# Policy Mixes for the Provision of Agri-environmental Public Goods and Additionality: Some country experiences

Tetsuya UETAKE[1]*
OECD Trade and Agricultural Directorate, France

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* Tetsuya UETAKE, OECD, Trade and Agriculture Directorate, Environment Division, 2, rue André Pascal - 75775 Paris Cedex 16, France; tetsuya.uetake@oecd.org

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## Abstract

Agriculture is a provider of food, feed, fibre and, to a certain extent, public goods. In order to secure the provision of agri-environmental public goods, some form of public intervention may be needed. Indeed, various agri-environmental policies are implemented in many countries. However, it is not clear which policy measures target which agri-environmental public goods, and identifying the appropriate policy mix for providing specific agri-environmental public goods is still open to debate. The study examines how policy measures target agri-environmental public goods in Australia, Japan, the Netherlands, the United Kingdom and the United States, and how they mix policies. Targeted agri-environmental public goods vary depending on the country. Regulations, agri-environmental payments and technical assistance in these countries target multiple agri-environmental public goods; while environmental taxes and tradable rights are used only for a limited number of agri-environmental public goods (e.g. water quantity). A complex set of policy measures in these countries also address the *additionality* of a policy measure, i.e. the extent to which the policy is a necessary condition for achieving the environmental target. Good policy mixes are key to providing agri-environmental public goods. This study can contribute to appropriate policy design for the delivery of agri-environmental public goods.

**Keywords** Public goods, Agri-environmental policies, Policy mixes, Additionality

**JEL code** Q15, Q18, Q58

[1] Note the views expressed in this article are the author's personal ones and do not necessarily reflect those of the OECD or its member countries.

## 1. Introduction

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. Some of these environmental externalities may also have characteristics of non-rivalry and non-excludability, i.e. can be defined as public goods. In order to secure the provision of such agri-environmental public goods, some form of public intervention may be needed (Cooper et al., 2009; OECD, 2010a). Indeed, various agri-environmental policies (e.g. regulation, payments) are implemented in many countries (Vojtech, 2010).

Many studies have examined agri-environmental public goods and policies (e.g. OECD, 2010a; OECD, 2013; Vojtech, 2010). These studies provide a lot of policy implications and country lessons. However, it continues to remain unclear how each OECD country defines agri-environmental public goods and what policies are implemented for targeting which agri-environmental public goods. These points have not been fully examined in previous studies. Moreover, identifying good policy measures and mixes for providing specific agri-environmental public goods is still open to debate. Thus, this paper examines the following points by examining the selected country experiences:

- How do countries define agri-environmental public goods?
- What policies are implemented to provide agri-environmental public goods and what agri-environmental public goods are targeted by which policy measures?

The main objective of the study is to contribute to a better understanding of good policy measures for agri-environmental public goods.

## 2. Main agri-environmental public goods targeted in the studied countries

Environmental externalities from agricultural activities can be classified into four types of goods: pure public goods, common pool resources (CPRs), club goods and private goods, depending on the degree of non-rivalry and non-excludability (Table 1). Some environmental externalities from agricultural activities can be treated as private goods. In this case, government direct intervention is not necessary. For example, where agricultural landscapes are exclusive to visitors, these visitors may be able to cover the costs for the provision of the agricultural landscapes and government direct intervention may not be needed (OECD, 2005). Therefore, environmental externalities from agricultural activities that have the characteristics of public goods (including impure public goods[2]) become issues of agri-environmental policies. Such goods are, in this paper, defined as agri-environmental public goods. Table 1 gives examples of agri-environmental public goods.

2. Pure public goods and impure public goods will need different degrees of government intervention. For instance, CPRs may need to create rules to manage resources, and governments can provide technical information and assistance. Club goods may need institutional assistance and legislations for creating clubs. On the other hand, pure public goods may need agri-environmental payments (OECD, 2003, 2005, 2013).

**Table 1. Classification of agri-environmental public goods**[a]

| | | Rivalry (subtractability) | |
|---|---|---|---|
| | | **Low** | **High** |
| **Excludability** | **Difficult** | *Pure public goods*<br>• Biodiversity (non-use value[c])<br>• Agricultural landscapes (non-use value)<br>• Flood control<br>• Landslide prevention | *Common pool resources*<br>• Biodiversity (use-value[b])<br>• Water quantity/availability |
| | **Easy** | *Club goods*<br>• Biodiversity (if exclusive to club members) | *Private goods*<br>• Agricultural commodities<br>• Agricultural landscape (use value by visitors if exclusion can be made) |

**Agri-environmental public goods**

a. The list given in each cell is not exhaustive, but covers some of the main examples. Depending on the situation, the same goods can be private goods (rival and excludable) or public goods (non-rival and non-excludable) and when they cause harm, they can be defined as private bads or public bads (Kolstad, 2011). Thus careful examination is necessary for each case and each situation.

b. Use-value: Value representing i) the value associated with actual use and ii) the value of having the ability to make choices in an uncertain future (option value).

c. Non-use value: Value representing i) the value that humans attach to the simple fact of a resource's existence and ii) the value that humans attach to the possibility of maintaining a resource for future generations.

