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Alternative Policies for Controlling Nonpoint Agricultural Sources of Water Pollution

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ALTERNATIVE POLICIES FOR CONTROLLING NONPOINT AGRICULTURAL SOURCES OF WATER POLLUTION

by

W. D. Seitz
D. M. Gardner
S. K. Gove
K. L. Guntermann
J. R. Karr
R. G. F. Spitze
E. R. Swanson
C. R. Taylor
D. L. Uchtmann
J. C. van Es
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

Contract Number 68-01-3584

Project Officers

George W. Bailey
Thomas E. Waddell
Environmental Research Laboratory
Athens, Georgia 30605

ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
ATHENS, GEORGIA 30605

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PARTICIPATING STAFF

RESEARCH ASSOCIATE

M. E. Hay

RESEARCH ASSISTANTS

S. B. Cherry
T. K. Clarke
K. L. Frohberg
J. T. Hannon
R. S. Hewett
L. K. Keasler
D. L. McLaughlin
M. C. Nelson
K. A. Olberts
R. K. Petges
S. J. Raines
I. J. Schlosser
C. S. Turner

EDITOR

T. W. Knecht

PARTICIPATING UNIVERSITY UNITS

Institute for Environmental Studies
Agricultural Experiment Station
College of Commerce
School of Life Sciences
Institute of Government and Public Affairs

FOREWORD

As environmental controls become more costly to implement and the penalties of judgment errors become more severe, environmental quality management requires more efficient analytical tools based on greater knowledge of the environmental phenomena to be managed. As part of this Laboratory's research on the occurrence, movement, transformation, impact, and control of environmental contaminants, the Technology Development and Applications Branch develops management and engineering tools to help pollution control officials achieve water quality goals through watershed management.

Agricultural sources contribute significantly to water pollution problems in many areas of the United States. This project was designed to evaluate the technological, economic, social, legal, and institutional aspects of implementing selected best management practices for these nonpoint sources. Emphasis by a multidisciplinary team of scientists is on policies to control soil erosion, which contributes to the pollution problem by increasing turbidity in waterways and by carrying nutrients, pesticides, and other substances into waterways.

Linkage of this kind of information with our best capabilities to predict the fate of pollutants in the environment should assist in ensuring that the wisest decisions in environmental management are made and that society's resources are effectively utilized.

David W. Duttweiler
Director
Environmental Research Laboratory
Athens, Georgia

ABSTRACT

Six soil conservation policies representing a variety of approaches for controlling water pollution from nonpoint agricultural sources in the Corn Belt were examined. The policy options were an education program, a tax credit for erosion control practices, a 50 percent subsidy for terracing and similar land modifications, a requirement that a conservation plan be developed, a requirement that a conservation plan be implemented, and a requirement that greenbelts be developed where needed. Because implementation of policies would likely be carried out by soil conservation agencies, existing state and Federal programs and laws directed to the control of soil erosion were surveyed. Clearly, soil conservation agencies must be considered in any attempt to develop effective and efficient pollution control policies in this area.

The aggregate economic impact of the policies was investigated using a state-of-the-art, market-equilibrium, linear programming model of crop production in the Corn Belt. The economic impacts of the policies at the individual farm level and their effects on long-term soil productivity were analyzed through the use of a watershed model. The Corn Belt model indicates that soil erosion policies will not have a significant negative economic impact--and may have a positive impact--on producers. The impact on consumers and the net social impact on erosion controls are highly dependent on soil-loss coefficients. Taken together, the models indicate that soil erosion control can be achieved without severe adverse effects on the agriculture sector in total and that arbitrary soil-loss standards could have adverse impacts on farm income in selected areas.

An analysis of social factors indicates that farm community acceptance of the policies will likely be better if traditional agricultural agencies are involved in the implementation of policies than if new agencies are developed or if existing nonagricultural agencies are used. Farmer resistance is expected if mandatory policies are adopted.

The equity of the policies was examined from the perspectives of the general public, the agricultural sector, conservation equipment manufacturers, and water users. An analysis of the legal framework under which policies of this type would be implemented indicated that such policies could be drafted so as to be consistent with existing legislation.

This report was submitted in fulfillment of Contract No. 68-01-3584 by the Institute for Environmental Studies of the University of Illinois at Urbana-Champaign under the sponsorshop of the U.S. Environmental Protection Agency. This report covers the period from January 26, 1976, to April 25, 1977, and work was completed as of November 30, 1977.

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ACKNOWLEDGEMENTS

The project was carried out with support provided by the Athens Environmental Research Laboratory, U. S. EPA, Thomas E. Waddell and George W. Bailey, Project Officers. The research was conducted by a large interdisciplinary team comprising staff members from seven academic units on the campus of the University of Illinois at Urbana-Champaign. The project was coordinated through the Institute for Environmental Studies, which provided secretarial, editorial, and business office support.

In addition to those directly involved in the project, numerous other staff members at the University provided assistance. Members of the Agricultural Experiment Station were particularly helpful. In addition, Arlo W. Biere, Kansas State University; Daniel Bromley, University of Wisconsin; George L. Casler, Cornell University; Neil E. Harl, Iowa State University; Gerald L. Horner, USDA, NRED; and William L. Miller, Purdue University, served as consultants in the early phases of the project. Soil Conservation Service personnel, at both the federal and state levels, and particularly in the Illinois office, were very helpful in providing information when requested. Personnel of the Agricultural Conservation and Stabilization Service and of numerous state agencies in the corn-belt states also provided needed assistance.

