. The weighting factors are as follows: 0.5: Products with low human health risk and low environmental risk; 3: Products with low human health risk and medium environmental risk, or products with medium human health risk and low environmental risk; 5: Products with low human health risk and high environmental risk, or products with medium human health risk and medium environmental risk, or products with high human health risk and low environmental risk; 7: Products with medium human health risk and high environmental risk, or products with high human health risk and medium environmental risk; 9: Products with high human health risk and high environmental risk; 50: Concentrated home garden products; 150: Ready-to-use home garden products.
4. Wood preservatives are exempted.
5. Earmarked for financing inspection activities.

*Sources:* OECD Secretariat drawing on: OECD (2010), *Taxation, Innovation and the Environment*, OECD, Paris; Vojtěch, V. (2010), "Policy Measures addressing Agri-environmental Issues", *OECD Food, Agriculture and Fisheries Working Papers,* No. 24, and the OECD *Environmental Tax database,* see www.oecd.org/env/policies/database.

### *Agri-environmental payments*

Most OECD countries offer monetary payments (including implicit transfers such as tax and interest concessions) to farmers and other landholders to address environmental problems (e.g. to reduce pollution) and/or to promote the provision of environmental amenities associated with agriculture (Vojtěch, 2010). These payments are mainly provided on a voluntary basis, however, there are payments (mainly investment subsidies) provided to farmers to assist them to comply with environmental regulations. In practice, many agri-environmental payments tend to be linked to land or other factors of production, and often function by lowering the intensity of production. While payments directly tied to broad environmental outputs are rare, some countries are beginning to develop payments based on environmental outputs linked to farmer's practices, such as in **France** where a payment is tied to the objective of reducing pesticide use (OECD, 2010e; Vojtěch, 2010).

Overall the relative amounts of agri-environmental payments (AEPs) as a share of the total producer support estimate varies, while in the **European Union** and the **United States** total AEP expenditure has risen significantly since the early 1990s (Vojtěch, 2010). For the **EU27** total AEP expenditure in 2007-09 was about EUR 6 billion annually, around 7% of the total PSE. The respective figures (figure in brackets is the share of the PSE) for the **United States** are USD 5 billion (16%); **Norway** NOK 950 million (5%); **Switzerland** CHF 240 million (4%) and **Australian** payments under the Natural Heritage Trust (Figure 1.5) have been around AUD 460 million annually (18%).[2] For most other OECD countries AEPs have either only just been introduced on a limited scale to date or are not used as a policy instrument.

The AEP data provided here covers payments across all environmental domains in agriculture, such as payments for biodiversity conservation, air pollution control, and soil conservation. These data also include AEPs directly used for controlling water pollution, for example, for nitrate reduction, green cover and buffer strips, and conversion of land to wetlands and ponds (Table 4.2). Many AEP programmes, however, have indirect benefits for water pollution control, such as those aimed at soil erosion control which reduces soil siltation and the transport of nutrient and pesticide pollutants into water systems. Equally, payments for biodiversity conservation which by providing green cover, for example, can help absorb pollutants before they reach watercourses (Table 4.2). In other cases regulatory rules to control pollution may exempt farmers from receiving AEPs. For example, this is a requirement under the **European Union's** *Nitrate Directive*.

For these reasons it is difficult to provide accurate estimates of annual AEP expenditure across OECD countries used for water pollution abatement. But as water pollution control often figures prominently in programmes using AEPs, for example, to assist farmers with compliance with the **European Union's** *Nitrate Directive* and funding under the **US** *Environmental Quality Incentives Program* (EQIP), the total OECD annual expenditure on water pollution abatement in agriculture probably amounts to hundreds of billions USD (EUR) annually.

### Table 4.2. Agri-environmental payments to address water quality in OECD member countries: 2008

| Programme / country | Austria | Australia[1] | Belgium[2] | Canada | Czech Republic | Denmark | Finland[3] | France | Germany | Greece[3] | Hungary | Ireland | Italy | Japan | Korea | Mexico | Netherlands[3] | New Zealand[1] | Norway | Poland | Portugal | Spain | Slovak Republic | Sweden | Switzerland | Turkey | United States | United Kingdom[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Payments directly impacting water quality** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Land improvement (liming, soil erosion prevention) | X | X | X | X | | | X | X | X | | | | X | | X | X | | X | X | X | X | X | X | X | | X | X | X |
| Payments for nitrate reduction | X | X | X | | | X | X | X | X | X | | | X | | X | | | | X | X | X | X | X | X | X | X | | X |
| Nutrient management plan | | X | | X | | X | | | | | X | X | X | | | | | | | | | X | | X | | | X | X |
| Maintenance of wetlands and ponds[5] | | X | X | | X | X | | X | | | X | | X | | X | X | X | | X | | | X | | X | X | X | | X |
| Conversion of farmland into wetlands and ponds | | | | | | X | X | | | | | | X | | | | X | | | | | | | X | | | X | X |
| Shelter belts/Buffer strips | X | X | X | X | X | X | X | X | X | | X | X | X | | X | | | X | X | X | X | X | | X | X | | X | X |
| **2. Payments indirectly impacting water quality** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Extensive crop production | X | | | | | | | X | X | | X | | X | X | | | | | | X | X | X | | X | X | | | X |
| Organic farming | X | | X | | X | X | X | X | X | X | X | X | X | | X | X | X | | X | X | X | X | X | X | X | X | X | X |
| Integrated production wine, fruits and vegetables | X | | X | | X | | | X | | | X | | X | | | X | | | | | | X | X | | | | | X |
| Integrated farming | | | X | | X | X | | X | | | X | | X | | | | | | | | X | X | | X | | | | X |
| Reduced tillage/Mechanical weed control | X | X | X | X | | | X | | X | | X | X | X | | | | | | X | | X | X | | | X | X | X | X |
| Green manure crops | | X | | | | | | | | | | | | | | | | | | | | | | | | | | |