*Source*: Adapted from OECD (2013), which is based on OECD (2001a) and Hess and Ostrom (2007).

Public goods, however, need not necessarily be desirable; that is, they may cause harm (OECD, 1992; Mas-Colell et al., 1995). If non-rival and non-excludable goods cause harm and people do not want them, the term, "public bads", may be used[3] (Mas-Colell et al., 1995; Dwyer and Guyomard, 2006; Kolstad, 2011). For a given goal or objective, a "benefit" is the result of some action that leads to an environmental outcome beyond a certain environmental level, while a "harm" is the result of some action that leads to an environmental outcome below that level. An environmental benefit (or harm) has to be viewed as relative to a certain environmental level (OECD, 1997), and this environmental level can vary depending on the country and the local situation.

This study looks at objectives and targets of policy measures implemented in the studied countries. Table 2 summarise what kinds of agri-environmental public goods are targeted in Australia, Japan, the Netherlands, the United Kingdom and the United States.[4] [5]

3. There are impure public bads as well, depending on the degree of non-rivalry and non-excludability (Kolstad, 2011).

4. Although some countries target social public goods (rural vitality, food security and animal welfare) (Cooper et al, 2009; OECD 2012), this study focuses on agri-environmental public goods. This is because the purpose of this study is to contribute to the development of better agri-environmental policies, and dealing with social public goods would include a broader discussion beyond the field of agri-environmental policies.

5. This analysis focuses on agri-environmental public goods targeted by current agri-environmental policies. There may be agri-environmental public goods that the studied countries do not currently target and can be significant in the future. But, these agri-environmental public goods are out of the scope of this study.

**Table 2. Agri-environmental public goods targeted in some OECD countries[a, b]**

| | AUS | GBR | JPN | NLD | USA |
|---|---|---|---|---|---|
| Soil protection and quality | XX | XX | X | X | XX |
| Water quality | XX | XXX | X | XX | XXX |
| Water quantity/availability | XXX | X | XX | X | X |
| Air quality | X | XX | X | XX | X |
| Climate change – greenhouse gas emissions | X | XX | XX | XX | NA |
| Climate change – carbon storage | X | XX | X | XX | NA |
| Biodiversity | XXX[d] | XXX | XX | XXX | XXX[e] |
| Agricultural landscapes | NA | XXX | XX | XXX | X |
| Resilience to natural disasters[c] | NA | X | XXX | XX | NA |

*Note:* NA – not applied or marginal; X – low importance; XX – medium importance; XXX – high importance.

a. The importance of the agri-environmental public goods is related to the priorities of the specific country. It is not designed to compare the importance of specific agri-environmental public goods across countries.
b. These goods are not always public goods. Sometimes, they can be private goods (e.g. agricultural landscape with use value by visitors can be a private good if exclusion can be made) or when they cause harm, they can be defined as private bads or public bads (Kolstad, 2011). Careful examination on whether these goods have characteristics of non-rivalry and/or non-excludability is necessary for each case.
c. Resilience to natural disasters includes resilience to flooding, fire, snow damage and landslide.
d. In Australia, the focus on biodiversity is on native vegetation that is on farms but not part of the agricultural production system.
e. In the United States, the focus on biodiversity is on protection of wetlands and wildlife habitat.

*Source*: Author

The domain of agri-environmental public goods varies according to the public concern and the development of policy measures. Agri-environmental policies began when public demand for environmental protection emerged and people recognised that agricultural practices could pose environmental risks. When it became evident that the quality of soil, water and air was affected by agricultural pollution this became a public policy issue. For example, the 1930s "Dust Bowl" in the Great Plains of the United States and Canada led to the development of an array of soil quality programmes. Other issues have since arose, such as biodiversity and climate change, and more recently there is growing interest in carbon storage, particularly following the release of the Intergovernmental Panel on Climate Change (IPCC) report in 2007, which stated that carbon storage could greatly contribute to climate change mitigation (IPCC, 2007).

