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Thomas Dobbs  
*South Dakota State University*

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**Agricultural, Resource, and Ecological Economics  
with a 'Multifunctionality' Perspective**

by

Thomas L. Dobbs\*

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\*Professor of Agricultural Economics at South Dakota State University

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## **Agricultural, Resource, and Ecological Economics with a 'Multifunctionality' Perspective**

**Thomas L. Dobbs**

It would seem that agriculture in industrialized countries is experiencing 'the best of times' and 'the worst of times'. Productivity per unit of land and, consequently, aggregate food and fiber output have climbed dramatically since World War II. Food is generally 'cheap' relative to average per capita incomes. However, the costs of this abundance are becoming increasingly apparent. Drinking water supplies are becoming contaminated, bird and fish populations have declined, plant and animal biodiversity has been lost, and soil organic matter has declined. Also, agriculture appears increasingly vulnerable to human and animal health scares. Witness the recent outbreaks in Europe of 'mad cow disease' (bovine spongiform encephalopathy, or BSE) and 'foot and mouth disease'. Moreover, hired farm laborers and animal slaughtering house workers often are poorly paid and work in unsafe conditions. In spite of the abundant and cheap food supplies, poverty and malnutrition persist among some groups within the larger, affluent societies of industrialized countries. Persistently 'low' crop prices have caused governments to continue—and even increase—large direct payments to farmers to support their incomes. Add to these concerns the increasing economic concentration and vertical integration within both the agricultural supply sector and the agricultural processing and marketing sector that are causing farmers to feel ever more vulnerable to 'market forces'.

This apparent contradiction between agricultural abundance, on the one hand, and ecological and social breakdown, on the other, has caused the British government to fold

its agricultural and food ministry into a new, combined Department of the Environment, Food and Rural Affairs. This was a prelude to proposals for radical reform of agricultural in the United Kingdom (UK) that would put much greater emphasis on ‘multifunctionality’. In France, the government has recently launched a program of Contrats Territoriales d’Exploitation (land management agreements, or CTEs) as part of its expanded emphasis on multifunctionality. Even the US Congress finally began to openly discuss a more multifunctional approach to agricultural policy in dialogue leading up to passage of a new Federal ‘farm bill’ earlier this year. Although that new legislation retains and reinforces the historically strong emphasis on support for conventional agricultural commodities, the newly created Conservation Security Program does contain elements of a more multifunctional perspective.

### **Multifunctionality**

A ‘multifunctionality’ approach to agricultural policy—or, more aptly, *agri-environmental policy*—explicitly acknowledges that agriculture has several functions in addition to producing food and fiber (Dobbs and Pretty, 2001b, pp. 2-6). Agriculture also can provide goods and services that are ‘ecological’ and ‘social’ in nature. Ecological or environmental functions include provision of clean water supplies, bird and other wildlife habitat, scenic landscapes, carbon sequestration (to reduce greenhouse gases and mitigate global warming), and flood protection (by wetlands). Social functions include provision of rural employment and, potentially at least, support for democratic institutions based on ‘Jeffersonian’ ideals of egalitarian land holding patterns and associated ‘structures of agriculture’.

How these multiple functions are expressed is often related to scale. Food production may be primarily for local or regional consumption, or primarily for national or international markets, depending on how agricultural economies are organized. Some ecological services, such as provision of habitat for particular wildlife species, may be primarily local in nature. Clean water supplies may sometimes benefit primarily people outside the local area, but elsewhere within the watershed—namely residents of urban areas. Carbon sequestration is very much a global function of agriculture. Rural employment is primarily local in nature, whereas contributions to ‘Jeffersonian democracy ideals’ have both regional and national implications.

It is apparent that multifunctional economic analyses must start with particular spatial perspectives. For purposes of this paper, I will assume three different perspectives: (1) that of the individual farm, where decisions in market economies about production practices and systems have traditionally been made; (2) that of the local or regional level, ranging from the community surrounding a rural town up to watershed, State, and multi-State areas representing particular types of agricultural ecosystems; and (3) that of national and international economies, where effects of agricultural systems on food prices, human and animal health, and climate change are felt—and where public policies are made that powerfully impact the structure and directions of agriculture.