While the contribution of all these individuals is recognized and appreciated, responsibility for any errors rests with the research team.

EXECUTIVE SUMMARY

Agricultural sources contribute significantly to water pollution problems in many areas of the United States. This report evaluates a number of alternative policies aimed at reducing the level of pollution emanating from those sources. The report concentrates on the problem of soil erosion from agricultural lands because it is an integral part of the pollution problem. Sediment particles increase turbidity in waterways and reduce the capacity of reservoirs, transportation arteries, and drainage ditches. In addition, the particles carry certain plant nutrients and other substances such as pesticides into waterways. Finally, the soil erosion process also reduces the productivity of agricultural land.

EXISTING PROGRAMS

Soil erosion control policy in this country has a long history. For more than 30 years the Soil Conservation Service (SCS), the Agricultural Stabilization and Conservation Service (ASCS), and the Soil and Water Conservation Districts (SWCDs) have conducted an extensive program which relies on voluntary compliance and provides some economic incentives to encourage farmers to implement soil conservation practices. Provisions exist, however, for the soil and water conservation districts to assume a regulatory stance and thus mandate the adoption of conservation practices. It is clear that this set of institutions will need to be considered in any attempt to develop new policies in this area if such policies are to be efficient and effective. For the same reason, a model state law developed for the improvement of soil conservation practices builds on the existing soil and water conservation districts.

The costs of administering the SCS and ASCS programs in the corn belt were found to vary widely among the states. An analysis was not successful in explaining the variation, perhaps because of the high proportion of overhead costs and the large number of programs. Thus, while administrative cost estimates are given for a typical county-level program, the variation in practice may be considerable in different areas.

In addition to the well-established programs at the federal level, the states have recently begun initiatives to control the level of soil erosion. Iowa, Hawaii, Pennsylvania, Michigan, South Dakota, New York, New Jersey, Montana, and the Virgin Islands have all adopted laws recently (most since 1970) pertaining to the soil erosion problem. Legislation is pending in Illinois, Indiana, Ohio, Kansas, and Minnesota. In general, this legislation is structured around the use of a soil conservation plan at the individual farm level and often involves meeting the soil-loss tolerance limits established for individual soils by the Soil Conservation Service and used in determining acceptable erosion rates. The policies in existence do not represent a wide range of approaches to the problem.

SELECTION OF POLICIES FOR ANALYSIS

Because of the narrow range of nonpoint policies existing or being considered at the state and federal level for the control of sediment and nutrients, the research team developed schematics to identify alternative policies. In these schematics, alternative control instruments, performance indicators, control techniques, compliance measures, and temporary penalties are identified. While the schematics can be used to conceive a wide range of policies, they do not contain information which would make it possible to identify radically new and superior policy options.

Six policy options were selected for detailed analysis in the study. They were: (1) an educational program, (2) a tax credit for erosion control practices, (3) a 50-percent subsidy for terracing and similar modifications, (4) a requirement that a conservation plan be developed, (5) a requirement that a conservation plan be implemented, (6) a requirement that greenbelts be developed where needed. The education program is essentially a promotional campaign directed at farmers to encourage them to cooperate voluntarily in the existing soil conservation program. It was selected because it was hypothesized to be the alternative most readily accepted by farmers, although it is recognized that its effectiveness is likely to be limited.

The tax-credit policy would provide tax reductions for farm operators who adopt pollution control practices such as terracing. Such a policy would be easy to administer. In some cases it might be necessary only to encourage farmers to take advantage of existing provisions in the tax law. Implementation would be difficult if it were necessary to revise the tax law. The policy could involve providing SCS-type assistance to individual farmers in determining the types of control techniques suitable for their farms.

The third policy would be an extension of the existing Federal program which subsidizes farm operators for the cost of implementing soil erosion control practices, particularly terracing of land. At present, the funds under this program are limited and the maximum amount payable to any farmer in a single year is $2,500. This policy would involve changing the present percent of cost shared by the government and the limits on the support that can be provided to individual operators.

The fourth policy analyzed would require farmers to develop (but not necessarily implement) a soil conservation plan for their farms. This policy would, in effect, be a mandatory education program to make farmers aware of the level of erosion occurring on their farms and of the measures necessary to reduce the erosion to tolerable rates. Such a policy should be reasonably easy to implement through the SCS and SWCDs. It might also be an effective precursor to the fifth policy analyzed, which would make it mandatory for farmers to implement the soil conservation practices specified in the plans. The latter policy would be comprehensive and would allow the farm operator to choose from the full range of options for the control of soil loss.

Because of decreased profitability and reduced freedom of choice, there would likely be significant reluctance to accept this program at the farm level, especially if government subsidies were not provided to cover a portion of the cost of adopting various conservation practices.

The sixth policy analyzed would require the development of greenbelts along water courses where appropriate. This policy is oriented primarily toward water quality (rather than erosion control) and thus represents an approach that differs substantially from that currently pursued by existing federal agencies. Research indicates that such greenbelts may be effective in improving water quality. These strips would provide a filtering mechanism to trap eroded soil particles and would support an ecosystem capable of using some of the plant nutrients lost from agricultural land. The shading provided by vegetation growing on the greenbelt would have a moderating effect on water temperature, contributing to improved water quality. While the use of greenbelts was considered as a separate policy option in this report, it is clear that such an approach would need to be implemented in conjunction with a soil erosion control program to maintain soil productivity and hold soil losses to a sufficiently low level that the greenbelts could continue to assimilate them over a long term. Conformance with the policy could be determined by air surveillance.

