A Conservation Program Retrospective: Gains Made And Lessons Learned, 1980-2000

A look at recent agri-environmental programs reveals significant environmental gains. A closer look at the agri-environmental gains, in turn, provides some lessons on the merits of past program features.

Agri-Environmental Gains

To date, measurements of physical and economic gains have been attempted only for major agri-environmental programs: conservation compliance and the Conservation Reserve Program. Data on the impacts of smaller programs are scarce, which means it is difficult to measure their environmental effectiveness relative to costs. However, since the excluded agri-environmental programs are small, their environmental gains relative to those of the major programs can be expected to be small.[8]

Soil Erosion Has Been Significantly Reduced

Between 1982 and 1997, total erosion on U.S. cropland fell from 3.08 to 1.89 billion tons/year, a decline of roughly 1.2 billion tons/year or nearly 40 percent. Of this, just over half, 641 million tons/year, was due to reductions in sheet and rill (water) erosion, while 552 million tons/year was due to reductions in wind erosion (table 2). Farm conservation programs—especially conservation compliance and the Conservation Reserve Program—have helped bring about reductions in soil erosion (Magleby et al., 1995).

Conservation compliance has helped reduce erosion on land that remains in crop production. Conservation compliance required farmers to file and implement an approved conservation plan on nearly 91 million acres of cropped HEL to remain eligible for many farm programs (Hyberg, 1997). In 1997, approved conservation systems were in operation on more than 95 percent of all land subject to compliance (Claassen et al., 2000). Furthermore, once farmers have adopted conservation or reduced tillage practices on their HEL, they may be more likely to use these same practices on their non-HEL.

Total erosion on cropped HEL was 323 million tons/year lower in 1997 than in 1982; erosion on non-HEL cropland decreased by 319 million tons/year (table 2).[9] The nearly equal decline in erosion on HEL and non-HEL cropland, despite the lower erosion rate on non-HEL, is explained, in part, by the 3-to-1 ratio of non-HEL to HEL acres nationwide.

Government programs may not be the only factor reducing erosion. Erosion reductions may also be the result of technological advances in the production and design of conservation-related inputs. For example, a recent improvement in corn planters ensures even spacing of the seed despite the level of crop residue. Technological advances increase the profitability, and thus the adoption, of some conservation practices.

The Conservation Reserve Program reduced erosion by taking cropland out of production and requiring that a permanent cover be established. The Conservation Reserve Program selected HEL when the program began in 1985 and was expanded to include HEL and non-HEL after 1991. Total CRP acreage has ranged from 30 to 36 million acres since the late 1980's. Approximately 31.5 million acres were enrolled as of June 15, 2000, at an average per-acre rental rate of $45 (USDA, FSA, 2000b).

On land enrolled in the CRP in 1997, total erosion was 406 million tons/year in 1982 (table 2). However, this number does not represent the CRP's total impact on soil erosion for several reasons. First, the CRP reduces erosion to very low levels, but not to zero. Second, with conservation compliance, erosion on many of these acres would have fallen without the CRP. Third, the CRP helped raise commodity prices, which brought more land into production (USDA, FSA, 1997). This "slippage" comes from converting hayland or pastureland to cropland, thus increasing erosion.

The erosion due to slippage is difficult to assess because other factors also affected farmland conversions. First, the sodbuster provision of conservation compliance discouraged farmers from converting HEL to cropland. Second, compliance was encouraging

[8] Expenditures on conservation practices through EQIP, which tends to be significant among remaining programs, averaged $155 million/year from 1997 through 1999 (see box, "EQIP")—approximately one-tenth those of the CRP.

[9] Estimates of changes in erosion between 1982 to 1997 are based on ERS analysis of National Resources Inventory (NRI) data of the USDA/NRCS.

