Symposium on Impacts on Rural America of the Federal Water Pollution Control Act Amendments, P.L. 92-500

Presented at the joint annual meeting of the American Agricultural Economics Association and the Western Agricultural Economics Association, August 2, 1977

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Preface

In 1972, Public Law 92-500, Amendments to the Federal Water Pollution Control Act, was enacted. This omnibus legislation set in motion considerable activity aimed at improving the water quality of the country. Billions of dollars have been or will be spent to meet the various provisions of this law. A casual reading of the act and its implementing regulations may lead the reader to the conclusion that the impact of this law will be primarily on urban America. However, there are provisions which have a considerable impact on rural America as well. In addition to the discharge requirements for municipal wastes from small communities and the construction grants programs for expenditures to meet these standards, the act has provisions which relate directly to pollution from agricultural sources, particularly from animal feedlots, agricultural processing firms, and more pervasively, from agricultural nonpoint sources.

The papers and comments which follow were prepared for a symposium presented at the joint annual meeting of the American Agricultural Economics Association and Western Agricultural Economics Association at San Diego, California, August 2, 1977. The topics presented were in no way designed to completely cover all impacts of P.L. 92-500. Rather, selected topics of importance to rural America were addressed. The objective of the symposium was to present ideas related to several impacts that P.L. 92-500 poses for rural America.

Our objective in presenting these papers here is to foster discussion of the effects and issues they raise. The views expressed are those of the authors and do not necessarily reflect the views of the U.S. Department of Agriculture.

Lee A. Christensen*
Symposium Chairman

This report has been reviewed by the Environmental Protection Agency (EPA) and clearance for publication has been granted. The policy issues evaluated and discussed herein are neither endorsed by EPA nor necessarily reflect Agency policy.

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Summary

Control of municipal wastewaters can impose a significant cost burden on rural communities. Rural communities are unable to take advantage of the significant economies of size in wastewater treatment. Additionally, fewer construction grant awards are going to small communities. Land application of wastewater provides rural communities with an inexpensive technology for advanced wastewater treatment, but also raises competitive land use issues.

The location and operation of agricultural processing plants is influenced by cost-sharing provisions of the law. A reduction in Federal grants from 75 percent to 55 percent is urged, along with adjustments to provide the same share for operating and maintenance costs and explicitly including subsidies for nonplant pollution control measures. The present subsidy system provides strong incentive to invest in capital-intensive systems and expensive designs, often leading to suboptimal decisions. Industries often treat their own wastes rather than connecting with municipal systems, due to their high costs and cost recovery programs. Investment in waste treatment systems in arid States (which previously had little need for expensive waste treatment plants) has increased substantially.

A third set of impacts relates to the control of erosion and sedimentation required by section 208. An analysis of policies (such as soil loss taxes, terrace subsidies, soil loss and nitrogen restrictions) found that reasonable soil loss restrictions do not have adverse economic impacts, but that stringent soil or nitrogen restrictions do. Farm income generally increases at consumer expense. Results of a watershed model showing longrun impacts of soil erosion indicated a complete loss of topsoil in the Corn Belt within 100 years if present practices are continued. Farmers cannot be expected to implement soil loss controls without subsidies.

The discussants tie the papers together using the planning requirements of Section 208 of P.L. 92-500. Section 208 planning requires new policies and organizations. A systematic management approach is needed to handle differences in approaches of State and local institutions. More information is needed on the distribution of costs and benefits incurred in the implementation phase.

A spirit of "ethically inspired voluntarism" would help economists have more impact on environmental policy formulation. Legislation comes out of a technological and legal mind set. The Environmental Protection Agency often goes to technical solutions because of the transactions and implementation costs of nontechnological solutions. Economists typically take a broader view of problems and sometimes appear to be uncompromising, but can make real contributions in developing economic compromises.

Upgrading Municipal Wastewater Treatment in Rural Areas

by C. Edwin Young*

The 1972 amendments to the Federal Water Pollution Control Act (P.L. 92-500) call for upgrading municipal wastewater treatment throughout the United States. The amendments established the goal of best-practical waste treatment by 1977 and best-available treatment by 1983 for all municipal wastewater treatment works. Although some delays have been granted, it is clear that many communities will eventually have to improve their treatment facilities.

Three features of P.L. 92-500 are of importance to rural communities. (1) The Federal government provides a grant to pay for 75 percent of the costs of constructing sewage treatment facilities.1/ (2) P.L. 92-500 calls for recycling wastewaters through land application and industrial reuse whenever practical. This requirement has the potential for significant impact on land use in rural America. (3) The act calls for regional water quality planning. This portion of the act calls for incorporating the impacts of sewage discharges, non-point waste discharges (such as agricultural runoff), and industrial discharges into a regional plan.

The first two features are discussed in this paper and the third in the two following papers in this symposium. Upgrading and expanding municipal wastewater treatment in rural areas imposes a greater per capita financial burden on smaller communities than on larger ones. The subsidies provided by P.L. 92-500 do not offset the financial burden. By definition, encouraging land application of wastewater and its residuals implies that it will have an impact on rural areas, since rural land areas on which to spread effluents and sludges will be required.

WASTEWATER TREATMENT ALTERNATIVES

Wastewater treatment consists of three separate stages: Primary treatment removes solids from wastewater. Secondary treatment is a biological treatment process for decomposition of organic material contained in sewage. (It significantly reduces the number of pathogenic organisms in wastewater.) Tertiary treatment or advanced wastewater treatment is primarily used for nutrient removal. Most U.S. wastewater treatment facilities provide either primary or

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1/ Grant funds are not applicable to all construction costs. Land which is not an integral part of the treatment process is not eligible for the subsidy.

secondary treatment. There are few existing tertiary treatment facilities, although P.L. 92-500 calls for their installation by 1983.

Two products result from the waste treatment process: liquid or effluent (generally discharged into a stream) and solids or sludge (generally disposed of by incineration, by putting it in a landfill, or by spreading onto the land). Ocean dumping has been used by major coastal cities but is being phased out.

In contrast to the centralized collection and treatment options described, rural communities have another option available for wastewater treatment: on-lot waste treatment systems. The most common on-lot treatment system is a septic tank. These systems are less costly than centralized collection and treatment systems, but do not provide as high a level of treatment as secondary treatment facilities. 2/

TREATMENT COSTS

Centralized wastewater treatment is relatively expensive. The Environmental Protection Agency (EPA) in 1977 estimated that an additional $96 billion will be required to upgrade municipal wastewater treatment to meet the 1983 goals of P.L. 92-500. Representative cost estimates for various wastewater treatment alternatives are presented in table 1. The selection between treatment processes is based on average costs, the degree of treatment desired or required, and other factors such as system reliability, labor requirements, and input costs.3/ For example, aerated lagoons appear to be relatively inexpensive based on the cost data presented; but larger communities may not be able to find enough isolated land to construct lagoons at a reasonable cost. Additionally, aerated lagoons may not be capable of providing a consistently high level of wastewater treatment in some regions.

There are significant economies of size to wastewater treatment (table 1). Increasing facility size from a 0.5 million gallon a day (mgd) facility (5,000 people) to a 1 mgd facility (10,000 people) would result in an average cost reduction of approximately 30 to 50 percent.4/ Based on the magnitude of economies of size, illustrated in table 1, it is obvious that requiring a uniform level of waste treatment throughout the United States (e.g., secondary treatment imposes a financial burden on rural communities relative to larger urban communities without an operation and maintenance cost-sharing arrangement).

In addition to the economies of size argument, upgrading municipal wastewater treatment in rural areas will place an additional financial burden on

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2/ When small quantities of wastes are generated, septic tanks can provide an environmentally acceptable method of sewage disposal at a lower cost than centralized treatment.

3/ Table 1 is not meant to list all treatment alternatives. It only illustrates relative differences in costs rather than absolute differences. Care should be exercised in comparing the treatment techniques listed in table 1. Different processes result in different effluent qualities.

4/ One mgd of wastewater is equivalent to waste discharge of a community of 10,000 people, assuming no industrial wastes.

Table 1--Average wastewater treatment costs for various facility sizes.

(1975 Dollars)

Treatment technique	Type of cost	Facility size (millions of gallons per day) 0.5	1.0	5.0	10.0
		Dollars per 1,000 gallons			
Trickling filter	O&M 1/	0.27	0.19	0.11	0.07
	Capital 2/	0.39	0.29	0.14	0.08
	Total	0.66	0.48	0.25	0.16
Activated sludge	O&M	0.34	0.26	0.12	0.10
	Capital	0.36	0.26	0.14	0.09
	Total	0.70	0.52	0.26	0.19
Aerated lagoon	O&M	0.13	0.07	0.03	0.02
	Capital	0.09	0.13	0.03	0.02
	Total	0.22	0.13	0.06	0.04
Activated sludge followed by:					
Nitrification-denitrification	O&M	0.61	0.46	0.23	0.18
	Capital	0.62	0.45	0.24	0.18
	Total	1.23	0.91	0.47	0.36
Lime addition, filtration, sludge recalcination	O&M	0.70	0.56	0.30	0.24
	Capital	0.95	0.73	0.41	0.27
	Total	1.65	1.29	0.71	0.51
Aerated lagoon followed by:					
Solid-set irrigation	O&M	0.23	0.18	0.12	0.11
	Capital	0.72	0.56	0.40	0.38
	NCR 3/	(0.09)	(0.09)	(0.09)	(0.09)
	Total	0.86	0.65	0.43	0.40
Center pivot irrigation	O&M	0.25	0.19	0.13	0.11
	Capital	0.64	0.48	0.32	0.30
	NCR	(0.09)	(0.09)	(0.09)	(0.09)
	Total	0.80	0.58	0.36	0.32

Sources: Van Nolte, et al. (1975) and Young (1976).
1/ Operation and maintenance costs.
2/ Assumes a 5-5/8 percent discount rate over a 20-year period.
3/ Net crop revenue from corn.

communities not having centralized treatment facilities. They must build expensive sanitary sewer systems in order to have centralized treatment. Thus, rural communities that do not have existing centralized treatment facilities are doubly penalized: (1) due to the economies of size in treatment processes and (2) because they do not have a collection system in place.

CONSTRUCTION SUBSIDIES

Communities can receive Federal grants for 75 percent of construction costs to offset the financial impact of constructing wastewater treatment facilities. Net costs to a community receiving a 75 percent subsidy for capital costs are illustrated in table 2. With a 75 percent grant a community with a 0.5 mgd

Table 2--Average net local wastewater treatment costs for various facility sizes with a capital subsidy.1/

(1975 Dollars)

Treatment technique	Capital subsidy level	Facility size (millions of gallons per day)			
		0.5	1.0	5.0	10.0
	Percent	Dollars per 1,000 gallons			
Trickling filter	0	0.66	0.48	0.25	0.16
	75	.37	.26	.14	.09
Activated sludge	0	.70	.52	.26	.19
	75	.43	.33	.16	.12
Aerated lagoon	0	.22	.13	.06	.04
	75	.15	.09	.04	.03
Activated sludge followed by:					
Nitrification-denitrification	0	1.23	.91	.47	.36
	75	.77	.57	.29	.23
Lime addition, filtration, sludge recalcination	0	1.65	1.29	.71	.51
	75	.94	.74	.40	.31
Aerated lagoon followed by:					
Solid-set irrigation	0	.86	.65	.43	.40
	75	.32	.23	.13	.12
Center pivot irrigation	0	.80	.58	.36	.32
	75	.32	.22	.12	.10

1/ Cost estimates are developed from data presented in table 1 and assume that all capital costs are eligible for a subsidy.

activated sludge treatment unit will have its total costs reduced to $0.43/1,000 gallons, a reduction of $0.27/1,000 gallons. A community with a 5 mgd activated sludge facility will have its costs reduced to $0.16/1,000 gallons, a reduction of $0.10/1,000 gallons. The subsidy reduces average treatment costs more for the smaller facilities.

It is interesting to note that the percent of total costs paid by local communities does not vary as facility size increases. For example, communities with 0.5 or 5 mgd activated sludge plants both pay approximately 60 percent of total costs when they receive 75 percent capital subsidies. Thus, while smaller communities receive larger absolute monetary reductions in average treatment costs they do not receive larger percentage reductions in total treatment costs due to the capital subsidy.

To determine whether or not the capital subsidy actually provides greater average reductions to smaller communities, one would need to compare total expenditures on wastewater treatment to subsidized expenditures for a range of community sizes. To conclude that the subsidy reduces the impact of the regulations on smaller communities, subsidized expenditures would have to cover a greater proportion of treatment costs for smaller communities than for larger communities. Construction grants for wastewater treatment facilities awarded under P.L. 92-500 are presented by community size categories in table 3. Comparable data on total expenditures are unavailable since EPA records only grant expenditures and does not maintain records on total expenditures for wastewater treatment.

Some indication of the impact of the current subsidy program can be derived from a comparision of the population distribution of communities and construction grant awards (table 3). Small communities (less than 5,000 people) have received less from the construction grants program than larger communities (greater than 25,000 people). Considering economies of size and the lack of collection systems in many rural communities, one might expect smaller communities to have received more grant dollars per capita. Instead, the per capita distribution is relatively constant across community sizes with larger communities receiving slightly more per capita (table 3). Communities with a population less than 5,000, 12 percent of the urban population, received 9 percent of the dollars awarded for construction grants, while communities with populations in excess of 25,000 which contain 67 percent of the urban population, received 72 percent of the grant monies (table 3). Small communities have also received fewer grants per community than larger ones. Communities with a population less than 5,000, the population category of 82 percent of the communities, received 57 percent of the grants, while communities with more than 25,000 population, 5 percent of all communities, received 19 percent of the grant awards (table 3). Smaller communities have received fewer grant dollars than their number and populations would lead one to expect.

The construction grants program does not offset the higher per unit treatment costs smaller communities must pay to comply with wastewater treatment requirements. For the grants program to reduce the impact of economies of size demonstrated in table 1, small communities would have to receive more per capita of the grant monies than larger communities. Table 3 demonstrates that small communities receive less than larger communities, indicating that

Table 3--Distribution of construction grants for wastewater treatment works awarded under P.L. 92-500, compared with the distribution of urban population.

Community size	Urban population 1/		Dollar awards 2/		Awards 2/		Communities 1/	
	Million people	Percent	Million dollars	Percent	Number	Percent	Number	Percent
2,500 and less	9.7	7	458	6	2,263	43	13,237	72
2,501-5,000	6.7	5	254	3	749	14	1,911	10
5,001-10,000	9.8	8	480	6	621	12	1,397	7
10,001-25,000	17.6	13	1,014	13	649	12	1,134	6
25,001-50,000	15.7	12	898	11	319	6	453	3
More than 50,000	72.6	55	4,897	61	697	13	384	2
Total	132.2	100	8,044	100	5,303	100	18,516	100

1/ U.S. Department of Commerce (1974).
2/ U.S. Environmental Protection Agency (1976).

current subsidy programs do not reduce negative effects suffered by smaller communities due to P.L. 92-500.

Two suggested approaches for reducing the cost burden of sewage treatment regulations for small communities are: requiring less wastewater treatment in rural areas (when possible) and relating the Federal share of total costs to community size.

The cost of wastewater treatment for small communities can be reduced by tailoring the required level of treatment to local water quality conditions. In many regions of the United States, small discharges of partially treated wastes will not have a significant effect on the environment. The volume of water in receiving streams is relatively large compared to the population density so the streams can assimilate the wastes.

