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Reforming Agricultural Nonpoint Pollution Policy in an Increasingly Budget-Constrained Environment

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ABSTRACT: Agricultural nonpoint source water pollution has long been recognized as an important contributor to U.S. water quality problems and the subject of an array of local, state, and federal initiatives to reduce the problem. A "pay-the-polluter" approach to getting farmers to adopt best management practices has not succeeded in improving water quality in many impaired watersheds. With the prospects of reduced funding for the types of financial and technical assistance programs that have been the mainstay of agricultural water quality policy, alternative approaches need to be considered. Some changes to the way current conservation programs are implemented could increase their efficiency, but there are limits to how effective a purely voluntary approach can be. An alternative paradigm is the "polluter pays" approach, which has been successfully employed to reduce point source pollution. A wholesale implementation of the polluter-pays approach to agriculture is likely infeasible, but elements of the polluter-pays approach could be incorporated into agricultural water quality policy.

■ INTRODUCTION

"Gentlemen, we have run out of money. It's time to start thinking." Ernest Rutherford (1871−1931)

Agricultural nonpoint source (NPS) water pollution (i.e., pollution that reaches receiving waters through diffuse and complex pathways) has long been recognized as an important contributor to U.S. water quality problems and the subject of an array of local, state, and federal initiatives to reduce the problem.[1] A crucial feature of these initiatives is that they rely heavily on a "Pay the Polluter" (PTP) approach[2] through which financial and technical assistance to farmers are used to encourage and support voluntarily adoption of pollution controls.[3]

It has been well established that agricultural NPS policies are not having the desired outcomes. While some water quality metrics have improved in some agriculturally influenced watersheds,[4] others have deteriorated[5] and, more generally, outcomes remain far short of established water quality goals.[6,7] The sector remains largely unregulated for water quality protection, and is a leading cause of continuing, and sometimes worsening, U.S. water quality problems.[3,6,8,9] Agriculture's role is particularly important for some of the nation's most important water resources (the Chesapeake Bay, the Gulf of Mexico, and the Florida Everglades) where agricultural nutrients have damaged major fisheries and ecosystems.[6,10,11] Policy reforms to improve agricultural pollution management

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are clearly necessary if water quality goals are to be attained.[12−15]

It is also well-known that existing agricultural NPS policies are not making the most effective use of the resources devoted to water quality protection.[15−18] This is a particularly important public policy concern given the historical reliance on financial assistance (i.e., subsidies), at a time when expenditures for environmental and other public goods are under substantial pressure in the search for solutions to large structural budgetary imbalances at federal and state levels. Congress cut over $500 million from U.S. Department of Agriculture (USDA) conservation programs in FY 2011, which have been the dominant vehicle for subsidizing agricultural BMPs, and additional large cuts are expected in 2012 and beyond.[19,20] Policy reforms that improve cost-effectiveness must be a priority for continued progress in managing agricultural NPS pollution.

We explore reforms to increase the environmental performance and reduce the cost of agricultural NPS pollution policies. We begin with a discussion of features of current policies that limit their cost-effectiveness. These features have received attention in prior literature, but not with concern for their implications in an increasingly budget-constrained policy environment. We present reforms within two paradigms. The first involves replacing the current PTP approach with approaches consistent with the "polluter pays principle" (PPP), in which polluters are expected to bear control costs.[21−23] Application of the principle has been variable in practice, with polluters in some sectors (e.g., municipal wastewater treatment facilities) receiving some public assistance for implementing mandated pollution controls. But agricultural NPS programs, which do not typically involve mandates requiring installation of costly agricultural NPS control practices, are at the PTP end of a PPP-to-PTP spectrum. The PPP paradigm is not costless for public agencies and society,[24,25] but it would reduce budgetary challenges inherent in the PTP approach.

The second paradigm modifies the existing PTP approach to enhance its impact and cost-effectiveness within a budget-constrained environment. The modifications could facilitate a transition from the current fiscally unsustainable PTP approach to a fiscally sustainable PPP paradigm, given that high political transactions costs associated with fundamental institutional change reinforce the status quo.

■ AGRICULTURAL NONPOINT POLICIES: BACKGROUND

Agricultural pollution policies are a mosaic of federal, state, and local initiatives. Some are modeled on the nation's earliest agricultural soil and water conservation policies. However, contemporary water quality initiatives are largely determined by the 1972 Clean Water Act (CWA) and subsequent amendments, which define the regulatory framework and the context for point source (PS) pollution (i.e., pollution is discharged directly into receiving waters from the end of a pipe or ditch) and NPS pollution control in U.S. surface waters.[3,26] We therefore begin our discussion of current policy with the CWA.