Table 2—Soil erosion reduction in the United States 1982-97

Item	Soil erosion reduction, 1982-97 *(million tons/year)*
Net reduction in **total** erosion on cropland from 1982 to 1997 (percent change)	1,192.7 (38.9)
Net reduction in sheet and rill erosion on cropland from 1982 to 1997	640.7
Net reduction in wind erosion on cropland from 1982 to 1997	552.0
Erosion on HEL cropped in 1982 and 1997[1]	322.9
Erosion on non-HEL cropped in 1982 and 1997[2]	319.4
Erosion in 1982 on cropland enrolled in CRP in 1997[3]	406.0
Net change due to non-CRP land use change[4]	144.4

[1]The erosion change on HEL cropped in 1982 and 1997. Therefore, it does not account for the erosion reduction associated with any HEL that was cropped in 1982 but in pasture, hay, or the CRP in 1997. It does not include the erosion increase on the non-HEL that was pasture or hay land in 1982 and cropped in 1997.
[2]The erosion change on non-HEL cropped in 1982 and 1997. Therefore, it does not account for the erosion increase on non-HEL that was pasture or hay land in 1982 and cropped in 1997. It does not account for the erosion decrease on non-HEL that was cropped in 1982 but in pasture, hay, or the CRP in 1997.
[3]Erosion on CRP land is very low but not zero. Thus this figure would be slightly larger than the actual reduction in erosion.
[4]The net change in erosion on land that was cropped in 1982 but not cropped or in the CRP in 1997 and of land that was not cropped in 1982 but cropped in 1997. In other words, this is net change in erosion on land cropped in either 1982 or 1997 but not in the CRP. This category includes the cropland excluded from the three previous categories.

Source: ERS analysis of 1997 National Resource Inventory (NRI) Data.

farmers to take HEL out of crop production. And third, changes in world commodity markets affected domestic prices and also affected crop acreage. Thus, the effects of slippage, sodbuster, and conservation compliance on land conversions and on erosion are not separated.[10]

The public gains when soil erosion is decreased. Reductions in sheet and rill erosion have improved surface-water quality, which increases the public's enjoyment of water-based recreation and decreases costs to municipalities, industry, and other public and private sectors. Reductions in wind erosion reduce airborne dust, which betters human health, reduces household chores (sweeping windblown dirt from sidewalks, cleaning within homes, etc.), lowers some costs to industries, and increases the visibility of scenic vistas. Reduced soil erosion also helps maintain soil productivity, which increases food security. Because the farmer is not able to market and to be paid for these benefits of reduced soil erosion, they are referred to as "nonmarket" goods or impacts.

Conservation compliance is estimated to provide nonmarket benefits of $1.4 billion/year. Erosion reductions by the CRP are estimated to provide $694 million/year in nonmarket benefits (table 3).[11] These values include impacts to water-based recreation, soil productivity, municipal and industrial uses, and household chores. This likely understates the true value of the reduced soil erosion because benefits associated with increases in waterfowl populations, improvements in coastal and estuarine recreation areas, increased likelihood of survival of endangered species, increases in marine fisheries' populations, and decreases in the cost that airborne soil imposes on industries, scenic views, and others have not been included.

Wetland Restoration Has Exceeded Losses

Perhaps the most dramatic change in agri-environmental performance has been with respect to wetlands. Trends in wetland conversion and conservation programs have helped agriculture become a net restorer of wetlands. The rate of wetland conversion in agriculture has dropped sharply in recent decades, reducing the overall rate of net wetland loss (Heimlich et al., 2000a; Heimlich et al., 1997). Through the Wetland Reserve Program (WRP), agriculture has become the single largest source of U.S. wetland restoration (Heimlich et al., 2000a; Heimlich et al., 1998).

[10] The total effect of these factors and of slippage reduced annual erosion by 144 million tons from 1982 to 1997 (table 2).

[11] Each benefit estimate assumes typical agricultural production with current programs in place.

Table 3—Environmental performance of conservation programs

Environmental performance measure	Program	Nonmarket benefits *($million/year)*
Soil erosion reduced		
	Conservation compliance	1,400[1]
	CRP	694[2]
Wildlife habitat improvement		
	CRP	704[3]

[1]Based on per-acre conservation compliance benefit measures and the 91 million acres meeting compliance in 1997 (Hyberg, 1997).
[2]Includes freshwater-based recreation benefits of $129 mil/yr (Feather et al., 1999), increases to soil productivity of $145 mil/year (Young and Osborn, 1990), impacts to costs of municipal water cleaning, dredging, etc. of $366 mil./yr (Ribaudo, 1989), and health impacts $50 mil/yr (Ribaudo et al., 1990). To be consistent with recreation estimates, all other reported values were adjusted to represent annual values on 35 million acres, a common approximate level of program enrollment.
[3]Benefits of wildlife viewing and pheasant hunting on CRP from Feather et al. (1999). Program acreage selected with an EBI.

