Pricing the Outputs of Multifunctional Agriculture[*]

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Given that agriculture produces a broad array of valuable amenities in addition to commodity outputs, "green payments" might be a tool for maximizing welfare from the agricultural enterprise. Here, I argue that getting the green prices wrong would entail welfare losses and trade distortions; and that failure to monitor green production would exacerbate trade distortions in the all-too-common case where farmers are choosing between two commodity production technologies, brown and cheap or green and more expensive. So, it is important to get the green prices right and to monitor green production. The valuation task requires making some fine distinctions in terms of amenity type, quality, and accessibility to demanders; and the valuation framework must be consistent as we move from single to multiple amenities and from local to continental spatial scales. The environmental valuation community is able in principle to provide good estimates of WTP for agriculturally-produced amenities, but the valuation task requires an effort on a larger scale than has yet been attempted. Finally, to approach the welfare optimum while minimizing trade distortions will require targeting green prices down to the farm level.

Keywords: *environmental amenities from agriculture, nonmarket valuation, willingness to pay, green payments, trade-environment interactions, targeting.*

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I. Introduction

Agriculture in its considerable variety produces a broad range of valuable outputs in addition to the commodities that generate most of its revenue. One list of the multifunctional outputs of agriculture (Romstad et al., 2000) includes biodiversity, cultural heritage, openness, borders/mosaics, active landscape, recreation access, food security, food safety, food quality, rural settlement, scientific/educational value, and negative external effects. Governments in the relatively well-off countries are encouraging these non-commodity outputs: examples include countryside stewardship programs in Europe, landcare programs in Australia, and conservation provisions of recent American farm bills. Governments encourage multifunctional outputs through education and persuasion, and often by subsidizing favored agricultural practices and technologies.

A rather dramatic step is starting to receive consideration in some agricultural policy circles: public willingness to pay for the non-commodity outputs of agriculture might be assessed and brought to bear systematically in the form of green prices (a term I use as shorthand for ”the prices of agriculture’s multifunctional outputs”) affecting the incentives facing agriculture producers[1]. Suppose that green pricing and green payments became standard practice. In what follows, I will argue first that the practice of systematic green pricing would influence green production, as would be intended, but also commodity production, trade, and welfare. This is true in the ideal case where the right green prices are applied and domestic welfare is maximized, and the impacts on commodity trade should not in this case bear any opprobrium – trade is not an end in itself, but merely an instrument for generating welfare. Nevertheless, the extensive influence of green prices on commodity production, trade, and welfare imposes a substantial burden on policy-makers (and the environmental economists who support them in this task) to get the green prices right – the impacts of getting the green prices wrong are inherently greater in the case of multifunctional agriculture than in many of the cases customarily addressed by environmental economists. Second, I will argue that getting the valuation of multifunctional outputs right is a much bigger task than is typically undertaken by environmental economists. The right green prices are particular and contextual, and must be estimated on a national or continental scale, but implemented farm-by-farm. With all due respect to the very considerable efforts and successes of environmental valuation specialists over three decades (Willis *et al*., 1999), I must observe that environmental economists have seldom attempted such a demanding task. Third, I will argue that targeting green prices to the farm level and monitoring green production are essential not only for assuring that the public receives value for the payments it makes to agriculture, but also for minimizing any potential distortions to international trade. Finally, I will suggest some strategies for overcoming those challenges.

1.1 Green Prices Would Influence Commodity Markets, Trade, and Welfare

How might green prices impact commodity markets, prices, and trade? To keep things simple, imagine that agriculture produces just two outputs, a commodity c (cheese) and a public good w (wildflowers), all factors and outputs are homogeneous, and production technology is homogeneous. Production technology matters, and I consider extreme cases where commodity and green production are strictly separable on the one hand and strictly fixed proportions on the other, and a third case in which farmers chose between a cheaper technology that produces c alone and a more expensive one that produces c and w jointly. The analysis is conducted under closed and open economy conditions; to keep things simple, again, the open economy models adopt the small country assumption.

Case 1. *Production technology is strictly separable in the joint products* (so that the joint products are independent, i.e., changes in p_i do not affect j). If the economy is closed to trade, the markets in cheese and wildflowers will clear separately (Figure 1a): (p_c, c) and (p_w, w) are set independently, and shifts in demand for w do not affect (p_c, c). If the economy is open to trade, (p_c, c) and (p_w, w) are set independently (Figure 1b). Shifts in demand for w do not affect (p_c, c), and the commodity market accommodates imports without disturbing (p_w, w). The diagrams assume the country is a commodity importer in the zero-green-payments baseline. However, an analogous set of results could be derived for green payments in commodity-exporter countries – whatever tends to increase domestic production reduces imports or increases exports and, regardless of which it is, tends (if anything) to decrease world prices.

