Agri-Environmental Payments: Policy Objectives and Program Design

In this section, we take up issues related to the selection of agri-environmental payment program objectives and the design of programs to meet these objectives. We focus on a payment or subsidy program for several reasons. First, voluntary subsidy mechanisms are the most widely used agri-environmental policy instrument in agriculture, owing largely to longstanding concern for and support of farm incomes. Second, two environmental payment programs have recently been proposed: the Conservation Security Program (CSP) proposed as a part of the Clinton Administration's FY2001 budget proposal, and the Conservation Security Act (CSA) introduced by Sen. Tom Harkin (D-IA). (Our analysis is not based on the specifics of either proposal.) Third, a payment program that deals with environmental performance on land in production may be suitable for addressing agri-environmental problems not well addressed by traditional land retirement or cost-share programs, namely nutrient loss to surface and ground water. Finally, we focus on a payment program because little formal analysis has been devoted to the design of such a program.

We raise a range of issues and analyze each issue conceptually, noting tradeoffs that may arise in developing a practical agri-environmental payment program. Ultimately, however, analyzing the effect of policy design on environmental, farm income, and other program outcomes benefits from empirical analysis. To illustrate some of these tradeoffs, we provide some empirical results from an analysis of hypothetical program scenarios.

We use two analytic tools for the empirical analysis. Our first tool, the U.S. Agriculture Sector Mathematical Programming Model (USMP) (see appendix 2), allows us to simulate a number of program alternatives. USMP is designed to predict producer response to policy incentives. Our second tool is a cross-analysis of data from the Agricultural Resources Management Survey (ARMS) and environmental indicators developed from USDA and the U.S. Geological Survey (USGS) data (see appendix 3). This analysis is designed to assess the overlap between specific producer groups and environmental indicators.

In our simulation modeling, we assume continuation of current farm programs, as specified by the Federal Agricultural Improvement and Reform (FAIR) Act of 1996: Production Flexibility Contract (PFC) payments are funded at their 2002 level (roughly $4 billion), Loan Deficiency Payments (LDP's) are available in case of low prices, and the Conservation Reserve Program (CRP) is continued at roughly 36 million acres. We also assume that conservation compliance, sodbuster, and swampbuster remain in place, but that producers are otherwise free to expand (or contract) crop acreage, consistent with the end of farm program base acreages and annual set-aside requirements under the 1996 Act. We model changes in commodity prices, farm income, and other economic variables as changes from those projected by the 1998 USDA baseline for the year 2005 (USDA-WOAB, 1998).

Agri-Environmental Payment Program Priorities

Agri-environmental payments could be used to address a myriad of environmental or farm income purposes. For example, payment programs may seek to improve water quality, increase wildlife populations, maintain soil productivity, and/or support farm incomes. Agricultural policy is now made up of multiple programs serving varying farm income, environmental, and other objectives. Because agricultural policy has multiple objectives, conflicts among objectives inevitably arise, if for no other reason than limited federal resources available to address these objectives. However, program design or lack of coordination among programs can also create or unnecessarily intensify tradeoffs among policy objectives.

Coordination across the full range of farm programs can reduce contradictory or duplicate efforts. The policy context is important to the selection of agri-environmental payment program objectives. If existing farm income support mechanisms are continued (e.g., production flexibility contract payments or loan deficiency payments), it may be appropriate to focus agri-environmental payment programs more heavily on environmental purposes. Likewise, if existing environmental programs are continued, it may be appropriate to focus on environmental issues not addressed by existing programs. For example, if land retirement programs are continued, policymakers may want to focus payments on production management or conservation practices on land in crop production.

In a multi-objective policy, addressing each objective explicitly will minimize tradeoffs. Stated another way, failure to explicitly address each objective can result in unnecessary tradeoffs among objectives. Some conflicts arise due to the *physical* nature of agri-environmental problems and cannot be avoided. For example, crop production management practices to slow rainfall runoff can reduce nitrogen runoff and soil erosion, but may increase nitrogen leaching into ground water (USGS, 1999). In other cases, environmental problems may be somewhat complementary, i.e., addressing one problem also addresses another, at least partially. For example, because a significant majority of phosphorus is lost to the surface through soil erosion (Litke, 1999; Sharpley et al., 1999), erosion reduction can reduce both sediment and nutrient damage to surface water. In general, however, failing to address each objective will expose policymakers to tradeoffs that could be avoided and may produce unintended consequences.

Some Examples of Likely Tradeoffs

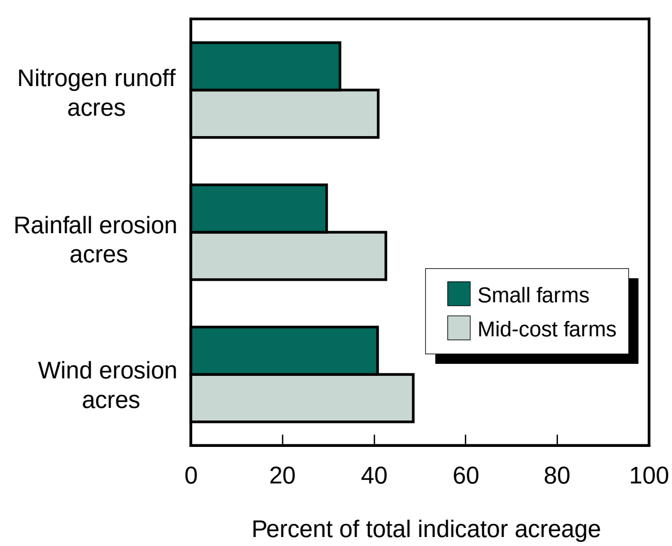
Targeting a specific environmental problem will not necessarily address other environmental problems and may make some worse. Even when environmental objectives are not at odds due to the physical nature of the environmental problems involved, policies that focus exclusively on a single environmental objective may produce unintended consequences that make other environmental problems worse.

To illustrate, we analyzed programs designed to reduce (1) sediment damage to water quality and (2) nitrogen damage to water quality (see box, "Evaluating Alternative Environmental Objectives"). Results suggest that conflict can arise. Directing payments to reduce sediment damage produces no change in nitrogen lost to water or excess nitrogen balances at the national level. By contrast, directing payments to reduce nitrogen damage *increases* annual soil erosion by 5.6 million tons or roughly 0.5 percent. This unintended consequence arises because payments are based on the use of "low" nitrogen application rates. Although producers reduce application rates on some acres in production, they also expand crop production where it is profitable using the low application rate, given the subsidy. The potential cures for such unintended consequences are discussed later in this report.

Tradeoffs can also arise between farm income support and environmental objectives. Environmental objectives can be achieved through payments for farm income support only to the extent that environmental problems occur on farms receiving income support. On the other hand, income support can be achieved through environmental payments only to the extent that farms targeted for income support also create environmental damages. To illustrate, we consider agri-environmental indicators related to rainfall erosion, wind erosion, and nitrogen runoff to surface water (see box, "Defining Farm Income Support 'Target' Groups and Environmental Indicators"). We assume that two specific groups are targeted for farm income support based on considerations of farm size and financial need: "small" farms and "moderately unprofitable" farms, e.g., farms that are not financially viable but could be with additional support. More generally, we look at the overlap between groups defined in the ERS farm typology (appendix 4) and the agri-environmental indicators.

Targeting payments to producers in need of income support is unlikely to fully address any specific agri-environmental problem. Directing payments to farms on the basis of financial or income criteria means that payments would not reach a large amount of land with environmental problems. For example, less than half of all *rainfall erosion, wind erosion, and nitrogen runoff* acres are likely to be located on either a small or moderately unprofitable farm (fig. 4). Of the three indicators, the proportion of *wind erosion acreage* managed by farms we target for income support in this example is highest, roughly 40 percent for moderately unprofitable farms and approaching 50

Figure 4
Percent of environmental indicator acreage on farms that could be targeted for income support

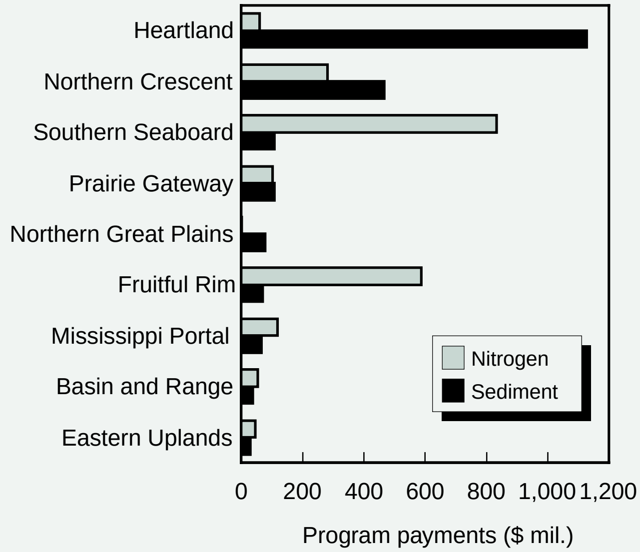


Evaluating Alternative Environmental Objectives

We use USMP (appendix 2) to compare programs designed to (1) reduce water quality damage due to sediment, and (2) reduce water quality damage due to nitrogen runoff from land in crop production (see table). Nitrogen runoff can be transported hundreds of miles, particularly in large rivers. Water quality damage due to nitrogen generally occurs in the coastal zone.

