Public Policy Solutions to Environmental Externalities from Agriculture

Nicolai V. Kuminoff [*]

[*] Assistant Professor, Department of Agricultural and Applied Economics. Prepared for American Enterprise Institute project, Agricultural Policy for the 2007 Farm Bill and Beyond, directed by Bruce Gardner and Daniel A. Sumner. The author is grateful to Ralph Heimlich and John Horowitz for numerous comments and suggestions on this research. He also thanks Darrell Bosch, David Orden, Jaren Pope, Michael Roberts, Daniel Sumner, and participants in the American Enterprise Institute conference, "The 2007 Farm Bill and Beyond," December 5 and 6, 2006, Washington, D.C. The views expressed here are those of the author and not those of any institution with which he is affiliated.

Introduction

The production of food and fiber by commercial agriculture has both positive and negative effects on the surrounding environment. Farms can provide wildlife habitat and scenic views for their urban neighbors, while the carbon sequestered by vegetation grown on that land can help mitigate global warming. At the same time, noise, dust, and odors produced by normal farming operations can annoy urban residents, and runoff of pesticides, fertilizer, and animal waste can lead to water pollution downstream. The economic values that society places on these byproducts of agricultural production are rarely captured fully by private markets for farmland and commodities. When market prices fail to reflect the impact of farming on the surrounding environment, farmers are left with little incentive to incorporate the value of off-farm environmental quality into their land management decisions. This type of market failure is often a rationale for government action such as regulation, taxes, subsidies, and the redefinition of property rights.

For the past 20 years, government intervention has primarily consisted of voluntary conservation payment programs funded by farm bill legislation. These programs pay farmers to manage their land in ways that reduce erosion and runoff, while increasing the provision of wildlife habitat and other environmental benefits. In addition to voluntary conservation programs, the federal effort to address the off-farm environmental impacts of farming also includes compliance provisions of the farm bill and regulations on chemical use, emissions of air and water pollutants, and the private use of endangered species habitat. The burden that these environmental laws can place on farmers has been highlighted by recent debates on amending endangered species legislation and expanding the federal regulation of confined animal feeding operations.

This paper describes the current regulatory environment before suggesting opportunities for reforming the Farm Bill conservation programs to achieve environmental goals more efficiently. Overall, production agriculture faces far less regulation than other sectors of the economy. Current laws addressing air pollution, water pollution, and the use of toxic chemicals implicitly or explicitly exempt all but the largest confined animal feeding operations from federal regulation. This lack of regulation underscores the role of Farm Bill conservation programs in addressing environmental issues. While the current programs generate benefits that exceed their costs of implementation, federal budget limits prevent them from being extended to more than a small share of farmland. If policymakers were willing to tax the management practices that negatively impact the surrounding environment, instead of paying farmers to change those practices, environmental issues could be addressed on a greater portion of farmland at a lower cost to taxpayers. Alternatively, if opportunities for reform are limited to changing the way farmers are paid, there are at least three ways to make the current conservation programs more efficient. First, there is potential for efficiency gains from coordinating the different programs. Second, linking payments to measurable outcomes would help to align farmers' financial incentives with public environmental goals. Finally, requiring the recipients of Farm Bill payments to report their management practices would create new opportunities to address environmental issues without additional government intervention.

Externalities as a Rationale for Government Intervention

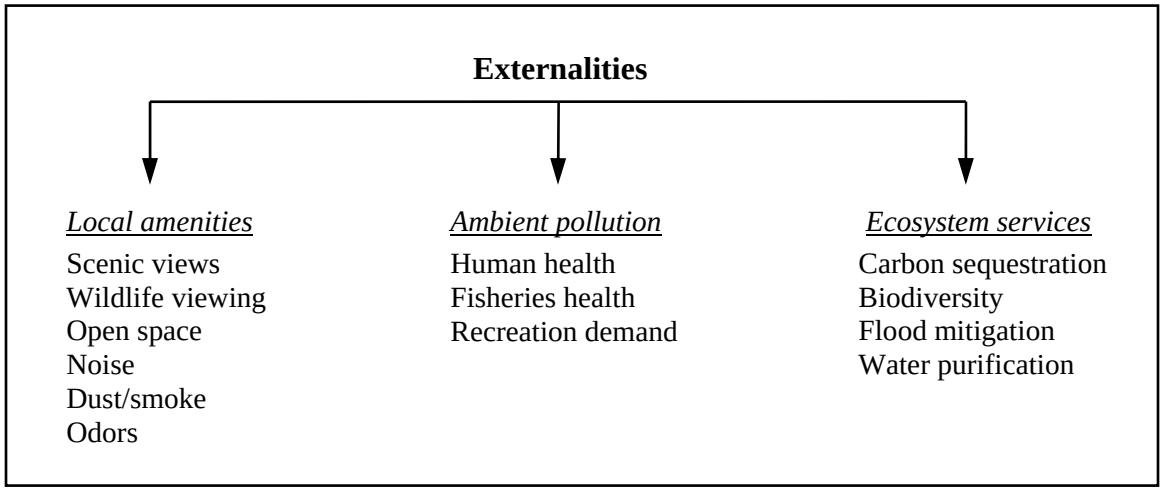
Market prices guide farmers' management choices. Farmland values provide most farmers with the incentive to manage their land in a way that will maintain its long-term agricultural productivity.[1] This often requires preserving on-farm environmental quality. For example, if a farmer uses a pesticide that inadvertently kills native populations of beneficial insects, the farmer's pollination and/or pest management costs may rise in the future. The decrease in future profitability stemming from this increase in production costs will also decrease the resale value of the farmer's land. Similarly, tillage methods that lead to high rates of soil erosion may increase short-term profits but will also decrease the land's future productivity and its resale value. In these two examples, private market prices provide an incentive for the farmer to make land management choices that preserve on-farm environmental quality. However, the farmer's choices can also influence environmental quality off the farm.

When farmers are not compensated for the impacts that their land management choices have on the welfare of people living off the farm, these impacts are termed *externalities*. The environmental externalities from farming can be divided into three categories according to their geographic dispersion—*local amenities*, *ambient pollution*, and *ecosystem services*. Figure 1 illustrates this taxonomy with commonly cited examples from each category.

Local amenities tend to be concentrated within a small geographic area around the farm where they originate. Since these amenities mainly affect people who live at the ag-urban fringe, the economic values that urban residents assign to them can be expected to be at least partly capitalized into residential property values. Some of the commonly cited positive amenities include scenic views, wildlife habitat, and access to open space. Farmland that provides these amenities has been found to increase property values in nearby residential neighborhoods. For example, Irwin (2002) examines how different types of farmland influence property values in suburban and exurban counties in central Maryland. Her results suggest that converting one acre of privately owned pasture to low-density urban development would decrease residential property values by 0.89 percent within a 0.25 mile radius of the converted acre. Meanwhile, farms that produce negative amenities such as noise, dust, and odors have been found to decrease housing prices nearby. Using data on housing transactions in Berks County, Pennsylvania, Ready and Abadalla (2005) analyze the impact of confined animal feeding operations. Their results imply that, on average, removing a confined animal feeding operation would increase housing prices by 6.4 percent within a 0.3 mile radius of the operation.

[1] This is less true in areas where farmland values mainly reflect the potential for urban development. If farmers plan to sell their land for development in the near future, they have little incentive to worry about its long-term agricultural productivity. However, only a small share of farmland is likely to be converted in the foreseeable future. Plantinga, Lubowski, and Stavins (2002) find that only 9 percent of the total agricultural land value in the United States reflects the capitalized value of the land's potential for future urban development.

Figure 1. Externalities from Agricultural Production



Source: Author's calculations.

Farmers contribute to ambient air and water pollution through their use of management practices that lead to soil erosion and emissions of fertilizer, pesticides, and animal waste. Compared to local amenities, the impacts of ambient pollution tend to be more diffuse and are therefore less likely to be reflected in residential property values near the farm. Instead, they contribute to pollution problems at distant locations, decreasing recreation opportunities and negatively affecting human and ecosystem health. For example, nitrogen runoff from farms in the Mississippi-Atchafalaya River Basin is a major contributor to the "dead zone" in the Gulf of Mexico, where a combination of high nitrogen concentrations and upwelling have led to algal blooms that decrease the water's oxygen content, ultimately leading to fish kills and other problems.[2] Overall, runoff from agriculture in the Mississippi Basin has been estimated to contribute 65 percent of the nitrogen flowing into the Gulf of Mexico, with 50 percent from fertilizer and 15 percent from animal waste (Goolsby and others 1999). While economists can estimate the ensuing revenue losses to fisheries and the resulting value of diminished recreation opportunities, it is difficult to identify how individual farms contribute to these losses. More precisely, it is difficult to monitor and track emissions from individual farms and to determine how those emissions contribute to measures of ambient water pollution.

The way that farmers manage their land also influences the performance of *ecosystem services* that are valued by local, regional, and global populations. Daily (1997, p. 3) defines ecosystem services as "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods such as seafood, forage, timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors." Specific services that are often associated with commercial agriculture include carbon sequestration, biodiversity, flood

[2] While the Mississippi-Atchafalaya River Basin includes all or parts of 30 states, Goolsby and others (1999) identify watersheds in southern Minnesota, Iowa, Illinois, Indiana, and Ohio as the principal sources of nitrogen runoff.

mitigation, and water filtration.[3] New York City's watershed in the Catskill Mountains is a classic example of the link between farmland management and the provision of ecosystem services that convey economic value. The Catskill watershed historically provided natural filtration of the city's drinking water. However, by the mid-1990s, increasing runoff of pesticides and nutrients in the watershed were making it increasingly difficult for the city to satisfy the requirements of the Safe Water Drinking Act. The city of New York was faced with the prospect of building and operating a water filtration plant that would have cost $6 to $8 billion. Instead, they were able to satisfy EPA by promising to invest $1 to $1.5 billion in reducing emissions into the watershed in order to improve its natural capacity for filtration. The money was used to purchase land in sensitive areas and to pay existing landowners to change their management practices in ways that would reduce runoff. This included paying farmers to plant native grasses and to install fences and pumps that would reduce nutrient emissions from animal feeding operations (Salzman 2005; Natural Research Council 2005).

