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DESIGN OF A NATIONAL NONPOINT SOURCE POLLUTION CONTROL PROGRAM: IMPLICATIONS FROM RCWP

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Control of point sources of water pollution in the 1970's and early 80's was not sufficient to meet national water quality goals. Additional measures have been necessary to control nonpoint sources of pollution. Agriculture is generally recognized as the primary contributor of nonpoint source pollutants. (Nonpoint Source Task Force).

This paper discusses implications for the design of a national agricultural nonpoint source pollution control program, based on an ongoing economic evaluation of the experimental Rural Clean Water Program (RCWP). Specific results of the economic evaluation are presented to illustrate the points that we wish to make. Details concerning data, models, and estimation procedures are discussed by Bouwes and Young; Carvey; Crowder and Young; Erickson; and Gum, Magleby, and Kasal. We proceed with a brief description of RCWP and the projects that we evaluated, followed by a discussion of the implications for the design of future programs that evolved from our evaluation of RCWP. The economic evaluation of RCWP demonstrates that by targeting specific locations nonpoint source pollution can be controlled and that the benefits of control can exceed the costs if impairments to water use affect a sizable number of people and costs can be minimized through applying the most cost effective practices.

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Rural Clean Water Program

The experimental Rural Clean Water Program was initiated in 1980 to demonstrate the effectiveness of an agricultural nonpoint source program. Approximately $60 million was allocated to 21 projects. These projects were selected to represent the range of potential agricultural nonpoint source problems. Farmers choosing to participate in the program were eligible to receive cost share funds for implementing practices to reduce pollution runoff from their land. Cost shares for these "best management practices" (BMPs) could range up to 75% of eligible costs with a maximum of $50,000 per farm.

Five of the RCWP projects received additional allocations to permit comprehensive monitoring and evaluation. These projects were: the Idaho Rock Creek Project, the Illinois Highland Silver Lake Project, the Vermont St. Albans Bay Project, the Pennsylvania Conestoga Headwaters Project, and the South Dakota Oakwood Lakes - Poinsett Project. The comprehensive monitoring and evaluation studies include both water quality and economic components. The water quality problems and use impairments originally identified for the comprehensive monitoring and evaluation projects are listed in Table 1, along with projected improvements in water quality.

In the Idaho project, high sediment levels in Rock Creek were identified as impairing recreational fishing in Rock Creek and downstream water storage capacity and power generation in the Snake River. The sediment loads were primarily attributable to sheet and rill erosion resulting from irrigation.

Irrigation systems are being modified and conservation tillage and sediment control structures are being installed to reduce sediment delivery. Preliminary evidence indicates that the quality of the water in Rock Creek is improving because of the RCWP but that the downstream effects on the Snake River are minimal.

In the Illinois Project highly erodible natric soils being carried off surrounding farmlands into Highland Silver Lake were identified as impairing municipal water supply and treatment and recreational fishing. RCWP erosion control practices appear to be decreasing turbidity levels in Highland Silver Lake. Sediment deposition is less than originally anticipated since the natric soils tend to remain suspended once they erode from the fields, and pass through the lake.

In the Pennsylvania Project, excess fertilization with animal manure and commercial fertilizer are degrading surface and groundwaters, impairing

Table 1 — Water quality problems, impairments and expected improvements

Project	Water quality problem	Use impairment	Water quality improvements
Idaho	Turbidity, sediment	Fishing, water storage, power generation, ditch capacity	Major reduction in sediment in Rock Creek Minor improvements in Snake River
Illinois	Turbidity Sediment	Water storage, water treatment, fishing	Some reduction in turbidity Minor change in lake sedimentation
Pennsylvania	Sediment, phosphorus in surface water, nitrates in surface and groundwater	Water supply, fishing	Limited improvement
South Dakota	Nitrates in surface and groundwater, phosphorus in surface water	Water supply, swimming, boating, fishing property values	Some improvement in surface and groundwater
Vermont	Phosphorus (algae, aquatic weeds)	Swimming, boating, fishing, property values	Major reductions in algae and aquatic weeds

domestic water supplies and contributing to downstream water quality problems in the Chesapeake Bay. The project is emphasizing animal waste storage, erosion control (primarily terraces) and nutrient management. Limited localized improvement in water quality has occurred but the large land area and limited farmer participation are restricting any general water quality improvement.