To focus program activity on regions where soil erosion or nitrogen runoff causes the largest potential damage to water quality, producers in those regions can receive higher payments, commensurate with higher water quality damages per ton of soil erosion or pound of nitrogen fertilizer application (see appendix 5, figs. 9 and 10). However, farm income support objectives may imply higher payment rates. Payment rates are varied by multiplying the benefit-based payment rate per acre by a constant. As payment rates increase, total program payments increase. Reported results are for program payments of $2.1 billion. Although this figure is arbitrary, it is modest relative to overall farm program expenditures in recent years. Finally, to guard against expanding crop production onto highly erodible land (HEL), producers who bring previously uncropped HEL into crop production are penalized. This provision is similar to sodbuster because the penalty is based on the level of other farm program payments (primarily Production Flexibility Contract (PFC) payments) and will be referred to as a sodbuster-type penalty. Results indicate that the sediment damage reduction and nitrogen damage reduction scenarios are not complementary. Targeting sediment damage exclusively produces no change in nitrogen fertilizer use or excess nitrogen balances. However, targeting nitrogen damage exclusively produces an *increase* in soil erosion and associated water quality damages. Because any non-highly erodible land is eligible for the "low" nitrogen application rate subsidy, producers

Program payments, by region, for alternate environmental objectives



USMP scenarios on alternate environmental objectives

USMP scenario	Environmental objective	Payment base	Payment rate (per acre)[1]
Sediment damage	Reduce sediment damage to water quality	Use of "low rainfall erosion" production systems[2]	Soil conserved[4] (tons per acre) multiplied by estimated water quality damage per ton (see appendix 5)
Nitrogen damage	Reduce nitrogen damage to water quality	Use of "low" nitrogen application rates[3]	Nitrogen application forgone[5], multiplied by a value per pound of reduced nitrogen application (see appendix 5)

[1] Payment rates are also adjusted by constant multiples of these rates to provide results on a range of program sizes. We report a range of results because environmental benefits may be underestimated and/or farm income support objectives may imply higher rates.
[2] A production system with a rainfall erosion rate below that for a system using a **predominant crop rotation** in combination with **conventional tillage** on the same soil and in the same region.
[3] A nitrogen application is considered "low" if it is below the average rate for a specific crop rotation, on a specific soil, in a given region.
[4] Difference between (1) the maximum erosion rate observed for any production system for a given soil in a given region (the reference level) and (2) the estimated rate of erosion for the system in use on the same soil in the same region.
[5] Difference between (1) the highest nitrogen application rate observed for a specific crop rotation, on a specific soil, in a given region (the reference level) and (2) nitrogen application rate in use on the same soil, for the same crop rotation, in the same region.

Continued on page 29

expand crop production using "low" nitrogen application rates. Erosion is increased, increasing sediment damage to water quality by $72.2 million.

The sediment damage scenario directs the largest payments to the Heartland and Northern Crescent regions (see figure on previous page). The Heartland benefits because the program pays for use of production systems with "low" erosion rates regardless of when these rates were achieved. The Heartland region contains more than one-fourth of U.S. cropland acreage and has been the focus of considerable conservation policy effort (e.g., conservation compliance). The Northern Crescent region receives large payments because the value of reduced soil erosion is high (fig. 9, p. 34.).

The nitrogen damage scenario directs payments to the Southern Seaboard, Fruitful Rim, and, to a lesser extent, the Northern Crescent (see figure). The proportion of nitrogen applied in agricultural production that ultimately reaches coastal waters depends greatly on the distance to the coast or major rivers (see appendix 5). Nearly all of the U.S. coastline is included in these three regions. Moreover, nearly all of the 5.6-million ton increase in rainfall erosion occurs in the Southern Seaboard and Fruitful Rim.

percent for small farms. While small farms contain just over 40 percent of rainfall erosion and nitrogen runoff acres, only about 30 percent of these acres are likely to be located on moderately unprofitable farms.

More generally, targeting any group defined by gross sales or source of household income (farm vs. nonfarm) is unlikely to capture a majority of environmental problems, unless the criteria are very broadly defined. No single group defined within the ERS farm typology accounts for more than 25 percent of any of our environmental indicator acreages (fig. 5).

Nationally, targeting multiple environmental problems makes it likely that most farms targeted for income support could participate in an agri-environmental payments program. In our illustration, 70 percent or more of both moderately unprofitable and small farms contain acreage susceptible to at least one of the three indicators (fig. 6), although not all acreage on these farms would be eligible. *Rainfall erosion acreage* occurs on roughly 70 percent of moderately unprofitable farms and 65 percent of small farms. Regionally, however, the proportion of small and moderately unprofitable farms that contains at least one of the three indicator acreages varies widely. More than 95 percent of small farms in the Heartland would qual-

Figure 5
Environmental indicator acreage by ERS farm type

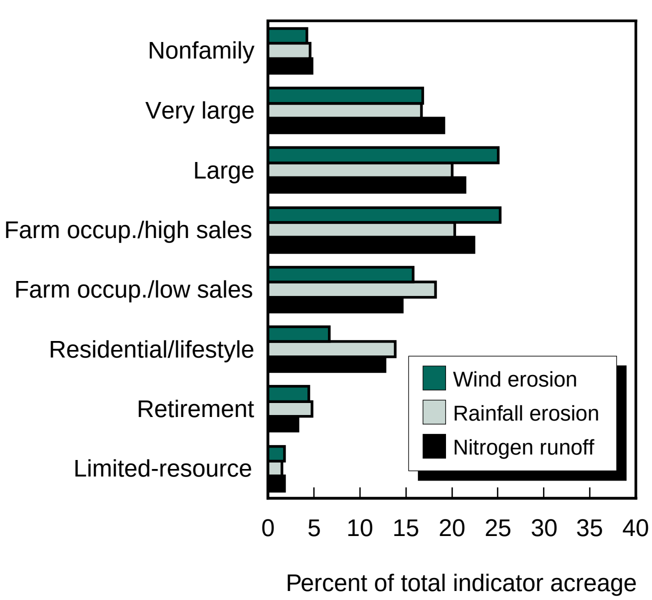
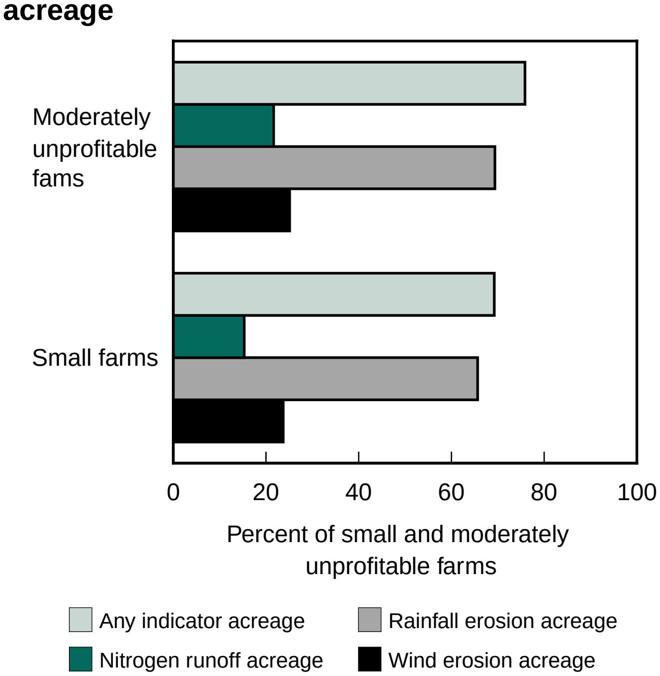


Figure 6
Percent of small and moderately unprofitable farms with some environmental indicator acreage



Defining Farm Income Support "Target" Groups and Environmental Indicators

We use a linkage between Agricultural Resource Management Survey (ARMS) data and some environmental indicators (see appendix 3) to estimate the extent of overlap between groups of farmers who could be targeted for farm support and selected environmental indicators.

Farm Income Objectives. We consider two groups that could be targeted for farm income support. Our objective is not to endorse any specific group for income support, but to illuminate issues that policymakers may face in designing a multi-objective agri-environmental payment policy. We also consider the groups defined in the ERS farm typology (see appendix 4). While the typology does not define or suggest a farm income target group, it divides farms into groups that may be useful to policymakers in targeting payments or assessing the distribution of agri-environmental (or other program) payments.

Small farms are farms with gross annual farm income of $250,000 or less, where farming is considered a primary occupation for at least one member of the household. The fate of small farms has concerned policymakers. The National Commission on Small Farms was created in 1997 to assess the status of small farms and determine ways USDA could "recognize, respect, and respond to their needs" (USDA, National Commission on Small Farms, 1998).

Moderately unprofitable farms are farms where the full (economic) costs of production exceed total revenue by up to 50 percent. These farms are not financially viable (i.e., revenue does not cover the full economic cost of production) but are more likely than higher cost farms to become so through government support payments (Morehart, Kuhn, and Offutt, 2000). If a policy goal is to keep farmers in farming, income support may be most helpful if directed toward moderately unprofitable farms.

Environmental Indicators. Agriculture affects a wide range of environmental resources (e.g., water quality), which provide many environmental amenities (e.g., water-based recreation). Many agri-environmental indicators could be used to determine eligibility for agri-environmental payments. For illustrative purposes, we consider three indicators:

- *Rainfall erosion acreage*—non-highly erodible cropland with rainfall erosion rates greater than the soil loss tolerance (T);
- *Wind erosion acreage*—non-highly erodible cropland with wind erosion rates greater than the soil loss tolerance (T);
- *Nitrogen runoff acreage*—cropland acreage where nitrogen runoff to surface water is estimated to exceed 1,000 kg/km^2/year.

Non-highly erodible cropland is considered here because it is not already subject to conservation compliance requirements, as is highly erodible land. The level of nitrogen runoff designated at "high" is arbitrary but is a level classified as high by Smith et al. (1997).

ify for payments while only 34 percent of small farms in the Eastern Uplands would be eligible (fig. 7). For moderately unprofitable farms, regional differences are more widespread. More than 90 percent of these farms in the Heartland and Northern Crescent regions would be eligible while less than 40 percent would qualify for payments in the Eastern Uplands and Fruitful Rim (fig. 8).

Nationally, the proportion of small and moderately unprofitable farms eligible for agri-environmental payments would almost surely be increased by targeting a wider range of environmental problems. Whether other environmental indicators (e.g., potential pesticide runoff) could significantly increase the proportion of producers covered in the Eastern Uplands and Fruitful Rim regions is difficult to predict. **However, targeting multiple environmental problems also means that significant funding would be directed toward farms that are not targeted for income support.** Given the high proportion of environmental indicator acreage outside small and moderately unprofitable farms, significant program funding would go to farms not targeted for income support.

A Framework for Considering Tradeoffs

Tailoring a program to meet multiple objectives as effectively as possible requires that each program objective be specifically addressed. Doing so requires a method for prioritizing objectives and devising a program to translate those objectives into producer incentives for program participation.