An alternative solution is a transfer of additional resources to rural communities using subsidies. If society imposes demands for advanced levels of treatment on rural communities, it may elect to share a larger proportion of treatment costs. The failure of existing cost-sharing formulas to reduce the impact on rural communities is discussed in the previous section. The subsidy could decrease as community size increases. The subsidy could cover up to 100 percent of construction costs and some proportion of operation and maintenance costs. An expensive treatment facility is useless if the local community cannot afford to operate it. For example, operation and maintenance costs for a 0.5 mgd activated sludge treatment facility are $0.34/1,000 gallons; while for a similar 5 mgd facility, total costs are $0.26/1,000 gallons (table 1). Thus, even with a 100 percent capital subsidy, treatment operation costs for the 0.5 mgd facility are higher than the unsubsidized costs for the 5 mgd facility. If the 5 mgd facility receives a 75 percent capital subsidy, local costs are $0.16/1,000 gallons (table 2). For the smaller facility to have similar local treatment costs, a 100 percent capital subsidy and a 50 percent subsidy for operation and maintenance would be required.

LAND APPLICATION OF EFFLUENTS AND SLUDGES

The second major impact of P.L. 92-500 on rural America is the increased emphasis being given the concept of recycling wastewater and sludges onto land, particularly agricultural land. Land application of wastewaters and sludges will impact rural communities in two ways. First, in many cases it is the most cost-effective method for high level wastewater treatment and for sludge disposal for small communities (table 1). Second, when larger communities decide to use land application they will have to go to rural areas in order to obtain sufficient land areas. For example, the city of Chicago transports its sewage sludge 200 miles south to Fulton County, Illinois, in order to dispose of it onto land (Zenz, Peterson, Brooman, and Leu-Hing, 1976). Muskegon, Michigan, pumps 27 mgd of wastewater 11 miles to its land application site (Walker, 1976). 5/ Land application by large communities in rural areas may or may not benefit rural regions. A well run land application system can increase job opportunities, agricultural production, and open space. A poorly operated

5/ The design flow at Muskegon is 42 mgd.

system may have odor problems, may be a health hazard, and may be aesthetically displeasing to view. A publicly owned land treatment system will remove land from the tax rolls, which can have a significant effect on property tax revenues. 6/

Land application refers to the controlled discharge of partially treated wastewater or sewage sludge (solids) onto the land. The soil filters and biologically reduces the components in the sewage. Sewage effluent can be applied to land using solid-set irrigation systems, center pivot irrigation systems, flood irrigation techniques, and infiltration basins. 7/ Sewage sludge can be applied to the land by several means. As sewage sludge comes from the wastewater treatment process it contains approximately 95 percent water and can be considered a liquid. In this form, it can be sprayed onto the land using irrigation equipment; it can be sprayed onto land using a tank truck; or it can be injected into the soil using special application equipment. By injecting sludge into the soil, odors and nitrogen losses due to volatilization are reduced. Sludge can be dried to approximately 80 percent moisture content (resulting in an 80 percent volume reduction) and applied to the land as a solid using a conventional manure spreader or special sludge handling equipment. The sludge can be further dried using heat treatment to kill pathogens. Milorganite, heat dried sludge from Milwaukee, Wisconsin, is such a product. Alternatively, the sludge can be composted to provide a very high degree of pathogen kill. Composted sludge can be handled easily with few odor problems.

Land application is one of the least expensive alternatives available to achieve high level wastewater treatment, especially for smaller communities A 0.5 mgd center pivot irrigation system will cost a community approximately $0.80/1,000 gallons opposed to a $1.65/1,000 gallons for a lime addition, filtration advanced wastewater treatment system (table 1). The lime addition, filtration advanced wastewater treatment system and the irrigation systems provide equivalent levels of wastewater treatment. The relative cost advantage of land application of effluent decreases as facility size increases. The 10 mgd center pivot irrigation system costs $0.32/1,000 gallons, opposed to $0.36/1,000 gallons for the lime addition, filtration advanced wastewater treatment system (table 1). Based on this cursory cost examination, it seems likely that land application will be most effective for smaller communities. Larger facilities will face an additional disadvantage in the use of land application. As the area required for the land application system increases, land acquisition costs will probably increase in order to obtain a contiguous site. A 50 mgd land application system will require more than 10,000 acres in order to apply 2 acre-inches of wastewater per week to the land.

Land application of sewage sludge is likely to be used by communities of various sizes. If a community's sewage sludge does not contain toxic metals or chemicals, it is likely that land application is the least expensive alternative for disposal of sewage sludge available. Land application and landfill disposal of sewage sludge cost approximately the same amount per

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6/ Chicago makes a payment to Fulton County in lieu of taxes.

7/ An infiltration basin is a shallow pond which through intermittent wetting and drying cycles applies sewage at the rate of 1 to 2 acre-feet per week to the land.

gallon of sludge and are considerably less expensive than incineration. When toxins are present in the sludge, the community can force industrial dischargers to remove them via pretreatment regulations or surcharges as discussed by Carlson and Seagraves (1977).

A major advantage of land application of wastewater and sludges in addition to wastewater treatment is the production of a by-product--agricultural crops--to offset a portion of treatment costs. At an application rate of 2 acre-inches per week of sewage effluent in Pennsylvania, agricultural yields generally exceed crop yields using fertilizer (Sopper and Kardos, 1973). Two acre-inches of effluent applied for approximately 40 weeks a year supply quantities of nutrients equivalent to recommended fertilizer practices for Pennsylvania. Yields have also been shown to increase with application of sewage sludge over time (Kelling, Walsh, and Peterson, 1976). Four major constituents of effluent and sludge are useful to agricultural crops: water, nitrogen, phosphorus, and organic matter.

Land application of effluent has been used throughout the United States for many years, especially in the arid southwestern States. The distribution of land application sites throughout the United States in 1968 is shown in table 4. Land application predominated in California, Texas, New Mexico, and Arizona. In these States, the average value of water for crop irrigation is high relative to the rest of the nation. Most of these facilities selected land application since it was less costly than conventional wastewater treatment. Land application systems in arid States will be expected to use lower application rates and therefore more land in order to maximize net crop revenue from the system. Systems in more humid regions will be expected to base their application rates on nutrient concentrations.

SUMMARY AND CONCLUSIONS

Upgrading the level of wastewater treatment as mandated by P.L. 92-500 will have a serious impact on rural economies. Centralized wastewater treatment is very expensive. This is particularly significant for small communities where per capita costs are higher due to economies of size in wastewater treatment. Average wastewater treatment costs decrease as much as 50 percent as facility size increases from 0.5 mgd (5,000 people) to 5 mgd (50,000 people). Rural communities not having collection systems in place will incur additional cost for their construction. P.L. 92-500 provides subsidies to offset a portion of the wastewater treatment costs. If all communities obtain Federal grants, smaller communities save more per unit of wastewater treatment than do larger communities but per unit costs remain higher for the smaller communities. However, examination of EPA construction grant awards indicates that small communities have received fewer grant awards than larger communities and that smaller communities have not received more grant dollars per capita than larger communities.

A second major impact of P.L. 92-500 on rural communities is the increased emphasis on land application of wastewater as a method for advanced wastewater treatment and for sludge disposal. For smaller communities, land application of sewage effluents is an economical method for advanced wastewater treatment.

Table 4--Distribution of municipal land treatment sites by State, 1968.[1/]

State	Land treatment sites	Wastewater treatment plants	Portion using land treatment
	---- Number ----		Percent
Alabama	1	267	.4
Arizona	17	79	21.5
California	259	534	48.5
Colorado	2	154	1.3
Florida	5	535	.9
Kansas	1	477	.2
Maryland	11	154	14.0
Massachusetts	1	192	.5
Nebraska	1	434	.2
Nevada	12	36	30.0
New Hampshire	2	79	2.5
New Jersey	2	380	.5
New Mexico	28	82	29.3
North Carolina	14	384	3.6
Oklahoma	3	374	.8
Oregon	6	178	3.4
Texas	106	918	11.5
Virginia	1	301	.3
Washington	10	140	7.1
West Virginia	3	101	3.0
Wisconsin	4	499	.8
Wyoming	4	82	4.9

1/ Young and Carlson, 1974.

This is especially true in those areas where crop yields increase substantially due to the water and nutrients contained in the sewage effluent. Land application of sewage sludge is likely to be utilized by many communities throughout the United States. It is one of the least costly methods available for disposal of sewage sludges which do not contain toxic contaminants.

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Impacts of Public Law 92-500 Grants and Cost Recovery on Efficiency

by Gerald A. Carlson and James A. Seagraves*

Sections 201 and 202 of P.L. 92-500 specify that the Environmental Protection Agency (EPA) will pay 75 percent of the capital cost of approved waste treatment works, including connecting sewers and land application systems. Growing awareness that funds are limited is forcing ever-narrower definitions of what will be funded and puts pressure on the States to figure out how to assign priorities. A high subsidy for some items and none for others can have a variety of negative effects on the allocation of resources. We advocate that Congress return to 55 percent grants, that they provide the same federal share of operating and maintenance costs, and that they explicitly include the same subsidies for non-plant pollution control measures.

Section 204(b) (1) (B) of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) requires industrial users of the treatment works to make payments for that portion of the cost of construction and operation of such works which is allocable to the treatment of such industrial wastes. The congressional intent of this provision is that "it is inappropriate in a large Federal grant program providing a high percentage of construction funds to subsidize industrial users from funds provided by taxpayers at large" (EPA, 1976). This provision is getting more and more attention as municipalities are required to have in operation an industrial cost recovery and user charge system prior to receiving more than 80 percent of the Federal grant.

The financial provisions of the 1972 Amendments are especially important for certain industrial firms whose waste streams contribute a large proportion of the treated wastes. This includes many food processing firms which have high biochemical oxygen demand (BOD) and suspended solid wastes that can be connected to small towns' facilities.

There are many forms of adjustment to the Federal subsidies and required taxes on industrial users. The service of waste treatment is a many dimensional good which has many margins of adjustment. Communities which seek Federal grants have multiple objectives of minimizing local tax and user payments, attracting and maintaining industrial jobs, and preserving healthy and aesthetic living conditions. All of this leads to a complicated set of incentives which the subsidy and changing system has imposed on many communities and agricultural processing units.

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INEFFICIENCIES OF MUNICIPAL GRANTS

It is widely recognized in the economics literature that subsidies to one factor input will induce excess use of the subsidized factor relative to the competitive norm. Capital subsidies will cause cities to construct municipal plants with excess capacity to the extent that operation and maintenance costs (which are locally financed) are not increased. To prevent such excesses in the use of capital relative to land, labor, or energy, EPA has had to institute many guidelines and "cost-effectiveness" checks. This has probably contributed to the slow rate of construction and the fact that about 50 percent of municipalities do not meet the P.L. 92-500 July 1, 1977, goal of secondary treatment.

Prior to P.L. 92-500, there was a strong incentive for small towns to jointly treat wastes with industry because average total costs of abatement fall drastically with the volume of flow through a treatment facility. For example, Young and Carlson (1975) found that total costs for 125 municipal systems increased only by 7 percent as size was increased 10 percent. Thus, a town could afford to offer inducements up to 30 percent of the facility's cost to attract a plant that would double treatment plant size. When the local share of capital cost is only 15 percent, then there is proportionally smaller incentive for municipal officials to combine with industries and other towns (see figure 1).

Likewise, a larger proportion of the risks of underutilization of capacity are borne by the Federal Government under P.L. 92-500. That is, if a municipality builds a treatment facility, it must collect capacity utilization charges (industrial cost recovery) from industry only as long as the industrial plant is on the system. Should an industry leave, it stops paying these charges to local government (50 percent) and Federal Government (50 percent). Prior to the 1972 laws, the local government would have borne <u>all</u> costs of underutilized capacity. Capacity utilization costs are not trivial. The Young and Carlson study showed that reducing capacity utilization 10 percent can increase average total costs 6 percent (see figure 2). Under earlier incentives, local government could afford to use long-term contracts to insure future capacity utilization. Again, it is easy to see that these considerations are most critical to towns with a small number of large industrial users.

It is interesting to speculate on the joint efforts of small towns and industrial plants to minimize treatment costs in the presence of the Federal grants program. Clearly, industry now has to pay for its use of capital and operation costs. Yet, no interest need by paid on these capital outlays by industry. Therefore, some industries are likely to use municipal facilities because they gain scale economies and pay no interest costs. Firms are occasionally taking active roles to help cities minimize average total locally borne costs. Yet, many firms choose not to hook on to city services. For example, a tabulation of fruit and vegetable processing firm waste treatment construction shows an increasing share of facilities utilizing land and water disposal (table 1). It may be that the reuse of residuals is more attractive than interest subsidies for industries producing high BOD levels.

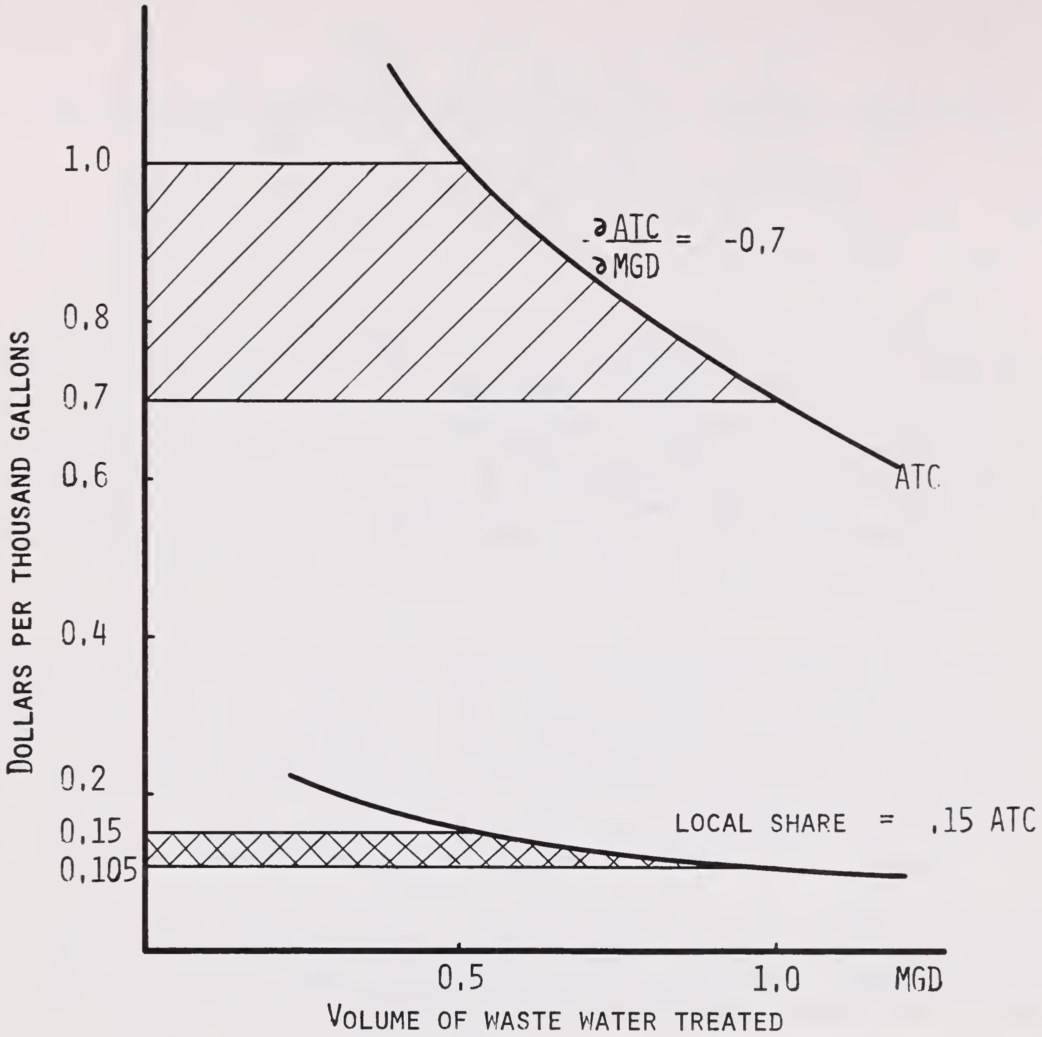

Figure 1. Illustrating savings (shaded areas) from reductions in average total costs associated with doubling the size of a waste treatment works for a small town and the relative insignificance of the local cost sharing. Source: Young and Carlson (1975)

One industry which appears to be heavily supported by other industries is the housing industry. Except for acreage or frontage fees, there is little evidence of charges to pay for additions to connecting sewers associated with providing sewer treatment services to homes, apartments, and commercial firms on the urban fringe. Such firms often cost more to serve because of longer distances to treatment sites, pumping costs, and low population density. Prior to P.L. 92-500, connecting sewers were not available for Federal matching grants. Now, such grants encourage development on the urban fringe (figure 3).