Wetlands provide myriad ecological, biological, and hydrological functions (e.g., wildlife habitat, water quality, and floodwater retention) (Novitski et al., 1996). For example, filtering sediment and nutrients improves water quality, enhancing the value of downstream and underground waters (Carter, 1996; Williams, 1996).

The adequacy of wetland protection and restoration programs is currently assessed in relation to the goal of "no net loss" of wetland functions and values (Heimlich et al., 1998; Conservation Foundation, 1988). Because wetland functions and values are difficult to assess, no net loss of wetland area has often been used as a proxy for no net loss of wetland functions and values.

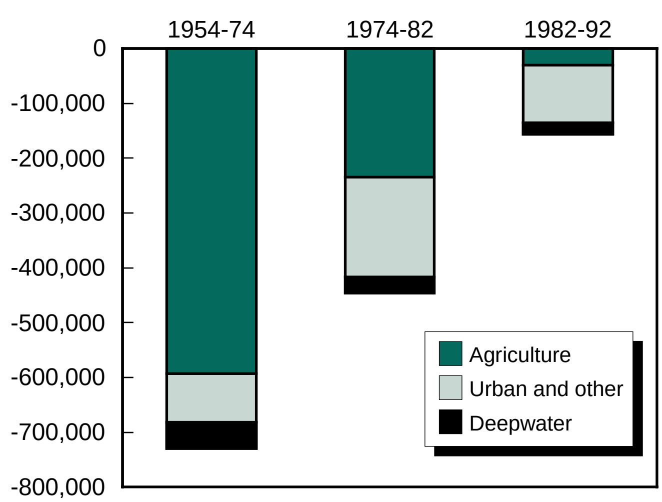
On the wetland conversion side of the ledger, conversions for agricultural production have decreased steadily in recent decades (fig. 3). Conversion of wetlands for crop production averaged 593,000 acres per year in 1954-74 (Frayer et al., 1983), but dropped to 235,000 acres for 1974-84 (Dahl and Johnson, 1991). Between 1982 and 1992 (the latest year data are available), gross agricultural wetland conversion fell to roughly 31,000 acres per year (Heimlich and Melanson, 1995).

The decline in the rate of agricultural wetland conversion has been attributed to several factors. First, roughly half of all wetlands in the conterminous United States in 1780 have been drained, including larger proportions in some heavily agricultural States such as Iowa, Illinois, Indiana, Ohio, and California (Dahl, 1990). Remaining wetlands may be more difficult or expensive to convert or may be less productive once converted. Second, the long-term decline in the real price of agricultural commodities has reduced the potential benefit of wetland conversion (Tolman, 1997; Kramer and Shabman, 1993). Finally, policy change has been a factor. Section 404 of the Clean Water Act of 1972 regulates discharge of dredge and fill material into wetlands, and the Tax Reform Act of 1986 eliminated tax preferences that encouraged wetland drainage. Under the swampbuster provisions of the 1985, 1990, and 1996 farm bills, producers who convert wetlands for crop production can be denied a wide range of farm program benefits.

Evidence on the role of policy change in reducing wetland conversion for agriculture is mixed (see Heimlich et al., 1998, for a full survey). Some analysts have concluded that wetland conversion for agricultural production has simply become unprofitable, with or without swampbuster sanctions (Tolman, 1997; Kramer and Shabman, 1993). Using more detailed data on the

Figure 3
Wetland losses, 1954-92

Average annual conversion



potential productivity of wetland soils, other work has estimated that, without swampbuster, 5.8 to 13.2 million acres of wetlands would be converted to cropland (Heimlich et al., 1998). Claassen and others (2000) estimate that between 1.5 and 3.3 million acres of wetlands are being preserved with swampbuster compliance, depending on producer price expectations.

On the wetland restoration side of the ledger, agriculture is a leading sector in wetland restoration. USDA's Wetland Reserve Program (WRP) and Emergency Wetland Reserve Program (EWRP) have restored more than 990,000 acres of agricultural land to wetland status (USDA, NRCS, 2000c), an average rate of nearly 110,000 acres per year—between three and four times the rate of gross wetland conversion to agriculture calculated for 1982-92 (Heimlich et al., 2000a). Cropped wetlands also account for 1.6 million acres enrolled in CRP; roughly one-third of these acres are actual wetlands, the rest is upland buffer acreage. A number of smaller programs also restore wetlands on agricultural land, but at a combined rate of less than 12,000 acres per year (Heimlich et al., 1998).