Carbon sequestration is a second example of an ecosystem service provided by farmland. Agricultural soils sequester carbon dioxide, the most prevalent of the greenhouse gasses addressed by the Kyoto Protocol. In the past, conventional crop practices have caused agricultural soil carbon levels to decline by 25 to 50 percent relative to uncultivated soils. Adopting alternative farming practices such as reducing tillage or changing crop rotations can increase the amount of carbon sequestered, helping to mitigate global warming (Antle and others 2003). Of the three categories of externalities in figure 1, ecosystem services are the most difficult to assign economic values and to link back to performance at the level of an individual farm.

While farmers can adopt management practices that reduce their contribution to negative externalities and increase their production of positive externalities, market prices rarely provide incentives for them to do so.[4] Coase (1960) observed that as long as property rights to an externality are clearly defined, the producers and consumers of that externality have an incentive to negotiate a solution without additional government intervention. However, as the number of producers and consumers increases, it can become increasingly expensive to organize the negotiation process. With a large number of disparate stakeholders, the incentive to negotiate may be dwarfed by the costs of negotiating. This situation can provide an economic rationale for government involvement.[5] In this case, the government's role is to provide farmers with incentives to simultaneously produce the socially efficient quantities of the crop and the externality associated with its production.

As one moves from left to right in figure 1, it becomes increasingly difficult to link environmental outcomes back to management choices made on an individual farm. The increasing difficulty in establishing theses linkages increases the cost of organizing negotiations between farmers and the people affected by externalities—which, in turn, increases the rationale

[3] As the quotation from Daily suggests, ecologists often define ecosystem services broadly enough to include local amenities and ambient pollution. However, for this paper it is useful to use a narrower definition in order to emphasize the distinctions between the dispersion of the different types of externalities.

[4] Price premiums for organic products are one case where markets provide an incentive for farmers to incorporate externalities into their management choices, if one believes that organic growing methods generally reduce negative externalities or increase positive externalities relative to conventional methods.

[5] Coase noted this in his original 1960 article. On page 18, he says "…there is no reason why, on occasion, such governmental administrative regulation should not lead to an improvement in economic efficiency. This would seem particularly likely when, as is normally the case with the smoke nuisance, a larger number of people is involved and when therefore the costs of handling the problem through the market or the firm may be high."

for government intervention. Unfortunately, as one moves from left to right in the figure it also becomes increasingly difficult for economists to evaluate the relative efficiency of alternative public policy responses to an externality.

Crafting a socially optimal response to an agricultural externality requires understanding the system of supply and demand relationships that characterize production of the crop, production of the externality, and consumers' willingness-to-pay for each. This requirement poses three difficulties. First, estimates of consumers' willingness-to-pay for externalities are imprecise. As the externalities or the people affected by them become more geographically dispersed (moving from left to right in figure 1) it becomes increasing difficult to recover the demand from market data. While economists generally agree that consumers' valuation of a small change in a local amenity can be inferred from housing price differentials with order-of-magnitude accuracy, there is less of a consensus on the accuracy of methods used to determine the values that consumers place on an ecosystem service such as biodiversity.

The second difficulty is learning the relationship between agricultural land management and the production of air pollution, water pollution, and ecosystem services. The cumulative effect of farm externalities is widely believed to make a significant contribution to some environmental problems, particularly water quality (see, for example, Ruhl 2000). However, data do not exist to consistently quantify most of the externalities from figure 1 on a national scale. The U.S. Department of Agriculture (USDA) tracks changes over time in the use of certain farm chemicals and growing practices, while the U.S. Environmental Protection Agency (EPA) tracks changes over time in measures for ambient air and water quality. What is generally missing is the link between the two sets of changes. EPA recently completed its first nationally consistent statistically based study of water quality in the nation's wadeable streams (U.S. EPA 2006b). It concludes that 42 percent of U.S. stream miles are in poor condition compared to the least-disturbed streams that remain.[6] Excess sedimentation, phosphorus, and nitrogen were found to be the three most significant stressors to water quality in poor stream miles. While the sources of these pollutants were not identified by the study, EPA's 2000 National Water Quality Inventory (2002a) cites production agriculture as the leading source of impaired river and stream miles.[7] Unfortunately, comparable efforts have not been made to characterize the link between farming and most other externalities.

The final difficulty in understanding the system of supply and demand relationships is that many of the externalities may be interrelated. A single management practice may produce multiple externalities. For example, removing intensively farmed land from production and replacing it with native grasses may simultaneously increase carbon sequestration, enhance scenic views, and reduce runoff of farm chemicals. Alternatively, an action taken to reduce one negative externality may create or exacerbate another negative externality. EPA is currently concerned about waterborne discharges of animal waste from confined feeding operations because they can lead to fish kills, diminished water clarity, and reduced aquatic biodiversity. These negative externalities can be mitigated by storing the manure in pits and lagoons or

[6] The study used an index of benthic macroinvertebrate health as a measure of overall water quality. Macroinvertebrate populations (aquatic insects, crustaceans, worms, and mollusks, among others) are believed to be a key indicator of ecosystem health. Within each of 9 eco-regions, EPA defined "poor" stream miles as those with index values below 95 percent of the least-disturbed stream miles. For more details on the methodology, see EPA (2006b).

[7] The term "impaired" in EPA's study means that, because of pollution, the relevant water body fails to adequately support one or more of its designated uses such as fish consumption, drinking water, swimming, and boating.

spreading it on fields, all of which reduce the chance of waterborne emissions. However, pits, lagoons, and land application of manure all create annoying odors for urban neighbors and increase the airborne emissions of ammonia, hydrogen sulfide, and other chemicals.

Without knowing the system of supply and demand relationships for the crop and each environmental externality, one cannot guarantee that any particular public policy will be socially efficient. Nevertheless, given the information available, policymakers have developed a variety of tools to address externalities from farming. At the federal level, these consist of environmental regulations and incentive payments for implementing certain land management practices.

Environmental Regulation

Environmental regulation in the United States is often described as following a "polluter pays" principle. That is, firms have to pay in order to legally emit pollutants into the air and water by purchasing a permit from the government or by installing pollution abatement equipment that satisfies minimum technology standards. Firms that are caught emitting illegally are punished through fines, injunctions, and occasionally jail time. In 2005, EPA's compliance and enforcement programs cost firms more than $11 billion in compensation for past damages to the environment, criminal fines, and the cost of court-ordered actions to comply with current regulations (EPA, Office of Enforcement and Compliance Assurance 2005). While the agricultural sector of the economy is no exception to the polluter pays principle, farmers receive preferential treatment.

Table 1 summarizes the major environmental regulations and their exemptions for farmers. Current laws regulating air pollution, water pollution, and the use of toxic chemicals implicitly or explicitly exempt all but the largest feedlots (also known as concentrated animal feeding operations, or CAFOs) from federal regulation. Together, these exemptions give farmers the right to discharge unlimited quantities of pesticides, fertilizer, and animal waste produced as a byproduct of normal farming operations. Only a small share of the largest animal feeding operations—less than 1 percent of all farms that account for approximately 10 percent of gross farm revenue—are required to obtain federal permits in order to discharge pollutants into U.S. waters. The authority for regulating emissions from the other 99 percent of farms is delegated to the states, which mostly rely on voluntary or incentive-based programs.

This leaves three major regulations with the potential to constrain farmers' management practices: EPA's pesticide registration program, endangered species legislation, and the compliance provisions of the Farm Bill. For most farmers, the actual burden imposed by these regulations appears minimal. Cancellation of a key pesticide certainly has the potential to decrease profits for farmers who depend on it. But the larger the economic burden, the greater the likelihood of a special exemption, as demonstrated by the recent exemptions for methyl bromide. The Endangered Species Act also has the potential to impose a regulatory burden on farmers by prohibiting normal farming practices that harm threatened or endangered species. The high profile conflict between farmers and fishermen over water allocations in the Klamath River Basin has draw attention to this issue. But there appear to be few comparable examples. Finally, although compliance provisions of the Farm Bill can be used to withhold payments to farmers who convert wetlands or farm highly erodible cropland, enforcement is limited by provisions of the 1996 farm bill and an appeals process that routinely waives most penalties. (See appendix A for a more detailed description of how farmers are affected by the regulations in table 1.)

While production agriculture clearly faces less environmental regulation than other sectors of the economy, it would be incorrect to claim that farmers are unaffected. Compared to developing countries, the United States tends to place more emphasis on using the pesticide registration process to protect food safety, the health of pesticide applicators, and wildlife populations, which may put domestic growers at a competitive disadvantage in international markets. Furthermore, farmers may be affected by environmental regulations on upstream and downstream firms. For example, firms that manufacture pesticides or process farm products do not enjoy the same regulatory exemptions as farmers. Part of the burden from these regulations may get passed on to farmers through higher pesticide prices and lower farm gate prices.

Overall, the lack of environmental regulations on production agriculture represents a drastic departure from the polluter pays principle that applies widely to other industries, including manufacturers of farm inputs and processors of farm products. Why treat farmers differently? Some have suggested that the lack of regulation stems from public belief in the Jeffersonian ideal that farmers are stewards of the land (see Ruhl 2000). Perhaps even more important is the logistical challenge of regulating more than 2 million farms, as EPA noted when it fought to exempt farmers from the Clean Water Act in 1977. Today, it would take more than a tenfold expansion of EPA's wastewater permit program to attain universal coverage of farms.[8] Rather than regulate, the United States has developed voluntary incentive-based programs to address the environmental impacts of agricultural production. The next section describes the incentives that these conservation programs provide for farmers to reduce negative externalities and increase positive externalities.

[8] As of January 1, 2006, there were approximately 88,000 active NPDES wastewater permits in the country.