The Clean Water Act. A key feature of the CWA is that it allocates authority for PS and NPS control between federal and state authorities. The CWA made PS pollution control a federal responsibility, though it allowed for the delegation of this authority to the states. PS controls are implemented through the National Pollution Discharge Elimination System (NPDES) that requires point sources to comply with technology-based effluent limits. Each point source discharger must obtain a discharge permit before it can discharge to surface waters. Under federal regulations, large concentrated animal feeding operations (CAFOs) that discharge directly to surface waters though a pipe or ditch are treated as point sources and must obtain NPDES permits.

The CWA allocated control of NPS pollution to the states. This is of fundamental importance to the management of the nation's water quality problems because NPS pollution is by far the greater form of agriculture's water quality impacts.[1,8,27] With some exceptions, the states have generally opted for voluntary compliance strategies for agricultural NPS control, supported to varying degree by state and federal programs for technical and financial assistance for agricultural BMP adoption.

USDA Conservation and Water Quality Programs. The CWA names the USDA as the primary federal source of financial and technical assistance to reduce agricultural NPS pollution (though not mandating such assistance be provided). While the USDA has a long history of assisting farmers to improve soil and water conservation, water quality has only recently become a mission objective of USDA conservation programs. Soil erosion to conserve soil productivity was the defining mission of USDA conservation efforts from their inception in the 1930s until the 1990s. In 1988 only 7% of the cost-share assistance from the Agricultural Conservation Program (ACP) was devoted to water quality-related issues, while 71% went to erosion control. By 1995, ACP funding for water quality had increased to 37%,[28] reflecting growing concerns about agriculture's contribution to water quality impairments.

Currently, the USDA administers several programs that pay farmers to adopt practices that reduce polluted runoff from cropland. The largest working land program is the Environmental Quality Incentives Program (EQIP) with current annual funding of US$1.3 billion. From 1997 through to 2004, 37% of EQIP funds were spent on water quality and water conservation-related practices; another 28% were spent on managing livestock manure nutrients, which are a major source of water pollution.[28] EQIP is a popular program with farmers, with demand exceeding available funds. In 2008, more than $487 million in requests for EQIP funding—equivalent to roughly 50% of what was actually spent—went unfulfilled.[29] Other USDA programs that can have positive water quality impacts include the Conservation Reserve Program (CRP) and the recently implemented Conservation Stewardship Program (CSP). The CRP is the largest USDA agri-environmental program in terms of budget, and water quality benefits are one factor (along with other environmental and nonenvironmental concerns) that is considered when choosing cropland to enroll into the program. However, first and foremost CRP operates as a land retirement program (converting cropland to grassland or forest), with water quality and other environmental outcomes being ancillary benefits. Research has shown it to be a very blunt and inefficient tool for addressing water quality objectives.[30]

A long-standing issue for USDA programs is a failure of technical assistance to keep pace with increases in financial assistance. Effective use of financial assistance requires USDA or third-parties to provide adequate technical resources to facilitate the proper design and implementation of funded practices. Expenditures for financial assistance increased 500% between 1985 and 2006, whereas expenditures for technical

assistance increased only 60%, largely due to caps imposed by the Office of Management and Budget (OMB).[31] Current resource allocations within the conservation programs may be limiting overall program effectiveness even without budget constraints on direct financial assistance for BMPs.

The billions of dollars provided to farmers in the form of financial and technical assistance over the years ($13 billion from EQIP alone since 2002)[28,32] have been associated with some improvements in soil conservation and water quality. Studies in the Upper Mississippi Basin, Chesapeake Bay, and Great Lakes show that agricultural conservation practices have reduced nonpoint source loadings.[12−14] However, the same studies also conclude that significant amounts of cropland are still in need of improved nutrient and soil management for water quality protection.

Water quality improvements would likely be greater if funding levels were increased. But it is not clear that this would be a good investment, as traditional federal conservation programs have serious weaknesses as cost-effective water quality programs. One weakness is that USDA programs have multiple environmental and nonenvironmental goals (e.g., farm income support), so only a portion of their sizable expenditures are directed at high priority water quality issues.[30] A second weakness is that resources allocated to purchasing environmental improvements are poorly targeted, either by design or through legal requirements.[33] A well-targeted program would direct resources to attaining specific, measurable water quality goals through the most efficient means possible, that is, through activities that realize these goals at lowest cost. Effective targeting would prioritize hot spots (e.g., particular watersheds and possibly locations within them) and BMPs to achieve the proverbial "biggest bang for the buck".[34] Current USDA programs are not designed to do this. Program goals include reaching as many farmers as possible, and treating them equally.[35] With some exceptions, Congress has prohibited geographic targeting in EQIP, as geographic targeting is seen as favoring farmers in one region over those in another. In exceptional cases, Congress has created special programs to address specific watersheds, such as the Chesapeake Bay.[36]

