Linkages Between Agricultural and Conservation Policies

Workshop Proceedings

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These are the summary proceedings of a workshop held on June 10-11, 2003, in Portsmouth, New Hampshire.

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LINKAGES BETWEEN AGRICULTURAL AND CONSERVATION POLICIES

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Preface

Farmers and landowners in general face an increasingly complex array of public regulations and programs that influence their decision making. Some of these regulations and programs may reinforce one another in terms of their goals and the incentives they provide, while others operate at cross purposes. We in fact know relatively little about how these programs and regulations interact, and sorting out their net effects on the behavior of landowners is critical for evaluating and fine-tuning these public interventions.

The Northeast Regional Center for Rural Development, in partnership with the USDA's National Research Initiative-Competitive Grants Program and the Economic Research Service, the University of Delaware, and the Northeastern Agricultural and Resource Economics Association, co-sponsored a workshop on "Linkages Between Agricultural and Conservation Policies," to begin to address this gap in knowledge. This proceedings document presents the results of research conducted to date and presented at the workshop, as well as challenges that remain in this subject matter area for researchers and policymakers.

This publication is the third in a series of workshop proceedings related to land use commissioned by The Northeast Center. The two earlier publications represent proceedings from the workshops on "Protecting Farmland at the Fringe: Do Regulations Work?" in 2001 (RDP No. 7) and "Conserving Farm and Forest in a Changing Rural Landscape" in 2002 (RDP No. 11). Both of these publications are available on The Northeast Center's website, along with many other resources on land use.

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Executive Summary

Linkages between agricultural and conservation programs have become an important aspect of research on policies' effectiveness. As policymakers have sought to provide income support for the farm community, to decrease any negative effects of farm practices on the environment and to respect trade agreements, they have begun to explore incentive-based programs aimed at achieving all three goals. On the other side, regulations have been implemented such as those from the Clean Water Act, that impact a farmer's management decisions. Farmers are faced with a myriad of programs and regulations which they must take into account. Complementarities and conflicts in the incentive and regulatory motivations underlying these programs may provide opportunities to improve programs or may result in unintended consequences.

This publication summarizes the proceedings of the 2003 Northeastern Agricultural and Resource Economics Association (NAREA) workshop, "Linkages Between Agricultural and Conservation Policies," held June 10-11 in Portsmouth, New Hampshire. The workshop sought to generate new research on policy linkages, to provide a forum for disseminating ongoing work, and to inform policymakers of various issues and remaining challenges. Individuals from academia, government agencies, and private institutions attended the workshop.

Invited presentations encompassed a range of topics, from positive and negative attributes that farming and farmland provide to society, (aside from food production) to the different types of policies that have been implemented in recent years. Several presenters suggested ways in which researchers could ensure that their analyses incorporated attributes of the ecosystem as well as farmer behavior. By incorporating more realistic physical ecosystem processes into analyses, the authors suggested, research results would be more useful and relevant to policymakers. Given the multiple interactions between programs and regulations, researchers can provide valuable information to policymakers about which pairings are complementary and which are conflictual and on how this information can be incorporated into the development of policies to ensure that the objectives of all the programs are achieved.

Selected papers focused on four main areas:

(1) The interaction between agricultural land preservation and conversion with quality of life in rural areas and farm income support and conservation programs
(2) Policies and methods to combat nonpoint-source pollution
(3) Interaction between regulations, incentive-based payments, and environmental improvement
(4) Linking environmental improvements to "green" cash payments

The presented papers used different approaches and methodologies to derive the following research results:

- The current farm income support programs are not the most effective way of providing positive public goods from farms since these attributes are

not linked to commodity production, and they are not an effective method of avoiding negative externalities since production could be intensified with the current commodity programs.

- As the U.S. increases its budget for resource conservation, program administrators need to determine the best methods to allocate this money – either based on achieving the highest environmental benefits, ensuring equity between different regions of the country, or using the least cost land/practices. Efficient management of conservation programs may be difficult but could have high payoffs.
- Some of the difficulty in management derives from the spatial heterogeneity and the temporal variability of agriculture and ecosystems. In addition, high management costs might decrease farm owners' ability to learn and implement conservation practices.
- Owners of agricultural land near cities substitute federal commodity programs for permanent state preservation.
- Conversion of agricultural land to other uses was found to be lower in areas with higher agricultural employment and higher sales per acre.
- Coordination between two programs was demonstrated to increase net benefits if both affect the decisions involving the last unit of pollution controlled. Farmers were paid by both programs to do the same thing or were permitted to "double-dip."
- Uncertainty about costs and benefits relative to agricultural and conservation programs was found to change the efficiency of certain methods used to achieve non-point pollution control because people reacted differently. Taxes were found to work better than price and quantity controls for nitrate pollution. Standards were more effective when farmers also could participate in income support programs than when they did not participate in these programs.
- Incentive-based programs can help mitigate the unintended consequences of regulations.
- Long-run net economic benefits are higher for farmers who use conservation tillage than for those who use conventional tillage.
- Performance-based (connected to an environmental change) programs would be more efficient than practice-based programs.
- When the adoption of more environmentally sensitive practices would lead to net economic benefits for farmers, but farmers are skeptical of these benefits, programs offering larger incentives over shorter time horizons can accelerate the rate of adoption more cost-effectively.
- Green payments can actually encourage farmers to expand cultivated acres or to intensify their production on existing acres. This has the potential to worsen environmental quality.
- Benefits per dollar expended criteria are more efficient than practice-based criteria for deciding who should be enrolled in a conservation program. Also, even though conservation practices may have multiple benefits, when they are complementary, targeting only one of them can work well as an enrollment strategy.

Discussions during the workshop revealed the strengths of the current research and the challenges remaining for economists who examine agricultural and conservation policies. Workshop papers demonstrated the breadth of possible findings:

- Complementarities and conflicts between programs have been identified and methods are suggested to effectively deal with these interactions.
- Bio-physical models are permitting researchers to look at potential environmental changes when conservation practices are utilized.
- An increasing number of research projects are demonstrating that using criteria based on environmental benefits achieved per dollar spent is most efficient.
- Green payments' effects on farmer behavior and environmental impacts are being examined with recommendations forthcoming.
- Different scenarios for conservation policies in development stages such as the conservation security program and other practices are being examined and the results are being disseminated.