Table 1. Summary of Federal Environmental Regulations and Key Exemptions for Farmers

Area	Statute[a]	Regulation	Key Exemptions/Limitations	Outcome
Water pollution	CWA, Sec 402	Point source wastewater permits *Point sources* must satisfy technology and water quality standards to obtain a permit to legally discharge pollutants into U.S. waters.	*Point sources* include CAFOs in general, but exempt "agricultural stormwater discharges and return flows from irrigated agriculture."	Approximately 4,100 CAFOs have permits. All other farms may legally discharge soil, animal waste, fertilizer, and pesticides into U.S. waters without a permit.
	CWA, Sec 404	Dredge or fill permits Permits are required to fill wetlands.	Excludes "normal farming" activities with incidental discharges of dredged or fill material.	In some cases, farmers can convert wetlands to crop production without a permit.
	CWA, Sec 208 CWA, Sec 303 CWA, Sec 319 CZMA	Nonpoint source pollution States must develop plans to address pollution from *nonpoint sources* in waters failing to meet ambient quality standards.	1) Federal funding and enforcement is limited. 2) States determine which *nonpoint sources* to regulate.	Some states exempt farmers, while other states promote voluntary adoption of best management practices. Direct regulation by state or local officials is rare.
Air pollution	CAA, Sec 110	State Implementation Plans Each state must develop an enforceable plan to meet national ambient air quality standards, or be regulated by EPA.	Regulations emphasize "major sources" that emit threshold levels of pollutants. Thresholds implicitly or explicitly exclude farmers.	Individual farms are not regulated under the CAA.
Chemical use	FIFRA TSCA	Pesticide/fertilizer registration Registration, determination of approved uses, and limitations on who can apply them.	Subject to EPA approval, states may register additional pesticide uses or temporarily use an unregistered pesticide to address pest emergencies.	EPA determines which pesticides and fertilizers farmers can use, but special exemptions have been allowed for methyl bromide and others.
	CERCLA EPCRA RCRA	Monitoring, reporting, and liability for storage/disposal of toxic chemicals.	Exempts FIFRA registered pesticides and agricultural use of fertilizer.	EPA does not regulate, track, or report farmers' use of registered pesticides and fertilizer.
Wildlife habitat	ESA FMBTA	Prohibits "takings" of threatened and endangered species, and migratory birds.	Unclear whether intent must be present in the case of poisoning of migratory birds.	Legal actions have been taken against farmers and ranchers who "take" threatened and endangered species.
Farm bill	Swampbuster and Sodbuster	Farmers who convert wetlands or fail to apply conservation systems on highly erodible land cannot collect payments.	Provisions apply only to a small share of current recipients of farm program benefits. Moreover, enforcement is questionable.	Farmers receiving payments have an incentive to comply. Other farmers do not.

Source: Author's compilations**.**

CAA=Clean Air Act; CERCLA=Comprehensive Environmental Response, Compensation, and Liability Act; CWA=Clean Water Act; CZMA=Coastal Zone Management Act; EPCRA=Emergency Planning and Community Right to Know Act; ESA=Endangered Species Act; FIFRA=Federal Insecticide, Fungicide, and Rodenticide Act; MBTA=Migratory Bird Treaty Act; RCRA=Resource Conservation and Recovery Act; TSCA=Toxic Substances Control Act.

Voluntary Conservation Programs

The farm bill provides the authority and the funding for USDA to operate a variety of voluntary conservation programs. Given the lack of federal regulation, these programs represent the primary set of instruments that policymakers can use to target agricultural externalities. The major conservation programs can be divided into three broad categories according to how they address externalities. Land retirement programs protect environmentally sensitive land by paying farmers to remove that land from active agricultural production. Working land programs pay farmers to continue farming, but to do so in a way that increases production of positive externalities and decreases production of negative externalities. Farmland protection programs purchase easements on farmland in order to ensure that it does not get converted to urban or other intensive uses. This section describes the individual programs that comprise each of these three categories, before analyzing their cumulative impact.

Land Retirement Programs. The Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP) are the two major land retirement programs. The CRP contracts with farmers to remove environmentally sensitive farmland from production for 10 to 15 year periods. Once removed, this land is planted to trees, grasses, and other forms of vegetative cover that help to reduce soil erosion and provide other positive externalities such as wildlife habitat or a buffer zone between actively farmed land and sensitive wetlands. Traditionally, the CRP has had the largest budget of any conservation program. In 2005, for example, it paid farmers nearly $1.7 billion to idle 35 million acres of farmland.

The CRP offers four enrollment options. Currently, about 90 percent of the participating acres were enrolled through the general signup, which requires farmers to compete nationally for acceptance into the program. Each farmer submits a bid stating an amount they would be willing to accept in order to take their land out of production. Their willingness-to-accept is evaluated together with the environmental characteristics of their parcel, using an "Environmental Benefits Index" that assigns specific weights to each parcel according to its cost and according to its potential to provide wildlife habitat, improve water quality, reduce soil erosion, and improve air quality. During each signup period, parcels are ranked according to their overall index scores and then accepted into the program as long as space is available. The remaining 10 percent of CRP acres were enrolled through three supplementary programs: the continuous signup, the Conservation Reserve Enhancement Program, and the Farmable Wetlands Program. Each of these programs gives priority to farmland that offers specific environmental benefits. For example, one objective of the continuous signup is to create buffer zones between active farmland and riparian areas. Likewise, the Conservation Reserve Enhancement Program is a state/federal partnership that allows individual states to designate priority areas for enrollment, and the Farmable Wetlands Program seeks to remove wetlands from agricultural production.

Compared to the CRP, the Wetlands Reserve Program is relatively small. The goal of the program is to enhance the services provided by wetland ecosystems. In 2005, the Wetlands Reserve Program paid farmers approximately $224 million to restore 142,000 acres of wetlands to a more natural condition, and to remove adjacent land from agricultural production. Restoration projects have been funded using a combination of permanent easements, 30-year easements, and 10-year cost-sharing agreements. The program has an acreage cap of 2.3 million acres, about 1.8 million of which is currently filled, mostly by permanent easements. For a more

detailed description of the history, structure, costs, and benefits of USDA's land retirement programs, see Heimlich (2007).

Working Land Programs. Until recently, land retirement accounted for the bulk of USDA's conservation expenditures. This changed when the 2002 Farm Bill authorized a five-fold increase in the budget for the largest working land program, the Environmental Quality Incentives Program (EQIP), which pays farmers to implement conservation practices that address various resource concerns on their farms, such as water quality, soil erosion, and wildlife habitat. One of EQIP's primary goals is to help farmers meet EPA's regulatory requirements. Thus one reason for increasing EQIP's budget in 2002 was to help owners of concentrated animal feeding operations (CAFOs) obtain permits under the revised NPDES guidelines which, at the time, were expected to take effect long before the 2007 Farm Bill. In addition to increasing the size of EQIP's budget, the 2002 Farm Bill also increased the share of the budget targeted to livestock producers to 60 percent. With an annual average of $967 million in authorized funding between 2002 and 2007, 60 percent of the EQIP budget ($580 million) far exceeds what EPA estimated as the cumulative cost of obtaining permits for all the animal feeding operations it designated as CAFOs ($326 million).

Funding through EQIP is distributed to farmers in two ways: cost-sharing and incentive payments. The cost-sharing percentage on an individual project can be as high as 75 percent.[9] In practice, however, the average rate has been closer to 50 percent (Cattaneo and others 2005). The incentive payments compensate farmers for adopting environmentally beneficial management practices, such as integrated pest management, which may increase their cost or exposure to yield risk. Each NRCS state office determines the size of the incentive payments based on what they expect would be sufficient to induce farmers to participate. To enroll in EQIP, farmers submit an application describing their land, the resource concerns they intend to address, and the practices they propose to implement to address those concerns. Each year, applications are ranked according to their ability to meet a combination of national and local resource concerns, and accepted until funding runs out. Unlike the CRP bidding process, farmers cannot increase their chance of being accepted into the program by bidding down the cost-sharing component of the contract. In 2005, approximately $1.4 billion was obligated to farmers and ranchers through new contracts, which can last for up to 10 years.

The second major working lands program is the Conservation Security Program (CSP). CSP is unique among USDA's conservation programs in that farmers do not need to engage in any new projects in order to receive payments. Instead, they can be paid for ongoing conservation efforts that would otherwise be considered part of their normal farming operations. Base payments are made for meeting minimum environmental criteria such as the *T*-score for soil erosion. Farmers can also collect "enhancement" payments for exceeding the minimum environmental criteria. Although CSP is operated as an entitlement program, it has been limited each year to selected watersheds. Farmers in a participating watershed can enroll in one of three payment tiers, where the size of the payment per/acre varies with the ongoing level of conservation. In 2005, CSP paid farmers approximately $456 million.

The final major working lands program is the Wildlife Habitat Incentives Program (WHIP), which pays farmers to undertake projects that improve habitat for wildlife populations. WHIP is operated as a cost-sharing program with NRCS providing technical assistance and

[9] This share can increase to up to 90 percent for "beginning" or "limited resource" farmers.

paying up to 75 percent of the implementation costs. The application process mirrors that of EQIP. In 2005, approximately $34 million was obligated to contracts, which can last for up to 15 years.

Farmland Protection Programs. The third set of conservation programs buys easements from farmers to prevent their land from being converted out of agriculture. The Farm and Ranch Land Protection Program (FRPP) pays up to 50 percent of an easement's cost, matching state and local funds provided by organizations that purchase development rights from farmers. With annual expenditures of about $100 million, the Farm and Ranch Land Protection Program provides nearly as much funding as the combined annual expenditures of state-level programs ($123 million) (Nickerson and Barnard 2006). Still, this amount is small compared to the cost of state-level "use value assessment" programs that tax farmers based on the agricultural value of their land rather than the total value of that land, which includes the capitalized value of the potential for future urban development. Heimlich and Anderson (2001) estimate that the total annual value of potential tax revenue foregone through preferential taxation is $1.1 billion.

The Grasslands Reserve Program (GRP), which was first authorized by the 2002 Farm Bill, provides funding to purchase temporary and permanent easements on working grazing lands. The easements prevent the land from being developed for urban use and from being converted to more intensive crop production. It is expected that the land will continue to be used in active grazing operations. In addition, a resource management plan is incorporated into each easement, specifying any necessary restoration activities. The easements pay farmers up to 75 percent of the grazing value of the land during each year of the contract, and GRP also provides cost-sharing for restoration activities. In 2005, $56 million was spent on new contracts.

Summary of Conservation Expenditures. Overall, USDA spent more than $5 billion on conservation in 2005. Nearly $4 billion was spent on the seven programs described above (CRP, WRP, EQIP, CSP, WHIP, FRPP, and GRP), $0.7 billion was spent on providing technical assistance to farmers on conservation issues, and another $0.5 billion was spent by emergency conservation programs to restore farmland damaged in natural disasters. Table 2 illustrates how funding was distributed geographically for each of the voluntary conservation programs. For EQIP, the numbers in the table represent the total value of contracts signed in 2005, even though some of the money will actually be paid over a number of years. For the other six programs, the table indicates the value of payments made to farmers during 2005.

