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Extra-Market Considerations in Farmland and Agricultural Policy

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Traditional approaches to evaluating farmland and agricultural policies have focused on commodity prices, input costs, and other factors affecting farm profitability and land use. However, there is a widespread recognition at the policy level that on-farm activities have social implications far beyond the fence posts of individual farms and that market factors simply do not account for the off-farm and social impacts of on-farm practices. Extra-market costs (e.g., ground and surface water contamination) and benefits (e.g., open space and rural landscapes) are increasingly becoming a principal consideration in farmland and agricultural policy. In New York, for example, land use regulations and whole farm planning programs are being considered in order to protect water supplies. At the same time, zoning and tax incentives are being used to protect New York farmland, in part because farmland is thought to provide public benefits as a scenic and community resource.

This bulletin discusses some concepts fundamental to economic analyses of extra-market values, and provides an overview of recent studies that have attempted to quantify the amenity benefits of farmland and the social environmental costs associated with agriculture. Importantly, the focus here is to build a foundation for understanding the economic motivation for trying to quantify these values, and for suggesting how they might be relevant to public policy decisions. All too often, it seems that discussions regarding extra-market values get bogged down in debates over the values themselves without a clear understanding as to why these values are relevant to policy decisions in the first place. For this reason, the next section

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provides an introduction to the economic concepts used in public policy. Subsequent sections apply these concepts to measuring amenity benefits of agriculture, the costs of soil erosion, and the costs of groundwater contamination. Although manure management and other agro-environmental concerns such as wetlands conversion are at the forefront of current policy, these issues have yet to be adequately addressed in the valuation literature and thus are not discussed explicitly in this bulletin. Still, the economic logic presented here is equally applicable to these and other policy issues that involve extra-market values.

Economic Concepts

In order to understand the reasons that economists seek to quantify, in monetary terms, the benefits and costs of policies and activities, it is necessary to first have some background in welfare economics. For some this term may initially be somewhat confusing. Welfare economics does not deal with programs for dependents on public relief. Instead, it is concerned with the well-being or welfare of society as a whole.

A basic premise of welfare economics is that the goal of society is to maximize the well-being that society derives from goods and services which people produce and consume, including those provided by natural resources and environmental quality. Alternatively stated, it is assumed that the goals of society is to attain the highest good for the greatest number of people. Using this criterion, welfare economists compare alternative policies or states of the world, typically using the present situation as a reference point. For example, a welfare economist might ask if the welfare of society would be improved by imposing agro-environmental best management practices on dairy farms in New York, compared with the current status of manure management.

But how are we to conceptualize the well-being of an entire society, and how are we to judge if an alternative policy would improve social well-being? To create a framework for making such evaluations, economists have relied on two basic value judgements: 1) that individuals are the best judges of their own well-being; and 2) that social welfare should be defined in terms of the welfare of individuals. One logical extension and interpretation of this principle is the so-called Pareto Criterion of social welfare, named after a 19th century philosopher. This criterion states that society should adopt a project or policy only if doing so makes at least one person better off and no one worse off. Continuing with the manure management example, the Pareto criterion would say that social welfare will increase with the manure management regulation only if they make someone better off while making no one worse off.

While few would debate the desirability of policies that meet the Pareto criterion, using this principle as a basis for public policy is impractical and would lead to social paralysis. In our example, if one farmer is made worse off by new manure management regulations (a very likely result), then the project should not be adopted under the Pareto criterion. Adopting a pragmatic stance, welfare economics has modified the Pareto criterion in the form of the compensation test. This test states that a policy is socially beneficial if the gainers from the action would be able to fully compensate the losers and still be better off. Actual compensation need not be paid. With respect to manure management regulations, the compensation test would require that the people who benefit from improved ground and surface water quality be able to compensate the farmers for their lost profits, and still be better off after they paid the compensation.