POLICY ANALYSIS THROUGH MODELING

One of the major analytical tools used in this project was a large linear programming model of crop production in the corn belt. This model was constructed to determine the impact of various constraints on both farmers and consumers. A unique feature of the model is that it can determine the competitive equilibrium prices and quantities of the major crops produced in the corn belt under various constraints, allowing a more accurate determination of the impacts of various policies than is possible with the more commonly used fixed-price models. In the development and revision of the model, two sets of soil-loss coefficients were generated in consultation with the Soil Conservation Service. These coefficients relate the amount of soil loss to specific crop production activities and were chosen to approximate the actual soil losses based on experience. Numerous runs of the model were made using the higher soil-loss coefficients to examine the effect of alternative constraints. A sufficient number of runs were made with the lower soil-loss coefficients to make comparisons. As a result, the output of the model can be expected to bracket the actual impacts of policy implementation on producers and consumers. This model was used to analyze the impact of both soil-loss and nitrogen-limitation policies.

The corn-belt model indicates that soil erosion control policies will not have a significant negative economic impact--and may have a positive impact--on producers. For example, when soil-loss constraints ranging from 2 to 5 tons per acre per year are applied, the range of impact on producers is from -\$80 million to +\$500 million per year. The model indicates that if the higher soil-loss coefficients are appropriate, then the soil-loss constraints will generate increases in producers' income. If the lower soil-loss coefficients are accurate, the impact on producers is relatively small and may be either positive or negative.

Obviously, the impact on consumers and the net social impact of soil erosion control policies are highly dependent on the soil-loss coefficients. If the lower coefficients are accurate, the impacts on consumers and society in general is small, amounting to less than $200 million. If the higher soil-loss coefficients are accurate, the impact on consumers is negative and ranges from $400 to $1,200 million because of the inelastic demands. The $1,200 million negative impact occurs with a soil-loss limit of 2 tons per acre per year applied uniformly over all acreage in the corn belt, a limit which would be much stricter than adoption of the soil-loss tolerance limits used by the Soil Conservation Service. The primary causes of these economic impacts are a reduction in acreage and a corresponding increase in crop prices for the major crops. For example, crop acreage and corn production would both decrease approximately 6 percent under a 2-ton-per-acre soil-loss limit, resulting in a reduction in gross soil loss of more than 70%. Soybean production would decrease over 15 percent. As a result, corn prices would increase by approximately 15 percent and soybean prices by almost 20 percent. A uniformly applied soil-loss limit of 5 tons per acre would achieve substantial reductions from current levels of total soil loss, almost 45%, with a much less dramatic impact on crop production, prices, and consumer costs as measured by changes in consumers' surplus.

When the effects of implementing soil-loss restrictions are compared with those of imposing taxes on soil losses, it is found that the net impact on society would be less with a soil-loss tax but that the incidence of the impact would be changed significantly. Producers would be very adversely affected by the tax, while consumers would be somewhat better off. The tax system has a negative impact on soybean production but very little impact on corn production. Policies which would subsidize terracing are not as efficient from a social perspective as either soil-loss constraints or taxes. A terracing subsidy program would benefit producers at increased governmental cost but would have little direct impact on consumers.

A number of runs were made with combinations of soil-loss limits and terracing subsidies. When the relative efficiency of such policies is considered, the combination of subsidies and constraints appears reasonably efficient in reducing gross soil loss at nearly the same level of social cost as under the restrictions discussed above. It is possible that if the environmental benefits of such policies were included in the computation of social cost and if the more flexible tolerance limits established by soil type were used, soil erosion control policies would be quite efficient from a social perspective.

It is important to realize that the impacts of soil-loss control policies are not evenly distributed among geographical areas. For example, under some policies a substantial number of acres are removed from production, but total farm income remains nearly the same because of increases in crop prices. Clearly, in areas where production ceases, farm operators would be adversely affected while in those areas where crop production continues, and especially in those areas where no expenditures are required for soil-loss control, the higher crop polices would have a significant positive impact on farm income.

The model was also used to analyze the impact of restricting the quantity of nitrogen that can be applied on agricultural land. The results indicate that a 100-lb-per-acre restriction would have a relatively small impact on both producers and consumers. The net social impact would be approximately $300 million with a very slight increase in producers' welfare and a decrease of slightly over $300 million in consumers' welfare. There would be some increase in soybean production and a decrease in corn production, but the impacts would not be great enough to generate large changes in product prices. A 50-lb-per-acre nitrogen restriction would, however, generate significant changes. The net social cost would be over $1 billion with a negative impact of approximately $3 billion on consumers and a positive impact of $2 billion on producers. This positive impact occurs because of the reduction in production costs, especially fertilizer costs, and the simultaneous increase in product prices due to the reduction in corn and soybean production. It is important to note that while a nitrogen restriction applied uniformly to all farmers can generate a substantial increase in total farm income, this gain occurs only through the operation of the market. If an individual farmer reduced fertilizer applications while others did not, it would put him at a competitive disadvantage. This distinction may explain the negative reaction of farmers to fertilizer limits.

As would be expected, when nitrogen limits are combined with soil-loss restrictions the impacts increase. In general, farmers gain and consumers lose. The results are quite significant under the 50-lb-per-acre nitrogen restriction and also become significant under a 100-lb-per-acre nitrogen restraint if it is combined with a 2-ton-per-acre soil-loss restriction. Under that combination the major portion of the impact results from the soil-loss restriction.