Table 2. Conservation Expenditures by Farm Production Region, FY 2005 ($ million)

Farm Production Region	Land Retirement		Working Lands			Farmland Protection		Total, All Programs
	CRP	WRP	EQIP	CSP	WHIP	FRPP	GRP	
Alaska/Hawaii	1	1	26	0	3	2	2	34
Appalachia	53	12	136	10	3	11	4	229
Corn Belt	459	50	113	118	2	7	7	756
Delta	61	42	75	54	3	0	2	236
Lake States	166	28	111	45	1	9	1	362
Mountain	249	6	286	51	4	10	7	613
Northeast	33	8	152	34	9	49	8	293
Northern Plains	349	21	107	28	2	1	13	521
Pacific	103	28	137	89	4	8	4	374
Southeast	45	20	128	19	2	7	3	225
Southern Plains	173	8	123	7	2	2	4	318
United States	1,690	224	1,394	456	34	107	56	3,961

Source: Natural Resources Conservation Service, USDA.
CRP=Conservation Reserve Program; CSP=Conservation Security Program; EQIP=Environmental Quality Incentives Program; FRPP=Farm and Ranch Land Protection Program; GRP=Grassland Reserve Program; WHIP=Wildlife Habitat Incentives Program; WRP=Wetland Reserve Program.

Together, CRP and EQIP account for more than three quarters of the total conservation expenditures. Since the Corn Belt and Northern Plains regions have the most cropland, it is not surprising that they also account for the largest shares of CRP payments. In contrast, expenditures on EQIP projects are more evenly distributed across the country, partly reflecting the distribution of CAFOs. The geographic distribution of CSP payments is likely to change from year to year as the program rotates across different watersheds whereas the distribution of WRP payments is largely determined by the locations of impaired wetlands. Finally, notice that the farmland protection programs make the largest contribution to total conservation effort in the Northeast. This is because the Northeast has relatively little farmland remaining and some of the most active state and local programs that purchase development rights from farmers.

While $4 billion may seem like a lot of money for conservation, it is not enough to enroll more than a small share of farmland in any given year. The combined expenditures on CRP, WRP, CSP, WHIP, FRPP, and GRP funded conservation projects on approximately 46 million acres in 2005—at most 10 percent of U.S. cropland.[10] Most of these programs were under-funded in the sense that more farmers wanted to enroll than were able. For example, 22 percent of the WRP applications were funded in 2005, compared to 60 percent for EQIP. Meanwhile,

[10] It is difficult to derive a comparable figure for EQIP since some practices are reported in acres while others are reported in different units (such as feet of pipeline or number of aquaculture ponds). Moreover, multiple conservation practices may be implemented on the same acre of land. If there were no overlap, EQIP would account for an additional 57 million acres. Adding this figure to the subtotal for the other programs would provide an estimate for an upper bound on the geographic scope of conservation programs in 2005.

CRP has been able to fund between 50 percent and 70 percent of the total applications each year since 1997 (Lambert and others 2006).

There is considerable overlap in the externalities addressed by the different conservation programs. Table 3 displays the geographic distribution of funding for working land programs by what NRCS defines as the "primary resource concern" addressed by each contract. Notice that the resource concerns addressed by these programs are very similar to the four main categories of environmental benefits that are used to define weights in the index ranking of contracts for enrollment in the CRP: water quality, soil erosion, wildlife habitat, and air quality.[11]

Table 3. Working Land Conservation Expenditures by Resource Concern, FY 2005 ($ million)

Farm Production Region	Water Quality	Soil Erosion	Wildlife Habitat*	Water Quantity	Other	Air Quality	Soil Quality	Wetland Health	Total
Alaska/Hawaii	6	3	12	6	2	0	0	0	29
Appalachia	51	28	12	15	6	1	2	0	113
Corn Belt	129	59	17	9	13	4	4	0	233
Delta	51	32	15	25	6	1	2	1	131
Lake States	96	32	13	3	2	6	5	1	158
Mountain	82	70	87	88	20	10	10	3	366
Northeast	95	27	24	14	6	5	5	1	168
Northern Plains	68	45	17	28	14	2	3	0	175
Pacific	83	51	34	42	7	9	6	1	230
Southeast	68	29	19	19	10	3	3	1	150
Southern Plains	27	19	45	33	6	2	0	0	131
United States	757	397	296	283	94	43	39	10	1884

* "Wildlife Habitat" includes the following NRCS resource concerns: forest health, habitat quality, plant population health, population health, and invasive species concerns on grazing land.

Source: Natural Resources Conservation Service, USDA.

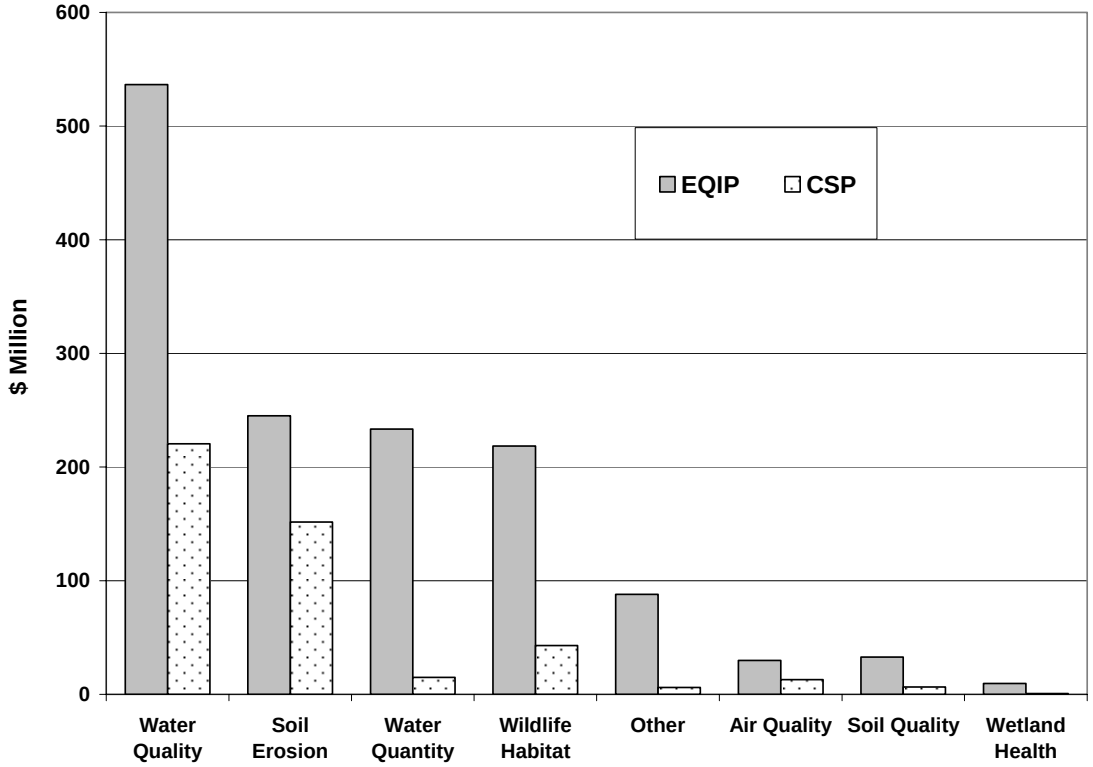
Note: Figures are for expenditures on EQIP, CSP, and WHIP.

a. Includes the following RRCS resource concerns: forest health, habitat quality, plant population health, and invasive species concerns on grazing land.

Water quality was the top resource concern for working land programs in 2005, accounting for 41 percent of total conservation payments. Most of this funding was allocated to projects that aim to reduce pollution from sediment, fertilizer, pesticides, and animal waste. Soil erosion accounted for the next largest share of funding, followed by wildlife habitat and water quantity. Considerably less funding was allocated to reduce air and soil pollution. Projects addressing "water quantity" attempt to improve the efficiency of water use in order to assure there are adequate supplies for human populations, wildlife, and farm livestock. For example, in the Pacific region, projects include a special EQIP program to conserve water in the Klamath River Basin.

[11] Heimlich (2007) provides the specific weights assigned to each resource concern in the EBI.

Figure 2. Funding for EQIP and CSP Contracts by Resource Concern, 2005



Source: Natural Resources Conservation Service, USDA.

Just as there is considerable overlap between the goals of the land retirement and working land programs, there is also considerable overlap between the resource concerns addressed by the different working land programs. Figure 2 compares the total funding allocated to each resource concern by EQIP and CSP. Both programs placed most of their emphasis on water quality and soil erosion. They also devoted considerable funding to providing wildlife habitat, creating some overlap with WHIP.

Opportunities for Policy Reform

The coupling of USDA's incentive-based conservation programs with minimal federal environmental regulation has been dubbed a "pay the polluter" approach to addressing farm externalities, in contrast to the "polluter pays" principle that applies widely to firms elsewhere in the economy (Runge 1991). This preferential treatment of farmers is at least partly due to the administrative costs of regulation. While it is feasible for EPA to regulate small groups of farmers like CAFOs, extending the existing permit and enforcement programs to the entire farm sector would require an order of magnitude expansion of EPA's current programs. Even if funding were available, it is doubtful that such an expansion would be politically feasible. The lack of environmental regulation underscores the importance of the role that USDA's conservation programs play in addressing farm externalities.

The first question one might ask about the current conservation programs is whether their environmental benefits exceed their implementation costs. Recent analyses suggest that they do.

Heimlich (2007) reports positive net benefits for the Conservation Reserve Program. USDA (2003) reports positive net benefits for the Environmental Quality Incentives Program. Although USDA (2005) reports a negative net benefit in their analysis of the Conservation Security Program, they suggest that net benefits would have been positive if they had been able to quantify the economic value of environmental impacts from conservation projects that were rewarded with enhancement payments. Of course, the exact size of the benefits estimated in these analyses must be treated as uncertain given the difficulties associated with quantifying environmental externalities. Nevertheless, because the analyses do not attempt to quantify many of the environmental benefits associated with the programs, including most ecosystem services, their measures for net benefits may be systematically underestimated.