In the South Dakota project, commercial fertilizer residues are degrading groundwater drinking supplies and recreational lakes. Conservation tillage and nutrient management are the primary BMPs being used to improve water quality. Preliminary evidence indicates that some improvement in water quality is likely because of RCWP.

In the Vermont project, phosphorus from animal wastes and sewage treatment plants has stimulated algae and weed growth in St Albans Bay, impairing swimming, boating and value of recreational property. This project is emphasizing storage and proper use of animal wastes. Significant improvements in water quality are anticipated as phosphorus discharges from cropland and from the sewage treatment plant are reduced.

Estimated Offsite Benefits

Estimates of the economic value of the water quality improvements for the five RCWP projects are presented in Table 2. Total estimated benefits of BMP implementation range from $0.1 million for the Conestoga Headwaters in Pennsylvania project to $4.9 million for the St. Albans Bay Vermont project. The much higher benefit estimate for St. Albans Bay stems from two major

Table 2--Estimated 50 year benefits compared with costs for five RCWP projects
(Preliminary)

Item	Idaho Project	Illinois Project	Pennsylvania Project a/	South Dakota Project a/	Vermont Project
	Million Dollars b/				
Benefits					
Offsite (water quality):					
Recreation	$.4	$ + c/	+	>1.4	3.9
Water Storage	0	0	NA d/	NA	NA
Property Values	NA	NA	NA	+	1.0
Water Conveyance	.2	0	NA	NA	NA
Water Treatment	NA	.2	+	+	NA
Other	.2	NA	NA	NA	+
Total Offsite	.8	.2	0	>1.4	4.9
Onsite Benefits:					
Soil Productivity	.8	0	.1	+	NA
Reduced Farm Costs	NA	NA	NA	NA	2.0
Total Benefits	1.6	.2	.1	>1.4	6.9
Costs					
Government e/	3.4	1.6	1.0	1.4	3.9 f/
Private	3.3	.3	.3	0	NA
Total Costs	6.7	1.9	1.3	1.4	3.9
Benefit/Cost Ratios	.2	.1	.1	>1.0	1.8

a/ The economic evaluations of the Pennsylvania and South Dakota projects were started a year later and were funded at significantly lower levels than the economic evaluations of the other projects.

b/ Adjusted to a 1980 base and discounted to current value at 7.875 percent rate.

c/ Positive benefits accrue but total value is less than $50,000.

d/ Not applicable.

e/ Includes cost share payments, technical assistance, and information and education costs.

f/ Includes costs of phosphorus wastewater treatment for the City of St. Albans.

factors--a greater marginal improvement in water quality and a greater number of people affected by the improvement. The importance of these factors can be seen better by examining how total benefits were estimated.

In Idaho, sediment in irrigation return flows and in Rock Creek will be greatly reduced. This will generate $0.4 million in benefits to recreational fishing and will reduce ditch cleaning cost by an estimated $0.2 million. However, this improvement in Rock Creek will minimally affect the quality of water downstream in the Snake River. Because of the hydrologic features of the Snake River, sediment from streambanks and the river bottom would be picked up, largely offsetting any savings from reductions in sediment entering from Rock Creek. Thus, water storage or power generation benefits appear negligible. Total estimated water quality benefits over 50 years are $0.6 million. In addition, the crop residue cover from use of conservation tillage is projected to improve upland game habitat, with a hunting benefit estimated at just over $0.2 million. Total offsite benefits of RCWP in Idaho would be $0.8 million.

In the Illinois Project, sediment entering the lake will be reduced, in turn, reducing the turbidity in the lake. Costs of water treatment to remove sediment will be lowered by some $0.2 million. Also, recreational fishing will marginally improve but, because of limitations on access and on boat size, only some $24,000 in benefits will be generated. Water storage benefits appear negligible because much of the sediment will remain in suspension and pass over the dam, and because the lake's capacity is large relative to future demand. Thus, total offsite benefits of $0.2 million appear likely over a 50-year period.