Remaining challenges for the research and policy community include the following:

- Understanding how much society is willing to pay for environmental improvement from the agricultural community.
- Developing methods by which to include the public's wish for environmental improvements in the selection criteria for conservation programs.
- How to incorporate the economic behavior of farmers and ecosystem models in a comprehensive and useful fashion to generate better policy recommendations. Multidisciplinary work is essential.
- Determining the best methods for allocating the limited budgets for these programs, given ecosystem properties such as threshold effects.
- How to incorporate non-marginal changes in farmer behavior or ecosystem processes into the analyses.
- Understanding and incorporating into the design of programs the political dimension, and understanding its effects on efficiency.
- Incorporating how and to what extent transaction costs may affect the net benefits of programs.
- Understanding at a deeper level what farmers are trying to do since evidence suggests they are not primarily maximizing profits. Risk and time limitations (such as the constraint working off the farm creates) need to be incorporated into the models.
- Collect and make widely available data at the individual farm level.
- Disseminate the research results widely and especially make them available and accessible to policymakers.

In addition to this Summary of invited and selected papers, workshop participants and speakers will also be submitting their manuscripts for a special issue of the *Agricultural and Resource Economics Review*, to be published in April 2004. This summary is being prepared and distributed by the Northeast Regional Center for Rural Development, a workshop sponsor.

I. Introduction

After moving toward a market-based approach in the 1996 Farm Bill, the U.S. reversed itself in the 2002 Farm Bill, increasing funding for agricultural commodity programs, which redistribute income to farmers. The bill linked some of the income support that farmers receive to their adoption of conservation practices that will improve environmental quality. Policymakers have become increasingly attracted to "green" payments linked to environmental objectives not only because of the increased concern about environmental quality in the U.S. but because of trade agreements that limit how income can be redistributed to the farm community. For example, trade agreements such as the General Agreement for Trade and Tariffs (GATT) and the current regulations of the World Trade Organization (WTO) state that farm income support strategies must have no or limited trade-altering side effects.

The 2002 Farm Bill, for example, includes provisions for reauthorized conservation programs (the Conservation Reserve Program, Environmental Quality Incentives Program, Wetlands Reserve Program, Wildlife Habitat Incentives Program, Farmland Protection Program) and new conservation programs (Conservation Security Program, Grasslands Reserve and Farmland Stewardship). Many have suggested that the linkages between agricultural policy and environmental policy will grow even more extensive in the future. The character of these policies is also evolving, focusing increasingly on environmental stewardship, sustainability, and the multi-functionality of agriculture in addition to the productive capacity of agriculture.

In addition, while many of these agricultural and conservation programs use voluntary incentive-based methods to encourage participation, farmers are also facing regulations from other environment policies, which may impact their management decisions and net farm incomes. The major federal environmental policies, notably the Endangered Species Act and the Clean Water Act, also impact farmers and increasingly expose the agricultural community to regulations made by agencies other than USDA. The institutional environment becomes even more complex when one considers that states also help to implement federal laws, have their own versions of federal laws, and have their own sets of agricultural and conservation programs affecting agricultural management.

Many research programs examine farmers' behavior related to a particular income support or conservation program. Yet farmers face a myriad of programs and regulations which they must take into account. There may be complementarities and conflicts in the incentive and regulatory motivations underlying these programs.

This publication summarizes the proceedings of the 2003 Northeastern Agricultural and Resource Economics Association (NAREA) "Linkages Between Agricultural and Conservation Policies" workshop, held June 10-11 in Portsmouth, New Hampshire. The workshop was organized by a committee comprised of Joshua Duke and Titus Awokuse (University of Delaware), Lori Lynch (University of Maryland), Stephen Swallow (University of Rhode Island), Robert Johnston (University of Connecticut), James Shortle and Elizabeth Marshall (Pennsylvania State University), and Roger Claassen (Economic Research Service). Individuals from academia, government agencies, and private institutions attended the workshop.

The workshop sought to respond to two emerging trends. First, farmers face an increasing complexity of voluntary programs and regulations. Program effectiveness is affected by its *attributes*, but it is also affected by farmer behavior – the *choice* to comply and the *choice* to participate. When agricultural management choices are made under many different rules and participation choices exist in many different programs, researchers and policymakers need to determine which policy or set of policies constitute the "binding constraint" rather than attribute the observed behavior to only one program. Differing behavior among farmers may be the result of the institutional environment, the characteristics of farmers and agricultural operations in various geographical areas, or other as of yet unidentified factors. Other possible explanations include the ease of participating in the programs, which is based on the availability and quality of the information about them, or the information gleaned from neighboring landowners or tenant farmers.

Despite the critical lack of published information regarding factors that influence choices among different agricultural conservation options, the trend in academia has been to evaluate these policies in isolation or to model conservation at a sufficiently general level that any single program might apply. Indeed, many researchers define their research programs according to the policies and problems they address (purchase of development rights, sustainability, hog waste, etc.). Yet many researchers have begun to address the issue of whether the programs conflict with or complement one another. The ongoing research and dissemination has begun to create a cohort of informed agricultural economists who conduct practical, micro-level analyses concerning farmers' choices to comply (or not comply) with regulations and to enroll (or not to enroll) in *packages* of agricultural support and agricultural conservation programs.

The workshop sought to generate new research, to provide a forum for disseminating ongoing work, and to inform policymakers of the various issues and remaining challenges. The specific goals included:

- To assess how conservation policies affect agricultural management;
- To provide a historical overview of existing policies, predictions for future trends, and a review of policy interactions;
- To develop a framework for research on the interactions among policies;
- To identify needs for advancing research in the area of policy interactions, including research gaps;
- To provide policy recommendations that consider possible interactions between programs to federal, state, and local decision makers to ensure better design policies; and
- To provide a forum for the sharing of ideas and collaboration.

Three invited presentations were made along with the presentation of ten selected papers. In addition to this Summary, these papers will be published as a special issue of the *Agricultural and Resource Economics Review* in April 2004. This summary was prepared and distributed by the Northeast Regional Center for Rural Development, a sponsor of the workshop. Other workshop sponsors included National Research Initiative (USDA), the University of Delaware, and the Economic Research Service (USDA).