Figure 7

Percent of small farms with some environmental indicator acreage, by region

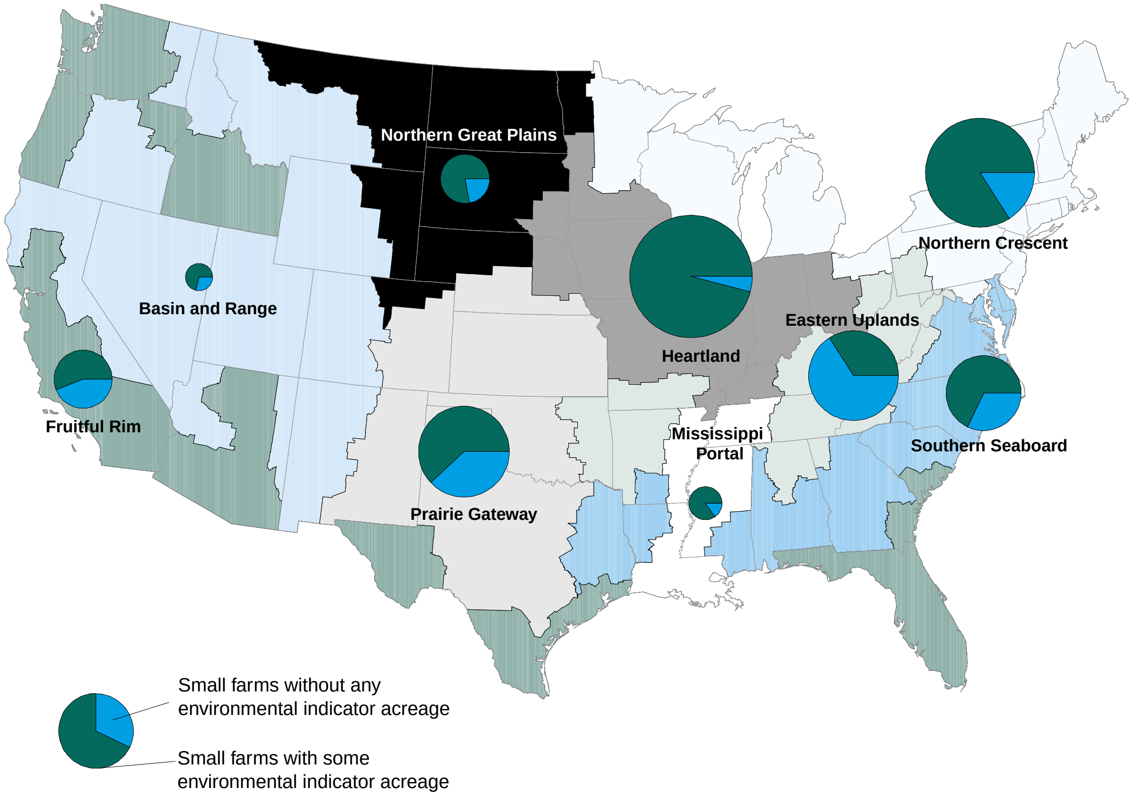
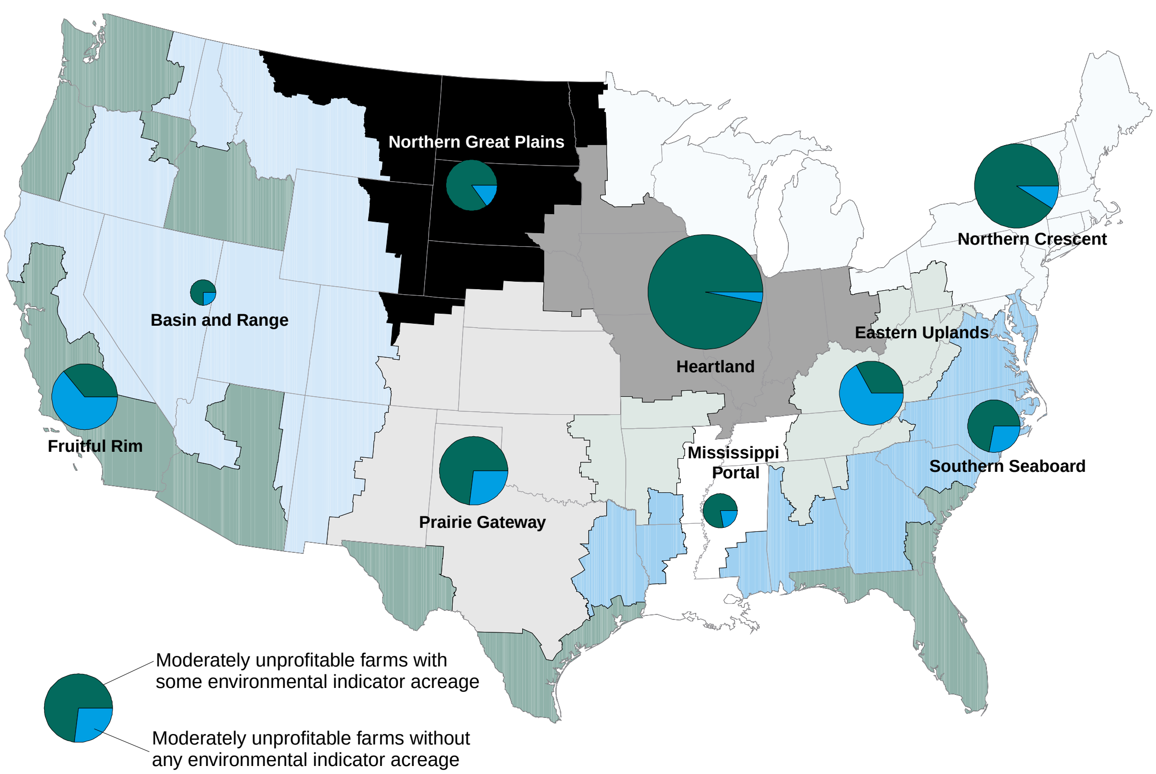


Figure 8

Percent of moderately unprofitable farms with some environmental indicator acreage, by region



In theory, agri-environmental problems can be prioritized on the basis of net economic benefits, i.e., the benefit of increasing environmental quality less the costs of making these improvements. Economic benefits flow from an increase in the quality of nonmarketed goods and services that depend on environmental quality; they are an estimate of the dollar value society places on improvements in such activities as boating, fishing, hunting, or wildlife viewing. Costs include the public and private costs of changing farm production management and conservation practices to obtain these improvements. Society gains when environmental benefits exceed the cost of producing those benefits.

If farm income is of concern, policymakers can assign a level of priority to farm income support. Then program funds can be allocated among environmental and farm income purposes in a way that maximizes the sum of net environmental benefits and gains due to farm income support.

The reality is considerably more complex. The nonmarket benefits of environmental improvements can be difficult to measure, improvements in environmental amenities can be difficult to link to specific changes in production management and conservation practices on a specific farm, and the cost of changing specific practices on specific farms is uncertain.

Nonetheless, a simplified version of the benefit-cost framework can be useful for program implementation. For example, policymakers or program designers can establish weights to account for (1) the relative size of potential benefits from specific environmental amenities and (2) the likelihood that a specific action, taken on a specific field, will increase the environmental amenity by a given amount. These weights can be derived from a variety of sources, including formal valuation studies, studies of physical links between agricultural production and resource quality, and expert opinion. A similar approach has been used, with some success, for targeting in the CRP.

Agri-Environmental Payment Program Design

Assuming that program budgets are limited, how can a program be best designed to make available funds go as far as possible toward achieving environmental and farm income objectives? For simplicity, we focus explicitly on maximizing environmental gains. Nonetheless, we note farm income implications of policy options and structure our empirical analysis around program designs that would have a relatively large farm income effect. Specifically, payments are designed to exceed the cost of environmental actions that trigger payment for at least some producers on some land. We also consider **equity** as it relates to whether so-called "good actors"—producers who have already attained a relatively high level of environmental performance or adopted good production management or conservation practices—would qualify for payments under various program designs.

Our review of past and present agri-environmental programs suggests that the net environmental benefits of a program can be enhanced by

- **spatial targeting**, directing payments to would-be program participants who can achieve the largest environmental gains relative to costs; and
- **producer flexibility**, giving farmers the flexibility to select the lowest cost method of improving environmental performance in specific resource and management settings.

In this section, we expand our discussion to consider

- **environmental effectiveness,** or program design features that pay for changes in production management or conservation practice that most directly address environmental objectives;
- **information** that will be needed to implement a given program design; and
- **administrative costs** such as conservation planning, technical assistance, enforcement, and other costs that may be required to deliver the program.

Finally, a critical point of our analysis will be to identify the **potential for unintended consequences** and to suggest ways to minimize them.

Some Program Design Options

Key program design choices are encompassed in three major issues: How much is paid to whom for taking what action on what land?

What Action? The action that triggers payment is often referred to as the ***payment base***. Choice of a payment base can be considered in two dimensions (table 6). First, payments can be based on environmental performance or on the use of specific production management or conservation practices. For example, producers could be paid for conserving soil (a per-

Table 6—Summary of payment base options for an agri-environmental payments program

Improve	Performance	Pay for adoption of production systems that improve environmental performance
	Practices	Pay for adoption of "good" conservation or production practices
Good	Performance	Pay for use of production systems that produce "good" environmental performance
	Practices	Pay for use of "good" conservation or production practices

formance-based payment) or for using soil-conserving practices such as conservation tillage, contour farming, or terraces (a practice- or design-based payment).

Agri-environmental payments cannot be based on *actual* environmental performance, such as nutrient runoff or soil erosion, because actual performance cannot be monitored at a reasonable cost and often varies with the weather or other factors outside the producer's control (Braden and Segerson, 1993; Shortle and Abler, 1994; Shortle and Dunn, 1986). However, average or expected environmental performance can sometimes be *estimated* using physical process models like Universal Soil Loss Equation (USLE) or the Wind Erosion Equation (WEE). From here forward, we use the term "environmental performance" to refer to application of a set of production management or conservation practices that results in a specific level of *estimated* environmental performance.