One other significant finding is that the adoption of conservation tillage would significantly reduce the level of soil loss and at the same time improve the income position of farmers and the welfare of consumers. This finding is consistent with the continuing adoption by farmers of these tillage practices. If this technique were adopted on that 70 percent of the crop acreage for which it is appropriate, significant reductions in soil loss would occur. It is also likely that implementing any policy requiring improvement in soil erosion control would stimulate even more rapid adoption of this technique.

To analyze in more detail the variation in impact of soil-loss constraints on individual farmers, a watershed model representative of the corn belt and surrounding areas was constructed. This second model also serves to determine the long-run impacts of soil erosion control policies on the productivity of agricultural land. The results indicate that the application of soil-loss restrictions would result in substantial differences in the impact on individual farmers with varying qualities of land. These differences are evident under watershed- or farm-level restrictions on soil loss and with nitrogen restrictions at several levels. The model also dramatically indicates the effect of soil erosion control policies in maintaining the productivity of soil over a long time period. It further indicates that it is not economic for the individual farmer to adopt soil erosion control policies unless that farmer has an extremely long planning horizon and assumes a very low discount rate on future income.

Taken together, the models imply that soil erosion control can be achieved without severe adverse effects on the agricultural sector in total and that arbitrary soil-loss standards could have adverse impacts on farm income in selected areas. The regional resource allocation implications of adopting soil loss control policies only in selected areas is not addressed.

INSTITUTIONAL ARRANGEMENTS AND COSTS

If soil erosion or nitrogen control policies are adopted, it will be necessary either to make institutional arrangements or to utilize existing institutions to carry them out. The costs of a hypothetical set of institutional arrangements were estimated using the cost synthesis technique of determining the cost of functions that would need to be performed under each of the six principal policies considered. Sixteen such functions were identified. The basic categories of costs for performing those functions included labor and labor support, equipment, buildings, office support, and program support. These costs were estimated on the assumption that entirely new institutions would be created to implement the policies. As noted earlier, however, some of these policies could be carried out primarily by using the existing institutional framework. Doing so should result in lower costs.

A cost estimate was derived for each of the six policies on the basis of a hypothetical county in a hypothetical state in the corn belt. It was assumed that the policy would achieve its objective in a five-year period. The cost of an education program was estimated at $163,000 per county per year for five years. The administrative costs of a terracing program designed to implement all needed terraces was estimated to be almost $1 million per county per year for 5 years. The cost of a tax-credit policy was estimated to be essentially zero because in this particular case it was assumed that the existing Internal Revenue Service agencies would be used. The development of a conservation plan for each farm in the county was estimated to cost just under $490,000 per county per year for five years. Required implementation of these plans would increase the cost to almost $590,000 per year. Finally, a program to develop greenbelts around water courses is estimated to cost $265,000 per year over a five-year period.

It is important to note that attaining these goals in a five-year period would be extremely difficult and perhaps impossible in some cases. The technical personnel required to develop conservation plans and the equipment necessary to implement the plans are probably not available at the level necessary to achieve the goals in a five-year period. A time frame of 10 to 20 or more years may be more realistic. Thus, the annual costs would more likely be lowered somewhat and extended over a longer period.

LEGAL AND SOCIAL FACTORS

An analysis of the legal framework under which policies of this type would be implemented indicated that such policies could be drafted so as to be consistent with existing legislation. An analysis of the social factors indicates that farmer and farm community acceptance of the policies will likely be better if traditional agricultural agencies are involved in the implementation of policies than if new agencies are developed or if existing nonagricultural agencies are used. It is reasonable to expect, however, that if mandatory policies are adopted, resistance will be encountered, even if implemented by the traditional agricultural agencies (which have relied in the past on voluntary cooperation). The primary thrust of these agencies in the past has been to encourage the adoption of practices that are consistent with both the short-term interests of individual farm operators and the long-term interests of society.

In a related study, Illinois farmers and ASCS directors were surveyed to ascertain their reactions to alternative policy options. The results indicated that 75 percent of farmers believed soil conservation to be necessary for maintaining soil productivity, and 70 percent felt that it is needed to maintain acceptable levels of water quality. Twenty-five percent of the farmers believed that they should be doing a better job of soil erosion control, while 35 percent replied that they are doing the best they can under the circumstances. In general, those policies which would allow the farmer some flexibility in selecting the means of controlling erosion were viewed as more fair than those which would impose uniform prohibitions of, for example, certain tillage practices. Nitrogen control policies were rated strongly negative, while interest-free loans and tax credits for soil erosion control were received quite favorably. In general, more farmers viewed flexible soil erosion policies as fair than unfair. It is also somewhat surprising that the requirement to develop greenbelts along streams was viewed as reasonably fair by about the same proportion of farmers as viewed the mandatory implementation of soil conservation plans as fair. When asked to estimate the percent of farmers who would develop a conservation plan if required to do so, the respondents estimated on the average that 45 percent would develop such a plan.