II. Workshop Presentations

Invited presentations were provided by Drs. David Abler, JunJie Wu, and Erik Lichtenberg. These presentations encompassed a range of topics, from positive and negative attributes (aside from food production) that farming and farmland provide to society, to the different types of policies that have been implemented in recent years. Several presenters suggested ways that researchers could ensure that their analyses incorporated attributes of the ecosystem as well as farmer behavior. By incorporating more realistic physical ecosystem processes into analyses, the authors suggested, research results may be more useful and relevant to policymakers. Given the multiple interactions between programs and regulations, researchers can provide valuable information to policymakers about which pairings are complementary and which are conflictual and on how this information can be incorporated into the development of policies to ensure that the objectives of all the programs are achieved.

Abler begins with the generally accepted view that even though farming seeks to supply goods to society, it also provides us with other positive and negative public goods. He then considers whether the existing agricultural price and income support policies are the most efficient methods to obtain positive public goods and decrease negative public goods. Two key considerations are identified. First, it is important to account appropriately not only for ways in which costs and benefits are sent from agriculture, but also for how they are received by neighbors and the public in general. Second, we need a better understanding of the jointness of commodity production and amenity production.

Wu explores many of the issues in the development of conservation programs, including equity issues between regions, benefits per dollar expended, most appropriate targeting criteria, and what factors ought to be used to establish payments. He stresses the need to incorporate science such as ecosystem processes to ensure that optimal policies are developed. Wu offers several concrete examples of how results from natural science have been used to design cost-effective natural resource management policies through the use of targeting. Not surprisingly, policies that target cost-effectiveness do not look like current policies that seek voluntary participation from landowners defined by political boundaries such as counties or states.

Lichtenberg addresses the difficulties of designing effective programs due to spatial and temporal heterogeneity. He explores the trade-offs between different policy tools for different "pollution" problems. Lichtenberg's conclusions are somewhat pessimistic. We must understand, he argues, that there will not be technological "fixes" to all these problems. In many ways, agriculture has been and continues to be a struggle *against* nature.

The selected speakers spanned the breadth of research questions and analytic techniques illustrating the complexity of programs and regulations facing the agricultural community. We have devised four sub-groupings for their papers:

(1) What is the interaction between agricultural land conversion and preservation with agricultural commodity programs and the factors that push people out of the cities such as crime, traffic congestion, and unsatisfactory schools?
(2) What are the most efficient policies and methods to decrease the nonpoint-source pollution associated with agriculture?
(3) What are some specific examples of interactions between regulations, incentive-based conservation techniques, and environmental quality improvements?
(4) Can "green" payments, cash payments connected directly to approved conservation practices, result in improvements in environmental quality given multiple objectives and multiple programs?

Specific conclusions from invited and the selected papers are offered below. An overall conclusion that emerged from the presentations is that economic research in complex policy environments is both difficult and challenging. All the presentations offered insights as to how researchers systematically control for complexity in order to derive conclusions about behavior. Yet, the papers also offered glimpses of how quickly such analyses can become unwieldy, which in turn might explain the dearth of research on the topic. The selected papers, therefore, offer 10 original efforts to integrate existing theory in two traditional areas of study: agriculture and the environment.

A. Invited Presentations: Issues When Addressing Linkages Between Agricultural and Conservation Policies

Multifunctionality, Agricultural Policy, and Environmental Policy, David Abler

The primary function of agriculture is to supply food, fiber, and industrial products. However, agriculture can also be a source of several public goods and externalities. The term multifunctionality refers to the fact that an activity can have multiple outputs and therefore may contribute to several objectives at once. This paper is motivated by two questions. First, do agricultural price and income support policies promote multifunctional agriculture in an effective manner? Second, would policies targeted more directly at multifunctional attributes be more efficient than traditional price and income support policies?

Agricultural land can be referred to as "multifunctional" because it has multiple outputs – food production and scenic landscapes for example – achieving more than one society's desires at the same time.

The answer to the first question appears to be "no," at least for agricultural policies targeted at outputs (price supports, output subsidies, etc.). Available evidence indicates that public goods associated with agriculture are not linked to commodity production per se but rather to land use practices, agricultural structures, and perhaps farm household labor. The

Public goods associated with agriculture are not linked to commodity production per se but rather to land use practices, agricultural structures, and perhaps farm household labor.
David Abler

elasticity of supply of land to agriculture is low, so that changes in commodity outputs are accomplished primarily through changes in purchased inputs rather than changes in land. On the other hand, negative externalities associated with agriculture are linked to production to some degree, and have worsened significantly in recent decades as the intensity of production has increased.

Available evidence on the second question is more sketchy. Agricultural price and income support programs in developed countries carry high consumer and taxpayer costs and encourage socially costly negative externalities. However, they may economize on policy-related transaction costs compared to more complicated agri-environmental policies. It is relatively easy to transfer funds to farmers based on acreage or production, but more difficult to ensure that environmental or land management conditions are followed in return. More research is needed on whether policy-related transaction costs for agri-environmental programs could be reduced through selective targeting of farms subject to the programs.

Using Sciences to Improve the Economic Efficiency of Conservation Policies, JunJie Wu

Over the last 20 years, both public and private expenditures on resource conservation have increased dramatically. With the increasing use of conservation investments, a number of issues have been raised, including how conservation funds should be allocated among the geographic areas. Should funds be concentrated in fewer watersheds or rather distributed over a wider geographic area? Should funding priorities be given to areas with the worst environmental problems or to areas that have made some environmental improvements? What criteria should be used to target resources for conservation? Should we target least expensive resources or rather resources that are most vulnerable to environmental problems? Or should we use some other criteria? If we are paying for conservation, what should payments be based on? Should we pay for specific practices or rather some measure of environmental benefit? If a conservation practice generates multiple environmental benefits, how should we target resources for conservation? What are the economic, environmental, and distributional implications of alternative targeting criteria? In this paper, I review some of the recent work that addresses these issues. I show that threshold effects, ecosystem linkages, and spatial connection between ecosystems pose three major challenges to the design of conservation policies. Ignoring these complexities of ecosystems is likely to result in a substantial efficiency loss. While challenges are daunting for the efficient management of conservation investments, the payoff is potentially high when science is used in the design of conservation programs.

