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Conservation Payments: Challenges in Design and Implementation

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Abstract

As Congress develops new farm legislation, some are lobbying for a new partnership between U.S. taxpayers and farmers. In exchange for an annual transfer of $10 to $20billion from taxpayers to agriculture, farmers would do much more to enhance environmental quality. An attractive feature of a new partnership is that paying for an improved environment provides a clear and justifiable rationale for farm program payments, something that is lacking under current farm programs. By changing management practices and land use, farmers can provide cleaner water, cleaner air, better wildlife habitat, lower net greenhouse gas emissions, and improved long-run soil quality. Private profit maximizers largely ignore the value of these environmental goods. Hence, the goods are underprovided. Having government step in to increase their supply may increase economic efficiency. New, highly funded conservation payment programs for agriculture could achieve both the current income support objective of farm programs as well as environmental objectives if program payments are targeted to achieve environmental benefits rather than targeted to low-income producers. Significant reductions in environmental benefits will occur if payment limits or means testing is used to target payments, unless low-income farmers provide the highest environmental benefits. For many farms, the potential quantity of environmental benefits that can be produced is proportionate to farm acreage. The two basic approaches to conservation payments are (1) voluntary programs that pay farmers for specific actions they take, and (2) programs that penalize farmers with taxes or disqualification from other program benefits if prescribed actions are not followed. The first approach is preferred if agricultural income enhancement is a goal. Also, it is doubtful that the second approach is political feasible given that farmers will be asked to give up the ?no strings? income support they have enjoyed in recent years. Past conservation programs have taught us three key lessons. The first is that making payments based on environmental benefit-to-cost ratios can greatly enhance program efficiency by either cutting the cost of meeting an environmental objective or by greatly increasing the amount of environmental benefits that can be obtained from a given expenditure. Second, adequate verification, monitoring, and enforcement programs will need to be put in place if the promised environmental benefits are to be realized. And third, land set-asides are the most costly way of obtaining environmental benefits. When possible, it is more efficient to encourage productive use of land rather than to retire land. So, for example, instead of paying a farmer to remove land from production in order to reduce nitrate water pollution, a program would pay the farmer to adopt practices that reduce the risk of fertilizer runoff.

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Contents

Table

Executive Summary

As Congress develops new farm legislation, some are lobbying for a new partnership between U.S. taxpayers and farmers. In exchange for an annual transfer of $10 to $20 billion from taxpayers to agriculture, farmers would do much more to enhance environmental quality. An attractive feature of a new partnership is that paying for an improved environment provides a clear and justifiable rationale for farm program payments, something that is lacking under current farm programs. By changing management practices and land use, farmers can provide cleaner water, cleaner air, better wildlife habitat, lower net greenhouse gas emissions, and improved long-run soil quality. Private profit maximizers largely ignore the value of these environmental goods. Hence, the goods are underprovided. Having government step in to increase their supply may increase economic efficiency.

New, highly funded conservation payment programs for agriculture could achieve both the current income support objective of farm programs as well as environmental objectives if program payments are targeted to achieve environmental benefits rather than targeted to low-income producers. Significant reductions in environmental benefits will occur if payment limits or means testing is used to target payments, unless low-income farmers provide the highest environmental benefits. For many farms, the potential quantity of environmental benefits that can be produced is proportionate to farm acreage.

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Past conservation programs have taught us three key lessons. The first is that making payments based on environmental benefit-to-cost ratios can greatly enhance program efficiency by either cutting the cost of meeting an environmental objective or by greatly increasing the amount of environmental benefits that can be obtained from a given expenditure. Second, adequate verification, monitoring, and enforcement programs will need to be put in place if the promised environmental benefits are to be realized. And third, land set-asides are the most costly way of obtaining environmental benefits. When possible, it is more efficient to encourage productive use of land rather than to retire land. So, for example, instead of paying a farmer to remove land from production in order to reduce nitrate water pollution, a program would pay the farmer to adopt practices that reduce the risk of fertilizer runoff.

CONSERVATION PAYMENTS: CHALLENGES IN DESIGN AND IMPLEMENTATION

I. Introduction

OVER THE LAST TWO years, Congress and farm groups have worked to find a farm bill formula that would be acceptable as a foundation for the next farm bill. Most ideas that have been floated—and that are finding some favor in the House of Representatives—largely continue the general thrust of current programs: some fixed payments, guaranteed prices for farmers, and perhaps a new countercyclical program that would largely duplicate the emergency market loss assistance payments that have been made the last three years.

Critics point out that the only policy objective consistent with current programs is stabilization of national net farm income. Rural activists and taxpayer groups note that because there are no means tests for the government subsidies, the largest farms and the wealthiest of farmers get the bulk of aid. But supporters of current programs counter that if we want to support sectoral income, then we need to support large farms (and sometimes wealthy farmers) because most production is carried out on large farms. The heart of the disagreement over farm programs is a disagreement over what the programs are supposed to accomplish, beyond a political response to rent-seeking activities. What exactly are taxpaying citizens receiving for the billions of dollars annually sent to agriculture? What broad public purpose is being met or which public goods are being purchased by the aid? When asked this question, supporters of current programs answer with "cheap food," "help with risk management," or "to keep people on the land." But the food stamp program already guarantees that most Americans have access to affordable food. And the federal crop insurance program has been greatly expanded in recent years, both in product offerings and in subsidies.

So the only broad public purpose we are left with is to keep people on the land. For what purpose? One is to maintain the vitality of rural communities. The other is to manage lands more carefully from an environmental stewardship perspective than they would be managed if farms were larger. From a public good perspective, it seems that the only possible public good justifications for farm programs are maintenance of rural populations and environmental stewardship.

Many argue that farm programs are poor rural development tools because the economies of most rural communities are increasingly becoming less farm dependent. The U.S. Department of Agriculture (USDA) states that only 45 rural counties can be classified as "farm dependent." Farm programs can, however, deliver significant environmental benefits. The Conservation Reserve Program (CRP), for example, has evolved into a program that helps protect water quality and enhance wildlife habitat.

If Congress chooses to reorient farm programs to enhance environmental quality, as advocated by Senator Tom Harkin, what kinds of programs would be adopted? What environmental goods should be purchased? How feasible is it to deliver environmental quality through USDA farm programs? Can an income support objective be reconciled with an environmental quality objective in a new farm program? Congress will need answers to these questions before a refocusing of farm programs can be made. This paper contributes to the discussion by considering the broad set of issues associated with the design and implementation of conservation payment schemes in the hopes of providing those charged with designing such programs a notion of the issues and tradeoffs involved.

First, we present a brief primer on the economic efficiency basis for conservation payments and a discussion of the environmental services available from agriculture. Next, we discuss the potential policy goals that might motivate conservation payments, with particular emphasis on income support and its implications for the design of an efficient conservation payment program. We follow with a discussion of the issues that will need to be addressed in the design and implementation of a conservation payment program. We conclude with lessons from past federal conservation programs and a look to the empirical environmental economics literature for insight into the possible costs and environmental benefits of a conservation payment program.

