Roles of Agriculture Project

# Policy Brief

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ROA's Policy Brief aims to explain conceptual or methodological issues pertaining to the Project in a non-technical manner.
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## *Economic Valuation on Environmental Services from Agriculture: Stocktaking for Incentive Design*

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**CONTENT**



### 1. Introduction: what this *Policy Brief* is about?

This first edition of *ROA Policy Brief* is designed to clarify the roles of economic valuation of the external impacts from agriculture in policy-making, by resolving misunderstanding and confusion pertaining to existing valuation studies.

In the wake of increasing interests in, and growing demand for, diverse environmental, ecological or ecosystem services, various techniques to estimate the potential values of these services have been rapidly developed over the past decades. This is undoubtedly a welcome development given that, without knowing the approximate of their values, we do not know whether the provision of a service is worthwhile from society's point of view and whether some form of conservation measures for the service is warranted. These 'non-market valuation methods' are by no means a panacea, and accompanying misunderstanding and confusion should not be overlooked.

For example, using estimates of total flows of a specific environmental attribute to justify specific conservation decisions is commonly done, but this is almost always wrong (Pagiola, von Ritter and Bishop, 2003). Similarly, the estimated value of an environmental service has little to do with the level of payments to be made to its suppliers, even if the payments are deemed to be the best approach for its conservation. For those who may not agree with these statements, this Policy Brief provides underlying justification for them.

The misunderstanding and confusion often originates from the failure to answer several key questions over the roles of valuation in decision-making. These can be largely distilled into the following:

- What types of economic values do agro-ecosystems provide?
- What kinds of valuation methods are currently available to estimate the values?
- To what extent have valuation studies been applied notably in developing countries?
- How can the results of valuation studies be employed to design incentive measures for environmental services?

The above four questions are addressed in turn in the subsequent sections. The scrutiny in this *Policy Brief* also paves the way for providing strong justification for normative analytical approach, as a logical extension of its precursor, adopted in the current phase of the ROA project, which aims at developing the policy guidance on pro-poor incentive measures for environmental services.

## 2. Environmental services from agriculture: categories, characteristics and values

### Main categories of ecosystem services

Environmental services generated from agriculture are a fraction of diverse ecosystem services, which are 'the benefits that people obtain from ecosystems' (MEA, 2005). The Millennium Ecosystem Assessment report (2005) classifies ecosystem services into four categories: (i) provisioning services (the products obtained from ecosystems), (ii) regulating services (the benefits obtained from the regulation of ecosystem processes) and (iii) cultural services (the non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences) that directly affect people, and (iv) supporting services needed to maintain other services (**Table 1**).

**Table 1 Ecosystem services**

| Services | Sub-category |
|---|---|
| **Provisioning services** | • food<br>• fiber<br>• genetic resources<br>• bio-chemicals, natural medicines and pharmaceuticals<br>• ornamental resources<br>• fresh water |
| **Regulating services** | • air quality regulation<br>• climate regulation<br>• water regulation<br>• erosion regulation<br>• water purification and waste treatment<br>• disease regulation<br>• pest regulation<br>• pollination<br>• natural hazard regulation |
| **Cultural services** | • cultural diversity<br>• spiritual and religious values<br>• knowledge systems<br>• educational values<br>• inspiration<br>• aesthetic values<br>• social relations<br>• sense of place<br>• cultural heritage values<br>• recreation and ecotourism |
| **Supporting services** | • soil formation<br>• photosynthesis<br>• primary production<br>• nutrient recycling<br>• water cycling |

Source: Millennium Ecosystem Assessment, 2005

Agriculture is essentially a human-made ecosystem, and it exhibits commonalities, as well as differences, with pristine ecosystems such as forests, wetlands and estuaries. There are plenty of cases where farming systems provide similar functions as natural ecosystems. For instance, paddy fields can serve as a substitute of wetlands, generating such benefits as flood mitigation, water purification and wildlife habitat conservation. The inclusion of paddy fields as wetlands to be protected for migratory birds in the Ramsar Convention is an example. Another case is agro-forestry, where such environmental services as carbon sequestration and biodiversity and wildlife conservation are provided in the same way as natural forests.