Public concerns and perceptions about agriculture and the environment differ among OECD countries so that the targeted agri-environmental public goods are also different. In the United States, for example, greenhouse gas (GHG) emissions recently became a target of federal regulatory measures, although agriculture does not yet have targets set to limit GHG emissions programmes. Carbon storage is also of considerable policy interest but not yet an area of significant policy development. In contrast, other four countries target greenhouse gas (GHG) emissions and carbon storage.

The farming system of the case study countries is related to targeted agri-environmental public goods. Since paddy fields constitute the main type of farmland in Japan, agri-environmental

public goods associated with paddy fields are important for Japan, but not for the other four countries. Paddy fields and their irrigation systems prevent some natural disasters by retaining water (resilience to flooding) and providing water for extinguishing fire (resilience to fire) and melting snow (resilience to snow damage). Prevention of natural disasters is also regarded as an agri-environmental public good in the United Kingdom and the Netherlands. Some flooding and fires are prevented by good grazing management and, in the United Kingdom, this contributes to improved soil permeability and water storage. In the Netherlands, flooding risks are reduced by the water retention capacity of the agricultural areas by controlling the level of water tables.

## 3. Policy mixes for the delivery of agri-environmental public goods in studied countries

A wide range of agri-environmental policy measures such as environmental standards or regulations, environmental taxes, tradable permits and agri-environmental payments are implemented for providing agri-environmental public goods in OECD countries. Table 3 summarises which agri-environmental policy measures are implemented in the studied OECD countries. It shows that regulatory requirements, payment based on farming practices and technical assistance and extension are used in the all case study countries. But, this table does not show which policy measures target which agri-environmental public goods.

**Table 3. Measures addressing environmental issues in agriculture in OECD countries[a]**

| Measure/Country | AUS | GBR | NLD | JPN | USA |
|---|---|---|---|---|---|
| Regulatory measures | | | | | |
| Regulatory Requirements | XXX | XX | XXX | XX | X |
| Environmental taxes/charges | NA | NA | X | NA | NA |
| Environmental cross-compliance[b] | NA | XX | XXX | X | XX |
| Financial incentives | | | | | |
| Payments based on farming practices | X | XXX | XXX | XXX | XXX |
| Payments based on land retirement | NA | X | X | NA | XXX |
| Payments based on farm fixed assets | NA | X | X | XX | X |
| Payments based on outcomes/ performance rankings | NA | NA | NA | NA | X[c] |
| Tradable rights/permits | X | X | X | NA | X |
| Community based measures | XX | NA | X | XX | NA |
| Facilitative measures | | | | | |
| Technical assistance and extension | XX | XX | XX | XX | XXX |

*Note:* NA – not applied or marginal; X – low importance; XX – medium importance; XXX – high importance.

a. The importance of the policy instruments in this table is related to the mix of the specific country. It is not designed to compare the importance of specific measures across countries.

b. Environmental cross-compliance may be characterised as de-facto regulatory requirements for farmers that are eligible for agricultural support payments (OECD, 2010b).

c. In the United States, the the Conservation Stewardship Program (CSP) uses a points system to determine a conservation performance ranking that is used to select applicants and determine payment levels. It is important, however, to note that the performance assessment of the CSP is not based on actual environmental outcomes, but on established scoring tables indicating the relative environmental benefit impact of different practices.

*Source*: Author based on Vojtech (2010)

### *Agri-environmental policies and policy mixes*

Table 4 summarises the kinds of policy measures that are implemented for each agri-environmental public good in the studied countries.

Regulatory requirements are used in many countries studied, in particular for soil protection and quality, water quality and quantity, air quality, and biodiversity; this is not the case, however for climate change and resilience to natural disasters. In many cases, regulatory requirements cover not only farmers, but also non-famers and non-agricultural sectors. They typically establish mandatory environmental quality levels that society tries to maintain.

Environmental taxes and charges are used in the Netherlands for water quantity and agricultural landscapes. Environmental taxes seek to alter the economic incentives of farmers and to correct incentive failures due to missing markets for agri-environmental public goods; price incentives are replaced with administered taxes or charges (OECD, 2010a).

Agri-environmental payments are the main policy instruments for most agri-environmental public goods in the case study countries. Those based on farming practices (input-based instruments) are used the most, and those based on outcomes are limited and used only in the United States. Even there, payments are not based on actual environmental outcomes but instead the Conservation Stewardship Program (CSP) uses a points system to determine conservation performance. The rankings established become the basis upon which applicants are selected and payments determined. The CSP is used for addressing various agri-environmental public goods such as soil protection and quality, water quality and quantity, air quality and biodiversity.