II. The Economic and Environmental Basis for Conservation Payments

We begin with a brief, general discussion of why government involvement, in the form of conservation payments or other policy measures, may be necessary to assure adequate provision of environmental goods in the agricultural sector.

Economic Efficiency as a Basis for Conservation Payments

The primary economic arguments supporting conservation payments are based on their potential ability to correct two well-known failures of the free market system: externalities and public goods. The term “externality” is used to describe a situation in which the actions of an individual or group inadvertently affect the well being of another individual or group. In the market setting, externalities are costs borne by a third party not involved in a market transaction. Consequently, externalities are costs that often get overlooked in market decisions, but because they are the true costs of the market activity, they should not be. A classic example of an externality is pollution from a factory or farm.

A farmer who applies pesticides and/or fertilizer to increase crop yields may generate an externality in the form of runoff of some of the pesticides or fertilizer into local waterways. The decline in downstream water quality from runoff is a cost of farm production that generally does not get captured in the market system; thus, government action to correct this externality may be justified. This side effect of agricultural production generates social costs (in the form of lower water quality) that are real and should be considered in the farmer’s fertilizer and pesticides application decisions, as well as other decisions, such as what crops to plant.

As is typical of externalities, farmers did not intend to inflict harm on their neighbors; such external costs are just a by-product of farming operations.[1] Nonetheless, external costs are generated by their activities and, for efficiency's sake, the costs should be incorporated into farming decisions. Thus, one justification for government action in agriculture is to make sure that externalities are incorporated into market decisions.

Conservation payments can correct the externality market failure by paying farmers to adopt practices that produce fewer or none of these negative externalities. Paying farmers to adopt practices that reduce soil erosion should yield improvements in water quality. Likewise, if the externalities are positive (if they provide a beneficial effect on the environment), payments can be structured such that practices that produce more of the positive externalities are encouraged.

It is important to note that a strong argument could also be made that generators of negative externalities should be taxed for generating the externality rather than paid not to do so. From an economic efficiency perspective, these two approaches may be the same in that they both, appropriately structured, have the potential to cause reductions in negative externalities and increases in positive ones.[2] However, the two approaches offer very significant differences to the income of farmers involved as well as to taxpayers. It's also important to note that the externalities are not eliminated by either payments or taxes; the externalities associated with farming still exist, but their costs are incorporated into decision making and thus more socially appropriate levels of the externalities are generated.

The presence of externalities that are not internalized into market decisions provides a clear basis for conservation payments. A second justification for intervention is the presence of "public goods" associated with agriculture. In addition to side effects associated with agricultural production, farmers can make land use choices that generate environmental benefits through, for example, retaining or creating wetlands, building and maintaining buffer strips, and preserving farmscapes. These are examples of public goods provided by agriculture. When the consumption of a good by one person does not diminish the enjoyment of the good by another, and when people cannot be prevented from consuming the good, then the good is said to be a "public" good.

Private markets exist when the willingness to pay for a good exceeds the cost of bringing the good to market. But private markets generally cannot supply public goods efficiently. This is due to the fundamental nature of public goods—once they are provided everyone can enjoy them whether they pay for them or not. Therefore, it is often difficult to establish a market in which fees can be collected to cover the cost of providing these services. Thus, the provision of public goods from agriculture is another strong justification for government policies such as conservation payments to encourage provision of these goods, as private markets cannot generally be relied upon to provide them.

An important caveat is in order. Just because an externality or public good is present, it does not necessarily follow that government intervention to provide the public good or internalize the externality is appropriate. If the costs of correcting the market failure (perhaps through establishing an agency with regulatory authority and enforcing a standard) are larger than the benefits of doing so, society is better off by doing nothing. Thus, the use of market failure arguments such as externalities and public goods only provide a basis for the use of conservation payments if the benefits of public good provision and/or negative externality reduction are "large."

Externalities and Public Goods from Agriculture

In this section, we document a variety of externalities and public goods that agriculture generates. This treatment is not meant to be exhaustive, only suggestive of the many environmental consequences of agriculture that may warrant conservation payments. Agriculture's environmental impacts are increasingly well documented. For careful reviews see Cox (2001) and Claassen et al. (2001). Table 1 contains a list of public goods and externalities commonly associated with agriculture.

Complexity and Interrelationships between Environmental Services from Agriculture

Before completing our brief discussion of environmental effects of agricultural operations, it is important to note that these effects are complex and may be highly interrelated.[3] In some cases the correlation is positive. Clear air, clean water, wildlife habitat, preservation of biodiversity, and other natural resource values are in most cases achieved jointly. The preservation of a wetland, for example, produces clean water, habitat for a variety of bird species and other wildlife and provides opportunities for outdoor recreation. Policies that are intended to provide a single environmental benefit will in all likelihood produce other complementary benefits. If environmental goods are produced jointly, the anticipated benefit from the provision of a single good will underestimate the total social benefit that is obtained.

In contrast, cases may arise in which the provision of a particular environmental benefit reduces other environmental benefits. A restored wetland, for example, can establish valuable bird habitat but the associated change in soil properties may increase emissions of nitrous oxide, a greenhouse gas. Likewise, conventional tillage is considered more damaging to bird populations than no-till, as it leaves less cover on the ground and necessitates more field operations. However, no-till tends to be more pesticide intensive and can therefore negatively affect water quality. Because the water quality effects can be both large scale and long term, they may be overlooked in the process of increasing wildlife habitat. Policies that alter the effects of agricultural activities on wildlife are also very likely to affect species differently. Some species will benefit while some will be negatively affected.

Complementarity and conflicts in the provision of environmental goods favor an approach to environmental policy that is inclusive. An inclusive policy approach will result in a more efficient allocation of public resources. Consider a simple example. Suppose a cost-benefit analysis is carried out to assess a policy to place buffer strips along stream banks. The cost that is borne by the farmer is the foregone net revenue that could have been realized if the land were kept in cultivation. A key benefit of the buffer strip is its beneficial impact on stream water quality. However, buffer strips can also enhance wildlife habitat and foster plant and animal biodiversity. Ignoring these complementary benefits would result in a cost-benefit ratio that was biased upward, and could inappropriately lead to rejection of a social-welfare-improving environmental policy. Fundamentally, the entire range of benefits associated with alternative practices should be addressed rather than focusing on single environmental targets.