*(continued)*

**Table 4.2. Agri-environmental payments to address water quality in OECD member countries: 2008** (*cont.*)

| Programme / country | Austria | Australia[1] | Belgium[2] | Canada | Czech Republic | Denmark | Finland[3] | France | Germany | Greece[3] | Hungary | Ireland | Italy | Japan | Korea | Mexico | Netherlands[3] | New Zealand[1] | Norway | Poland | Portugal | Spain | Slovak Republic | Sweden | Switzerland | Turkey | United States | United Kingdom[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2. Payments indirectly impacting water quality (cont.)** | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Green set-aside/Fallows | X | X | | X | | X | | X | | | X | | X | | X | | X | | | | | X | | | X | | X | X |
| Catch crops, green/winter cover | X | | X | X | X | X | X | X | X | | | X | | | X | | | | X | X | | X | | X | | | X | |
| Extensive management of all land | | | | | | | X | X | | | X | | | | X | | | | | X | | X | | X | | | | |
| Extensive grassland management (pastures/meadows) | | | X | X | X | X | | X | X | | X | X | X | | X | | X | | X | X | X | X | X | X | X | X | X | X |
| Conversion of arable land into grassland (pastures/meadows) | | | | X | X | X | | X | X | | X | | X | | | | | | | | | X | X | | X | | X | X |
| Grassland/biodiversity/habitat schemes | X | X | X | X | X | | X | X | X | | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | | X | X |
| Maintaining and improving groundcover | | X | | | | | | | | | | | | | | | | | | | | | | | | | X | |
| Long term set-aside | X | X | | | | X | | | X | X | | X | X | | | | | | | | | X | | | | X | X | |
| Afforestation | | X | X | | X | X | | X | | X | X | X | X | X | X | X | X | X | | X | X | X | X | | | X | X | X |
| Converting pasture to perennial vegetation | | X | | | | | | | | | | | | | | | | | | | | | | | | | | |

1. In Australia and New Zealand, there is very limited use of payments to farmers (and, where payments are made, this is in the form of one-off or transitional payments) and support to agri-environmental programmes is provided mostly through general services.
2. In Belgium, only programmes used in the Flanders region are reported.
3. In Finland, Greece and the Netherlands, the information for 2008 is not available and the programmes in the table correspond to programmes applied in 2000-06.
4. In United Kingdom, only programmes used in England are reported.
5. In Spain, the payments for water quality in wetlands are included in this line.

*Source*: Adapted from, Vojtěch, V. (2010), "Policy measures addressing Agri-environmental Issues," *OECD Food, Agriculture and Fisheries Working Papers,* No. 24.

### *Water quality trading*[3]

Water quality trading (WQT) refers to the application of emissions trading to water pollution control. Traditional air and water pollution regulations entail imposing periodic (e.g. annual) maximum limits on emissions sources (e.g. smokestacks, outfalls), and requiring that those limits be met at the source. The requirement that limits are met at the source prevents emissions reductions from one source being used to meet the requirements of another.

Prohibiting the use of emissions reductions from one source to offset emissions from another serves no environmental purpose if the environmental conditions are unaffected by the offset. However, the inability to use offsets increases the costs of pollution control when the incremental cost of pollution abatement differs between sources. Emissions trading introduces flexibility into how emissions limits can be met, and a source may meet the limit on its allowable emissions in part or in whole (depending on trading rules) by acquiring offsetting emission reductions from other sources.

Applications of emissions trading to date have largely occurred in the domain of air pollution. There is now substantial interest in extending the method to water pollution, including to water pollution from agriculture. WQT initiatives have been implemented in **Australia**, **Canada**, **New Zealand**, and the **United States** (Figure 4.1). WQT is also being studied elsewhere, including by **Denmark**, **Finland**, **Sweden**, and other countries surrounding the Baltic Sea to address nutrient pollution in the Baltic Sea (Chapter 5.7).

WQT experiments began in the **United States** in the early 1980s, mostly in the form of pilot or demonstration projects. Early initiatives were disappointing, producing little or no trading activity. Despite this experience, but in the light of the success of air emission trading programmes, interest in WQT increased beginning in the mid-1990s with water quality policy developments requiring caps on pollution from point and diffuse sources in impaired waters. State water quality managers have been the innovators with support and encouragement from the US Environmental Protection Agency, including the creation of national policy guidelines for WQT in 2003, and technical assistance and funding for WQT projects.