It is this test that provides the motivation for assigning monetary values to benefits and costs. Of course, this approach has obvious problems and very few economists would claim that the compensation test should serve as the sole criterion for social decision making. Importantly, the compensation test is a purely hypothetical exercise, in that actual compensation is never actually paid. Thus, there will be some winners and some losers under any policy choice even when the compensation test is passed. As such, the test ignores equity issues; it focuses only on maximizing the size of the economic pie rather than investigating how the pie is divided. It also does not account for the rights of future generations and non-human species. Yet, in spite of these ethical limitations, the compensation test does provide critical information that can be useful for decision making. All we economists are saying, ". . . is that society should think twice about doing things when those who would be made better off could not fully compensate those who would be harmed. . . in cases that fail the compensation test, would it not make sense to clearly and objectively consider the reasons for going ahead?" [Bishop].

But how do we estimate these values? Economists have long relied on market prices as a signal of economic values and a basis for determining social benefits and costs. The rationale behind this approach is that market exchanges involve voluntary transactions in which participants are concerned with their own best interest. In choosing whether or not to purchase a parcel of land, for example, I implicitly weigh the value of that land against the value of all the other goods that I must give up to purchase it. If I decide to purchase the land, then the value I place on that land is greater than the opportunity costs, measured in dollars, of all other goods that I have to give up to buy the parcel. In contrast, the relative value of the land and the other goods is reversed if I decide not to buy it. At some intermediate price level I will be indifferent between purchasing the land and not purchasing the land. This price is said to be my maximum willingness to pay for the land, and is the appropriate value for compensation tests involving policies that affect goods that are traded in markets.

However many "public" goods, such as environmental quality and open space amenities, are not traded in markets and thus do not have a price to serve as a benchmark for valuation. This does not mean that such goods have no value, it merely indicates that the goods cannot be bought and sold in markets. For example, a scenic view along a country road is said to have some value if it brings pleasure to someone driving down the road. Although markets do not presently exist for such items, the concept of opportunity cost, indifference, and maximum willingness to pay are equally relevant in this instance. The difference between the privately purchased land parcel (private good) and the scenic view (public good) is that the driver has probably never had to compare his or her personal value with a market price, since he/she does not have to pay for it. Moreover, in contrast to purchasing a private good, one viewer's consumption of the scenic view does not take away any value from subsequent viewers. Thus many individuals may receive value from one scenic view. As such, the sum of maximum willingness to pay across individuals for preserving the scenic view is the appropriate benefit measure in welfare analyses of public goods. Typically, this value is expressed on an average per-person or per-household basis by dividing the aggregate value by the relevant number of participants.

A similar logic extends to public disamenities or damages such as water contamination. In many instances, people would be willing to give up scarce resources in order to protect themselves from actual or perceived harm. For such situations the damages of contamination, or conversely the benefits of protection, can be measured by the maximum willingness to pay for a program that protects groundwater from contamination.

In the last few decades economists have developed techniques that try to measure these extra-market willingness to pay values [Anderson and Bishop; Mitchell and Carson; Freeman]. Although relatively new, these valuation techniques are accepted for use by many U.S. agencies including the USEPA, various agencies within the Department of Interior, and resource oriented agencies within the USDA. Such techniques are also accepted for use in environmental damage litigation [Kopp and Smith]. The remainder of this bulletin provides a summary of studies that have applied these techniques to the extra-market benefits and costs of agriculture.

The Amenities Benefits of Agricultural Lands

There are several motivations for protecting agricultural land. In the *Declaration of Legislative Findings and Intent* for the New York Agricultural Districts Law, two separate motivations for preserving agricultural land are specifically identified as follows:

> The socio-economic vitality of agriculture in this state is essential to the economic stability and growth of many local communities and the state as a whole. . . It is also the declared policy of the state to conserve and protect agricultural lands as valued natural and ecological resources, which provide needed open space for clean air sheds as well as for aesthetic purposes.