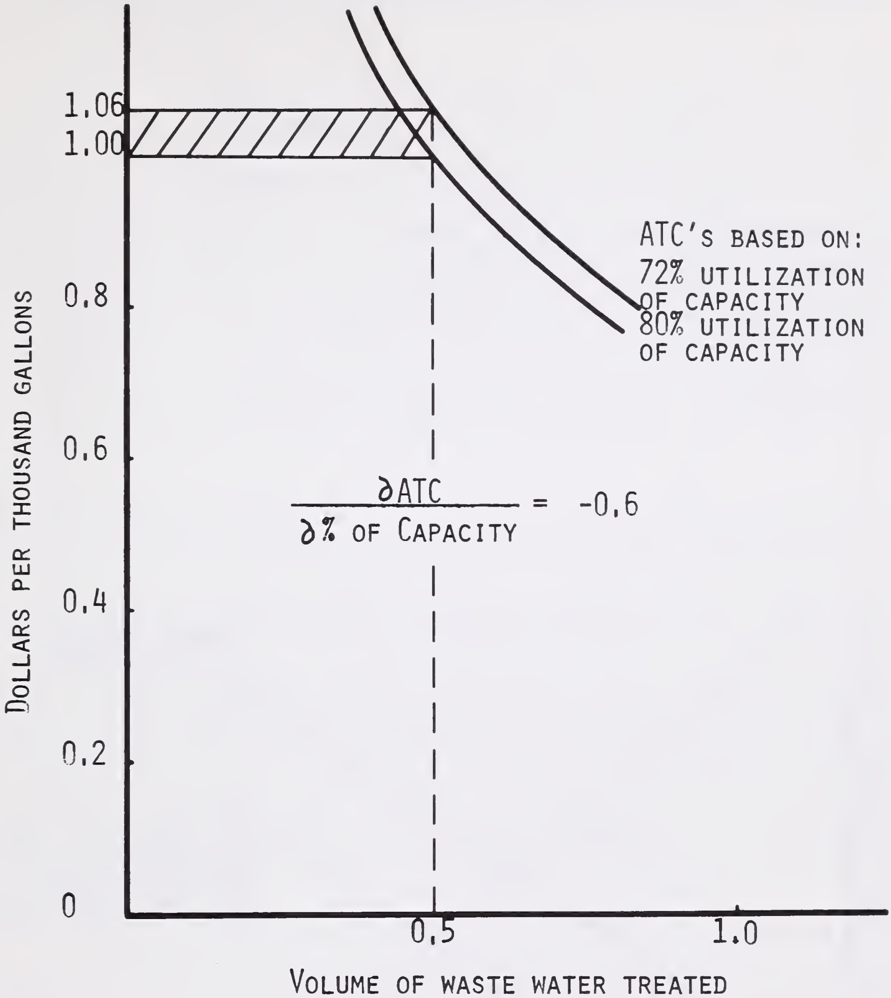

Figure 2. Illustrating losses in terms of average total cost associated with a ten percent reduction in utilization of capacity of waste treatment plants.
Source: Young and Carlson (1975)

This social inefficiency is aggravated by other external costs associated with urban sprawl-congestion externalities.

Another inefficiency associated with the design of treatment facilities is long-run in nature. Subsidizing conventional treatment facilities tends to induce technical change in these methods of treatment at the expense of other methods. Land treatment adoption has been delayed (Carlson and Young, 1975). There is less emphasis on municipal treatment plant operator skills. There is little research in the technology and management of such systems as

Table 1--Methods of ultimate waste disposal chosen by new food processing plants, by selected construction periods

Methods of disposal	Before 1960	1960-69	After 1969
		Percent	
To municipal treatment plants	20	48	35
Land application	60	29	41
Water (to stream or ocean)	20	23	24

Mar and Swayne (1976)

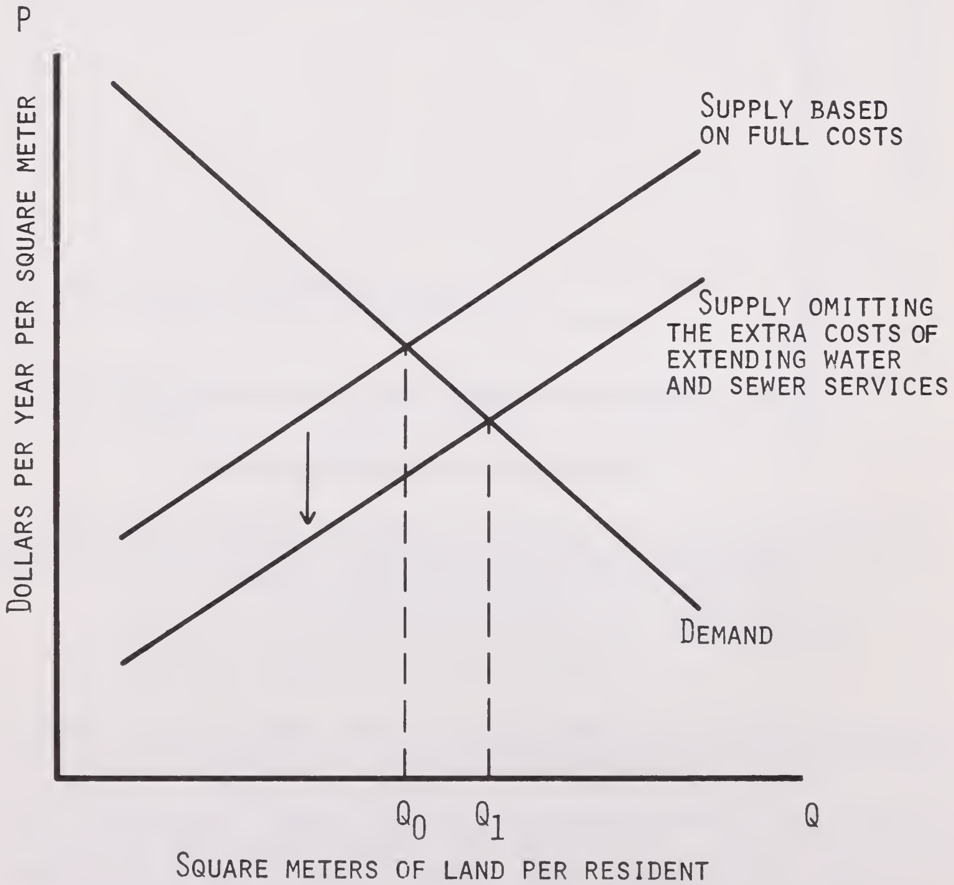

Figure 3. Illustrating effects of not charging the added cost of water and sewer services on lot size and urban sprawl.

low-flow augmentation, instream aeration, and lagoons. Little research on these technologies can be expected in the presence of large incentives for conventional treatment systems.

DISTRIBUTION OF P.L. 92-500 GRANTS

Prior to the Federal financing of public waste treatment, there were relatively larger per capita expenditures in smaller communities (perhaps because of scale economics), in wetter parts of the country (perhaps because there are fewer opportunities for land application), and in higher income States. Some hypotheses about these relationships are that increasing Federal grants would raise relative expenditures in areas with larger communities, in dry areas, and in low income States. An analysis of per capita waste treatment facility expenditures by city size, income level, and climate for the 1968 to 1974 period supports the first two hypotheses. During this period, EPA's share of waste treatment construction contracts rose from 14 percent to 62 percent.

Table 2 gives the percent of expenditures per capita by size of community the treatment facility serves. Prior to P.L. 92-500, communities with less

Table 2--Effect of Federal grant shares on distribution of waste treatment grants, by size of city, selected periods

Item	1968-69 1/	1970-71 1/	1973-74 1/	1976 2/	Urban population 3/
	Percent				
Federal grant shares	14	40	62	75	--
City size:					
500- 2,499	11	12	9	7	7
2,500- 4,999	8	9	6	3	5
5,000- 9,999	12	13	9	6	8
10,000-24,999	18	15	15	13	13
25,000-49,999	15	16	12	11	12
50,000 or more	36	35	49	61	55

1/ Expenditure shares, Environmental Protection Agency, 1968-74 (1974).
2/ Environmental Protection Agency figures from Young (1977).
3/ U.S. Department of Commerce (1974).

than 50,000 people spent 65 percent of the waste treatment dollars while having only about 45 percent of the urban population. This is undoubtedly due to higher treatment plant costs per capita for serving these smaller and less densely populated communities. However, inclusion of storm sewers and collection facilities in the grant program in the 1972 amendments and the red tape involved in grant application favored larger cities. By 1973-74, expenditures per capita closely followed the city-size distribution; 1976 data from Young (1977) shows this trend continuing to give a disproportionate share to cities with over 50,000 in population.

Table 3 shows the results of two tests of the shift of waste treatment to dry States. Prior to the 1972 amendments, States with low rainfall and high evapotranspiration spent about 100 to 150 percent less than the wettest States for waste treatment facilities. It must be that previously people in dry States were content to use land treatment, lagoons, and other forms of inexpensive treatment. Also, they have not had to contend with urban storm waters like wet States have. The 1973-74 expenditure data (2 years averaged) shows a tendency for expenditures to increase relatively more in dry States. Single-equation regression coefficients for 3 cross-sectional (48 States) models are also given in table 2. In each of the three time periods, the dryness index (rainfall-evapotranspiration) is significantly associated with lower waste treatment expenditures for all waste treatment facilities and for collection facilities alone (not shown). The implication is that there has been increased emphasis on waste treatment facilities construction in dry areas. This doesn't seem to have been one of the intentions of the proponents of P.L. 92-500.

It was also hypothesized that P.L. 92-500 affected the relationship between per capita income and the expenditure on waste treatment by States. The single-equation model fit to State expenditure data showed a statistically significant positive income effect for all three periods. (See income coefficients in last row of table 4.) Cleaner water is a normal good. There does not seem to be any significant shift in relative expenditure per capita toward low-income States as a result of P.L. 92-500. (The coefficient .0046 in 1973-74 is not significantly different from .0052 in 1970-71.) This can be interpreted as saying that raising local monies for local matching shares has not served as a barrier to low income States' participation in waste treatment subsidies. Alternatively, one could not say that lowering the local share has speeded waste treatment in low-income relative to high-income States.

WHAT ARE EFFICIENT CHARGING SCHEMES?

Like most other services, there are many dimensions or qualities to waste water service which give it utility to purchasers and others. Municipal waste treatment costs are affected by volume of water flow, content of waste loads, distance to service, and many other characteristics. Consequently, when municipalities charge customers for waste treatment services they may be charging for several qualities of service. In the past it has not been efficient for towns to measure and charge for many service dimensions. It is a question of comparing marginal cost of monitoring and administration of a new charge with the marginal benefits of added metering and charging. Both the metering costs and the resource allocation effects of the pricing

Table 3--Per capita changes in waste treatment expenditures per year in wettest and dryest States with rising Federal cost shares, selected periods

Item	Unit	1968-69	1970-71	1973-74
Federal cost shares	Percent	14	40	62
Expenditures per year:				
20 wettest States	Dollars per capita	8.50	10.05	19.05
20 mid-dry States	Dollars per capita	6.20	6.24	16.96
8 dryest States	Dollars per capita	4.06	3.84	12.38
Wettest-dryest ratio		2.09	2.62	1.65
Regression coefficients E, reflecting added dollars per capita per added unit of "dryness" (average evapotranspiration minus rainfall per State 1/	R^2	-0.062	-0.153	-0.127
	t-ratio	(2.72)	(5.32)	(2.81)

1/ From the following cross-sectional multiple regression equations for State average annual expenditures per capita for waste treatment works:

Years	Equations	R^2
1968-69	E = -2.43 + 0.0006 N + 0.00245*Y + 0.9764 P - 0.06226**D	0.37
1970-71	E = -7.57 - 0.0062 N + 0.00518**Y - 1.8669 P - 0.15269**D	0.52
1973-74	E = 2.23 + 0.0038 N + 0.00459*Y - 1.8955 P - 0.1269**D	0.38

where:

N = population density of States; (It would probably be better to use the percent of the population in cities over 50,000.)

Y = per capita disposable income of States;

P = percent of industries with approved permits for independent discharges as of 1970 (same for each regression); and

D = dryness of States as indicated by evapotranspiration - rainfall + 20 inches; * and ** indicate that coefficients are significantly different from 0 at more than the 5 and 1 percent levels, respectively.

Table 4--Per capita waste treatment works expenditures in high and low income States with rising Federal cost shares, selected periods

Item	Unit	1968-69	1970-71	1973-74
Federal cost shares	Percent	14	40	62
Expenditures per year				
8 Highest income States	Dollars per capita	7.43	9.41	18.75
32 Mid-income States	Dollars per capita	6.79	6.86	16.93
8 Lowest income States	Dollars per capita	5.08	4.69	11.36
High-low ratio		1.46	2.01	1.54
Regression coefficients reflecting added expenditures per dollar of added disposable income per State 1/	R^2	.0025	.0052	.0046
	t-ratio	(2.53)	(4.25)	(2.39)

1/ These partial regression coefficients are from the multiple regression equations given in table 3.

mechanisms are important. That is, assuming firms pay the same total amount in each case, more sophisticated pricing schemes must be justified in terms of improved resource allocation.

There is a tendency in the administration of EPA grants to require that charges be based on usage and especially that industrial firms pay according to pounds of BOD and suspended solids treated as well as the volume of waste water.

Before P.L. 92-500, a number of cities adopted waste strength charges on their own. These were primarily cities with high waste treatment requirements located on small streams that had some industries sending them treatable wastes. Elliott and Seagraves (1972) estimated elasticities of industrial waste (water-carried BOD -0.8, and industrial water consumption -0.6) with respect to surcharges on BOD and suspended solids. McLamb and Seagraves are in the process of making a new survey of cities using strength charges; they hope to improve upon earlier estimates.

Many people would agree that such incentive charges do affect usage. But, should charges on BOD and suspended solids be recommended to all cities? Our reaction is "no!" They are only worthwhile if extra monitoring and administrative costs are less than marginal benefits.

One adverse incentive of charging food processing industries for their wastes is that some of the processing then will be driven to homes and restaurants which don't "feel" these costs or pay strength charges.

Strength charges may make sense for some potentially toxic materials and for some pollutants which cities are not now treating. Cities might encourage removal of such materials at the industrial plants with a system of permits plus penalties. This would be logical if States held cities responsible for water quality. Cities could assign penalties based on their expected future costs of tertiary treatment of such substances. If such a charge led to complete in-plant recovery of such "byproducts," so much the better.

WHAT ARE EFFICIENT WASTE MANAGEMENT UNITS?

P.L. 92-500 specifies in Section 201 (e) and Section 208 that EPA shall encourage the establishment of regional waste management agencies. Their scope of activities is broadly defined to include solid as well as liquid wastes, waste heat, and probably even air pollution and water supplies. Once established, these agencies would be the sole recipients of EPA grants (Section (d)) in each region and eventually they should be self-sufficient units of government. These regional management agencies could be units of a State-owned waste management corporation. Another possibility is that the State could franchise major cities or counties to carry out a set of well-defined tasks within a region.

