

## **Multifunctionality and Non-trade Concerns: Implications for Future Agricultural Policy in Asia<sup>12</sup>**

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### **Abstract**

Agriculture's multifunctional role as provider of non-commodity outputs has received increased attention in the debate on the future of agricultural policy. To identify appropriate economic policies, a distinction must be made between concerns involving market failure and a consequent misallocation of resources, and those relating to distributional issues. We argue that it is essential to restrict the concept of multifunctionality to non-commodity outputs involving technical externalities or public goods and for which market failure and the misallocation of resources are important (e.g., amenity values and agricultural pollution). Other non-trade concerns, such as rural incomes and employment and food security, involve distributional issues, but no resource misallocation. This distinction makes it possible to identify different types of domestic policy measures to address them effectively and efficiently. Through reference to an empirical application to Taiwanese paddy rice policy, we illustrate that the most effective way to reconcile non-trade concerns is through policy measures that correct for market failure by valuing non-commodity outputs appropriately and a separate set of measures that address distributional issues.

**Key Words:** Non-commodity Outputs, Joint Production, Agricultural Policy Reform, WTO Non-Trade Concerns

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## **1. Introduction**

The characterization of agriculture as a multifunctional industry has helped to broaden the debate on agricultural policy. Some views of multifunctionality encompass a wide range of attributes, including those relating primarily to land use, such as protection of wildlife habitat, biodiversity, and the provision of landscape amenities, through to various social attributes such as agriculture's contribution to cultural heritage, the viability of rural communities, and food security. In other cases, the focus is on environmental attributes of agricultural production. It is essential to use a clear definition of multifunctionality to determine appropriate policy approaches. We illustrate the importance of this by discussing results of a recent application to Taiwanese paddy rice.

## **2. Defining Multifunctionality**

For policy purposes, a workable definition of multifunctionality must be restricted to non-commodity outputs of agriculture that satisfy two conditions: they are jointly produced with commodity outputs; and they provide social value (impose social costs) not reflected in markets.

### **2.1 Joint production**

*Jointness in production* can arise from: 1. technical interdependencies; 2. competition among outputs for an (allocable) input that is fixed to the firm; and 3. production from a non-allocable input (Shumway, *et al.*, 1984). Cases 2 and 3 are most relevant to multifunctional agriculture. Case 2 applies when fixed amount of land is allocated among crops and other uses with environmental benefits, such as trees, grasses or other cover. The outputs from these land uses are interconnected, as an increase in the amount of land devoted to one will reduce the amount of land available for the others. An example of case 3 that has figured prominently in Taiwanese rice policy are the multifunctional outputs of rice production, such as the benefits of groundwater recharge and the environmental impact of methane released to the atmosphere (Boisvert, *et al.*, 2004 list other multifunctional outputs of paddy rice). Since groundwater recharge is related to total land planted to paddy rice and the intensity of the application of irrigation water, it is impossible to disentangle the contribution of these two inputs to the production of rice from their contribution to groundwater recharge. The contributions of land, water, and fertilizer to rice production cannot be separated from their effects on methane generation. These examples also illustrate that multifunctional outputs are generally not produced in fixed proportions with agricultural commodities.

### **2.2 Social value or cost**

A multifunctional output must also generate a *social value or cost* that is not reflected in organized markets, and thus is un-priced. This applies to landscape amenities (a non-excludable public good) because their enjoyment by one individual does not exclude their enjoyment by others. Positive and negative externalities are also un-priced, but unlike public goods, some may be excludable. The benefits from groundwater recharge and environmental costs of methane emissions are examples of technical externalities. Since farmers have no incentive to take into account these external costs or benefits to society in making production decisions, resource allocation will not be socially optimal.

### 3. Optimal economic policy for multifunctionality

By defining multifunctionality in this way, the optimal policy approach is to internalize the effects of the externalities or public good attributes of the non-commodity outputs, i.e., to ensure that they are taken into account in farmers' resource allocation decisions. The standard economic prescription is to "compensate" producers by an amount equal to the marginal social value of a positive externality and "charge a fee" equal to the marginal social cost of a negative externality. In so doing, we obtain the social welfare maximizing levels of non-commodity outputs. While these are the well-known Pigouvian subsidies and taxes, we avoid referring to appropriate compensation and fees in terms that may have a pejorative connotation. Since the non-commodity outputs are of value to society, the payment to producers is for services provided, rather than a means of redistributing income. For a negative technical externality, the fee is for a cost imposed on society. It also follows that we need at least as many policy instruments as there are multifunctional outputs to achieve their optimal supply. Often, it is difficult, or impossible to measure or observe the environmental damage. In these cases, socially optimal policies can also be achieved by a tax (subsidy) on each input equal to that input's marginal production of the externality multiplied by the marginal social cost (value) of the externality. Moreover, when commodity and non-commodity outputs are not produced in fixed proportions, social optimality cannot be assured by merely using traditional domestic price support policies for agricultural commodities (Chang, *et al.*, 2005).