Economists have turned to a "non-market" valuation technique called contingent valuation in order to estimate the value of amenity benefits -the second motivation- and have generally not addressed the more equity based issues associated with economic stability and growth. The contingent valuation method uses survey techniques to ask people about the values they would place on specified improvements in environmental commodities if ideal markets did exist or other means of payment were in effect. With respect to agricultural lands, willingness to pay is elicited for protecting farmland from further urban encroachment or development.

A summary of the studies that have been conducted in the United States is provided in Table 1. In addition to the average values reported, several factors have been found to affect willingness to pay.

Table 1: Willingness to Pay (WTP) for Amenity Benefits of Agricultural Land

Authors (Date)	Location	Good	Average Annual WTP/Household ($)	Aggregate Annual WTP/Acre ($)
Bergstrom, Dillman and Stoll (1984)	Greenville Co., SC	General Farmland	7-12	18-44
Halstead (1984)	3 Counties, MA	General Farmland	34-230	56-492
Ready (1990)	KY	Horse Farms	73-252	n.a.

Dollar values converted to 1990 using the Consumer Price Index. Averages vary because a range of acreage or farms protected was evaluated in each study.

Among these, willingness to pay rises with the ratio of urban to agricultural land in the region, the income of respondents, and the degree of perceived threat to agricultural lands.

Researchers also note that quality/quantity issues may be important determinants in estimated willingness to pay values. That is, the type of agriculture being protected is at least as important as the amount of land or number of farms being protected. For instance, Ready argues that his estimated average willingness to pay values are higher than those found in other studies because Kentuckians have a particular affinity for horse farming. Similar arguments might be associated with nostalgic or scenic motivation attributed to smaller farm operations. A second quality issue raised in these studies is the fact that it is not clear whether these willingness to pay values are for farmland preservation *per se*, or if the values are motivated by a broader need for open space. While in some areas farmland and open space preservation are synonymous, in other areas a conflict between the two land uses may arise. Clearly, both considerations should be taken into account when evaluating policies that will affect the total land in farming as well as the composition of the farm sector.

Thus, while there is a strong indication that amenity benefits may be substantial, there is still much research left to be conducted in the measurement of these values in order to disentangle the motivations for valuing farmland preservation. Perhaps a more important issue at the local level is comparing these perceived benefits of protecting agricultural land with the perceived costs of certain agricultural practices discussed below.

The Costs of Soil Erosion

Soil erosion has on-site and off-site costs; both of which are generally not accounted for in markets. On-site costs of erosion are primarily associated with the long-term impact of soil loss on productivity potential. Excessive erosion diminishes this potential by reducing nutrient supply, water infiltration, and soil water holding capacity.

One method of evaluating productivity losses is to estimate soil depth and yield relations for individual soils. These "microstudies" compare the yields on land that has had varying levels of topsoil removed with the yields on undisturbed land of the same soil type. Cultivation techniques are typically assumed to be the same across levels. Aggregating the results from a number of soil loss microstudies, Lyles arrived at an average linear yield reduction per inch of topsoil lost equal to 6.3%, with a standard deviation of 1.3%. In a separate review of a number of studies, Langdale and Schrader found a much wider variation in observed yield loss: ranging from over 6% per inch of soil lost in one study to no observed effect when 10 inches of topsoil were removed in another study. The principal conclusion to be drawn from these microstudies is that productivity losses from erosion are site and soil specific.

A second method of evaluating the impacts of soil loss on crop productivity focuses on the impacts of cropland erosion at a regional or national level. These "macrostudies" are generally reported in terms of percentage reductions in potential productivity per period of time. For example, the USDA estimated that productivity losses associated with 1977 erosion rates are approximately 8% over 50 years; a University of Minnesota model estimated that the average change in productivity for each of the Major Land Resource Areas in the Corn Belt ranged for 1.0 to 4.9% over 50 years [Pierce *et al.*]; and a Resources for the Future study estimated that 1980 corn and soybean production was 2-3% lower than it would have been without erosion in the period from 1950-80 [Crosson and Stout].