The technical assistance addresses issues of legal compliance with national law but also presents guidelines for the creation of successful trading models based on lessons learned from *ex post* evaluations of early initiatives. These lessons include:

- Binding regulatory limits on pollution levels are essential for trading activity to occur. Such limits are essential to create the incentives for polluters to seek out options for pollution control cost savings.

- Trading activity requires sufficiently large differences in pollution control costs between polluters to make economic gains from trading possible, after deducting transactions costs incurred in conducting trade (Box 4.2).

- Trading rules must be clearly established to assure that water quality goals will be satisfied, but must also be designed to facilitate trading. Rules that are overly complex and costly create barriers to trading activity.

- Successful trading requires the development of institutions for organising trade that are trusted by, and effective for, intended programme participants.

The **United States** leads in the development of water quality trading initiatives, with 22 schemes located in 14 states. Agriculture is included as a potential participant in several US initiatives. Some of these are one-time sole-source offsets in which voluntary agricultural pollution reductions are used by a regulated point source to address facility-specific compliance problems. Agriculture is also a potential participant in several water catchment-based trading programmes that envision routine trading between multiple point and diffuse sources. The most notable of these are the Greater Miami River Watershed Trading pilot programme in Ohio and the Pennsylvania Water Quality Trading programme both initiated in 2005 (Figure 4.1). Both involve nutrient trading between point and agricultural diffuse sources.

The Grassland Farmers selenium trading project established in 1998 in the San Joaquin Valley in California, **United States**, is one water catchment based trading programme limited to agricultural sources. The Grassland Farmers traded and met pollution reduction goals for the two-year period before trading was suspended due to the development of a selenium recycling project that eliminated the need for trading. The Greater Miami programme is producing trade that promise reductions in nitrogen loads from agriculture, and has some innovative features that make it an important model for trading with agricultural diffuse sources. However, programme development and trading activity have been substantially supported by federal grants. The Pennsylvania nutrient trading programme has had only limited trade since its inception.

The **Canadian** programme, initiated in 2000, involves phosphorus trading between industrial and municipal point sources and agricultural diffuse pollution sources in the Ontario South Nation River water catchment (Figure 4.1). The programme has produced pollution reductions and pollution cost savings in the ten years that it has been in operation. The **New Zealand** programme, initiated in 2010, is limited to nitrogen trading between agricultural sources in the Lake Taupo water catchment on the North Island (Figure 4.1; and Chapter 5.4). **Australia** has a couple of successful trading programmes for industrial point sources but none at the present for agriculture. A nutrient trading programme that would include agricultural sources is being considered for Moreton Bay.

Emissions trading is typically described as a market-based pollution control instrument that sets a cap on the total emissions of a pollutant. Market transactions allocate emissions under the cap among individual pollution sources. The role of trading is to harness market forces to promote cost-efficiency in emissions reductions. WQT programmes that allow agricultural participants to conform to this description are only found under the **New Zealand** and Grassland Farmers selenium trading programme in the **United States**. Both of these are cap-and-trade programmes designed to achieve specific pollution reduction goals from agricultural sources. The **Canadian** and **US** nutrient WQT programmes that include agricultural sources are only partially capped. These programmes allow trading between point sources that are subject to explicit regulatory limits and agricultural sources that are not. They allow point sources to use pollution reductions produced voluntarily by agricultural diffuse sources to offset point source emissions as a means for complying with the point sources' emissions limits.

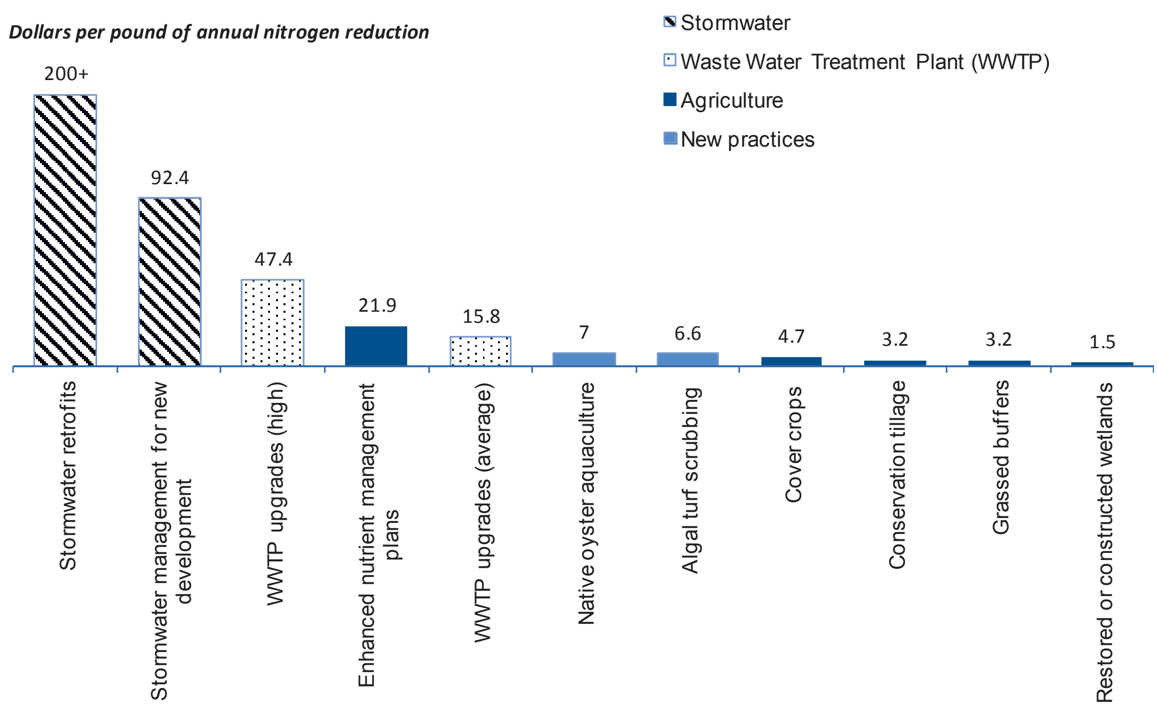
**Figure 4.1. Water Quality Trading Programmes: Canada, New Zealand and the United States**