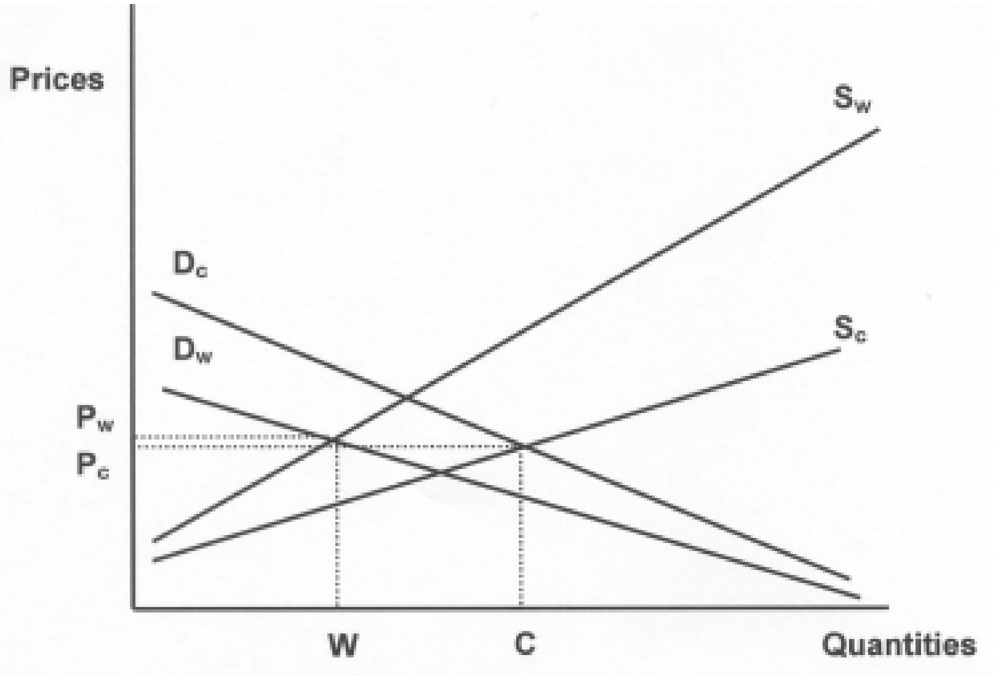

Figure 1a　Separable production, closed economy

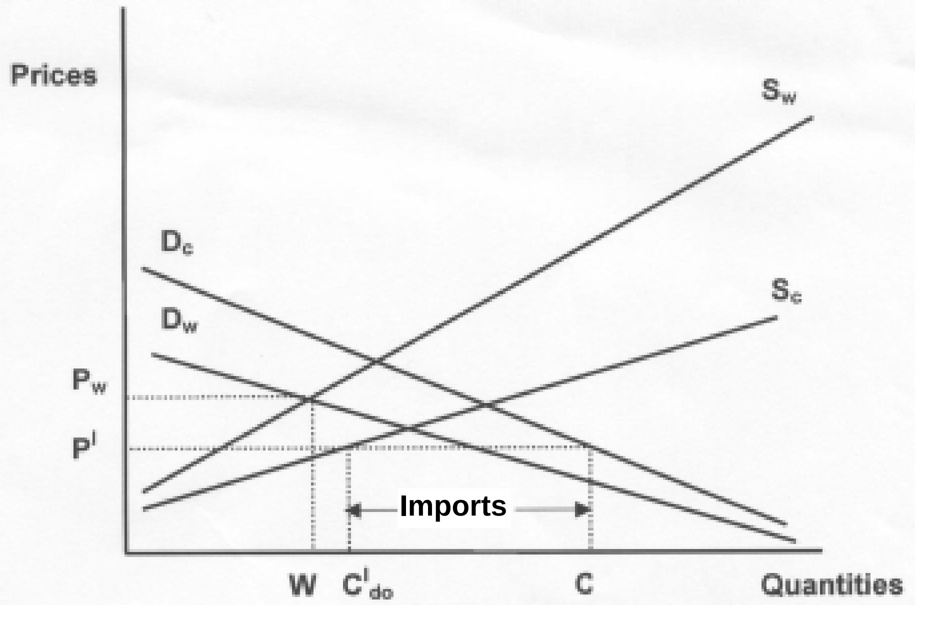

Figure 1b Separable production, open economy

With strictly separable production, optimal green payments optimize domestic welfare and production of green things without influencing domestic or international commodity markets.

Case 2. *The joint products are produced in strictly fixed proportions.* If the economy is closed to trade, (p_c, c), (p_w, w), and welfare can be optimized by paying p_c for cheese and p_w for wildflowers, or p_{c+w} (= $p_c + p_w$) for either cheese or wildflowers, it does not matter which (Figure 2a). If the economy is open to trade, the price for the cheese-wildflowers bundle becomes $p^I_{c+w} = p^I_c + p_w$ because p_c isupper-bounded by the price of imported cheese and the demand for the bundle (given that all demands for cheese can be satisfied at p^I_c) is upper-bounded at D^I_{c+w} (Figure 2b). Equilibrium, in general, departs from the closed economy optimum. Imports may be positive, depending on the level of D_w and, given that imports do not deliver wildflowers, equilibrium w is reduced to w^I when cheese is imported. In equilibrium, the Kaldor-Hicks welfare gain from cheaper imported commodities offsets the welfare loss from fewer wildflowers.