Federal budget limits will prevent the current conservation programs from being extended to cover most U.S. farmland in the near future. If policymakers were willing to tax the management practices that generate negative externalities, instead of paying farmers to change those practices, the environmental impacts of production agriculture could be addressed on a greater portion of farmland at a lower cost to taxpayers. The monitoring and enforcement costs of operating such a program could be at least partly funded by the tax revenue it generates. Of course, such a drastic departure from current policy may be politically infeasible. If realistic opportunities for introducing reform through the 2007 Farm Bill are limited to changing the way farmers are paid, there are at least three ways in which the existing set of conservation programs could be reorganized to address environmental externalities more efficiently

Coordinating Conservation Programs. Given heterogeneity in the distribution of land characteristics, input use, and farming methods, there is an advantage to having a mix of land retirement and working land tools because it allows policymakers to provide incentives for farmers to adjust their behavior at the intensive or the extensive margin, whichever is more effective at addressing a particular externality (Just and Antle 1990). However, the efficiency gains from having a mix of policy instruments may be diminished by allowing farmers to self select into programs. Consider a farmer whose land offers sufficient environmental benefits to be accepted into either CRP or EQIP. The profit-maximizing farmer will choose to enroll in whichever of the two programs offers the greatest potential to increase his profits. The program that the farmer chooses may or may not be the one that offers the most efficient approach for addressing the relevant set of externalities. If profitability and program efficiency are negatively correlated, allowing farmers to sort into programs will decrease the overall efficiency of conservation policy.

Land retirement and working land programs may each have advantages in addressing particular externalities. For example, Heimlich (2007) suggests that land retirement is probably better suited to preserving habiatt for sensitive wildlife species. In contrast, it may be more efficient to address runoff of farm chemicals by paying a farmer to reduce applications of fertilizer or to install buffer zones adjacent to waterways. Retirement and working land programs also differ in their ability to reduce preexisting distortions created by other farm bill policies, such as price supports. Retiring land and paying farmers to use less intensive (lower yield) production methods will both decrease aggregate crop production. To the extent that this increases the market price of program crops, it will reduce the size of payments made under a target price scheme. The tax savings can be substantial. Heimlich estimates that the value of reduced domestic support payments under the first 20 years of CRP was equivalent to approximately half the total program cost.

One way to exploit the mix of tools provided by existing conservation programs would be to coordinate the enrollment processes for EQIP and CRP. This could involve merging the two programs. The idea would be to have farmers simultaneously submit one application that outlines land retirement *and* working land options, knowing that program officials would choose which (if either) contract to offer them. In this scenario, farmers' application would contain information about the environmental characteristics of their land, the crops that would be grown on that land if it were in production, their land retirement bid, and their working land proposal. Program officials could use the applications to allocate funds between land retirement and working land practices in a way that exploits each instrument's relative advantages at addressing environmental externalities and preexisting distortions. If merging or coordinating the two programs is not feasible, a simpler approach to reducing the potential for overlap would be to adjust the weights on the indices used to select contracts for EQIP and CRP to emphasize the relative strengths of each program.

Linking Payments to Environmental Performance. Another potential source of inefficiency in USDA's working land programs is that they pay farmers to implement management practices *regardless of the environmental outcome*. This approach gives farmers an incentive to propose projects that are primarily intended to increase their profits, rather than projects that will provide the most efficient solution to an externality. Policymakers can align farmers' incentives with public goals by linking conservation payments to environmental performance. For example, suppose policymakers want to increase the population of endangered Grey wolves. Under the current Wildlife Habitat Incentives Program, a farmer could collect payments for implementing a project that is believed to have a beneficial effect on wolf habitat, regardless of whether any wolves actually visit the farm. A performance-based version of the same program might pay farmers in proportion to the number of wolves that visit the farm (using radio collars) or in proportion to the number of wolf pups born on the farm. In this example, linking payments to the behavior of the wolf population provides a stronger incentive for the farmer to enhance wolf habitat. More generally, linking payments to environmental outcomes rewards farmers for developing new, cost-effective ways of addressing externalities. This incentive for innovation is missing from the current conservation programs.

Reforming USDA's conservation programs to be performance-based would require determining how individual farmers contribute to environmental outcomes. In the case of endangered species, one can imagine NRCS field specialists visiting farms to verify the presence of populations. However, as discussed in the second section, it becomes more difficult to link environmental externalities back to management choices made at the level of an individual farm as one moves from local amenities like wildlife viewing to ambient pollution and ecosystem services. This is a problem because agriculture is widely believed to make a substantial contribution to water pollution and has also been linked to the provision of ecosystem services such as water filtration and carbon sequestration. Economists have proposed at least two strategies for this situation: group incentives and calibrated ecosystem models.

A group incentive scheme would avoid the need to understand how individual farmers contribute to an externality by paying the entire group based on their collective contribution. Theoretical and experimental research on group incentives has envisioned using these schemes to control agricultural runoff of pesticides, fertilizer, and animal waste at the watershed level. Suppose that nutrient concentrations measured at the base of a watershed depend on farmers' land management choices as well as random weather events and runoff from urban and industrial

sources. Within this conceptual framework, policymakers can achieve a target reduction in pollution by monitoring water quality at the base of the watershed and paying farmers if nutrient levels decrease, with the size of the payment depending on the size of the reduction (Segerson 1988).[12] This result relies on the assumption that each farmer balances the cost of reducing runoff with the expected payoff from their reduction. The difficulty with implementing this scheme is that individual farmers must believe that their own efforts to reduce runoff will have a detectable impact on ambient pollution at the base of the watershed. Farmers are unlikely to share this perception except in watersheds with: a small number of relatively homogeneous farms, few or no non-farm polluters, readily monitored water quality, and short time lags between emissions and detectable changes in pollution (Shortle and Horan 2001). Few watersheds appear to meet these criteria. The average watershed selected for the Conservation Security Program in 2005 and 2006 had 1,114 farms, and only 5 of these 280 watersheds had fewer than 25 farms.[13] These statistics suggest there is limited scope for reforming the working land conservation programs as group incentive schemes, although the idea could work in a small number of watersheds that meet the above criteria.

Agricultural ecosystem models form the basis for a second strategy to link farmers' management practices to externalities. These models use chemical and biophysical relationships to explain how environmental outcomes depend on farm characteristics, climate variables, and individual farmers' management practices. For example, Antle and others (2003) used the Century model to predict how carbon sequestration rates vary with crop rotations in the Northern Plains region, given data on climate factors and the soil properties of individual farms. More recently, Feng and others (2006) used the Environmental Policy Integrated Climate (EPIC) model to predict how different tillage methods would affect carbon sequestration, soil erosion, nitrogen runoff, and nitrogen leaching in Iowa. The difficulty with models like Century and EPIC is that because they necessarily abstract from the complexity of natural ecosystems, their predictions will be inaccurate. The question is: how inaccurate? This is the subject of ongoing research (Izaurralde and others 2006). While agricultural ecosystem models are still being refined, they could form the basis for future policy reform. Antle (2007) provides more detail on the data requirements for these models and the prospects for using them to make performance-based payments to farmers.

Reforming the working land conservation programs to base payments on environmental performance would provide farmers with the right incentives to develop efficient methods for increasing positive externalities and decreasing negative externalities. From an administrative standpoint, the question is whether these efficiency gains will be outweighed by the technical costs of linking farmers' management practices to environmental outcomes. This will have to be determined on a case-by-case basis. In the case of carbon sequestration, Antle and others (2003) suggest that the efficiency gains are likely to outweigh the expected measurement costs of using agricultural ecosystem models to predict sequestration rates. Using these models as the basis for policy reform would require information on the physical characteristics of farmland and farmers'

[12] While Segerson's model would also tax farmers if ambient pollution concentrations exceed the target levels, it seems unlikely that a pollution tax would be politically feasible as a feature of a farm bill conservation program. It is also important to note that obtaining the socially efficient level of pollution requires that the "price" of polluting is set to reflect the social benefit of a marginal reduction.

[13] In contrast, experimental research typically utilizes groups of fewer than 25 members. For example, recent laboratory experiments by Vossler and others (2006) and Spraggon (2004) used groups of six.

management practices. One way to provide this information would be to add an information compliance provision to the farm bill.

An Information Compliance Provision. Asymmetric information is part of the rationale for government intervention to address farm externalities. Farmers know how much pesticides and fertilizer they apply, and they know the geographic features of their farm and the surrounding landscape that influence the amount of chemical drift and runoff. But the privacy of this information poses a barrier to direct negotiation by preventing the people who are ultimately affected by externalities from determining their origins. Adding an information-based compliance provision to the farm bill would require that, each year, farmers who receive payments must report some basic information to USDA about the geographic characteristics of their farm and their land management practices. Making some of this information publicly available would reduce information asymmetries and expand the opportunities for private parties to negotiate solutions to externalities without additional government involvement. These data would also provide an important input to research on linking farmers' management practices to environmental outcomes.

Past experience with mandatory information reporting comes from the Toxic Releases Inventory (TRI) created by the Emergency Planning and Community Right to Know Act. As discussed in appendix A, each firm covered by this act is required to report to EPA its production, use, and releases of 666 different chemicals and chemical categories. The annual release of this firm-specific information to the public has been found to decrease the stock prices of firms with unexpectedly high levels of releases. Moreover, this decrease in stock prices has been found to cause firms to decrease their on-site releases of toxic chemicals (Khanna, Quimio, and Bojilova 1998). Environmental groups have also used the TRI as a way to rank firms according to their emissions of toxic chemicals. Preliminary evidence indicates that firms have made a substantial effort to avoid being ranked near the top of these highly publicized lists (Scorse 2005).

If USDA were to systematically collect land management data from farm bill program participants, reporting some of this information as a Farm Management Inventory (FMI) could provide an inexpensive way to address externalities. First, the FMI could provide feedback to farmers on how their management practices compare to other farms that grow the same crops in similar areas. For example, if some farmers systematically apply chemicals at rates that are unnecessarily higher than their peers, the FMI could help them to recognize this. Second, the FMI could serve as a de facto certification for product labeling purposes. That is, farmers who avoid certain chemicals or implement certain conservation practices could use the FMI to differentiate their product for consumers who may be willing to pay more for strawberries or tomatoes that are "FMI-certified" to be grown without methyl bromide, for example. This could provide a niche for farmers who use less intensive growing methods but do not want to take on the risk of converting to organic. Finally, having the FMI publicly available would create an opportunity for environmental groups or others who are directly affected by externalities to negotiate directly with farmers.