| | Canada | New Zealand | United States | | |
|---|---|---|---|---|---|
| **Programme** | *Ontario South Nation River Total Phosphorus Management* | *Lake Taupo Nitrogen Trading Program* | *Grassland Area Tradable Loads Program* | *Greater Miami River Watershed Trading Pilot* | *Pennsylvania Water Quality Trading Program* |
| **Administrator** | South Nation Conservancy (SNC) | Environment Waikato | Grassland Area Farmers (GFA) | Miami Conservancy District (MCD) | Pennsylvania Department of Environmental Protection |
| **Year initiated** | 2000 | 2010 | 1998 | 2005 | 2005 |
| **Pollutant** | Phosphorus | Nitrogen | Selenium | Nitrogen, Phosphorus | Nitrogen, Phosphorus, Sediments |
| **Eligible pollution sources** | Industrial, municipal, agricultural | Agricultural | Agricultural | Industrial, municipal, agricultural | Industrial, municipal, agricultural |
| **Commodity type** | Emission reduction credits (ERCs) | Emission allowances | Emission allowances | Emission reduction credits | Emission reduction credits |
| **Emissions quantification** | Calculated | Calculated | Measured | Calculated | Calculated |
| **Agricultural sources capped?** | No | Yes | Yes | No | No |
| **Market organisation** | SNC sells ERCs to point sources. Proceeds are used to fund agricultural projects. Farmers do not participate directly. | The market is designed for voluntary exchange between landowners or third party agents. An online registry has been developed for posting offers. | Trades are negotiated between the 7 irrigation district members of the GFA association. Farmers do not participate directly. | MCD buys ERCs from Soil and Water Conservation Districts (SWCDs) using reverse auctions. The SWCDs use the proceeds to fund agricultural projects. Farmers do not participate directly. The programme is funded by ERCs sold to municipal waste water treatment plants and federal grants. | The market is designed for voluntary exchange credit suppliers and demanders, or third party agents. An online registry has been developed for posting offers. A clearing house intended to increase market activity was created in 2010. |
| **Baseline participation requirements or initial allowances** | None. Farmers do not participate directly. Eligible projects are funded by SNC. | Initial allowance allocation is based on the average nitrogen losses between 2000 and 2005 | Total Maximum Daily Loads (TMDL) | Credits generated by agricultural projects funded by the programme cannot be funded by other programmes or otherwise required. | Farmers must meet minimum nutrient and sediment management requirements to be eligible to participate. |
| **Trading activity** | Yes. The programme has produced emissions reductions and cost savings. | Emerging | Yes. 39 trades during two years of operation. Pollution goals met. Trading has been suspended due to new control options. | Yes. 6 reverse auctions have been conducted providing funding for 99 agricultural projects. | Yes. Very low compared to the expected potential. |

*Source:* Shortle, J. (2012), *Water Quality Trading in Agriculture*, OECD Consultant Report, available at: *www.oecd.org/agriculture/water*.

**Box 4.2. Opportunities for water quality trading: Nitrogen reduction cost differences within and between sectors – United States 2009**

The opportunity for nutrient trading arises because large differences in the cost to reduce a kilogram (pound) of nitrogen exists within and between different sectors and practices, as shown in the Box Figure example of the Chesapeake Bay, United States. In a trading market, sources that can reduce nutrients at low cost have an economic incentive to make reductions below target levels and then sell the credits to those facing higher costs. Trading therefore creates new revenue opportunities for farmers, entrepreneurs, and others who can generate nutrient credits. At the same time, trading allows those wastewater treatment plants (WWTPs) and municipal stormwater programmes that face higher nutrient reduction costs to save money by purchasing credits to meet a portion of their nutrient reduction obligations. As a result, trading can help achieve overall nutrient reductions in a more cost-effective manner.




*Note:* It should be noted that the figure above does not show credit prices in a nutrient trading market, but current average costs to reduce a pound of nitrogen based on a number of studies. Prices are determined by the market dynamics of supply and demand. The costs in this figure do not take into account the baseline or minimum practices that agriculture would have to implement prior to selling credits.

*Source:* OECD Secretariat, adapted from World Resources Institute (2010), *How nutrient trading could help restore the Chesapeake Bay*, Working Paper, Washington, D.C., United States.