Wildlife Habitat on Agricultural Land Is Enhanced

The availability of permanent cover, in some parts of the country, has grown significantly, primarily through the CRP. The CRP has provided 30 to 36 million acres of cover since the late 1980's, although slippage (the conversion of land to cropland) again reduces the program's net contribution. Wetland protection and restoration, through swampbuster and the WRP, have also contributed significantly to enhancing wildlife habitat.

Permanent cover greatly improves the health of wildlife ecosystems. The permanent cover of the CRP and the habitat diversity it adds to intensely cropped landscapes provide nesting cover, wintering habitat, and plant and insect feeds for most wildlife species not indigenous to forestland. This includes the large class of upland species.

The WRP has increased the availability of a unique habitat used by the greatest diversity of wildlife species. Wetlands are the most biologically productive ecosystems in the temperate regions, rivaling tropical rain forests (Mitsch and Gosselink, 1993). A wide variety of fish, birds, mammals, reptiles, insects, and plants take advantage of the wetlands' various functions. Over a third of all bird species in North America rely on wetlands for migratory resting stops, breeding or feeding grounds, or cover from predation (Kroodsma, 1979).

Increases in fish and wildlife populations provide the public better wildlife viewing, fishing, and hunting. These are nonmarket goods or benefits that the conserving farmer is unable to sell.[12]

The value of the CRP's improvements to wildlife viewing and to pheasant hunting has been estimated at $704 million/year (table 3). This represents a lower-bound estimate of wildlife benefits because it does not include improved hunting for many other species and the increased protection of threatened and endangered species. Note too that some impacts can be unexpected. For example, the added CRP acres in the Northern Plains have significantly increased duck populations, which require dense vegetative cover within 3 miles of the wetland for successful nesting (Reynolds et al., 1994).

The impacts of farm programs, as measured here, are lower-bound estimates because only major agri-environmental programs are included and because numerous wildlife, wetland, and soil erosion impacts have not been assessed. Furthermore, impacts on other agri-environmental resources—many of significant public concern—are not included. These include impacts on:

- Chemical loadings in water and the environment—Land retirement programs will decrease nutrient and pesticide use, although slippage offsets some reductions. Conservation tillage slightly increases herbicide use but leads to little change in nutrient and insecticide use (Padgitt et al., 1997). Any decrease in agri-chemical use can help decrease loadings in ground and surface water and in wildlife food sources.
- Climate change—Land in retirement programs increases the soil's carbon sequestration, which

[12] Farmers do sell fishing or hunting access to pond-raised or pen-raised species. Because farmers hold property rights on these species and they are not dependent on wild ecosystems, the hunting and fishing of pond- and pen-raised species are not considered here. In limited cases, farmers sell access to species dependent on wild ecosystems. However, unless the farmer owns full access to affected water bodies and the essential parts of wildlife ecosystems, environmental impacts will not be privatized. For example, the farmer who provides the essential nesting and winter habitat may see many of the pheasant raised on his/her land hunted in the corn stubble of neighbors' land.

reduces atmospheric carbon loads. For example, a CRP acre in the Great Plains is estimated to sink approximately 0.85 metric ton of carbon per year (Lewandrowski et al., 2000). These benefits are temporary, however; should the acreage move back into crop production, the sequestered carbon will be released. Soil conservation practices associated with conservation compliance, including reduced tillage systems and use of winter cover crops, are also credited with reducing atmospheric carbon loads (Kern and Johnson, 1993; Lal et al., 1998).

- Groundwater quality and availability—Land retirement, through both the CRP and the WRP, helps improve the quantity and quality of groundwater recharge. The CRP is designed to account for potential groundwater quality impacts of fields offered for enrollment when a field is located in a groundwater protection area (table 4). The WRP restores wetlands, which not only improve groundwater resources by filtering chemicals from recharge but increase the rate or quantity of groundwater recharge (USDA/NRCS, 1997).

Lessons Learned

Factors That Sustain Environmental Gains

Only one program—the Wetlands Reserve Program—ensures permanent environmental gains through the purchase of permanent easements. For other programs, environmental gains are not sustained unless the programs themselves are sustained and the program incentives remain adequate. Failing that, farmers must find it profitable to maintain the land use or conservation practices.