On the other hand, agro-ecosystems are inherently different from natural ecosystems in many ways. One of the distinctive features is that, as opposed to natural ecosystems that provide solely benefits, agriculture generates not only positive but also negative externalities for society. Furthermore, the direction of such external impacts of agriculture can change depending on a benchmark against which the impacts are assessed. For example, even if a small-scale farming in Cameroon provides several private and social benefits, the total benefits can be inferior to sustainable forestry in the same region (MEA, 2005, p.57). This shows that the identification of a proper benchmark is of crucial importance in assessing the impacts of agro-ecosystems.

### Characteristics of environmental services

Most ecosystem functions other than the provisioning functions listed in Table 1 are often characterized by three peculiar features that lead to market failure, i.e. markets fail to reflect the full social costs or benefits of a good or service. The causes of market failures include: (i) externalities, (ii) public goods and (iii) unclear property rights. In the current phase of the ROA project, including this *Policy Brief*, environmental services from agriculture signify 'un-internalized external benefits and costs generated through agricultural production processes'.

Externalities occur when agro-ecosystems generate unintended and uncompensated side effects on the production or consumption of third parties. Positive externalities are beneficial side effects of agricultural activities, while negative externalities are the detrimental impacts on society other than farmers. The former include, for instance, scenic rural landscape and cultural heritage maintained through cultivation, while the example of the latter is the run-off of harmful

nitrates from crop land to downstream catchments.

Public goods can be viewed as an extreme form of externalities (Stiglitz, 2000) if they are provided by such entities as governments, and are commonly characterized by non-excludability and non-rivalry. 'Non-excludability' means that consumers cannot be prevented from enjoying the service in question, even if they do not pay for the privilege. 'Non-rivalry' implies that the consumption of a service by one individual does not reduce the amount available to others. Because of these two peculiar characteristics, beneficiaries of public goods have no incentive to pay suppliers but rather a motive to 'free-ride'.

These market failures characterized by externalities and public goods arise essentially from the fact that property rights related to agro-ecosystem services are not clearly defined. In contrast to provisioning services (e.g. food and fiber), which are owned by producers and thus entail inherent incentives to ensure sustainable use of these services, there is no incentive to conserve regulating, cultural and supporting services from agro-ecosystems since no one has ownership for these services. As such, positive externalities are often under-provided, whereas negative externalities tend to be over-provided from society's viewpoint, leading to sub-optimal provision of agro-ecosystem services.

**Values pertaining to environmental services**

The previous sections explain how agro-ecosystems exhibit various environmental services underlined by their peculiar characteristics. What types of economic values do these environmental services provide? The two main categories of values pertaining to environmental services are 'use value' and 'non-use value'. Use-values are the values derived from the actual use of a good and service, whereas non-use values are those that are not associated with actual use or even the option to use a good or service (**Table 2**).

Use-value can be further classified into three categories: (i) direct use value, (ii) indirect use value and (iii) option value. 'Direct-use value' includes the provision of food and fiber, an inherent function of agriculture, and these are the only values that are normally incorporated into decision making in private markets. 'Indirect use value' refers to the values provided through agricultural production processes that benefit society indirectly, such as flood mitigation, soil conservation and carbon sequestration. An example of an 'option value' is biodiversity conservation, of which people value the option to enjoy something in the future, although they may not currently use it.

Non-use value is composed of (i) bequest value and (ii) existence value. A 'bequest value' is the value that people place on knowing that future generations will have the option to enjoy something. The difference of 'bequest value' from the aforementioned 'option value' is that the former thinks of the option for use in the future generation, while the latter is concerns with the option for use in the current generation in the future. 'Existence value' is, in contrast, the value that people place on simply knowing that something exists, even if they will never see it or use it.