Consider a simple example where a firm is engaged in the *joint* production of two goods. The market agricultural good,  $X$ , has a production function,  $X = f(L, B)$ , where  $L$  might be an input such as labor or land and  $B$  is another input. The second good is the environmental improvement,  $E = e(B)$ , from a multifunctional good such as groundwater recharge or reduced soil erosion. Production of the two goods is joint in  $B$ , a non-allocable input. The firm maximizes profits:

$$(1) \max. \pi = (P_X + S_X)f(L, B) + S_E(e(B)) - P_L L - (P_B - S_B)B,$$

where  $P_i$  are output or input prices of  $i = X, L$ , and  $B$ , and  $S_j$  are policy compensations (payments or fees) for  $j = X, E$ , and  $B$ . First-order conditions for profit maximization in a competitive market are:

$$(2) \partial\pi / \partial L = (P_X + S_X)\partial f / \partial L - P_L = 0; \text{ and}$$

$$(3) \partial\pi / \partial B = (P_X + S_X)\partial f / \partial B + S_E \partial e / \partial B - (P_B - S_B) = 0$$

By setting  $S_j = 0$  for all  $j$ , we obtain the competitive profit maximizing solution; the private value of the marginal product (e.g., price times the marginal product) of each input be set equal to the price of the input. However, there is market failure because the solution ignores the social value of the environmental improvement  $V(e(B))$ .

To account for the environmental improvement maximum social welfare is found by:

$$(4) \max. SW = P_X f(L, B) + V(e(B)) - P_L L - P_B B$$

The first-order conditions for the social welfare maximum are:

$$(5) \partial SW / \partial L = P_X \partial f / \partial L - P_L = 0 ; \text{ and}$$

$$(6) \partial SW / \partial B = P_X \partial f / \partial B + [(\partial V / \partial e)(\partial e / \partial B)] - P_B = 0 .$$

Firms will produce the social welfare maximizing levels of  $X$  and  $E$  *only if* one or more policy instruments can be set so that equation (2) equals equation (5) and equation (3) equals equation (6). Let's consider three cases each involving one of the three single policies (e.g. in each case setting the other two policy instruments to zero). First, these corresponding first-order conditions are equal to one another if we set the per unit payment for environmental improvement at its marginal social value (e.g.  $S_E = \partial V / \partial e$ ). This is the standard Pigouvian solution to internalize the value of the positive externality. Second, the corresponding first-order conditions are equal for the case where input  $B$  is subsidized at a per unit rate of  $S_B = (\partial V / \partial e) (\partial e / \partial B)$ , the marginal value of a unit of environmental improvement multiplied by the marginal production of the environmental improvement from an additional unit of  $B$ . In both cases, the first-order conditions in the market for  $B$  reflect the social value of the environment, and the value of the marginal product of  $B$ , plus the value of its social product, is now set equal to the price of  $B$ . When compared to the private optimum, the value of the marginal product of  $B$  must now be lower. With a downward sloping value of the marginal product schedule for  $B$ , more  $B$  is used, implying greater production of environmental improvement. The policy intervention accounts for the underproduction of the environmental improvement in the private market equilibrium.<sup>3</sup> Also, there is no resource misallocation in the market for  $L$  since the first-order conditions are unaffected by the payment.

In contrast, if we attempt to correct for this market failure by supporting the price of commodity output,  $X$ , condition (2) can never equal condition (5). In this simple case, it may be possible to support the price of  $X$  to generate the optimal level of environmental improvement, but there would now be resource misallocation in the market for  $L$ . Such a price support will always violate the social first-order conditions in the other input markets when there is more than one input used in the production of either of the joint outputs (e.g. Plott, 1966). Social optimality of multifunctional agriculture cannot be assured by using domestic price support policies for agricultural commodities.