A second dimension of the payment base decision refers to the timing of and reason for a farmer's change in environmental performance or related production management or conservation practices. Payments might go to those who improve environmental performance or adopt specified practices after enactment of the program. In other words, producers would not be paid for production management or conservation practices previously adopted.

Alternately, payments may be extended on the basis of "good" environmental performance or the use of "good" production management or conservation practices, regardless of when or why good performance was attained or good practices were adopted. In other words, all "good actors" would be eligible for payments. To implement such a program, *good performance or good practices* must be defined. For example, *good performance* could be tied to a specific threshold of estimated soil erosion or nutrient runoff. *Good practices* could be defined as use of conservation tillage, nutrient management, or other production management or conservation practices.

What Land? If producers choose to expand crop production, will the additional land be eligible for agri-environmental payments? Will producers be penalized in some way for converting environmentally sensitive land, such as HEL or wetland, from noncrop uses to crop production? In other words, will sodbuster- or swampbuster-type provisions apply to these payments? This question is particularly relevant to payments based on *good performance* or *good practices* because these payment bases do not explicitly require environmental improvement, as does the *improve performance* payment base. *Good performance*, for example, does not depend on past land use. If previously uncropped land is eligible for the agri-environmental subsidy, it could encourage producers to expand crop production with negative consequences to the environment. Improved performance, on the other hand, does depend on past land use and, thus, will not encourage producers to expand crop production.

How Much? To Whom? In a voluntary program, producers will participate only if the payment offered covers the cost of changing production management or conservation practices as required by the program. On the other hand, payments larger than the value of the environmental benefit produced by the change in production management or conservation practices (to the extent this is known) need to be justified on grounds of other program objectives (e.g., farm income support). We consider three cases. First, policymakers could set payments that approximate the social benefit of environmental gains. Second, payments could be based on producer cost of participation. Because information on benefits and costs is limited, these cases cannot be fully achieved in practice. However, they are quite instructive. A third option is to establish payments, based on environmental actions, at levels that could support farm income. Thus, payments would exceed producers' costs, for at least some producers on some land.

Benefit-level payments. First, we consider the case where producer payments attempt to approximate the environmental benefit that flows from subsidized changes in conservation and management practices. This approach can provide direct income support to producers because payments can exceed the producer's cost of changing production management or conservation practices. In a sense, producers can earn profit from the "sale" of environmental goods and services. Subsidy rates effectively serve as "prices" for these environmental goods, inducing producers to allocate additional effort to producing them. If production declines because of the program, indirect farm income support may also result from higher commodity prices.

If payments vary spatially with the variation in expected environmental benefits (see appendix 5; figs. 9 and 10), **spatial targeting** is accomplished through producer self-selection. Producers who can achieve large environmental gains (i.e., are located in areas where the value of improved environmental quality is large) at a relatively low cost have the largest incentive to participate. Producers who can achieve only small environmental gains or can achieve gains only at a high cost will have less incentive to participate.

If benefit-level payments are based on *good performance* or use of *good practices*, policy decisionmakers will also have to decide how much environmental "improvement" or practice "change" will be credited to "good actors." For example, if a program seeks to conserve soil (to reduce water quality damage due to sediment, for example), how much soil conservation will be credited to a producer who has already achieved relatively low soil erosion rates?

One way to determine payment credit is to establish a *reference level* of environmental performance or practice use. Consider subsidies for soil conservation. The soil conservation credit assigned to a production system (that qualifies as good performance) could be calculated as the difference between the reference erosion rate and the estimated erosion rate for the system. Then the *payment rate* for the production

Figure 9

Estimated water quality damage from soil erosion

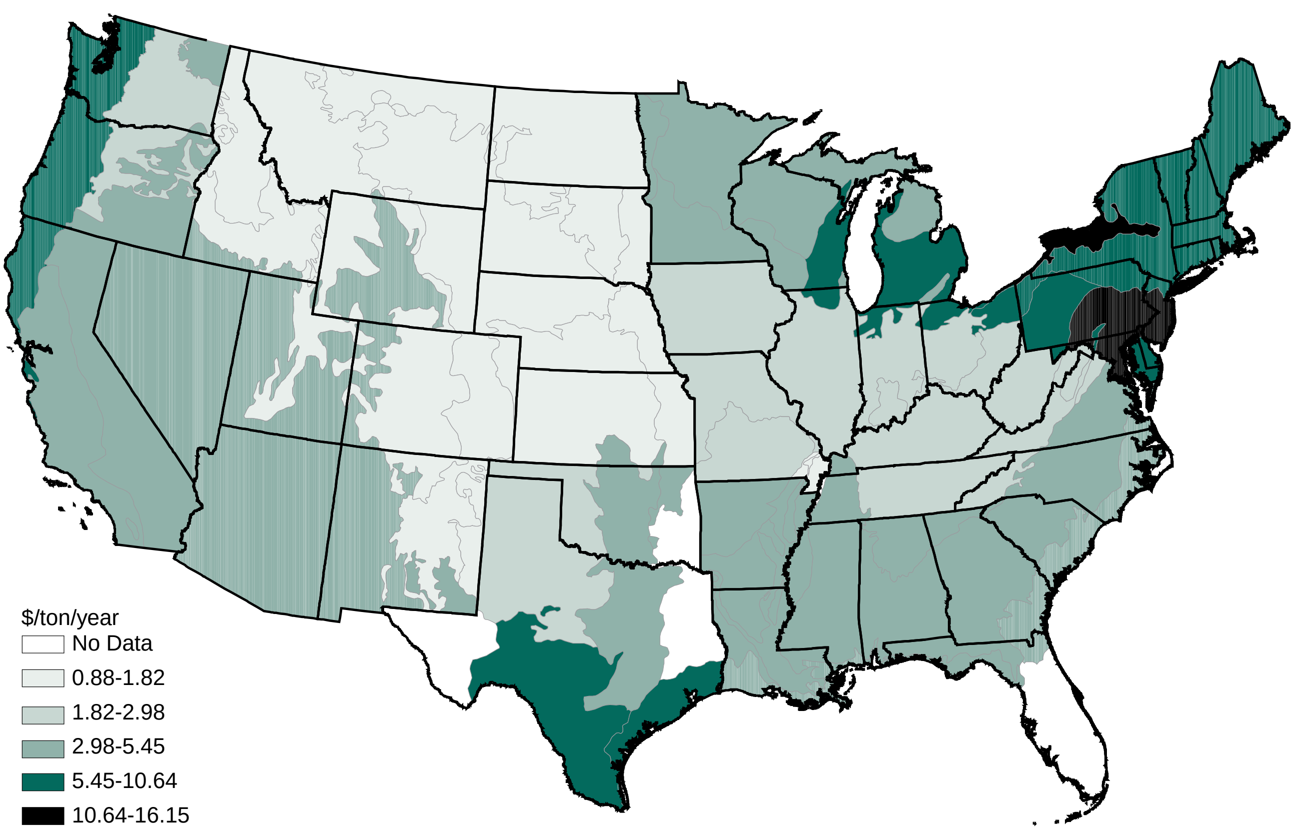
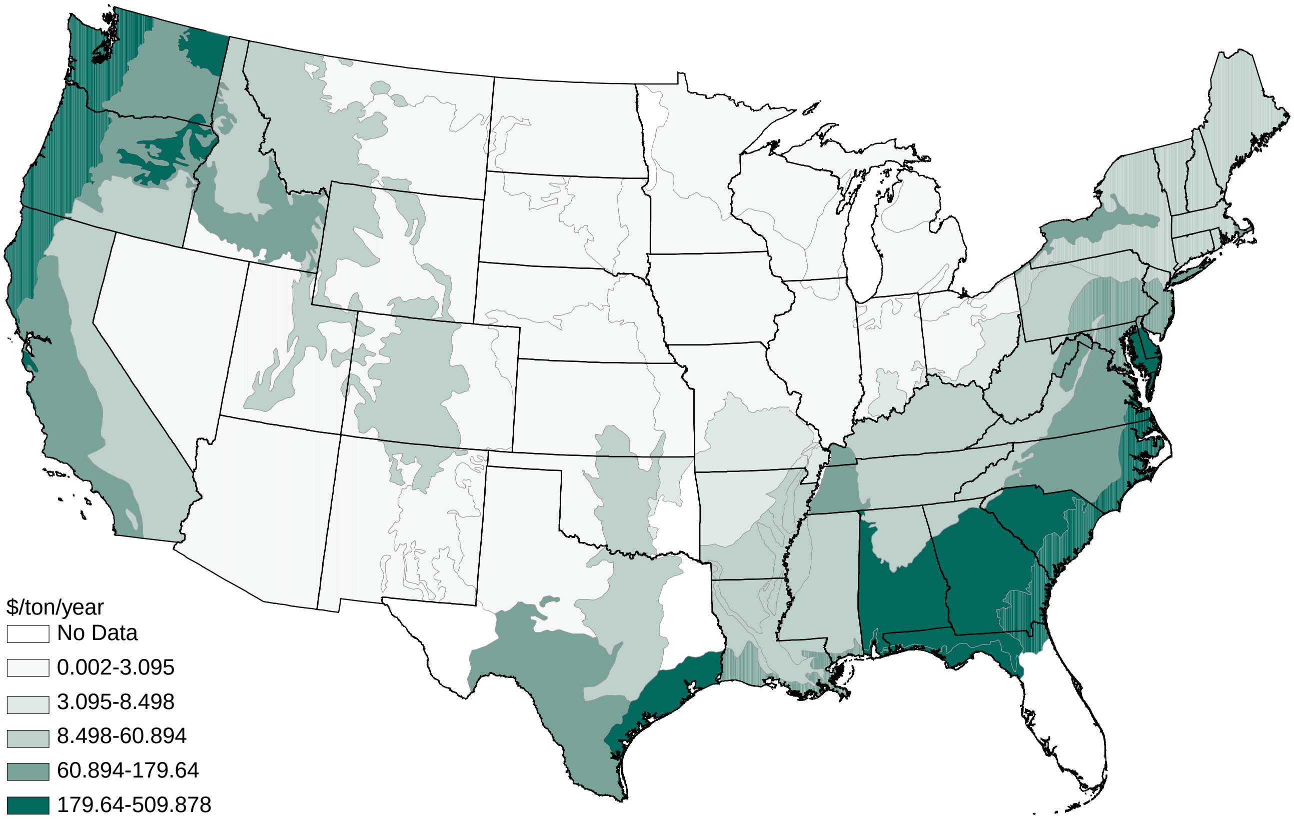


Figure 10
Estimated coastal water quality damage from runoff of fertilizer nitrogen



system could be the soil conservation credit (in tons) multiplied by the (dollar) value per ton of soil conserved. (Note that the reference level need ***not*** be the threshold used to determine which systems qualify as good performance.)