Finally, because programs are voluntary, water quality benefits tend to be supply driven rather than demand driven. That is, farmers propose contracting for conservation practices based on their own self-interest (however interpreted), and not on society's demands for environmental quality. Farmers tend to be well informed about agri-environmental problems, and most hold very favorable attitudes toward the environment and perceive themselves to be stewards of the land.[37] But, like any business in a highly competitive economic environment, the realities of economic survival drive firms to minimize production costs.[38−41] This means that farmers are likely to propose practices that yield both public and private benefits (i.e., addressing resource concerns on the farm) or that do not significantly affect their financial bottom line, rather than costly practices that may yield large public benefits (e.g., downstream water quality improvements) but no private benefits. The consequence is that voluntary PTP programs can only offer limited water quality improvements, particularly given limited program budgets and the requirement that farmers are treated equally. A successful and efficient PTP approach would require differentiated payment rates that are high enough to entice all farmers to participate and to adopt the most socially desirable (demand driven) water quality practices. This would be enormously expensive given the improvements still needed to attain water quality goals.

State Water Quality Programs. As noted previously, the CWA gives the states the primary responsibility for nonpoint pollution controls. Early on, states developed nonpoint source programs almost exclusively around voluntary approaches, supported by some cost sharing.[30,42] Voluntary approaches have generally not provided the level of protection required to achieve water quality goals.[43] In recent years, some states have developed programs that contain nonvoluntary elements. The most common mechanism is technology standards.[30] States apply this approach either uniformly across the state, or targeted to specific geographic areas. Laws directed at crop production generally allow voluntary adoption at first, with a regulatory backup. Enforcement is generally triggered by citizen complaint.[43]

Perverse Incentives Arising From Non-Environmental Agricultural Programs. While federal programs and significant federal resources are devoted to agricultural NPS pollution control, it is important to understand that some nonenvironmental federal agricultural programs inadvertently work in opposition to federal, state, and local efforts to reduce agricultural NPS. Specifically, these programs may create incentives that adversely affect the nature, size and spatial distribution of agricultural externalities, diminishing the return on pollution control investments, and ultimately straining conservation program budgets.[44−51]

For instance, policies that increase producer prices without restricting output (such as price floors, subsidies on farm output or on related products such as ethanol, and price-enhancing import restrictions) encourage farmers to increase production. Adverse impacts occur when environmentally sensitive lands are converted to agricultural production, and when inputs with potentially harmful environmental effects (for example, pesticides, fertilizers, irrigation water, and fossil fuels) are used more intensively. Input subsidies can also encourage more intensive use of potentially harmful inputs, either because these are subsidized directly or because subsidies on other inputs encourage increased production and greater use of all inputs.[50,51]

Parallel reasoning suggests supply controls would be environmentally beneficial by reducing input use, but this need not be the case. For example, acreage restrictions may lead farmers to substitute relatively harmful inputs for land (e.g., higher fertilizer applications on land remaining in production).

Although the adverse environmental effects of agricultural commodity and input policies were first demonstrated more than twenty years ago, the use of such policies continues. A compelling recent example is federal support for ethanol production, which has resulted in higher corn prices globally. In turn, U.S. corn production—a major source of nutrients entering the nation's waters—has intensified. Some of this additional production has come from land which would otherwise be in the CRP. Higher corn prices attributable to the U.S. ethanol policy are estimated to reduce acres offered into the CRP by about 5%.[52] In addition, about a third of acreage currently enrolled in the program would likely opt-out to take advantage of higher corn prices if there were no penalties for doing so.[52] Increased corn acreage in the Midwest is estimated to increase nutrient loading to the Gulf of Mexico.[53] Global emissions of greenhouse gas likely have also increased as ethanol policies have created global changes in cropland use.[54]

REFORMS UNDER THE POLLUTER PAYS PRINCIPLE

In this section we sketch the essential elements of an agricultural NPS policy regime that is intended to promote the cost-effective achievement of water quality goals, and that is also consistent with the PPP. While the PPP is often endorsed primarily on ethical grounds (i.e., that it is fair or just for those who are responsible for pollution to bear the costs of remediation), societal interests in achieving water quality goals cost-effectively are compelling in a budget-constrained environment. The PTP can only attain water quality goals if governments are willing and able to tax citizens or reallocate public funds to purchase sufficient water quality improvements. The nearly 40 year history of agricultural NPS programs suggests such improvements are unlikely to materialize. Given the increasing sharp competition for limited government budgets, there is no reason to believe the future effectiveness of current policy structures will differ. In contrast, the PPP approach does not depend on public expenditures to purchase water quality improvements. Indeed, some PPP options are revenue generating. For example, fees on fertilizer and pesticides have been applied in several European countries.[55]

The potential economic and environmental benefits of a PPP approach go beyond untying the knot between environmental outcomes and public spending. An important example comes from research comparing the economic and environmental impacts of pollution charges (e.g., implemented via administratively determined fees or determined in tradable permit markets) and pollution reduction subsidies.[56,57] A key finding is that, while pollution reduction subsidies can be designed to provide individual producers with the same marginal pollution control incentives as pollution charges, they may create adverse incentives for the product composition, scale, and location of production. Specifically, because subsidies lower production costs—particularly for practices or lands that place water resources at risk—they may create incentives for producers to increase the scale of production, or maintain production in environmentally sensitive locations, thus mitigating environmental improvements.[44,58,59]

Selecting Among PPP Instruments. A large menu of policy instruments can be used to address agricultural NPS pollution within the PPP approach. The merits of alternative approaches are explored in a number of studies.[18,60−63] We summarize some key lessons based on two criteria: (i) instruments should produce the desired water quality impacts; and (ii) instruments should promote cost-effectiveness.