### **Economic Treatment of Multifunctionality**

Economists have been using some economic analysis methods for many years that directly relate to agriculture’s multifunctionality. The field of ‘natural resource economics’ (earlier known as ‘land economics’) has roots in late-18<sup>th</sup> and early-19<sup>th</sup> Century writings of the British ‘Classical’ economists Adam Smith, David Ricardo, and

Thomas Malthus. 'Land economics' became an important area of inquiry in the U.S. in the late-19<sup>th</sup> and early-20<sup>th</sup> Centuries, drawing initially on the German historical school of economics. The University of Wisconsin was an early and prominent leading institution in land economics research and teaching. The economics of conservation took on prominence in the 1950s at the University of California, under the leadership of Ciriacy-Wantrup, and comprehensive work on a broad set of natural resource economics concerns began to take place under the leadership and sponsorship of Resources for the Future, established in Washington, D.C. in 1952. The body of work known as modern 'welfare economics' began to be systematically included in natural resources research and policy analysis. This led to many published works about, and a deeper understanding of, 'externality' and 'public goods' dimensions of agriculture in the 1950s, 1960s, and 1970s. (Castle, et al., 1981) Resource economists devoted substantial attention to the valuation of 'non-market' environmental goods during the last three decades of the 20<sup>th</sup> Century.

While the concepts of 'externalities' and 'public goods' dominated mainstream natural resource economics work from the 1960s through the 1990s, a related but more radical form of economic thinking about agricultural and other natural resources arose during the 1980s—'ecological economics' (Costanza, et al., 1997, p. 49). This emerged out of a combination of ecology and economics, much as the discipline of 'agricultural economics' had emerged out of a combination of agronomy and economics around the beginning of the 20<sup>th</sup> Century (Dobbs, 1987). The writings of University of Colorado economist Kenneth Boulding, starting in the mid-1960s, were instrumental in helping to bring together the thinking of ecology and economics, disciplines which had been

pursued largely apart from each other during most of the 20<sup>th</sup> Century (Costanza, et al., 1997, p. 51). ‘Ecological economics’ takes a more holistic perspective than does ‘natural resource economics’, and—drawing on its ecology roots—explicitly considers the interconnectedness of the various components of natural resource systems. Ecological economics also poses fundamental questions about the ecological sustainability of different economic systems, whereas natural resource economics tends to take market-based economic systems as given and considers how the systems might be fine-tuned to produce more socially desirable ecological results. In fairness, ecological economics draws heavily on the body of theory that was built up over a century in ‘land’ and ‘natural resource’ economics. However, ecological economics opens the door to a wider range of policy considerations than, traditionally applied, does natural resource economics.

In the sections of this paper to follow, I will draw on both ‘natural resource economics’ and ‘ecological economics’, though I will not stress distinctions between the two. First, I will discuss applications of multifunctional economic analysis at the farm level. Then, I will discuss applications at the local or regional level, drawing heavily on ‘natural resource economics’. In the last section, dealing with multifunctional economic analysis at the national and international level, I draw on both natural resource economics and ecological economics.

### **Analyses at the Farm Level**

Following Crews, et al. (1991), I usually define ecological sustainability in ecological terms. Once ecological sustainability objectives have been specified at the farm level, economics enters the picture. Farming systems thought to satisfy ecological

sustainability objectives must be attractive to farmers if they are to be voluntarily adopted and continued.

### **Farmer incentives**

Goals to maintain or increase profits are central to virtually all analyses of farmers' incentives to adopt new or different technologies or systems. However, it is well recognized that goals related to risk also play an important role in farmers' decisions. The risk averse behavior that farmers (like other people) often exhibit can have substantial implications for agri-environmental policy. Oglethorpe (1995), for example, has demonstrated that greater variability in the market for agricultural goods can be more conducive to farmer-adoption of less intensive practices than would be the case with more stable markets. One implication of this is that if government income protection policies take most of the risk out of intensive, specialized farming, the costs of utilizing agri-environmental policies to induce farmers to voluntarily adopt less intensive, more ecologically sustainable farming systems can be high.

Many farmers obviously have other goals, as well—including having adequate leisure and family time and having a sense of independence. A set of goals with special relevance to this paper, however, relates to stewardship of natural resources. Some farmers base their farm stewardship decisions on ethical grounds to a much greater extent than do others, where ethical is meant to include reasons other than pure self-interest (Colman, 1994). Thus, it is logical to posit a 'stewardship' goal when examining farmer incentives to adopt ecologically sustainable systems. This goal can be interrelated with goals to have social standing in the local community, when and where the public values sound stewardship.

Other considerations certainly enter into farmers' decisions about adoption of sustainable practices, including the ability to maintain flexibility and not be tied down by bureaucracy. While those considerations should not be ignored, the primary focus in this paper—following Dobbs and Pretty (2001a)—is on the following three sets of goals:

1. To maintain or increase net income (profits) from farming.
2. To avoid 'excessive' risk with the income-generating activities of the farm;
3. To maintain sound stewardship of the farm's natural resources.

These goals are the ones thought to be most directly relevant to farmers' decisions about adoption and continued use of ecologically sustainable farming practices.