TABLE 1. Public goods and externalities associated with agriculture

Externality	Primary Cause(s)	External Effect(s)	Location	Empirical Evidence
I. Water Quality				
Nutrient Runoff	Fertilization in excess of plant uptake	At low concentrations: variety of disturbances of natural ecosystems, flora, and fauna in affected waters affecting wildlife populations, biodiversity, recreational opportunities, and aesthetic aspects of water; At higher concentrations also: human health threat, i.e., nitrite poisoning (infants) and increased rates of cancer	Downstream located water streams including ground and subsurface water streams	According to a 1988-90 survey of drinking water wells, nitrates are found in more than a half of the 94,600 community water system wells, and in almost 60% of the 10.5 million rural domestic wells (Claassen et al. 2001).
Water Erosion	Temporary removal of vegetation cover of soils, especially through tillage on sloped land	Sedimentation, siltation, hypoxia, long-run soil fertility loss	Downstream located water streams	Maintenance dredging of sediments at federal navigation channels in the Great Lakes costs over $20 million annually. The costs and controversy for managing dredged material can be even more substantial (The U.S. Army Corps of Engineers).
Pesticides	Field applications of pesticides, air application and windy weather increase drift, heavy rainfall following application increase water contamination	Increased mortality among nontarget organisms (bees, fish, fish consumers), increased health threat for organisms on higher food chain levels than fish (including humans), increased pest resilience/resistance, human health threat from direct exposure to these chemicals; Some effects may be caused by metabolized chemicals which are more dangerous than the original active ingredient	Downstream located water streams including ground and subsurface water streams Airborne effects are local	At least one of 7 major herbicides (atrazine, cyanazine, simazine, alachlor, metolachlor, prometon, and acetochlor) was found in 37% of the groundwater sites examined by USGS but all at low concentrations (Barbash et al. 1989, as cited by Claassen et al. 2001).
Hypoxia	Fertilization in excess of plant uptake (phosphorous and nitrogen); Soil erosion promoting practices	Increased nutrient concentration, enhanced algae growth, increased algae deposition at bottom of water body, increased bacterial decomposition of deposited algae, increased rates of oxygen removal by bacterial activity, increased fish mortality from lower oxygen availability	Primarily still waters located downstream of heavily fertilized fields	Agricultural sources are estimated to contribute about 65% of the nitrogen loads entering the Gulf of Mexico from the Mississippi Basin (Goolsby et al. 1999, as cited by Claassen et al. 2001). Aral lake has shrunk about 4% for the last 25 years and will soon vanish (National Geographic ****)

TABLE 1. Continued

II. Restoration and Preservation of Natural Habitat				
Loss of natural wetlands and prairies, wildlife and biodiversity preservation	Conversion of natural wetlands and prairies into cropland; Use of farming techniques that leave little or no vegetation cover from harvest to planting next crop	Reduction in biodiversity because many organisms depend on wetlands, prairies, and riparian zones for feeding, breeding, and shelter	Globally effective	Agricultural wetland conversions averaged 31,000 acres per year in 1982-1992 (Heimlich et al. 1998, as sited in Claassen et al. 2001). Agriculture has been a factor in the decline of 380 of the 663 species federally listed as threatened or endangered in the U.S. (USDA-ERS 1997, as cited in Claassen et al. 2001)
III. Restoration and Preservation of Farmscapes				
Aesthetic properties of farmscapes	Use of "traditional" farming practices and structures.	Traditional barns and other farm structures, windbreaks, and alternative conservation practices are "eye pleasing".	Local	Although difficult to quantify, more than 60% of agricultural production, by value, is produced in metropolitan counties or counties adjacent to metropolitan counties. This implies that large numbers of people have ready access to such aesthetic amenities.
IV. Global Climate Change				
Greenhouse Gas Emissions	Direct fossil fuel use via agricultural machinery, indirect fossil fuel use through agricultural inputs, reduction of soil organic matter, deforestation, enteric fermentation of ruminant livestock, livestock manure (handling)	Global temperature increase, changes in precipitation, wind, and storm patterns, rise of sea level, habitat changes, extermination of species, change in crop yields	Globally effective, negative effects more likely in topical and subtropical climates; Positive effects more likely in temperate and tundra climates	In 1996, U.S. agricultural activities were responsible for 114 million metric tons of carbon equivalent, or about 6% of total U.S. greenhouse gas emissions. Worldwide, the agriculture sector produces about 50% and 75% of anthropogenic CH_4 and N_2O emissions and about 5% of anthropogenic CO_2 emissions.
Carbon Sequestration	Reduced tillage, Conversion of cultivated land to grassland or forest, Tree planting	Temporary absorption of carbon dioxide from the atmosphere, Mitigation of greenhouse gas emission externality as long as soil carbon accumulates or trees accumulate biomass	Same as for greenhouse gas emission externality	Growing trees sequester about 1 metric ton of carbon per acre and year.

TABLE 1. Continued

Biomass	Energy crop plantations (switchgrass, hybrid poplar, willow, eucalyptus, crop residues, cornstarch); Processing of biomass harvest into ethanol or electricity	Reduction in fossil fuel use; Recycling of emissions; Mitigation of greenhouse gas emission externality	Same as for greenhouse gas emission externality	Hybrid-Poplar-fed power plants reduce carbon emissions by 95 percent per electrical energy unit relative to coal power plant
V. Air Quality				
Wind Erosion	Temporary removal of vegetation cover of soils in windy areas	Sedimentation on neighboring lands, machinery damage, increased capital deterioration /cleaning cost from soiling,	Local; The smaller the soil particle and the higher the wind force, the farther soil particles can be carried away	According to the 1992 National Resources Inventory (NRI), the estimated annual soil loss from wind erosion on nonfederal rural land in the United States was 2.5 tons per acre per year (SCS 1994).
Livestock odors	Concentrated livestock facilities	Human discomfort, decrease in residential value	Local	Livestock odor has been an increasing public concern. However, since the emission and dispersion of gases and particulates are not fully understood, we cannot reliably predict the environmental impact of current animal production systems.
Smoke from residue burning	Burning of crop residue after harvest	Release of smoke particles and health threatening substances including lung-damaging and carcinogenic substances; Decreased visibility, intensifies greenhouse gas emission externality through nitrous oxide and carbon emissions	Local	Crop residue burning is a net source of methane (CH_4), nitrous oxide (N_2O), carbon monoxide (CO), and nitrogen oxides (NO_x), which are released during combustion. Annual emissions from this source over the period 1990 through 1999 averaged approximately 27 Gg of CH_4, 1 Gg of N_2O, 704 Gg of CO, and 30 Gg of NO_x. (USEPA).

III. The Goal(s) of Agricultural Policy and Conservation Payments

Improving the environmental performance of agriculture has emerged recently as an important goal of U.S. agricultural policy. For example, farmers have been paid to set aside environmentally sensitive land from production and to change their farming practices in ways that enhance environmental performance. Farm-income support continues to be another important policy objective. In this section we discuss the challenges facing policy makers who wish to design and implement a conservation payments program. The advantages and disadvantages of alternative program elements are understood best when related to a specific policy objective. For this purpose, and for the purpose of clarifying the presentation, we list three key objectives that appear to be relevant to designing sound conservation payments policy.

1. Improve environmental quality in a way that provides the largest benefit to the citizens of the United States.
2. Minimize all costs of administering the conservation payments program.
3. Support farm income levels.