Perhaps the most significant challenge in developing an FMI would be to certify the accuracy of self-reported information. While the extent of misreporting is difficult to verify, it has been an ongoing concern with EPA's Toxic Releases Inventory. EPA addresses this issue by randomly auditing a small share of firms. In addition to random audits, they also visit firms that report unusual activity such as the largest year-to-year changes in TRI chemicals. Firms are fined

for misreporting information or failing to submit the required information. If farmers were caught misreporting their management practices in the FMI, one enforcement option would be to remove their right to collect future payments from farm bill programs.

Conclusion

Current federal laws addressing air pollution, water pollution, and the use of toxic chemicals only apply to the largest confined animal feeding operations. These operations represent less then 1 percent of all farms but account for a much larger share of agricultural sales value and are believed to make a substantial contribution to ambient pollution. These farms also remain the most likely target for any near-future expansion of environmental regulation. With few exceptions, the other 99 percent of U.S. farmers have the legal right to discharge unlimited quantities of pesticides, fertilizer, and animal waste produced as a byproduct of normal farming operations. Nevertheless, there are three ways in which federal regulations have the potential to constrain farmers' land management practices: cancellation of key pesticide registrations, limits on the private uses of endangered species habitat, and the Swampbuster and Sodbuster compliance provisions of the farm bill. However, for the majority of farmers, the actual burden imposed by these regulations appears to be minimal.

Rather than regulate, the government has used voluntary conservation programs to address farm externalities. The federal budget for these programs has grown to more than $5 billion annually, but the programs still only enroll a small share of U.S. farmland. Recent analyses of the three largest programs funded by the 2002 farm bill (CRP, EQIP, and CSP) suggest that they all generate environmental benefits that exceed their program costs. However, the current approach of allowing farmers to sort themselves across the programs fails to exploit some of the potential efficiency gains from having a mix of contract styles. This could be addressed by synchronizing future CRP and EQIP signups or by adjusting the weights on the indices used to select contracts into the two programs in a way that emphasizes the relative strengths of each. Likewise, the current approach of paying farmers to implement conservation practices regardless of the environmental outcome fails to align farmers' financial incentives with public environmental goals. Policymakers should link the size of conservation payments to environmental performance wherever it is cost effective to measure individual farmers' contributions to environmental outcomes.

Combining minimal regulation with incentive payments is often described as a "pay-the-polluter" approach to environmental policy. While the allocation of property rights to the environment is inherently arbitrary, one justification for allocating them to farmers is the enormous regulatory burden of permitting, monitoring, and enforcing management practices on two million farms. Adding an information compliance provision to the farm bill would be a relatively inexpensive way to collect information about farmers' management practices and the characteristics of their farms. In the near term, these data would provide an important input to the continuing research effort to understand the links between farmland management and environmental externalities. In the longer run, the information provided by the compliance provision could serve as the basis for making performance-based payments to farmers, using agricultural ecosystem models to predict how a farmer's management practices will affect carbon sequestration or runoff of pesticides, fertilizer, and animal waste. Finally, making some of this information available to the public would create new opportunities for private negotiation to address externalities without additional government intervention.

Appendix A. Environmental Regulation of Production Agriculture

Air and Water Pollution. The Clean Air Act (CAA) and the Clean Water Act (CWA) are two of the pillars of modern environmental regulation. Written shortly after EPA was formed in 1970 and amended periodically thereafter, both acts embody the polluter-pays principle by requiring major industrial polluters to satisfy technology-based standards for emissions abatement.[14] Importantly, the acts distinguish between "point" sources that are relatively easy to monitor because they emit large quantities of pollutants from smokestacks or pipes, and "nonpoint" sources such as cars and farms, which tend to be large in number, widely dispersed, and difficult to monitor individually. Only point sources are required to install technology-based standards. EPA's past regulation of point sources has been insufficient to bring many air basins and watersheds into attainment of national standards for air and water quality. The responsibility for bringing these areas into attainment has been passed from EPA to the individual states, which are encouraged to address sources of nonpoint pollution. However, the states have considerable leeway in which nonpoint sources they choose to regulate, and most states have chosen not to regulate farmers. Current regulations that do apply to farmers are almost entirely limited to concentrated animal feeding operations (CAFOs).

Regulation of Non-CAFO Farms. Three elements of the Clean Water Act have the potential to influence farmers. First, the act requires point sources to obtain a permit to discharge pollutants legally into U.S. waters. However, CAFOs are the only type of farm with the potential to be treated as a point source. While the term "pollutant" is defined in the act to include "agricultural waste discharged into water," the definition of a "point source" excludes "agricultural stormwater discharges and return flows from irrigated agriculture."[15] This exemption covers all runoff of pesticides, fertilizer, and animal waste from farmland. Interestingly, the exemption was not part of the original Clean Water Act that Congress passed in 1972. EPA's 1973 decision to exclude all non-CAFO farms from its permitting program led to a lawsuit by the Natural Resources Defense Council, during which EPA argued that the prospect of regulating millions of farms posed an "administrative infeasibility."[16] Although EPA lost the lawsuit, Congress overruled the court by codifying the exemption as part of its 1977 amendments to the CWA. Thus under current regulations, non-CAFO farms (which include 99 percent of all farms) can legally discharge unlimited quantities of pesticides, fertilizer, and animal waste into U.S. waters.

Amendments to the Clean Water Act in 1987 shifted some of the emphasis to nonpoint sources of pollution, creating a second potential source of regulation for farmers. However, instead of regulating nonpoint sources directly, the amendments delegate responsibility to the states, which, in turn, often delegate responsibility to local regulatory authorities—which tend to exempt farmers or make compliance voluntary. The Clean Water Act amendments require each state to identify water bodies that cannot be expected to meet water quality standards due to pollution from nonpoint sources. For each of these water bodies, the state must define total

[14] More precisely, both acts were drastic amendments to existing legislation. The 1970 Clean Air Act amended the 1963 Clean Air Act. The 1972 Clean Water Act (also known as the Federal Water Pollution Control Act) was enacted as the latest set of amendments to the 1948 Water Pollution Control Act.

[15] For the full definitions of a "pollutant" and a "point source" see section 502 of the Clean Water Act.

[16] Natural Resources Defense Council, Inc. v. Douglas M. Costle, Administrator, Environmental Protection Agency, et al. 568 F.2d 1369 (D.C. Cir. 1977).

maximum daily loads (TMDL) of emissions that would allow the water body to meet national standards. Finally, the state must define a set of best management practices for nonpoint polluters that would allow TMDL limits to be met. If EPA approves the state's plan, it is eligible to receive some federal funding. A similar program for coastal waters was established by the 1990 amendments to the Coastal Zone Management Act (CZMA). Although the Coastal Zone Management Act amendments explicitly recognize agriculture as a source of nonpoint pollution, the individual states have the authority to decide whether pollution controls will be voluntary or mandatory. In practice, the states often exempt farmers from any regulatory requirements placed on other nonpoint sources, or they implement voluntary programs that provide cost-sharing and other incentives for farmers to implement best management practices. Strictly enforced state regulations on non-CAFO farms are rare (Environmental Law Institute 1998).

The third feature of the Clean Water Act with the potential to affect farmers is section 404, which requires a permit to fill wetlands for agricultural use or urban development. EPA operates a "no-net-loss" program, whereby each acre of wetlands that is filled must be replaced by at least one acre of restored wetlands. Areas of restored wetlands act as mitigation banks. The owners receive permits for having restored the wetlands and can then sell those permits to developers that would like to fill wetlands elsewhere.[17] However, permits are not required for "normal farming" activities that lead to incidental discharges of dredged or fill material.[18]

For the most part, EPA's regulation of air pollution parallels its regulation of water pollution. The Clean Air Act sets national ambient air quality standards for a variety of chemicals and requires *major* industrial sources of emissions to satisfy technology-based abatement standards. "Major" sources are those that emit more than threshold quantities of regulated chemicals. For most chemicals, the thresholds are set at levels above what would be expected from an individual farm.[19] For chemicals with emissions thresholds that do not implicitly exempt farmers, such as ammonia and propane, the Clean Air Act contains provisions that explicitly exempt farmers.

Like the Clean Water Act, major sources of air emissions must obtain permits to operate legally, whereas the responsibility for regulating emissions from nonpoint sources is delegated to the states. Under section 110 of the Clean Air Act, each state must develop an enforceable State Implementation Plan to meet national ambient air quality standards. The plans, which are supposed to address both major and nonpoint sources, are subject to the approval of EPA. In practice however, state-level regulation of farmers is mostly characterized by exemptions and voluntary programs. For example, Kansas has a regulation that prohibits open burning in general but exempts farmers (Kansas Administrative Regulations 1996). In Louisiana sugarcane burning can lead to substantial emissions of particulate matter. The state has addressed the issue by introducing a voluntary information-based program to encourage farmers to adopt best management practices when burning (Louisiana Department of Agriculture and Forestry 2000). Though rare, stricter regulations have been adopted in some states. California has imposed restrictions on rice straw burning in the Sacramento Valley Air Basin—a nonattainment area for

[17] No-net-loss of wetlands does not necessarily imply no-net-loss of ecosystem services. Polasky (2002) observes that there is no guarantee that an acre of restored wetlands in one location will provide the same set of ecosystem services that were formerly provided by an acre of wetlands in another area.

[18] It is unclear whether this exemption has led to a significant amount of conversion. Ruhl (2000) describes a recent court's ruling that a farmer who had drained wetland for crop use by installing drainage tiles had produced more than "incidental" discharges.

[19] Emissions thresholds vary by chemical. The lowest threshold is 10 tons/year for hazardous air pollutants.

ozone and particulate matter. These restrictions limit each farmer to burn no more than 25 percent of their total acreage each year, while simultaneously limiting the total acreage that can be burned to 125,000 acres, and placing additional restrictions on the days when farmers can burn. In addition to these restrictions, California's rice straw program has also made incentive payments to farmers for developing alternative uses for rice straw (California Air Resource Board 2003).