If the CRP were eliminated, some portion of land would continue in the program until all contracts expire (no more than 15 years). When a contract expires, landowners are free to return land to crop production, although conservation compliance requirements must be met if the farmer is to remain eligible for many USDA programs (see box, “Conservation Compliance Requirements”). Whether land is returned to crop production depends on whether the landowner believes crop production will be more profitable than economic use of the existing land cover (e.g., the farmer may maintain tree cover). Profitability will depend on commodity prices relative to production costs (Osborn et al., 1993) and the productivity of land under the expiring CRP contract (Johnson et al., 1997; Johnson and Segarra, 1995).

Enterprise mix and related investments also appear to influence the likelihood of post-CRP conversions. Farmers who produce both crops and cattle are less likely than crop producers to say they will return CRP land to crop production (Johnson et al., 1997; Cooper and Osborn, 1997). Land irrigated prior to CRP enrollment may be more likely to return to crop production (Skaggs et al., 1994). Larger tracts of CRP land may be more likely than smaller tracts to be returned to crop production because small acreages are less likely to be productive or add significantly to farm revenue (Skaggs et al., 1994).

Socio-economic factors may also determine post-CRP land use. Producers who were motivated by conservation concerns to enroll land (Johnson et al., 1997), have obtained off-farm employment (Skaggs et al., 1994), or who are retired (Cooper and Osborn, 1997) are less likely to return land to crop production. Contract holders who are older but not retired (Skaggs et al., 1994) and those who are more risk-averse (Johnson and Segarra, 1995) are more likely to return land to crop production.

Sustaining gains achieved from conservation compliance, sodbuster, and swampbuster provisions depends on: (1) the size of Federal farm program payments that can be withheld relative to the costs of complying with HEL and wetland conservation requirements; and (2) the extent to which producers with highly erodible land (HEL) or wetlands on their farms participate in Federal farm programs. It is difficult to predict future farm programs or producer participation. Although evidence suggests that farm support programs will continue into the foreseeable future, it is reasonable to ask whether gains in soil conservation and wetland protection could be sustained without the incentive provided by these programs through compliance mechanisms.

Conservation compliance requires application of approved conservation systems (see box “Conservation Compliance Requirements”). Once established, the cost of maintaining conservation systems may be quite low, especially in cases where a significant capital investment is required. Conservation tillage—used on 33 percent of the HEL acres subject to compliance (table 5)—may have reduced per-unit production costs in many cases, although studies of the production efficiency of conservation tillage suggest that conservation tillage is not equally well adapted in all soil and climate conditions (Sandretto, 1997; McBride, 1999). However, once the investment in conservation tillage

Table 4—Factors generating points for the Conservation Reserve Program's environmental benefit index[1]

EBI factor	Definition	Features that increase points	Maximum points
Wildlife	Evaluates the expected wildlife benefits of the offer.	• Diversity of grass/legumes • Use of native grasses • Tree planting • Wetlands restoration • Beneficial to threatened/endangered species • Complements wetland habitat	100
Water quality	Evaluates the potential surface and ground water impacts	• Located in ground or surface water protection area • Potential for percolation of chemicals and the local population using groundwater • Potential for runoff to reach surface water and the county population	100
Erosion	Evaluates soil erodibility of field	• Larger field-average rate of estimated soil erosion	100
Enduring benefits	Evaluates the likelihood of CRP cover to remain	• Tree cover • More points for hardwoods	50
Air quality	Evaluates gains from reduced dust	• Potential for dust to affect people • Potential for wind erosion	35
Conservation Priority Area (CPA)	Evaluates potential to improve a CPA	• Located within a CPA	25
Cost	Evaluates cost of parcel	• Lower CRP rent • No government cost share • Payment is below program's maximum acceptable for area and soil type	Varies

[1]This table includes the most common and highest scoring practices. For more information, see USDA, FSA, 1999.

machinery is made, its continued and extended use may prove practical. Terraces—used in 13 percent of conservation systems—also require a significant capital investment (table 5). Once in place, terraces are relatively inexpensive to maintain.

Other practices are less likely to be maintained in the absence of an effective compliance incentive. Conservation cropping sequences—included in 81 percent of the conservation compliance systems—may be abandoned if less profitable than other sequences. However, because available data do not fully describe the conservation cropping sequences, an assessment has not been possible. Producers may also choose to remove grassed waterways and field borders—included in plans covering 9.2 and 3 percent of HEL cropland (table 5)—because they take land out of production.