Tradable rights and permits are used, but are still limited to specific cases. Australia relies exclusively on water rights to control water quantity, while other countries implement multiple policy measures for managing water quantity.

Community-based measures are used in Australia, the Netherlands and Japan for some local agri-environmental public goods such as soil quality, water quality and quantity, and biodiversity. Collective action can involve local communities and local groups (local people, local NGOs, local authorities, etc.) and leverage resources among members, and cover broader areas that are necessary for providing agri-environmental public goods (OECD, 2013).

Lastly, facilitative measures such as technical assistance and extension are used widely for many agri-environmental public goods in the all case study countries. These measures are particularly useful when farmers are unaware of the importance of potential agri-environmental public goods. Typically, these facilitative measures are used with other policy measures, such as payments and regulations.

**Table 4. Agri-environmental policy measures and targeted agri-environmental public goods in the studied OECD countries**

| | | Soil protection and quality | | | | | Water quality | | | | | Water quantity/availability | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AUS | GBR | NLD | JPN | USA | AUS | GBR | NLD | JPN | USA | AUS | GBR | NLD | JPN | USA |
| **Regulatory** | Regulatory requirements | X | | X | X | | X | X | X | X | X | | X | X | X | X |
| | Environmental taxes/ charges | | | | | | | | | | | | | X | | |
| | Environmental cross-compliance | | X | X | | X | | X | X | | | | X | X | | |
| **Financial incentives** | Payments based on farming practices | X | X | | X | X | X | X | | | X | | | X | X | X |
| | Payments based on land retirement | | | | | X | | X | | | X | | | X | | X |
| | Payments based on farm fixed assets | | X | | X | | | X | | X | | | X | | | |
| | Payments based on outcomes | | | | | X | | | | | X | | | | | X |
| | Tradable rights/permits | | | | | | | | | | X | X | X | | | X |
| | Community based measures | X | | | | | X | | | X | | | | | X | |
| **Facilitative** | Technical assistance/ extension/ R&D/ labelling/standards/certification | X | X | | X | X | X | X | | X | X | | X | | | X |

| | | Air quality | | | | | Climate change (greenhouse gas emissions) | | | | | Climate change (carbon storage) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AUS | GBR | NLD | JPN | USA | AUS | GBR | NLD | JPN | USA | AUS | GBR | NLD | JPN | USA |
| **Regulatory** | Regulatory requirements | X | X | X | X | X | | X | | | | | | | | |
| | Environmental taxes/charges | | | | | | | | | | | | | | | |
| | Environmental cross-compliance | | | X | | | | | | | | | | | X | |
| **Financial incentives** | Payments based on farming practices | | X | | | X | X | X | | | | X | X | | X | |
| | Payments based on land retirement | | | | | X | | | | | | | X | | | |
| | Payments based on farm fixed assets | | | X | X | | | X | X | | | | | X | | |
| | Payments based on outcomes | | | | | X | | | | | | | | | | |
| | Tradable rights/permits | | | | | | | | X | X | | | | | | |
| | Community based measures | | | | | | | | X | | | | | X | | |
| **Facilitative** | Technical assistance/ extension/ R&D/labelling/standards/certification | | | X | X | X | | X | X | X | | | X | X | | |

| | | Biodiversity | | | | | Agricultural landscapes | | | | | Resilience to natural disaster | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | AUS | GBR | NLD | JPN | USA | AUS | GBR | NLD | JPN | USA | AUS | GBR | NLD | JPN | USA |
| **Regulatory** | Regulatory requirements | X | X | X | | X | | | X | | X | | | | | |
| | Environmental taxes/charges | | | | | | | | X | | | | | | | |
| | Environmental cross-compliance | | X | X | X | X | | X | X | | X | | X | X | | |
| **Financial incentives** | Payments based on farming practices | X | X | X | X | X | | X | X | X | | | X | | X | |
| | Payments based on land retirement | | X | X | | X | | X | X | | | | X | | | |
| | Payments based on farm fixed assets | | | X | | | | X | | | | | | | | |
| | Payments based on outcomes | | | | | X | | | | | | | | | | |
| | Tradable rights/permits | X | | X | | X | | | X | | | | | | | |
| | Community based measures | X | | X | X | | | | X | X | | | | | X | |
| **Facilitative** | Technical assistance/ extension/ R&D/labelling/standards/certification | X | X | X | X | X | | X | X | | X | | X | X | | |

1. This table is not meant to convey the policy measures used most frequently in each country.

*Source*: Author.