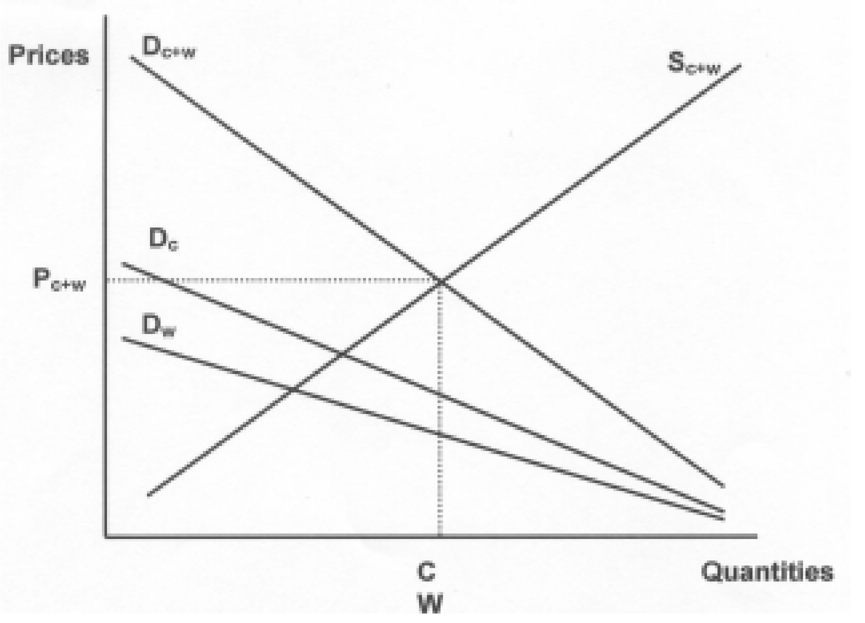

Figure 2a　Fixed proportions joint production, closed economy

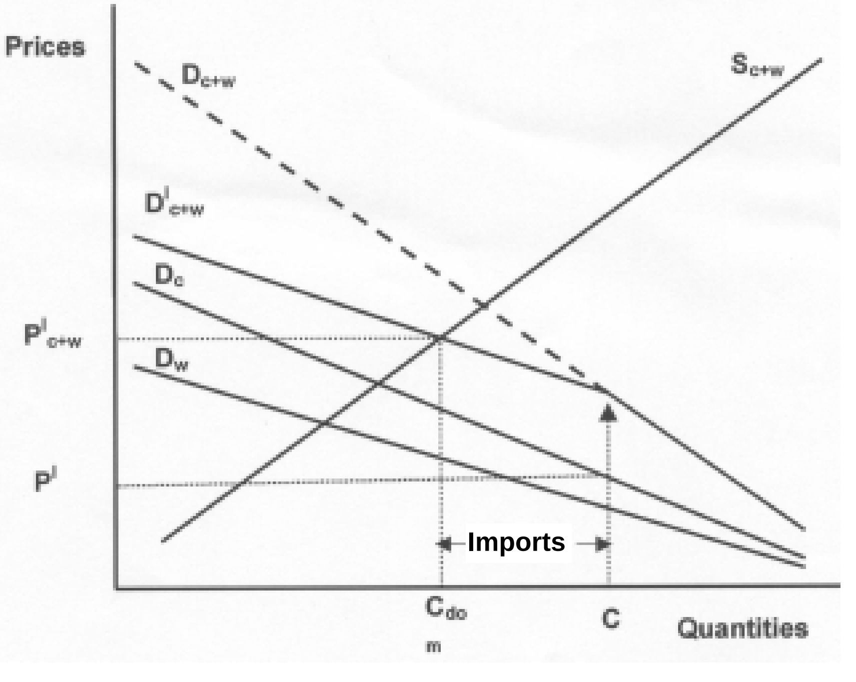

Figure 2b　Fixed proportions joint production, open economy

The reader may conduct thought-experiments concerning the influence of the level of D_w, and the effects of green payments that are to high or too low, on domestic commodity production. With fixed-proportions production and the economy open to commodity imports, green payments influence domestic production of commodities. With zero green payments, imports may devastate green production along with domestic commodity production, reducing domestic welfare – this is the anti-globalist's nightmare. Excessive green payments would reduce domestic welfare while distorting trade by impeding market access for imports – the US (and Cairns Group) trade negotiator's nightmare.

Case 3. *Farmers choose between two technologies, brown and cheap or green and more expensive.* If the economy is closed to trade, *c*, *w*, and welfare can be optimized by paying p_c for cheese and p_w for wildflowers, or p_{c+w} (= $p_c + p_w$) for the cheese and wildflowers combination (Figure 3a). Paying only p_c would induce farmers to choose the cheaper technology, reducing *w* to zero while perhaps increasing *c*. If the economy is open to trade, the price for the cheese-wildflowers bundle becomes $p_c^I{}_{+w} = p_c^I + p_w$, as in Case 2 (Figure 3b). Equilibrium, in general, departs from the closed economy optimum. Imports may be positive, depending on the level of D_w and, given that imports do not deliver wildflowers, equilibrium *w* is reduced to w^I when cheese is imported. In equilibrium, the Kaldor-Hicks welfare gain from cheaper imported commodities offsets the welfare loss from fewer wildflowers. With zero green payments, imports may devastate domestic commodity production and eliminate green production, reducing domestic welfare – the anti-globalist's nightmare, in even starker form. Excessive green payments would reduce domestic welfare while distorting trade by impeding market access for imports.

The three cases have quite different implications concerning the need to monitor green production. In Case 1, failure to monitor, while undermining green production,

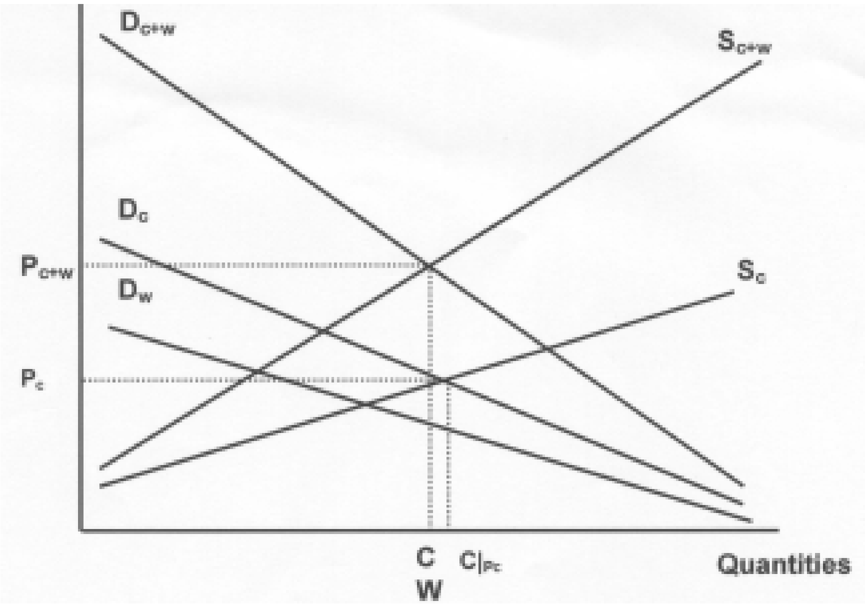

Figure 3a　Competitive production, closed economy

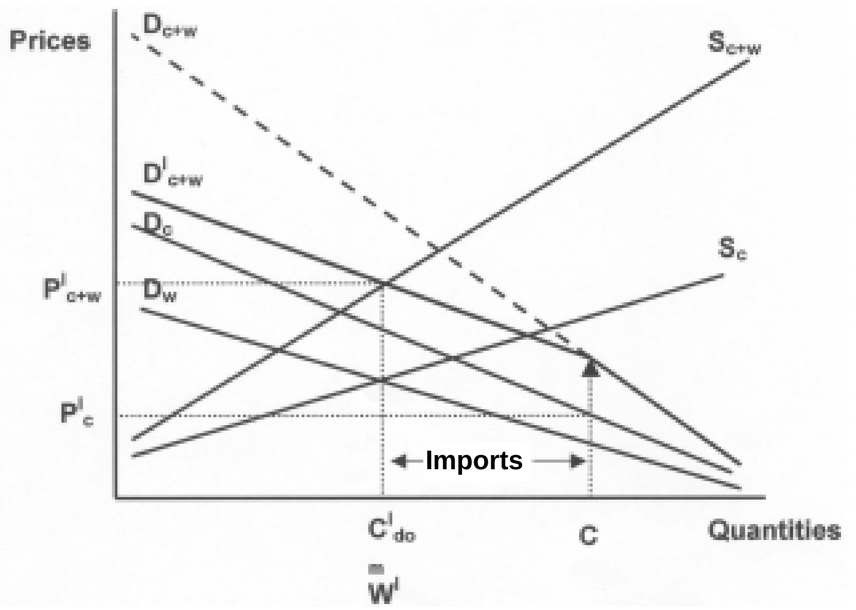

Figure 3b　Competitive production, open economy

would not impact commodity markets. In Case 2, monitoring is not an issue: green production proceeds in lockstep with commodity production. But in Case 3, monitoring of green production matters to commodity markets. Absence of monitoring may be characterized as paying p_{c+w} with no assurance that *w* is actually produced. Under these conditions, farmers would switch to the brown technology, and the green payments would induce no green production but would stimulate domestic commodity production, thereby impeding imports – the US (and Cairns Group) trade negotiator's nightmare in even starker form.