Trading rules are typically designed with the intent that agricultural offsets produce a net reduction in total pollution. For example, the Ontario South Nation River programme requires a reduction of 4 kg of phosphorus from an agricultural source for each kg of point source phosphorus emissions allowed. **Canadian** and **US** nutrient WQT programmes essentially create profit-making opportunities for agriculture that can reduce agricultural pollution, but do not cap agricultural pollution.

The partially-capped nutrient trading model used in **Canada** and the **United States** was developed by water quality managers seeking to improve the efficiency and effectiveness of water pollution control by adapting a first-generation (i.e. pre cap-and-trade) air emissions trading model to the trading of agricultural diffuse source pollution. This adaptation took place within water pollution policy frameworks that did not actively regulate agricultural diffuse source pollution, and which did not envision trading.

Agricultural and other diffuse source pollution can pose significant technical challenges to a fully capped trading design. One lesson is that some methods used in the design of point-diffuse source pollution trading programmes are scientifically flawed and may lead to designs that diminish the capacity of WQT to efficiently and effectively achieve water quality goals.

It is important to emphasise that water quality trading programmes differ substantially from theoretical models of emission trading and from well-known large scale cap-and-trade markets for sulphur dioxide air emissions in the **United States** and carbon emissions in the **European Union**. These differences include:

- Water quality trading programmes are not defined at national or international scales, instead, they address specific local or regional water quality problems within well-defined hydrological boundaries.
- With a few exceptions, existing water quality trading programmes make limited use of markets in the conventional sense. The most effective agricultural trading models to date make use of traditional agricultural soil and water conservation institutions to recruit farmers and fund agricultural pollution reduction projects, and do not engage farmers directly in trading.
- Theoretical models usually assume, and the major cap-and-trade programmes are defined for, point sources of pollution. Some water quality trading programmes are limited to point sources, but most include agricultural or other diffuse sources.
- By definition, theoretical models and the large cap-and-trade programmes place a cap on the total emissions of eligible participants. Markets serve to allocate emissions under the cap among the various sources. With one exception across OECD countries, active water quality trading programmes with agricultural diffuse sources are only partially capped. These programmes do not limit agricultural diffuse source pollution. Instead, they allow point sources to use pollution reductions produced voluntarily by agricultural diffuse sources as a technology for point source regulatory compliance. These water quality trading programmes essentially create profit-making opportunities for agriculture that can reduce agricultural pollution, but do not in fact cap agricultural pollution.

The differences outlined here emerge for several reasons, including:

- ***Spatial scales****:* the comparatively small spatial scales appropriate to water quality management.
- ***Regulatory context****:* The cap-and-trade air emission programmes result from legislation specifically intended to create them. Most water quality trading programmes have emerged as innovations within, and constrained by, existing water pollution control laws and policies that did not envision trading. Thus, for example, **US** and **Canadian** pollution control measures do not explicitly regulate emissions from most agricultural diffuse sources. Instead these programmes use agricultural diffuse source offsets as off-site technologies that can be used for point source compliance. Further, these programmes are

analogous to **US** first-generation (pre cap-and-trade) air emissions trading programmes that similarly emerged as cost-saving innovations within a pre-existing regulatory framework that did not specifically enable trading. Thus, these programmes trade emissions reduction credits rather than emission allowances.

- ***Point sources**:* The theoretical model of trading that has guided the development of cap-and-trade air emissions trading assumes participants are point sources. The point source model does not address challenging measurement and management issues associated with diffuse source pollution.

## 4.2 Environmental regulations

Since the 1980s there has been a general expansion in regulatory measures affecting agriculture to protect water systems, which usually make farmers liable for the water quality damage they cause. These measures are frequently compulsory or the producer faces penalties, such as fines and, where eligible, withdrawal of agri-environmental payments. Regulations are the most widespread and common policy measure used across OECD countries to limit the environmental impacts of agriculture on water systems (Table 4.3). Regulations range from very broad prohibitions (e.g. the blanket ban on DDT pesticide) or requirements (e.g. compliance with the **EU** *Nitrates Directive*) to intricate details about specific farm management practice (e.g. pesticide spraying distance from a river) (OECD, 2003b).

In brief the regulatory approaches across OECD countries that address water pollution from agriculture can be summarised in terms of (Table 4.3 provides an illustration of the range of these regulations related to pig and dairy cow manure management for selected OECD countries):

- Prohibitions on the direct discharge of farm wastes into rivers and lakes, such as livestock manure or disposal of unused pesticides;
- Limits on the marketing and sales of products prior to a human health and environmental risk assessment, which is mainly relevant to pesticides and other emerging contaminants (Box 4.3), to ensure their health and environmental safety prior to use on-farm;
- Rules concerning the distance and sitting of livestock waste and pesticide storage in the proximity to surface water and groundwater;
- Permits, for example, to operate large-scale livestock operations and control potential polluting emissions from these facilities, and also for aerial spraying of pesticides; and,
- Restrictions of on-farm management practices, which in general will affect the handling of potentially water-polluting materials (fertilisers, manure, pesticides), their storage and application onto fields (including the quantities that can be applied, the timing, and the distance from watercourses).