### **Economic measurement**

Sometimes economic measurements to determine farmers' incentives to change to more environmentally sound farming *practices* can be carried out with farm management budgeting on a single crop or enterprise. Changes in tillage practices or timing of fertilizer applications are examples where such an approach might suffice. Moves to fundamentally different farming *systems*, however, require measurement of economic changes across the entire farm or, at least, a major portion of the farm. A change from a chemical-intensive corn-soybean crop system with no livestock to a farming system that integrates small grains, forage legumes, and one or two livestock enterprises with reduced-chemical corn and soybeans would call for a 'whole-farm' analysis that accounts for the numerous interacting changes that impact profits, risk, and natural resource stewardship. An interrelated set of changes in crop rotations and fertility and pest control methods would necessitate, at least, a 'whole-rotation' analysis. Side-by-side economic comparisons of profits and risks of individual crops—say, comparison of corn in the

farmer's current system to corn in the new or proposed system—would have little meaning. It is only the net, overall effect on profits, risk, and stewardship that has meaning for such *system* changes.

Madden and Dobbs (1990) have discussed some of the procedures and considerations in carrying out whole-farm and other systems analyses. There often seem to be conflicting findings among various economic analyses comparing 'conventional' and 'more ecologically sustainable' farming systems. Among the reasons that underlie *apparent* conflicts in findings from different studies are these (Dobbs, 1994):

1. Are short-run or long-run measures of profitability used?
2. Are Federal farm program provisions accounted for in the whole-farm models or are they ignored (or greatly simplified)?
3. Is family labor included as a cost in the enterprise budgets?

The approaches taken sometimes depend on the question(s) being asked. In our farming systems studies at South Dakota State University (SDSU), we generally have asked "Is there adequate incentive over the long run for farmers in particular agro-climatic areas to adopt organic farming systems or other systems with dramatically lower chemical-input needs?" Consequently, we have attempted to include all costs related to 'conventional' and 'alternative' systems—including machinery depreciation costs and family labor costs. Over the long run, machinery must be replaced, and even family labor has 'opportunity cost'. We also have generally included farm program payments and related provisions (e.g., acreage set-aside requirements, when they existed), since payments and restrictions in some form seem to be permanent fixtures of agriculture in industrialized countries. However, since the level and forms of payments and related

provisions are constantly changing, we often conduct sensitivity analyses to observe how economic comparisons are affected by possible changes.

### **Applications**

Under the leadership of James Smolik, researchers at SDSU carried out of two sets of studies at the Northeast Research Station from 1985 through 1992, comparing selected 'alternative' (organic), 'conventional', and 'reduced tillage' crop rotation systems. Descriptions of the systems and the agronomic and economic methods of analysis are presented in Smolik, et al. (1995). This was a 'whole-system analysis' of the crops portion of hypothetical farms using the different systems. Possible changes in livestock that might result from changes in crop systems were not explicitly considered. We assumed that markets would be available for hay produced by one of the alternative (organic) systems. A summary of the profitability comparisons from 1986 (omitting 1985, the establishment year) through 1992 is shown here as Table 1.

Several measures of net income, averaged over the 7-year study period for each system, are shown in this table. The first measure, shown in the third column of data, includes a deduction for all costs (including items like machinery depreciation and interest) except land, labor, and management. The next measure (in the fourth column) includes all costs in the first measure plus a charge for labor used for crop production. A land charge is included in the final measure (in the fifth column); this final measure is referred to as net income over all costs except management. The land charge is the same for all systems. This final measure constitutes what is often referred to as pure profit or as return to management for planning and risk taking. The same measure is shown in the last column of Table 1, except there it is on a whole-farm (540 crop acres) basis.

**Table 1. Average economic results in the Farming Systems Studies (1986-1992).**

System <sup>a</sup>	Dollars/Acre					
	Direct Costs Other Than Labor	Gross Income	----- Net Income Over -----			Whole Farm Net Income Over All Costs Except Management (\$) <sup>b</sup>
			All Costs Except Land Labor, and Management	All Costs Except Land and Management	All Costs Except Management	
<b>Farming Systems Study I</b>						
1. Alternative (oats-alfalfa-soybeans-corn)	45	153	75	63	37	20,139
2. Conventional (corn-soybeans-s. wheat)	62	151	58	49	23	12,328
3. Ridge Till (corn-soybeans-s. wheat)	69	139	41	32	6	3,149
<b>Farming Systems Study II</b>						
1. Alternative (oats-clover-soybeans-s. wheat)	30	101	47	38	12	6,443
2. Conventional (soybeans-s. wheat-barley)	48	127	49	39	13	6,803
3. Minimum Till (soybeans-s. wheat-barley)	59	116	29	20	-6	-3,360

<sup>a</sup> Crops are shown in the order in which they occur in each rotation.

<sup>b</sup> For farm with 540 tillable acres.