For the project in Pennsylvania, the limited nature of BMP implementation over a wide area will result in minimal improvement in water quality. Localized improvements in groundwater will result in small benefits to households from improvement in water wells. In addition, minor improvements in surface water quality are expected to occur. Since the potential for increased recreational use of the Conestoga River is limited, recreational benefits are expected to be positive but quite small.

In South Dakota offsite benefits are projected to be substantial. The drainage basin includes several popular recreational lakes that have been degraded by agricultural nonpoint source pollution. If recreational use of the lake increased by 4 percent due to water quality improvement, recreational benefits would exceed $1.4 million. There is a significant number of seasonal homes located adjacent to the lakes. The value of these properties is expected to increase in conjunction with the improvement in water quality. The magnitude of this increase has not been estimated. The groundwater aquifer in the South Dakota project area serves as a source of potable water for local residents. Positive benefits are expected to occur with water quality improvement.

In the Vermont Project, greatly reduced phosphorus loadings from RCWP and better sewage treatment will improve the water quality in St. Albans Bay over time, to near that in the larger Lake Champlain. This will produce swimming and other recreational benefits of nearly $4 million, and will increase recreational property values by over $1 million. Costs of weed treatment removal will be reduced by $27,000. Thus, the total offsite benefits over 50 years are estimated at nearly $5 million.

Onsite Benefits

In four of the five projects, RCWP is generating some onsite economic benefits from preserving soil productivity or from reducing farmers' operational costs, which more than offset their RCWP installation costs.

In Idaho, planned implementation of conservation tillage and other practices that help keep soil in place on the fields will reduce long-term soil productivity loss and generate benefits estimated at $0.8 million (Table 2). In this case, these productivity benefits are as great as the offsite benefits.

In Pennsylvania, heavy manure applicationn are largely offsetting soil erosion. In the Illinois project, because soils are deep and fertile, long-term productivity benefits are negligible.

In the Vermont project, the installation of improved animal waste storage facilities reduces manure handling and fertilizer costs over time by more than the farmers' initial share of putting in the systems. This negative cost of over $2 million can be considered an onsite private benefit. Note that it is about 40 percent as large as the public benefits.

Costs

Each project has two cost components: government costs and private cost (Table 2). Government costs range from $1.0 million for the Pennsylvania

project to $3.4 million for the Idaho project. This cost includes government cost-share payment, technical assistance, information and education expenditures, and local administrative costs.

Private costs are the net costs before taxes that the farmer incurs from paying his share of the BMP installation, plus the net change in operating costs. Notice that the private costs in the Idaho project are very high, nearly equal to government costs. 1/ By comparison, in the Vermont Project net private costs are zero because the reduction in operating costs exceeds the installation cost, so the negative cost gets listed as a private benefit.

Benefits Versus Costs

How do the estimated benefits in the three comprehensive monitoring and evaluation projects compare with the costs of implementing the projects to generate the benefits? The answer to this question is affected by which benefits we compare with which costs. First, let's compare total benefits, including both public and private, with total costs, again including both government (or public) and private. The Vermont project with a benefit/cost ratio of 1.8 to one and the South Dakota project with a benefit/cost ratio that exceeds one are the only projects of the five that are economically justified (Table 2). For these projects total economic benefits will likely exceed costs. In the Idaho, Illinois, and Pennsylvania projects, total economic benefits are projected to be only one-fourth or less as large as total costs.

1/ It appears the farmers in the Idaho project are able to shift much of this cost back on the government through investment tax credit and depreciation.

If we say that these projects were undertaken to improve water quality and produce offsite benefits, and we are interested in how much we are getting for the government buck, we would compare offsite benefits against government costs. When we do this, the benefit to cost ratio for the Idaho project drops to 0.2 and the ratio for Pennsylvania approaches zero, while the others remain the same.

Implications

The results from the individual economic evaluations of the five comprehensive monitoring and evaluation RCWP projects can be generalized to provide guidance in planning future projects and programs designed to control agricultural nonpoint source pollution. For convenience we group the implications from the economic evaluations into four categories: economic impairment, costs and effectiveness of BMPs, incentives to participate, and benefits versus costs.