Off-site costs of soil erosion and erosion related pollutants are largely incurred by the public and can be separated into in-stream damages (biological impacts, recreational impacts, water storage damage, navigation, and other "preservation values") and off-stream effects (flood damage, sediments in water conveyance, water treatment). As Table 2 suggests, the estimated average off-site costs per ton of soil erosion are not uniform across the country. The wide deviations in these estimated costs across cropping regions are primarily attributed to regional differences in the demand for surface water. With high population concentrations and high demands for in-stream and withdrawal uses of water, the Northeast has relatively high off-site damages per ton of soil eroded. In contrast, although the aggregate levels of soil

Table 2: Off-Site Damages per Ton of Soil Erosion by Farm Production Region

Farm Production Region	Northeast	Lake States	Delta States	Pacific	Southern Plains	Southeast	Appalachian	Corn Belt	Mountain States	Northern Plains
Erosion (1,000 tons)	185,000	181,000	234,000	669,000	490,000	250,000	484,000	970,000	1,003,000	671,000
Damages per ton ($)	7.30	3.77	2.72	2.01	1.98	1.93	1.44	1.26	1.06	0.64

Source: Ribaudo, M., 1986. Dollar values updated to 1990 by Consumer Price Index.

erosion are much higher in the Northern Plains and the Mountain States, the average damages per ton are much lower due to lower demands for surface water.

In general, off-site costs of agricultural erosion exceed the on-site costs of erosion by a factor of 2 to 8. For example, Crosson and Stout estimate that the national on-site costs of agricultural soil erosion to be $600 to $800 million annually. For comparison, Clark estimates that the national off-site costs of agricultural erosion are at least $2.2 billion annually.

Table 3 translates on-site and off-site estimates of costs to the farm level for soil conditions and three different crop rotations that might be found in Central New York. Using continuous corn as an example, a farm with 200 acres of cropland eroding at 8.2 tons per acre could result in $11,972 of off-site costs per year. From the perspective of the compensation test, the important question in examining these costs is, "Do they matter?". In other words, would farm production decisions change if farmers took these costs into account. The answer, of course, depends on many factors. For example, in comparing such costs with the profitability of alternative rotations ranging from continuous alfalfa to continuous corn, Poe *et al.* 1991 found that the net benefits (i.e. profits less erosion costs) were maximized in mixed rotations for those midwest farmers who did not participate in government commodity programs continuous corn maximized net benefits even though erosion levels were quite high. However, for farmers who did participate in government commodity programs. Continuous corn received the most privately profitable rotation even when off-site and on-site erosion costs were considered. Similarly, Leathers examined the costs and benefits of installing Soil Conservation Service best management practices on individual farms in Maryland, and found

Table 3: USLE Values and Off- and On-Site Costs of Erosion ($)

Rotation	USLE (T/A)	On-Site Costs/Acre	Off-Site Costs/Acre
Continuous Corn	8.2	3.62	59.86
Corn/Corn/Corn/ Small Grain/Hay/Hay	2.5	1.13	18.25
Corn/Corn/Small Grain/Hay/Hay	1.3	0.59	9.49

USLE Assumptions: 6 percent 200-foot slope; contour strip cropping where appropriate; fall plowing, R=100; silt loam soil. On-site costs calculated following Poe *et al.* 1991; 20-year time horizon.

that the costs of adopting practices exceeded the erosion benefits in 28% of the cases studied. In both these studies, it is important to recognize that the production changes investigated involved relatively large investments or shifts in practices. It is likely that more marginal changes in production, such as contour plowing or strip cropping, might have relatively little production costs but result in large societal benefits.