Regulation of CAFOs. Since the air emissions produced by CAFOs have not been monitored in the past, it is unclear whether they emit sufficient quantities to be treated as a major source of pollution under the CAA. Thus far, EPA's regulation of CAFOs has been limited to their discharge of wastewater. In order for CAFOs to legally discharge wastewater, they must first obtain a permit to do so through the National Pollutant Discharge Elimination System (NPDES). Each permit certifies that the holder satisfies industry-specific abatement standards and that the affected water body satisfies water quality standards. For CAFOs, the abatement standard is to adopt land management practices that lead to zero discharges into U.S. waters except during the worst 24-hour storm in a 25-year period.[20] EPA defines a CAFO as any facility that meets all three of the following criteria:

(1) Animals are confined or maintained for at least 45 days during any 12-month period.

(2) Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility (that is, it is not rangeland).

(3) The facility has:

a. More than 1,000 animal units, or

b. More than 300 animal units and discharges directly into U.S. waters, or

c. Fewer than 300 animal units and discharges directly into U.S. waters and has been identified by the regulatory authority as a significant polluter.[21]

While EPA estimates that 12,700 animal feeding operations meet these criteria, only 4,076 had obtained a permit as of January 1, 2006.[22] There are two reasons why. First, the current regulations include a stormwater exemption that creates ambiguity about when permits are required. An animal feeding operation that discharges only during a 25-year 24-hour storm is automatically exempted from the CAFO designation. This exemption creates a catch-22 for the permitting process. Consider an operation that meets all three of EPA's criteria for the CAFO designation. In order for the operation to obtain an NPDES permit, it must adopt a management plan that leads to zero discharges except during a 25-year 24-hour storm. But if the operation

[20] Some individual states impose additional standards on CAFOs (Ribaudo and others 2003).

[21] 1,000 animal units is equivalent to 1,000 cattle or cow/calf pairs, 700 mature dairy cattle, 2,500 swine weighting over 55 pounds, 10,000 swine weighting less than 55 pounds, or 30,000 laying hens or broilers (with a liquid manure handling system).

[22] This is the number of facilities in SIC category 02 (livestock) holding NPDES permits according to EPA's Permit Compliance System database on September 30, 2006: http://www.epa.gov/enviro/html/pcs/pcs_query.html.

discharges only during a 25-year 24-hour storm, it receives a special exemption from the CAFO designation and therefore does not need a permit. So why would anyone apply for a permit? In its most recent proposal to revise the NPDES regulations, EPA notes that since a permit guarantees the CAFO is in compliance with the Clean Water Act, a permit can provide a form of insurance against citizen lawsuits or EPA enforcement in the event of an unexpected discharge (EPA 2006c). The second reason why so few CAFOs have obtained permits is that current regulations do not cover land application of manure. Once the manure has been spread on a farm field, any subsequent runoff is treated as nonpoint source pollution, even if the application rate far exceeds the land's capacity to absorb nutrients.

EPA is currently seeking to expand its regulation of air and water emissions from animal feeding operations, partly due to changes in the structure of the livestock industry. Between 1982 and 1997, the number of confined animal operations decreased from 435,000 to 213,000, while the number of confined animals increased by 10 percent (Ribaudo and others 2003). This pattern of consolidation reflects a substantial increase in the number of large CAFOs. For example, the number of farms in EPA's largest CAFO category (those with more than 1,000 animal units) more than doubled. The increase in the number of large CAFOs has increased concerns about the air and water pollution produced as a byproduct of livestock production.

In early 2003, EPA attempted to revise the NPDES permit regulations to reflect changes in the livestock industry. The new regulations contained the following three major changes: elimination of the stormwater exemption; expansion of the CAFO definition to include heifer operations, veal operations, and poultry operations that use a dry-manure handling system; and provisions to regulate the land runoff of manure. Under these changes, the number of animal feeding operations requiring permits would have increased from about 4,100 to about 15,400. Moreover, without the stormwater exemption, each of these 15,400 CAFOs would have to either obtain a permit or demonstrate that it had no potential to discharge. However, shortly after the final rule was released, livestock industry groups and environmental groups both sued EPA. The 2005 court decision upheld EPA's plan to regulate the land application of manure and to expand the definition of a CAFO, but vacated EPA's plan to remove the stormwater exemption and required some other minor changes. These changes have since been incorporated into a revised version of the NPDES regulations released by EPA as a proposed rule in June 2006.

If the final NPDES regulations look like the June 2006 proposal, animal feeding operations will be subject to increased public scrutiny over their land management practices. While farmers will continue to be able to avoid permits under the stormwater exemption, the proposed rule emphasizes that exploiting the exemption will expose them to lawsuits in the event of an unexpected discharge. Furthermore, those seeking to use the stormwater exemption will have to document their land application rates for manure in order to demonstrate that they are not exceeding the soil's capacity to absorb nutrients. Given EPA's desire to have all CAFOs obtain permits, it would not be surprising to see an increase in monitoring effort. Meanwhile, CAFOs that apply for NPDES permits will have to provide nutrient management plans, which will be open to public comment during the permitting process.

In addition to the NPDES revisions, EPA is also investigating new strategies for monitoring air emissions from animal feeding operations. In January 2005 EPA announced the Air Compliance Agreement, which outlines a plan to investigate the feasibility of monitoring airborne emissions of ammonia, hydrogen sulfide, particulate matter, and volatile organic compounds from animal feeding operations: partly to investigate the feasibility of monitoring emissions, and partly to determine whether they emit sufficiently large quantities to be treated as

major sources under the Clean Air Act. The research is being funded by a group of CAFO owners, each of whom has contributed between $2,750 and $3,500 to the program. In exchange, they have been given amnesty from past violations of the Clean Air Act or violations that occur during the monitoring period. As of August 2006, agreements have been signed covering 6,267 animal feeding operations. The actual monitoring is scheduled to take place on a small number of sites starting in March 2007. It remains to be seen whether this program will result in new regulations on air emissions.

If EPA's proposed revisions to the NPDES regulations are written into law and/or it redefines some animal feeding operations as "major" sources under the CAA, the costs of obtaining permits will be borne by the largest operations. While these operations account for a small share of farms (less than 1 percent) they represent a much larger share of gross national agricultural sales value (approximately 10 percent).[23] Table A-1 shows the number of farms that would be defined as CAFOs under EPA's revisions to the NPDES permits by sector and by farm production region (see figure A-1). Together, swine and dairy operations account for more than half of all CAFOs. The greatest concentration of swine operations are in the Corn Belt and Appalachia, while dairy operations are more evenly distributed across the country. However, a count of operations may provide a poor indicator of the regulatory burden, since the costs of obtaining a NPDES permit will vary by sector. According to EPA's economic analysis of the 2003 rule, the annual cost of obtaining a permit (in year 2001 dollars) would be approximately $45,000 for dairy and beef operations, $20,000 for turkeys, $14,000 for layers, $13,000 for heifers, $10,000 for broilers, and $6,000 for swine. The cumulative annual cost for all CAFOs to obtain permits would be $326 million.

[23] The 10 percent figure was calculated by comparing the gross market value of agricultural products sold, as reported in the 2002 Census of Agriculture, with an estimate for the gross market value of sales by the 12,700 animal feeding operations identified by EPA as satisfying the definition of a CAFO. The aggregate sales value for these CAFOs was calculated using assumptions about the number of CAFO farms and the sales value per farm from EPA's economic analysis of its proposed revisions to the NPDES regulations.

Table A-1. Number of CAFOs by Sector and Farm Production Region

Farm Production Region	Swine	Dairy	Broiler	Beef	Layer	Heifer	Turkey	Veal	Other*	Total
Alaska/Hawaii	2	6	0	2	3	0	0	0	---	13
Appalachia	1,194	216	383	5	45	0	63	0	---	1,906
Corn Belt	2,418	190	47	230	237	52	91	5	---	3,270
Delta	124	47	557	0	70	0	43	0	---	841
Lake States	755	506	29	62	58	97	56	11	---	1,574
Mountain	41	404	0	281	21	142	22	0	---	911
Northeast	161	661	175	10	174	0	39	0	---	1,220
Northern Plains	531	77	0	963	24	29	13	0	---	1,637
Pacific	18	894	24	77	127	110	47	0	---	1,297
Southeast	101	194	738	1	273	0	35	0	---	1,342
Southern Plains	64	204	199	309	130	42	16	0	---	964
United States	5,409	3,399	2,152	1,940	1,162	472	425	16	392	15,367

* Horses, ducks, and AFOs with fewer than 300 animal units that are designated as CAFOs by the regulatory authority.

Source: Environmental Protection Agency, *CAFO Final Rule Technical Support Documents*.

a. Horses, ducks, and CAFOs with fewer than 300 animal units that are designated as CAFOs by the regulatory authority.

Figure A-1. U.S. Farm Production Regions

Source: U.S. Department of Agriculture.

Chemical Use. The industrial use of chemicals is heavily regulated in the United States. The Emergency Planning and Community Right to Know Act requires individual firms to report their production, use, intended releases, and unintended releases of 666 different chemicals and chemical categories. The Resource Conservation and Recovery Act establishes a set of "cradle-to-grave" regulations governing the storage, use, and disposal of chemicals defined as hazardous waste. If a firm's past use of chemicals is found to have contaminated the surrounding environment, it can be held liable for the cleanup costs under the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund). Fortunately for farmers, each of these regulations explicitly exempts on-farm use of pesticides and fertilizer. Nevertheless, EPA indirectly regulates on-farm chemical use through its guidelines for registering individual pesticides and fertilizers, and their allowable uses.

The Toxic Substances Control Act (TSCA) requires EPA to register new chemical fertilizers before they can be sold on the market to ensure that, when used properly, they will not harm humans or the surrounding environment. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) serves a parallel purpose by requiring EPA to register each agricultural pesticide and to approve the manufacturer's directions for when, where, and how it can be applied. Before a new pesticide can be sold on the market, EPA must first certify that the pesticide will not harm human health or impose unreasonable risks to nontarget species. The

same certification process is required to register an existing pesticide for a new crop or a new geographic area. EPA also periodically reregisters older pesticides to ensure that they meet current standards. The federal registration process imposes a minimum standard on farmers' use of pesticides in the sense that the states can impose additional restrictions on the use of federally registered pesticides.

