ALLOCATION OF FEDERAL ASSISTANCE TO SOIL CONSERVATION

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A. E. Research Series #253

July 1986

Abstract

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Fixed and variable cost sharing can be given for economically feasible conservation practices and can exceed the minimum subsidy needed for adoption. Both situations decrease net public benefits. This paper compares the net public benefits and public cost per ton of erosion reduction and the economic efficiency of fixed and variable cost sharing to an alternative method which maximizes net public benefits. Application is made to 16 resource management systems and two soil types in the Rebel Flat Creek watershed in eastern Washington.

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Soil erosion is a significant social and economic problem. About 23% of U.S. cropland is eroding at rates exceeding soil loss tolerances established by the Soil Conservation Service (SCS) (Bills and Heimlich). National soil erosion is 6.4 billion tons annually, 44% of which occurs on cropland (USDA, 1980 and 1981b). High erosion rates can permanently reduce soil productivity and adversely affect long-term agricultural productive capacity. Sediment from cropland erosion is deposited in waterways causing additional expense for dredging navigation channels, maintaining hydroelectric, water treatment and water storage facilities and flood control. Sedimentation in fish spawning areas lowers reproduction rates decreasing fish populations and lowering the net economic value of commercial and recreational fishing.

Since the public benefits of reducing soil erosion often exceed the private benefits, erosion reduction falls short of the socially optimal level. However, when the marginal net public benefit of erosion reduction is positive, it is in society's interest to stimulate adoption of conservation practices by providing farmers with financial assistance. In this regard, two questions arise. First, how much should the nation spend on soil conservation and second, how should federal assistance be allocated among alternative soil conservation practices. This paper addresses the second question. Its major purpose is to evaluate the physical and economic effects of three schemes for allocating federal financial assistance to soil conservation practices.

Background

Public policy for erosion control is aimed at reducing erosion rates to soil loss tolerances or T values. T values are defined as "the maximum rate of annual soil loss that will permit a high level of crop productivity to be obtained economically and indefinitely" (McCormack, et al.). The T value is typically 5 tons per acre per year (TAY) for deep soils but can be as low as 1 TAY for shallow soils. Soil conservationists consider erosion rates exceeding T as an impairment to long-term soil productivity. However, the economic loss due to soil erosion, as pointed out by Crosson, Walker and Prato, is a more valid criterion for assessing the impacts of soil erosion than the T value.

Since farmer participation in federally-supported soil conservation programs is voluntary, federal assistance is not necessarily directed to the most severely eroding land. For example, from 1975 to 1978, about one-half of the conservation practices receiving cost sharing funds from the Agricultural Stabilization and Conservation Service (ASCS) were used on land where sheet and rill erosion was less than 5 TAY (USDA, 1981a). This situation has led some analysts to propose that federal conservation assistance be allocated to areas having the highest erosion rates (Erwin and Washburn). Despite the problems inherent in a voluntary conservation program, cost sharing assistance has been effective in reducing erosion rates. Average erosion rates on selected cost-shared practices fell from 10.7 to 4.2 TAY (61%) in the 1975-78 period, from 13.8 to 3.9 TAY (72%) in 1982 and from 12.9 to 4.5 TAY (65%) in the first six months of 1983 (American Farmland Trust, p. 66).

In an effort to improve federally-supported erosion control programs, the National Conservation Program mandates the targeting of federal assistance to areas having critical resource problems. In FY-1984, about 10% of ASCS' financial assistance and SCS' technical and financial assistance was allocated to targeted areas (USDA, 1984). Initially, funds were targeted to areas having the highest erosion rates. Later, the program was expanded to include low erosion rates on "sensitive and fragile soils" and "offsite damages."

Since high erosion rates do not necessarily result in significant economic losses, particularly in areas having deep soils, greater emphasis is being given to selecting areas for conservation treatment on the basis of the potential long-term monetary damages from soil erosion (Walker, Prato). The damage approach requires information on the effect of soil loss on crop yields. Prior to development of EPIC (Williams,et al.) and the productivity index (Pierce, et al.) models, this type of information was only available for a few geographic areas.