EQUITY

Finally, to analyze the equity of public policies, three criteria were developed: Equality, earned-rewards, and least-risk. Any policy which would tend to reduce the income or wealth differences in the population would be consistent with the equality criterion. Any policy which would improve the degree to which individuals pay for benefits received or are compensated for costs incurred would be consistent with the earned-rewards criterion. Under the least-risk criterion, the policy that best conserves resources for future generations or avoids the adoption of technology with the possibility of future adverse consequences is regarded as the most equitable. The six alternative policies were rated as to their consistency with these three equity criterion, both from the general standpoint of consumers and taxpayers and in terms of their impact on various members of the agricultural community and on water users. Considerable variation was found among the policies when their conformity to these criteria was subjectively evaluated, and no one policy was highly rated according to all three criteria. It appears that the policies could be modified or elements of several policies could be combined to produce a policy more consistent with the equity criteria. While significant additional work could be done in assessing the degree to which policies conform with the equity criteria established, the present effort indicates that such an analysis is feasible and may be helpful to the decision makers who will determine public policy.

The major conclusions drawn from the study are presented in Chapter 9 of this report.

CHAPTER I

INTRODUCTION

NATURE OF THE PROBLEM

For over 30 years, public policy has been in effect in this nation to attempt to reduce the rate of soil erosion from agricultural land. The primary reason for this policy was to maintain the productivity of the soil, although it was also recognized that erosion causes sedimentation problems in reservoirs. Much remains to be done, however, even from the perspective of maintaining productivity. In addition, the relatively recent increase in interest in environmental quality has resulted in concern about the effects of soil erosion on water quality. It is now recognized that not only eroded soil but also plant nutrients and other chemicals applied to agricultural land may contribute to water pollution. This combination of concerns has led to a search for an effective and equitable policy for the control of agricultural nonpoint-source (NPS) pollution.

From an agricultural perspective, soil erosion is the primary concern because the quantity of sediment is large and because plant nutrients and other substances may move into the waters in association with the sediment. It has been estimated that approximately four billion tons of sediment enter the waterways of the 48 contiguous states each year and that three-quarters of this sediment comes from agricultural lands (National Research Council Committee on Agriculture and the Environment, 1974).* In a nationwide survey of seven types of NPS pollution it was estimated that 85 percent of the soil erosion occurs on croplands (USEPA, 1973). The same study estimates that cropland is the source of 50 percent of the total sediment that enters our waterways. The USDA has estimated that 64 percent of our cropland needs treatment for soil erosion (Trimble, 1974). The erosion problem is especially serious in certain areas of the cornbelt where row crops are grown on soils susceptible to high erosion rates. Numerous other examples of soil-loss estimates can be found in the literature. The January-February, 1977, issue of the *Journal of Soil and Water Conservation* carried a series of articles on the problem.

By 1940, the potential for producing food had been lost or seriously reduced on some 200 million acres in the U.S. (Bennett, 1939). "Based on the fact that at least a third of the topsoil on the remaining cropland has been lost, and that for each inch of topsoil loss there has been a corresponding decrease in productivity, we estimate that the production potential of U.S. cropland has been reduced 10 to 15 percent" (Pimentel *et al.*, 1976).

*References are listed on pp. 198-203.

Corn yields are reduced annually by an average of four bushels per acre for each inch of topsoil lost (Pimentel *et al.*, 1976), and yield reductions for other crops have also been estimated. On many types of soils changes in equipment, increased application of fertilizers, and other technical changes can compensate for the reduction in productivity caused by soil loss; however, these activities often raise the costs of production.

The full costs associated with sediment in waterways generally cannot be estimated because a substantial portion of these costs are aesthetic in nature and therefore not readily quantifiable. It has been estimated, however, that the decrease in the useful life of reservoirs resulting from sedimentation costs 50 million dollars annually (Stall, 1962). The annual cost of dredging rivers and harbors has been placed at 250 million dollars. A study of identifiable damages from sediment in the upper Mississippi River basin found annual damages of 25 million in 1960 dollars (U.S. Army Corps of Engineers, 1970). The major categories of damage were those to transportation facilities and drainage improvements. An estimated 90 percent or more of the sediment in reservoirs in this river basin is accounted for by sheet erosion (Glymph, 1957). A U.S. estimate of sediment damages was $500 million per year (Wadleigh and Dyal, 1970). In a recent series of estimates based on six watersheds in Illinois, Guntermann, Lee, and Swanson (1975) estimated that the offsite damages from sedimentation exceed the on-the-farm damages due to productivity losses.

In addition to these direct costs associated with sedimentation, the erosion problem is of concern because sediment is a principal carrier of plant nutrients and other potentially detrimental substances into the water. Thus, the control of sediment may provide a means of controlling associated pollutants as well.

While it is clear that sediment plays a role in the transport of plant nutrients and other substances, the exact levels are not clear (Logan and Schwab, 1976). Work is now being initiated to develop procedures for the systematic tracing or routing of sediments and nutrients through a watershed (McElroy *et al.*, 1976). Until such work is successful, planning sediment control by means of watershed treatment will remain a difficult problem.

It has been estimated that more than half of the surface waters in the U.S. used as water supplies have been affected by excessive algae growth. It has also been estimated that up to 60 percent of the nitrogen and 40 percent of the phosphorus found in these water supplies may be attributed to agricultural runoff (McCarty *et al.*, 1967). Approximately 50 million tons of plant nutrients are lost annually from croplands (Wadleigh, 1968). In addition to the impact on water quality, these lost nutrients must be replaced if the land is to produce the desired yields. Several estimates indicate that the replacement of lost nutrients (nitrogen, phosphorus, and potassium) will cost approximately $7 billion annually (Beasley, 1972; USDA, 1965).