Effective policy mixes are key to enhancing the cost-effectiveness of policy measures and achieving environmental targets. Among the nine agri-environmental public goods targeted in the case study countries, all countries use a mix of policy measures for biodiversity (the total number of policy measures (X) in Table 4 is 29; the average is 5.8 per country). This large number reflects the complexity of biodiversity issues. Policy mixes are also used for other agri-environmental public goods such as water quality (total 23: average 4.6) and water quantity (total 21: average 4.2), followed by soil protection and quality (total 19: average 3.8), and air quality (total 15: average 3). In the two European countries (the United Kingdom and the Netherlands), many policy measures are mixed where agricultural landscapes are concerned (a total of 13 for an average of 7.5), but there are few policy measures that address agricultural landscapes in Japan and the United States (a total of 4 for an average of 2).

***Synergies or conflicts***

There are many good reasons for applying a mix of instruments to provide agri-environmental public goods, rather than relying on a single one. This is because a majority of agri-environmental public goods have "multiple aspects". For example, water quality issues associated with nutrients has to be considered from the aspects of the total amount of surplus nutrients in an area as well as when, where and how nutrients are applied to the fields, etc. Policy impacts on a single agri-environmental public good often affects other such goods as well, and this must be taken into consideration (de Groot et al., 2010; Helin et al., 2013). In general, it is best to apply agri-environmental policy instruments as close to the underlying agri-environmental public goods as possible. However, in several cases it is difficult to apply instruments that target the agri-environmental public goods directly. For instance, it is not practical to measure the run-off of nutrients from individual farms to surface or groundwater. In such situations, one or more "proxy instruments" may need to be applied (OECD, 2007).

In some cases, policy mixes are implemented usefully, while in others some instruments have negative impacts on either the environmental effectiveness or the economic efficiency of the overall instrument mix or both. There may be situations where the environmental effectiveness or the economic efficiency of an instrument mix is jeopardised because some potential instruments are not applied or are only very partially applied. The consequences of unaligned policies can be serious (OECD, 2007). Moreover, sometimes, some farming practices can bring both positive and negative impacts on the environment (ENRD, 2010). For instance, in the Netherlands, higher water tables in peat areas can reduce carbon emissions. However, this higher water tables cause higher methane and nitrous oxide emissions. If policy measures just try to target higher water tables, there is a risk of net environmental damage. Therefore, other policy measures targeting methane and nitrous oxide emissions are also necessary.

A recent OECD study on climate change, water and agriculture also revealed that climate change mitigation practices may have positive or negative implications on agricultural water management and on water quality. The potential synergies and trade-offs between mitigation and agricultural management practices are site-specific and for many cases there are substantial knowledge gaps. It is important to recognise these linkages in the design of mitigation policies, to reduce the risk of conflict between mitigation and water policy objectives, and to maximise potential synergies (OECD, 2014). Coordination mechanisms to overcome conflicts between environmental goals are needed.

In particular, agri-environmental policies are designed and developed by various government departments, both at national and local levels. For instance, in the United States, at the

Federal level, the United States Department of Agriculture (USDA), the United States Environmental Protection Agency (USEPA), the United States Fish and Wildlife Service and the United States Army Corps of Engineers develop programmes. State governments also develop various programmes, sometimes mandated by federal law, and other times at their own initiative. This highlights the importance of co-ordination within agricultural ministries, and between agricultural ministries and other ministries such as environmental ministries and local governments.

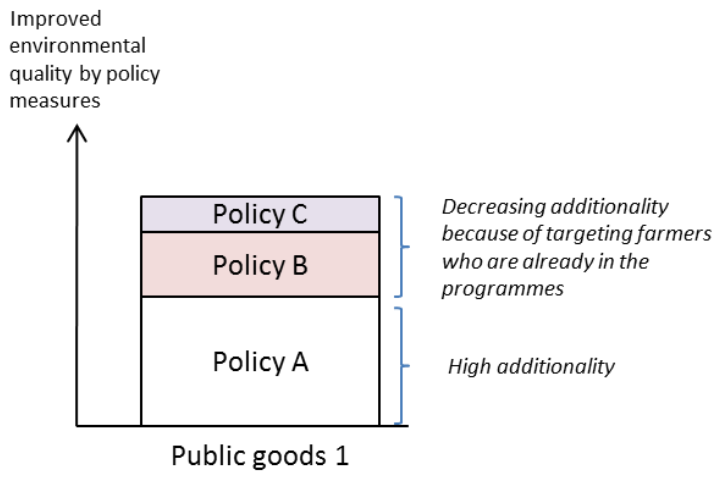
Each policy measure has different historical backgrounds, and different government sections are involved in policy designs. As a result, in many cases, current agri-environmental policy measures are complex sets of measures. In order to understand the current situation of policy measures, at both national and local levels, and examine whether they have synergies or conflicts, developing a policy matrix table can help. Beyond the boundaries of organisations, it is important to design appropriate policy mixes for agri-environmental public goods.