Source: Dobbs (1993), p. 51

Just for illustrative purposes, see the net income over all costs except management data in the last two columns. The alternative system was the most profitable in Study I. Net income per acre was almost identical for the alternative and conventional systems in Study II, and net income for the minimum till system in that study actually was negative, on average—meaning gross returns fell short of covering all costs for that system. (Dobbs, 1993)

‘Management costs’ refer here to opportunity costs of the farmer’s time spent in planning, observing crops and making production-related decisions, and marketing. They were not included simply because of the difficulty in objectively measuring differences among systems in those costs. Overall, management costs probably are somewhat higher for the types of alternative systems we analyzed than for the other systems. Therefore, a net income measure that also factored in management costs probably would have slightly reduced the profit advantage of the alternative system in Study I, and it probably would have caused the slight advantage of the conventional system in Study II to increase (relative to the alternative system).

The Federal farm program during the study period affected the net income of the various systems differently, with the alternative system receiving an average of \$9/acre less per year in government payments than the other systems in Study I. In Study II, the alternative system received an average of \$4/acre less than the other systems. (Dobbs, 1994)

We also examined the relative attractiveness of these systems to farmers from the standpoint of *risk*. One measure of the risk associated with different farming systems over time is the variability in profits over time, as measured by the *standard deviation*.

Net income over all costs except management was much less variable for the alternative system in Study I, for example, than for the conventional and ridge till systems. The standard deviation for the alternative system was \$16.60/acre, compared to \$31.30/acre for the conventional system and \$29.60/acre for the ridge till system. Also, the alternative system never had negative net returns; this downside risk protection is an important consideration for most farmers. (Smolik, et al., 1995)

What about measures of the possible implications of these different systems for farmers' stewardship goals? It is difficult, if not impossible, to quantify all the relevant dimensions of stewardship. The research team did examine possible soil erosion and water quality implications, however. The alternative and reduced till systems were the only systems that consistently met or exceeded Federal farm program conservation compliance regulations for residue cover on highly erodible land. Therefore, it was concluded that both types of systems should adequately address soil erosion concerns and may help limit nitrogen and phosphate runoff. Nitrate-N levels in Study I were measured by soil cores in the last year, and were found to be about 2 to 3 times higher in conventional and ridge till systems than in the alternative system. Higher N levels may not necessarily indicate an environmental problem if groundwater is not vulnerable, or if the N is in the upper layers of the soil profile, where crops can readily use it. However, most of the nitrate-N in the conventional and ridge till systems was below 2 feet, suggesting the potential for groundwater pollution is greater for those systems than for the alternative system. (Smolik, et al., 1995)

The economic results cited here for our studies at SDSU's Northeast Research Station were based on the assumption that no organic price premiums were received for

production from the alternative (organic) systems, even though farmers using those systems would have been eligible for organic certification and any available price premiums after 3 years. We made this assumption to be 'conservative' with respect to organic market expectations, in case substantial expansions in organic acreages were to wipe out or greatly diminish price premiums. In a companion study comparing an actual operating organic farm in east-central South Dakota with a neighboring organic farm, we did include organic price premiums for years in which we had appropriate data. In that study—covering 1985 through 1992—the organic farm was less profitable than the conventional farm most years, when organic price premiums were not factored in. Over the 4-year period 1989-1992, for which we had information on price premiums the organic farmer received on some of his production, including those premiums added an average of \$11/acre to net income over all costs except management. This was enough to narrow but by no means close the net returns gap between the organic and the conventional farm during that period. (Dobbs and Smolik, 1996) Organic price premiums generally were much higher in the late-1990s (Bertramsen and Dobbs, 2001), so the results might have been different had the study been continued for several more years.

### **Analyses at the Local and Regional Level**

Multifunctional economic analysis at the local or regional level takes account of certain 'external' effects of agricultural production systems that are not necessarily considered by farmers in their management decisions. The natural resource economics literature dealing with 'market failure' provides the theoretical basis for this analysis.

## **Market failure**

‘Externalities’ consist of spillover effects from agricultural production—either positive or negative—that are uncompensated (or not accounted for in farmers’ costs, if negative) in unregulated markets. Since externality values are not reflected in market transactions, markets often ‘fail’ to produce the socially desired amounts of primary agricultural commodities and the externalities associated with those commodities. In the case of negative externalities, such as nitrate contamination of local groundwater by intensive corn production, ‘too much’ corn is produced and ‘too much’ polluted water (‘too little’ clean water) is produced. Farming systems that incorporate forage or green manure legumes and small grain crops in rotations with row crops provide a biologically diverse habitat for many birds and beneficial insects. This can be thought of as a positive external effect, in part, of forage and green manure legumes that is uncompensated in the market. Consequently, ‘too little’ of such legumes is grown, relative to, say, corn and soybeans. (Prato, pp. 91-104; Zilberman and Marra, pp. 221-234)

Market failure is based on ‘technological’ (or physical) externalities, rather than on ‘pecuniary’ (or price-effect) externalities. Pecuniary externalities result, for example, when individuals or firms purchase or sell large enough quantities of a good or service to affect price levels. The change in price levels affects people who are not directly involved in the original transactions, but who now face higher or lower prices as a result of those original transactions. These pecuniary externalities help some groups and hurt others, but they do not necessarily constitute a ‘failure’ of the market economy (Davis and Kamien, 1972). In contrast, ‘technological’ externalities—such as the off-site effects of soil erosion—often do result in market failure. It is technological externalities that are

commonly simply termed ‘externalities’ in most of the current environmental literature (see Common, 1995; Knutson, et al., 1998).