The first criterion, relating to an instrument's capacity to achieve water quality goals, seems obvious, but experience shows that choosing instruments that actually achieve these goals is not a trivial matter.[57] Adopting the PPP approach helps in this regard because, rather than voluntary participation, the policy options all include enforceable requirements (e.g., mandates may require some reduction in pollution loads, or perhaps farmers may be required to pay a fee to pollute). Moreover, unlike the PTP approach, policy choices under the PPP are not conditional on program budgets. Absent participation or budgetary constraints, the only remaining consideration under the PPP is that instruments be set at levels that can produce the desired water quality outcomes. More stringent water quality are expected to generate larger abatement costs. Hence, the policy focus under the PPP turns to cost-effectiveness, our second criterion.

A policy instrument can be judged to be cost-effective if it minimizes the social cost of achieving a water quality goal. There are several dimensions of cost-effectiveness. At the farm level, cost-effectiveness refers to minimizing the costs associated with a particular farm's environmental performance. This notion is important, but it is incomplete. A broader notion is cost-effectiveness at the watershed level, also known as *allocative efficiency*. Allocative efficiency, which subsumes farm-level cost-effectiveness by requiring each farm's environmental performance be attained at minimum cost, promotes adopting different environmental performance goals for different farms so as to minimize costs over the landscape. Spatially differentiated performance goals promote cost-effectiveness when these farm-level goals adequately account for the spatial variation in each farm's abatement costs and water quality impacts.[34,64−66]

Theory and experience suggest the following lessons for making agri-environmental instruments more cost-effective.[60,62] First, successful policies are *performance-based*, that is, they are designed to encourage effort to improve a specific environmental performance measure rather than simply to encourage expenditures on problems or to encourage the adoption of particular pro-environment technologies. Performance-based policies may include limits or taxes based on indicators of environmental stress, and markets for trading pollution allowances (with enforceable requirements placed on agricultural sources, unlike current point-nonpoint trading programs). Note that *actual* NPS emissions generally cannot be measured with certainty, due to their diffuse and random nature. Therefore, feasible indicators of environmental stress must be highly correlated with emissions, such as an emissions *estimate* derived from a computer model.

A second lesson is that successful policies target producers differentially based on their ability to address environmental problems, thereby promoting allocative efficiency. Regulations that target producers who either are incapable of producing significant environmental impacts or can only do so at very high cost will be ineffective or waste resources.

Finally, successful policies provide producers flexibility in how to meet performance goals. Flexibility allows producers to make use of specialized knowledge in their individual circumstances to achieve performance goals more cheaply than rigid regulations, and encourages environmentally beneficial innovation.

Other Considerations: Ancillary Benefits and Costs. A final consideration for instrument design and evaluation is ancillary benefits and costs. Ancillary impacts of an instrument may be environmental or economic. Consider environmental impacts. Agriculture is a source of multiple externalities, not just water pollution. Some are detrimental, like odors and air pollution. Some are beneficial, like carbon sequestration, wildlife habitat, and landscape amenities. An ideal PPP policy regime would utilize separate instruments to compensate agriculture for the good and to penalize agriculture for the bad. The combination of these penalties and payments would provide a suite of incentives that optimize agriculture's market and nonmarket services.[67] The balance of payments to or from a producer would reflect the net social value of the externalities at the particular time and location. We emphasize that reducing a negative externality, though beneficial for people and ecosystems, would not be positively compensated in a PPP world.

Alternative Models: The PPP Approach Applied Outside the U.S. The PTP approach to agricultural NPS control is found in varying forms in other developed countries, and can be explained by similar political, cultural, and historical factors as those in the U.S.[63,68−70] But notable applications of PPP instruments also exist.

As noted above, several European countries levy environmentally based taxes on pesticides and fertilizers. Belgium and the Czech Republic tax ammonia emissions from large-scale animal operations.[55] Germany, Denmark and The Netherlands control animal manure via mandatory rules governing manure handling and land application, and stocking densities.[69,70] The Netherlands has also experimented with manure markets and taxing surplus nutrients, but now complies with the European Commission's Nitrate Directive via technology-based regulations.[70] The Nitrate Directive primarily protects against agricultural nitrate pollution. The UK initially responded to the Nitrate Directive with a PTP approach that compensated farmers through voluntary contracts for actions to reduce nitrate pollution risks. This has subsequently been replaced by a PPP approach: farmers in designated Nitrate Vulnerable Zones are given mandates on the type, quantity and timing of applications of inorganic fertilizer and organic manure.[69] This change expresses a distinct shift in societal expectations of "good farming practices" and farmers' environmental obligations.