### *Policy mixes and additionality*

A complex set of policy measures questions the additionality of a policy measure. Additionality refers to whether the environmental services associated with agriculture that are supported under a given programme would have been provided in the absence of the programme (Mezzatesta et al., 2013). A policy measure has full additionality if all participating farmers needed the incentive provided by the scheme to change their farming practices or improve their environmental performance, and would not have done so in the absence of the scheme. On the other hand, additionality is low when a large proportion of incentive recipients would have changed their behaviour or complied with the programme requirements even without the incentive (OECD, 2012).

Figure 1 illustrates the additionality and improved environmental quality by policy measures in a highly stylised form. It assumes that Policy A can have high additionality and let many farmers change their farming practices or improve their environmental performance. In many cases, multiple policy measures target the same agri-environmental public goods. However, the second and the third policies (Policy B and C) may not bring high additionality, since they may target the same farmers who are already targeted by the first policy and they may have already adopted good management practices.

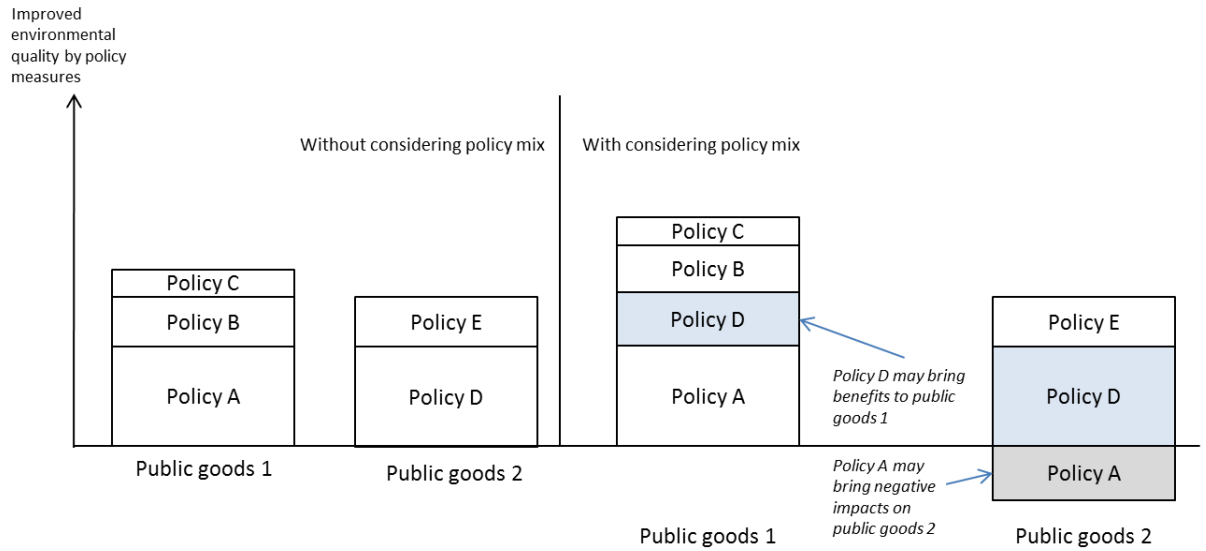
**Figure 1. Additionality of policy measures**




Source: Author.

In the context of policy mixes, this additionality is particularly important because some policies can be redundant and may not be able to bring high additionality, if policy mixes are not well developed. Now, Figure 2 includes two agri-environmental public goods. Policy A, B and C target Public goods 1, while Policy D and E target Public goods 2. In many cases, these policy measures can also bring both positive and negative impacts on other agri-environmental public goods. Figure 2 assumes that Policy A can bring greater environmental benefits to Public goods 1, but may bring negative impacts on Public goods 2. On the other hand, Policy D may be able to bring environmental benefits not only for Public goods 2, but also for Public goods 1. These multiple impacts on agri-environmental public goods must be considered at the stage of policy design.