Regardless of the degree of centralization, one factor that is not often recognized about P.L. 92-500 is that it does allow the State to implement stream charges both for withdrawals of water and for discharge of wastes; each charge could depend on both water qualities and quantities. It is important that waste management agencies be allowed to dispassionately consider the advantages of liquid versus solid means of transporting, utilizing, and disposing of various wastes. Also, such agencies should be encouraged to use non-plant techniques such as in-stream aeration, flow augmentation, and controls on non-point pollutants and to implement the most cost-effective ways to improve the environment.

While P.L. 92-500 seems to permit many things, it is also being interpreted by some to require uniform implementation of new regulations and agencies on strict timetables. This is not logical. Regional waste management agencies are needed in some places much more than in others. They represent expensive social experiments. Obviously, the States and EPA should try out these new ideas where they are most needed first.

SUMMARY AND RECOMMENDATIONS

It appears to be clear that Congress wants to continue funding publicly owned waste treatment works including sewage collection, community septic, and land application systems at the 75 percent level. Local communities are paying a small proportion of capital costs compared with their paying 100 percent of operation and maintenance costs; if States pick up an additional share of these capital costs, the resulting misallocation of resources can be serious. There is a strong incentive to buy capital intensive systems and expensive designs. EPA has had to try to offset many such adverse incentives with regulations regarding the size, "cost effectiveness," and the operation and maintenance of systems.

Even though "waste treatment works" that may be funded by P.L. 92-500 are broadly defined, there is still a marked bias against non-plant techniques for improving the environment (such as in-stream aeration and low-flow augmentation). Limited funds plus the 75 percent constraint will probably cause further reduction in the classes of projects funded. A more sensible position for EPA to take would be to ask Congress to switch back from 75 percent to 55 percent matching grants while adding non-plant alternatives for improving the environment. Land application techniques of waste treatment should be given equal consideration in the analysis of alternative systems.

Add to these large subsidies and the capital intensive waste treatment plants that cities want to build a requirement that industrial users will have to pay their fair share of total costs, and you have a strong incentive for larger firms to treat their own wastes. It will be profitable for some firms to treat their own wastes despite the interest-free loans they receive via the repayment policies of the municipal grants program.

Thus, we hypothesize that both the scale and the percentage utilization of waste treatment plants financed with matching grants will be less than optimal. The grants encourage costs to be excessive; and the high costs of the industrial costs recovery program cause industries to go their own way. Depending on when they pull out, it affects either scale or percentage utilization. We recommend EPA require long-term contracts between cities and firms to improve capacity utilization.

Another allocative effect of making industry pay full cost of waste removal while subsidizing the same in households could be to shift more food preparation and preservation to households. Further study of the resource allocation costs of this and similar effects are needed.

P.L. 92-500 also contributes to geographic dispersion of households and urban sprawl by paying a high proportion of the cost of trunk lines and collection systems. We would recommend elimination of grants for collection systems and storm sewers. Guidelines for cost recovery from households or apartments should require cities to consider the marginal cost of additional service to serve fringe area subdivisions.

Allocation systems for grant monies have boosted investments in waste treatment systems in dry areas and other regions which previously had little need for expensive waste treatment plants. We encourage less equalization of grant allocations by insisting on more analysis of assimilative capacities of both land and water.

Prior to P.L. 92-500, charges based on the strength of industrial waste water were mainly used in regions which had high waste treatment requirements and only then by cities with some industries that were discharging large amounts of treatable wastes (usually BOD). P.L. 92-500 has caused many cities in other regions to build expensive waste treatment plants, has added requirements that industry pay its share of the costs and has caused a number of these cities to adopt industrial waste strength charges on BOD and suspended solids. In certain cases it is sensible for EPA to encourage the use of more sophisticated incentives including charges and penalties for pounds of various harmful waste materials discharged. Such charges should not exceed the future incremental cost of removing these substances plus the damaging effects of the remaining quantities on downstream populations.

Emphasis on conventional waste treatment and removal of BOD has been stressed in some regions where oxygen depletion in water is not a problem. Perhaps regulations promulgated by P.L. 92-500 have been more costly in this regard than financing schemes. Still, it would seem that some cities are now being encouraged to charge industries for BOD levels when the emphasis would be better placed on toxic materials. We recommend consideration of penalties or subsidies for non-municipal treatment plant removal of these wastes.

One of the critical issues relating to Section 208 planning is that it is difficult to know how much to plan new programs and regulations if one doesn't know what units of government will be implementing them (local governments or new regional waste management agencies of States). We recommend reallocation of funds away from planning and toward highly selective trials of regional management agencies in some regions where the need for coordinated programs is greatest. These agencies would be encouraged to use a variety of charges and subsidies for water withdrawals and waste discharges and to experiment with non-plant treatment techniques.

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An Aggregate Economic Analysis of Potential Erosion and Plant Nutrient Controls in the Corn Belt[1/]

by C. Robert Taylor, Klaus K. Frohberg, and Wesley D. Seitz*

Agricultural non-point sources of water pollution are receiving increasing attention because of impending controls under the 1972 amended Water Pollution Control Act (P.L. 92-500). The two non-point sources that have been receiving primary attention in the Corn Belt are sediment and nitrates. Sediment may be classified as a pollutant because of its deleterious effect on stream water quality and the filling up of reservoirs. Nitrates in water supplies are of concern because at certain concentrations they are dangerous to human and animal health. In certain circumstances nitrates also pose a threat to balanced aquatic life in surface waters. Finally it has recently been alleged that the increased fixation of nitrogen threatens to reduce the protective ozone content of the upper atmosphere, thus increasing the incidence of skin cancer. See CAST (1976) for a review of the allegations.

This paper presents estimates of the intermediate term economic effects of imposing various controls on erosion and nitrogen fertilizer use in the Corn Belt. Controls imposed uniformly throughout the Corn Belt are being considered now because the Federal EPA must approve all State and local non-point pollution controls; Section 103 of the act states "The Administrator (of EPA) shall encourage--so far as practicable, uniform state laws relating to the prevention, reduction, and elimination of pollution..." Also, consideration of all combinations of controls that differed by State would be impractical.

[1/] Research supported by a contract from the U.S. Environmental Protection Agency #68-01-3584. The final report "Alternative Policies for the Control of Nonpoint Sources of Water Pollution from Agriculture" by Seitz, et al., is in preparation. The research was conducted through the Institute for Environmental Studies with the cooperation of the Agricultural Experiment Station at the University of Illinois, Urbana-Champaign. The authors acknowledge the contributions of other members of the research team.

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THE MODEL

Impacts of soil-loss and nitrogen restrictions were analyzed through the solution of a large linear programming model of Corn Belt crop production. This model provides the capability to estimate market prices for corn and soybeans based on estimates of the demands for these products. Thus, the model generates a competitive market equilibrium in the production of these crops and is able to indicate the price impacts of several types of restrictions. In addition to estimating the effects on producers and consumers, solutions to the model indicate changes in soil loss, nitrogen use, crop production, acreage, pesticide use, and crop prices.

The land base for the area modelled was divided into 11 land capability units (LCU's) within each of 17 geographical regions which are land resource areas (LRA's) defined by the Soil Conservation Service (table 1).

Crop production activities in the model differ by crop rotation (an average of about 11 rotations for each LCU within each LRA), conservation practices (straight row, contouring, and terracing) and tillage methods (fall plow, spring plow, and chisel plow). Rotations rather than just single crop activities are included in the model to reflect the influence of the previous crop on the fertilizer and pesticide requirements of the current crop. The model has 14,372 crop production alternatives and 545 resource constraints. With the exception of the soil loss coefficients, the model is the same as one used in an earlier study by Taylor and Frohberg (1977).

Two sets of soil-loss coefficients were used. The model was initially constructed with coefficients supplied by the Federal Soil Conservation Service. Local SCS personnel reviewed these results and suggested that the soil losses were higher than expected. A new set of soil-loss coefficients were constructed by Illinois SCS personnel using the Universal Soil Loss Equation (USLE). A number of policy runs were repeated using these coefficients. As will be indicated in the discussion of results, the revised soil losses may be somewhat low. If so, the two sets of results bracket the actual soil losses to be expected.

MODEL RESULTS

The model was run for each of the following conditions and constraints:

A. High Soil-Loss Coefficient:[2/]

1. Benchmark
2. Soil-loss constraints of 2, 3, 4, 5 tons/A (*)
3. Soil-loss taxes on $4, $2, $1, and $.5/T (*)
4. Terracing subsidies of $4, $10, $15, $20, and $40/A (*)
5. Prohibition of chisel plowing

2/ Results of runs designated by an * asterisk were reported in an article by Taylor and Frohberg (1977) and are duplicated here for comparison with the additional runs.

Table 1--Actual acreages of crops planted in 1969 compared to acreages in the benchmark solution of the Corn Belt model, using high soil-loss coefficients

LRA	Region	Corn and grain sorghum		Soybeans		Small grains		Hay and pasture	
		Actual	Model	Actual	Model	Actual	Model	Actual	Model
		Thousand acres							
91	Wisconsin and Minnesota Sandy Outwash	218	0	7	0	153	487	608	781
95	Southeastern Wisconsin Drift Plain	1,677	789	191	789	781	1,810	1,981	1,930
97	Southwestern Michigan Fruit and Truck Belt	109	95	16	0	46	223	106	136
98	Southern Michigan Drift Plain	1,428	2,844	607	645	610	523	1,184	1,225
102	Loess, Till, and Sandy Prairies	5,259	5,718	1,151	2,039	3,689	2,611	3,803	4,145
103	Central Iowa and Minnesota Till Prairies	4,976	4,993	3,644	4,308	1,132	1,460	2,084	2,276
104	Eastern Iowa and Minnesota Till Prairies	1,630	1,356	789	1,356	465	415	984	1,021
105	Northern Mississippi Valley Loess Hills	1,440	1,980	133	0	660	22	2,511	2,644
106	Nebraska and Kansas Loess-Drift Hills	1,474	1,028	280	748	418	382	1,013	1,112
107	Iowa and Missouri Deep Loess Hills	3,189	2,001	1,406	2,001	530	328	2,205	2,613
108	Illinois and Iowa Deep Loess and Drift	7,874	8,241	4,090	4,619	1,218	247	3,096	3,328
109	Iowa and Missouri Heavy Till Plain	1,207	890	897	611	253	0	2,927	3,270
110	Northern Illinois and Indiana Heavy Till Plain	1,472	1,541	1,135	1,541	203	56	291	395
111	Indiana and Ohio Till Plain	4,480	4,591	3,475	2,272	1,687	4,283	2,434	2,329
113	Central Claypan Areas	870	1,421	983	657	384	302	956	907
114	Southern Illinois and Indiana Thin Loess and Till Plain	1,729	2,035	1,420	2,035	563	0	1,236	1,364
115	Central Mississippi Valley Wooded Slopes	2,015	2,249	1,269	1,238	627	339	2,506	2,340
	Total	41,047	41,700	21,493	24,859	13,419	13,488	29,925	31,816

6. Soil loss of 3 tons/A and terracing subsidies of 50 percent of costs, $15/A and $20/A
7. Nitrogen restriction to 50 lbs/A
8. Nitrogen restriction to 50 lbs/A and soil-loss constraints of 2, 3, 4, 5 tons/A
9. Nitrogen restriction to 100 lbs/A
10. Nitrogen restriction to 100 lbs/A and soil-loss constraints of 2, 3, 4, 5 tons/A

B. Low Soil-Loss Coefficients:

1. Benchmark
2. Prohibition of chisel plowing
3. Restriction of chisel plowing
4. Soil-loss constraints of 2, 3, 4 tons/A
5. Soil-loss tax of $4/T
6. 100 percent cost sharing for terracing
7. 100 percent cost sharing for terracing and soil-loss constraint of 2 tons/A
8. Nitrogen restriction to 50 and 100 lbs/A

In the following discussion, selected results of these runs will be presented to illuminate the nature of the impacts of the several policies and policy components studied.

Benchmark Solution

An understanding of the benchmark runs is important because the results serve as a basis of comparison for results obtained under each of the constrained runs. Table 1 gives the actual acreages of crops planted in the several regions of the Corn Belt and crop acreages developed in the benchmark solution of the model using the high soil-loss coefficients. The two sets of acreages are reasonably consistent. Regions with large acreage tend to be more accurately reflected in the model results than some of the regions with less acreage. Because farm operators may prefer certain crops and because any given field may include several LCU's, results would not be as clear cut as indicated here. These factors tend to give model results indicating more efficient crop production, with higher net farm income and less soil loss, than would actually be observed.

The LCU designations are based on the 1967 Conservation Needs Inventory. Thus, conservation practices in effect at that time are reflected in the model.

In general, the benchmark solution indicates a somewhat more efficient organization for the production of crops than would be expected in practice. This fact should not have a significant adverse effect, however, on comparisons among solutions.

Restriction of Chisel Plowing

The runs in which varying levels of chisel plowing were permitted are summarized in table 2. When chisel plowing was used in all situations where it would have been profitable, as reflected in two benchmark solutions, over

Table 2--Computer-simulated effects of restricting chisel plowing

Item	Unit	Benchmark 1/ (High SLC) 2/	Chisel plowing prohibited (High SLC)	Chisel plowing prohibited (Low SLC)	Chisel plowing on 33 million acres only (Low SLC)
Social cost 3/	Mil. dol.	0	-270.80	-281.55	-269.14
Consumer cost 4/	Mil. dol.	0	210.51	269.60	222.60
Producer cost 5/	Mil. dol.	0	-481.31	-551.15	-491.74
Corn prices					
Corn	Dol./bu.	2.46	2.46	2.46	2.46
Soybeans	Dol./bu.	5.26	5.22	5.22	5.22
Production					
Corn	Mil. bu.	3744.20	3736.60	3740.30	3738.40
Soybeans	Mil. bu.	785.00	792.30	792.30	792.30
Acres terraced	Mil. acres	0	0	0	0
Reduced tillage	Mil. acres	77.33	0	0	33.22
Gross soil loss	Mil. tons	595.81	2275.85	578.07	478.19
Gross soil loss	Tons per acre planted	5.30	20.35	5.17	4.27
Insecticide expenditures index		100	92	97	98
Herbicide expenditures index		100	86	87	93
N load	Bil. lbs.	4.19	4.19	4.19	4.19
N load	Lbs./acre	100.58	100.93	100.24	100.21

1/ Some small price and production differences were found between the benchmark run with low soil-loss coefficients and the benchmark run with high soil-loss coefficients. These differences must be due to the random choices possible in a model of this size and complexity and to rounding errors. To avoid confusion, only the run for the high soil-loss coefficients is shown. The minor differences that were found should remind the reader of the need to interpret all results with care; minor differences among model runs may not be significant.

2/ SLC denotes soil-loss coefficients used in the model.

3/ Social cost is defined to be the sum of producer cost and consumer cost.

4/ The method used to estimate consumer cost accounts for both the price and quantity impacts.

5/ Producer cost includes the impact on returns to land, labor, capital, and management.