A particularly interesting policy innovation is Environment Waikato's (New Zealand) water quality trading (WQT) program, initiated in 2010 to control agricultural nutrients entering Lake Taupo. WQT for nutrient pollution that includes agricultural sources has also been implemented in several U.S. locations. Although there are several factors that have led state environmental authorities to adopt WQT programs (with the support and encouragement from the U.S. EPA), expanding the scope of water pollution controls to agricultural nonpoint sources, and improving the cost-effectiveness of water quality protection have been key objectives.[18,71] There are two main differences between the Lake Taupo program design and those in the U.S. First, the U.S. programs include both municipal and/or industrial point sources of nutrients as well as agricultural, whereas the Lake Taupo program only includes agricultural sources. Second, the U.S. programs are "partially capped", with only voluntary participation from agriculture. That is, point sources must comply with enforceable permit requirements, whereas farmer participation is voluntary and serves largely to reduce the cost of point source compliance.[72] This feature has been a key factor undermining the performance U.S. WQT programs.[18,71,73] In contrast, the Lake Taupo design is a fully capped program with explicit binding permit requirements for farmers.[72]

■ IMPROVING POLICY PERFORMANCE WITHIN THE PTP PARADIGM

It is probably unrealistic to expect imminent, widespread adoption of the PPP principle as a response to the challenges of achieving nonpoint pollution reduction goals even with the increasingly constrained budgets that will likely dominate conservation and agri-environmental policy in the future. Adopting the PPP principle would require significant changes to the institutional structure, entailing high political transactions costs.[74] Nor is the elimination of distortionary farm payment programs likely. Barring such radical institutional reforms, how might programs be modified within the existing framework to generate significant water quality improvements with fewer federal and state resources? We propose as key elements of more modest reforms; (i) tying instruments to explicit, measurable changes in environmental performance, rather than to the installation of BMPs; (ii) improving instrument design (better payment mechanisms and targeting); (iii) improving the integration of water quality programs with farm commodity and other farm programs to increase the resources available for water quality protection and reduce perverse incentives; and (iv) adding modest PPP reforms in the overall PPP-PTP mix

Replace Practice-Based Payments with Performance-Based Payments. The first reform is to tie instruments to the achievement of explicit, measurable performance goals (performance-based instruments), rather than to the installation of BMPs (practice-based instruments). Current water quality policy sets the stage for establishing explicit, watershed-level goals for agricultural nonpoint source pollution. Specifically, Section 303(d) of the Clean Water Act requires states to develop total maximum daily loads (TMDLs) for water bodies that do not meet designated uses even with point source NPDES compliance. Over 46 000 TMDLs have been developed, addressing about 64% of impairments listed by the states.[75] A TMDL establishes the maximum amount of a pollutant that a water body can receive and still meet water quality standards. It also specifies how the overall pollutant load is allocated among the various sources, including nonpoint sources. This allocation defines the total allowable load from each source class (e.g., the agricultural sector). Accordingly, the TMDL is an environmental objective or goal, not a firm-level regulation. This is an important distinction, as cost-effectiveness requires both an environmental goal and an efficient regulatory approach for achieving the goal. States are permitted to adopt traditional voluntary (PTP) approaches or other approaches to attain NPS-related TMDLs. There is ample evidence that practice-based instruments policies tend not to be as cost-effective as performance-based instruments for pollution control because they overly limit producers' flexibility to choose cost-effective production and pollution abatement options.[26,54,57,60,62,76] In contrast, performance-based instruments give farmers flexibility to choose how to improve their environmental performance, and to do so at minimum cost, where performance is defined in terms of the NPS abatement goals of the TMDL. The ideal performance-based compliance measure is a farm's contribution to the externality (e.g., nutrients or sediment entering and impaired water). But such performance-based measures are problematic for agricultural NPS emissions for at least two reasons. First, NPS emissions are hard to measure accurately and routinely at reasonable cost because they result from diffuse and complex processes that occur over landscapes. Second, NPS emissions are difficult for farmers to control with any level of certainty, as NPS emissions, being driven in large part by weather and other environmental conditions that fluctuate over time, are often highly random. These two features also generally prevent accurate inferences about individual farm contributions, particularly for the large number of potential contributors that are often characteristic of agri-environmental problems (e.g., even a small watershed may contain thousands of farms).