Many of the positive externalities relevant to multifunctional analysis at the local or regional level have characteristics of what economists call ‘public goods’. These are goods for which no one (practically speaking) can be excluded from enjoying, and use by one individual does not diminish the availability of the good for use by other individuals. Examples include certain types of wildlife for observation and scenic rural landscapes. (Mullarkey, et al., 2001, p. 32) Of course, beyond some point of ‘crowding’, some such amenities could lose the characteristic of non-competitiveness in use.

An important consideration in multifunctional economic analysis is the extent of ‘jointness in production’ (Cahill, 2001). A true technological externality implies some jointness, say between dairy production in Wisconsin and a scenic landscape dotted with big white barns. In that example, the end of dairy production in an area could spell the eventual deterioration and disappearance of the scenic barns. On the other hand, more cows or more milk production per cow will not necessarily lead to more barns and ‘improved’ scenery. Thus, there is some ‘jointness’, but it is not absolutely rigid. How best to save the white barns depends in part on this degree of jointness. One might let dairy production disappear altogether in particular areas, yet pay farmers for maintaining the barns, i.e., for the scenic ‘function’. But would barns without any dairy cows at all around them or in nearby pastures provide quite the same ‘scenery’? The point here is that analyses of policy alternatives for encouraging the beneficial multiple functions of agriculture must consider the nature and degree of ‘jointness’ between commodity and non-commodity outputs (Cahill, 2001, pp. 37-38).

I will return to the topic of policy alternatives in the section on multifunctionality analysis at the national and international levels. At this point, however, I turn to economic measurement of non-commodity outputs of agriculture.

### **Economic measurement**

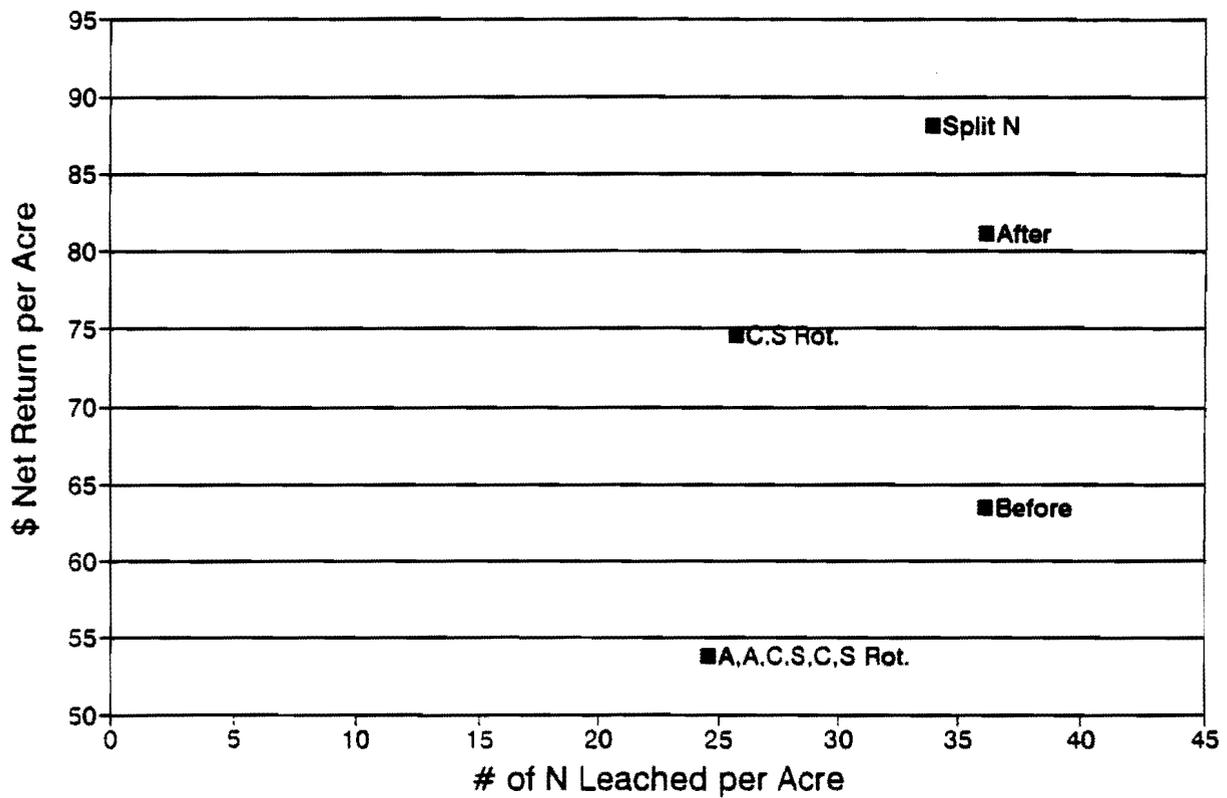
By their very nature, many of the non-commodity outputs of agriculture are difficult to quantify, especially in monetary terms. Consequently, non-monetary measures of benefits or costs frequently are heavily relied upon. Examples might be bird species restored, reductions in soil erosion in terms of tons of soil per acre, miles of public footpaths provided through scenic farm landscape, or acres of native grassland preserved.