In the context of the analysis presented in this report, it should be recognized that the relationship between soil erosion and water quality is not precisely understood. It is obvious that greatly accelerated erosion rates result in increased turbidity and sedimentation, but the exact proportion of the eroded soil that reaches the water and the manner in which it moves once it arrives there are not known. Also, the impact of the sediment on the aquatic habitat is not fully understood. While these questions are addressed in a section of this report, the major thrust of the analysis is on methods for reducing soil erosion from agricultural land. Concentrating on such control measures is a reasonable approach because (1) erosion is clearly a partial cause of the water problem, (3) there are associated implications for soil productivity, and (3) this aspect of the physical problem entails important public policy issues.

OBJECTIVE

As a step toward solving the problems outlined above, the USEPA sponsored the research project described in this report. The objective of the project was to examine alternative policies for the control of agricultural nonpoint sources of water pollution. The research, carried out during the one-year period by an interdisciplinary team of scientists at the University of Illinois at Urbana-Champaign, was administered and coordinated by the university's Institute for Environmental Studies.

APPROACH

The approach planned for this study was to examine in a preliminary manner a wide range of existing policies for the control of agricultural nonpoint sources of pollution and then to select from among them six representative policies for intensive analysis. A search of existing and proposed state and federal legislation and programs, however, produced only a limited number and variety of NPS control strategies. Team members therefore supplemented the list by developing additional control policies by a method described later in this report. The six ultimately selected for analysis were chosen to represent a broad range of approaches to NPS control and to provide opportunities to analyze the potential impacts of such a diverse array of policies. Those chosen varied from programs in which participation would be completely voluntary to ones which would mandate performance and impose penalties for noncompliance.

The search for existing policies and laws related to NPS pollution control at the federal and state level is discussed in Chapter 2. Also presented is a history of federal and state soil conservation efforts and agencies, a summary of proposed state legislation, and a brief discussion of the costs of present federal programs directed toward the reduction of soil erosion.

Chapter 3 discusses the development and selection of the six policies subjected to detailed analysis during the course of this project. One of the policies would require the establishment of "greenbelts" along waterways to provide vegetative filtering of runoff water, thus capturing sediment and plant nutrients and preventing them from entering the waterways. Because such a policy has not been widely considered, a discussion of the underlying principles and possible impacts of greenbelts on water quality is included.

The remaining chapters present analyses of the various aspects of the six policies and of related NPS control techniques. Chapter 4 presents the results obtained when two linear programming models were applied to determine the impacts of a number of alternative control techniques. One of these models is applicable to the entire corn belt and indicates the impacts that can be expected at the aggregate level. The other is a watershed model which concentrates on the impacts of soil erosion control practices in maintaining soil productivity over a long planning horizon.

Chapter 5 describes the institutional arrangements necessary to carry out each of the six policies and provides an estimate of the cost at the county level of implementing these policies. To generate these costs it was necessary to identify in detail all of the activities required under each policy and their component costs. Chapter 6 discusses the sociological factors involved in implementing policies of this type and discusses the results of a survey which indicates the possible reaction of Illinois farmers to these policies.

Chapter 7 presents three equity criteria that could be used in evaluating alternative policies. A subjective analysis of the six policies according to these criteria is also presented. Chapter 8 reviews the legal implications of implementing the six policies analyzed and discusses whether nitrogen constraints are legally feasible. The final chapter indicates the principal conclusions that can be drawn from this work.

CHAPTER 2

EXISTING SOIL CONSERVATION PROGRAMS, POLICIES, AND LAWS

During the initial phase of this project, a number of current and recent institutions, programs, and laws related to the control of soil erosion and thus to the control of pollution from agricultural nonpoint sources were examined. The purpose for this review was to obtain information on a wide range of control policies which could then be analyzed for their legality, equity, cost, and administrative characteristics. Pertinent literature was reviewed and numerous individuals in appropriate positions were contacted to determine what policies were currently in effect. The variety of the policies discovered was not wide.

The initial section of this chapter presents background information on existing agricultural agencies concerned with soil erosion problems. Such agencies provide obvious opportunities for implementing agricultural NPS control programs. The second section analyzes those present federal and state laws which have a bearing on existing and potential erosion control and NPS pollution control programs. Costs for the existing programs, insofar as they could be ascertained, are presented in the final section.

EXISTING PROGRAMS AND AGENCIES

The federal Soil Conservation Service (SCS), the local Soil and Water Conservation Districts (SWCDs) and the federal Agricultural Stabilization and Conservation Service (ASCS) are governmental agencies that have been developed, in part, to address the problem of soil conservation.

The first funds ($160,000) for soil erosion investigations were appropriated in 1929. A temporary Soil Erosion Service was established in 1933 within the U.S. Department of the Interior, partly as a conservation measure and partly as a means of providing employment through conservation demonstration projects in conjunction with the Civilian Conservation Corps and the National Industrial Recovery Act.

In 1935, the various soil erosion activities of the U.S. Departments of Interior and Agriculture were merged into the Soil Conservation Service within the latter department. The SCS set a policy of providing planning, organizational, and technical assistance to individual farm producers and watershed groups to aid them in developing sound soil conservation practices. That policy continues today. The objectives of the SCS are to bring about desirable physical adjustments in land use with a view to bettering human welfare, conserving natural resources, establishing a permanent and balanced agriculture, and reducing the hazards of floods and siltation. These objectives are pursued through complementary programs of soil conservation, farm forestry, flood control, submarginal land utilization, drainage, and irrigation. The central thrust is to extend sound land-use practices to all land, public and private, which is vulnerable to soil erosion.