Allocation Schemes

Three schemes for allocating federal financial assistance to soil conservation practices are evaluated, namely: fixed cost sharing; variable cost sharing; and the net benefit scheme. Only the two cost sharing schemes are currently used. With fixed cost sharing, farmers who install eligible soil conservation practices receive between 50 and 60% of the average installation cost, not to exceed $3,500 per year. Variable cost sharing is similar to fixed cost sharing except that the cost share rate increases in direct proportion to the pre-practice erosion rate and the percent reduction in soil loss achievable with the practice. ASCS is now testing variable cost sharing in a pilot program.

While cost sharing can stimulate the adoption of soil conservation practices, it is possible for a farmer to receive cost sharing payments for economically feasible conservation practices. It is also possible for the cost sharing payment to exceed the minimum amount necessary for adoption. Both of these situations result in an inefficient allocation of federal assistance to soil conservation practices. For example, Tice and Epplin found that cost sharing payments for conservation tillage in Oklahoma resulted in a windfall gain to farmers of $10.73 per acre.

The net benefit scheme would allocate federal assistance to soil conservation practices that are economically infeasible without financial assistance and for which adoption increases net public benefits. Economically feasible practices would not receive financial assistance with this scheme because it would reduce public benefits. This assumes, of course, that economically feasible practices would be adopted without financial assistance; a simplifying assumption made in this analysis. Financial constraints and risk considerations could prevent this from occurring. The economic inefficiencies associated with cost sharing cannot occur with the net benefit scheme because economic infeasibility is a prerequisite for obtaining financial assistance and the assistance provided to farmers is equivalent to the minimum amount needed for adoption.

Analysis

Resource management systems (RMS) in the Rebel Flat Creek watershed located in eastern Washington are evaluated. An RMS is a combination of interrelated conservation practices and management techniques which maintain or improve the soil, water, plant and related resources for a particular land use. The RMS analyzed here are a combination of the following crop rotations, tillage practices and cultivation methods:

Crop rotations: Wheat/Fallow (WF)

Wheat/Barley/Fallow (WBF)

Continuous Barley (CB)

Tillage practices: Low Residue (LR)

High Residue (HR)

No Till (NT)

Cultivation methods: Up-and-down (V)

Divided Slope (D)

Sixteen RMS were evaluated. These RMS were divided into source and target RMS as follows:

Source RMS: WF LR V, CB HR D (Athena only), CB NT V, CB HR V,
CB LR V, CB LR D

Target RMS: WF HR V, CB NT V, WBF NT V, WBF HR V, WF HR D,
WBF LR V, WF LR D, WBF NT D, WBF HR D, WBF LR D,
CB HR D (Thatuna only)

Source RMS have erosion rates above the soil loss tolerance of 5 TAY for the two soils analyzed, namely Athena and Thatuna, and target RMS have erosion rates below this tolerance. The average reduction in soil loss between the source and target RMS is 7.19 TAY for Athena soil and 5.39 TAY for Thatuna soil.

Use of the net benefit scheme requires knowledge of erosion rates, net returns per acre, and offsite benefits of erosion reduction for each RMS.

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Erosion rates and net returns per acre were calculated with the Soil Conservation Economics (SOILEC) model (Eleveld, et al.). SOILEC predicts soil erosion rates for each RMS based on the Univeral Soil Loss Equation (USLE) and calculates net returns per acre by annualizing the present value of net returns for a designated time horizon and discount rate. The soil parameters for predicting erosion rates and the economic parameters for calculating net returns per acre are given in Table 1.

Since SOILEC does not calculate the losses in crop yields due to soil erosion, these losses were estimated using the productivity index (PI) model (Pierce, et al.). The erosion rates estimated with the USLE and the yield losses estimated with the PI model were used in SOILEC to calculate the net returns per acre for each RMS. Since the PI model was originally developed for midwestern soils, its use with other soils is likely to give inaccurate soil productivity losses. Despite this limitation, the PI model was used because it was not practical to use more sophisticated models such as EPIC. Furthermore, any inaccuracies stemming from use of the PI model are likely to have a minor effect on the conclusions of this study because the estimated yield losses were only used to make relative comparisons among RMS.