77 million acres were chisel plowed, resulting in substantial reductions in soil loss. The magnitude of the impact can be appreciated by comparing runs where chisel plowing is completely prohibited with those restricting chisel plowing to 33 million acres--the estimated acreage on which the practice is currently used (see figure 1). With high soil-loss coefficients, use of chisel plowing (wherever profitable) would have reduced soil loss to 26 percent of the more than 20 tons per acre lost when chisel plowing was pro-

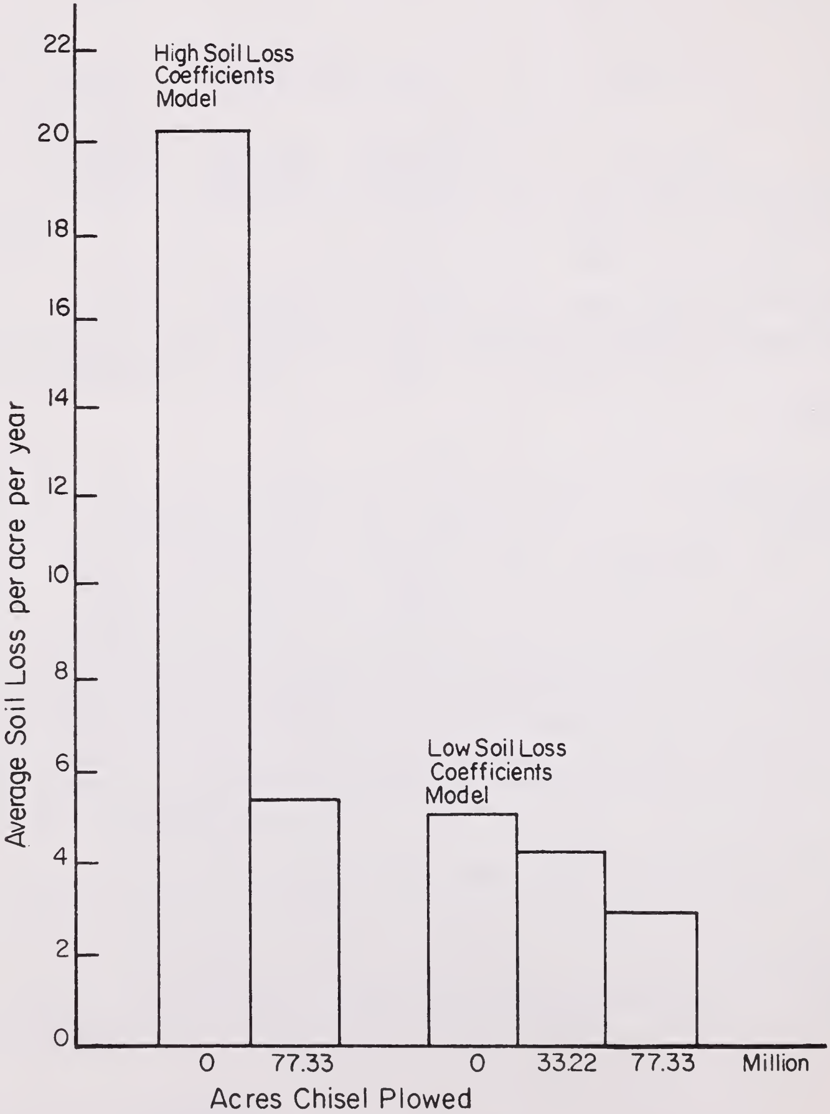

Figure 1. Average soil loss per acre per year with and without chisel plow constants.

hibited. With low soil-loss coefficients, chisel plowing on 33 million acres would reduce losses from 5.33 to 4.27 tons per acre, while use on 77 million acres would hold soil losses to 2.96 tons per acre. Because soil losses would have been reduced if chisel plowing were expanded, and since more farmers continue to adopt the practice, the benchmark runs may be interpreted as a projection of what can be expected in the future under the present institutional arrangement.

All soil-loss and nitrogen fertilizer constraint runs in this analysis were compared to the benchmark solutions where chisel plowing was not limited. If all runs with soil-loss constraints were made with no restrictions on chisel plowing (thus showing the tendency to shift to that practice as a means of meeting the constraint) and were compared to a run with restricted chisel plowing (reflecting current practice) the following changes would be observed: (1) the reduction in soil loss from soil-loss constraints would be greater, (2) the social cost of soil-loss control would be reduced, and (3) some modifications in crop production pattern changes might be observed. Thus, the manner in which chisel plowing is handled in the model results in conservative estimates of the impact of expenditures for soil erosion control.

Soil-Loss Limitations

The results presented in figure 2 illustrate the impact of restricting Corn Belt soil losses to 2, 3, 4, and 5 tons per acre. If the low soil-loss coefficients were correct, costs to society would not be large. If the high coefficients were accurate, costs would be significant, especially if the lower soil-loss restrictions were adopted. Because of the manner in which the model is constructed, it is not possible to model the impact of adopting the soil-loss tolerances set by the SCS. These tolerances generally vary between 2 and 5 tons, so results presented here should bracket the expected impact. SCS limits are established at a level which will not prevent production; hence the impact would be less severe with those limits than indicated by the model solution. In the latter case, considerable acreage is not used for production because the technology required to achieve the specified soil-loss limit is not available. (Erosion is assumed to cease to be a problem on land removed from the productive base.)

Contrary to popular belief, the burden of the restrictions falls more on consumers than producers. For all soil-loss restrictions, consumers lose, while producers gain with some restrictions and lose with others. In this particular case, it is thought the mixed impact on producers results from idiosyncrasies of the model (related to steps on the demand function). Allowing for these, it would seem that the effect on producers is either very small or beneficial. Although the restrictions increase the prices of major crops and the cost of production on land in production, producers benefit because effects on costs are smaller than price effects. The crop price and production impacts using the low soil-loss coefficients are not shown in figure 2 because they are insignificant. For example, soybean production drops only 3 percent with a 2-ton-per-acre limit. Of course, producers with high soil-loss rates would earn lower profits if a restriction were imposed; those without serious soil erosion problems would gain. Thus, we see that under a soil-loss restriction the largest losses would be taken by producers with serious erosion problems and by consumers.

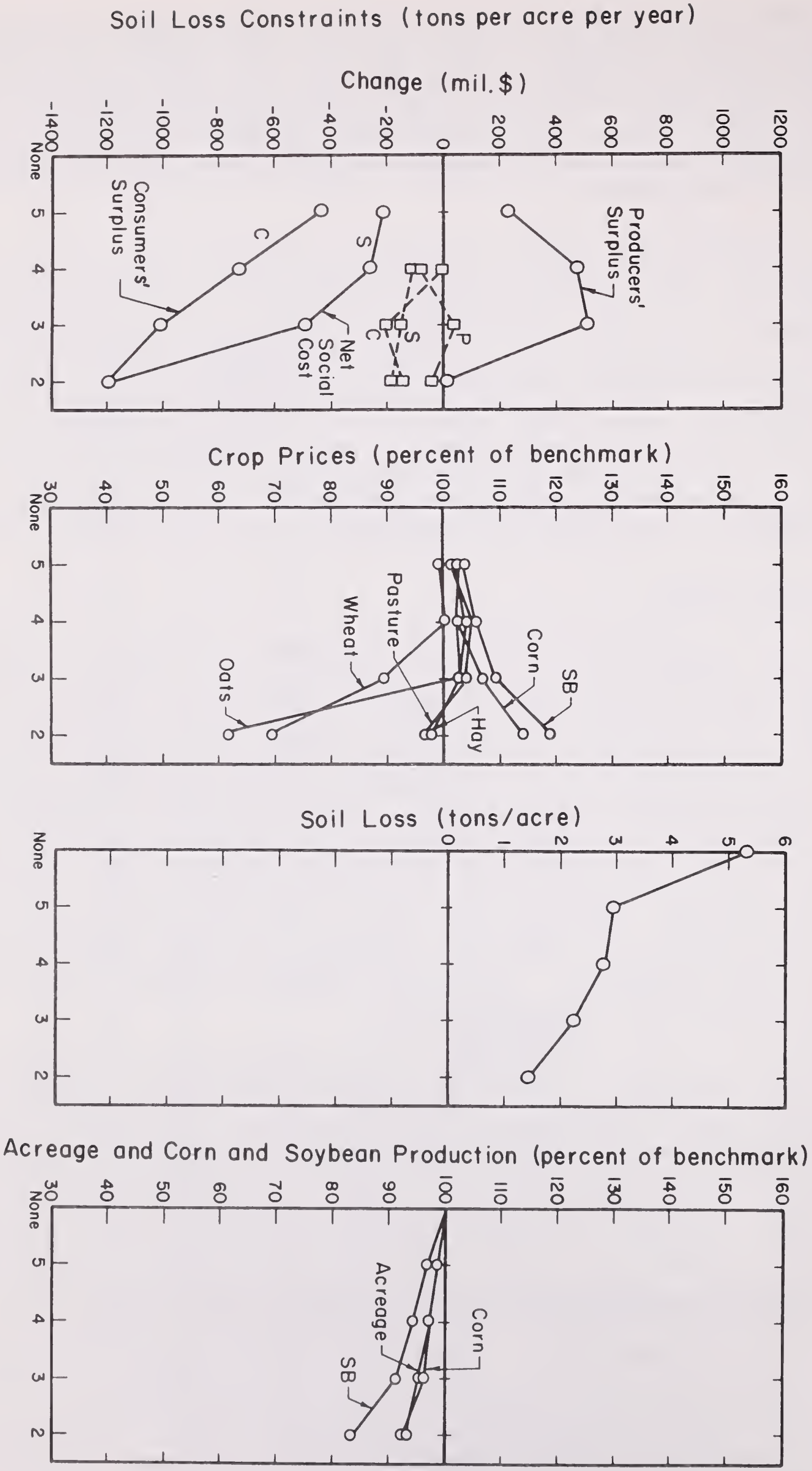

Figure 2. Impacts of soil loss limits.

Although consumers would pay more for food, some of them, and many farmers, would benefit from a restriction because off-site damages would be reduced. All future consumers would be expected to benefit from the maintenance of a higher quality soil resource.

The soil-loss restrictions do not significantly affect the total use of pesticides (the only substantial changes in pesticide occur in those runs in which the acreage chisel plowed changes). With increasingly stringent soil-loss limits, nitrogen use per acre increases slightly, but the total amount used decreases as a result of reduced corn acreage.

Soil-Loss Taxes

Figure 3 summarizes impacts of imposing soil-loss taxes at rates of $.50, $1.00, $2.00, and $4.00 per ton of gross soil loss. The net social cost of achieving reductions in soil loss would be somewhat less with soil-loss taxes than with soil-loss limits. Consumers would fare somewhat better. The impact on producers would be reversed. Soil-loss taxes would result in a large negative impact on producers, as is reflected by the significant government receipts that would be generated by the taxes.

Crop prices would be significantly affected. The price of soybeans--the most erosive of the crops--would increase dramatically, while corn prices would hold about constant; prices of non-row crops would decrease significantly. Higher soybean prices would be consistent with the significant reduction in soybean production in the Corn Belt.

As expected, all of the impacts (except for hay and pasture prices) were reduced when the $4.00 per ton constraint model was run with the low soil-loss coefficients.

Terracing Subsidies

Figure 4 summarizes the impacts of terracing subsidies ranging from $5 to $40 per acre. In the model, costs of terracing were annualized to reflect the annual impact on farm income of an investment in a terrace system. It was assumed that an annual terracing subsidy at a fixed rate per acre would be paid to encourage installation of terraces. It was assumed that the total amount would be paid regardless of the annual cost of the terrace. Thus, in the $40-per-acre run, the farm operator would receive compensation above the actual cost of installing terraces. Since the $40-per-acre-per-year subsidy would be higher than the actual annual cost of terracing on any of the land where the technique was assumed to be possible, the $40 run would indicate the maximum possible impact from a terracing program.

Prices and acreages under the several runs were not summarized in figure 4 because there were no significant changes from the benchmark solution. The high government cost and high levels of producer benefits under the larger terrace subsidies result from the way subsidies were assumed to be paid; that is, more funds would be paid to producers than necessary to fully compensate their terracing costs. Governmental costs and producer benefits could cancel each other where overpayment occurs. Thus, the terracing subsidy plan is a reasonable indication of the cost of achieving given levels of reduction in soil losses. It is of particular interest that the

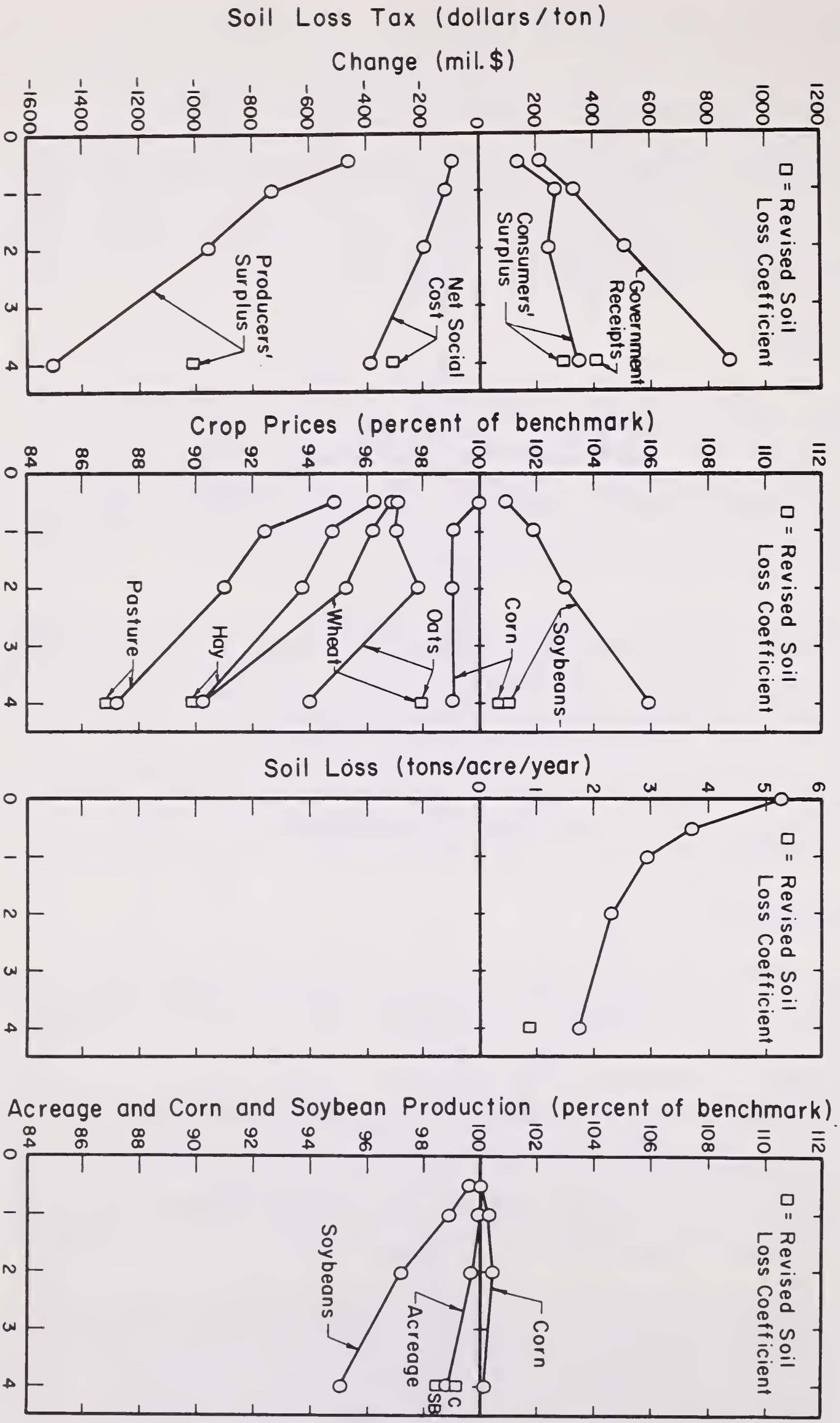

Figure 3. Impacts of soil-loss taxes.