Because the pace of achievement was slow when all the initiative was at the federal level, a novel institutional development was fostered. Local identification was seen as being a necessary ingredient in fashioning a national program which could meet local conditions, assimilate the insights of the practicing farmers, and encourage the necessary farmer cooperation. The development of Soil and Water Conservation Districts (SWCDs) met these needs. The districts were authorized under standard state enabling laws which outlined district functions, powers, and organizational arrangements. Legally, the districts are subdivisions of the state but are clearly dependent upon and a complementary vehicle for implementation of the policy envisioned for the U.S. Soil Conservation Service. Cooperation between the districts and the SCS is facilitated through a formalized memorandum of understanding.

All states have enacted the enabling legislation, in most cases patterned after a model act. The linkage at the state level is often a state agency with other general code responsibilities for conservation and management of natural resources. Essentially all of the nation's farmland is encompassed in the almost 3,000 districts. Each district was initiated upon petition of the farmers and is partly governed by an elected farmer committee system. Under the auspices of these districts, federally-funded and well-trained conservation specialists provide educational, planning, and technical assistance to cooperating farm operators to aid them in developing basic farm conservation plans.

Two types of powers are vested in the districts to enable them to achieve erosion control and, specifically, to promote the application of soil conservation practices by individual farm operators. Under the first power, authorized in the standard enabling act in almost all states, the districts can offer a variety of voluntary conservation activities in agreement with land users. These activities include developing conservation plans, conducting demonstrations, providing information on prevention and control measures, and lending equipment. The second, provided in a majority but not all of the states, is the power to prescribe types of compulsory land-use regulations for the prevention and control of erosion. Such regulations are imposed subsequent to specified processes which include petitions, hearings, and a referendum approved by the affected land users. For example, Illinois districts are authorized to adopt land-use regulations with the approval of three-fourths of those landowners voting. Except in a few western states, however, few such regulations have been developed.* In addition, SCS is providing assistance to some 148 projects of the Resource Conservation and Development Program in specific agreement with public agencies involved in particular land or water management activities.

The federal Agricultural Stabilization and Conservation Service (ASCS) administers a policy of providing financial assistance to achieve agricul-

*Such regulations are more frequently used in watershed drainage districts.

tural soil conservation. Initiated in 1936 with the Soil Conservation and Domestic Allotment Act, the Agricultural Conservation Program (ACP), also now referred to as the Rural Environmental Assistance Program (REAP), has functioned under the federal agency charged with production control and with price and income support. This administering agency was first named the Agricultural Adjustment Administration (AAA), but is now the ASCS. The ACP was originally conceived as a means of controlling production. By offering federal payments, it sought to induce farmers to engage in soil-conserving practices and, hence, to curtail the production of soil-depleting annual crops. This approach to production control was developed as a way of bypassing the restraints upon direct control imposed by the U.S. Supreme Court's ruling that the 1933 Agricultural Adjustment Act was unconstitutional. Later, the ACP was converted to an independent program of cost-sharing for specified voluntary soil conservation practices by farmers.

Currently, the ASCS, SCS, and SWCDs cooperate in implementing soil conservation programs. The local SWCDs provide direction, the SCS provides technical assistance, and the ASCS provides funding (up to $2,500 per farm per year) to cooperating farmers for the adoption of soil conservation practices.

The technical assistance, subsidization, and sometimes compulsory performance aspects of these existing soil conservation policies have obvious implications for the development of programs by the states to achieve the now-federally-mandated control of agricultural NPS water pollution.

EXISTING AND PROPOSED LAWS

Federal Laws

As indicated in the preceding section, federal laws related to soil erosion control have generally been promulgated for the purpose of preserving natural resources and maintaining crop productivity (or for indirectly controlling production). The Federal Water Pollution Control Act (FWPCA) of 1972 was the first federal legislation to formally recognize the problem of nonpoint-source pollution and to cite agricultural activity as one of the many diffuse sources of such pollution.

Nonpoint sources of pollution are excluded from the effluent limitations set forth in Sections 104 and 402 of the act, which identify water pollutants and establish the nationwide point-source management system (National Pollution Discharge Elimination System, or NPDES). A number of sections in the act, however, apply directly or indirectly to the control of nonpoint sources.

Section 304 the most directly stated NPS provision, mandates the analysis and study of NPS pollutants. Subsection 304(e) specifically directs the Environmental Protection Agency to issue guidelines for identifying and evaluating nonpoint sources of pollution and to recommend control methods and procedures.

Section 208 contains the strongest statement concerning NPS pollution. This section directs the development and implementation of area-wide water quality management plans. The objective in formulating such plans is to identify those areas which have substantial water quality control problems, leading to the development of corrective planning and regulatory programs. These management plans are being designed to achieve the goals of the act -- namely, water that is fishable and swimmable by 1983, and the complete elimination of pollutant discharges by 1985 where technically, economically, and socially achievable. Specifically, the plans are to identify and set forth procedures and methods for the control of agricultural nonpoint pollution sources and the means of implementing such controls.

This "208 planning process" is now underway. Detailed management plans and implementation time schedules for the states will be due in 1978. The EPA originally required that this planning be carried out only in certain designated areas with severe problems. In such areas, the planning effort is generally carried out by a regional commission formed for that purpose. As the result of a court decision (Natural Resources Defense Council, *et al.* v. Train, *et al.*), however, the EPA now must require the states themselves to carry out this planning activity for those areas which are not included in the designated planning areas. The EPA is also required to provide support to the states for such planning activities.

It is the intent of Congress that in implementing Section 208, provisions be made to involve citizens in the planning process and the design of control policies.