Joint production technologies in multifunctional agriculture will seldom be strictly separable or strictly fixed-proportions, and several authors have elaborated the possibilities: fixed-proportions, complementarities, independence, and competitive relationships among outputs (Blandford and Boisvert, 2002; Gatto and Merlo, 1999; Romstad *et al.*, 2000). Despite the broad range of possibilities, the following generalizations are plausible.

- *For many green products, production conditions are likely to involve some degree of complementarity with commodity production*, which implies that green payments are likely to increase domestic commodity production and reduce commodity imports (or increase exports).
- Other kinds of green products – those that reduce pollution from farming and those that require pre-modern farming technologies come to mind -- are likely to be competitive with commodity production, *which implies that payments to encourage these kinds of green production are likely to reduce domestic commodity production and increase commodity imports (or reduce exports).*

Optimal green prices generate domestic welfare optima, but the character of these optima depend on underlying production and trade conditions. In all but the strict separability case, green payments (in general, including optimal green payments) will affect domestic commodity production, often but not always reducing imports and increasing exports. These implications for trade will bring increased pressure for detail and precision in the virtual prices that support green payments. The more precisely targeted are green payments, making relatively fine distinctions reflecting the economic value of green products, and the more rigorously green production is monitored, the easier it is to explain and justify them in standard efficiency and welfare terms. The blunter the green pricing instrument – in the extreme, all farmers would receive identical green payments per hectare or per unit of commodity production -- the more the whole enterprise looks like (and probably is) a crude attempt to subsidize domestic farming regardless of the impacts on international trade.

Policy to encourage the multifunctional outputs of agriculture will work best when formulated as public goods policy, with its traditional concerns for optimal pricing and monitoring, not as something to be piggy-backed on traditional agricultural commodity policies. Nevertheless, the typically nonseparable relationship between green production and commodity production imposes a burden on the valuation enterprise that is, if anything, greater than in the ordinary public goods case. Imagine nonmarket valuation specialists had (for example) overestimated the value of damage from the *Exxon Valdez* oil spill. Had the overestimate survived political and legal scrutiny, the harm done would have been relatively confined: too much money would have been spent on restoration, and many people would each have suffered rather modest diminutions in their retirement expectations to the extent that Exxon stock was included in their retirement plans. In the case of overestimating the value of multifunctional agriculture, too much green production would be forthcoming, and taxpayers would see their wealth diminished a little – impacts analogous to those in the *Exxon Valdez* hypothetical example – but, in addition, commodity markets would be impacted with effects on imports, exports, and perhaps world prices. The burden to get the values right in the case of multifunctional agriculture is if anything greater than valuation specialists usually encounter.

1.2 The Right Green Prices Are Contextual, Particular, and Richly Detailed

In the real world, the land factor is heterogeneous and producers differ in their costs of producing both commodities and green things. Location matters to demand because transportation costs loom larger for some commodities than others, and demand for green things depends on the size of the population affected. The virtual price of wildflowers is now p_{wj}, where j identifies the particular circumstances relevant to that virtual price, which include at least the following: the quality of wildflowers, which is likely to be multidimensional (profusion, variety, prevalence of preferred species, longevity, etc.); location (visibility from residential areas, major transportation routes, tourist attractions, even highway rest stops, would increase demand); the size of the population that lives in the viewshed, visits it, or travels through it; and the availability at each location of complements and substitutes for wildflowers in generating human utility. It follows that j is a vector of contextual variables.

The green products of multifunctional agriculture are not limited to wildflowers. In the previous section, I defined cheese as a homogeneous commodity produced on farms, which was a bit of a stretch: in the real world, cheese spans the range from generic commodities produced in industrial plants to highly specialized artisanal cheeses produced on farms according to local tradition. While the market distinguishes among these cheeses and prices them differentially, the multifunctionality idea takes seriously the possibility that there are unpriced public benefits associated with traditional on-farm cheese production.

Agriculture produces multiple commodities and multiple green things (Romstad *et al.*, 2000). It follows that w is not a single heterogeneous commodity, but a vector of multifunctional outputs of agriculture. All of the products on the Romstad list (or any other) are themselves multidimensional, just like wildflowers. It follows that p_{wj} is a very complicated vector of function-specific and context-specific virtual prices paid to farmers to ensure that society enjoys an optimal supply of green things from farming. Optimality involves variety, quantity, quality, location, and availability of substitutes and complements. The valuation task is demanding and challenging, again to an extent greater than the valuation community customarily encounters.

II. The Valuation Challenge

Economic valuation attempts to provide an empirical account of the value to people of the services and amenities produced by multifunctional agriculture. We ask a lot of these value accounts. They should serve simultaneously as a utilitarian account of the contribution of multifunctional agriculture to human welfare, because a plausible case that policy should respond to these values requires at least that much (Randall, 1999), and as the source of a set of efficient virtual prices to direct resource allocation.

2.1 Welfare Change Measurement

The foundation of economic valuation is welfare change measurement: the value of some proposed action is the money-metric welfare change it will generate. The conceptually valid measures of welfare change are willingness to pay (WTP) for benefits, and willingness to accept (WTA) for costs. WTP is the amount of money the individual would pay willingly to get a desired good, service, or state of the world, rather than go without. WTA is the amount of money that would induce the individual willingly to give up the good, service, or state of the world. These welfare measures are readily defined in market terms -- WTP is buyer's best offer, and WTA is seller's reservation price -- but by no means are restricted to commodity markets. Some people are willing to pay serious money for improvements in the quality of life. Some willingly would accept a lower level of amenities if compensated with real money: some people would move willingly to a less attractive location if promised a large enough pay raise. These values – individual WTP and WTA in total or at the margin for services and amenities, and individual demand for commodities -- are functions of baseline and incremental quantity, availability of substitutes and complements, and various attributes of the demander. Aggregating these individual values to the affected population requires unweighted summation of individual WTP, WTA, or demand, as the case may be.

WTP (or WTA) for an increment (decrement) in some natural resource or amenity captures the *total economic value* of the prospective change, which is the sum of *use value* and *passive use value* and, as such, offers a complete account of economic value. *Use value* is generated when a person uses the environmental service actively, typically by consuming it directly or combining it with other goods and services and the person's own time to "produce" an activity that generates utility. Recreation experiences, for example, are produced by combining on-site amenities with travel services, recreation equipment and the participant's time. Use value includes the expected value of future use. If uncertainty attends future availability of the amenity or future demand for it, and potential users are risk-averse, *use value under uncertainty* may include *option value* and *quasi-option value*. Use value is likely to be reflected (at least, in part) in behavioral evidence such as purchases, visits, and so on. *Passive use value* captures the intuition that people may enjoy genuine satisfaction from “just knowing” (i.e., enjoying the assurance) that a particular state of the world (say, a cultural landscape) is being maintained in good condition. There is no general expectation that passive use values involve overt activities, or leave behavioral traces. However, contributions to voluntary organizations providing preservation, and political support for pro-preservation policies are consistent with passive use value.