> Threshold effects in ecosystems, ecosystem linkages, and spatial connection between ecosystems pose three major challenges to the design of conservation policies. Ignoring these complexities is likely to result in substantial efficiency loss.
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> JunJie Wu

> While challenges are daunting for the efficient management of conservation investments, pay-off is potentially high when science is used in the design of conservation programs.
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Hard Truths about Agriculture and the Environment, Erik Lichtenberg

Agriculture is a form of resource extraction that involves harvesting biota under naturally occurring conditions. As a result, spatial heterogeneity and temporal variability

The sustainability of agriculture is limited by the fact that farming is largely a struggle to maintain agro-ecosystems in the face of countervailing ecological and evolutionary pressure.
Erik Lichtenberg

are ineradicable features of agriculture, persisting even in the long run. We explore the implications of these features for policies aimed at improving agriculture's environmental performance. The sustainability of agriculture is limited by the fact that farming is largely a struggle to maintain agroecosystems in the face of countervailing ecological and evolutionary pressure. New technologies featuring more precise application of inputs have the potential to reduce adverse environmental spillovers from agriculture but require more extensive, more sophisticated management to adapt them to spatial and temporal variations in production conditions. Farmers' adoption of these technologies is limited by the fact that management is expensive relative to inputs. Spatial heterogeneity and temporal variability make incentives preferable to direct regulation for reasons of economic efficiency as well as practicality. Subsidizing for environmental improvements can be subject to slippage. Administrative and targeting problems have rendered existing subsidy programs largely ineffective. Theory and experience suggest that pollution taxes should perform better than both subsidies for pollution reduction and direct regulation. Tax systems close to social optima should be feasible for many environmental problems, notably those arising from pesticides and soil erosion. Devising pollution taxes on fertilizer is more difficult. Interdisciplinary modeling of the linkages between agriculture and ambient environmental degradation is needed to provide a basis for improving policy performance.

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B. Selected Presentations:

1. Interaction Between Agricultural Land Preservation and Conversion with Quality of Life and Farm Income Support.

Agricultural land preservation and conversion issues continue to be important issues for researchers and policy-makers alike. Since factors affecting the decision to participate in a state land preservation program are not necessarily limited to local or state conditions, it is important to examine possible determinants such as federal subsidy and conservation programs as well. Agricultural land conversion results from a range of "push" factors such as crime, poor schools, and deteriorating housing that make urban living unattractive, and "pull" factors such as rural ambiance and a slower pace of life. Both local and state land-use policies and federal policies affect these factors. It is important to provide policymakers with the tools necessary to determine how they might alter these factors while the land continues to be agricultural. The effects of land use policies in place before development occurred need to be measured and considered in the creation of new policies.

The Effect of Federal Subsidies on Participation in State Farmland Preservation Programs,
Joshua M. Duke

Data on owner and land characteristics are used to analyze factors affecting participation decisions in Delaware's agricultural land preservation program, federal commodity programs, and federal conservation programs. Survey and public data are assimilated for 377 Delaware agricultural landowners, representing approximately 16.5 percent of the target population. Preservation program participation increases for farms with a higher number of acres, a preponderance of agricultural land use, higher sales, more farming hours worked, a preservation aesthetic, and owners' value of nature, but it decreases for farms closer to urban areas and poultry production. Participation decisions at the state level are found to be almost entirely independent of federal program participation. Yet, owners near cities and with parcels of low relative environmental quality tend to substitute federal commodity programs for preservation. In part, the complex policy environment may limit the effectiveness of programs seeking to preserve parcels facing the greatest development pressure.

> Landowners may be selecting programs that best reward, or at least do not penalize, the relative environmental quality of their land.
>
> Joshua Duke

Growth Equilibrium Modeling of Urban Sprawl on Agricultural Lands,
Randall S. Rosenberger and Yohannes Hailu

The conversion of agricultural land to other uses, especially when this conversion is essentially irreversible (such as conversion to suburban, commercial, and industrial uses), continues to be a significant social issue. Several factors are associated with the spatial pattern of agricultural land conversion, including household and firm migration. This paper develops a model for identifying and measuring factors associated with agricultural land conversion patterns. Our model simultaneously measures the effect of factors directly and indirectly associated with population and employment distributions over space and time, and subsequently the pattern of agricultural land conversion. An agricultural land conversion equation also identifies characteristics associated with the agricultural industry that enable agriculture to sustain itself in light of competing demands for its land base. We apply the model to county-level data for West Virginia. Changes in the density of population, employment, and agricultural land are measured from 1990 to 1999. Initial conditions are those from 1990. Several factors were found to be significant determinants of changes in population and employment densities over the specified time period. Change in agricultural land density was found to be greatest where larger densities of agricultural land exist and land is adjacent to larger urban areas. Counties with larger proportions of total employment in the agricultural sector and higher agricultural sales per acre had lower conversion rates, indicating that more viable agriculture resists losses of its land base. Our land conservation variable also was significantly associated with less conversion of agricultural land. The application of our model to a broader, more heterogeneous region would enable the measurement of the

> Counties with larger proportions of total employment in the agricultural sector and higher agricultural sales per acre had lower conversion rates, indicating that more viable agriculture resists losses of its land base.
>
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effect that various policies have on the patterns and rates of agricultural land conversion, potentially leading to the development of more effective and efficient policies.

2. Policies and Methods to Combat Nonpoint-Source Pollution

Programs might not achieve their intended results for a variety of reasons. They might overlap with other existing programs, causing countervailing effects, or there might be gaps between programs. Coordination of programs is essential to ensure the maximum efficiency and minimal redundancy (of payments for something the farmers are already being paid for). Another reason, which might be so obvious it is often overlooked or examined only conceptually, is the uncertainty about the costs and benefits of the program. Thus efforts to decrease the uncertainty about costs and benefits will assist in the design of more effective programs.

The Coordination and Design of Point-Nonpoint Trading Programs and Agri-Environmental Policies, Richard D. Horan, James S. Shortle and David G. Abler

Coordinating USDA and US EPA water quality programs provides gains only when the two programs jointly influence decisions – implying double-dipping – being paid twice (once from each program) for undertaking a particular combination of pollution control actions.