Where environmental performance cannot be measured directly, compliance measures may be based on performance indicators that are constructed from farm- or field-specific data (e.g., estimates of field losses of fertilizer residuals to surface or

ground waters).[60,62,77] This approach is exemplified by WQT programs involving agriculture that have been developed in the U.S. and Canada. The programs trade nutrient reduction credits generated by adoption of BMPs or conversion of crop land to riparian buffers. Credits are calculated based on computer models or other procedures to estimate long-run average annual reductions in nutrient loadings from farms.[73,78]

Designing policies to achieve outcomes implies a shift in the PTP model, from one that directly subsidizes practice installation or land use change, to one that "pays for performance." The concept is one of increasing interest in agri-environmental policy, although current incarnations—which we refer to as "performance-related"—differ somewhat from our proposed "performance-based" payments. The U.S. CRP program is a performance-related program where the enrollment decision, rather than actual payments, relates to performance. Specifically, the Environmental Benefits Index (EBI) is used to calculate the "expected" environmental benefits of a farmer's bid for program participation, where the bid consists of specifying lands to be retired and the ensuing practices to be adopted on those lands (i.e., investments to convert those lands to an alternative use, such as planting trees or grasses) (for more on the enrollment process, see the *Competitive Bidding* section below). The EBI, however, does not calculate the estimated environmental impacts of practices for particular farms, as the scoring system is the same regardless of a farmer's location relative to environmental concerns. The CRP program is also not the best U.S. example of a performance-related program for water quality. Water quality-related variables are considered in the CRP, but explicit water quality outcomes are not.

The Conservation Stewardship Program (CSP) is a USDA financial assistance program that bases payments, as well as enrollment, on a performance-related scoring system.[79] To participate, farmers and ranchers must, at minimum: (1) have already addressed at least one resource concern throughout their farm and (2) agree to address at least one additional USDA-defined priority resource concern during the 5-year contract term. CSP pays participants based on a scoring system that relates practices to environmental performance − the higher the score, the higher the payment. New activities receive a higher payment rate than existing activities, creating incentives for landowners to provide more conservation than a simple cost-share approach. However, the CSP's scoring system is similar to the EBI, in that practice-based scores are calculated the same regardless of a farmer's location relative to environmental concerns.

Nutrient WQT programs are truly performance-based water quality programs. These programs are essentially designed to facilitate the purchase of nutrient pollution reductions from agricultural nonpoint sources by municipal and industrial point sources.[72,73] Each trade is contracted separately and must be designed to ensure the point source's NPDES permit requirements are reasonably expected to be satisfied. Hence, performance is a key element of WQT programs.

Improve Instrument Design: Payment Mechanisms and Targeting. The second reform is to improve the design of water quality instruments for agriculture within the pay-for-performance PTP paradigm that we recommended above. Specific mechanisms for making performance payments generally fall into one of two categories: performance subsidies, or performance contracts. We will describe this and their merits below. For both types, allocative efficiency is enhanced by targeting the incentives spatially to induce the greatest farm-level performance improvements in locations where these improvements are relatively inexpensive and have a relatively large environmental impact.[34] As noted previously, the impacts of agricultural operations on water quality, and the lowest cost strategies for reducing agricultural NPS pollution, will vary over the landscape.[37,80] Given a limited budget for environmental payments, efficient targeting likely will require first identifying priority watersheds, and then targeting funds within those watersheds.[34] Each payment mechanism and the associated targeting choices are described in turn.

Performance Subsidies. We define a performance subsidy as a payment per unit of improved performance, as defined by the chosen compliance measure. This mechanism sets the "price" of performance (the subsidy rate), and then allows farmers to choose their level of supply. A larger supply nets farmers a larger total payment. Farmers therefore have incentives to find the least cost approach to improving their compliance measure, with the overall level of performance chosen to equate the marginal cost of provision with the subsidy rate.

As participating farms already have incentives to improve their individual compliance measures at least cost, allocative efficiency is promoted by spatially differentiating subsidy rates to reflect locationally distinct environmental impacts. Specifically, larger subsidy rates would be applied to locations where a given change in farm-level compliance corresponds to greater environmental impacts. This ensures farms having a greater ability to generate environmental gains also have greater incentives to provide them.

Allocative efficiency is also affected by the baseline from which changes in compliance are calculated. The simplest approach is to pay farmers for each unit of improvement relative to historical performance levels. However, this approach has been shown to result in farmers being paid more than their compliance costs.[81] These excess payments benefit farmers, but they reduce society's ability to pay for water quality benefits. More benefits are obtained if baselines differ from historical levels, so that farmers are only paid for some of their improved performance. This approach means farmers will pay for initial performance improvements, but they will still participate as long as the total payments exceed their total compliance costs. The key is to set baselines so that excess payments are limited. Adopting stringent, differentiated baselines also limits participation to only the most efficient providers of water quality benefits, so as to make the most of limited program budgets.[82]

The standard criticism of targeting is that it is unfair to "discriminate" against certain producers based on their geographic location. But it is unfair to taxpayers, and it is transparently poor public policy, to pay producers for practices that do not generate water quality improvements cost-effectively. Tying policies to performance goals will help address the standard criticism, while at the same time providing a mechanism for evaluating program success and for updating programs to improve performance.