We have seen that there is a multiplicity of outputs from multifunctional agriculture, and that valuing each requires dealing with the dimensions of variety, quantity, quality, location, and availability of substitutes and complements. Here, we see that multifunctional agriculture is likely to generate values in all of the use and passive use categories. From a valuation perspective, then, multifunctional agriculture is perhaps the ultimate complex policy. The components of a complex policy typically are not independent, but are linked by substitution and complementarity relationships, as well as by mutual scarcity operating through the budget constraint. It might seem easiest to value each component independently and add up the values thus obtained, in order to arrive at a total value for the complex policy. However, Hoehn and Randall (1989) show that such a procedure (called independent piecewise valuation) is generally invalid, whereas a valid valuation scheme for complex policies is theoretically and empirically much more demanding. To avoid the independent piecewise valuation problem, the outputs of multifunctional agriculture should be valued as a package on a national or continental scale. Yet green prices should be implemented farm-by-farm, respecting the differences in local demand and supply conditions for green production. It will be a considerable challenge to achieve consistency in these tasks.

2.2 Methods of Valuation

Valuation requires evidence of WTP and WTA, and such evidence may be generated by direct and indirect observations from existing markets or from surveys and/or experiments designed by the researcher.

2.2.1 Direct and Indirect Evidence from Existing Markets

While it is hard to imagine a market for multifunctional agriculture in the large, various components thereof are marketed routinely, a circumstance that enables application of various revealed preference (RP) methods. Consider a diverse farming landscape that supports a variety of activities whose productivity and value depend on the way the landscape is managed, so management decisions will generate costs and benefits that are reflected, to various degrees, directly or indirectly in markets.

- Agricultural commodities, and perhaps timber or firewood, may be produced and sold. Assuming the market itself is competitive and undistorted by policy, ***market prices*** reveal the marginal value of these commodities, and ***consumers' surplus*** measures the value of non-marginal increments and decrements in their quantity.
- The landscape may provide catchment for water that is valued by downstream farmers and urban residents. If market demands for agriculture's contribution to water supply and quality are hard to observe directly, the ***avoidance cost method*** might value improved water quality by observing the household water filtration costs avoided, and the ***replacement cost method*** might value increased water catchment by calculating the cost of additional reservoir capacity that would serve the same purpose. Either method would provide an upper-bound value for the particular services they address.
- Tourists and nature-lovers may devote real resources (money and time) to visiting the landscape, leaving a trail of indirect evidence about their WTP for the services

and amenities it provides. ***Travel cost methods*** apply the principle of weak complementarity (Bradford and Hildebrandt, 1977) to estimate this WTP. The random utility model (RUM) has become the travel cost model of choice (Bockstael, 1995; McFadden, 2002), because its systematic treatment of substitute sites allows it to characterize site quality more completely. RUMs are therefore more useful than basic travel cost models for valuing changes in environmental amenity levels.

- People may buy homes nearby, so as to have access to the amenities. ***Hedonic price analysis*** applies statistical techniques to estimate the marginal impact of amenity levels on house prices, thus generating estimates of marginal WTP for the amenity. Recent advances in spatial econometrics have spawned explicitly spatial, "general equilibrium" hedonic analyses that have potential application to multifunctional agriculture (Epple and Seig, 1999; Seig *et al*., 2001). For valuing nonmarginal changes in amenity levels, it is necessary to estimate hedonic demands (i.e., demands for amenities), so that the consumers' surplus can be calculated.

While certain caveats apply specifically to particular methods in this group, these methods share in common an advantage and a limitation, both arising from the same source: the data were generated by natural (rather than controlled) experiments. The advantage is that data generated by market transactions are convincing in at least one respect – real choices are more credible than statements of conditional intent. The limitation is that data generated by natural experiments may fail to measure key components of value (some kinds of use values, passive use values in general, and total economic value), and for those value components it does address, may depart from the ideal value concepts.

2.2.2 Evidence from Surveys and Experiments

Contingent valuation and contingent choice methods, which sometimes are called stated preference (SP) methods, implement researcher-controlled valuation experiments.

This opens up the possibility of estimating total economic value, passive use value, and various relatively inaccessible use values, and of valuing amenity levels beyond the existing range; if a prospect can be described by the researcher and comprehended by the respondent, it can be valued. The potential disadvantage lies in the self-reported nature of the data: critics worry that confusion, carelessness, and strategic response may contaminate these data sets.

2.2.2.1 Contingent Valuation

The essential elements of a contingent valuation (CV) exercise are a description of the default and alternative situations (respectively, what you get if the proposal fails, and if it passes) and the institutional environment, the valuation question, and the policy decision rule (how does the answer to the valuation question affect whether the proposal passes or fails?). The valuation question may take various forms, which has implications for the kind of analyses required for estimating WTP or WTA (e.g., Hanemann, 1984), and for the incentives for careful and truthful response (Hoehn and Randall, 1987). There is an extensive literature on contingent valuation applications, and attempts to validate CV include tests for internal consistency and tests of convergent validity using value estimates obtained with different methods. While encouraging results have been obtained (e.g., Carson *et al.*, 1996; Smith and Osborne, 1996), critics have raised enough doubts (e.g., Hausman, 1993) that CV remains a controversial, if widely applied, method.

2.2.2.2 Contingent Choice Experiments

In contingent choice experiments, data generated by a sequence of choices are analyzed with RUMs to generate value estimates (Adamowicz, *et al.*, 1998). Contingent choice experiments are a fairly recent development, so the evidence concerning their performance is rather thin (many of the key papers are collected in

Bennett and Blamey, 2001). Initial applications have emphasized site-specific amenity use values, but there is no inherent reason why they could not be used to estimate passive use (Adamowicz, *et al.*, 1998) and total values.

2.2.3 Prospects for Advances in Valuation Methods

On the horizon, it is possible to discern several promising developments in valuation methods. The thriving research program in experimental economics is casting new light on the familiar concern that SP methods, especially contingent valuation, generate data inconsistent with the requirements of economic theory. Evidence is accumulating that data generated by "real money" experiments exhibit quirks that are similar in direction, if not always in degree (Camerer and Hogarth,1999; Horowitz and McConnell, 2002; McFadden, 1999). We are learning, slowly, about human behavior rather than (merely) exposing problems with SP methods.