Reference levels could vary with soil type and topography, geographic region, or all these factors. While a reference level is not an environmental baseline—it would not be specific to a particular farm or field—it would reflect the cropping patterns and production management or conservation practices generally in place under homogeneous soil and climate conditions.

Reference levels will be a direct determinant of payment rates. If the reference level reflects poor environmental performance for a specific soil and region, soil conservation credits to "low erosion" production systems would be large. Alternately, if producers are credited only with gains beyond a typical or predominant level of environmental performance, credits and payments will be smaller. Clearly, a wide range of reference levels and associated rationale are possible.

Finally, program size (total government expenditure for producer payments) would ultimately be determined by producer participation, much as in past commodity programs. Participation would depend largely on the subsidy rates offered to producers. Policymakers could attempt to adjust program size by adjusting one or more of the variables (e.g., the reference level or the payment rate (dollars per ton of soil conserved)) that go into determining the per-acre payment rate for specific systems, in much the same way past commodity programs were adjusted. However, such adjustments may result in only imprecise control over total program size.

Cost-level payments. If payments are to approximate the cost of making changes in production management or conservation practices, a different set of issues arises. Because payments are designed to more closely approximate costs than benefits, there will be less direct income support under this type of a program. However, producer incomes may still rise if commodity production is reduced and prices rise.

Because farm-specific costs are unknown, cost information must be gotten from farmers. Requiring farmers to produce receipts for purchases would work for changes involving large one-time expenditures (e.g., for building a terrace), but may fail to capture the costs of less concrete changes (e.g., reduced yields or increased labor). Or producers could submit bids describing proposed actions and a proposed level of payment. If the bid process is well designed, bids will represent the lowest payment the bidder is willing to accept for taking the proposed action. These bids may approach producers' costs in very competitive situations.

Moreover, **spatial targeting** does not happen by producer self-selection under cost-level payments. To target producers who can achieve high net benefits, bid acceptance can be based on producer bids *and* an estimate of potential environmental benefits. In the CRP, for example, producer bids for rental payments are considered together with EBI scores to determine which contracts will be accepted (see table 4). Targeting is achieved because producers who exhibit high environmental scores relative to their participation costs are more likely to have their bids accepted.

Finally, policymakers can control program costs by deciding how many proposed agri-environmental payment contracts to accept. By adjusting the acceptance criteria once bids are received but before they are accepted or rejected, policymakers may gain some additional measure of control over program expenditures with a cost-level payment approach.

Farm income support-level payments. Payments would be based on agri-environmental actions, as in the benefit-level or cost-level payments. However, the level of payment would depend on the level of income support policymakers want to extend to agricultural producers. Actual income support to producers would depend on the level of payments, producer participation costs, and income gain or loss due to commodity price changes.

Analysis of Alternative Program Designs

To illustrate the consequences of some program design choices, we focus on a limited number of program designs. This approach is necessary because some program features interact so that individual features cannot be adequately analyzed apart from overall program design.

Our comparison of program designs is organized around the question of payment base. Payment rates consider both environmental benefits and farm income considerations. Thus, farm income is supported directly. Payment rates recognize spatial variation in potential benefits (see figs. 9 and 10, appendix 5), so spatial targeting is achieved through producer self-selection. Payment rates are also varied (by multiplying all payments rates by a constant) to reflect the possibility that a larger program may be desirable on the basis of farm income considerations.

For the *good performance* and *good practices* payment bases, non-HEL that was not previously cropped is eligible for agri-environmental payments if it is converted to crop production using *good practices* or production systems that meet the definition of *good performance*. However, producers who bring previously uncropped HEL into crop production are penalized. This provision is similar to sodbuster because the penalty is based on the level of other farm program payments (primarily Production Flexibility Contract (PFC) payments) and will be referred to as a sodbuster provision in the subsequent discussion.

We discuss and demonstrate the potential for unintended consequences in several ways. In one case, we relax the sodbuster provision. In another case, we compare a spatially targeted scenario (i.e., where the value per ton of soil conserved varies with potential benefits) with one where the value per ton of soil conserved is uniform across the country. These comparisons help illustrate how high payment rates in specific regions can encourage expansion of crop production and, potentially, undo the beneficial effects of spatial targeting.

Paying producers on the basis of improved environmental performance ensures that payments leverage environmentally effective actions, minimize producer participation costs, and minimize the risk of unintended consequences.

Paying producers on the basis of improved environmental performance ensures that payments leverage environmentally effective actions, minimize producer participation costs, and minimize the risk of unintended consequences. First, payments are **effective** in furthering the program's environmental objectives because they are based on production management and conservation practice changes that *directly improve* environmental performance, adding to environmental quality. Second, performance-based payments are **flexible** for producers, allowing them to select low-cost methods of achieving environmental gains. Finally, the risk of unintended consequences due to cropland expansion is minimized because producers must *improve* overall performance on the entire farm. For example, bringing hay or pasture land into crop production would almost surely reduce environmental performance and would count against the producer in determining an overall level of environmental performance.

However, payments based on improved performance also require USDA to have a great deal of information, may entail high costs for planning and enforcement, and may be viewed as inequitable by some producers. First, a farm-level or field-specific baseline of past production management and conservation practices will be needed to assess the change in performance. Depending on the environmental performance measure sought, extensive data on past land use, crop rotations, input use (e.g., fertilizer application rates), and cropping practices (e.g., tillage systems) will be needed. Such baseline information is not widely available. Collecting baseline information after enactment of an agri-environmental payment program would invite gaming: producers could temporarily abandon some environmentally favorable practices to obtain a more favorable baseline. Second, basing payments on estimated environmental performance may entail significant planning and enforcement costs. To date, only the USLE and WEE models have been used in program implementation. Other models for estimating other physical processes (e.g., nutrient runoff) are more complex, requiring more user training and more data for successful implementation. Finally, paying for *improvement* in environmental performance excludes past gains by "good actors." These producers may argue that past gains entitle them to the same payments received by producers who improved environmental performance only in response to agri-environmental payments.

Paying for "good" environmental performance requires no baseline information and treats "good actors" equally with other producers. Significant environmental effectiveness and producer flexibility are maintained, but payments are less effective and less flexible than in the *improve performance* scenario. This approach may also result in significant unintended consequences.

Payments based on good environmental performance are less effective environmentally and less flexible than payments based on improved performance because some options for improving environmental performance are precluded. In some cases, for example, the best way to improve environmental performance will be to retire land from crop production. The *good performance* payment base does not subsidize land retirement (to subsidize land not in crop production, simply because it is not in crop production, would be quite expensive). In this case, coordination between land retirement and agri-environmental payments may be important to ensure that gains from land retirement are realized and that the more appropriate instrument is used case-by-case. An agri-environmental payment program with broader objectives could also provide payments for good grazing management that would provide some incentive for returning land to, or retaining land in, grazing.

Payments based on improved performance require USDA to have a great deal of information, may entail high costs for planning and enforcement, and may be viewed as inequitable by some producers.

Moreover, if payments are limited to production systems with *good performance*, some more modest conservation strategies that do not attain the *"good performance"* standard (e.g., giving up a moldboard plow for conventional tillage) would be excluded from the subsidy program. If the focus of the program is on mitigation of offsite damages, any improvement in onfarm environmental performance is useful. Still, there may be legitimate objections to extending agri-environmental payments to producers who do not meet some minimum standard of environmental performance. If "bad actors" receive subsidies for modest environmental improvement while "good actors"—with much better environmental performance—are excluded, producers will be discouraged from taking any unsubsidized action that improves environmental performance.

Our empirical analysis illustrates how differences in environmental effectiveness and producer flexibility affect environmental outcomes in the *improve performance* and *good performance* scenarios (see box, "Payment Bases and Program Performance"). These scenarios are directed toward soil conservation and targeted to reduce sediment damage to water quality.

Paying for "good" environmental performance requires no baseline information and treats "good actors" equally with other producers. Significant environmental effectiveness and producer flexibility are maintained, but payments are less effective and less flexible than in the improve performance scenario. This approach may also result in significant unintended consequences.

Differences in erosion reduction per dollar of program payment between the *improve performance* and *good performance* scenarios are quite large. At $1 billion in producer payments, the *improve performance* scenario reduces soil erosion by roughly 110 million tons, just under 15 percent. By contrast, the *good performance* and *good practices* scenarios produce only 20 million and 22 million tons of erosion reduction. Moreover, as the level of producer payments rises (as the result of raising payment rates per ton of soil erosion reduced or soil conserved), the level of erosion reduction increases rapidly for the *improve performance* scenario but only slightly for *good performance* and *good practices* scenarios.

There are several reasons for the difference in erosion reduction per dollar of program payments. First, much of the additional money in the *good performance* and *good practices* scenarios goes to increasingly large payments to "good actors." Very little of the additional program funds leverage new conservation effort. A second reason for this large difference in performance is the effect of alternate designs on land use. In the *improve performance* scenario, when annual producer payments are $1 billion, total land in crop production declines nearly 8 million acres. In the *good performance* scenario, crop acreage increases by 500,000 acres. Basing payments on improved performance is unlikely to be practical given information requirements. However, this comparison does suggest that there could be advantages to using *good performance* or *good practices* programs in conjunction with a land retirement program.

The cropland expansion effect in the *good performance* scenario results from unintended incentives to expand crop production. Subsidizing the expansion of environmentally good crop production systems or specific practices will *not* ensure that these systems are expanded on cropland where environmentally damaging production systems are being used. Without proper safeguards, subsidies could prompt producers to convert hay or pasture land to crop production, possibly increasing—rather than reducing—environmental damage (Malik and Shoemaker, 1993).