Regular exceptions to the FIFRA registration process are allowed to address local pest emergencies. Subject to EPA approval, an individual state can temporarily register additional uses for a registered pesticide or use an unregistered product. For example, during October 2006, the California Department of Pesticide Regulation had 10 different emergency exemptions in effect. EPA has also created a special "critical use exemption" for the fumigant methyl bromide. This ozone-depleting gas was originally scheduled to be phased out by 2005 under the Monterey Protocol. Carpenter, Gianessi, and Lynch (2000) estimated that a complete ban on methyl bromide would have cost tomato growers approximately $90 million per year, based on the alternatives available in the year 2000. Since then, growers have been able to leverage this potential burden to slow the phaseout process. Farmers who grow tomatoes, strawberries, peppers, and other crops that rely heavily on the fumigant continue to receive critical use exemptions (EPA 2006a). Each year, individuals or groups can apply for a critical use exemption by demonstrating that there is no technically and economically feasible alternative to the pesticide. In 2006, EPA's cumulative allocation of permits was equivalent to 32 percent of the baseline quantity applied in 1991 (EPA 2006a).

Wildlife Habitat. Unlike the regulations on air pollution, water pollution, and chemical use, federal laws aimed at protecting wildlife habitat do not give farmers preferential treatment. The Endangered Species Act (ESA) prohibits "taking" threatened and endangered species, where "taking" is defined broadly to include virtually any action that would harass, harm, or kill a species. Like any other private landowner, a farmer can be prosecuted for actions that harm endangered species—even if those actions would be considered normal farming activities. In addition, if a farmer's land is classified as "critical habitat" for a species, the farmer may be prohibited from performing certain farming activities, without receiving any financial compensation. The presence of an endangered species can also limit registered pesticide uses. According to EPA's Office of Pesticide Programs, 24 states have at least one county with additional limitations on pesticide use designed to minimize harm to threatened and endangered species. For example, farmers in Dubuque County, Iowa cannot ground apply methyl parathion within 20 yards of critical habitat for the endangered Iowa Pleistocene Snail.

The Migratory Bird Treaty Act (MBTA) is another federal statute regarding wildlife habitat. Its provisions are similar to the Endangered Species Act in that it prohibits anyone from "taking" migratory birds, their eggs, or their nests.[24]

While there does not appear to have been any systematic effort to estimate the aggregate cost to farmers of the Endangered Species Act and the Migratory Bird Treaty Act at the national level, there have been a few case studies. For example, the Fish and Wildlife Service has fined farmers who have killed grizzly bears in order to protect livestock. Likewise, during the 2001 growing season, irrigation flows to farmers in Oregon's Klamath River Basin were curtailed in

[24] The courts have split on whether intent is required for farmers to be liable for the deaths of migratory birds poisoned by pesticides. For references to specific court cases, see the National Association of State Departments of Agriculture Research Foundation (2000).

order to provide more water for endangered sucker and Coho salmon fisheries. The cumulative value of the subsequent crop losses was estimated to be $59 million (Burke 2002).

The regulatory approach taken by the Endangered Species Act and the Migratory Bird Treaty Act has been widely criticized for providing landowners with perverse incentives. By essentially penalizing them for providing wildlife habitat, the two statues give farmers an incentive to destroy habitat and to kill endangered species before their presence can be verified by the Fish and Wildlife Service. This incentive would have been mitigated somewhat by a bill to reauthorize and amend the Endangered Species Act (H.R. 3824), which passed the House of Representatives in 2005. The controversial bill was supported by developers and farm lobby groups because it introduced an amendment to compensate private landowners for any decrease in land value resulting from actions taken to protect endangered species. However, H.R. 3824 also included amendments that would have weakened the government's authority to protect species. For example, the bill removed provisions protecting threatened species and added an exemption for "takings" of species that result from the use of FIFRA-registered pesticides. Not surprisingly, H.R. 3824 was strongly opposed by environmental groups. Although the bill ultimately failed to pass the Senate, it seems likely that policy debate on the Endangered Species Act will continue, given the perverse incentives created by the current legislation.

Farm Bill Compliance Provisions. As a precondition for receiving payments under most farm bill programs, farmers must first satisfy minimum standards for conservation of any wetlands or Highly Erodible Land (HEL) on their property. This precondition applies to price support programs, income support programs, and all of the voluntary conservation programs. Overall, farms participating in these programs represent 86 percent of U.S. cropland (Claassen and others 2004). The original motivation for the three compliance provisions—Conservation Compliance, Sodbuster, and Swampbuster—was to counter the incentive created by price support programs to bring environmentally sensitive land into production.

The Conservation Compliance and Sodbuster provisions seek to reduce soil erosion on HEL by requiring farmers to adopt conservation plans that reduce erosion rates. Conservation Compliance applies to HEL brought into production before the 1985 Food Security Act; Sodbuster applies to HEL brought into production after the 1985 Food Security Act. Of the two provisions, Sodbuster is stricter. It requires farmers to reduce erosion rates to the soil loss tolerance level, *T*, which represents the maximum rate of erosion that will allow soil productivity to be maintained indefinitely (Claassen and others 2004). In contrast, Conservation Compliance allows higher erosion rates in areas where reducing erosion rates to *T* would make farming unprofitable. The "Swampbuster" provision makes farmers ineligible for current farm program payments if they grow crops on a wetland converted after 1985. In addition, farmers can lose the right to all future payments if they convert existing wetlands into crop use.

There are four limitations to the actual burden imposed on farmers by the compliance provisions. First, while a large share of cropland is technically subject to the provisions, less than a third of U.S. cropland consists of HEL and wetlands. Second, farmers who do not collect farm program benefits have no incentive to comply. For example, if a farmer collects only price support payments, the farmer may have no incentive to comply during a period when market prices exceed the target price. Third, the 1996 Farm Bill introduced a series of changes to the compliance provisions, making them easier to satisfy. These changes included: granting farmers flexibility in how they develop and implement conservation plans; allowing them to "self-certify" their own compliance; giving farmers a year to correct any deficiencies noticed by

USDA field staff who provide technical assistance; making it easier to satisfy the "good faith" provision that decreases the size of penalties for farmers who violate compliance provisions unintentionally; making it easier for farmers to offset wetlands conversion by enhancing existing wetlands or creating new wetlands; and removing crop insurance from the list of farm program benefits that can be withheld for violating the provisions (GAO 2003).

The final limitation to the actual burden imposed by the compliance provisions is that evidence on enforcement is mixed. The Natural Resource Conservation Service (NRCS) is the agency responsible for enforcement. NRCS selects farms for compliance checks and then reports violations to the Farm Service Agency, which is responsible for withholding farm program payments. While NRCS indicates that compliance is higher than 98 percent, a recent review by the General Accounting Office questions the accuracy of this figure (GAO 2003). The GAO review concludes that nearly half of the NRCS field offices do not follow the prescribed enforcement procedures. For example, 36 percent of NRCS offices do not always check for wetlands violations during a compliance review and 19 percent do not always report a farmer who is in violation for failing to implement a required conservation practice. GAO also finds that the procedure used by NRCS to select farms for compliance checks "disproportionately emphasizes tracts with little or no potential for noncompliance, such as permanent rangelands," which account for 20 percent of all farms sampled. Perhaps most notable is GAO's observation that the Farm Service Agency and other outlets for the appeals process waived penalties for 61 percent of the violations that NRCS reported between 1993 and 2001, reinstating 79 percent of the farm program benefits that would have been withheld. Overall, the total value of payments withheld during the entire nine-year review period was only $12.4 million. Either the program has enjoyed near-universal compliance or enforcement has been lax.

Summary of Environmental Regulation. Current laws addressing air pollution, water pollution, and the use of toxic chemicals implicitly or explicitly exempt all but the largest confined animal feeding operations from federal regulation. Together, these exemptions give farmers the right to discharge unlimited quantities of pesticides, fertilizer, and animal waste produced as a byproduct of normal farming operations. Only a small share of the largest animal feeding operations—less than 1 percent of all farms—is required to obtain federal permits in order to discharge into U.S. waters. The authority for regulating emissions from the other 99 percent of farms is delegated to the states, which mostly rely on voluntary programs or simply exempt farmers from state regulations that apply to other nonpoint sources.

This leaves three federal regulations with the potential to constrain farmers' land management practices: EPA's pesticide registration program, endangered species legislation, and the compliance provisions of the farm bill. However, for most farmers, the actual burden imposed by these regulations appears minimal. Cancellation of a key pesticide certainly has the potential to decrease profits for farmers who depend on it. But the larger the economic burden, the greater the likelihood of a special exemption. The Endangered Species Act also has the potential to impose a regulatory burden on farmers by prohibiting normal farming practices that harm threatened or endangered species. The high profile conflict in the Klamath River Basin has drawn attention to this issue. But there appear to be few comparable examples. Finally, while the farm bill compliance provisions have the potential to penalize farmers for converting wetlands or farming highly erodible cropland, these regulations apply to farmers who are currently receiving payments from farm bill programs, and enforcement has been limited by provisions of the 1996 Farm Bill and an appeals process that waives penalties for most violations.

Production agriculture clearly faces less environmental regulation than other sectors of the economy. Nevertheless, some growers are regulated more heavily than their counterparts in other countries. Compared to the United States, developing countries tend to place less emphasis on protecting the health of pesticide applicators and wildlife populations, which may put domestic growers at a competitive disadvantage in international markets. For example, the Monterey Protocol allows Mexico and other developing countries to implement a slower phaseout of methyl bromide. Meanwhile, China has not committed to reduce its use of the fumigant. If continued gradual reductions in the domestic use of methyl bromide increase the price of U.S. strawberries and tomatoes, domestic growers may lose some of their share in international export markets to their competitors in Mexico and China (Carter and others 2005).

Any near-future expansion in the environmental regulation of U.S. farmers seems likely to be targeted toward the largest animal feeding operations. Increased concentration in the livestock industry has provoked EPA to rewrite its wastewater permit regulations to include more CAFOs, and to investigate the possibility of monitoring their air emissions. While no new regulations have been finalized, CAFO owners are already facing increased scrutiny, and it seems probable that at least some owners will soon have to develop waste management plans that satisfy EPA. While there is also considerable interest in amending the Endangered Species Act, recent discussion has focused on changing the incentives for private landowners to reward them for providing habitat.

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