Horan, Shortle and Abler

Discussions of agricultural and environmental policy linkages usually focus on the impacts that agricultural price and income policies have on the achievement of environmental objectives. In this paper we address a related but different issue: coordinating USDA water quality initiatives with U.S. EPA or state water quality programs to cost-effectively address water pollution problems on a watershed-based scale. Specifically, we examine issues involving the coordination of input-based agricultural green payment approaches to water quality protection with the point-nonpoint trading schemes that are of growing interest to state water quality agencies. We examine how green payments may influence key design parameters (e.g., trading ratios) of point-nonpoint trading programs under alternate rules for how farmers may participate in the two programs. We also examine the potential gains from policy coordination and the distributional impacts of coordination under various rules.

Coordinating these agri-environmental incentive-based programs provides gains only when the two programs jointly influence decisions involving the last unit of pollution controlled. In the present case this implies that double-dipping – being paid twice (once by each program) for undertaking a particular combination of pollution control actions – is necessary to reap the benefits of coordination.

When the programs are uncoordinated, then double-dipping may or may not provide social net economic gains. Double-dipping will provide additional gains if the input-based policies are well-targeted because it is only under double-dipping that farmers make all of their production and pollution control decisions with the incentives of both programs in mind. Both farmers and point sources are better off under double-dipping in the well-targeted case. In fact, double-dipping actually transfers much of the agricultural subsidies to point sources. If the input-based policies are not well targeted, then a performance-based trading program provides better incentives. In this case it is better to prohibit double-dipping so that farmers face only performance-based incentives for their marginal choices. Of course, double-dipping may result in a substantially higher income transfer to farmers.

The Performance of Compliance Measures and Instruments in Nitrate Nonpoint Pollution Control Under Uncertainty, Nii Adote Abrahams and James S. Shortle

The economic performance of alternative instruments for nitrate nonpoint pollution control have been examined in several articles. However, a major gap in the nitrate nonpoint pollution control literature, as well as in the broader economic literature on nonpoint pollution control, is the lack of empirical findings on instrument performance that takes into account the substantial uncertainty about costs and benefits that exists in practice.

> Uncertainty about how producers will respond can be a very important factor in the choice between price and quantity controls for nitrate pollution from agriculture.
>
> Abrahams and Shortle

Whereas prior research on the choice of instruments under uncertainty is almost exclusively conceptual, our analysis is based on a simulation model that incorporates various sources of uncertainty. Public uncertainty about both economic and environmental variables is captured by the model.

We explore two aspects of the agricultural nonpoint nitrate pollution control problem: the choice between alternative bases, and the choice between price and quantity controls. We explore the relative performance of the alternative instruments with or without agricultural commodity and income support programs.

In both the "with" and "without" income support program scenarios, the tax instruments substantially outperform the standards. This suggests that uncertainty about producer responses can be a very important factor in the choice between price and quantity controls for nitrate pollution from agriculture. The tax on excess nitrogen substantially outperforms the fertilizer tax in the scenario with support programs, while the ranking is reversed in the scenario without support programs. The reason for the change in ranking has to do with the relative effects of the two instruments on the deadweight loss associated with the income support programs. Without income supports, a tax on fertilizer substantially outperforms an excess nitrogen standard. The fertilizer and excess nitrogen standards perform better in the scenario with income supports than the one without. The difference is the larger external costs and the extra dividend from reducing deadweight costs in the scenario with income support policies.

3. Interaction Between Regulations, Incentive-based Payments and Environment Quality Improvement

Incentives or carrots that encourage certain conservation behavior can mitigate some of the unintended consequences of regulations such as the nutrient standards EPA is imposing on large Animal Feeding Operations. Authors also suggest that performance-based criteria for payments, such as improvements in fish habitat, are more efficient than practice-based criteria such as installing a riparian buffer. When crop hydrologic nutrient cycles and fertilization inefficiency are included in a dynamic sense, conservation tillage is found to have net economic benefits to farmers.

A Carrot and Stick Approach to Environmental Improvement: Marrying Agri-Environmental Payments and Water Quality Regulations, Robert C. Johansson and Jonathan D. Kaplan

Funding for conservation practices on animal feeding operations (AFOs) and cropland through the Environmental Quality Incentives Program is scheduled to increase

> The impacts of regulations on animal feeding operations will be more pronounced in the livestock and poultry sectors in regions where there is relatively less cropland per ton of manure produced.
>
> Johansson and Kaplan

to more than $1 billion by 2005. In addition, the U.S. Environmental Protection Agency (EPA) has mandated nutrient standards for the largest AFOs. We describe these policy options in terms of agri-environmental "carrots" and regulatory "sticks," respectively.

The U.S. agricultural sector is likely to respond to these carrots and sticks in a variety of ways. Recent national-level studies by USDA, EPA, and FAPRI explore the implications of the new water quality regulations for animal production in the U.S. These studies predict adverse economic impacts for the regulated AFOs, improved water quality, and increased commodity prices. However, missing from the literature are analyses of how alternative approaches for improving water quality might interact across crop, livestock, and poultry sectors.

Our analysis suggests that impacts of regulation will be more pronounced in the livestock and poultry sectors in regions where there is relatively less cropland per ton of manure produced. As the willingness of crop producers to substitute manure nutrients for commercial fertilizer increases, we find smaller changes in commodity prices, quantities, and net returns in response to carrot and stick policies. However, as more animal feeding operations meet nutrient standards, the reverse occurs. Turning to the potential environmental impacts, our results suggest an overall improvement in water quality, but note the possibility of unintended consequences. There is the potential of increased nitrogen leaching to groundwater and increased discharge of sediment and pesticides to surface waters in some areas. We find that agri-environmental carrots have the potential to mitigate many of these unintended consequences, as crop producers are encouraged to adopt conservation practices.