In the absence of a sodbuster provision, our empirical analysis (see box, "'Good Performance' and Unintended Consequences") indicates cropland expansion can severely undercut environmental gains. Without sodbuster, a program that subsidizes good performance on soil conservation (the use of "low erosion" production systems) can actually *increase* total soil erosion. Because the program has a very modest effect on commodity prices, cropland acreage expansion and erosion increases are due almost entirely to subsidy response.

Cropland expansion can also undercut efforts to increase water quality benefits by offering relatively high payments to producers in areas or regions where the water quality benefits of erosion reduction are high. Even with a sodbuster provision, subsidies can encourage expansion of crop production on non-highly erodible land. When payments are varied to reflect variations in potential benefits, the cropland expansion effect can be particularly severe in regions where payments are high.

When payments are based on *good performance*, empirical analysis suggests that water quality benefits due to sediment reduction can be larger when payments per ton of soil conserved ***do not*** vary spatially to reflect potential benefits. High payments in high-benefit regions intensify incentives to expand crop production on non-highly erodible land, undercutting the increase in soil conservation effort on previously existing cropland.

By contrast, when payments are based on *improved performance*, varying payments to reflect variation in potential benefits does increase water quality benefits. Producers can receive payments only in exchange for erosion reduction. In this context, varying payments to reflect variation in potential benefits intensifies efforts for environmental improvement because payments subsidize only those actions that result in environmental improvement.

These empirical results do not imply that payments based on *good performance* cannot be successfully targeted to increase environmental benefits. However, agri-environmental payment programs that induce producers to increase cropland acreage—even on land that is not highly erodible—can erase environmental gains on existing cropland. Policymakers may want to consider land-use safeguards that go beyond a sodbuster provision. It may be useful to limit eligibility for agri-environmental payments to land already in crop production, as closely as that can be determined. A more aggressive solution would be to expand sodbuster to cover non-HEL, requiring strict conservation and environmental compliance on any additional land brought into crop production after enactment of the agri-environmental payment program. Also, a broader program, which included payments for *good performance* or the use of *good practices* on grazing land or other non-cropland, could reduce the incentive to shift land into crop production.

Paying for use of specific practices can mean low planning and enforcement costs and low information requirements, and will ensure that early adopters are treated equitably. However, this approach eliminates producer flexibility and may not be environmentally effective in some resource settings.

A key difference between payments based on *good performance* and *good practices* is the level of environmental effectiveness and producer flexibility. Our empirical analysis shows that the *good performance* scenario produces more erosion reduction and water quality benefit than the *good practice* scenario ***per dollar of measured net cost to the economy*** (for definition see box, "Payment Bases and Program Performance"). However, this analysis could not measure the planning and enforcement costs associated with a performance-based payment. The greatest advantage of a *good practices* payment base is its potential for low planning and enforcement costs. For example, if producers are paid to adopt conservation tillage, planning and enforcement are straightforward: 30 percent of the soil surface must be covered with crop residue after planting. Implementation would require limited planning, and compliance is readily measurable. While no specific conclusion can be drawn from our empirical example, it is generally important to consider both potential savings due to flexibility and program implementation costs in selecting a program payment base.

Paying for use of specific practices can mean low planning and enforcement costs and low information requirements, and will ensure that early adopters are treated equitably. However, this approach eliminates producer flexibility and may not be environmentally effective in some resource settings.

Paying for adoption of a specific practice can mean low planning and enforcement costs. However, producer flexibility is eliminated, environmental effectiveness may be low in some resource settings, and baseline information will be required. Producers who have already adopted a given practice or cannot easily use the favored practice may view this approach as inequitable. These issues have been discussed at length in the preceding discussion and will not be repeated here.

Who Pays? Who Gains?

The choice of payment base will largely determine who reaps economic gain and who suffers loss due to an agri-environmental payment program. The distribution of gains and losses among producers[15], consumers, and taxpayers and among different producers depends on (1) how payments are distributed among producers, (2) the cost producers incur in changing production management or conservation practices to earn payments, (3) how these costs translate into commodity output and price changes, and (4) how price changes affect farm income and consumer welfare. On a conceptual basis, little can be said about the distribution of cost and benefits. This section focuses on empirical analysis, with specifications exactly as reported in the box, "Payment Bases and Program Performance."

In the *improve performance* scenario, producers must reduce erosion to receive payments. In many cases,

[15] Our analysis cannot distinguish returns to farmers versus returns to landowners. When farmers are not landowners, support may accrue to landowners (see box "Supporting Farm Incomes and Protecting the Environment: The Case Where Farmers Are Not Landowners").

Payment Bases and Program Performance

We use USMP (see appendix 2) to analyze the relative efficiency of achieving environmental gains using three alternative payment bases, or approaches to defining the action(s) that will trigger agri-environmental payments: ***improve performance***, ***good performance***, and use of ***good practices***.

In our hypothetical scenarios, the policy objective is to reduce water quality damage due to sediment. At the farm level, soil conservation is the focus of the payment base alternatives (see table). To focus program activity on regions where soil erosion causes the largest potential damage to water quality, producers in those regions can receive higher payments, commensurate with higher water quality damages per ton of soil erosion (see appendix 5 and fig. 9). However, farm income support objectives may imply higher payment rates. Payment rates are varied by multiplying the benefit-based payment rate per acre by a constant. As payment rates increase, total program payments increase. Finally, to guard against expanding crop production onto highly erodible land (HEL), producers who bring previously uncropped HEL into crop production lose other farm program benefits. This provision is similar to the sodbuster provisions of current farm commodity policy and is referred to as a sodbuster-type penalty.

Producer payments are the government expenditure for payments to producers, excluding conservation planning, technical assistance, and enforcement costs. ***Measured cost*** reflects the change in total income in the economy required to produce the agri-environmental gains due to the subsidy program, including the direct cost of changing production management or conservation practices to achieve environmental gains and indirect costs such as the loss of commodity output if producers shift to less erosive but less productive production systems. The *measured costs* reported here *do not include* (1) payments to producers, (2) government expenditures for program implementation, and (3) economic costs of raising taxes to fund government program expenditures.[1] Producer payments are not included because they are transfers of income from taxpayers to agricultural producers rather than actual costs to the overall economy. Government expenditures for program implementation and the economic cost of taxation are real costs of achieving environmental gains but could not be accounted for in our modeling framework. Thus, differences in measured costs must be considered against the potential for differences in costs not accounted for.

The *improve performance* scenario produces *much greater* erosion reduction per dollar of program payment and per dollar of *measured cost* to the economy than either the *good performance* or *good practice* scenarios.

[1] The economic cost of taxation is the value of economic activity lost due to the tax. Taxes on productive resources will reduce the utilization of those resources. For example, an increase in the tax on labor income may prompt some workers to leave the workforce, reducing production. While the magnitude of these costs is unknown, reasonable estimates range from 20 to 50 cents for each dollar of additional tax revenue (Browning, 1987).

Payment bases and payment rates for reducing sediment damage to water quality

USMP scenario	Payment base	Payment rate (per acre)[1]
Improve performance	Reduce erosion from pre-program baseline	Erosion reduction (tons per acre) *multiplied by* estimated water quality damage per ton (see appendix 5)
Good performance	Use of “low rainfall erosion” production systems[2]	Soil conserved[4] (tons per acre) *multiplied by* estimated water quality damage per ton (see appendix 5)
Good practices	Use of “conservation tillage” production systems[3]	Soil conserved[4] (tons per acre) *multiplied by* estimated water quality damage per ton (see appendix 5)

[1] Payment rates are also adjusted by constant multiples of these rates to provide results on a range of program sizes. We report a range of results because environmental benefits may be underestimated and/or farm income support objectives may imply higher rates. [2] A production system with a rainfall erosion rate below that for a system using a **predominant crop rotation** in combination with **conventional tillage** on the same soil and in the same region. [3] Any tillage system that **covers 30 percent or more of the soil surface with crop residue**, after planting, to reduce erosion by water. [4] Difference between (1) the maximum erosion rate observed for any production system for a given soil in a given region (the reference level) and (2) the estimated rate of erosion for the system in use on the same soil in the same region.

Continued on page 41

At $1 billion in producer payments, the *improve performance* scenario reduces soil erosion by roughly 110 million tons, just under 15 percent. By contrast, the *good performance* and *good practice* scenarios produce only 20 million and 22 million tons of erosion reduction. For $250 million in *measured cost*, the *improve performance* scenario produces more than 100 million tons of erosion reduction, compared with 37 million tons in the *good performance* and 30 million tons in the *good practices* scenarios. Similar results are obtained with respect to water quality benefits.

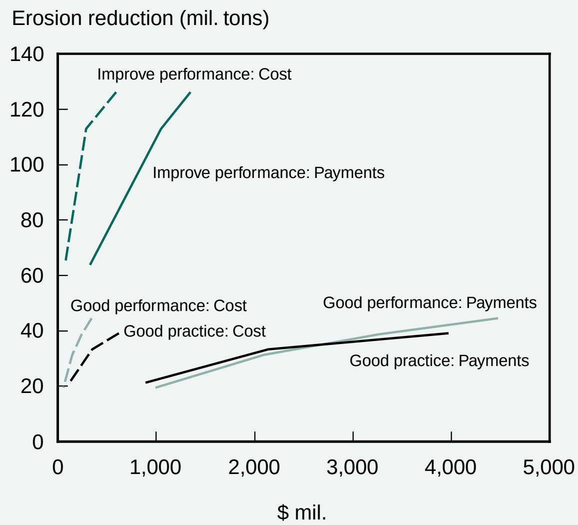
As the level of producer payments rises, these differences rapidly become larger. Erosion reduction ranges from just 2 to 5 percent in the *good performance* and *good practices* scenarios as producer payments range from $1 billion to $4 billion. Much of the additional money expended in these scenarios goes to increasingly large payments to "good actors." Very little of the additional program funds leverage new conservation effort.