Producers may also drain some wetlands or plow some previously uncropped HEL in the absence of effective swampbuster[13] and sodbuster[14] provisions. However, some authors have suggested that wetland conversion for crop production is no longer profitable, with or without swampbuster sanctions (Kramer and Shabman, 1993; Tolman, 1997). Similar arguments could be made with respect to conversion of HEL, but little formal research has been carried out on HEL conversion in recent years. New research, based on more detailed data than used in past efforts, indicates that 7.1 million to 14.1 million acres of wetland and HEL could be

[13] The discharge of dredged and fill materials in wetlands is regulated under the Clean Water Act. These provisions have been used to regulate wetland drainage. However, this authority has not been effective in regulating wetland conversion for agricultural production. See Heimlich and others (1998) for a full discussion.

[14] HEL can be converted to crop production without sodbuster violation if a stringent and potentially expensive conservation system is applied. See Claassen and others (2000) for a discussion.

Conservation Compliance Requirements

Conservation compliance requires all farmers who produce crops on highly erodible land (HEL) and who receive or request certain USDA benefits to have an approved conservation system applied on those lands. Violations may result in disqualification from USDA programs or reduction of benefits. Conservation compliance was enacted in the 1985 farm bill. Producers were required to devise USDA-approved conservation plans by 1990 and to actively apply the conservation systems called for in the plans by 1995.

An approved conservation system is a set of field-specific cropping and managerial soil conservation practices designed in cooperation with local NRCS agents to reduce soil erosion. Basic conservation systems reduce erosion to the soil tolerance level. The soil tolerance level, or T, is the rate of soil erosion that can continually occur on specific soil without reducing its productivity. Soil erosion rates are estimated using the Universal Soil Loss Equation (Wischmeier and Smith, 1978) and the Wind Erosion Equation (Skidmore and Woodruff, 1968). Alternative conservation systems are allowed where basic conservation systems would place an excessive economic burden on producers. These systems must provide “significant” erosion reduction, but producers are not required to reduce erosion to the T level. The 1996 farm act requires that plans developed after July 3, 1996, reduce erosion by at least 75 percent of potential erodibility, not to exceed 2T. On land returning to crop production from the Conservation Reserve Program (CRP), however, conservation compliance requirements cannot exceed the requirement existing when the land entered the CRP.

Based on the FSA 1997 Conservation Compliance Status Review data (the most recent review data available), 95.9 percent of producers were actively applying conservation systems. Two percent of producers were actively applying conservation systems with variances. Fewer than 0.1 percent of operators subject to conservation compliance were *not* actively applying conservation systems in 1997.

Conservation systems are made up of conservation practices, such as conservation tillage or terraces. While 1,674 different combinations of conservation practices are approved as conservation compliance systems (Claassen et al., 2000), most systems are combinations of a handful of practices.

profitably converted to crop production without swampbuster and sodbuster, depending on producers’ commodity price expectations (Claassen et al., 2000).

Similar issues apply to voluntary agri-environmental programs such as EQIP. To the extent that these programs leverage conservation investments with low maintenance costs or promote practices that reduce costs or provide other ongoing benefits to producers, e.g., protection of their own ground water, these investments or practices are more likely to be retained over the long term. Because technical assistance and cost-share programs require producers to pay part of the cost of conservation practices, producers who participate in EQIP or other cost-share programs are likely to adopt only those practices that reduce costs or provide other ongoing benefits.

Features That Provide Greater Environmental Gains Relative to Costs

Features of recent agri-environmental programs now allow these programs to provide more environmental quality relative to costs. Gains can be measured in physical or economic terms, with economic measures capturing the nonmarket value of the improvements in environmental amenities. Costs are represented by the net decrease in incomes of taxpayers, consumers, and farmers. (Although incomes of some groups may rise, they can be more than offset by losses in other groups.)