The Costs of Groundwater Contamination

Agricultural contamination of groundwater is probably the dominant agro-environmental policy issue at present. Nationwide, the Environmental Protection Agency has detected the presence of 74 pesticides in groundwater in 38 states (USEPA) and a recent United States Department of Agriculture study projects that as many as 53.8 million people could be negatively affected by agricultural contamination of groundwater [Lee and Nielsen; Nielsen and Lee].

In fact, and in public perception, it is clear that agricultural contamination of groundwater is no longer simply a problem of farmers polluting their own wells. Public opinion polls indicate that people perceive agricultural practices as a problem affecting their well-being. For example, a 1986 poll in Iowa found that 52% of those surveyed identified farm chemicals as the biggest threat to drinking water, and 78% favored limiting the amount of fertilizers, herbicides, and insecticides that farmers could use even if such action resulted in reduced agricultural production [Batie].

The costs of groundwater contamination have not been adequately addressed at the regional or national level, and have not been traced back to practices on individual farms. However, there are some strong indications that economic damages associated with degradation in groundwater quality are being incurred because of agricultural practices. In some areas of the U.S., public wells have been closed because of nitrate and pesticide contamination, neighbors are suing farmers for contaminating the groundwater, cities and towns are annexing lands to protect their wellheads, households with contamination are investing in water purification systems, and banks are requiring safe drinking water tests for nitrates. All these actions serve as indicators that society is willing to give up scarce resources to protect its drinking water from agricultural contamination. In other words, there are economic costs associated with groundwater contamination.

Economists are developing techniques to estimate the magnitude of these damages in dollar terms. One approach has been to use averting costs as a proxy for damages. For example, how much would a household have to pay to purify their water if it were determined to be contaminated? Using these techniques, studies suggest that the damages associated with removing nitrates and pesticides from water range from $160-580 per year depending on the option selected and the number of people in the household. Table 4 provides estimates of some of these costs for households in Northern New York.

A second possible approach to valuing the cost of groundwater contamination would be to examine the effects on private property values, under the assumption that homeowners are willing to accept a lower price when selling their homes in order to avoid the risk of drinking contaminated water and that buyers similarly prefer houses without contamination. From an

Table 4: Estimated Costs of Household Remedial Responses to Reduce Agricultural Chemicals in Drinking Water

Option	Estimated Costs per Year
Water Treatment Unit:	
Distillation P,N	$360 (lease)
Ion Exchange N	$360 (lease)
Reverse Osmosis P,N	$216-580 (rent/lease)
Bottled Water P,N	$160-175 per person per year delivered to home

P = Pesticide, N = Nitrates

Source: Poe, G. L., M. Duroe, and H. vanEs, 1994.

econbomic perspective the reduction in property would be approximately equal to the amount that a household would be willing to pay to avoid such exposure. Whereas some studies have found that residential values are reduced if a site is near a sanitary landfill or a hazardous waste site [e.g., McClelland *et al.*; Reichart *et al.*], other research that has focused on the relationship between actual contamination levels and the value of residential properties have found little or no effect of contamination on property values [Page and Rabinowitz; Malone and Barrows]. These latter studies note, however, that the lack of an statistically significant relationship between contamination and property values may be attributed to other factors in the study design, location, and analysis.

It is likely that the costs of groundwater contamination exceed estimated costs that are based on averting expenditures or changes in property values. Recall that from an economic perspective the benefits of a project that reduces groundwater contamination are equal to the maximum (or total) amount that individuals would be willing to pay in order to experience that reduction. With respect to averting expenditures, bottled or treated water may not be perceived as a perfect substitute for pure unpolluted water, and individuals may be willing to pay much more for groundwater protection than they would be for groundwater treatment. Averting expenditures and property value reductions might also underestimate true willingness to pay for groundwater protection because individuals may also value groundwater protection for stewardship, altruistic, or bequest motivations. [See O'Neil and Raucher article] Moreover, households may be worried about their exposure levels outside the home, such as at school, at work, at restaurants, or at a neighbor's home.