However, information for a pre-program baseline is not likely to be available and equity concerns may require that "good actors" be eligible for payment. Then agri-environmental payments must be based on current producer actions without regard to past actions, e.g., *good performance* or *good practices*. Per dollar of *measured costs*, the *good performance* payment base delivers greater erosion reduction and water quality benefits than do payments for *good practice*. However, program administration costs may be significantly higher for the *good performance* scenario due to (1) the effort needed to develop farm- or field-specific conservation plans and (2) the complexity of enforcement when every farm or field has a unique plan. When these costs are considered, the *good practice* scenario may well be more cost-effective in achieving environmental gains.

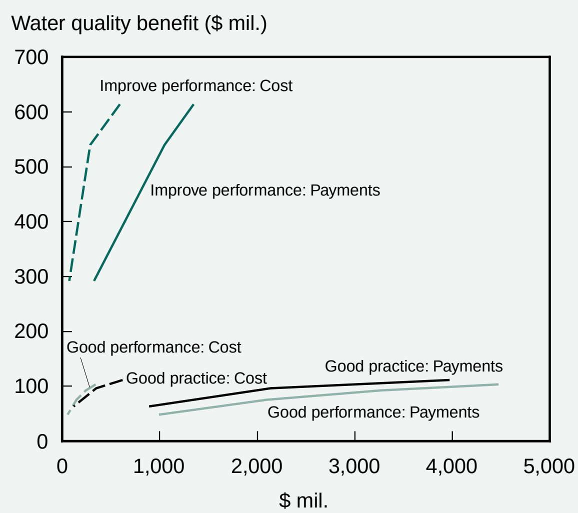
On the other hand, per dollar of *producer payments*, the *good practices* scenario produces *more* erosion reduction (for producer payments of up to $2.7 billion) and *more* water quality benefit over the full range of program sizes investigated. In general, there is no reason that erosion reduction or water quality benefits per dollar of *payment* under these scenarios should have any specific relationship, since payments are not based on erosion reduction (as they are in the *improve performance* scenario). The *good practice* scenario compares favorably with the *good performance* scenario in terms of producer payments for two reasons. First, the practice subsidized—conservation tillage—is well adapted in regions where potential water quality benefits (and therefore payments) are high. This is particularly true in the Northern Crescent region. Second, because conservation tillage is not as widely used as some other conservation practices, relatively few funds are used for payment of erosion credits due to past actions.

Finally, the analysis presented here was designed to illustrate program design issues and cannot be construed as a cost-benefit analysis. The water quality benefits we measure exceed the costs we measure for the *improve performance* scenario but fall short of measured costs for the *good performance* and *good practices* scenarios. However, some benefits of soil erosion reduction (e.g., maintenance of soil productivity) and some costs (e.g., conservation planning, technical assistance, and enforcement) are not measured. Moreover, we have no estimate of the value of farm income support, although farm income support legislation in recent years indicates that policymakers do value it.

Producer payments, measured costs, and erosion reduction for alternate payment bases



Producer payments, measured costs, and water quality benefit for alternate payment bases



"Good Performance" and Unintended Consequences

We use USMP to demonstrate the potential for expanded crop production under a *good performance* base. Similar criticisms may apply to *good practices* bases for agri-environmental payment programs. Safeguards against expansion of crop production can include sodbuster-type provisions or program "base" acreage provisions (or eligibility criterion) similar to those of previous farm commodity programs. Programs that provide payments on grazing land or other noncropland may also be effective if the profitability of that acreage rises due to the agri-environmental payment program.

In our hypothetical scenarios, the policy objective is to reduce water quality damage due to sediment. At the farm level, soil conservation is the focus of the program alternatives. The scenarios analyzed here include two payment bases: *improve performance* and *good performance* (see table). To focus program activity on regions where soil erosion causes the largest potential damage to water quality, producers in those regions can receive higher payments, commensurate with higher water quality damages per ton of soil erosion (see appendix 5 and fig. 9). However, farm income support objectives may imply higher payment rates. Payment rates are varied by multiplying the benefit-based payment rate per acre by a constant. As payment rates increase, total program payments increase.

Finally, to guard against expanding crop production onto highly erodible land (HEL), producers who bring previously uncropped HEL into crop production lose other farm program benefits. This provision is similar to the sodbuster provisions of current farm commodity policy and is referred to as a sodbuster-type penalty. We also estimate *good performance* scenarios in which (1) payments per ton of soil conserved are uniform across the Nation (not targeted), and (2) the sodbuster penalty is dropped.

First, we compare erosion reduction in the *good performance* scenario, with and without the sodbuster provision. Without sodbuster, previously uncropped HEL land is eligible for subsidy payments. Crop production expands significantly onto uncropped HEL, resulting in a net *increase* in soil erosion. Even with the sodbuster provision non-highly erodible land can be brought into crop production and receive agri-environmental payments.

Payment bases and payment rates for reducing sediment damage to water quality

USMP scenario	Payment base	Payment rate (per acre)[1]
Good performance	Use of "low rainfall erosion" production systems[2]	Soil conserved[3] (tons per acre) *multiplied by* estimated water quality damage per ton (see appendix 5)
Good performance: No Sodbuster	Use of "low rainfall erosion" production systems[2]	Soil conserved[3] (tons per acre) *multiplied by* estimated water quality damage per ton (see appendix 5)
Good performance: Not Targeted	Use of "low rainfall erosion" production systems[2]	Soil conserved[3] (tons per acre) *multiplied by* nationally uniform rate per ton
Improve performance	Reduce erosion from pre-program baseline	Erosion reduction (tons per acre) *multiplied by* estimated water quality damage per ton (see appendix 5)
Improve performance: Not Targeted	Reduce erosion from pre-program baseline	Erosion reduction (tons per acre) *multiplied by* nationally uniform rate per ton

[1] Payment rates are also adjusted by constant multiples of these rates to provide results on a range of program sizes. We report a range of results because environmental benefits may be underestimated and/or farm income support objectives may imply higher rates.
[2] A production system with a rainfall erosion rate below that for a system using a **predominant crop rotation** in combination with **conventional tillage** on the same soil and in the same region.
[3] Difference between (1) the maximum erosion rate observed for any production system for a given soil in a given region (the reference level) and (2) the estimated rate of erosion for the system in use on the same soil in the same region.

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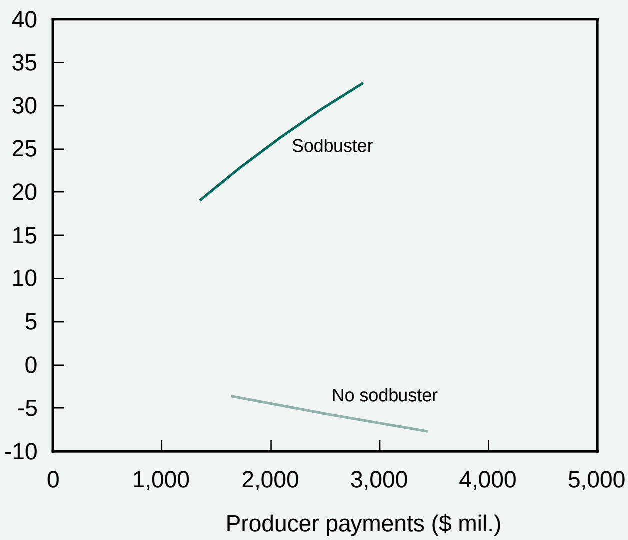
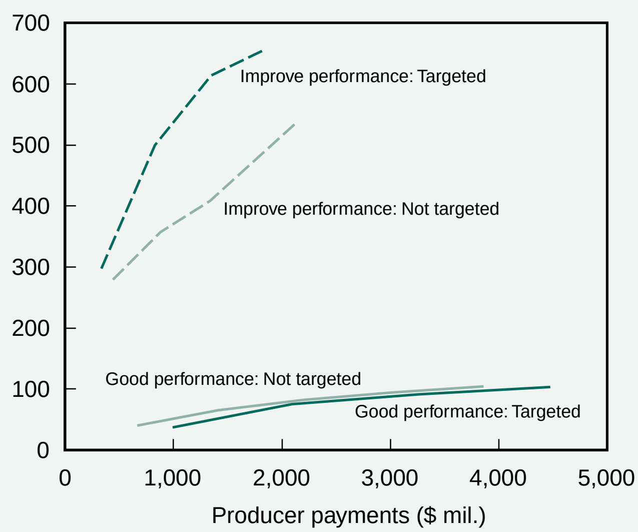
Producer payments and erosion reduction with and without sodbuster



This cropland expansion effect also limits the environmental performance of good performance programs, although not as much as expanding crop production on HEL. The consequences of bringing non-HEL into production can best be seen by comparing scenarios in which payments per ton of soil erosion vary with potential benefits (targeted) and where this payment is uniform across the Nation (nontargeted). Targeting is designed to redirect conservation effort from low-cost/low-benefit erosion reductions to higher cost/higher benefit reductions. Targeting results in less erosion reduction but, presumably, more water quality benefits.

For the *improve performance* scenarios, targeting produces greater water quality benefits per dollar of producer payments. For example, at roughly $1 billion in producer payments, targeting produces roughly $550 million in water quality benefits, a 32-percent increase over the nontargeted scenario ($375 million). However, erosion reduction is less in the targeted scenario because targeting redirects program funds away from low-cost/low-benefit erosion reductions to higher cost/higher benefit reductions.

Improved performance vs. good performance: Producer payments and water quality benefits



Regional changes due to targeting in the low erosion systems scenario

Farm resource region	Change from nontargeted to targeted scenario: Payment	Water quality benefit	Crop acreage
	$ Million	*$ Million*	*Million acres*
Northern Crescent	282.7	4.1	0.5
Southern Seaboard	30.9	-0.7	0.7
Mississippi Portal	14.4	0.3	0.2
Fruitful Rim	9.0	-0.8	0.1
Eastern Uplands	1.7	0.0	0.0
Basin and Range	-6.2	-0.3	-0.3
Prairie Gateway	-60.0	-1.4	0.1
Northern Great Plains	-79.6	-2.9	0.0
Heartland	-171.0	-2.4	-0.1
U.S. Total	21.9	-4.1	1.2

[1] Benefits associated with reductions in water erosion including water-based recreation benefits, municipal water cleaning, industrial impacts, shipping, water storage, etc.