Performance Contracts (Competitive Bidding). Whereas performance subsidies invite farmer responses to a government-set price for environmental improvements, performance contracts involve the government responding to farmers' offers to provide environmental improvements. Specifically, farmers simultaneously offer (or "competitively bid") a level of performance and also state their required

compensation level. The managing agency then chooses among the bids to find the most efficient allocation, given their budget. Farmers who seek "excessive profit" from their offer risk being outcompeted by other bidders. Accordingly, farmers have incentives to provide improvements at lowest possible cost, and to not bid much higher than this cost.

Three USDA conservation programs have used or are currently using competitive bidding to reduce costs and/or to increase cost-effectiveness. Cost-benefit bidding is a feature of the CRP and the CSP. As the enrollment processes are similar, we describe CRP enrollment. A farmer wanting to enroll in the program submits a bid to the local USDA field office, during a specified enrollment period, stating how much land would be enrolled and the management practices on the enrolled land (rather than a proposed quantity of farm-level performance), and a rental rate (i.e., compensation price). All submitted bids are ranked by USDA on the basis of their EBI score and their cost. Bids are accepted until the acreage goal, rather than a budget goal or performance objective, is met (CSP operates according to a budget and/or acreage goal). Farmers can improve the chance of inclusion by reducing the rental rate they are willing to accept, or by proposing to implement certain management measures on enrolled land to boost their environmental score (such as planting trees rather than grass). Several studies have concluded that the bidding process has increased the CRP's cost-effectiveness[82,83]

Prior to 2001, competitive bidding was also a feature of EQIP. Farmers could improve their chances of receiving a contract by offering to implement a practice (again, rather than a performance quantity) for a lower price than the maximum payment rate. Between 1996 and 2001, strong competition for enrollment resulted in payment rates being much lower than maximum rates because of aggressive bidding for contracts.[77] Competitive bidding was eliminated in 2001 because it was deemed unfair to limited resource farmers, who could not compete with larger farms in the bidding process. We should emphasize that the former EQIP bidding, though economically meritorious, is not the environmental performance-based bidding program that we are advocating.

Bidding alone, even if performance-based, does not ensure allocative efficiency; the "right" producers have to bid, and they have to bid the right amount. A particular problem is that bids are "lumpy": once the bidding process is closed, new producers cannot volunteer and participants cannot change their contracted performance levels in response to changing economic or environmental conditions. Bidding does have an advantage over performance subsidies, however, when it comes to differential treatment of farmers. As mentioned previously, setting differential subsidy rates and compliance baselines may be challenging both legally and administratively (e.g., there may be significant heterogeneity among thousands of farmers even within "small" watersheds). In contrast, performance-based enrollment screens used in competitive bidding represent a simpler way to ensure that producers who receive higher payments also supply more environmental benefits.[77] Factors such as location in a watershed, proximity to other "protected" land, and permanence are all factors that could be considered in the bidding process to increase the allocative efficiency of conservation expenditures

Improve Farm Program Integration. Agricultural programs serve a variety of goals. We have noted that program implementation to serve these goals is at times counterproductive, with commodity programs increasing the cost and reducing the effectiveness of conservation and water quality protection programs. Reforms to reduce conflicts and to leverage limited budgets to serve multiple goals should be a high priority.

Conservation Compliance,. which essentially leverages farm commodity program payments to serve environmental goals, is the most obvious and least radical form of integration. Presently, compliance requires farmers to implement soil conservation practices on highly erodible land and refrain from draining wetlands if they are to remain eligible for selected Federal agricultural program benefits. Compliance provisions were introduced in 1985 to counteract the negative environmental effect of increased production under commodity programs. There is strong evidence that these provisions have been effective in reducing erosion on farms receiving government program payments, and in slowing the draining of wetlands.[84]

Compliance provisions could be expanded to cover other environmental issues. Farm program benefits subject to compliance, including farm commodity, disaster, and conservation programs, ranged from $8 billion to $27 billion between 1997 and 2007.[85] Roughly 86% of U.S. cropland is on farms that receive Federal program payments subject to current compliance requirements. Thus, compliance could provide leverage in addressing any agri-environmental issue that applies largely to land in crop production. Expanding compliance to address nutrient runoff and leaching from cropland could force many farmers to consider the adoption of practices that reduce nutrient losses from their fields. Claassen et al.[84] estimated that 75% or more of cropland acres with medium, high, or very high potential for nutrient runoff or leaching are located on farms that receive government payments. Their analysis also shows that the value of these payments generally exceeds the cost of addressing nutrient loss through either on-field nutrient management or the installation of vegetative buffers. A drawback of compliance provisions is that they only affect farms receiving commodity payments. This means that most producers of fruits and vegetables and livestock and poultry would not be covered. Another consideration is that as farmers have to comply with more and more environmental performance requirements, the total costs of compliance increase, and the incentive provided by program payments is reduced. Indeed, compliance is unlikely to be effective as a standalone program for this reason, and also because compliance provisions generally are not well targeted to environmental problems.