Determination of the offsite benefits of erosion reduction requires knowledge of sediment delivery ratios for each RMS and field condition within the watershed, sediment transport from receiving waters to critical stream/river reaches and the benefits of reducing sediment and other forms of water pollution in critical reaches. Clark et al. estimated the national offsite damages from cropland erosion. Clark's estimates were not used in this analysis because they do not represent the offsite benefits of erosion control and they are not applicable to a specific watershed.

Gianessi et al. found that controlling cropland erosion by itself would not result in major improvements in water quality except in a few regions east of the Great Plains. This occurs because of significant nonpoint source pollution from other sources such as pastureland, rangeland, forest land and roads. Therefore, even if the offsite benefits of reducing sediment could be estimated, it would be difficult to allocate these benefits to erosion control on cropland within a specific watershed. For these reasons, the offsite benefits of erosion control were not accounted for in this study.

Net private returns per acre were calculated for a one-year planning horizon, which assumes that farmers do not consider the long-run productivity losses of soil erosion when evaluating the economic feasibility of alternative RMS. A one-year planning horizon was chosen because it is the only short-term evaluation that can be performed with SOILEC. Net public returns per acre were based on a 20-year planning horizon and a 4% real discount rate. Although the precise length of the public planning horizon is somewhat arbitrary, a 20-year period was selected for three reasons. First, SOILEC requires a minimum planning horizon of 20 years in order to ensure accurate results. Second, while a longer planning horizon would capture more of the yield losses caused by soil erosion, such losses are not likely to be significant because of discounting and the relatively deep topsoils in the study area. Third, results obtained using a longer time horizon (50 years) are very similar to those for 20 years. A 4% public discount rate has been used by federal agencies such as the Bonneville Power Administration and in other studies (e.g., Jolly, Lind et al., Park and Sawyer).

Cost of production included variable and ownership costs. Variable cost changed with yield and ownership cost remained fixed per acre as indicated in

Table 1. Divided slope farming was assumed to cost $4.25 per acre more than up-and-down cultivation. The added cost of divided slope farming is the average increase for a typical Palouse farm as estimated by Brooks and Michalson. Cost sharing payments were calculated by multiplying the fixed or variable cost share rate by the increase in production cost per acre for each RMS. The formula for determining variable cost share rates is identical to the one used by ASCS.

Four criteria were used to evaluate and compare the three allocation schemes, namely: changes in net public benefits per ton of erosion reduction resulting from federal financial assistance; public cost per ton of erosion reduction; economic efficiency; and informational requirements. The change in net public benefits from adoption of a target RMS is defined as the net public returns with the target RMS minus the net public returns with the source RMS, minus the public cost. The specific combination of source and target RMS, allocation scheme and soil type affect the change in net public benefits.

Public cost per ton of erosion reduction includes the level of financial assistance and the cost of technical assistance. Technical assistance cost was set at $0.062 per ton of soil saved, which is the level estimated by SCS for targeted areas. It is assumed that technical assistance would be required for a period of five years commencing with practice installation.

Economic efficiency is defined as the change in net public benefits per dollar of public cost. When economic efficiency is negative, net public benefits decrease and public cost increases, indicating that provision of federal assistance is inefficient. A positive efficiency indicates that provision of federal assistance is economically efficient. Since the informational requirements for each allocation scheme were not quantified, they were evaluated subjectively.

Results

The six source RMS and 10 target RMS for Athena soil and the five source RMS and 11 target RMS for Thatuna soil allow for 115 possible replacements of a source RMS with a target RMS (60 for Athena soil plus 55 for Thatuna soil) for each of the three allocation schemes. Of the 115 possible replacements, only 20 qualified for fixed cost sharing, 15 for variable cost sharing and none for the net benefit scheme. Replacement of a source RMS with a target RMS does not qualify for cost sharing if adoption of the target RMS reduces cost per acre or private net returns per acre. Cost sharing is provided for replacing CB LR V or WF LR V only. Fixed and variable cost sharing is given to replace CB LR V with CB HR D in Thatuna soil. Thirty-three of the 35 replacements eligible for fixed and variable cost sharing involved replacing WF LR V with one of the following target RMS: WF HR V, WBF NT V, WBF HR V, WF HR D, WBF NT D, WBF HR D and WBF LR D for both soils. Fixed cost sharing is provided to replace WF LR V with CB NT D or WBF LR V.