Recently, several contingent valuation studies have been conducted to try to estimate the total value of groundwater contamination (or conversely the benefits of protection). Results from these studies indicate that the average willingness to pay for protection of groundwater from contaminants may be in the several hundred dollar range. Some regional and agriculturally related willingness to pay values for protecting groundwater contamination levels from exceeding government standards are presented in Table 5. In addition to the average values reported, willingness to pay was found to be positively correlated with exposure risks in these studies: households with high levels of exposure were willing to pay much more for protection than households with low levels of exposure [Boyle, Poe, and Bergstrom]. Again, this raises the point observed in erosion and amenity valuation that the perceived benefits of changing policy will vary across sites and communities.

Table 5: Willingness to Pay (WTP) for Groundwater Protection ($/household/year)

Authors (Date)	Location	Contaminants	Average Annual WTP ($)
Agricultural			
Jordan and El Nagheeb (1993)	GA	Nitrates	142-184
Poe (1993)	Portage Co., WI	Nitrates	211-353
Sun, Bergstrom and Dorfman (1993)	Dougherty Co., GA	Nitrates and Pesticides	493-890
Regional			
Powell and Allee (1990)	15 Communities MA, PA, NY	General, Including Agricultural Sources	55
Schultz and Lindsay (1990)	Dover, NH	General	129

In comparing the values associated with contamination to the benefits of agriculture in Portage County, Wisconsin, Poe and Bishop estimated that the damages associated with groundwater contamination from nitrates corresponded to less than 7% of the net returns to farming. In another comparison, Smith estimated that the value of the crops produced was about 16 times the costs associated with groundwater contamination from agricultural practices in states that had counties with potential agricultural contamination. Whether these costs seem large or small is a matter of personal perspective. Moreover, such broad comparisons are largely irrelevant for the compensation test criteria. Instead, from a policy perspective, it would be more appropriate to examine the benefits and costs associated with alternative agricultural practices. In some instances small changes in practices might lead to substantial reductions in contamination, and hence have very high benefit to cost ratios. In others, very costly changes in practices might results in fairly low benefits. Unfortunately, as noted previously, economists, hydrologists, and agronomists have not yet linked the values associated with groundwater contamination back to the farm level, and thus such a comparison remains an important area of future research.

The Policy Challenge

This bulletin has provided a rationale for and some examples of measuring extra-market values in agriculture. The results suggest that both the extra-market benefits and costs may be large, and that they may vary substantially from site to site. As a result, the implications for land use will vary from site to site. If, in a given area, there are significant positive amenity benefits, then private land markets will tend to underallocate land to agriculture [Lopez, Shah, and Altobello]. In contrast, if it is found that the costs of agriculture are high and exceed the amenity benefits, then land retirement as a primary pollution control tool may be a socially desirable intervention in the marketplace [Ribaudo, Osborn, and Konyar].

The challenge for policy makers at the federal, state or local levels is to incorporate these concepts into farmland policy. Because agricultural land is associated with both extra-market benefits and extra-market costs, and these values are site specific, greater consideration needs to be given to developing new policies that account for site variation, differences in social structure, and relationship of farms to the broader community, in order to maximize the net benefits from agricultural land uses. At the federal level, balancing the social benefits and costs of farmland use might be obtained by more specific targeting of reserve, cross compliance, and water programs. At the state and local levels, policies might be adopted which use monitoring and targeting to restrict selected farm practices only when needed, link-use value taxation and other farmland preservation strategies to the implementation of best management practices, and aid farmers in adopting practices that reduce off-site costs. For example, Nebraska has instituted a series of fertilizer restrictions that kick in when increasing levels of nitrates are found in area wells. Counties in Wisconsin have created a pilot program that links property tax credits to implementation of an approved conservation plan. Other states and cities have identified high priority watersheds or wellheads in which greater cost sharing is provided to encourage the implementation of best management practices.

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