Several comments about Objectives 1-3 are in order. First, each is admittedly vague. Second, the objectives do not exhaust the possible goals that may be important or may be incorporated into a U.S. conservation payments policy. Finally, Objectives 1 and 2 combined relate the idea that sound policy should be designed with careful consideration to principles of economic efficiency. In other words, the policy that is selected from among the set of policies considered to be feasible should provide the greatest net benefit to the citizens of the United States, where net benefit is defined as the total value of the environmental improvements generated, less the total opportunity costs of the resources foregone in achieving the improvements. We decompose net benefits into benefit generation, Objective 1, and program cost minimization, Objective 2, only to clarify the discussion of the advantages and disadvantages of alternative policy design elements.

In the next section we discuss the degree to which multiple policy objectives can be met with the single policy instrument of conservation payments. We also discuss two additional policies issues. The first relates to the fact that different regions of the country also have different environmental concerns and income distributions, resulting in different goals for farm policy. Second, we consider the consistency of conservation payments with the goals of international agricultural policy.

Dual Goals for Conservation Payments: Environmental Benefits and Income Support

Some critical questions must be asked when considering conservation payments policy: Can environmental payments alone meet income support goals? Is the distribution of payments that would result from an efficient conservation payments program “desirable” from an income support perspective? What alternative targeting strategies might yield a more desirable distribution of program payments?

A farm program based entirely on environmental concerns should target programs on farmland that can provide the highest environmental services at the lowest cost, that is, focus exclusively on Objectives 1 and 2 (more will be said on the idea of targeting in Section IV). Moreover, in a program intended to deal strictly with environmental concerns, there would be no reason to offer farmers payment for services above the cost of providing them. Thus, competitive bidding for payment of environmental services and/or taxing those who cause externalities would be natural instruments. In contrast, if conservation payments are to be used for transferring income to the agricultural sector, then it does not really matter who receives the payments unless Congress changes course and adopts means testing for payment eligibility. If means tests are adopted then payments should be targets so that low-income farmers benefit the most. This might be accomplished in a conservation payments program by restricting participation to particular types of farm operations.

If means tests are not adopted then the dual goals of income support and conservation are not in conflict because it is the aggregate level of payments that meets the income support objective, not who receives them. With means tests, the ideal targets of conservation payments under the dual goals of income assistance and conservation would be farmers with both low income and high conservation efficiency, where high conservation efficiency indicates the potential for large environmental benefits relative to other farmers. Providing payment in excess of the costs of these services can meet both policy goals when low-income farmers have significant environmental services to offer. However, a trade-off will have to be made when low-income farmers have few environmental services to offer or farmers with significant environmental services have high income.

When income support is provided through conservation payments, it may be possible to eliminate or at least cut back other distortionary income support programs. Lynch and Smith (1994) summarize these potential benefits and note that, among other advantages, conservation payments can provide income support without introducing output price distortions, and they avoid land retirements, thus having less of an effect on commodity production and supply. However, several challenges exist in designing a conservation payments program to generate these advantages.

First, the overlap between farmers with low income and high conservation services may be low. Claassen et al. (2001) show that targeting payments to support the incomes of any specific group of farmers is unlikely to solve any given environmental problem, which implies that targeting only low-income farms may not serve the goal of conservation very well. They also show that targeting any specific environmental problem may exclude many producers that qualify for income support.

Second, program designers may have difficulty designing a politically acceptable conservation program that focuses too explicitly on income. Paying high-income farms less for the same conservation services likely will be difficult to justify. Caps on total payments to farms can partly accomplish this, but not without achieving fewer environmental services. On the other hand, farm programs have been criticized for transferring too much income to large and wealthy farms, so such caps may well be politically feasible.

Scale and Regional Trade-offs

In general, environmental goals should be prioritized based on a ranking of environmental benefit per dollar invested in the improvement. However, it may well be that the benefits that are generated by reducing chemical runoff in the Midwest are significant but accrue primarily to people living in the Gulf states. For this reason, policies that address hypoxia in the Gulf may not be politically palatable from the perspective of local Midwest farmers but may generate a larger social return per conservation payment dollar.

Hypoxia in the Gulf of Mexico provides a clear example of the latter case. The geographical separation between where the chemical runoff occurs (in the Midwest) and where the damage accrues (in the Gulf of Mexico) raises the issue of whether policymakers may wish to consider the incidence of costs and benefits when designing environmental policies, and what level of government (local, state, or federal) is most appropriate to allocate conservation funds.

Considering two extremes illustrates the trade-off between local and national control of conservation payment funding. At one extreme, conservation payments might be allocated to state or local government agencies with few restrictions on how funds should be used. The advantage of this design is that localized information will be used to direct funds and manage environmental improvements. The associated disadvantage is that projects that provide national benefits are likely to be overlooked in favor of projects that provide only local benefits. Of course, compromise policies can also be designed where, for example, some payments are earmarked to address specific national environmental goals while other funds are controlled by state and local governments to focus on local environmental and income transfer goals.

International Trade Policy and Conservation Payments

Domestic agricultural policy should be consistent with international agreements and policy. Policies that harm the interests of international trading partners will be met with resistance, raising the costs of administering a conservation payments program.

A first important issue is whether conservation payments will be consistent with the rules set by the World Trade Organization (WTO). The WTO, through the Uruguay Round Agreement on Agriculture, provides some discipline and guidance on which forms of environmental payments are acceptable and which are not. The Uruguay Round aims to reduce direct trade distortions and to put a cap on production-enhancing/distorting policies, which depress world prices.

As a general principle, environmental payments are allowed (they fit into the so-called green box) under these criteria: they must be decoupled (are not production enhancing), cannot involve transfers from consumers (do not raise prices), and cannot exceed the cost or revenue loss incurred by farmers in complying. The Conservation Reserve Program, Wetland Reserve Program, and Environmental Quality Incentive Program have been identified as green-box policies. The United States has almost doubled its assistance to farmers through green-box payments since 1988 to about $51 billion in the late 1990s.

Even though programs meet the green-box criteria, one could argue that it is impossible to design truly decoupled policies. For example, many of the components of the proposed Conservation Security Act of 2000 (United States Congress) are “decoupled” in the sense that they do not alter production incentives at the margin for existing farmers. But virtually all policies leading to additional payments, even “decoupled” policies, are trade distorting to the extent that they influence entry/exit decisions by maintaining farmers in production who would otherwise exit the industry.

The second question addressed is the impact of conservation payments on competitiveness. Here, we can look to existing environmental programs to gain some insight into the potential effects of conservation payments. Existing programs to reduce soil erosion and water contamination with buffer strips are voluntary, select farmers with low abatement costs, and provide compensation for the income loss; hence, they probably do not significantly affect competitiveness. However, the CRP and other large conservation programs increase land value, thus decreasing competitiveness on international markets. For example, the CRP currently enrolls 31.4 million acres, representing about 11 percent of the total area devoted to the 15 major crops. Such extensive programs reduce output, increase world price moderately, and increase land value through capitalization of payments.