Continued on page 44

For the *good performance* scenarios, however, the targeted scenario produces less erosion reduction ***and slightly less water quality benefit*** per dollar of producer payments over a wide range of program sizes. For example, if producer payments in both scenarios are roughly $2.1 billion, the targeted scenario produces $4.1 million less in water quality benefits.

This result stems from the fact that *erosion reduction* is not guaranteed in the *good performance* scenario. A significant share of higher payments may simply go to increase payments to "good actors," and without safeguards, the *good performance* scenario will encourage expansion of crop production.

Regional results show how the cropland expansion effect undercuts spatial targeting in the *good performance* scenario. Targeting increases payments in five regions: the Northern Crescent, Southern Seaboard, Mississippi Portal, Fruitful Rim, and Eastern Uplands (see table). However, water quality benefits improve in only two regions—the Northern Crescent and Mississippi Portal—and actually decline in the Southern Seaboard and Fruitful Rim regions. Total cropland acreage expands (relative to the nontargeted case) in four of the five regions where payments rise, offsetting gains from adoption of low erosion systems on existing cropland. The sodbuster provision, included in both scenarios, affects only highly erodible land, leaving producers free to expand production onto, and receive agri-environmental payments on, other land.

These results do not imply that "good actor" programs cannot be successfully used to improve environmental performance or cannot be targeted to increase environmental benefits. However, program designs that induce producers to increase cropland acreage – even on land that is not highly erodible – can erase program-induced environmental gains on existing cropland. A sodbuster provision is critical, and policymakers may want to add land-use safeguards similar to the "base acreage" (land eligibility) provisions of previous commodity programs.

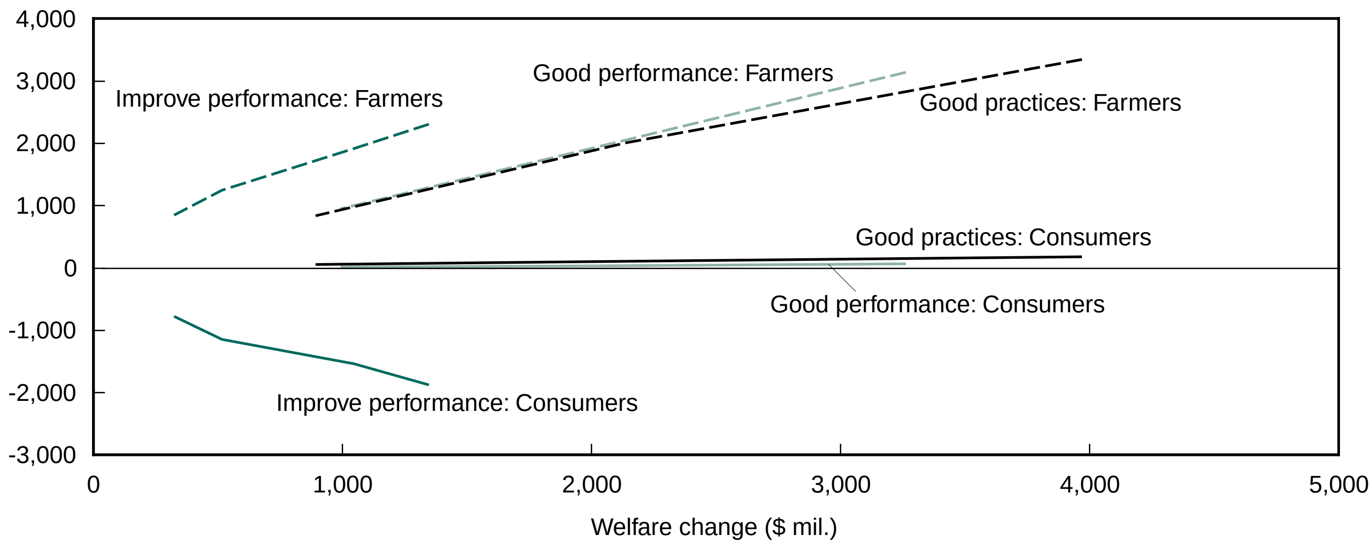
producers opt for less productive (but less erosive) production systems, reducing commodity output and increasing commodity prices. Consumer welfare is reduced due to higher commodity prices (fig. 11). The increase in overall farm income exceeds producer payments because of higher commodity prices, although producer gains are offset to some extent by the costs of erosion reduction. The incomes of livestock producers fall modestly due to higher feed grain prices.

In the *good performance* and *good practices* options, producers can receive payments based on past actions, so the increase in conservation practices is lower for a given level of producer payments. Commodity price effects and producer costs for changes in production management or conservation practices are small compared with the *improve performance* scenario. Consumers are largely unaffected, but taxpayers shoulder a larger burden for farm income support than for the *improve performance* scenario. Small price effects and little change in production and conservation costs mean that 1 dollar in producer payments translates roughly into 1 dollar in increased farm income (fig. 11).

The choice of payment base also affects the regional distribution of payments and farm income gains. Regions with many "good actors" will receive a relatively large share of payments from the *good performance* or *good practices* scenarios. In our empirical examples, producers in the Heartland and Northern Crescent regions reap relatively large gains in the *good performance* and *good practices* scenarios (fig. 12). Because price effects are small, payments translate more or less directly into farm income gains in most regions (fig. 13). Rice, soybean, and cotton prices decline in the *good practices* scenario, leading to small declines in farm income in the Fruitful Rim and Mississippi Portal regions (fig. 13).

Payments in the *improve performance* scenario fall in areas where environmental improvement is valuable and/or can be achieved at low cost. In our empirical example, payments for erosion reduction are largest (relative to the baseline level of farm income) in the Northern Crescent, Basin and Range, and Mississippi Portal regions (fig. 12). Because price effects are significant, however, farm income gains may be larger or smaller than payments. Farm income gains are larger than payments in the Heartland and Prairie Gateway regions (fig. 13). In these regions, producers benefit from increased grain prices, while making only minimal investments in erosion reduction. Farm income gains are smaller than payments (or even negative) in the Northern Crescent, Northern Great Plains, Mississippi Portal, and Fruitful Rim. In all four regions, significant erosion reduction is achieved as land is removed from crop production. Although per-acre payments tend to be high in these regions, land retirement

Figure 11
Producer payments and consumer and producer welfare for various payment bases



is also an expensive erosion reduction strategy, so that costs largely offset payments.

In summary, program outcomes—environmental improvement and effects on agricultural producers, consumers, and taxpayers—vary widely depending on the details of program design. We find that **no single program design rises above others as an obvious choice** for agri-environmental policy. The *improve performance* scenario appears to offer the most environmental improvement per dollar of producer payments and provides the largest farm income boost per dollar of payment. However, baseline information needed to implement the improve performance payment base is not available. Moreover, this approach could also be viewed as inequitable by "good actors" and requires consumers to shoulder a significant share of program costs through higher commodity prices.

Figure 12
Payments as a percentage of farm income, by region, for various payment bases

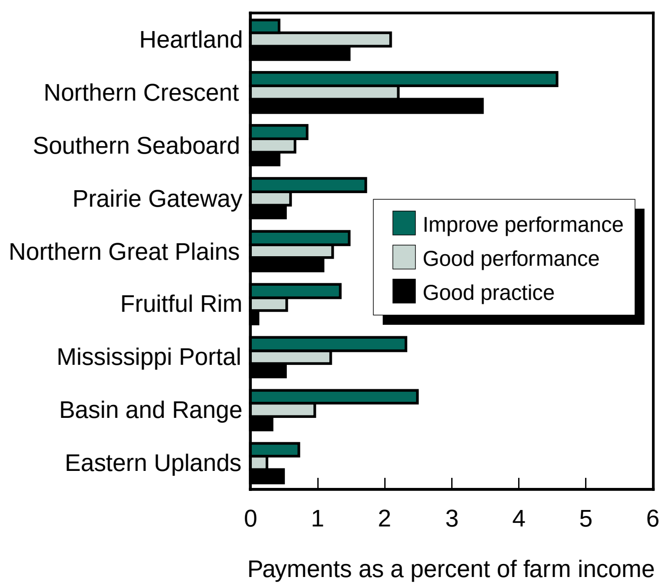
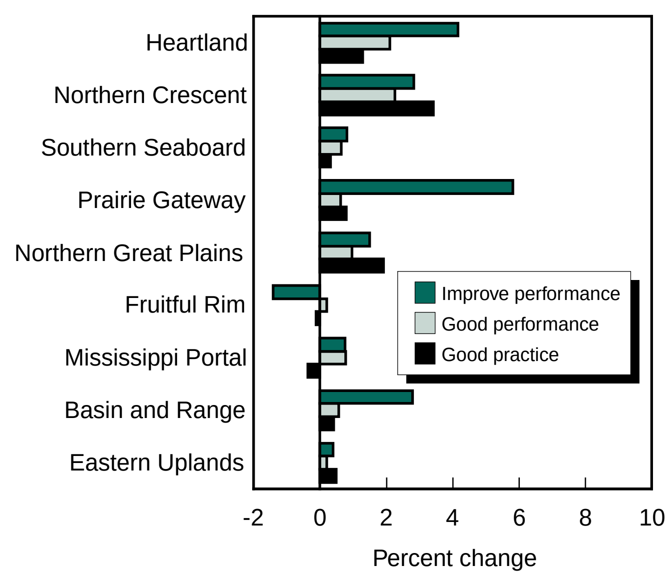


Figure 13
Percent change in farm income, by regions, for various payment bases



The *good performance* and *good practices* payment bases offer significant income support, do not adversely affect consumers, and do not require pre-program baseline information. While these payment base options are realistic, they produce only modest environmental gain and place a significant burden on taxpayers. Program designers must be careful to minimize incentives for cropland expansion. The *good performance* payment base offers some advantages over the *good practices* payment base in terms of directing payments to environmentally effective actions and allowing producers to select low-cost options where there is more than one way to achieve an environmental outcome. On the other hand, the *good practices* payment base is likely to require significantly less planning and enforcement effort.