There are some major challenges in implementing optimal economic policies for multifunctionality (Blandford, *et al.*, 2003; Randall, 2002). First, we must identify what should be valued. For example, what are the specific attributes of landscape that have value? Difficulties in applying non-market valuation methods, such as Contingent Valuation Methods (CVM), are compounded if

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<sup>3</sup> For a negative externality, the private optimum would lead to overproduction of the multifunctional output. The imposition of a fee on the input responsible for an externality or on the externality itself would be required to encourage the optimal level of multifunctional output.

several non-commodity outputs are jointly produced. Problems can arise if net social benefits are estimated by summing individual valuations for non-market goods, each generated independently using CVM or other valuation procedures. By ignoring joint production and policy interactions, such procedures will systematically overstate benefits or understate costs (Hoehn and Randall, 1989). Second, we must quantify the technical relationship between commodity production and the supply of non-commodity outputs. The relevant attributes (e.g., landscape amenities or the production of environmental residuals) may not be uniquely associated with particular combinations of inputs, composition of commodity outputs, production method or pattern of land-use. The new policies will also have to bring into sharper focus the spatial diversity of non-commodity outputs, be they site- or area-specific, regional, or nationally differentiated. Due to differences in soils, climate, etc., some areas are less vulnerable to erosion; others are better suited for wildlife habitat, promoting biodiversity, or the provision of environmental ecological services. Boisvert, *et al.* (2004) discuss some of these issues in reference to Taiwanese paddy rice.

Low-income countries may also face some additional challenges in implementing optimal multifunctional policies. As incomes and wealth increase, people place a far higher value on amenities, environmental quality (or the lack thereof), and other multifunctional outputs. Even though this means that the values assigned to these multifunctional outputs could be relatively low in many developing countries, their governments may still lack sufficient budget resources to compensate producers for their contributions to the production of multifunctional outputs that generate positive social benefits. In cases where these benefits are global or have other trans-boundary dimensions, cooperation and/or assistance to these countries from the international community is both essential and appropriate to ensure optimal levels of these multifunctional outputs. The existing Global Environment Facility (GEF) could be adapted to serve this purpose. The GEF, for example, could be used to provide incentives for farmers to expand production in areas that would reduce the rate of deforestation in recognition of the contribution to global biodiversity and to the reduction in the rate of global climate change. The Facility could also be used to provide incentives to encourage production practices that would reduce emissions of green house gasses. An example of the need for more limited international cooperation is where a river crosses an international boundary downstream from where agricultural nutrients or chemicals are released into the water. Unless there is joint approach to limiting the negative externality directly, the net effect might simply be a relocation of production to a lower income country rather than an overall reduction in contamination.

#### **4. Economic policies for other domestic objectives**

The level of agricultural production can have important implications for other domestic policy objectives, such as the economic viability of farm and rural households and food security. These interrelationships are qualitatively different from the public good or technical externality issues associated with multifunctionality. They fall under the economic heading of pecuniary externalities (Baumol and Oates, 1988). By affecting other markets, changes in agricultural production may have redistributive effects on different segments of society, but this does not involve a

misallocation of resources. They require no public action to correct for inefficiency, but there may be political incentives to address the distributional consequences.

#### **4.1 Farm household incomes and the viability of rural economies**

The contraction of a previously supported agricultural sector may have undesirable implications for incomes and employment in agriculture, and this may in turn have a negative impact on the economies of rural areas. In wealthy countries, even in areas that are considered to be predominantly rural, agriculture has a declining role in the local economy. With a growing proportion of farm household income derived from off-farm activities, the broader rural economy is often more important for the economic viability of agriculture rather than the reverse. The reform of agricultural policies may create pressures for adjustment in the sector. The solution is to deal directly with adjustment issues, and to use policies that generate other sources of income in rural areas (Castle, 2001). In the European Union, there is a trend towards the increasing use of funds previously used for agricultural price and income support for rural development initiatives (Cahill and Hill, 2005). The United States has a program for adjustment assistance to address displacement of labor resulting from trade liberalization (Blandford and Boisvert, 2005). This involves compensation for short-term income loss, and payments to facilitate labor retraining and relocation. Policy reform can also reduce farm asset values. The United States recently made lump sum payments to holders of marketing quotas in the reform of the peanut support program (Dohlman, *et al.*, 2005). Compensatory time-limited payments were made to farmers as part of Australian dairy policy reform (Harris and Rae, 2005).

In developing countries, farm household incomes can be improved by increasing agricultural productivity and through broader development of rural economies. Agricultural development should be tackled directly, for example, through the diffusion of improved production practices, provision of farm credit or irrigation infrastructure, rather than indirectly through subsidies on inputs or output. In many developing countries rural development is often impeded by poor infrastructure (e.g. roads, water and power supplies) and the lack of services (e.g. education and health). An effective rural development policy would focus on improving these aspects in order to promote economic growth and diversification and to improve the quality of life for rural residents.