Economists have devoted a great deal of effort over the last several decades to developing techniques for placing monetary values on 'non-market' goods. The economic theory upon which these techniques are based rests on concepts of 'willingness to pay' and 'willingness to accept compensation'. Both indirect and direct methods of measurement have been used. An indirect method that has been much used for certain kinds of recreational experiences is the 'travel cost' approach. In this approach, travel distances and costs of participants in a recreational activity are used to estimate demand—or willingness and ability to pay—functions for the activity. The 'contingent valuation method' (CVM) is the most common direct valuation method. This method relies on surveys of sample households in which responses are elicited about willingness to pay or to accept compensation. (Prato, pp. 305-329)

## Applications

A study of the relationships between farming practices and systems and water quality in the Sioux River drainage of eastern South Dakota illustrates quantitative, but non-monetary measurement of an environmental externality. Dobbs and Bischoff (1996) estimated net returns to land and management for different practices and crop rotation systems on four farms in the study area, as well as the probable nitrate leaching to groundwater with each of the same combinations of farm practices and systems. A model called the Nitrate Leaching and Economic Analysis Package (NLEAP) was used to estimate nitrate leaching. The relationships measured in this study for one of the case study farms are shown in Figure 1. This farm was an irrigated farm, on which continuous corn was being grown on 73 acres (the 'Before' scenario in Figure 1). The other scenarios represent various changes that might have been possible, with financial assistance at the time from an agri-environmental program called the Water Quality Incentives Program (WQIP). Estimated net returns increased by \$18/acre (29%) where the WQIP involved eliminating dry pre-plant inorganic fertilizer (i.e., moving from the 'Before' to the 'After' scenario); the nitrate leaching did not change much, however. Profitability was 9% greater when the alternative practice of splitting nitrogen applications also was added to the 'After' scenario. Changes that involved alternative crop rotations lowered net returns—to \$75/acre for a corn/soybean rotation and to \$54/acre for a 6-year rotation involving alfalfa, corn, and soybeans—compared to \$81/acre in the 'After' scenario and \$88/acre in the 'splitting nitrogen' scenario. Environmental results for splitting nitrogen applications indicated an 8% decrease in the amount of nitrate leached when compared to the 'After' scenario. Changing rotations

**Figure 1. Profitability/N Leaching Relationships:  
Case Farm #4 (typical year)**



Source: Dobbs and Bischoff (1996), p. 19

showed greater decreases in nitrate leaching, however. Estimated nitrate leached went from 36 lbs/acre in the 'After' scenario to 26 lbs/acre in the corn/soybean rotation system and to 25 lbs/acre in the 6-year crop rotation system (Figure 1).

Our research comparing organic to other farming systems in northeastern South Dakota, discussed in the section of this paper on analyses at the farm level, can be used to illustrate non-monetary measurement of a 'social function'. There is a great deal of interest in how different farming systems affect farm size and the resulting structure of agriculture. Many factors affect farm size, including the farm's ability to generate adequate levels of family income. Therefore, we analyzed the potential farm size implications of the labor and management returns associated with different systems included in that research. In Study I, where systems included substantial amounts of corn and soybeans and where labor intensiveness was greater for the organic system, a conventional farm would have had to be nearly twice as large as an organic farm to generate \$40,000 in net returns to family labor and management. On the other hand, in Study II, where systems consisted primarily of small grains, labor intensiveness was lower for the organic system and there was little difference between the organic and conventional systems in returns per hour of labor and management. Therefore, the implied difference in farm size was much less in Study II. (Smolik, et al., 1995, pp. 32-33)

Economists in Iowa recently estimated 'willingness to pay' for either prevention of further deterioration of water quality or for improved water quality (Azevedo, et al., 2001). This was part of a comprehensive analysis of alternatives to maintain and improve water quality in Clear Lake, Iowa. Monetary estimates were made of the value

both visitors and local residents placed on preservation and/or restoration of the lake. Estimates revealed a high willingness to pay to avoid further deterioration of the lake, a willingness to pay only moderate amounts for a low quality improvement, and a willingness to pay substantial amounts for a significant quality improvement to lake conditions.