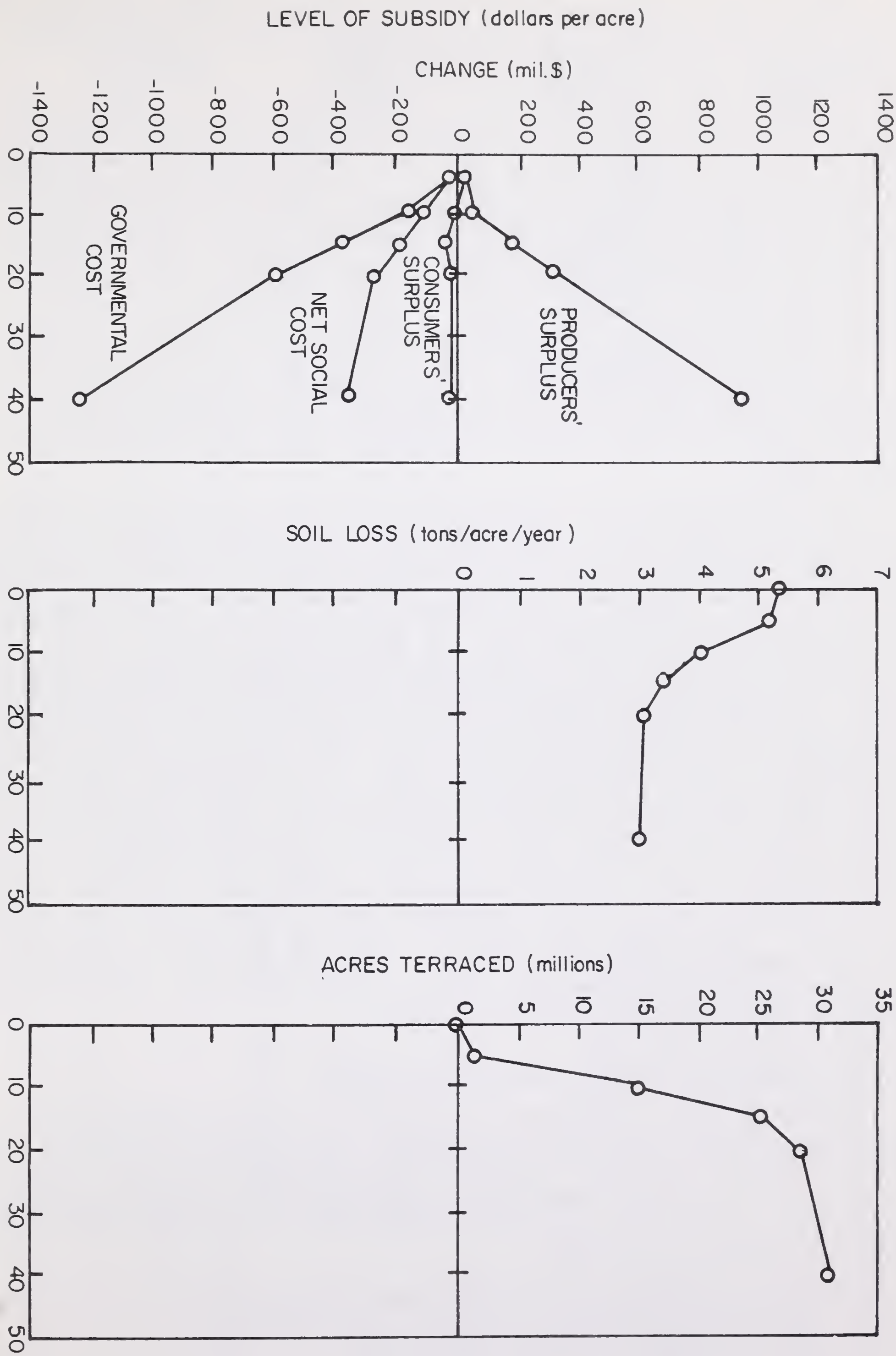

Figure 4. Impacts of terrace subsidies.

model showed little reduction in soil loss or only a slight increase in acres terraced when the subsidy level was increased from $20 to $40 per acre.

Combinations of Soil Erosion Control Policies

Figure 5 compares impacts of several approaches to controlling soil losses. Policy D would combine a soil-loss restriction of 3 tons per acre with a 50 percent reduction in the cost of terracing through a government cost-sharing program. Policy E would combine a soil-loss restriction of 3 tons per acre with a $15-per-acre terracing cost subsidy, the full amount of which would be paid regardless of the cost of terracing to any farm operator installing terraces. In policy F, a soil-loss restriction of 3 tons per acre would be imposed and cost-sharing at $20 per acre would be provided: that is, a farmer who terraced his land would be eligible to receive the full cost of the terraces--up to $20 per acre. In each case, the terracing-cost subsidy is computed on an annualized basis. Also included in the figure is policy A, the benchmark solution; policy B, which would provide a $15 terracing subsidy alone; and policy C, which would include only a soil-loss restriction of 3 tons per acre.

From these results it is apparent that the impacts of the three combination policies (in terms of soil-loss rates and economic effects) would be approximately equivalent to those of a 3-ton-per-acre soil-loss restriction. They would also be equivalent in terms of acreage planted, production of corn and soybeans, and commodity prices. The social costs for all of the combination policies would be higher than for the terracing subsidy alone, reflecting primarily the higher cost to consumers in the form of reduced consumers' surplus. Producers would benefit from all of the policies, but the combination policies would generate a higher level of producer benefits than the soil-loss limits alone or the terracing subsidy alone. The difference would be greater when compared to the terracing subsidy alone. The combination policies and the soil-loss restrictions all would generate lower levels of soil loss than the terracing subsidy alone. This $15-per-acre terracing subsidy would reduce soil losses from 5.3 to 3.46 tons per acre. A soil-loss restriction of 3 tons per acre would generate a soil loss of 2.25 tons per acre. The most effective of the combination policies (one combining the soil-loss limit with a $15-per-acre subsidy) would reduce soil losses to 1.87 tons per acre. Thus, the terracing subsidy alone would reduce soil losses 35 percent. Soil-loss limits alone would reduce it 58 percent. The most effective of the combination policies would reduce soil losses 65 percent.

Relative Efficiency of Soil-Loss Control Policies

Figures 6, 7, 8, and 9 indicate the relative economic efficiency of the several policies for controlling soil loss. The changes in net social cost, producers' surplus, consumers' surplus, and governmental cost are plotted relative to the percentage reduction in gross soil loss in the Corn Belt. It is important to note three additional categories of costs and benefits not included in these calculations:

1. Costs of administering the policies in question.
2. Environmental benefits associated with adopting the policies.
3. Long run impacts on soil productivity.

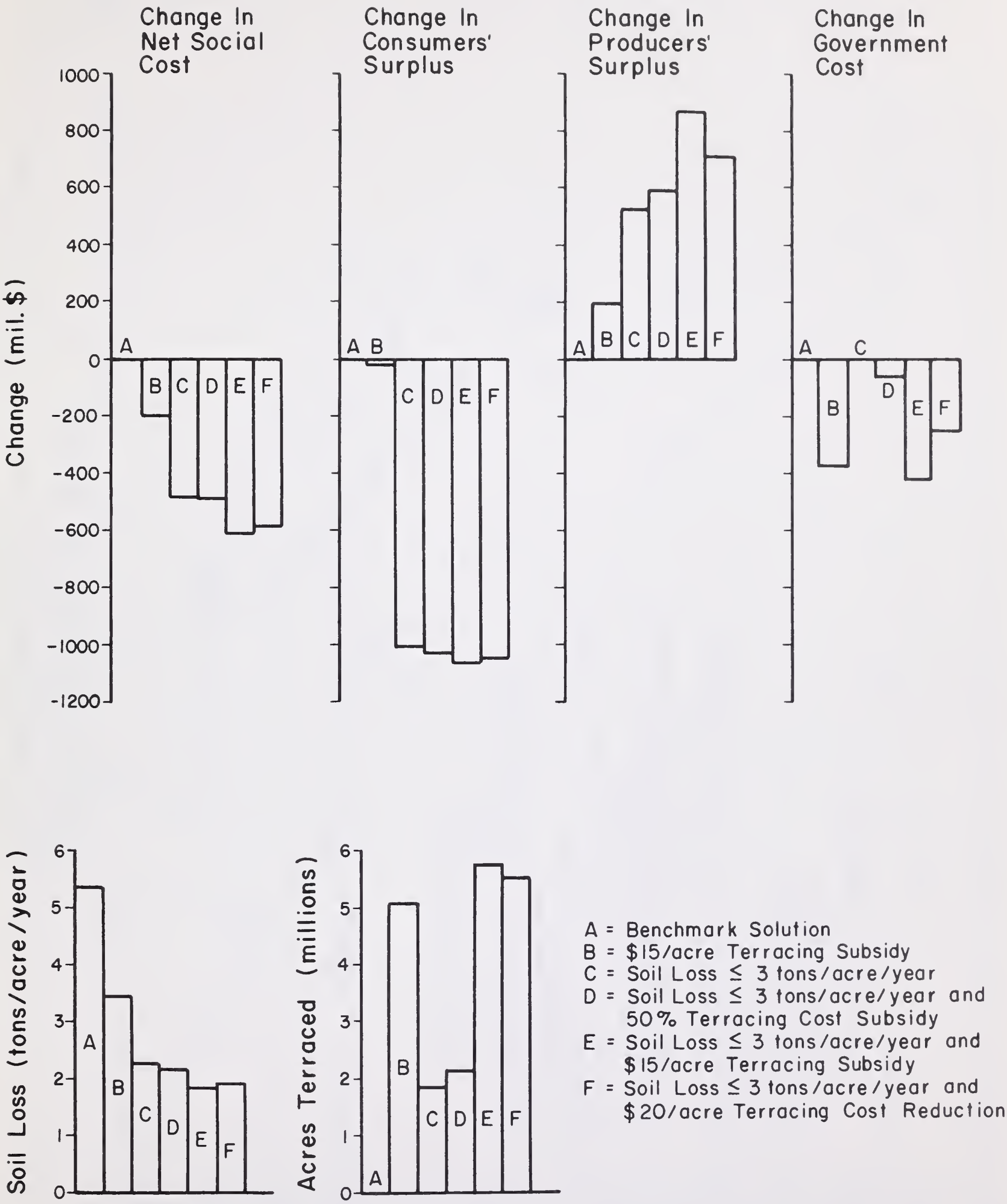

Figure 5. Impacts of terracing subsidies and soil-loss constraints.

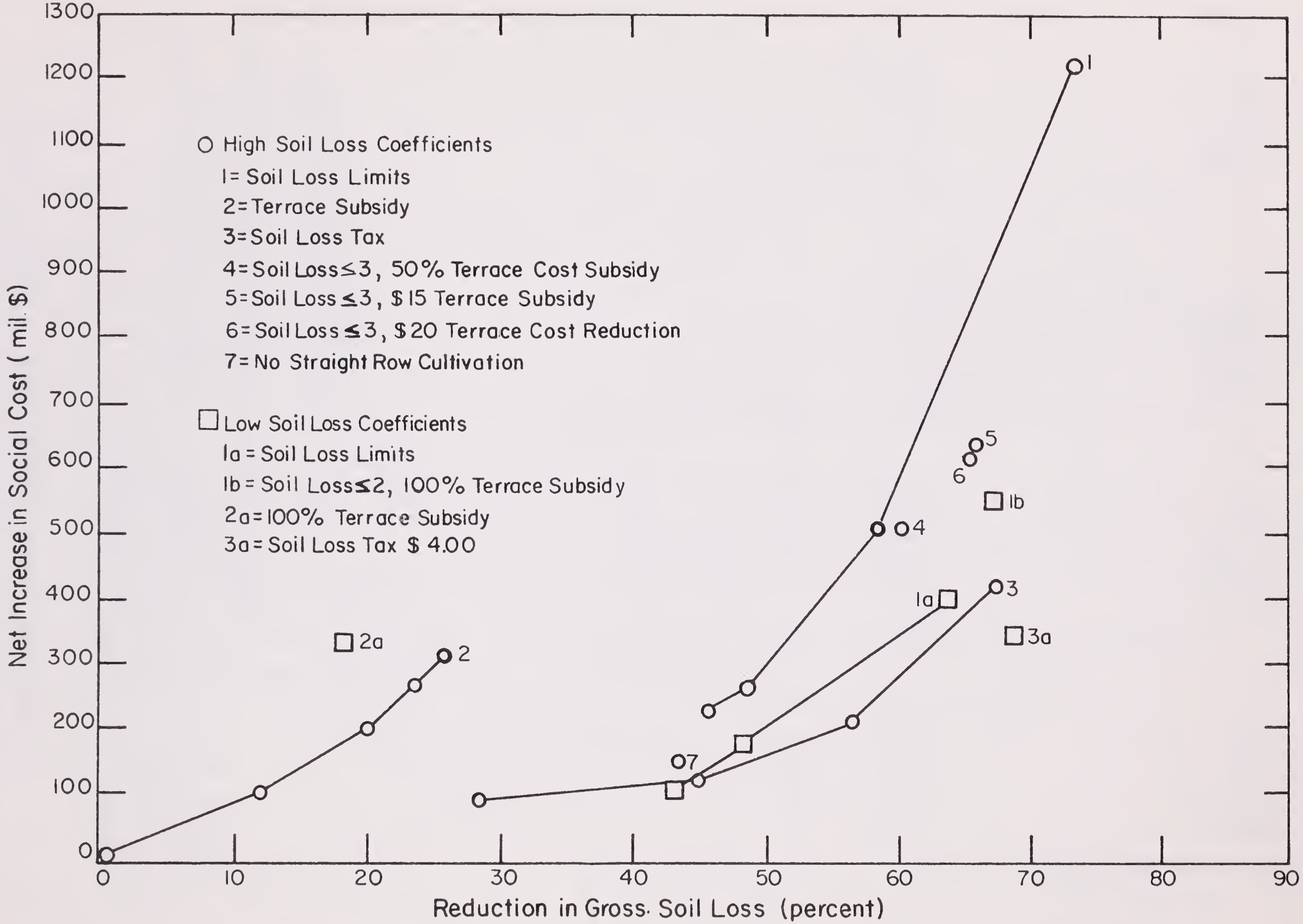

Figure 6. Change in net social cost and percentage reduction in gross soil loss.

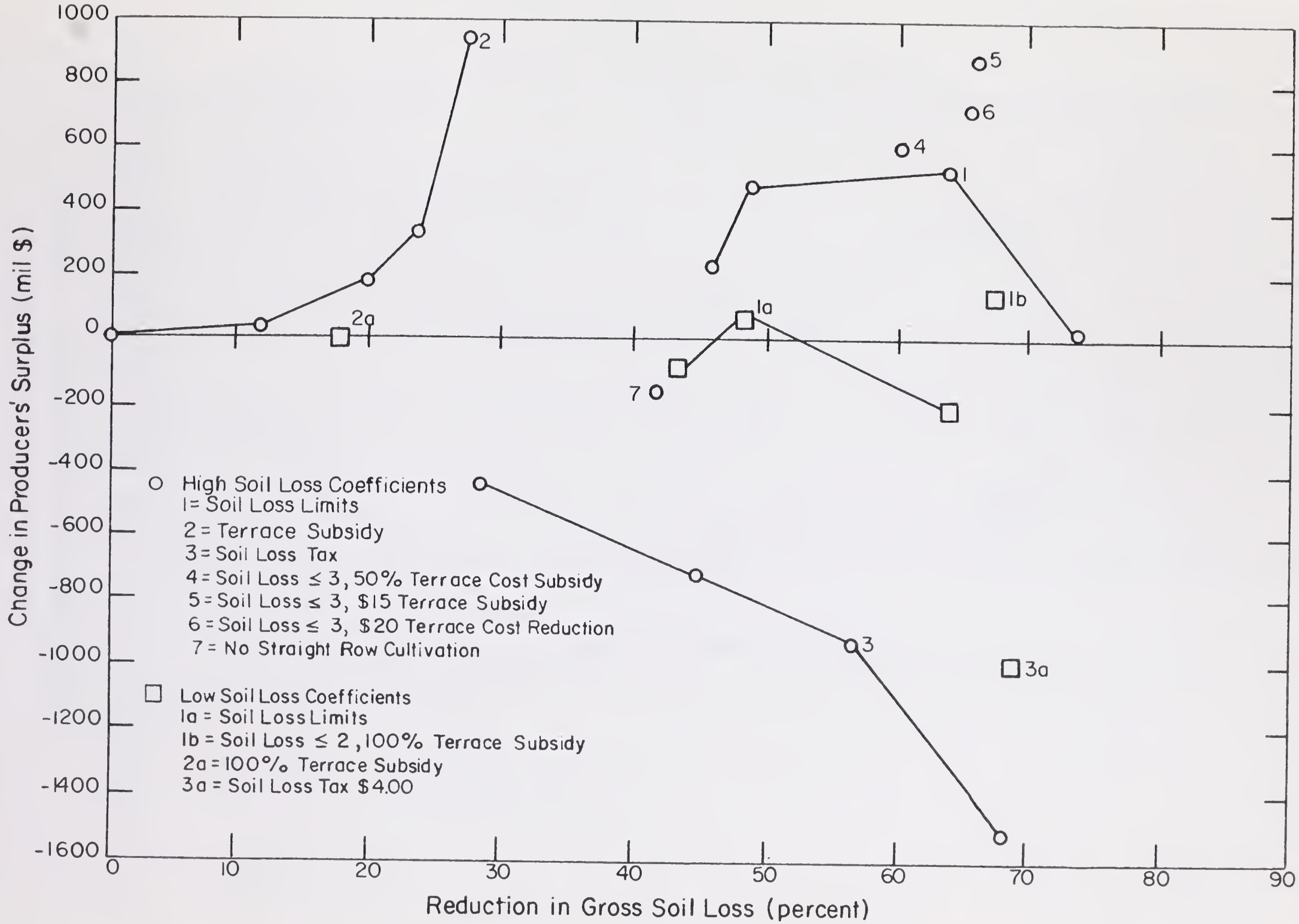

Figure 7. Change in producers' surplus and percent reduction in gross soil loss.