**Table 2 Types of economic values**

| | use value | | | non-use value | |
|---|---|---|---|---|---|
| | **direct use value** | **indirect use value** | **option value** | **bequest value** | **existence value** |
| **definition** | outputs that can be consumed directly | functional benefits | future direct and indirect use values | value of leaving use and non-use values for offspring | Value from knowledge of continued existence |
| **examples** | • food<br>• biomass<br>• recreation<br>• health | • ecological functions<br>• flood control<br>• storm protection | • biodiversity<br>• conserved habitats | • habitats<br>• irreversible changes | • habitats<br>• endangered species |

Source: Author based on Munasinghe, 1992.

## 3. Valuation methods: objectives, typology and methodology

### What is the valuation for?

Various valuation methods have been developed in an attempt to estimate the diverse values that an ecosystem provides, be it pristine or human-made. Valuation techniques are often complex, however, and can be interpreted in many different ways. For example, asking about the value of the current flow of benefits provided by an ecosystem is totally different from asking about the value of an intervention that alters the conditions of that ecosystem (Pagiola, von Ritter and Bishop, 2003). As such, valuation is a function of its objectives, and there is no such thing as the valuation for any circumstances. The objectives of valuation exercises can be divided into four main categories as is shown in **Table 3**. The focus and mechanisms to estimate the different values are considerably distinct from each other.

**Table 3 Approaches to valuation**

| Objective | What to do? | How to do? |
|---|---|---|
| To understand the contribution that ecosystems make to society | Determine *the total value of the current flow of benefits* from an ecosystem | Identify all mutually-compatible services provided; measure the quantity of each service provided; multiply by the value of each service |
| To assess whether the intervention is economically worthwhile | Determine *the net benefits of an intervention* that alters ecosystem conditions | Measure how the quantity of each service would change as a result of the intervention, as compared to their quantity without the intervention; multiply by the marginal value of each service |
| To identify winners and losers, for equity and practical reasons | Examine how *the costs and benefits of an ecosystem (or an intervention) are distributed* | Identify relevant stakeholder groups; determine which specific services they use and the value of those services to that group (or changes in values resulting from an intervention) |
| To help make conservation financially sustainable | Identify *potential financing sources* for conservation | Identify groups that receive large benefit flows, from which funds could be extracted using various mechanisms |

Source: Author based on Pagiola, von Ritter and Bishop, 2003.

Given the thrust of the ROA Project to develop the policy guidance on pro-poor incentive measures for environmental services (Sakuyama, 2005), this *Policy Brief* focuses on the second objective of valuation, i.e. the role of valuation in assessing the feasibility of an intervention. Corrective interventions with environmental purposes can be generally divided into public-funded measures and market-based initiatives (*ibid*). What is the relationship between valuation methods and the types of intervention aiming at internalizing externalities from agriculture?

In the case of a public-funded measure, valuation plays a prominent role in its policy design. In particular, the second approach in Table 3 to assess the need of an intervention is the key. Even in that case, however, valuation results tell little about the level of payments, i.e. the cost of the intervention. Although the value obtained from a valuation study sets the ceiling for payments, the premium should be determined based on the opportunity cost of conservation activities (i.e. the returns gained from alternative land use), because the opportunity cost for alternative land use is usually lower than the value from valuation studies. Thus, payments based on valuation results overstate the cost of the intervention and causes over-compensation to the recipients.

As far as the market-based provision of environmental services through clubs and voluntary agreements are concerned, it is often not necessary to do a full economic valuation of environmental services on buyer side and an economic study of farming system returns on the provider side. In principle, any price the two parties jointly negotiate can be 'the right price'. However, some back-of-the-envelope calculation can certainly help each side to strengthen their negotiating positions, or even to predetermine whether a market-based scheme is a realistic option or not (Wunder, 2005).