More generally, the familiar categories of valuation methods are likely, it seems, to break down in the relatively near future. We can expect major advances arising from information and communications technologies that will facilitate the melding of quantitative and qualitative methods, surveys and experiments, and modes of administration. Furthermore, combining existing methods, a process already underway, will expand our capacity to calibrate valuations and extend their range.

Finally, the urge to generalize empirical findings is motivating *meta-analysis* (e.g., Smith and Osborne, 1996), which seeks to draw empirical generalizations from a set of particular studies, and *benefits transfer*, BT, (Bergstrom and de Civita, 1999; Smith *et al.*, 2001; Van den Bergh and Button, 1999), which seeks to economize on valuation research costs by applying the findings of particular local valuation studies to a broader set of sites. These methods, too, have their limits: the economists' craving for methodical novelty has limited our ability to find data sets of sufficient commonality for robust meta-analysis, while the empirical tests of BT models have not yet vindicated the decision-makers' enthusiasm for the savings in research costs that BT promises. There is a pressing and largely unsatisfied need for systematizing our empirical knowledge about the value of environmental amenities – one can imagine a regularly updated "environmental price index" that tracks how virtual prices for a bundle of amenities change over time.

III. A Valuation Strategy for Multifunctional Agriculture

In valuing the outputs of multifunctional agriculture, we are dealing mostly with public goods and, typically, with local public goods. It is fairly easy to design a study to get a sense of the value of something local and particular (e.g., preserving several square kilometers of classic pastoral landscape, whether it be Ardennes bocage, Luneberg heath, or Swedish savannah) and, despite some controversies concerning valuation methods, there is fairly widespread confidence in our ability to get the values approximately right. Already, there is a substantial literature addressing aspects of the green benefits of European agriculture. Drake (1992), Hanley *et al*. (1999), and several of the papers in Willis *et al*. (1999) provide examples. To get a sense of the value of agriculture's contribution to landscape aesthetics on a continental scale is harder. To devise and implement a valuation scheme that does both of the above in consistent fashion is "frontier" stuff – it requires a valid valuation scheme for complex policies (Hoehn and Randall, 1989), whereas most existing work is best adapted to independent piecewise valuation, which is generally invalid. Here, I suggest two strategies that, while less than ideal, might serve to generate decently good estimates of the value of outputs for multifunctional agriculture that are consistent as we move from single to multiple components of multifunctionality, and from local to continental spatial scales.

1. This strategy begins with a contingent valuation estimate of holistic WTP for the multi-component green outputs of agriculture on a continental scale. It is likely that the resulting aggregate WTP would be an under-estimate: first, being a holistic valuation, it avoids the over-estimation problems of independent piecewise valuation; and, second, the truism that people tend to over-value little things and under-value big things would likely apply to the holistic total valuation of multifunctional agriculture on a continental scale. This holistic total valuation would then serve as an upper-bound on the sum of all the local and particular component values, which would be estimated by decomposition CV procedures and subjected where possible to convergent validity tests involving estimates obtained with revealed preference techniques. This procedure would ensure that the local and particular virtual prices that influence on-farm resource allocation are consistent with the continental-scale and holistic total value. The conjecture that contingent holistic valuations are likely to be under-estimates is if anything reassuring. As governments move to implement a richly-detailed set of demand-based virtual prices for green products, it seems best not to overshoot at the outset: the virtual prices can always be adjusted upward later, as experience suggests.
2. Using contingent choice experiments and the techniques of random utility modeling and conjoint analysis, with a sufficiently large sample of respondents each addressing only a small sample from the whole array of alternatives, it should be possible to estimate a consistent set of particular and local virtual prices for the green products of agriculture (McFadden, 1978; Ben-Akiva and Lerman, 1985, esp. 261-275). This approach was demonstrated in a study of more than 1,300 recreational sites in Maine (Parsons and Kealy, 1992). For multifunctional agriculture, we want to know for the relevant population the marginal rates of substitution between members of a set of goods including at least one marketed

commodity and many green goods. One might imagine each respondent addressing a sample of one priced good (to serve as a numeraire) and perhaps five green products assigned according to some sampling scheme. Rather than a RUM (as would be appropriate for a site selection problem), conjoint analysis may be indicated because multiple levels of each of the public goods should be considered. Green payments to individual producers should vary with the level of production of the public goods.

These valuation structures, being holistic, are founded of necessity upon SP methods, such as contingent valuation and choice experiments. Nevertheless, RP methods can provide important reality checks in the form of convergent validity tests for valuations of amenities that are susceptible to both kinds of methods.

My intuition is that both of these valuation schemes are promising. In either case, the research task would be large, as would the sample of respondents necessary to get reliable value estimates. And, I should emphasize that these valuation schemes have not yet been demonstrated on the scale that would be necessary to obtain consistent estimates of the value of outputs from European multifunctional agriculture.

IV. Targeting Virtual Prices at the Farm Level

For reasonably efficient targeting, virtual prices must reflect demand and value. To accommodate the rich detail of multifunctional output, the valuation process should be designed to produce value functions rather than point estimates. The value of a particular green output (e.g., wildflowers) produced at a particular location would be a function of product quality, availability of substitutes and complements, the size and demographic characteristics of the demander population, and perhaps other variables. To specify the quality attributes of the particular green product and its substitutes and complements, both for estimating the value functions and for applying them at the local level, science-based data may play an important role (Hoehn *et al*., 2001).

To this point, the discussion of valuation has been addressed implicitly to the demand side but, in order to maximize welfare, we would need equilibrium virtual prices that attend also to supply conditions that reflect the direct and opportunity costs of producing green things. These costs vary across farms in response to local conditions. Estimating a set of general equilibrium green virtual prices turns up the challenge yet another notch. An alternative approach, and preferred (I think), would be to focus the valuation process on estimating green demands. Armed with demand information – preferably value functions capable of generating context-dependent virtual demand-prices at the farm level -- and conceding that farmers know more than anyone else about their own supply conditions, the planner would then attempt to design a bidding process for farmers seeking contracts to produce green things, that would maximize social surplus across all green products and all farms.

How finely should these virtual prices be calibrated, at the farm level? I would reject the idea that since some farmers produce a fine display of wildflowers, all should receive wildflower payments; or since the highly-visible wildflowers on some well-located farms are much appreciated by the many non-farm residents and travelers who see them, all farmers regardless of location should receive similar wildflower payments. Such strategies might be an effective means of delivering money to farmers (with predictable impacts on trade in agricultural commodities), but would fail dismally in delivering wildflowers to those who appreciate them. So, the principle should be that farm-level green prices should be calibrated as finely, and farm level performance in multifunctional production should be monitored as rigorously, as is feasible. The logical limits to feasibility are set by transactions, monitoring, and enforcement costs: targeted virtual prices at the level of the individual farm should not be pursued beyond the point where these costs exceed the benefits of finer calibration, at the margin. The goal of keeping these costs within reason might be facilitated by specifying particular technologies (e.g., artisanal cheese), and age and style of farm buildings (as is done for historic districts), and by establishing particular multifunctional agriculture zones where particular virtual prices would be paid to farmers in compliance. Nevertheless, effective monitoring of green production is likely to require at least the credible threat of inspection and punishment for non-compliance.