Consistency among farm and environmental programs improves agri-environmental protection. It was recognized in the mid-1980’s that Federal commodity, loan, and crop insurance programs often induce production patterns that are inconsistent with soil conservation and water quality goals (Reichelderfer, 1985). This effect was unintentional, and arose from a complicated and unanticipated set of policy interactions. A history of land set-asides to achieve production controls for particular commodities led to an artificial scarcity of land, consequential hikes in farmland values, induced development of land-saving technologies, and a more intensive set of production systems, especially in times of high prices (Miranowski and Reichelderfer, 1985). Before 1985, a land owner/operator might be receiving commodity program payments that encouraged expansion of input-intensive production on additional land, while also receiving conservation cost-share payments to reduce the agri-environmental damages from that same production. The 1985 farm bill explicitly recognized this inconsistency, and attempted to reconcile it with conservation compliance

Table 5—The nine most widely used conservation compliance practices

Soil conservation practice	Definition	HEL acres using practice[1] (percent)	Requires large initial investment	May provide cost savings	Removes land from production
Conservation cropping	Crop rotation that preserves organic residue and improves soil tilth	81.1			
Crop residue use	Plant residue to protect cultivated fields during critical erosion periods	51.3			
Conservation tillage	System in which at least 30 percent of surface is covered by plant residue after planting	33.0	X[2]	X	
Contour farming	Preparing, planting, and cultivating land on the contour	19.3			
Terrace	Earth embankment, channel, or ridge and channel across slope	13.0	X		
Grassed waterway	Natural or constructed channel to provide for stable runoff	9.2	X		X
Surface roughening	Roughening soil by ridge or clod forming tillage	4.6			
Cover/green manure	Grasses, legumes, or small grain for seasonal protection and soil improvement	3.4			
Field border	Strip of perennial vegetation on edge of field	3.0	X		X

[1]Source: USDA, ERS, compiled from NRCS 1997 Status Review of Conservation Compliance data. Percentages sum to more than 100 because of multiple practices being applied to the same land.
[2]An 'X' indicates column consistent with row.

provisions and a CRP that melded conservation and supply control objectives.

In retrospect, the program consistency or coordination aspects of the 1985 legislation were highly successful. The conservation compliance, sodbuster, and swampbuster provisions assured that in order to participate in commodity and other farm programs, participants had to meet a minimum standard for environmental protection. Incentives to expand cropland into environmentally sensitive areas to build the “base” upon which commodity program benefits were multiplied ended in 1986 with a new base acreage calculus. And the CRP further targeted for retirement a large portion of that expansion acreage, about which there were environmental worries.

Program consistency and coordination remain concerns, however. As of 1996, federally subsidized crop insurance cannot be withheld from producers who violate conservation compliance, sodbuster, and swampbuster. Yet most empirical evidence suggests that the availability of subsidized crop insurance does result in expanding cropland acreage (Young et al., 1999; Keeton et al., 1999; Wu, 1999;). Griffin (1996) argues that much of the erosion reduction achieved in the Great Plains through CRP was offset by shifting land from pasture or hay to crop production to capitalize on subsidized crop insurance and disaster payments. Goodwin and others (1999) obtained similar results.

While some proposals for future legislation, such as the Conservation Security Program, do address agri-environmental issues and farm income simultaneously, there is little evidence that the issue of program coordination among future programs is getting a lot of attention. Nevertheless, it is only by explicitly addressing how future farm, commodity, insurance, resource conservation, and agri-environmental programs will interact that inherent inconsistencies can be minimized and complementarities found.

Producers have utilized flexibility in the conservation compliance program. In many cases, farmers can change production methods in more than one way (e.g., crop rotations, tillage practices, etc.) to achieve an environmental objective. A program is **flexible** if producers are allowed to select the production methods most suitable to their economic objectives yet consistent with the environmental goals of the program.

Flexibility can reduce costs to growers of participating in or complying with an agri-environmental program. The geophysical and biological environment, as well as producer management skills, production practices, preferences, and attitudes regarding environmental performance, vary widely among agricultural producers, even within small geographic areas. A specific conservation practice may fit well into one farming operation and boost environmental benefits, but increase production costs or provide little environmental gains when adopted by others. Thus, a one-size-fits-all agri-environmental program is unlikely to minimize costs.

The implementation of conservation compliance provided great producer flexibility. The program requires application of soil-conserving production systems on highly erodible cropland as a condition of farm program eligibility but gives producers significant latitude in customizing conservation plans (see box, "Conservation Compliance Requirements"). The program goal is to reduce erosion (as estimated by the Universal Soil Loss Equation (USLE) or the Wind Erosion Equation (WEE)) to a level that can be sustained without long-term damage to agricultural productivity.