### Monetary and non-monetary valuation

Valuation methods to assess the value of environmental services can largely be classified into two categories: monetary measures and non-monetary measures. Monetary valuation methods are based on individual preferences, i.e. what people, not the government, scientists or preachers, want. This approach, often termed 'economic valuation', is an enormously useful and

universally accepted basis for expressing and comparing economic values because the sum that people are willing to pay for something reflects how much of all other for-sale goods and services they are willing to give up to get it (King and Wainger, 2001).

Sometimes, it is more useful or practical, however, to make decisions based on non-monetary measures by ranking or prioritizing the expected benefits of environmental investments. Such indicator-based valuation tools may be less expensive and require less time to apply. Thus, they may be more broadly applicable. To sum up, while monetary-based measures may be necessary to justify spending on conservation programmes, non-monetary indicators of expected benefits are more useful for managing spending to achieve the greatest environmental and economic payoff (King and Mazzotta).

As for the monetary methods, economists have developed a variety of techniques to value non-market environmental and cultural amenities consistent with the valuation of marketed goods; i.e. based on individual preferences (**Table 4**). They are based on either observed behavior (revealed preferences) towards some marketed good with a connection to the non-marketed good of interest, or stated preferences in surveys with respect to the non-marketed good (Navrud, 2000). These two approaches are further divided into direct and indirect methods, depending on whether the value is obtained directly from market prices or surveys, or indirectly from markets for related goods.

**Table 4 Classification of valuation techniques**

| | Direct | Indirect |
|---|---|---|
| **Revealed preference** | • market price method<br>• replacement cost method | • travel cost method<br>• hedonic pricing method |
| **Stated preference** | • contingent valuation method | • contingent choice method |

Source: Author based on Navrud, 2000.

**Methodology of economic valuation**

The remainder of this *Policy Brief* addresses monetary-based economic valuation given its strong relevance to the incentive design for environmental services. Among various valuation techniques identified above, the followings are the succinct summary of most frequently used valuation methods (King and Wainger, 2001):

- **Market price method:** Estimates the economic value of commercially traded products and services from an ecosystem (e.g. peat, hay, and hunting rights) on the basis of their market prices.
- **Replacement cost method:** Estimates the value of a non-market services based on the cost of substitution. This involves three steps: estimate level of service provided, identify least cost alternative, and establish public demand for this alternative.
- **Travel cost method:** Used to estimate the value of recreational benefits generated by an ecosystem. Assumes that the value of a site is reflected in how much people are willing to pay to get there.
- **Hedonic pricing method:** Hedonic techniques assume that the price paid for a commodity is directly related to the supply of the commodity's attributes. Most common is the property value approach, which uses variations in property values to reveal implicit values and demand for environmental amenities.
- **Contingent valuation method:** The only available technique for estimating non-use values. Questions are posed to individuals directly about their willingness to pay (WTP) or willingness to accept (WTA) payment.

**Table 5** summarizes which values can be estimated by which valuation technique. If necessary data are available, use values are relatively straightforward to estimate, and many valuation techniques can be applied for this purpose. On the other hand, non-use values can be estimated only through the contingent valuation method and its variants. Given that these non-use values are not traded in markets and are not closely related to any marketed goods, there is no option but ask people directly what they are willing to pay or willing to accept, based on a hypothetical scenario.

**Table 5 Scope of valuation technique**

| | direct use value | indirect use value | option value | bequest value | existence value |
|---|---|---|---|---|---|
| **market price** | ☺ | | | | |
| **replacement cost** | ☺ | ☺ | | | |
| **travel cost** | ☺ | | | | |
| **hedonic pricing** | ☺ | ☺ | ☺ | | |
| **contingent valuation** | ☺ | ☺ | ☺ | ☺ | ☺ |
| **contingent choice** | ☺ | ☺ | ☺ | ☺ | ☺ |

Source: Author based on Dixon and Pagiola, 2001.