Like the CRP, a large conservation payments program likely would have notable effects on land prices. However, it is important to point out that competitiveness is a relative concept. If all exporting countries face tighter environmental standards, market shares are little affected. Therefore, it is doubtful that environmental standards in agriculture have had a significant impact on international competitiveness, first because the share of the "environmental" input in total cost of production is small, and second because the increased stringency is occurring in most countries (Beghin and Metcalfe).

IV. Design and Implementation Issues in a Conservation Payment Program

The success of a conservation payment program depends critically on its design and implementation. The design choices will ultimately affect the ease of implementation, and details of both design and implementation will have important consequences for the total environmental gains from the program, how these gains are distributed geographically, and who receives the payments.

Key Design Issues

In identifying the key issues, we have attempted to pay particular attention to those that seem most crucial to the success of the program, particularly as it relates to seeing real gains in environmental quality, as well as the income transfer aspect of the program.

1. Establishing the Baseline. The least-cost approach of improving environmental quality requires that conservation payments reward "new" environmentally friendly activities that otherwise would not be undertaken. In other words, from a pure static efficiency perspective, or to satisfy Objectives 1 and 2, the payments should induce "new" activities and not reward environmentally friendly activities that have already been undertaken without the payments. Of course, this has important implications for public perception and may be perceived as unfair to good stewards. However, an efficiency problem associated with making payments for only new activities also arises in that farmers who have already adopted such activities may temporarily end their conserving practices so that they can become "new adopters," thereby qualifying to receive payments. This is an example of slippage and is clearly inefficient. Incentives in the conservation program should be designed to discourage such behavior. (Note that the slippage issue would not arise if a tax were used, that is, if farmers who do not adopt the activities are taxed.) This can be done through properly choosing a baseline for the program.

A baseline determines "how new" a certain activity must be to be eligible for conservation payments. The simplest baseline may reward the activity without considering its starting date. For example, the government may simply reward conservation tillage, regardless of how long the practice has been adopted. On the other hand, the government may choose to reward only new activities under the program. For instance, it may reward conservation tillage adopted on lands that have been using conventional tillage continuously for a certain number of years in the past.

In practice, the baseline will likely depend on the importance of Objective 3 and the extent to which questions of fairness dictate rewarding early and new adopters. Choosing a baseline will involve trading off the program cost against equity. These trade-offs are substantial. In one study focused on carbon sequestration, the authors found that paying all farmers for carbon gains would require a budget three times larger than if only new adopters were paid (Pautsch et al. 2001).

2. Performance- versus Practice-Based Instruments and the Nonpoint Nature of Environmental Services from Agriculture. A critical feature of a conservation payment program is the form of the instrument that is used to convey the payments. To satisfy Objective 1, the fundamental variable of interest is the *flow* of environmental services from the farming practices, such as the lowered pesticide runoff due to the use of precision technologies (for example, IPM and drip irrigation), the increased rate of carbon sequestration from conservation tillage, and so forth. Performance-based instruments determine payments according to the flow, thus targeting the environmental service directly, and can be cost effective in that the marginal costs of producing the environmental services are equalized across farmers.

However, such instruments require the direct monitoring of the flow of pollutants, which is often difficult or impractical. Many agricultural pollutants are nonpoint in nature (it is difficult to identify the exact field or source from which the effluent or service flows) and/or are ephemeral (the flow rate must be measured at the moment of release). Examples are methane emission from livestock, air pollution from farming equipment, and nutrient contributions to surface waters. Both of these factors suggest that direct monitoring of the services would be very expensive, necessitating the use of other instruments that require only indirect methods of monitoring.

Indirect monitoring refers to the monitoring of *farmer activities* that contribute to the flow of environmental services and is required by practice-based instruments that reward farmers for their activities. For example, instead of directly measuring the carbon flow into and out of the agricultural soil, an agency can measure the soil characteristics and the farming practice, and rely on some scientific model that links these factors to the flow of services. The payments to farmers are then determined based on the model and farmer activity (such as tillage practices). The major advantage of practice-based instruments lies with the relative ease of monitoring and enforcement. Models related to pesticides, water pollutants, and soil erosion, among others, are also available.[4]

For practice-based instruments to perform well, it is important to understand the relationship between the practices and the environmental services so that the appropriate payment schedules can be constructed. As noted earlier, this relationship will often need to be based on scientific models rather than on direct measurements. The relationship will typically depend on regional or local characteristics, such as soil type and crops grown, and it will be subject to random weather shocks such as temperature, rainfall, and wind.

The efficiency of practice-based instruments depends to a large extent on the accuracy of the relationship. There are two types of errors in deciding the rewards for certain farmer activities. The first occurs when an environmentally beneficial practice is adopted but not rewarded, and the second occurs when a reward is provided but the practice is not adopted. In general, given the inherent uncertainty in scientific models, one type of error can be reduced only at the expense of the other type. Thus, if the government wants to minimize the first type of error, it is likely to make some payments that bring little or no environmental benefits. Both error types can be reduced, however, if the scientific model accuracy is enhanced.

Unlike performance-based instruments, when there is significant heterogeneity in activities and their environmental benefits across regions, practice-based instruments should be designed to vary across regions in response to the heterogeneity. For example, the environmental benefits of conservation tillage, such as soil erosion and carbon sequestration, are likely to vary significantly across regions. Increased heterogeneity in the rate structure can enhance the efficiency of the payment but also incurs higher transaction costs. Again, the benefits and costs should be balanced in determining the rate structure.

3. Targeting Benefits and Costs in Making Payments. To meet Objective 1, conservation payments should go first to producers who offer the greatest amount of environmental benefits per dollar of payment. That is, program payments under an efficient program would need to be both geographically and economically targeted. Geographic targeting accounts for spatial heterogeneity in environmental benefits offered due to variations in soil, climate, and other landscape variations. Economic targeting accounts for variability among farm managers and farm operations in terms of their willingness to adopt conservation practices. In an ideal world, targeting payments to producers who offer the highest environmental benefit-to-cost ratios makes the most efficient use of a fixed program budget.

But successful implementation of such a program would require estimates of the quantities of environmental benefits available on a particular site if a conservation practice were adopted, as well as estimates of the relative willingness of the site's producer to adopt the practice. Conceptually, combining models of adoption behavior with crop growth/environmental simulation models that estimate the environmental impacts of cropping and conservation practices could yield these estimates. In reality, basing payment rates on estimated site- and producer-specific benefit-cost ratios is probably not practical given the lack of precision with which the ratios can be estimated. An alternative would follow the example of the Conservation Reserve Program and allow farmers to bid on willingness to adopt practices. This would help reveal their adoption preferences. Then the simulation models could be used solely to estimate the environmental impacts of adoption. Bids would be accepted according to the resulting benefit-cost ratios.