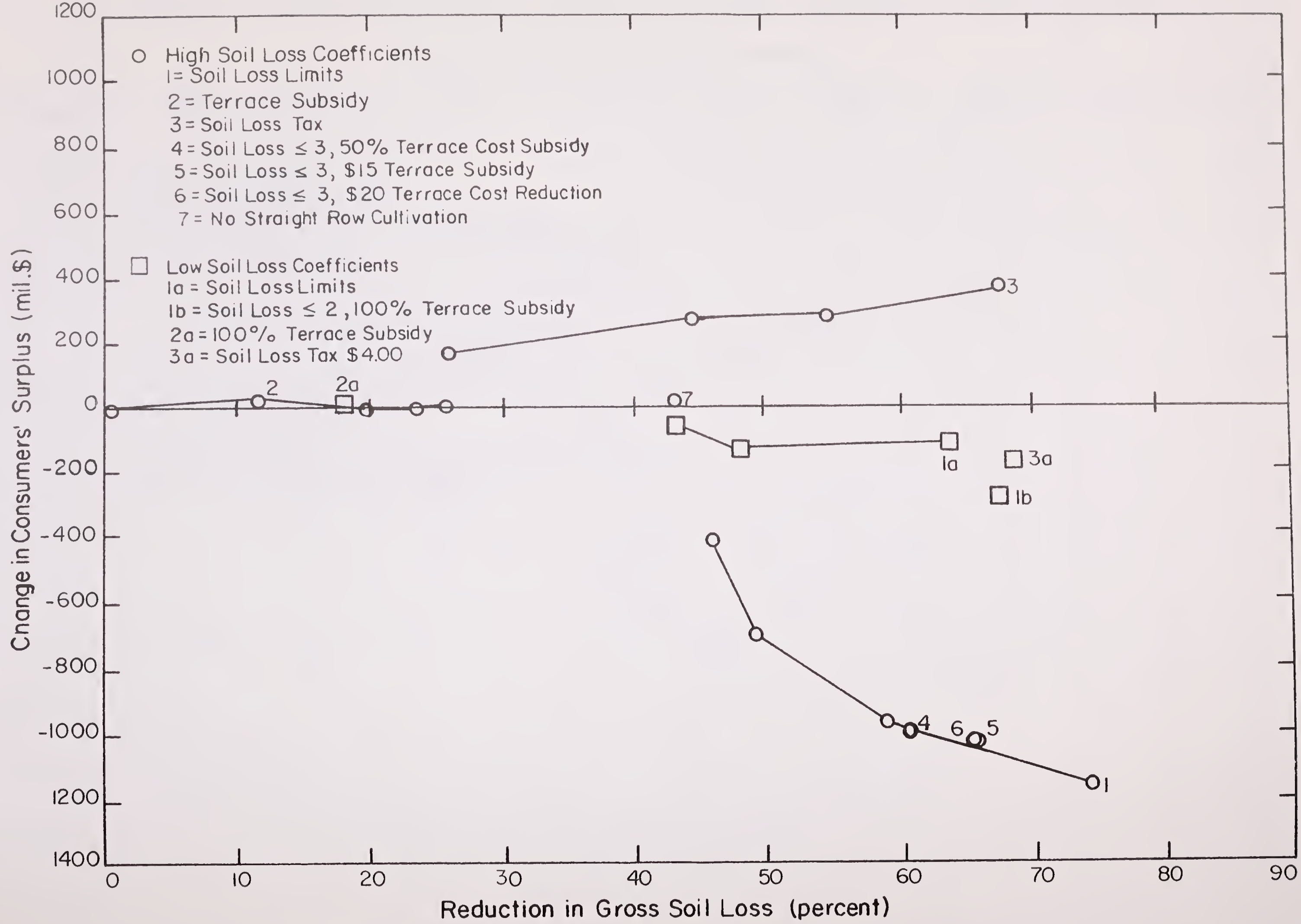

Figure 8. Change in consumers' surplus and percent reduction in gross soil loss.

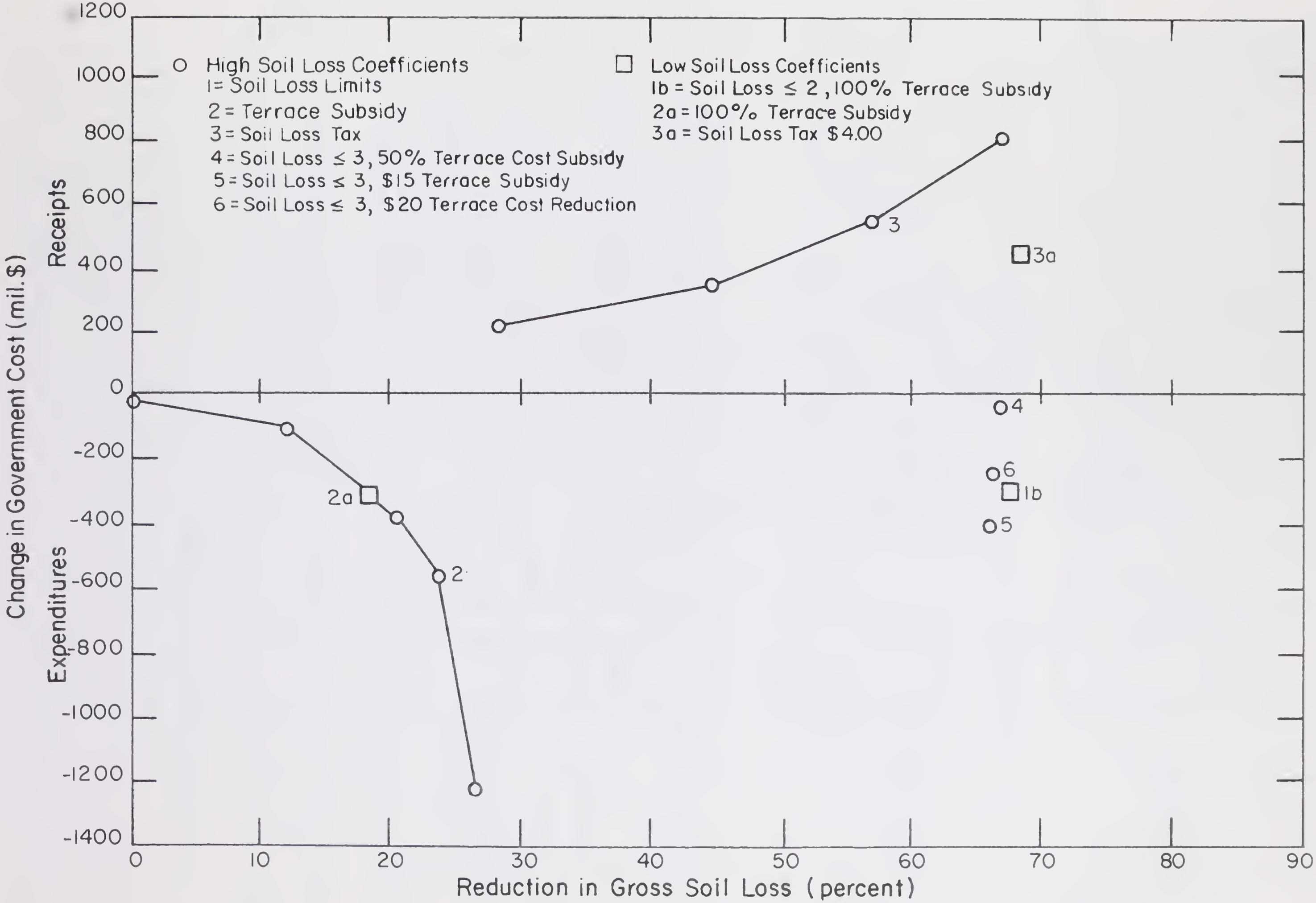

Figure 9. Change in government cost and percent reduction in gross soil loss.

When comparing results generated by the model (using the high soil-loss coefficients), it is clear that the soil-loss tax would be the most economically efficient overall, as would be expected from economic theory. However, while net social costs of achieving a given reduction in soil loss would be lowest in the case of taxation, it is important to realize that such a policy would significantly reduce producers' surplus as a result of taxes paid. These governmental tax receipts would be reflected in the net social cost, raising the overall efficiency of that policy. The taxation policy, then, would be the only one generating a significant reduction in the producers' well-being, with benefits to both government and to consumers. It is also likely that administrative costs--primarily for tax collection--would be quite significant under a policy of this type.

Soil-loss restrictions, except for the 2-ton-per-acre limit, would approximate the tax solution reasonably well when high soil-loss coefficients were used. That is, a soil-loss limit policy would not be significantly less efficient than the tax policy. The distribution of benefits and costs, however, would be quite different. If a policy limiting soil loss to 3 tons per acre per year would result in a $500 million increase in cost over the benchmark solution, the total negative impact on consumers would be approximately $1 billion, because producers gain $500 million. As noted earlier, low soil-loss coefficients would significantly lower the net economic impacts to less than $200 million.

As previously discussed, the higher net social cost generated by soil-loss restrictions would be due in part to the fact that some land must be taken from production to meet soil-loss limits, which were applied on a uniform per-acre basis. Hence, impacts on individual farmers would be quite variable. While some farmers would receive higher net incomes resulting from higher prices for the major crops, others would be forced to remove land from production and would, therefore, be adversely affected.

Terracing policies would not be as effective in reducing soil losses as the soil-loss restriction or taxation policies. With a terracing subsidy providing a fixed number of dollars per acre, there would be a significant shift of funds from taxpayers to farmers as a result of subsidizing at a higher level than the cost experienced. Policy 2A (a 100-percent subsidy) shows that the transfer would be eliminated if the subsidy were based on a percentage of the actual cost incurred, as in the present practice.

Combining terracing subsidies with soil-loss restrictions would produce a more efficient result than can be achieved by a soil-loss restriction alone. In this case, benefits would flow to producers from both consumers and taxpayers.

Soil-Loss and Nitrogen Restrictions

Figure 10 summarizes some of the major impacts of imposing soil-loss limits while constraining maximum nitrogen application rates to 50 and 100 pounds per acre. The nitrogen restriction would reduce application rates from approximately 140 pounds per acre to the constraints level. The constraints were assumed to apply to all sources of nitrates--including those added by legumes. They would be, therefore, quite restrictive. In general, it is

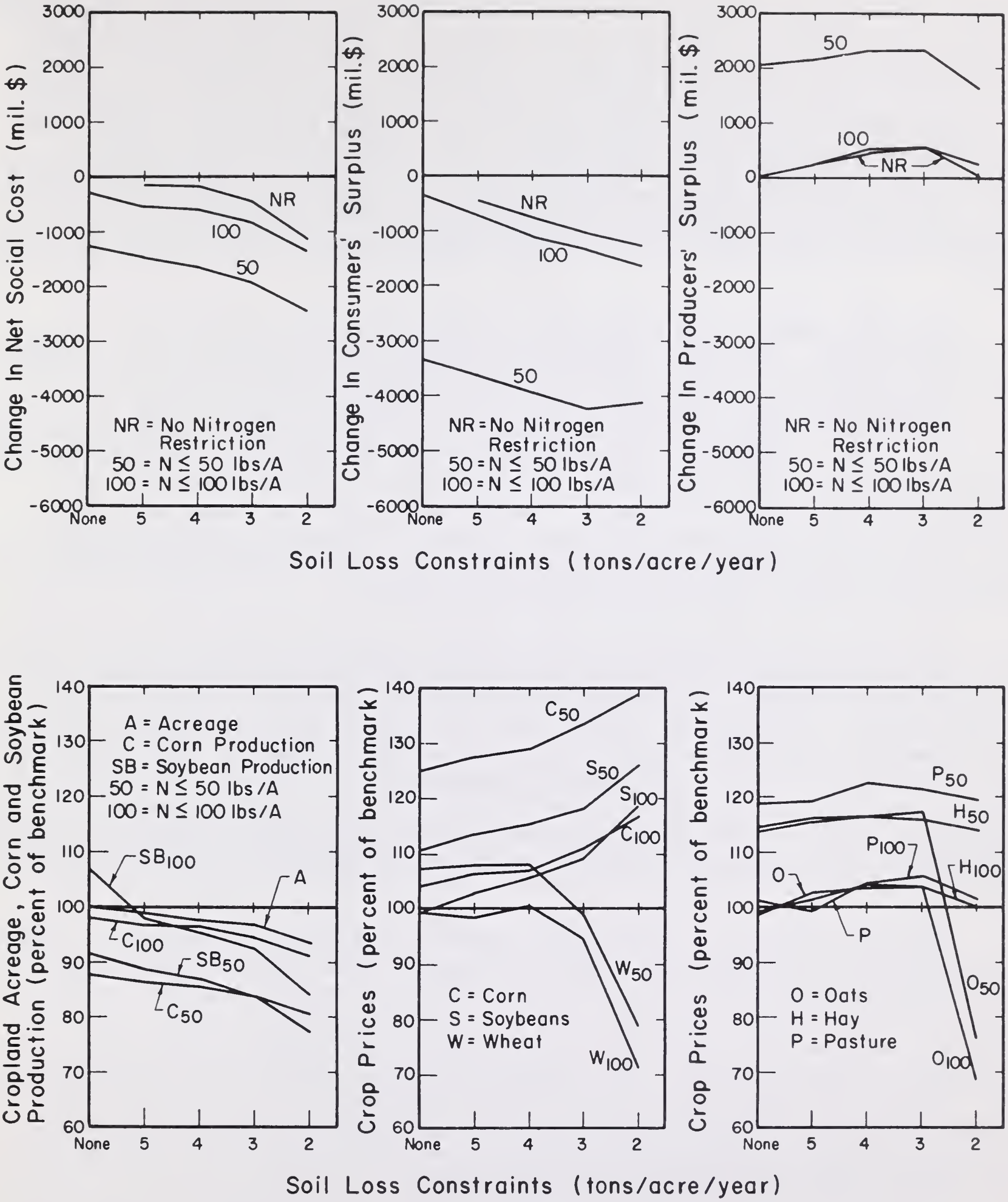

Figure 10. Impacts of restrictions on nitrogen application and soil loss.

clear that the 50-pound-per-acre nitrogen restriction would have a significant impact when applied alone; if more stringent soil-loss limits were added, the impact would generally increase. The impact of 100-pound-per-acre nitrogen restriction would not be significantly different from the impact of a soil-loss restriction alone; the impact on producers would be almost exactly the same. Another significant result would be increased producers' income when nitrogen applications were restricted. Thus, while farm income would be reduced by restrictions at the individual farm or regional level (realization of this explains the negative farmer reaction to nitrogen restrictions), restrictions at the national level would improve overall farm income. The difference is explained by the price-increasing effect of a national restriction.