#### **4.2 Food Security**

Food security concerns have traditionally revolved around potential vulnerability associated with increased dependence on food imports. Such concerns have been heightened by potential threats of terrorism to international trade. Several approaches can be taken to address these issues. Wealthy countries that rely on food imports can use long-term contractual arrangements with exporters to provide guaranteed supplies or can maintain strategic stocks of foodstuffs. Poorer countries can be provided with access to finance to overcome short-term foreign exchange constraints on purchasing food. Short and longer-term food needs for poorer countries can also be addressed through food aid. Targeted food subsidies can be used to protect the poorest segments of society from the effects of sharp increases in food prices.

## 5. Lessons from an application of the policy principles to Taiwanese rice policy

In a recent examination of agricultural policy in Taiwan (Chang, *et al.*, 2005), we used a partial equilibrium model to simulate the effects of replacing price support and land set-aside payments with optimal policies for two multifunctional outputs. Rice production follows a Cobb-Douglas production function in four inputs: land, labor, fertilizer, and irrigation water. Demand for rice is linear in price and limited imports of rice are allowed. The supplies of inputs are assumed to be log-linear in their prices. The positive externality for paddy rice is groundwater recharge, which increases with the use of both land and water, but at decreasing rates. The negative externality for paddy rice is methane emission, which increases with water, fertilizer and land, but also at decreasing rates. Since the multifunctional outputs are difficult to monitor, the policy approach is to tax fertilizer and subsidize land and water application at rates that reflect the marginal contribution of each input to the social values of the multifunctional outputs.

One important lesson from the empirical analysis is that the existing price support policy will not result in the desired supply of multifunctional goods. The policy implicitly values groundwater recharge below social value (production 7% too low), and underestimates social costs of methane abatement (production 2% too high). Under the new policy, land and water use increase by 5% and 8%, respectively, in line with their contributions to the social value of multifunctional outputs. Fertilizer use falls by 8%; despite the increased use of land and water, rice production falls by about 4%. Further, it is possible to achieve optimal supplies at far lower government costs (over 90% reduction), while at the same time, social welfare (measured as the sum of producer and consumer surplus, the values of the multifunctional outputs less government costs) improves by 2%.

The efficiency gains from the new policy are also re-distributed toward consumers (a 2% increase in consumer surplus) and away from farmers (a 28% reduction in producer surplus). As a result, the annual return to land falls by 42% under the new policy. We have emphasized above that these distributional issues fall outside our definition of multifunctionality, and therefore, they must be addressed with a different policy approach. The objectives of a re-distribution policy would be to ensure a smooth transition to a new long-run equilibrium number of rice farmers of appropriate size, and to address issues related to the economic viability of the affected farm households.

To address this issue, we extend the previous analysis by Chang, *et al.* (2005) to identify an adjustment policy to compensate farmers for the reduction in land values due to the reform. To compensate for this annual loss in land value, direct payments of about \$NT 11,400/ha. would be required. The cost, if this payment is made only to land in production (including the 4.6% increase in rice area) would be \$NT3.96 billion, or 59% of the annual government outlays for price support and land set-aside payments. If direct payments were also made to the remaining set-aside land, the cost would rise to \$NT 5.33 billion or 79% of the budget outlays under the traditional support policies.<sup>4</sup>

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<sup>4</sup> So as to not affect rice output in order to meet conditions for inclusion in the WTO “green box” provisions, the adjustment payments may also have to be applied to this remaining land that was in the set-aside program.

A one-time payment of this size would compensate producers for a single year's reduction in returns to land. To account for losses in future years, the government could make a much larger one-time payment, or make annual payments for a fixed number of years into the future. The one-time payment for the lost value of quota permits in the United States, for example, was equal to the loss in value discounted at 5% over a 24-year period (Orden, 2005).

## **6. Conclusions**

We have demonstrated that the identification of effective policy approaches to multifunctionality requires a clear definition of the non-commodity outputs and attributes of agriculture, and how these relate to land use and the production of commodities. Those attributes that can be identified as public goods or technical externalities may require the use of policy measures that correct for market failure and the resulting misallocation of resources. Those attributes that can be identified as pecuniary externalities may require measures that address resulting distributional issues. We describe the types of policies needed to ensure optimal levels of multifunctional attributes and discuss important challenges in policy implementation, including some related specifically to developing countries. Through an examination of summary data from an empirical application to Taiwanese agricultural policy reform for admission to the WTO, we illustrate that optimal levels of multifunctional output, as well as the adjustment assistance in the form of compensation for loss of asset values, can be consistent with trade liberalization, lead to improved social welfare, and reduce government costs.

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