The variable cost-share rate is zero in five cases because not enough erosion reduction is achieved with the target RMS. Of the 35 cost-shared replacements, 13 are economically feasible without financial assistance. This indicates that a farmer can receive cost sharing payments for a target RMS even though it is economically feasible without financial assistance. None of the 115 possible replacements qualified for financial assistance with the net benefit scheme because either adoption was economically feasible without financial assistance or the provision of financial assistance ensures private economic feasibility but reduces net public benefits.

Table 2 shows the average changes in net public benefits, public cost and economic efficiency for the ten target RMS involved in cost sharing. The average is taken over the source RMS that were replaced by the target RMS. Net public benefits are negative for all cost-shared RMS. The average public loss is greater for fixed than for variable cost sharing, namely $9.08 vs. $4.39 per ton of erosion reduction on Athena soil and $9.92 vs. $4.26 on Thatuna soil. When a target RMS is cost shared and it is economically feasible for a farmer to adopt this RMS without cost sharing, the increase in public benefits is zero and the increase in public cost is positive. In these cases, the change in net public benefits is equal to the negative of the public cost and economic efficiency is -1.0. Net public losses for fixed cost sharing are over twice (120%) as much as for variable cost sharing. In addition, the public cost of fixed cost sharing is two and one-half times (152%) greater than for variable cost sharing. Each cost-share dollar is associated with a net public loss of $1.21 to $1.31.

Fixed cost sharing has the least demanding and the net benefit scheme the most demanding informational requirements. With fixed cost sharing it is sufficient to know whether cost sharing will result in adoption of the target RMS and the average cost of installing the RMS. Variable cost sharing also requires knowledge of the erosion reduction achieved by the target RMS. Application of the net benefit scheme requires the information for variable cost sharing, plus the decrease in the present value of net private returns per acre and the increase in net public benefits per ton of erosion reduction for each RMS. Net present values are especially difficult to estimate because they vary over producers, RMS and regions.

It may be more efficient to implement the net benefit scheme by having farmers bid for the minimum subsidy required for adoption of an RMS where bidding is limited to RMS and areas expected to yield the greatest increase in net public benefits per ton of erosion reduction. Competitive bidding would also minimize the federal subsidies required to achieve the desired level of erosion reduction. A competitive bidding system is currently being used to allocate federal subsidies to farmers participating in the Conservation Reserve Program established by the Food Security Act of 1985.

Conclusions

Preliminary findings based on this evaluation suggest that cost sharing of soil conservation practices can be economically inefficient despite the fact that cost sharing payments have stimulated adoption of conservation practices. Net public benefits decreased for all RMS eligible to receive cost sharing. Fixed cost sharing was less efficient than variable cost sharing, entailing a 120% greater average public loss and a 152% higher public cost. No target RMS were eligible for financial assistance with the net benefit scheme. Target RMS that substantially reduce erosion might qualify for financial assistance under the net benefit scheme if the offsite benefits of erosion reduction are significant. Unfortuately, lack of knowledge regarding sediment delivery from the watershed to affected water bodies and the contribution of cropland-generated sediment to total sediment, did not permit estimation of offsite benefits.

As federal financial support for soil conservation activities becomes more limited, there will be a greater need to maximize net public benefits per federal dollar spent on erosion control. In view of the potential inefficiences in cost sharing, implementation of the net benefit scheme deserves further scrutiny.

References

American Farmland Trust. Soil Conservation in America: What Do We Have to Lose. Washingtion, D. C. 1984.

Brooks, Robert O. and Edgar L Michalson. "An Evaluation of Best Management Practices in the Cow Creek Watershed, Latah County, Idaho." Idaho Agricultural Experiment Station Bulletin No. 127. 1983.

Eleveld, Bartelt, Gary Johnson, Parveen P. Setia and Robert G. Dumsday. "SOILEC Users Guide." Department of Agricultural Economics, University of Illinois, Urbana-Champaign. September 1983.