A 1997 USDA review of conservation compliance found 1,674 different conservation systems that brought erosion to compliance levels had been approved (Claassen et al., 2000). Conservation systems involving only conservation cropping sequences, conservation tillage, crop residue use, or some combination of these three practices were applied on 54 percent of HEL cropland (Claassen et al., 2000). Plans vary widely among regions, based on cropping patterns, production systems, climate, and soils (USDA, FSA, 2000a).

Targeting has increased environmental benefits of the CRP. The Conservation Reserve Program was USDA's first exercise in environmental **targeting** in agri-environmental programs. In 1985, CRP was designed to enroll highly erodible land to reduce soil erosion and, perhaps more importantly, to reduce farm production during a time of low farm incomes. Improved water quality, wildlife, and air quality were secondary objectives and played no role in program qualification. The 1990 farm bill mandated that program enrollment be based on a more comprehensive assessment of potential environmental benefits that must then be compared with costs. The Environmental Benefits Index (EBI) was devised to meet this program objective.

The EBI is made up of a number of factors that account for environmental benefits (e.g., water quality) and contract costs (the proposed annual rental payments and cost of practice installment). Some environmental factors are given more points (e.g., water quality) than others are (e.g., air quality) because their nonmarket benefits are thought to be larger. The scoring of points for each EBI factor for each field that farmers offer to enroll is based on features such as soil type, location, county population, and the proposed CRP land cover (e.g., multiple grasses, trees, etc.) (table 4). The factor points a field earns serves as a proxy for the relative value of the field's potential environmental impact. For example, a field located near surface water receives a higher water quality score because its sediment, nutrients, and pesticides are more likely to reach the water. Fields in counties with large populations also rate a higher score because there are more people to appreciate (value) the increase in water quality.

An early economic analysis of environmental targeting indicated that the first EBI substantially increased environmental benefits relative to costs, compared with the program's original, erosion-based design (Osborn, 1993). This first EBI was based on four major benefit areas (water quality, wildlife, erosion, and permanent cover).

A more recent study shows that moving to environmental targeting provided a $370-million/year increase in CRP benefits with program acreage and costs virtually unchanged (Feather et al., 1999). This value represents a lower-bound estimate of the increase in benefits because only three environmental benefits—water-based recreation, pheasant hunting, and wildlife viewing—are included.

While it is clear that environmental targeting with the EBI has increased benefits relative to program costs, recent research indicates two adjustments that would further this increase. First, points given some EBI factors could be adjusted to reflect the associated benefits. That is, making EBI factor points earned proportional to the factor benefit estimates would increase environmental benefits from the CRP. The actual EBI points earned by acres selected into the CRP in signups 1997-2000 totaled 1,685 million for wildlife, 1,097 million for water quality, 1,382 million for soil productivity, and 263 million for air quality. By contrast, factor benefits are estimated at $704 million/year for wildlife impacts, $499 million/year for gains in water quality, $145 million/year for gains in soil productivity, and $50 million/year for gains in wind erosion benefits. Thus the estimated annual water quality and wildlife benefits are approximately 40 percent of their respective total EBI scores. However, total CRP erosion reduction benefits are only 10 percent of the total EBI points for erosion reduction. Since 10 percent is one-fourth of 40 percent, the EBI factor scores for erosion are four times what they should average if proportional to benefits. Likewise, the EBI factor score for air quality is approximately twice what it should be if factor score and benefits are to be proportional. However, adjusting factor scores is tenuous because only the erosion factor's benefit estimate is thought to be nearly comprehensive (Feather et al., 1999).

Second, environmental improvements near populated areas are, in many cases, of higher value than those in more rural areas because more people are there to enjoy the improvements. As previously noted, the current EBI attempts to incorporate this effect by including county populations. However, populations in neighboring counties are also relevant when impacts to environmental amenities are local, and populations in more distant areas are relevant when impacts are downstream, downwind, or along a migratory route. Research results indicate that the relative size and distance of the population surrounding the environmental improvement and the fate and transport of the environmental resources determine this population effect (Feather et al., 1999). An accounting of the impact on the affected population would likely enhance the targeting efficiency of the EBI and the CRP.

While coordination, flexibility, and targeting are three significant improvements in program design, they are not likely to be the only way an agri-environmental policy might be improved. However, these are the most apparent improvements demonstrated in programs implemented over the last two decades.