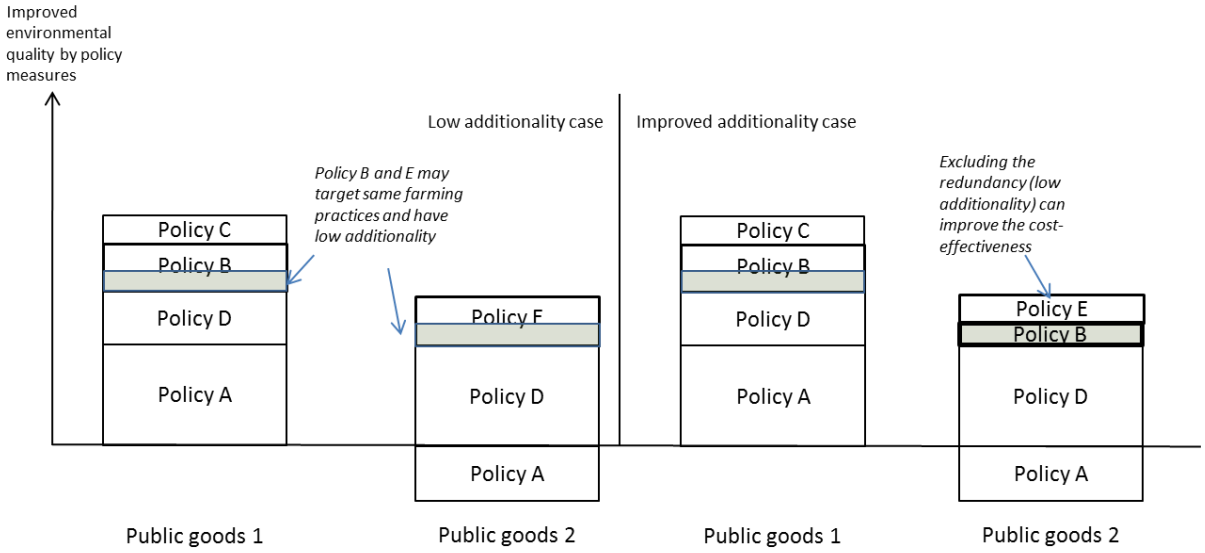
**Figure 2. Policy mixes and their impacts on different public goods**




Source: Author.

It is also possible that co-ordination among policy measures is not sufficient enough that different policies target the same farming practices. For example, a policy measure for improving water quality may target the installation of buffer strips, while a different policy measures for improving biodiversity may also include buffer strips as a part of farming practices and farm infrastructures for better biodiversity. In this case, if farmers have already installed the buffer strips under the biodiversity policy, the water quality policy may not bring high additionality and can be redundant. If this is the case, the water quality policy may be better to focus on controlling farm-inputs such as pesticides and chemicals. Figure 3 illustrates this situation in a highly stylised form.

**Figure 3. Policy mixes and additinality**




Source: Author.

Some countries try to examine the additionality of their country programmes. For example, Claassen (2012) studied the additionality of agri-environmental payments targeting the adoption of conservation practices in the United States and, based on the Agricultural Resources Management Survey 2009 and 2010, he identified that among the wheat and corn producers surveyed a considerable number of them adopted the targeted conservation practices without the stimulus of an incentive payment, either because they are profitable on their farms (conservation tillage) or because targeted practices are required by state regulations (nutrient or manure management). Mezzatesta et al. (2013) analysed cost-shared programmes to promote conservation practices in Ohio in the United States, and found that the degree of additionality among conservation practices varied depending on the practice: high additionality for hayfield establishments, cover crops and filter stripes, while low additionality for conservation tillage. Additionality of agri-environmental schemes in the United Kindgom was found for agricultural landscapes and biodiversity in Environmentally Sensitive Areas (Boatman et al., 2008). Boatman et al recommended that short- and long-term monitoring and evaluation, incorporating baseline data and repeat surveys for key indicators, should be implemented for agri-environmental schemes to ensure that they could bring additionality.

Policy mixes of payments may bring larger environmental effects if additionality is considered. For example, Busch (2013) found that a mixture of carbon payments and biodiversity payments has the potential to provide greater incentives than would an equal amount of money spent only on carbon payments if payments are allocated more towards new suppliers (high additionality) than to existing suppliers (low additionality). However, policies that focus on additionality may raise a concern on equity, since these programmes give a lower (or no) payment to farmers who have voluntarily adopted improved practices; these farmers would consider themselves penalised compared to others (OECD, 2010a).