Clark, Edwin H. Jennifer A. Haverkamp and William Chapman. Eroding Soils: The Off-Farm Impacts. The Conservation Foundation. Washington, D.C. 1985.

Crosson, Pierre R. and Anthony A. Stout. Productivity Effects of Cropland Erosion in the United States. Research paper from Resources for the Future, Inc., The Johns Hopkins University Press, Baltimore, Maryland. 1983.

Erwin, D.E. and R.A. Washburn. "Profitability of Soil Conservation Practices in Missouri." J. Soil and Water Cons. 36(March-April 1981):107-110.

Gianessi Leonard P., Henry M. Peskin, Pierre Crosson and Cyndi Puffer. "Nonpoint Source Pollution: Are Cropland Controls the Answer?" A special report by Resources for the Future, Inc. February 14, 1986.

Heimlich, Ralph E. and Nelson Bills. "An Improved Soil Erosion Classification for Conservation Policy." J. Soil and Water Cons. 38(July-Aug. 1984):261-266.

Jolly, Robert W. "Effective Subsidy Rates for Permanent Soil Conservation Practices." Paper presented at the AAEA conference. Cornell University, Ithaca, N.Y. July 1984.

Lind, Robert C. "The Rate of Discount and the Application of Social Benefit-Cost Analysis in the Context of Energy Policy Decisions." In Robert C. Lind, Kenneth J. Arrow, Gordon R. Corey, Partha Dasgupta, Amartya K. Sen, Thomas Stauffer, Joseph E. Stiglitz, J.A. Stockfisch and Robert Wilson. Discounting for Time and Risk in Energy Policy. Johns Hopkins University Press for Resources for the Future. 1982.

McCormack, D.E.,K.K. Young and L.K. Kimberlin. "Current Criteria for Determining Soil Loss Tolerance." In B.L. Schmidt, R.R. Allamaras, J.V. Mannering and R.J. Popendick (eds.), Determinants of Soil Loss Tolerance. ASA Special Publication No. 45, American Society of Agronomy and Soil Science of America. Madison, Wisconsin. 1982.

Park, William M. and David G. Sawyer. "Cost Sharing and Cost-Effective Soil Erosion Control Policy." Paper presented at the AAEA conference, Cornell University, Ithaca, New York. July 1984.

Pierce, F.J., W.E. Larson, R.H. Dowdy and W.A.P. Graham. "Productivity of Soils: Assessing Long-Term Changes Due to Erosion." J. Soil and Water Cons. 38(Jan.-Feb. 1983):39-44.

Prato, Anthony A. "Private and Public Value of Conservation Tillage in the Palouse." Paper presented at the AAEA conference, Iowa State University, Ames, Iowa. Aug. 4-7, 1985.

Tice, Thomas F. and Francis M.Epplin. "Cost-sharing to Promote Use of Conservation Tillage." J. Soil and Water Cons. 39(Nov.-Dec. 1984):395-397.

U.S. Department of Agriculture. Annual RCA Progress Report, National Program for Soil and Water Conservation. Washington, D.C. July 11, 1984.

U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service. National Summary Evaluation of the Agricultural Conservation Program, Phase I. Washington, D.C. 1981a.

U.S. Department of Agriculture, Soil Conservation Service. Basic Statistics, 1977 National Resources Inventory. Washington D.C. 1980.

U.S. Department of Agriculture. Soil, Water and Related Resources in the United States: Status, Condition and Trends: 1980 RCA Appraisal, Part I. General Accounting Office, Washington, D.C. 1981b.

Walker, David J. "A Damage Function to Evaluate Erosion Control Economics." Am. J. Agr. Econ. 64(1982):690-698.

Williams, J.R., K.G. Renard and P.G. Dyke. "EPIC: A New Method for Assessing Erosion's Effects on Soil Productivity." J. Soil and Water Cons. 38(Sept.-Oct. 1983):381-383.