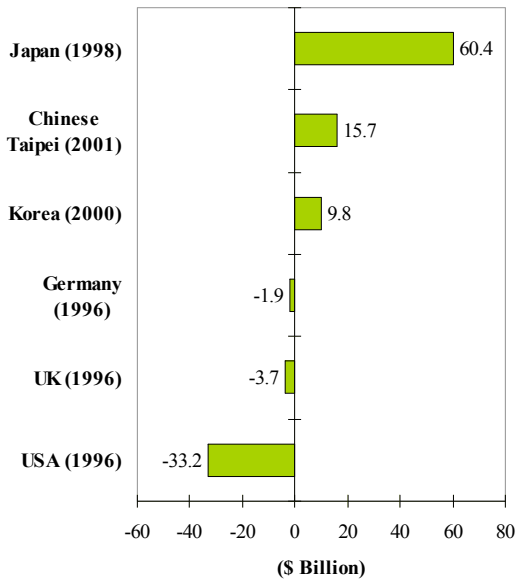
## 4. Compendium of valuation studies: total economic values and site-specific studies

Existing economic valuation studies can largely be classifies into two in terms of their scope: those estimating the total economic value of environmental externalities in a country as a whole (macro-level), and those evaluating the value of their specific attribute in a specific area in a country (micro-level). For either type of valuations, vast majority of existing studies has been applied to the developed country context. Moreover, valuation exercises in developing countries, if any, have primarily focused on the environmental services from pristine ecosystems (e.g. tropical forest, national parks, water supply), rather than those from man-made agro-ecosystems (Alberini and Cooper, 2000).

**Valuation studies on total economic value**

The compilation of selected valuation studies estimating the total economic values of agriculture is presented in **Chart 1**, even though they are all the cases in high-income industrialized economies. These studies are neither comprehensive nor comparable partly because neither result reveals 'net' benefits. The first three examples from East Asia focus solely on positive externalities of agriculture (the studies in Chinese Taipei and Korea are those merely of paddy fields), whereas the remaining three cases in Europe and North America address exclusively negative externalities.

**Chart 1 Total economic values of agriculture**




Source: Japan: Yoshida and Goda, 2001, Chinese Taipei: Tan *et al.*, 2005, Korea: Suh, 2001, and Germany, UK and USA: Pretty *et al.*, 2001.

**Valuation studies on specific attribute**

In contrast to high-income developed countries, valuation studies on environmental externalities from agriculture are rare in developing countries. In an effort to fill this research gap, site-specific valuation studies to quantify the value of externalities were conducted under the auspices of the environment module of the first phase of the ROA project. Site specific studies target one or two farming systems, representative of dominant agricultural systems within each country. These site studies take stock of environmental externalities provided by the farming systems and assess them, including a monetary valuation, using one or more non-market measurement techniques (FAO, 2004). **Table 6** summarizes the environmental attributes, measurement techniques and valuation results of these studies.

Two groups of studies emerged from these novel attempts in the ROA project. The first group includes the use of willingness to pay estimates of positive externalities using such techniques as replacement cost, travel cost, hedonic pricing and contingent valuation. The positive externalities are the sequestration of green house gases (GHGs), agro-tourism, agro-forestry benefits and rural amenities. The second group of studies employs similar non-market measurement methodologies or econometric techniques to quantify the value of reducing negative externalities or the willingness to pay for reduced pollution: GHGs, water pollution, and soil degradation. (*ibid*).

These site-specific valuation studies on environmental externalities from agriculture provide several useful insights into the common features and constraints pertaining to developing countries. These insights can be summarized as follows:

- Basic physical information on external benefits and costs from agriculture is seriously lacking, hampering sensible decision making.
- Negative externalities are more prevalent than positive ones, and regulatory and advisory measures prevail over economic instruments such as incentive payments.
- Unawareness of, and insufficient effective demand for, environmental quality is commonly observed especially in low-income developing countries.