4. Jurisdiction. The next issue in designing a conservation payment program relates to which level of the government should be responsible for the program design, the degree to which activities are to be rewarded, the rate structure, monitoring, and enforcement. Adequate consideration should be given to the information available and to the costs and incentives of performing the functions for each level of the government. Lower levels of government (state and local agencies) in general have better information about farmer activities and incur lower costs to monitor them. They may also know more about the environmental benefits of these activities if the benefits are local. However, as noted earlier, local government may not give adequate attention to pollutants that are global or regional and to the program costs if the federal government finances the conservation payments.

5. Tradable Conservation Credits. Traditionally, environmental regulation in agriculture and in general has relied heavily on command-and-control approaches, such as standards. Recently, market-based instruments, such as emission charges and tradable emission permits, are increasingly being used in air pollution control (such as the sulfur trading) and even in water pollution control. The use of market-based instruments faces more challenge in agriculture because of the nonpoint source nature of many agricultural pollutants. Rather than specifying a payment for a particular performance or practice, a tradable permit or credit system could require that farmers meet a particular standard for performance. If farmers do better than the standard (that is, achieve greater environmental gains or pollute less than required), they would then be able to sell their credits at market prices. Conversely, farmers who do not wish to adopt activities that will meet the standard could purchase credits from the market, effectively paying others to provide the environmental services.

The advantage of tradable credits is that they directly limit the amount of pollution while being cost effective. Farmers who can provide environmental services cheaply will do so and sell their "excess" to higher-cost providers; farmers maintain flexibility in deciding how to produce the services. However, tradable permits work most directly in the context of a performance-based instrument and will be more difficult to implement with a practice-based strategy. Permits can either be grandfathered by the government or auctioned off to farmers. So far, emissions permits in practice in the U.S. have primarily been grandfathered. The efficiency of the permit system is independent of the initial allocation; however, there are important income distribution issues associated with the initial allocation because permits are valuable. Clearly, income support goals would dictate giving permits or credits to farmer directly rather than selling them initially. To the extent that political lobbying by interest groups may occur to influence the pattern of initial allocation, the success of a trading system may depend on the allocation.

In principle, permits can be traded if the pollutants are homogeneous in that they cause the same environmental damage. For example, farmers above the same aquifer can trade permits that allow emissions to pollute groundwater. However, if the emissions pollute different aquifers, it would not be appropriate to allow permits to be traded across aquifers. If a trading area becomes small, the permit market may be too thin, reducing the effectiveness of the trading program.

Further, farmers in different regions may pollute the same river but at different intensities, with emissions from those further away polluting the river less intensely. In that case, ambient permits may have to be used that explicitly treat the different impacts of the pollutants from different farmers. Such a trading system may be quite complicated and difficult to implement.

A credit program has another advantage in that it would allow easy integration of the agricultural sector into a broader environmental market. For example, if farmers generate carbon credits, they might then be able to sell those credits to an energy company or other firm. Although there is currently no formal market for carbon credits, firms wishing to appear "green" and future environmental regulations could potentially provide sizable markets for credits.

Key Implementation Issues

Once a program has been designed, a variety of problems associated with implementation will need to be addressed. The first issue, and one of overarching concern to any conservation payments program, relates to the ability of the agency charged with implementation to monitor the environmental gains. As we shall see, this can be problematic for environmental quality associated with agriculture.

1. Monitoring and Verification. The ease of carrying out the task of monitoring and verification will depend critically on whether a performance- or practice-based system is adopted. Even for practice-based payments, monitoring and enforcement will not be trivial activities. Various practices differ in the ease with which they can be monitored. Generally, discrete actions, such as tillage practices, irrigation equipment, and buffer strips, are easier to monitor as they involve only a small number of actions. Continuous actions, such as the amount of fertilizer and pesticide used, are more difficult to monitor. Similarly, imprinted actions can be monitored for a while after the actions take place and as a result are easier to monitor. Examples include technology choices (by examining the equipment), and tillage practices (by examining the field). On the other hand, ephemeral actions are more difficult to monitor. Of course, many actions fall between these extremes.

Monitoring can take place continuously (for example, water meters) or discretely (for example, sampling of irrigation equipment). The choice of monitoring equipment depends to a large extent on the nature of the action, especially whether it is ephemeral or imprinted, and the costs of monitoring. Different monitoring methods can also be combined. The final choice should balance the costs and the accuracy.

Because monitoring and its verification or auditing is costly, who conducts the monitoring and auditing may directly affect a program's performance. Parties who could potentially conduct these functions include government agencies, private companies, or farmers themselves. For example, farmers can report their practices to obtain conservation payments, and either a government agency or a certified private company can conduct (periodic) auditing.

A critical issue in determining whom to monitor is to balance the costs of monitoring and the incentives of the parties to misreport. The government can promote truthful reporting either by careful auditing and/or by providing appropriate incentives or designing efficient contracts, as discussed later on.

2. Enforcement. The ease of enforcing a conservation payment program depends directly on the effectiveness of monitoring and verification, on the accuracy of the scientific models used to make payments, and on the complexity of the payment rate structure. Enforcement will be more difficult as the payment rate increases, as monitoring and verification are less precise, and as the scientific model is influenced more by random shocks. Conservation payments should reflect the actual environmental benefits more closely as enforcement becomes stricter. However, increased enforcement is costly, so the gains in environmental benefits need to be carefully compared to the costs in making decisions about how carefully to enforce the provisions of a conservation payments program.

Enforcement involves two elements: the probability that any cheating behavior is detected through activities such as auditing, and the size of the penalty when cheating is caught. Increasing the probability of catching any cheating activities may require higher enforcement cost, while the size of the penalty is limited by legal and political restrictions.

Voluntariness and Distributional Aspects of Conservation Payment Designs

Before leaving issues related to implementation and design, we briefly consider some of the implications for income transfers and the voluntary nature of conservation payment programs. In theory, similar environmental improvements can be achieved regardless of whether a program is voluntary or required. The only difference lies in who pays for the improvement. In a voluntary program, taxpayers (or whoever funds the required subsidies) pay for environmental improvement. In a required program, farmers pay (or are penalized for lack of performance). Because similar outcomes can be achieved with either type of program, the choice between voluntary and required is usually thought to be simply a matter of who owns the “property right” for polluting. That is, do farmers have the right to pollute, or do nonfarmers have the right to a clean environment?

Depending on the form of conservation payments, income could also be redistributed within the farming sector. If conservation payments were based on the number of acres on which particular practices are adopted or on the total amount of environmental services produced, then more payments would likely flow to large farms. However, it is critical to understand that, by providing a return to the land, conservation payments can be expected to be factored into the expected income from farming the land, and land prices will increase to reflect that value. Thus, in the long run, it is the landowners who ultimately receive the income support. To the extent that landowners and farmers are different people, this is important to recognize when considering possible income support goals.

The impact on land values and the magnitude of the impact would depend on the type of program that was initiated. With a targeted approach, land that provides more environmental services will receive higher payments. If, on average, this corresponds to lower quality agricultural lands, conservation payments will result in an equalizing effect on land values between types of land. In contrast, if higher quality lands provide higher environmental services, price differences between land qualities will be accented. In this way, conservation payments may have important distributional consequences within the agricultural sector. When the CRP bids were first accepted in 1986, theycreated a floor on land prices equal to the present value of the 10 years of CRP annual per-acre payments.