Table 1. Soil and Economic Paramaters

Physical	Athena	Thatuna	Economic
Erosivity factor (R)	43	39	Public horizon: 20 yrs. @ 4%
			Private horizon = 1 yr.
K factor:			Fixed cost sharing rate = 55%
A horizon	.43	.49	
B horizon	.49	.45	Wheat price = $3.75/bu
			Barley price = $100/ton
Slope length (L)	30′	30′	
			Added cost of divided
Slope steepness (S)	16%	16%	slope farming = $4.25/ac
C factors:			Technical assistance
WF	.40-.092		cost = $.062/ton
WBF	.24-.044		
CB	.39-.075		Cost of production:
			Per unit yield:
P factors:			High residue = $.53/bu
Up-and-down	1.0		$21/ton
Divided slope	.61		Low residue = $.60/bu
			$25/ton
Thickness (inches):			Per unit area:
A horizon	20	39	$33/ac for WF LR
B horizon	28	21	$60/ac for WBF LR
			$86/ac for CB LR
Wheat yield (bu/ac):			$36/ac for WF HR
0" eroded	85		$67/ac for WBF HR
			$81/ac for CB HR
Barley yield (ton/ac)			$63/ac for WBF NT
0" eroded	2.5		$75/ac for CB NT

a. W=wheat, B=barley, F=fallow, LR=low residue, HR=high residue and NT=no till.
b. R, K, L, S, C and P are factors used in the USLE to predict soil erosion.
c. Price base is 1984 dollars.
d. The lower limit for the C-range corresponds to 300 lb/acre and the upper limit to 2,500 lb/acre or more residue remaining after planting.
e. SOILEC requires costs to be separated into those that vary with yield and those that are fixed per acre.

Table 2. Net Public Benefits, Public Cost and Economic Efficiency for Cost-Shared RMS, by Soil Type

Target RMS/ Performance Measure	Variable Cost Sharing		Fixed Cost Sharing	
	Athena	Thatuna	Athena	Thatuna
WF HR V				
Net Pub Ben ($/ton)	-.17	-.19	-.27	-.30
Public Cost ($/ton)	.17	.19	.27	.30
Econ Eff ($/$)	-1.0	-1.0	-1.0	-1.0
CB NT D				
Net Pub Ben ($/ton)	-.01	-.01	-35.8	-39.3
Public Cost ($/ton)	.01	.01	35.8	39.3
Econ Eff ($/)	-1.0	-1.0	-1.0	-1.0
WBF NT V				
Net Pub Ben ($/ton)	-5.71	-6.12	-5.81	-6.32
Public Cost ($/ton)	4.82	5.32	4.91	5.53
Econ Eff ($/$)	-1.18	-1.15	-1.18	-1.14
WBF HR V				
Net Pub Ben ($/ton)	-6.65	-7.16	-6.74	-7.38
Public Cost ($/ton)	5.15	5.68	5.24	5.90
Econ Eff ($/$)	-1.29	-1.26	-1.28	-1.25
WF HR D				
Net Pub Ben ($/ton)	-.51	-.57	-.58	-.66
Public Cost ($/ton)	.51	.57	.58	.66
Econ Eff ($/$)	-1.00	-1.00	-1.0	-1.0
WBF LR V				
Net Pub Ben ($/ton)	-	-	-10.59	-11.62
Public Cost ($/ton)	-	-	5.99	6.66
Econ Eff ($/$)	-	-	-1.77	-1.74
WBF NT D				
Net Pub Ben ($/ton)	-6.47	-7.09	-6.12	-6.61
Public Cost ($/ton)	5.08	5.74	4.74	5.27
Econ Eff ($/$)	-1.27	-1.23	-1.29	-1.26
WBF HR D				
Net Pub Ben ($/ton)	-7.33	-8.06	-6.96	-7.55
Public Cost ($/ton)	5.41	6.11	5.04	5.60
Econ Eff ($/$)	-1.35	-1.32	-1.38	-1.35
WBF LR D				
Net Pub Ben ($/ton)	-8.24	-9.10	-8.84	-9.67
Public Cost ($/ton)	4.17	4.71	4.78	5.29
Econ Eff ($/$)	-1.97	-1.93	-1.85	-1.83
CB HR D				
Net Pub Ben ($/ton)	NA	-3.06	NA	-9.81
Public Cost ($/ton)	NA	3.06	NA	9.81
Econ Eff ($/$)	NA	-1.0	NA	-1.0

NA = Not applicable