Regulations can lead to modifications in farmer behaviour, especially where the expectation is that a producer will have to pay a large fine, penalty or compensation for water quality damage. Such regulations can be effective for point source pollution in agriculture where the source of pollution and polluter is easily identified, and the transaction costs of regulatory enforcement can be minimal. But for diffuse source agriculture water pollution as these conditions do not prevail, then such regulations can only be a complimentary mechanism with other policy instruments, such as a compliance condition to receive a pollution abatement payment (Weersink and Livernois, 1996).

**Table 4.3. Regulatory requirements for pig and dairy cow manure management in selected OECD countries**

| | Denmark | Netherlands | Switzerland | Canada (Ontario) | United States (Iowa) | Japan | Korea | Australia (New South Wales) | New Zealand (Waikato) |
|---|---|---|---|---|---|---|---|---|---|
| Maximum allowable manure application (kgN/ha)[1] | 170 kgN | Arable land 170 kgN<br>Grassland 230 kgN<br>(total allowable nutrient surplus 100-180 kgN) | 150-315 kgN (depending on region)<br>or 3 large cows | 244 kgN<br>(Surplus ≈ 36 kgN) | Up to 1.5 times crop usage rates of N | Probably no regulation | 340-640m$^2$ of land per pig | 50-200 kgN/ha | No regulations but 150 kg from effluent. To this comes manure deposit in the field. (Surplus >140 kgN is assumed high leaching potential.) |
| Manure storage capacity and technology | Minimum 180 days (270 days in practice)<br>Concrete | 6 months. From 2012: 7 months<br>Concrete with tent or hard cover | 120-210 days<br>Concrete | 240 days<br>Concrete or liners | Minimum 225 days' capacity; Tank or lagoon, with straw cover | n.a.;<br>Concrete or liners with cover and side wall | 180 days; for compost: 30-60 days;<br>Tanks are common | Sufficiency requirement (180 days); Tank or lagoon | Not applicable -<br>Sealed ponds |
| Allowed manure application technology | Trailing hose or injection | Injection and trailing hose injection | All | All | Any | All | Any | Any | All |
| Application-free period | From harvest to 1 Feb. On snow and frozen soils. | 15 Sept.-1 Feb.<br>On snow and frozen soils. From 1 Sept 2011 application on grass over sandy soils prohibited. | On snow and frozen soils | When snow cover >5cm and on frozen soils | Winter | - | Summer rainy season | Winter | Not applicable |
| Nutrient planning | Yes | Yes | Yes | Yes | Yes, except small farms | Yes | No | Yes | No |
| Nutrient book-keeping | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No |

**Table 4.3. Regulatory requirements for pig and dairy cow manure management in selected OECD countries** (*cont.*)

| | Denmark | Netherlands | Switzerland | Canada (Ontario) | United States (Iowa) | Japan | Korea | Australia (New South Wales) | New Zealand (Waikato) |
|---|---|---|---|---|---|---|---|---|---|
| Nutrient accounting | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | No |
| Soil analysis | No | Yes | Yes, every year | Yes, every 3rd year | n.a. | No | n.a. | n.a. | No |
| Pollution permits required | No | Yes | No | No | Yes | No | Some | Yes | No |
| Environmental Impact Assessment | For farms larger than 250 animal units | Yes | No | Yes | Yes | No | No | Yes | No |
| Land ownership requirements | Yes | Yes | No | No | No | No | Yes | No | No |
| Buffer zones | Minimum 2 m along water-courses | 2000 km fertiliser-free zones around ecologically sensitive streams | Minimum 3 m along watercourses and hedges | Different zones, minimum 3 m, and up to 30 m to water catchments. Minimum distance to several objects | Yes | n.a. | No | 200 m from plant | 20 m for effluents |
| Compliance incentives | Levies | Levies | Yes | Yes | Fines | Yes | Fines | Fines | No |

n.a.: not available

*Sources:* OECD Secretariat, adapted from OECD (2003), *Agriculture, Trade and the Environment: The Pig Sector,* OECD, Paris, www.oecd.org/tad/env; and OECD (2004), *Agriculture, Trade and the Environment: The Dairy Sector,* OECD, Paris, France.

**Box 4.3. Regulatory approaches to address agricultural water pollution from emerging contaminants**

The environmental impacts of a number of classes of emerging contaminants (ECs) are largely controlled across OECD countries by conducting compulsory Environmental Risk Assessments (ERAs) of veterinary medicines, human pharmaceuticals, transformation products, engineered nanoparticles and other potential ECs before they are marketed.

Historically, individual authorities have had their own guidelines for assessing the risks of a ***veterinary product***. The Veterinary International Co-operation on Harmonisation (VICH) was officially launched in 1996 to harmonize technical requirements for veterinary product registration across the **United States, Canada, Australia, Japan** and **Europe**. Its members include representatives from government agencies and industry. VICH currently has working groups drafting recommendations in a number of areas including ecotoxicity, safety, efficacy, and pharma-covigilance.

In the **European Union** and the **United States**, guidelines are also available for the ERA of ***human pharmaceuticals***. The current guidance document, adopted by the European Medicines Evaluation Agency Committee for Human Medicinal Products, came into effect 2006. An ERA is required for all new marketing authorisation applications for medicinal products. Unlike veterinary medicines, a marketing authorisation for a human pharmaceutical will not be refused based on the ERA.