Nitrogen restrictions alone have a reasonably strong impact on the agricultural sector. Reducing the level of nitrogen applied would reduce yield and profitability of corn, making soybeans relatively more attractive. At the 50-pound-per-acre nitrogen limit, yield would be reduced enough to reduce total production, despite increased acreage of corn and beans relative to that of other crops. When increased prices for corn and soybeans are combined with lower production costs (resulting from the use of less nitrogen) net farm income would increase $2 billion. The 100-pound-per-acre restriction would not significantly influence producers' income. Both the 50 and 100 pound restrictions would generate costs to consumers, with the 50-pound-per-acre restriction having a much more significant effect.

When soil-loss restrictions are applied along with nitrogen restrictions, impacts are increased. Soil-loss restrictions would force some acreage out of production entirely, because soil-loss limits could not be met, as discussed above. In addition, at the more restrictive soil-loss limits, the use of intensive row-crop production would be reduced in favor of less intensive crop rotations, significantly reducing wheat and oats prices. Reductions in yield resulting from fertilizer restrictions and lower row-crop acreage would combine to reduce production and increase prices for corn and soybeans. This combination would lead to a significant positive impact on producers' surplus and a major negative impact on consumers' surplus.

While the results presented here indicate the general tendency of response to specific restrictions, the fact that demand curves for the minor crops are not included may introduce some bias (a fixed quantity of the minor crops is specified in the model under a perfectly inelastic demand curve). The model does not have as much fexibility to meet these constraints as would be expected in the real world. The general findings, however, are considered to be a reasonable reflection of what could be expected in a real situation--reduced corn and soybean acreage, and consequently higher prices for these crops resulting in improved farm income, a negative impact on consumers, and an overall impact in terms of net social costs.

CONCLUSION

This study indicates that reasonable soil erosion control programs can be implemented without having serious economic impacts on the agricultural sector or on consumer expenditure.[3/] If however, the high soil loss coefficients are accurate, and if a stringent soil loss restriction such as a 2-ton-per-year limit were adopted, the economic impacts would be serious. Serious economic impacts would also be generated by tight controls on nitrogen use. Contrary to popular belief, the economic burden of the restriction falls more on consumers than on producers for many of the controls considered. This occurs because the model includes demand and supply functions for the major crops, allowing impacts of controls to be translated into higher prices generating higher gross receipts at the farm level. The higher receipts help offset or, in some cases, more than offset the higher production costs or lower yields associated with controls. Such results will not be demonstrated by a model limited to fixed commodity prices.

Two sets of soil loss coefficients were used in the study. One set was supplied by the Federal Soil Conservation Service, while the other set was supplied by Illinois Soil Conservation Service personnel. It appears that the two sets of coefficients bracket actual soil losses. To obtain more precise estimates of the economic impacts of non-point pollution controls, precise estimates of soil loss coefficients must be obtained.

3/ Although not tested with this model, the tolerance limits used by the Soil Conservation Service are expected to be "reasonable" limits.

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Discussants' Comments

Lawrence W. Libby, Associate Professor of Agricultural Economics, Michigan State University.

Symposium Chairman Lee Christensen asked me to present a short response to the three papers presented here today. In my judgment, these are three very useful contributions to what is currently a relatively thin literature on the economic implications of water quality planning and P.L. 92-500. They are provocative, thoughtful, and evoke discussion, thus meeting their purpose for today's session. Two of these papers, the one by Young and the other by Carlson and Seagraves, essentially focused on the consequences of the current set of Federal rules for implementing P.L. 92-500 for various kinds of communities or participants in this policy process. Particular emphasis was given to rural communities. Carlson and Seagraves present an important set of recommendations that deserve the attention of all who are involved in water quality policy.

The paper by Seitz dealt more specifically with implementation of water quality plans; it dealt almost exclusively with non-structural approaches to dealing with non-point pollution. His approach suffers the usual limitations of any use of linear programming in a policy context. We have the difficulty of generalizing from a given case or set of cases to a broader problem, and of course, all of the limiting assumptions of linear programmming as an analytical technique. But the Seitz paper is an extremely important contribution. It helps us to see more clearly the implications of different approaches to water quality improvement within a specific setting. It might be seen as one experiment in a larger set of specific case studies that will eventually permit generalization in coping with some of the distributional implications of P.L. 92-500.

In the few minutes that I have available, I will not delve into the specifics of any of these papers, and certainly not the specifics of the LP model presented by Seitz. The papers and the model stand on their own. But I would like to expand a bit on topics raised, and add a few biases of my own regarding future social science research on this symposium topic.

My point of departure for discussion of this whole issue is captured in Carlson and Seagraves' last recommendation. They confess some uneasiness with next steps in efforts to implement water quality plans, given the amount of public money involved. They state: "We recommend reallocation of funds away from planning and toward highly selective trials of regional management agencies in some regions where the need for coordinated programs is greatest." They are uncomfortable with the apparent lack of direction in the planning process under P.L. 92-500, and in the process of choosing among alternative implementing techniques.

Seitz gets at this same issue in his repeated references to "reasonableness" in accomplishing water quality goals. He says, "Taken together these results indicate that water quality planning may have desirable impacts on long term productivity at reasonable costs to current consumers if carried out in a reasonable manner" (my emphasis). The problem, of course, if to define reasonable. In my opinion, that is the fundamental issue in the whole water quality planning process. "Zero pollution," the basic goal of P.L. 92-500, may be the best living example that we have of Boulding's "suboptimization devil"--singleminded, efficient pursuit of the wrong objective.[1/] We are systematically accomplishing intermediate steps toward zero pollution with no real possibility of achieving that objective and no explicit consideration of the cost.

There are two major problems that I believe are basically untouched by social science literature relating to water quality planning and implementation. First, we have had inadequate attention to the design of the planning process itself. We have little explicit attention to the way we make choices with respect to water quality. There are many different planning models at work in all parts of the country. In each case, planners are hoping to create an acceptable plan. We need observation on how planning structure affects performance in designing "reasonable" water quality management schemes. The second major issue has to do with the implementation process. The fundamental policy problem here is who will pay the cost of achieving pure water. We have very little treatment of this issue in the current literature. Even with all the public involvement that we have had, all of the attention to public participation in water quality planning, the question of who is going to pay the cost has just not been addressed effectively in the planning process. There has been no way for people to effectively react to questions of cost and particularly the matter of separable cost or "how much am I going to be asked to pay to achieve water of a certain definable level of quality." Voters, group leaders, and others must have that question before them if the necessary political compromises are to be built. It is very difficult for people to react effectively to the macro questions of total cost. The more important question is one of marginal cost--cost per unit of water quality achieved. Nowhere in our public involvement in Section 208 planning has this question been effectively recognized. Some interest groups, notably the Farm Bureau, have begun to act more aggressively in this area by arguing that agriculture should not be forced to pay more than its "share." The problem is to provide a setting for bargaining on what that share might be. We may be expecting farmers to give up more than they or society feel is appropriate.

In public involvement on Section 208 planning, for example, a nonstructural approach to achieving water of a certain quality always ranks very high because it seems to be cheaper. Participants have a general feeling that we ought to keep public cost down. I suspect, however, that many people who are acting as free riders in this kind of discussion are going to find it very difficult to get off this free ride where they want to. That is, they may assume that by opting for nonstructural approaches to implementing water quality planning, they will be better off, when in fact, they may be asked to bear substantial personal cost, either in direct dollars or in loss of opportunities, when those nonstructural techniques are used.

1/ See M. M. Kelso, "Natural Resource Economics: The Upsetting Discipline" Fellows Lecture, AAEA Annual Meeting, August 1, 1977.

Section 208 planning, particularly related to non-point pollution, is going to require some major adjustments in our patterns of doing business if we are to accomplish water quality goals through nonstructural means. I am afraid that those who are going to be asked to bear those costs have not yet fully comprehended the stake they have in the decision process. Section 208 planning implies major new power and authority toward solving a national problem. We all have great expectations for the results of that effort. Section 208 of P.L. 92-500 is definitely an exciting policy initiative on behalf of a clean enviornment. For too long we have avoided strong national measures to improve the quality of natural resources. But in my opinion, we are moving toward a confrontation with a set of interest group power relationships in State and local land use politics that have existed for many years. They have been there throughout the debates on comprehensive planning, local land use planning, and all of those attempts to give public direction to use of land. There is no reason to assume that this political power situation is going to dissolve or drastically realign in the face of Section 208 planning. The planning itself may continue with relatively little confrontation. When we get to the point of making choices and accomplishing some actual reductions in water pollution, however, the confrontations will emerge. We must deal with the same windfall/wipe-out kind of phenomenon that we have observed for a long time in land use policy. There have been changes in land use policy to be sure, but these adjustments have occurred at a glacial pace over many decades. There is no reason to assume that huge changes will occur in the next 3 or 4 years to accomplish the deadlines in Section 208 planning.

It seems to me that major emphasis in Section 208 planning must be on fashioning the various economic compromises that must exist between the thousands of millions of people who benefit very slightly from cleaner water, and the few people in our society who may be asked to bear enormous short run personal cost to achieve that water quality. Until we can accomplish these political compromises, the process of water quality planning is largely transparent. I applaud the efforts of our speakers here today for the work that they have done on these papers, and the valuable research that they have accomplished. It is only a step in the direction of effective water quality policy, however. The real big challenges remain in front of us, and they pertain primarily to our techniques for making public choice.

Clyde Kiker, Assistant Professor, University of Florida, Institute of Food and Agricultural Sciences:

The 1972 amendments to the Federal Water Pollution Control Act (P.L. 92-500) have many components. Some aspects are quite specific with exact guidelines and predictable outcomes, while other aspects are broad in nature with unclear ultimate consequences. The three papers presented did a good job of covering several aspects of the amendments. I'm sure I could find some specifics in each of the papers on which to comment, but for the purpose of broadening the topics considered in this symposium, I would rather bring up some additional topics.

I want to raise some issues relating to Section 208 and agricultural lands. Recall Section 208 requires development of State and areawide quality management programs. The first step under Section 208 is the planning process. Objectives of the planning as related to agricultural land are to:

1) Identify water quality problems;
2) Identify pollution sources;
3) Recommend guidelines for locally developed "best management practices" to curb pollution from identified sources; and
4) Recommend State and local agencies for implementing long-term water quality management programs.

It is these last two items in which I am interested. The regulation to come has great potential for affecting rural communities and agriculture as well as an area's waters. My concern is with the State and local agencies which will ultimately develop the details of the regulatory programs and finally implement the program to achieve the goal of "swimmable-fishable waters."

Seitz has delved into the impacts of various approaches to managing non-point source pollution in the Corn Belt. I believe this is the type of information that will bring about water quality goals with minimal disruption of agricultural productivity. But, if your experience is similar to mine in Florida, you will find that the agencies are likely to develop the rules and regulations without economists or even good economic counsel. These agencies usually consist of engineers and physical planners, and their backup lawyers. Their understanding of and capability of including economic criteria are almost nonexistent.

I realize EPA is suggesting the concept of "best-management practices" with heavy reliance on voluntary compliance. They emphasize that water quality is a measure of good stewardship of the land. In effect, EPA is assuming that the change to practices which will reduce non-point source pollution will improve farmers' net revenues and that farmers will realize this and make the changes voluntarily. I hope these changes will improve net revenues, but as of now I'm certainly not sure this will always be the case. Seitz, in using his watershed model to assess long run impacts, partially supports this suspicion. The analysis supports the contention that in the long run (100 years), present agricultural practices will reduce farmers' net revenues. But, the analysis also points out that in a shorter period (20-40 years), net revenues occurring under the SCS tolerance limits are lower than under present practices. Seitz states "...even with these substantial losses of productivity and a moderate discount rate of 5 percent, farm operators cannot be expected to implement soil loss controls without public sector involvement." It is probable then, that State and/or local water management agencies will step in and take some action to assure some form of compliance.

Although economic efficiency and equity are referred to in EPA criteria for an effective water quality management program, my experience with these State and local agencies causes me to seriously doubt that efficiency and equity will be handled in anything more than an intuitive way. Since planners and engineers dominate these agencies I believe the regulations will have, as they tended to have in the past, a very strong physical bias. The question I believe we need to ask ourselves as agricultural economists is: How can we assist these agencies in developing regulatory approaches that will improve water quality and also make economic sense?

Generally, I find that most land grant universities have research and extension programs dealing with the technical questions related to agriculture and point and non-point source pollution and its control. There is some economic research on these topics, but it is not sufficient and we need to expand our efforts. Seitz' research is a good example of the type that is needed in many other loactions. His research is interesting and points out approaches that can be used. It does not, however, answer the questions we are facing in Florida. Our agriculture, our natural resource base, our environment, and our society are different. We need to undertake research to answer the questions as to what impacts Section 208 of the Federal Water Pollution Control Acts Amendments will have on our region. Likewise, I believe economists in other areas will have to take on the assessment of impacts in their areas. Without this effort, little economics will be included in the implementation of the Section 208 plans.

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The three papers presented at this symposium have discussed various aspects of the impacts of implementing P.L. 92-500, the Federal Water Pollution Control Act of 1972 as amended. While the point (e.g., waste treatment plants) and nonpoint source (e.g., agricultural) problems are quite different by nature as well as by the regulatory requirements of the legislation, many of the economic questions are similar as well as interrelated (e.g., utilization of sludge and wastewater on agricultural land).

Today's situation with respect to environmental quality and other social goals is quite different from, say, the early 70's. Environmental goals are no longer seen in isolation as a sole social objective. The realization of the environmental goals will necessarily incur tradeoffs with other, often antagonistic, social objectives. For example, we are only now beginning to discuss seriously, and with some sophistication, the tradeoffs of environmental goals and food policy.

A recent article by A. Fisher and F. Peterson (1976) asserted that there has been a lack of input by economists into the development of environmental policies. Why has this been the case? Perhaps it is partially due to the regulatory/technical approach much environmental legislation has taken. This lack of input may also be due in part to the uncomprising positions economists have taken on issues that were perceived by decisionmakers as largely administrative or political in nature. The need at this point then is for the economist to work with the politicians and representatives of other disciplines to develop workable solutions that are technically feasible, politically and socially acceptable, as well as economically efficient and equitable.

2/ A. C. Fisher and F. M. Peterson, The Environmental in Economics, The Journal of Economic Literature, Vol. 14, No. 1, March 1976.

A major contribution by the economist at this point, as I understand the situation and the needs, concerns the implementation question--timing, incentives/disincentives, institutional facilitators and barriers, etc. This need is apparent in both the point and nonpoint areas. This need presupposes that an appropriate program has been specified, and the issue that remains is how to get the program efficiently implemented. Given that the goal has been identified, whether via the political process or some analytical/tradeoff exercise, the cost-effectiveness questions remain: How do you achieve a goal at minimal cost? What are appropriate tests of "reasonableness" of Best Available Technology (BAT) or "unrealistic" BAT requirements?

In the nonpoint source area, the nagging question to be addressed by many areawide planners is: What are desirable goals? Also, what are appropriate criteria for an equitable solution--subsidies vs. tax schemes, low vs. high income producing areas, small operators vs. big, etc.

We need to extend the work of Carlson, Young, and Seitz into these areas. I think that the kind of research discussed here is moving us in the right direction.

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