V. Concluding Comment

The idea of systematically green-pricing the outputs of multifunctional agriculture raises serious challenges for policy-makers and the valuation specialists who would provide empirical support for the effort. First, the costs of getting the valuation wrong are inherently greater in this case than in many of the cases customarily addressed by environmental economists: in addition to inducing inefficiencies in the public goods markets, wrong green prices would (under a fairly robust set of conditions) distort domestic and international commodity markets. Second, getting the green prices right is a considerable task. The right green prices are contextual and richly detailed, and must be estimated on a national or continental scale, but implemented farm-by-farm reflecting local demand and supply conditions. Consistency as we move from single to multiple components of multifunctionality, and from local to continental spatial scales, is a substantial conceptual and empirical challenge. Third, a green-pricing policy that induces efficient green production without distorting commodity trade requires that green prices be targeted to the farm level and green production be monitored with at least a credible threat of penalty for non-compliance.

Nevertheless, we would be doing a disservice to overstate the challenge – we can have some confidence that good-faith efforts to do decently-well at green-pricing, targeting, and monitoring would serve to improve the multifunctional performance of agriculture without undue distortion to commodity trade.

Endnotes

1. One may quibble with whether all of the items on Romstad's (or any other) list of the outputs of multifunctional agriculture are subject to market failure, as would be implied by an effort to green-price them. It could be argued that market failures pertaining to food safety and food quality might be resolved via labeling, food security might be assured via storage strategies rather than by subsidizing domestic agricultural production, and the values associated with rural settlement should be confined to aesthetic values associated with settlement patterns in order to avoid falling into the "secondary benefits" trap. Even if all of these objections were granted, there is nevertheless a rich and lengthy list of legitimate market failures attending multifunctional agriculture.
2. It is traditional in these kinds of analyses to upper-bound commodity supply at the world price, but this practice turns out to over-complicate the diagrammatic analysis of the fixed-proportions joint production case. My strategy of upper-bounding commodity demand serves the same analytical purpose.
3. In general, WTA is equal to or greater than WTP in absolute value. For small changes in the quantity of efficiently allocated and priced goods, WTP and WTA and market price tend to converge. For all-or-none changes in highly-valued things, WTA and WTP may diverge dramatically (Randall and Stoll, 1980; Hanemann, 1991).
4. For making policy judgments (for example, in a benefit cost context), some critics object to unweighted interpersonal aggregation. Individuals with greater income and wealth are likely (other things being equal) to have greater WTP (or WTA, as the case may be), and the simple aggregation procedure makes no attempt to "correct" for this or to place extra weight on things that benefit the disadvantaged.
5. There is no claim that total economic value, however, captures the totality of value: there are many different ways of valuing. Total economic value, then, represents a comprehensive application of the economic way of valuing.
6. The material summarized in this section is elaborated in more detail in Randall (2002).
7. Here, I offer three examples. First, travel cost methods encounter difficulties in accounting for the cost of travel time (Bockstael, 1995), while Randall (1994) argues that this difficulty applies more generally. Second, despite many attempts to find conceptually-valid methods of identifying hedonic demands (e.g., Bartik, 1987; Epple,

1987), no method has yet proven generally acceptable. Third, RUMs (widely applied in travel cost methods and contingent choice experiments) have substantial information needs, which in practice lead often to the use of very large data sets and simplifying analytical assumptions that impose rigidities so that the results are to some degree influenced by analytical choices of the researcher.

8. Cameron (1992) combined contingent valuation and travel cost data sets, Adamowicz *et al.*, (1994) combined revealed and contingent choice data, and Adamowicz *et al.*, (1998) combined contingent valuation and contingent choice experiments.
9. For example, List and Shogren (1998) found that amateur collectors of baseball cards systematically overbid for low-value cards but underbid for high-valued cards.
10. I thank Tim Haab for conversations that increased my optimism about this strategy.
11. To limit excess supply of green products, virtual prices must reflect actual demand. To use an American example, I suspect that under current conservation policies there is excess supply of conservation in southwestern Iowa and the Texas panhandle, where farmers are efficient producers of conservation and public expenditures for conservation are targeted to reflect soil characteristics but not demand for conservation services.

References

Adamowicz, W., P. Boxall, M. Williams, and J. Louviere, 1998. "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation," *American Journal of Agricultural Economics.* 80: 64-75.

Adamowicz, W., J. Louviere and M. Williams, 1994. "Combining Revealed and Stated Preference Methods for Valuing Environmental Amenities," *Journal of Environmental Economics and Management.* 26: 271-292.

Bartik, T., 1987. "The Estimation of Demand Parameters in Hedonic Price Models," *Journal of Political Economy*. 95: 81-88.

Ben-Akiva, M. and S. Lerman, 1985. *Discrete Choice Analysis: Theory and Application to Travel Demand*, MIT Press, Cambridge, MA.

Bennett, J. and R. Blamey, eds., 2001. *The choice Modeling Approach to Environmental Valuation*. Edward Elgar, Cheltenham, UK, and Brookfield, VT.

Bergstrom, J. C. and P. DeCivita, 1999. "Status of Benefit Transfer in The United States and

Canada: a Review," *Canadian Journal of Agricultural Economics*. 47(1): 79-87.

Blandford, D. and R. Boisvert. 2002. "Non-trade Concerns and Domestic/International Policy Choice" Working Paper #02-1. International Agricultural Trade Research Consortium. January 2002.

Bockstael, N. 1995. "Ecological economic modeling and valuation of ecosystems," *Ecological Economics*. 14: 143-159.

Bradford, D. and G. Hildebrandt, 1977. "Observable Preferences for Public Goods," *Journal of Public Economics*. 8:111-131.

Camerer, C. F. and R. Hogarth, 1999. "The Effect of Financial Incentives in Experiments: A Review and Capital-Labor-Production Framework," *Journal of Risk and Uncertainty*. 19:7-42.

Cameron, T., 1992. "Combining Contingent Valuation and Travel Cost Data for the Valuation of Nonmarket Goods," *Land Economics*. 68:302-317.