The environmental risks of ***transformation products*** have to be considered for many classes of chemicals. For example, the **EU**'s *Pesticides Directive* (2009/1107) requires assessment of major transformation products and relevant transformation products of plant protection products. Similar requirements also exist for transformation products of pesticides, biocides and human and veterinary medicines in other countries (e.g. **United States**).

As engineered ***nanomaterials*** are expected to be used in a wide range of product types, it is likely that a range of environmental regulatory frameworks will apply to them. For example, industrial uses are likely to be covered by the recent **EU** Regulation on the Registration, Evaluation, Authorization and Restriction of Chemicals (the "REACH Regulation") which, entered into force in 2007. Applications for pharmaceutical, biocides, veterinary medicines and plant protection products will be covered by other specific frameworks.

Many ECs that are not covered by the mechanisms described above are likely to be covered in the **European Union** by the REACH Regulations. REACH will require an environmental safety assessment of all chemicals used or imported into the European Union in quantities exceeding one tonne. The EU *Water Framework Directive* and the new European soils policy may also influence the management of ECs in the natural environment.

In the event that an EC is identified as posing an unacceptable risk to the environment, there are a number of options that exist for managing or mitigating the risks. For example, over recent years there has been a steadily increasing drive within the pharmaceutical industry towards the synthesis of "greener" pharmaceuticals and the adoption of green chemistry methods and technologies. Most improvements have been made to the manufacturing process, although increasing emphasis is being placed on the development of approaches for minimising impacts during use, including development of pharmaceuticals that are benign or designed to be biodegradable.

Classification and labelling approaches may also help to minimise risks. A good example of such a scheme is a system running in **Sweden**, which is voluntary and targets active pharmaceutical substances where information on their environmental impacts is made publicly available on websites and in information booklets. The extension of a model similar to the Swedish scheme could potentially be desirable at the OECD level. Key issues for developing and implementing classification and labelling schemes include: the standardisation of the information used; the criteria applied; who provides the information; and the mode of communication.

In **Europe**, drug take back schemes of unused/expired medication are an obligatory post-pharmacy stewardship approach that reduces the discharge of pharmaceuticals into environmental waters and minimises the amounts of pharmaceuticals entering landfill sites. Although the contribution of improper disposal of pharmaceuticals to the overall environmental burden is generally believed to be minor, drug take back schemes are still considered to be important. High levels of public awareness and education on the environmental consequences of the disposal of unused/expired drugs are key for the success of such schemes.

*Source:* Boxall, A. (2012), *New and Emerging Water Pollutants arising from Agriculture*, OECD Consultant Report, available at: *www.oecd.org/agriculture/water*.

## 4.3 Information instruments and other persuasive approaches to address water pollution

Information instruments are used widely across OECD countries in support of economic instruments and regulations to address water quality issues in agriculture. Some of these instruments are well developed, especially public and private research on water pollution abatement technologies and BMPs, and diffusing these technologies and practices to farmers through support mechanisms and capacity building (Table 4.4). Eco-labelling is one example of an information instrument that can provide incentives for farmers who wish to certify their products and adopt sustainable agricultural practices, and bring benefits for water quality and other environmental media (Box 4.4).

Other persuasive approaches are not so widespread and less developed, such as private and voluntary regulation and co-operative arrangements in the area of water pollution control, as summarised in Table 4.4 (Barnes *et al.*, 2009; Dowd *et al.*, 2008; Gouldson *et al.,* 2008; Kay *et al.*, 2009). There is growing interest and experimentation, however, with developing these approaches, especially co-operative arrangements, as discussed in the following section (Chapter 5.8).

**Table 4.4. Information instruments and other persuasive approaches to address water pollution from agriculture**

| Communicative approaches | Specific policy instruments and approaches | Examples related to improving water quality in agriculture |
|---|---|---|
| Information-based instruments | • Targeted information provision | • Advice specific to a farm or sub-catchment |
| | • Publicising farmer performance | • Publicising farmers that have achieved improvements in water quality |
| | • Registration, labelling, certification | • Organic standards symbol |
| Private and voluntary regulation | • Self-regulation | • Farmers acting to regulate themselves |
| | • Voluntary regulation | • Developing agro-food industry codes of conduct, such as by the pesticide industry |
| | • Covenants and negotiated agreements | • Formalised voluntary agreement, that may include sanctions for non-compliance |
| | • Corporate regulation | • Water companies, for example, requiring farmers to comply with farming practices to ensure improved |
| | • Professional regulation | • Codes of practice developed by professional organisations |
| | • Civic regulation | • Community based regulation, such as between conservation groups and farmers |
| Support mechanisms and capacity building | • Research and knowledge generation | • Private and public research and knowledge to improve understanding of agriculture and water quality links |
| | • Demonstration projects and knowledge diffusion | • Farm advisory services and demonstration projects to encourage greater uptake of best management practice |
| | • Network building and joint problem solving | • Can involve developing network of farmers and other stakeholders in a water catchment to discuss problems collectively |

*Source:* OECD, adapted from Gouldson, A., *et al.* (2008), "New alternative and complementary environmental policy instruments and the implementation of the Water Framework Directive", *European Environment*, Vol. 18, pp. 359-370.