Economists in the UK have conducted extensive analyses of agri-environmental schemes carried out there since the mid-1980s. Hanley, et al. (1999) recently summarized a review by Stewart, et al. (1997) of the major cost-benefit analyses of those schemes. Ten of the twelve schemes covered in this review were part of the Environmentally Sensitive Areas (ESA) program. (When the ESA program was launched in 1986, it was the first agri-environmental program in the European Union.) The CVM method was used in most of the studies to estimate monetary benefits of the schemes. In many of the evaluations, a range of benefit estimates was presented. Benefit estimates at the upper ends of those ranges exceeded costs for each of the ESA schemes, sometimes by many times the costs. Hanley, et al. (1999) discuss a number of problems associated with such evaluations, as does Whitby (2000, pp. 324-325), who notes that most evaluations of UK agri-environmental schemes have not actually been able to value benefits at the margin. In other words, even if the ESA scheme in one area has produced more environmental benefits than costs, that does not necessarily imply that expanding the scheme or adding similar schemes elsewhere will produce greater benefits than costs.

Although much researched by economists, monetary measurement of 'non-market' outputs of agriculture remains a difficult and challenging task. It is not

something to be undertaken lightly or by analysts not fully versed in the various available methods and their strengths and shortcomings.

### **Analyses at the National and International Level**

In many ways, multifunctional economic analyses at the national and international level are similar to ones at the local or regional level—especially in the sense that ‘externality’ effects constitute a central consideration. However, analyses of policy alternatives for dealing with agriculture’s multiple functions generally need to be national and international in scope. While local and regional policies are important, and certainly can make a difference, they often can be undermined by contrary policies at the national level or in other countries.

### **Externality effects on a broader scale**

Analyses of agricultural externality effects at the national scale, or other scales broader than local or regional levels, call into question the sustainability of ‘modern’, ‘conventional’ agricultural systems. One of the most recent and comprehensive such analyses was conducted in the UK, under the auspices of the University of Essex’s Centre for Environment and Society (Pretty, et al., 2000). This study, carried out by a multidisciplinary team of researchers based at several different institutions, covered a number of different types of external environmental and health costs of modern agriculture in the UK. Seven broad categories of such costs were examined: (1) damage to natural capital—water; (2) damage to natural capital—air; (3) damage to natural capital—soil; (4) damage to natural capital—biodiversity and landscape; (5) damage to human health—pesticides; (6) damage to human health—nitrate; and (7) damage to human health—microorganisms and other disease agents.

Aggregating the results across all of these categories, the researchers found total external costs of UK agriculture in 1996 to be the equivalent of roughly \$3.6 billion, or \$318/hectare of arable land and permanent pasture.<sup>1</sup> These estimated externalities are equivalent to 89% of average net farm income and 13% of average gross farm income in the UK during the 1990s. Of course, there is a great deal of uncertainty associated with any such estimates. Therefore, the researchers showed the following estimated range of annual external costs for the period 1990 to 1996 (converted here to US dollars): \$1.8 to \$6 billion. (Pretty, et al., 2000, pp. 113-118)

As large as these estimates are, they are based only on externalities that produce “financial” costs. Therefore, the authors feel they underestimated the total negative impacts of modern agriculture (Pretty, et al., 2000, p. 113). Regardless of the exact values, the magnitudes of external costs are alarmingly high, as they no doubt are in many other countries where agriculture has become highly ‘industrialized’. I turn now, in the final section of this essay, to economic analysis of policy approaches for addressing externality and related multifunctionality concerns.

### **Analysis of policy alternatives**

Natural resource economics and, more recently, ecological economics have contributed greatly to our understanding of how best to encourage the positive, and discourage the negative, dimensions of agriculture’s multifunctionality. Broadly speaking, the alternative approaches can be classified as either regulatory or incentive-based.