**Table 6 Site specific valuation studies in the ROA Phase I**

| Country | Positive externality | Reduction in negative externality | Valuation technique | Value |
|---|---|---|---|---|
| **Chile** | GHGs | | Market value | Carbon sequestration service of avocado site in Aconcagua Valley is worth $2 million per year, 3% of the value of avocado exports. |
| **China** | GHGs | | Contingent valuation | GHGs fixation estimated at Zhenjiang site is $1.5 million. |
| | | Water pollution | Contingent valuation | 元255 RMB per household per year for clean water, 2% higher than that of average household income. |
| **Dominican Republic** | Agro-tourism | | Contingent Valuation | Agro-tourism value is 8.4% of the tourism income in 2002 and 10% of the farming GDP. With support could reach US$364 million, or 12% of the tourism income and 14% of the farming GDP. |
| **Ethiopia** | Genetic diversity | | Market value | Genetic diversity of coffee valued at $830 million. |
| | | Soil erosion and siltation | Market value | Organic enset production practices save $1,250,000 year in negative externalities. |
| **Ghana** | Benefits of agro-forestry | | Contingent valuation, replacement cost | Benefits per hectare of agro-forestry farm is ¢14,166,310, and the mean willingness to pay is ¢70,832. The present value of the replacement costs of agro-forestry farm over a 15 year period is ¢8,879,080 per hectare. |
| **India** | | Soil erosion, water savings and GHGs | Market value | Zero tillage net savings in wheat based systems is Rs1736 per hectare. Carbon sequestration value of zero tillage is $52,000 per year in Haryana. |
| **Indonesia** | Rural amenities, environmental services | | Travel cost, replacement cost | The total economic value of agriculture's environmental services in the Citarum river basin is about $3.98 billion per year. |
| **Mexico** | Organic coffee | | Economic assessment | Up to 20 percent price premium for organic coffee production. |
| **Morocco** | Rural amenities | | hedonic pricing | Agricultural amenities explain a variation in weekly rental prices of 14.5% for farmhouses. |

Source: FAO, 2003.

## 5. Implications for policy design: a case for normative work in the ROA phase II

This issue of the ROA *Policy Brief* examines the roles of economic valuation on environmental services from agriculture in designing effective incentive measures for ensuring better environmental outcome. To this end, it (i) identified the categories, characteristics and values pertaining to environmental services from agriculture, (ii) reviewed the objectives, typology and methodology of available valuation methods, and (iii) summarized the existing valuation studies with emphasis on site-specific cases undertaken under the auspices of the ROA project.

The scrutiny in this note shows that there is a long way to go from economic valuation to incentive design. First of all, economic valuation on the total flow of benefits shown above tells little about the need and nature of an intervention. Secondly, a valuation study in a specific region can rarely be applied to other contexts (i.e. benefit transfer) due to site-specificity of environmental services. Thirdly, even if the net-benefits of an intervention can be obtained with the aid of valuation methods, such information is a fraction of data necessary for designing economically feasible, environmentally effective and socially acceptably incentives. In short, economic valuation is a necessary but far from sufficient element for better decision-making.

This conclusion provides strong justification for normative analytical approach pursued by the ongoing environmental service research component in the ROA project phase II, which aims to deliver the guidance on the best policy practice to design, implement and enforce incentive measures for better environmental outcome and for contributing to poverty alleviation in developing countries (Sakuyama, 2005).

This policy guidance is expected to serve as a useful reference for policy-makers to initiate incentive measures, but it does not intend to be a rigid prescription applicable to all circumstances. It goes without saying that, whether valuation studies or incentive design, it is national, regional and local policy-makers and practitioners who conduct these tasks in the field. The mission of this Project is to assist such spontaneous initiatives by providing a practical set of 'menu' in the form of policy guidance and tools.

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