The impact of a conservation payment scheme on rural viability is unclear. To the extent that conservation payments improve the quality of the environment and the quality of life in rural areas, more people may be attracted to living in rural areas, thereby improving the viability of rural communities. On the other hand, if conservation payments should be structured so that large farms are favored, there may be pressure for further enlargement of farms, thereby possibly reducing the number of farmers and rural viability. Caps on the total payments allowed per farm could counter this effect.

V. Lessons from the Past, Costs, and Environmental Effectiveness of Conservation Programs

In this section, we look to experience with previous conservation programs to see what lessons can be learned in shaping future policy. Next, we look to the empirical environmental economics literature to consider the likely costs and benefits of acquiring environmental services with conservation payments. Here, we consider the retrospective evidence concerning land retirement programs (primarily CRP) to assess the effectiveness of these programs in achieving environmental gains. Next, we look at studies that have been undertaken to assess the likely (or actual) gains from policies that change land use practices on lands kept in agricultural production.

Lessons from Previous Conservation Programs

The discussion so far makes clear that, at least conceptually, a wide variety of options (each with different distributional implications) are available for achieving conservation objectives. In practice, however, conservation programs in the United States have been limited mostly to land set-asides, to cost sharing for adoption of conservation measures, and to "cross compliance," where compliance with particular conservation measures is a requirement for participation in farm income-support programs. In this section, we briefly discuss the U.S. experience with this restricted set of policy instruments.

1. Land Set-Asides. Efficient design of programs that provide direct payment for land set-asides requires information about the conservation benefits of setting land aside, and about the opportunity cost of land set aside. As noted earlier, recent rounds of the Conservation Reserve Program (CRP) have used an environmental benefits indicator (EBI) as a proxy for conservation benefits and have effectively elicited information about costs by employing an auction to allocate set-aside acres. For a given level of EBI, farmers who are most willing to set land aside (that is, who have the lowest land costs) are likely to submit low bids relative to others and therefore to be awarded set-aside acreage.

While superior in design to earlier rounds (where there was no EBI, and where farmers uniformly bid at county-level "bid caps"), there is still considerable room for improvement. In particular, some believe that the current EBI reflects both conservation benefits from land set aside and political economy considerations arising from concern about the distribution of program benefits across the country. If this is indeed the case, allocating fixed amounts to various regions and allowing each region to design its own EBI can more efficiently achieve a similar end. Also, there has been very little research regarding efficient auction design in the context of land set-asides.

Recent experience from government-sponsored auctions in other industries (for example, telecommunications) suggests that substantial benefits can be garnered from careful auction design. For example, the auction approach used by USDA allows only a single bid entry by each farmer, rather than giving farmers an opportunity to bid more competitively in response to others' bids. That is, the USDA/CRP auction is static, rather than sequential.

There are also important improvements to the EBI that could be addressed. First, for some environmental benefits, such as wildlife habitat, the benefit of setting aside contiguous land is high relative to setting aside noncontiguous land. This could be reflected in a bidding procedure by appropriately modifying growers' EBIs to reflect such benefits. Second, a more careful development of the EBI based on the value of services generated by various practices would increase efficiency. Third, more attention to the regional variability in benefits of various practices would also likely improve the efficiency of the program. Of course, these design improvements would be costly to implement, and the benefits of improved design must be weighed against these costs.

2. Cost Sharing and Incentive Payments. Conservation benefits can also be obtained from farmland that remains in production. As with land set-asides, an efficient allocation of funds toward conservation projects depends on the costs and benefits of project adoption across farms. Although there are a variety of specific "cost-sharing" programs administered at both the federal and state levels, they all have a similar structure. Farmers are offered fixed per-acre amounts for adoption of specific management practices (or some combination of practices) and shares of the installation cost for other conservation measures (for example, a manure storage facility). Unlike the CRP, there have been only limited attempts to ensure that program payments are allocated efficiently. EQIP (Environmental Quality Incentive Program) is a recent exception, though even here it's not clear that program design fully reflects its stated objective (to maximize environmental benefit per dollar expended).

There are at least two ways that such programs could be improved. First, payment could be made to vary with measures of conservation performance. This could occur with direct pay-for-performance (for example, dollars per ton of soil erosion reduction) or indirectly with per-acre payments varying according to conservation performance.

Alternatively, conservation project dollars could be auctioned with an approach similar to that used in the CRP. Rather than submit bids for land set-asides, farmers could submit bids for (possibly multiyear) conservation projects. The benefit of this approach would be to encourage competition for project dollars.

3. Conservation Compliance. "Conservation compliance" refers to the tying of traditional farm program benefits to satisfying a set of conservation requirements. In the past, federal farm programs benefiting producers existed independently of conservation programs. With conservation compliance requirements these programs provided a way to penalize bad performance while simultaneously rewarding good performance. This provides an interesting solution to the issue raised earlier of not wanting to discriminate against early adopters of conservation practices. It requires, of course, that there be a significant traditional subsidy program in existence and it cannot be implemented on crops for which subsidies are not provided.

Costs and Benefits from Land Retirement Programs

Claassen et al. (2001) report U.S. conservation expenditures from 1983-2000. The CRP is at present the major conservation program in the United States, and since 1986 land retirement programs (CRP and wetlands reserve programs) have accounted for roughly 70 percent of all conservation expenditures. Information and technical assistance programs account for another 20 percent, and cost share and incentive payments programs make up the remaining 10 percent. There have been several methods used to entice farmer participation in the CRP and other programs, including annual payments for a fixed period of time, perpetual easements, one-time payments, and cost sharing arrangements.

Since the beginning of the program, about 10 percent of U.S. cropland (36 million acres) has been enrolled in CRP (Osborn, Llacuna, and Linsenbigler, as reported in Claassen et al. 2001). Some 91 million acres were meeting conservation compliance in 1997. These two conservation programs are believed to be the major reasons for the nearly 40 percent reduction of the total erosion on U.S. cropland between 1982 and 1997. The reduction in soil erosion is associated with reduced siltation and eutrophication of waterways, reductions in air pollution from soil particles, improved landscape aesthetics, and more regional biodiversity.

Estimates of the value of these reductions are substantial. Hyberg (1997), as reported in Claassen et al. (2001), estimates that conservation compliance provides nonmarket benefits of $1.4 billion/year due to the reduction in soil erosion. Likewise, the CRP is estimated to provide some $694 million/year nonmarket benefits due to soil erosion reduction. This number includes freshwater-based recreation benefits of $129 million/year, increases to soil productivity of $145 million/year, impacts to costs of municipal water cleaning and dredging of $366 million/year, and health impacts of $50 million/year (see Claassen et al. 2001 for references to specific studies). Feather et al. (1999) further estimate the benefits of wildlife viewing and pheasant hunting on CRP to be $704 million/year. These estimated benefits compare favorably with the payments of some $1.4 billion being made to CRP land users in 2000 (FSA 2000).