Evaluating the effects of additionality is challenging due to the lack of data and the complexity of agri-environmental programmes. To identify whether gains are additional or not, estimation of a baseline is necessary (Claassen et al., 2008). Identifying the extent to which farmers can voluntarily provide agri-environmental public goods without government

intervention is necessary to avoid paying farmers who would have improved their environmental performance without a payment, and develop better policy mixes.

### *Policy choices*

Best overall policy measures for agri-environmental public goods do not exist. A case-by-case analysis will inevitably have to be made (Claassen et al., 2001; OECD, 2007). However, as a general rule, an optimally chosen instrument would equate the marginal social benefits and marginal social costs. Estimating benefits to society in the absence of well-functioning markets is of course a major difficulty. As a result, most agri-environmental policy measures concentrate on the costs of provision which are usually easier to assess (OECD, 2008). If multiple payments exist, it is necessary to pay attention to potential overlap of these payments, and promote good farming practices in a cost-effective way by targeting marginal changes as much as possible.

One simple basic approach for policy mixes and policy choices is to use the reference level framework (OECD, 2001b). Farmers are obliged to meet the minimum level of environmental quality (reference level) at their own expense. Thus, environmental regulations may be needed. But, beyond the reference level to reach environmental targets, agri-environmental payments may be necessary to promote environmentally friendly farming. Technical assistance can support these activities and through the combination of financial incentives, it would be able to address heterogeneous farmer behaviour as well. For instance, to improve water quality, many countries set water quality regulations and farmers have to reduce nitrates from agricultural sources. To further improve water quality, payments to farmers who adopt good management practices and/or technical assistance are provided. Reference levels and environmental targets are not always clearly defined and policy mixes using the framework of reference levels are still rarely used in OECD countries.

In many cases, multiple objectives are targeted by multiple policy measures and it is not always clear to what extent a particular policy measure tries to address the issue, and to what extent other policy measures do so. Each policy's target, reference levels and the relations with other policy measures should be carefully reviewed.

For good agri-environmental policy mixes and choices, careful assessments of any new instruments and regular ex ante and ex post assessments of all instruments impacting on agri-environmental public goods are necessary. In order to develop instrument mixes that are environmentally effective and economically efficient, it is important to enhance possibilities for instruments to mutually reinforce each other by applying instruments that provide flexibility, and pay attention to the incentive impacts of various instrument-design options. It is necessary to avoid overlapping instruments, except when they can mutually reinforce each other, or address different aspects of the environmental problem. Appropriate monitoring and enforcement mechanisms are essential (OECD, 2007).

## 4. Conclusion and policy implications

This study has examined policy measures and policy mixes for agri-environmental public goods in five countries (Australia, Japan, the Netherlands, the United Kingdom and the United States).

Targeted agri-environmental public goods vary depending on the country. This is because various factors such as histories, cultures, climate, farm systems affect the perception of what

agri-environmental public goods are. Five agri-environmental public goods (soil protection and quality, water quality, water quantity and availability, air quality and biodiversity) are targeted in the all studied countries. Climate change (greenhouse gas emissions and carbon storage) is a targeted agri-environmental public good except in the United States. Agricultural landscapes are targeted agri-environmental public goods except in Australia. Resilience to natural disasters such as flooding and fire are targeted agri-environmental public goods in Japan, the Netherlands and the United Kingdom, but not in Australia and the United States. Countries' priorities for agri-environmental public goods vary.

These goods, however, do not always have characteristics of non-rivalry and non-excludability. Some environmental externalities from agricultural activities have characteristics of private goods, in which government intervention might not therefore be necessary. It is important to clearly identify environmental externalities from agricultural activities that are important to countries and regions, and examine whether they have the characteristics of non-rivalry and/or non-excludability, and can be defined as agri-environmental public goods in each case.

Many policy measures target multiple agri-environmental public goods (especially financial incentives such as agri-environmental payments), and each agri-environmental public good is targeted by multiple policy measures. Policy measures are complex because of the history of policy development and the involvement of multiple actors (e.g. ministries, central and local governments, stakeholders). Discussion on best policy mixes and co-ordination among actors is still inadequate. It is not always clear to what extent a particular policy measure tries to address agri-environmental issues, and to what extent other policy measures do so.

It is also important to avoid paying farmers who would have improved their environmental performance without the payment. The additionality of a policy measure, i.e. the extent to which the policy is a necessary condition for achieving the environmental target, must be examined further. Good policy mixes are key to providing agri-environmental public goods. Reviewing current policy measures and examining whether policy measures are not conflicting but creating synergies and bringing additionality is a first step towards developing better policy mixes.

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