Regulatory approaches generally set limits which can not be exceeded for negative externalities or other adverse effects of agriculture; or, sometimes they specify

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<sup>1</sup> British pound = 1.53 US dollars in July 2002.

required (minimum) levels of positive action or provision of non-market goods. 'Conservation compliance' provisions of US Federal farm policy, dating back to 1985, require minimum groundcover on highly erodible soils as a condition for receiving commodity support payments. Although farmers could forgo such payments and thereby not be bound by these provisions, payments have been so substantial most years that the provisions, effectively, constitute regulations. In comparing the relative effectiveness of regulatory and incentive-based approaches for dealing with environmental concerns, Costanza, et al. (1997) list the following advantages and disadvantages of regulatory approaches:

#### Advantages

1. Simplicity, familiarity, and acceptance.
2. Historical U.S. reliance upon legislative regulation in order to deal with perceived problems.
3. Acceptance by emitters and interest groups
4. Long-term incorporation into the legal system. (Costanza, et al., 1997, p. 196)

#### Disadvantages

1. Effective regulation requires a level of technical and proprietary information that is seldom available to regulators.
2. Successful enforcement of regulation requires high monitoring and enforcement costs.
3. The costly bureaucracies associated with regulation result in high expenditure per unit of pollution reduction.
4. Environmental regulations are easily evaded or avoided.
5. The lack of strong incentives to reduce pollution below the mandated level reduces motivation for technological advance and for preventing pollution before it is generated.
6. Polluters are permitted to ignore the costs their actions impose upon society *at the time decisions are made*. (Costanza, et al., 1997, pp. 196-197)

Incentive-based approaches attempt to take advantage of market forces as much as possible, in order to achieve least-cost solutions to environmental objectives. Examples of such approaches are pollution-based taxes or fines and incentive payments based on the extent of positive environmental performance. Potential advantages and disadvantages of incentive-based approaches, in comparison to regulatory approaches, include the following:

#### Advantages

1. They have the ethical advantage of consistency with the .. “polluter pays” principle.
2. They raise public revenues.
3. They pass the cost of pollution control along to the consumer of pollution-intensive products . . .
4. They provide polluters with economic incentives to prevent pollution . . .
5. Marketable permits do not require that regulators have the level of technical proprietary information required for efficient regulation.
6. They can provide incentives for shifting the burden of monitoring from the government to the polluter.
7. They offer profitable opportunities for industry to undertake development projects for improvements in pollution abatement technology.
8. They can shift the incidence of tax burdens away from socially desirable objectives (incomes and jobs) toward reducing socially undesirable phenomena (pollution). (Costanza, et al., 1997, p. 205)

#### Disadvantages

Incentive-based approaches based on market theory do not directly address the issues of:

1. sustainable scale;
2. income distribution, or equity, and therefore of unequal access to environmental protection among individuals, nations, regions, and generations;
3. limitations of scientific information and of knowledge by individuals may impair their ability to make wise choices; and
4. additionally, the market failures that would need correction in order to make markets work for environmental quality are numerous and

perverse. They include externalities, excessive time discounting, common property resources, open-access resources, public goods, and noncompetitive markets. (Costanza, et al., 1997, p. 205)

Up to the present time, policies for agriculture in the US and European Union countries have emphasized incentive-based approaches. Moreover, the incentives used have generally been *positive*, such as cost-share agri-environmental schemes, rather than *negative*, such as taxes on polluting practices or inputs (though such have been used some). Reasons for heavy reliance on the incentive-based approach in agriculture include certain disadvantages of the regulatory approach listed above (#1, #2, #3, and #4) and #4 in the above list of advantages of incentive-based approaches. Dobbs and Pretty (2001a and 2001b) have examined a number of issues associated with continued reliance on and expansion of incentive-based agri-environmental schemes to provide positive non-market goods and discourage negative environmental externalities from agriculture. Among those issues are the following: (1) To what extent is continued financial subsidization by governments of the commodity production function of agriculture compatible with agriculture's environmental stewardship functions? (2) How can governments strike an appropriate balance between agri-environmental 'stewardship payments' and regulatory approaches? (3) Can agri-environmental programs simultaneously promote 'social' and 'stewardship' functions of agriculture? (4) Under what conditions are stewardship payment schemes likely to be compatible with World Trade Organization rules? and (5) Should farmers who are already practicing good environmental stewardship be eligible for agri-environmental incentive payments?

It remains to be seen how long citizens in North America and Western Europe will continue to support environmental approaches that rely primarily on incentive

payments to farmers. The UK government has already shown some shift in its approach to reducing nitrate contamination from agriculture by beginning to phase out its incentive-based Nitrate Sensitive Areas scheme and placing primary reliance of the regulatory Nitrate Vulnerable Zones scheme (Dobbs and Pretty, 2001a). As Western governments place increased emphasis on agriculture's multifunctionality in public policies, the challenge will be how to strike an appropriate balance between policy options in three areas (Pretty, et al., 2001): (1) environmental taxes; (2) production subsidy and agri-environmental incentive reform; and (3) institutional and participatory mechanisms. Approaches in this third area rest on the knowledge that if agriculture is truly to be sustainable in all of its important functions, farmers eventually must 'take ownership' of sustainable approaches, and not just be 'forced' to continue certain approaches by government carrots and sticks. Institutions must exist that foster and support on-going learning and adjustment, since there never will be a simple set of formulas for agricultural sustainability.

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