**Box 4.4. Eco-labelling and agricultural water pollution**

Eco-labelling is a voluntary method of certifying products that are produced in a way that is environmentally preferable to other products in the same product category based on life cycle considerations. Eco-labelling is intended to stimulate consumer preference for "green" products and thus generate a financial return to the supplier of the certified product in the form of increased revenues. Eco-labelling of agricultural products can provide incentives for farmers who wish to certify their products and adopt sustainable agricultural practices, and bring benefits for water quality and other environmental media (Selman and Greenhalgh, 2009).

The organic label is the most well established eco-label across OECD countries, with organic farming seen as providing a host of environmental benefits, including improving water quality (Chapter 3). It has benefited from consumer demand, a clearly defined set of standards, a strong certification system, and a system of enforcement. However, the adoption of organic production systems across OECD countries still remains relatively low (OECD, 2008). Obstacles to adoption by farmers include: high managerial costs and risks of shifting to a new way of farming; limited awareness of organic farming systems; uncertainty over expected yields and returns; lack of marketing and infrastructure; and the inability to capture marketing economies. These factors are likely to be issues for other types of eco-labels (Ribaudo *et al.,* 2010a).

As well as organic labels, a number of other eco-labelling programmes have emerged with a specific connection to improving water quality related to agriculture. In 1998, the World Wildlife Fund collaborated with a **United States** environmental non-governmental organisation (NGO), *Protected Harvest*, to initiate a label for potato farmers in Wisconsin that would reduce the use of some toxic pesticides and encourage other environmentally beneficial production practices. Another US environmental NGO in the Pacific Northwest developed a *Salmon Safe* label that recognises the adoption of "ecologically sustainable agricultural practices that protect water quality and native salmon." This label encourages restoration of riparian habitat adjacent to fields, as well as improved cropping system practices.

About 100 growers in New York State, **United States**, with a variety of production systems, are using a *Pure Catskills* promotional label to indicate their participation in a water catchment protection programme. *Water Stewardship* is also working with agricultural producers in the Chesapeake Bay and other areas of the **United States** to develop and implement plans to reduce the impacts of nutrients on water. Producers that implement these plans will be able to market their products to beverage manufacturers, processors, and distributors as sustainably produced (Ribaudo *et al.,* 2010a; Selman and Greenhalgh, 2009).[1]

The proliferation of other local and national eco-labels for a variety of environmental services and labels for other causes may pose a challenge to consumers (Ribaudo *et al.,* 2010b). Many of these labels do not come with the standards and certification of the organic label, raising the uncertainty of the label claims. Even if consumers are willing to pay a premium to support the supply of environmental services on farms, too much information may make deciding between competing goods difficult. However, careful development of new production standards and labelling regulations, along with consumer education, production research, and other policy initiatives, can mitigate consumer confusion and address the obstacles to adoption (Ribaudo *et al.,* 2010b).

Even if price premiums for eco-labels can be maintained, however, the public-goods nature of environmental services, such as water quality, implies that they do not reflect the true social value of these services. Eco-labels alone cannot provide a socially optimal level of environmental services, such as high levels of water quality (Ribaudo *et al.,* 2010b).

1. For further details on these environmental NGOs with a focus on standards and certification of sustainable agriculture in relation to water quality, see the following websites: Protected Harvest: *www.protectedharvest.org/;* Salmon Safe *www.salmonsafe.org/;* Pure Catskills: *www.buypurecatskills.com/;* and Water Stewardship: *www.waterstewards.net/*.

*Sources:* OECD Secretariat, drawing on, in particular, Ribaudo, M., C. Greene, L. Hansen and D. Hellerstein (2010a), "Ecosystem services from agriculture: Steps for expanding markets", *Ecological Economics*, Vol. 69, pp. 2085-2092; Ribaudo, M., L. Hansen, D. Hellerstein and C. Greene (2010b), *The use of markets to increase private investment in environmental stewardship*, Economic Research Report No. 64, Economic Research Service, U.S. Department of Agriculture, Washington, D.C., United States; Selman, M. and S. Greenhalgh (2009), *Eutrophication: Policies, actions and strategies to address nutrient pollution*, World Resources Institute, Washington, D.C., United States; OECD (2008), *Environmental Performance of Agriculture in OECD Countries since 1990,* OECD, Paris, *www.oecd.org/tad/env/indicators*.

# *Notes*

1. There is a long tradition of analysis and quantitative modelling, both theoretical and empirical, describing how different policy instruments or mixes of policy instruments influence water quality related to agriculture, see for example: Ribaudo, Horan and Smith, 1999; and Shortle and Horan, 2001.
2. These data are from Vojtěch, 2010 and the OECD *PSE/CSE database*. For Australia the share of expenditure is the total support estimate, however, not all of the Natural Heritage Trust expenditure is directed at agriculture.
3. This section draws from Shortle, 2012.

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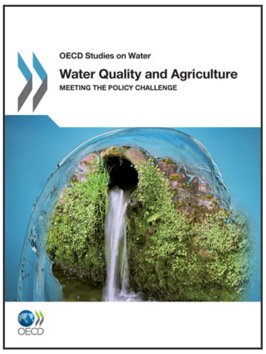


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