> Agri-environmental "carrots" have the potential to mitigate many of the unintended consequences of the animal feeding operation regulations as crop producers are encouraged to adopt conservation practices.
>
> Johansson and Kaplan

Economic and Environmental Effects of Adopting Conservation Tillage Practices,
C.S. Kim, Stan G. Daberkow, Glenn D. Schaible and William A. Quinby

Many of the environmental externalities associated with agricultural chemical use involve transport processes such as leaching, runoff, erosion, and gaseous losses. Conservation tillage is widely promoted as a production management practice designed to enhance both economic and environmental conditions for agriculture. While the merits of conservation tillage practices in reducing erosion and runoff are well known, the effect of these practices on leaching and their groundwater quality impacts remains uncertain.

> The time paths of nitrogen fertilizer application and the stock of nitrates in groundwater are likely to be consistently greater with the use of conventional tillage compared to conservation tillage.
>
> Kim, Daberkow, Schaible and Quinby

This study used a competitive-dynamic model of nitrogen fertilizer use to evaluate the economic and environmental benefits of adopting conservation tillage practices. The model quantifies the social and private economic benefits associated with shifts from

conventional to conservation tillage practices, while accounting for the crop-hydrologic nutrient cycle and rates of fertilization inefficiency across tillage systems. The economic analysis accounts for changes in the stock of nitrates in groundwater, as well as aquifer thickness and the rate of nitrate discharge from the stock of nitrates in groundwater.

The model was applied to an irrigated, continuous corn-producing area in central Nebraska. Results reveal that the time paths of nitrogen fertilizer application and the stock of nitrates in groundwater are likely to be consistently greater with the use of conventional tillage, and that the present value of net economic benefits to the farmer is likely to be smaller compared to conservation tillage. Optimal rates of nitrogen fertilizer application are lower than observed rates; however, these results are understandable given that it appears that farmers do not account for the value of nitrates in irrigation water, and that the model does not account for the full risk and uncertainty that farmers face.

Potential Economic and Environmental Effects of Select Conservation Programs of the 2002 Farm Bill, John V. Westra, Julie K.H. Zimmerman and Bruce Vondracek

The proposed Conservation Security Program (CSP) in the 2002 Farm Bill may allow producers to be compensated for conservation practices that provide some positive environmental externalities to a watershed – "green payments." A computer simulation model was used to examine the relationship between agricultural practices under a "working lands" conservation program like CSP, a "land retirement" program like the continuous Conservation Reserve Program (CRP), water quality (nutrient and sediment loss), fish communities, and net farm income within two small watersheds. We used the Agricultural Drainage and Pesticide Transport (ADAPT) model to relate land use to calculated in-stream suspended sediment concentrations and then quantified the effects of suspended sediment exposure on fish communities. When CSP agricultural practices were implemented with selected land being enrolled in CRP, net farm income (NFI) (excluding potential CSP payments) declined slightly (1-3 percent) in both study areas, relative to current conditions. Including potential CSP and CRP payments caused NFI to increase by 8-9 percent relative to the baseline. We found a decrease in "lethal" concentrations of suspended sediment on fish in the coolwater watershed when conservation tillage and riparian buffers increased and nutrient application rates decreased to recommended levels (CSP scenario). However, while land use changes in the warmwater watershed decreased soil loss by nearly the same percentage as in the coolwater watershed, "lethal" effects on the targeted fish community remained unchanged. This difference between watersheds is likely due to differential tolerance to suspended sediment between coolwater and warmwater fish communities and differences in topography, runoff, and bank erosion between the two streams. These results highlight the need to use performance-based rather than practice-based payments when dealing with fisheries or biological communities. In one study area watershed, over $100,000 could be spent annually under the programs examined with no noticeable improvement in the targeted resource concern – the fisheries communities.

Programs need to use performance-based rather than practice-based payments when dealing with fisheries or biological communities.

Westra, Zimmerman and Vondracek

4. Green Payments: Linking Environmental Improvements to Cash Payments

There are two main reasons why agricultural policies are increasingly linked to environmental goals. The first is that agriculture's role in causing environmental pollution is being increasingly acknowledged. "Green payments," or payments to farmers for using more environmentally friendly practices in their operations, could help alleviate the non-point source pollution from agriculture. Some green payment programs are designed to maximize the number of acres enrolled, without taking into account the environmental benefit derived from each acre, while other programs seek to produce the most environmental benefit per dollar spent. Policymakers continue to experiment with both while considering how to determine who can participate. The second reason is that green payments permit income to be redistributed to farmers without violating our international trade agreements. Thus society is achieving two objectives. Supporting farm income and improving the environment while remaining committed to the international obligations the U.S. has incurred.

Simulating the Effect of a Green Payment Program on the Diffusion Rate of a Conservation Technology, Kenneth A. Baerenklau

Despite a significant amount of work on technology adoption theory and an ever-growing number of empirical applications, there has been surprisingly little research on the use of economic incentives to control the speed of adoption of conservation technologies. This is unfortunate because such research clearly would benefit the many federal, state, and local agencies that currently use cost-sharing arrangements to promote voluntary adoption of best management practices by agricultural producers.

This paper addresses this need by simulating the impact of a hypothetical green payment program designed to encourage Wisconsin dairy farmers to reduce the amount of phosphorus fed to their milking herds. Adoption of low phosphorus diets is thought to be an opportunity for farmers to save money on feed costs and reduce their nutrient loadings into the environment without suffering production losses; but phosphorus input levels remain relatively high and continue to cause environmental harm.

> A green payment program can accelerate learning and produce significant, permanent changes in behavior relatively quickly and for a reasonable cost.
>
> Kenneth Baerenklau

The simulations are based on a novel microeconomic model of rational choice under uncertainty that incorporates three key behavioral elements: risk preferences, endogenous learning, and peer group influence. Adoption decisions are cast in a sequential multi-period framework where each farmer learns about the impact of reducing phosphorus on his profits over time as he and his peers experiment with lower input levels after enrolling in the program.

The simulations show that a green payment program can accelerate learning and produce significant, permanent changes in behavior relatively quickly and for a reasonable cost. They also suggest that, compared with typical cost-sharing arrangements, shorter contracts offering larger incentives may be able to achieve load reduction targets more cost-effectively when learning plays an important role in behavioral change.