Carson, R., N. Flores, K. Martin and J. Wright, 1996. "Contingent Valuation and Revealed Preference Methodologies: Comparing the Estimates for Quasi-public Goods," *Land Economics*. 72:80-99.

Drake, L., 1992. "The Non-market Value of Agricultural Landscape," *European Review of Agricultural Economics*. 19:351-364.

Epple, D., 1987. "Hedonic Prices and Implicit Markets: Estimating Demand and Supply Functions for Differentiated Products," *Journal of Political Economy*. 95: 59-80.

Epple, D. and H. Sieg,1999."Estimating Equilibrium Models of Local Jurisdictions," *Journal of Political Economy*. 107(4): 645-681

Gatto, P. and M. Merlo, 1999. "The Economic Nature of Stewardship: Complementarity And Trade-Offs With Food And Fibre Production. In Van Huylenbroeck, G. and Whitby, M. (eds.)," *Countryside Stewardship: policies, farmers and markets.* Pergamon Elsevier. 21-46.

Hanemann, W.M. 1984. "Welfare Evaluations in Contingent Valuation Experiments with Discrete Responses," *American Journal of Agricultural Economics*. 66:332-341.

Hanemann, W.M. 1991. "Willingness to Pay and Willingness to Accept: How Much Can They

Differ?," *American Economic Review*. 81:635-647.

Hanley, N., M. Whitby and I. Simpson, 1999. "Assessing the Success of Agri-Environmental Policy in the UK," *Land Use Policy*. 16(2):67-80.

Hausman, J., 1993. *Contingent Valuation: A Critical Assessment*. Elsevier Science, Amsterdam.

Hoehn, J.P., F. Lupi, and M.D. Kaplowitz, 2001. *Untying a Lancastrian Bundle: Ecosystem Valuation in Wetlands Mitigation*. Working paper available from the authors.

Hoehn, J.P. and A. Randall, 1989. "Too Many Proposals Pass the Benefit Cost Test," *American Economic Review*. 79:544-551.

Hoehn, J. and A. Randall, 1987. "A Satisfactory Benefit Cost Indicator From Contingent Valuation," *Journal of Environmental Economics and Management*. 14:226-247.

Horowitz, J. K. and K. E. McConnell, 2002. "A Review of WTP/WTA Studies," *Journal of Environmental Economics and Management*. 44:426-447.

Kissling, M., K. Schmitz, P. M. Schmitz, and T. C. Wronka, 2003. *Pricing Environmental Services of Agriculture*, Kiel, Germany: Wissenschaftsverlaug Vauk Kiel KG, 1-20.

List, J. and J. Shogren, 1998. "Calibration of the Difference between Actual and Hypothetical Valuations in a Field Experiment," *Journal of Economic Behavior and Organization*. 37:193-205.

McFadden, D., 2002. "Disaggregate Behavioral Travel Demand's RUM Side: A 30-Year Restrospective. Forthcoming," In *The Leading Edge Of Travel Behavior Research.* Heshner, D., and King, J. (eds.) Pergamon Press, Oxford.

McFadden, D., 1999. "Rationality for Economists?" *Journal of Risk and Uncertainty*. 19(1-3): 73-105.

McFadden, D., 1978. "Modeling the Choice of Residential Location," In *Spatial Interaction Theory And Planning Models*. Karlqvist, A. Loudqvist, L. Snickars, F. and Weibull, J.W. eds.75-96.

Parsons, G. and M. Kealy, 1992. "Randomly Drawn Opportunity Sets in a Random Utility Model of Lake Recreation," *Land Economics.* 68:93-106.

Randall, A., 2002. "Valuing the Outputs of Multifunctional Agriculture," *European Review of Agricultural Economics.* 29(3):289-307.

Randall, A., 1999. “Taking Benefits and Costs Seriously,” In *The International Yearbook of Environmental and Resource Economics 1999/2000.* Folmer H. and Tietenberg, T. (eds.) Edward Elgar, Cheltenham, UK, and Brookfield, VT, 250-272.

Randall, A., 1994. “A Difficulty with the Travel Cost Method,” *Land Economics.* 70:88-96.

Randall, A. and J.Stoll, 1980. “Consumer's Surplus in Commodity Space,” *American Economic Review*. 70:449-455.

Romstad, E., A. Vatn, P.K. Rorstad and V. Soyland, 2000. *Multifunctional Agriculture: Implications for Policy Design.* Agricultural University of Norway, Department of Economics and Social Sciences, Report # 21.

Seig, H., V.K. Smith, H. Banzhaf and R. Walsh, 2001. *Estimating the General Equilibrium Benefits of Large Changes in Spatially Delineated Public Goods*. Working paper available from V. K. Smith at Department of Agricultural & Resource Economics, North Carolina State University.

Smith, V.K. and L. Osborne, 1996. “Do contingent valuation estimates pass a "Scope" test: A meta analysis,” *Journal of Environmental Economics and Management* .31:287-301.

Smith, V. K., S. Pattanayak and G. Van Houtven, 2001. “Benefit Transfer with Moments,” Paper presented to Allied Social Science Association Meeting, New Orleans, January.

Willis, K., K. Button and P. Nijkamp, eds. 1999. *Environmental Valuation.* Edward Elgar, Cheltenham, UK, and Brookfield, VT.

Van den Bergh, J. and K. Button, 1999. Meta-Analysis, Economic Valuation, and Environmental Economics. In *Handbook of Environmental and Resource Economics*. van der Bergh, J. (ed.)Edward Elgar, Cheltenham, UK.

農業多功能產出之評價

Alan Randall

在認定農業能生產出農產品之外的其他各式多元有價值的舒適美質之前提下,「綠色給付」或許是一個能使農業此一產業達到福利最大的工具。在本文,我論述的主要重點是,如果沒有得到正確的綠色價格將帶來福利的損失,同時也會產生貿易扭曲。而無法監控綠色生產所造成貿易扭曲的惡化,將全面反應在農民對便宜的棕色與昂貴的綠色生產技術之間做選擇。因此,獲得正確的綠色價格與有效監控綠色生產是極其重要的。然而,價格評估工作必須能區分不同型態之美質舒適、品質及可親近性的需求者,而評估之架構要能由單一面向之美質擴及多面向,且要由區域擴及全國的空間範疇。當前,環境評估社群原則上可為農業所產生之相關舒適美質的願付價值提供良好的估計,但未來努力的方向應擴大過去所嘗試過的層面。最後,為達成福利最大,同時使貿易扭曲最小,需要將綠色價值之目標鎖定在農場上。

關鍵詞:農業之環境舒適美質、非市場價值評估、願付價值、綠色給付、環境貿易互動、標的物