Green Payments. A more radical approach to integrate income support programs with water quality programs would be to substitute "green payments" for commodity payments in farm income support. Farm payments have averaged about 20% of net cash farm income since 2000.[84,86] Switching income supports from commodity production to environmental services provision could serve to reduce policy conflicts and increase the resources for environmental protection, provided the payments do not generate conflicting incentives, such as inducing increased or more intensive production on environmentally sensitive or marginally productive lands. A variety of options for the design of an integrated program to achieve the suite of environmental, conservation, and income support objectives have been proposed. We do not dwell on the details, but we do endorse the general concept as a way to address fundamental tensions in the existing design of farm policy and to address the budget-imposed constraints on agricultural

nonpoint pollution reductions within the existing PTP policy paradigm.

Under a green payments program, program eligibility would not be confined to farms that currently receive program payments, so income support and conservation effort would be spread more broadly across the farm sector.[87] Current commodity and conservation programs reach different groups of farmers. In 2004, only 6% of farms received payments from both programs. Only 43% of conservation program payments went to farms that also receive commodity program payments. Most commodity payments go to large, commercial farms, while most conservation payments go to smaller, rural residence farms where farming is considered a secondary occupation.[87] Integrating the two programs could therefore significantly alter the distribution of payments across farms.

Add Modest PPP Reforms in the Overall PPP-PTP Mix. Beyond reforms to the traditional PTP approach that we have suggested, there are some "minimal" PPP elements that are both appropriate and conceivable if budget constraints limit what can be achieved through the PTP approach. Modest regulation of farming practices to prevent harmful practices in environmentally sensitive locations in watersheds with significant or chronic water quality problems would serve environmental goals within public budget constraints. Several states are already taking this approach, such as Maryland to meet the Chesapeake Bay TMDL and Nebraska to protect drinking water aquifers. Ideally, performance-based measures would be used to encourage farmers to take appropriate management measures, provided farmers understand how their actions affect the compliance measures and provided farmers reasonably expect enforcement. The use of compliance rewards schemes could also enhance compliance rates with limited budgetary sources.[88] This is an approach in which farmers are rewarded for good environmental practices if inspected, but penalized if found to be underperforming. Research indicates compliance rewards can be more effective in increasing overall compliance with environmental standards than up-front payments, particularly when farmers are risk-averse.[88]

In the U.S. and Canada, water quality trading (WQT) involving agricultural sources is an example where the government has encouraged point sources to pay farmers to reduce their nutrient emissions. As described above, agricultural sources participate in existing U.S. WQT programs on a voluntary basis, with point sources contracting with farmers to reduce NPS pollution. Unfortunately, few trades have been generated. Switching from a partially capped to a fully capped system, with enforceable NPS requirements chosen to satisfy TMDL requirements (rather than relying solely on historical NPDES permits), may increase the likelihood of trades that both improve water quality and cost-effectiveness.[89] NPSs may have to pay for some improvements under this approach, but they could be compensated for other improvements, possibly realizing a net gain if they are a net supplier of emissions reductions.

DISCUSSION

Traditional approaches for addressing water quality problems from agricultural NPS pollution have not yielded the pollution reductions needed to achieve established water quality goals. Nor have they achieved the water quality improvements that could be expected from the resources that have been devoted to the problem. We argue that it is time for significant institutional change to address the problem, especially given that increasingly tight state and federal budgets will likely severely limit public funds for subsiding BMP implementation in the future. We present reforms within two paradigms. The first involves replacing the current PTP approach with approaches consistent with the PPP. The PPP paradigm is not costless for public agencies and society, but it would largely eliminate budgetary challenges inherent in the PTP approach and would allow innovations in policy that would increase the effectiveness of agricultural NPS programs. The second paradigm modifies the existing PTP approach to enhance impact and cost-effectiveness within a budget-constrained environment. Key elements of these more modest reforms are (i) tying instruments to explicit, measurable performance goals, rather than to BMPs; (ii) improving instrument design (better payment mechanisms and better targeting); (iii) improving integration of water quality programs with farm commodity and other farm programs to increase the resources available for water quality protection and reduce perverse incentives; and (iv) adding modest PPP reforms in the overall PPP-PTP mix. The modifications could facilitate a transition from the current fiscally unsustainable PTP approach to a fiscally sustainable PPP paradigm, given that high political transactions costs associated with fundamental institutional change reinforce the status quo. While the undesirable characteristics of subsidies for environmental improvement are not eliminated during the transition (incentives for landowners to continue production when they otherwise might not), their impacts would be reduced.

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