Despite these impressive numbers, some research has questioned the cost-effectiveness of the CRP. Smith (1995) estimates that an upper bound on the cost of retiring 34 million acres is about $1 billion, a savings of approximately $600 million per year. Thus, he suggests, the CRP clearly acted as an income transfer program, and environmental services could have been achieved for less. Of course, this is not a problematic feature of the program if income transfer is a dual or even primary objective.

Research further suggests that targeting can increase environmental benefits while preserving income support levels for farmers (Hansen, Feather, and Shank 1999; Feather et al. 1999; Babcock et al. 1996). Feather et al. (1999) estimate that the value of the environmental services from more effective targeting of the CRP would roughly double. Overall, the literature suggests that land retirement is expensive, though effective, in providing environmental services. The performance of CRP likely could be further improved through better targeting.

Costs and Benefits from Programs that Alter Agricultural Production Practices

Rather than remove land from agricultural production, conservation payment programs may focus on payments for practices that are employed in conjunction with agricultural production. Here, we summarize some of the empirical evidence available to indicate whether such benefits are likely to be substantive. Since few direct payments have been made for changes in farming practices, these studies are primarily prospective.

Sinner (1990) argues that a $200 million subsidy targeted to environmentally friendly practices, such as low-till, could have approximately the same effect on soil erosion as $2 billion spent through the CRP for land retirement. Kurkalova, Kling, and Zhao (2001) provide estimates of the payments needed to induce farmers in Iowa to adopt low-tillage practices. They estimate that payments of $3 per acre could increase the adoption rate to 66.2 percent from its current rate of 57.1 percent. A payment of $5 per acre could achieve a 71.7 percent adoption.

Currently, land use payment policies in effect include EQIP and WHIP (wildlife habitat incentives program). These policy tools provide payments to agricultural producers to offset the costs of adopting specified best management practices. Under these policies, farmers sign contracts for 5 to 10 years. Since the beginning, land users have shown a great interest in the program, and the demand for the EQIP contracts well exceeds the funds available. While estimates of the EQIP realized benefits are not available, at the time the policy was proposed it was estimated that the overall benefit-to-cost ratio would be 1.46.

WHIP is a voluntary program for farmers who want to develop and improve wildlife habitat, primarily on private lands. Participants prepare a wildlife habitat development plan. Similar to EQIP, the WHIP contracts generally last from 5 to 10 years, and USDA agrees to provide technical assistance and pay up to 75 percent of the cost of installing the wildlife habitat practices. For the WHIP, some $20 million was distributed to states for financial and technical assistance in 1999. By 1999, 3,855 long-term agreements were approved, enrolling 721,240 acres in the program nationally.

Although no current policies to curb greenhouse gas emissions currently exist in the United States, a number of studies have been performed to estimate the likely costs and environmental gains from adopting various policies to encourage adoption of climate friendly agricultural practices. Pautsch et al. (2001) examine various policy instruments that promote carbon sequestration in agricultural soils and mitigate greenhouse gas emissions through increased adoption of conservation tillage. They find that, depending on the degree of targeting and the amount of carbon desired, agriculture could provide carbon reductions at a cost from $20 per ton of carbon. Antle et al. (2000) find that continuous cropping can sequester carbon in the Great Plains at a cost between $5 and $70 per ton depending on area and degree of targeting of the payments. McCarl and Schneider (2000) provide a review of cost estimates for carbon emission reductions through sink enhancements in forests and agriculture. They report costs, primarily for tree planting, ranging from $0 to $110 per ton of carbon.

Finally, there is some empirical evidence on the value of designing conservation payment programs that focus on multiple environmental benefits rather than targeting a single one. Connor, Perry, and Adams (1995), focusing on an important irrigated agricultural region of eastern Oregon, also find that potential environmental benefits from coordinating erosion and nitrate leaching policies are large. For example, they find that an expenditure of $10/acre with the sole objective of controlling erosion in a cost-effective manner could reduce erosion by 49 percent but could increase nitrate leaching by 27 percent. In contrast, the same expenditure could achieve an erosion reduction of 42 percent and a nitrate leaching reduction of 12 percent if an efficient mixed objective policy were used.

VI. Concluding Comments

As Congress rewrites farm legislation, many are pushing for a new partnership between farmers and taxpayers. In exchange for continued taxpayer support of farm incomes, farmers would do much more to enhance environmental quality. Congress needs to understand whether such a partnership might make sense, how such a partnership might be implemented, and the feasibility of farmers providing real environmental enhancement through changes in management practices and land use before it will be willing to depart from traditional income support policies. In this paper we have provided economists' insights into these issues to help clarify the farm bill discussion.

Clearly there are economic efficiency gains to be obtained by increasing conservation efforts by farmers if the transaction costs of program implementation are small relative to the value of the environmental gains. As public demands for clear air and clean water continue to increase, there is growing justification for tying federal farm income support to increased conservation. No trade-offs between income support goals and conservation objectives need to be made unless Congress adopts new means tests for eligibility, in which case conservation will be concentrated on relatively small operations. Because much of agricultural conservation involves control of nonpoint source pollution and provision of geographically varied environmental benefits, the design and implementation of a successful conservation payment program needs to account for possibly significant transactions costs. Verification, monitoring, and enforcement costs could be greater than the value of the environmental benefits obtainable from farmers. Past conservation programs show that farmers are willing to participate if the payments are large relative to the cost of compliance. Payments in excess of costs will help meet the twin goals of income support and conservation, but they count against our WTO limits on agricultural support.

Of course, ultimately the farm bill is a political piece of legislation. The political calculus over the last few years has resulted in billions of dollars in federal farm aid with few strings attached. Whether the calculus has changed enough to increase the likelihood of an altered course in farm policy depends on whether the political influence of those rural and urban constituencies that will benefit from increased on-farm conservation has grown relative to the influence of the farm lobby, which is largely supporting the status quo for farm programs.

VII. Endnotes

1. It is likely that farmers would have taken into consideration the potential environmental damages to their on-farm water when making their fertilizer and pesticide use decisions. The difference, of course, is that the on-farm problems are borne directly by the farmer and are thus internalized in the farmer's decision making, whereas the off-farm problems are external to the farmer and therefore not likely to be considered by the farmer.
2. An important exception does exist. When payments to farms affect the ability of some farmers to stay in farming, payments versus taxes can have very different consequences, as payments might actually increase the size of the farming sector and, with it, the size of the negative externalities. Taxes on negative externalities would be generally preferred in such a setting.
3. Lewandrowski and Ingram provide a useful overview of the complexity of the relationship between agriculture and the environment.
4. Carbon models include CENTURY and CQUESTER. Other environmental models include EPIC for soils erosion and nutrients, SWAT for water quality movements in watersheds, and PRISM for pesticides.

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