Are Green Payments Good for the Environment? Erik Lichtenberg

The 2002 farm bill authorizes a large increase in subsidies for conservation on working farmland. This paper examines theoretically whether such green payments actually result in improvements in environmental quality. We use a Ricardian land market equilibrium model to analyze the effects of two forms of green payments: fixed per-acre payments and reimbursements based on actual costs incurred. Fixed per-acre payments can induce farmers to expand intensively cultivated acreage. Environmental quality may worsen as a result. Reimbursements based on actual costs incurred can induce farmers to intensify cultivation as well as expand intensively cultivated acreage. Again, environmental quality may worsen as a result. While careful targeting can reduce some of these potential adverse effects, the basis for that targeting may differ significantly from common expectations. The analysis also underscores the potential for adverse selection problems, specifically, awarding green payments to land on which it would be profitable to implement conservation even without subsidies. In such cases, green payments are pure transfers with no effect on environmental quality. The potential for these selection problems makes targeting more difficult.

> Green payments, unless carefully targeted, could induce farmers to expand intensively cultivated acreage and environmental quality may worsen.
>
> Erik Lichtenberg

Alternative Green Payment Policies under Heterogeneity when Multiple Benefits Matter, Jinhua Zhao, Catherine L. Kling and Lyubov A. Kurkalova

This study addresses the question of how to design a subsidy policy that would offer payments to farmers in return for the adoption of conservation tillage when there are multiple benefits associated with its adoption. We also study alternative single-benefit targeting designs for such a policy. We develop a modified version of the environmental Lorenz curves to compare the targeting designs. The proposed methodology is applied to evaluate least-cost incentive payment policy schemes for the state of Iowa using simulations on about 13,000 National Resource Inventory (NRI) points. At each of the NRI points, the costs of adoption are evaluated using an economic-based conservation tillage adoption model, and the environmental benefits due to the adoption of conservation tillage are assessed using a physical process simulation model named EPIC.

> The choice of the best benefit-targeting design for a policy was found to depend on the substitutability of the multiple benefits that society sought and on the program's budget.
>
> Zhao, Kling and Kurkalova

Two targeting options are considered. The costs and environmental consequences of a practice-targeting policy design (which maximizes the acres of land in conservation tillage, regardless of their level of environmental benefits) are assessed and contrasted to those of a benefit-targeting policy design (which yields the highest amount of an environmental benefit per dollar spent). Carbon sequestration in agricultural soils, reduction of soil erosion by wind and water, and the reduction in nitrogen runoff are considered as possible targets for the benefit-targeting policy instrument. The practice-based instrument was found to provide high proportions of the four benefits relative to the policies that target the benefits directly, especially at the higher policy budget levels. Similarly, targeting one of the four benefits considered was estimated to provide high percentages of the other benefits as compared to the amounts of the

benefits obtainable if they were targeted directly. The choice of the best benefit-targeting design was found to depend on the substitutability of the benefits in social preferences and on the policy budget.

III. Continuing and Improving Economists' Contribution to Research and Policy Recommendations

The workshop sought to generate new research on the interaction between different types of programs and regulations, provide a forum to disseminate ongoing work, and to inform policymakers of the various issues and remaining challenges. Papers were selected that would help us assess how conservation policies affect agricultural production decisions, assess how existing policies have interacted in order to make predictions for the future, discuss some of the research gaps and ongoing challenges, and provide some recommendations to policymakers to help design more effective programs. The invited and selected papers as a body contributed to these objectives. At the end of the workshop, we concluded with a discussion on the challenges that remain for us as researchers and what additional information policymakers continue to need to optimally design both conservation and agricultural programs. Thus, while workshop participants acknowledged that research programs have progressed in addressing the interaction between different types of programs, there were significant gaps and limitations that we still need to overcome.

A. Strengths of Current Research – What Are We Doing Right?

The invited and selected presentations provided information that could improve economists' analyses of these issues and that could be used directly by policymakers to evaluate existing programs and better design new programs. The current body of research and policy analysis has incorporated much of the complexity of these issues:

> Many of the workshop papers examined how the conservation and regulatory policies at various levels affected farmers' management decisions. Conversely, several examined how the commodity programs affected farm practices with environmental implications. The work on these linkages demonstrates that certain policies can be complementary, working together to achieve the same goals and doing it more efficiently, and that some policies conflict, working against one another so that no goals are fully met. We can use these lessons to determine how to increase the complementarities between policies and avoid the conflicts, achieving more efficient outcomes. Complementarities might also include whether farmers can "double-dip" and receive two payments for doing the "same" thing. If programs coordinate and ensure that a farmer's incentives are aligned, then double-dipping can ensure that all the production and pollution control decisions farmers make fulfill the obligations of both programs.
>
> Economists have found models that look at ecosystem processes which permit incorporation of the effects society desired such as the changes in environmental quality rather than the changes in the level of input uses. Models include the Agricultural Drainage and Pesticide Transport Model (ADAPT) and Erosion-Productivity Impact Calculator (EPIC). These models

link farmer behavior to biophysical processes. This has been invaluable in understanding more about the impact of voluntary and regulatory programs on farmers' behavior and the role of these behaviors in environmental change.

Advances are being made in examining the efficiency of the programs in terms of achieving the highest environmental benefits given each dollar expended. Research has addressed several different types of methods to determine which type of landowner will participate. Characteristics of program techniques might include how easy it is to apply for enrollment and how well they might achieve the stated goals under a variety of observable and unobservable characteristics. Thus we can compare how the selection between different participants (or using a regulatory approach under which everyone must participate) and the use of green payments for practices or outcomes can affect goal achievement.

Three papers focused on green payments, which reward farmers for adopting conservation practices. The results find that green payments can accelerate the rate of adoption and, if targeted toward those areas with the least cost and highest environmental benefits, can be efficient. However, green payments may actually expand cultivated acreage, which in some cases can worsen environmental quality. Or, these payments may be simply an income transfer because payments are made to farmers who would have adopted these conservation practices even without a green payment. While they are an attractive policy instrument, some additional analysis may be warranted to determine how to use these targeted payments most effectively.

The workshop papers also demonstrate how researchers have not just been analyzing existing programs and conservation practices, but have been anticipating policy changes before they actually occur. For example, one workshop paper examined the implications of the Conservation Security Program. The regulations for this program have not yet been adopted. Thus policymakers can use the results to ensure an optimal design of the program. In addition, new inputs have been proposed to combat certain pollution sources. One paper examines how to encourage adoption of this new input, finding that large incentives for a shorter period of time might be more effective than smaller incentives for a longer contract period.