Before drawing some implications from these evaluations, several limitations need to be pointed out. First, these evaluations are preliminary. Second, the RCWP projects were not selected on the basis of anticipated benefit/cost ratios, but rather to experiment and try out the program in different problem and geographical settings. Although the Idaho, Illinois, Pennsylvania, and some other RCWP projects may have low benefit/cost ratios, the information they provide will be valuable for guiding future programs. A third limitation is that the RCWP projects are not representative statistically of possible agricultural NPS projects. Thus the results should not be used to generalize about the economic efficiency of a future program.

Economic Impairment

The importance of pre-project assessment of the economic impairment and of the potential benefits from improving water quality is demonstrated by the economic evaluation of RCWP. Potential benefits can vary considerably among areas and should not be measured only by examining levels of pollution. Each of the RCWP projects were targeted to areas with highly polluted water. However, the estimated offsite water quality benefits for pollution control ranged from under $250,000 for the Illinois project to nearly $5 million for the Vermont project (table 2). 2/

A key factor affecting potential offsite benefits appears to be the level of demand for the water resource, particularly with regard to recreational opportunities. Potential benefits depend on the number of activities impacted, and economic importance of these activities. In Vermont and South Dakota, the likely recreational benefits are sizable, while in the other three projects they are relatively small. In addition to increased recreational opportunities, other offsite impacts associated with the various RCWP projects include: property values, sedimentation of water storage facilities, power generation costs, water supply and treatment costs, and ditch cleaning costs.

The importance of measuring the contribution of agricultural nonpoint source pollution to water quality and determining an economic impairment before

2/ The estimate of negligible water quality benefits for the Pennsylvania project reflects the failure to implement a sufficient number of the appropriate BMPs. If water quality were improved in the project area, the magnitude of the offsite benefits would be significant.

project implementation is illustrated in the case of the Illinois RCWP project. When the project was initiated, the loss of storage capacity from deposition of sediment in the Highland Silver Lake was identified as the principal impairment. Reductions in erosion in the watershed would reduce sediment delivery to Highland Silver Lake, the primary source of drinking water for the City of Highland. Substantial offsite benefits were envisioned through elimination of the need for dredging the lake or finding an alternative source of water. However, subsequent analysis of the Lake's siltation revealed that much of the sediment was not settling out and remaining on the lake bottom but rather was either staying in suspension or being resuspended and passing through the lake. Also the reservoir capacity was large relative to future demand. Thus, there was no significant problem in terms of lost water storage capacity in the lake and the primary benefit identified for the project had negligible economic value.

A similar situation occurred in the Rock Creek Project in Idaho. Reduced siltation of power-generation reservoirs behind dams on the Snake River was identified as a significant potential benefit from the Rock Creek project. However, subsequent evaluation revealed that reductions in erosion in the Rock Creek watershed were unlikely to significantly affect the water storage facilities 100 miles downstream. Although measurable reductions in sediment delivery to the Snake River occur, the Snake River itself will tend to pick up replacement sediment from streambanks and the river bottom.

In addition to offsite water quality benefits the Idaho and Pennsylvania projects generate onsite soil productivity benefits. A policy question is

whether offsite and productivity benefits should receive the same or differing priorities in allocating resources. A similar concern exists with regards to wind erosion. Although none of the RCWP projects experienced wind erosion, in some regions offsite wind erosion damages can be significant. Whether or not productivity and wind erosion benefits are included with water quality benefits could make a major difference in the economic feasibility of a project.

Costs and Effectiveness of BMPs

The costs and effectiveness of BMPs (best management practices) to improve water quality are dependent upon proximity to watercourse, surface slope, soil type, timing of precipitation, other BMPs in place, agronomic practices in the area, and the water quality problem being addressed.

In general BMPs were effective in improving water quality in the projects. However, the relative effectiveness varied considerably from one project to another. For example, in Vermont animal waste storage reduced the quantity of nutrients reaching the watercourse by permitting more timely application to meet crop needs and avoid runoff. A different result occurred in Pennsylvania where Lancaster County, the site of the RCWP project, has the highest concentration of animals per acre of any county in the United States. Installation of animal waste storage facilities conserves nutrients, resulting in greater amounts of high nutrient manure being applied at a given time than would otherwise occur. However, the increased levels of nutrients resulting from animal waste storages surpasses the amount of nutrients that the crops can use. These excess nutrients appear to be moving downward into the groundwater