Researchers have evaluated ongoing programs and have been successful at convincing policymakers that certain alterations to the programs would make them more effective.

B. Challenges – What Can We Do to Do It Better?

While impressive, the workshop papers also illustrate some of the gaps and remaining challenges to the research profession:

Assessing what the general public desires in terms of environmental quality and amenities and how much it is willing to pay to achieve these things remains one of the ongoing challenges for economists.

Society may have multiple environmental objectives making it necessary to determine how to incorporate these in a meaningful way into an easy to apply

method of selecting program participants to ensure the highest overall benefits are derived for the environment. Given the multiple objectives, one needs to determine whether and how programs can efficiently achieve their goals given that policy instruments are limited.

Workshop participants recognize the need to develop models of ecosystem processes that move beyond the "edge of the field." These models need to consider the heterogeneity among landscapes. In addition these models need to capture the environmental changes that society finds important. For example, if farmers were to use manure in the most economically efficient way, a better environmental outcome might result. However, many of the existing models look at farm-level practices (practice-based criteria) rather than at the actual environmental outcome achieved (performance-based criteria). Economists need to collaborate with other disciplines to ensure that they are incorporating the environmental changes correctly. Depending on what the desired environmental benefit is – whether it is increased fish populations or improved water quality – policy analysts need tools that move the research off the farm into the actual ecosystem to be able to assess the changes and improvement that the general public and policymakers care about.

In addition, society often cares about multi-pollutants (or multiple benefits) but our models tend to focus on just one. In many areas, analyzing the effect of programs and conservation practices on nitrogen reductions has dominated the research and policy agenda because nitrogen has been a limiting factor. However, if farmers achieve reductions in nitrogen, then phosphorus might become the limiting factor. These potential adjustments require including multiple pollution sources in the model.

Given that programs often have limited budgets and thus cannot achieve the level of environmental changes and/or benefits that society desires, incorporating threshold effects in assessing environmental effects is very important. Because so many of our programs are voluntary and equity concerns result in offering the programs to multiple regions, one needs to demonstrate threshold effects to justify targeting resources to one area or to one watershed as being possibly the only method of attaining environmental improvements. For example, if nutrient enrichment must decrease by 25 percent in a watershed to have any impact on water quality and if that necessitates that 50 percent of the streams adjacent to cropland have riparian buffers, then one should put the entire budget into achieving this goal. If only 25 percent of the streams have buffers or only half of the required budget is spent in the targeted watershed, then the program would have little or no impact.

As a rule, economists have focused on marginal effects, answering questions such as how environmental quality will change for small changes in incentives, in crop prices, and in input costs. Yet, our focus on marginal effects may be too narrow, though technically accurate for the kind of changes society desires from these programs. We need to develop analytical tools that rigorously examine non-marginal changes.

Understanding the political issues of how and why agricultural and conservation programs are developed is also important. Research on the policymakers' and regulators' motives is essential. Given the complex policy environment, researchers need to increase their efforts to understand how policies are developed given multiple objectives, spoken and unspoken, from the various stakeholder groups.

Economists often assume that the transaction costs to implement and administer agricultural and environmental programs are negligible. Yet monitoring how and what farmers are doing and enforcing regulations or program requirements can be costly. The cumulative effects of these "costs" could be greater than the benefits our research predicts. It can also vary by the type of the program being implemented. Therefore, more analysis of these types of costs is needed to fully inform the policy process.

Several workshop papers found that there was "money left on the table." In other words, farmers are not using inputs as efficiently as they could and not achieving the highest net profit. Environmental policies, in some cases, have helped farmers "find" this money, overcoming the tendency to operate in a more costly way than was optimal. Thus one of the questions among the research group was "what are farmers maximizing?" Economists haven't been able to figure out exactly what farmers are including in their profit functions (or utility functions), whether it be weather risk, personal time constraints, the high cost of obtaining information on new environmentally friendly practices, or whether they are using more inputs like fertilizer as a way of over-insuring against the inherent riskiness of farming. In addition, we often do not observe the landowner behavior that research predicts. Thus, evaluating what we have left out and how to incorporate it is important if we are to achieve relevant policy implications.

Obtaining data at the individual farm level also continues to be a struggle. Researchers hope that farm-level surveys such as ARMS continue to be taken. Several would like to develop a protocol wherein university researchers can obtain access to this data more easily.

Several workshop participants suggest that one of the remaining challenges is to incorporate the role of off-farm work into the analysis. Many analyses have incorporated farm attributes into the decision to enroll in conservation programs. Yet the role of off-farm work for the farm family has not received as much attention. Given that many individuals work off the farm, they might have limited time to learn new conservation technologies or stop by the local USDA or soil conservation office to enroll in these conservation programs. A challenge is how to best disseminate information to farmers.

Society and researchers face many challenges in evaluating policy impacts and making policy recommendations, in fact we may never find the optimal policy or solution. However, we can evaluate and suggest changes that result in comparatively better solutions. As one of our participants advised, "Don't let the perfect be an enemy of the good."

C. Conclusions

Economists have been examining the linkages between conservation and agricultural programs in interesting and useful ways. They have also been communicating the information to policy-makers, generating changes in these programs. Given the continued interest in supporting the farm community and in improving environmental quality, these research and dissemination projects are essential. The advances in theory, modeling and analytical tools demonstrated at the workshop generate much optimism for continued success in analyzing these programs. The issues are increasingly complex given the on-going trade negotiations and the new knowledge of eco-system functions. While many questions remain unanswered and further work is definitely needed, the presentations at the 2003 NAREA Linkages between Conservation and Agricultural Workshop demonstrate the strides that the profession has taken and the level of knowledge that policy makers will have to assist them in the future in developing more efficient programs.

The overall sense of the workshop was that linkages are important and if ignored can bias the research results. Taking linkages into account has been difficult but several different methods were presented all of which incorporate the interactions between incentives, regulations, and behavior in useful ways. Participants stress the need for more accessible data and bio-physical models that go beyond the field edge so actual environmental changes can be incorporated. The need for additional interdisciplinary work was acknowledged.

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