Unlike the specific effluent limitations and standards the act authorizes for the control of point sources, effluent standards are not specified for the abatement of NPS pollution. Since nonpoint sources are only partially controllable, the EPA has indicated that states should adopt, when possible, "best management practices" (BMPs). These practices are the control techniques that a state considers to be the most reasonable and effective and which are suitable to local conditions at the time of implementation. Such practices include crop rotation, less intensive cropping systems, conservation tillage, and structural controls. It is significant to note that these best management practices are preventive measures--they are directed toward controlling soil erosion on-site rather than dealing with sediment after it has eroded.

Section 209 of the FWPCA deals with river-basin planning and undoubtedly will cover 208 plans as they affect a particular basin.

Section 303 is concerned with elements in proposed state programs dealing with water-quality standards and implementation plans. State planning and management for the control of NPS pollution are elements of this overall state water-quality management process and represent a combination of planning and implementation as directed in Sections 303 and 208.

Section 305 of the act instructs each state to carry out water-quality inventories, which involve reporting annually on the nature and extent of NPS pollutants, recommending methods for controls, and estimating the cost of control.

State Laws

This section presents a general survey of existing and proposed state statutes relevant to the agricultural NPS pollution problem and also describes a model law. The individual statutes are summarized in Appendix A. Research revealed little in the way of innovative approaches to soil erosion control at the state level.* (The CRIS and WRSIC data retrieval systems also produced little information of value.†) Many states and counties have erosion-control regulations, but these regulations are primarily applicable to the disturbance of land by commercial, highway, and construction activities. In a number of states, controlled agricultural activities are specifically exempted from soil erosion ordinances and laws.

Control of sediment pollution involves constraining the way land is used. Jurisdiction over land-use policy has traditionally been delegated to states and often by them to local governments. These units, in turn, have usually left the problem to the realm of private policy. Most federal or state policy directed at agricultural erosion has been a response to concerns not about water quality but about soil productivity, food supply, and reservoir damage. Significant policies of this nature have been in effect for decades.

As outlined in the first section of this chapter, public policy responding to problems of agricultural soil erosion originated in the early 1930s. Development of these policies followed a slowly rising national consciousness, initially appearing in the early 1900s, of the waste and exhaustion of the nation's natural resources. A quarter century later, public awareness was sufficient to precipitate the development of agricultural soil conservation policies. The principal concerns addressed by these policies were farmland productivity, farm family livelihood, community economic viability, flood damage, and reservoir capacity. Water quality, although a factor, was a lesser concern. Erosion was perceived primarily in terms of a loss in food-production capacity rather than of the detrimental effect on stream water quality resulting from sediment and the chemicals it carries.

The several state laws reviewed in this section were written during the extended period between implementation of SWCD-type legislation and passage of the Federal Water Pollution Control Act Amendments in 1972. As in earlier statutes and programs, these laws emphasize soil erosion control for

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*A number of reference sources, reports, and papers present summaries of state statutes covering soil erosion controls. Rather than duplicate such previously published material, only those states having agricultural land controls will be discussed here. For additional information see the recent six-state study prepared by the National Association of Conservation Districts (NACD) for the EPA, *Erosion and Sediment Control Programs*, 1976 (NACD P.O. Box 855, League City, Texas 77573). Also, see (1) *Compilation of Federal, State and Local Laws Controlling Non-Point Pollutants,* September, 1975; (2) NACD-208 Series of Informational Newsletters, Nos. 1, 2, 3, 4, and 6.

†Current Research Information Retrieval System, UDSA; Water Resources Scientific Information Center, UDSI.

the purpose of saving the soil resource, not preserving water quality. Appendix A contains a summary of the major provisions of the enacted laws and proposed bills covering agricultural activities.

Some of the existing state laws are complementary to the Federal Water Pollution Control Act of 1972, and the states therefore may choose to coordinate their Section 208 water quality management planning with those existing state statutes. Some state laws, however, may be contradictory to the objectives and mandate of the FWPCA. In such cases it will be necessary to amend or replace the existing laws and programs with ones that are compatible with federal directives. Particular problems may arise if it is found necessary in meeting the objectives of Section 208 to replace present voluntary soil conservation programs with mandatory programs or regulatory action. Despite the fact that the state statutes characterized in the following discussion are of several different types, they contain similar patterns of provisions. For example, these laws and proposed bills include agricultural activities either by direct enforcement or indirectly by requiring compliance with an approved conservation plan. Some states have exempted plowing and tilling from their laws if the landowners are farming under the guidelines of an accepted conservation plan, while others have deleted agriculture altogether. While not all of the statutes require implementation of conservation plans, they at least demand more than intent to show compliance with the law.

Citizen participation is required under many of the laws. For example, Iowa and South Dakota statutes both provide for citizen participation but in different ways. South Dakota legislation requires the "development of guidelines with full opportunity for citizen participation," while in Iowa, the implementation of conservation practices on a farm can be made mandatory only after a complaint is filed by a neighbor alleging erosion damage from that farm. Thus, action on the part of the injured citizen is a necessary element. The state of Kansas has proceeded with planning for soil erosion control by first offering a public education program and an opportunity for citizens to become involved in the design of erosion-control legislation.

Next to the conservation plan, the most common feature of state laws and bills is the provision for economic assistance in forms such as cost-sharing incentives and conservation practice financing. Most states will continue to rely on ASCS-SCS technical and financial assistance in their soil erosion control programs. In other states, such as Iowa and Ohio, the laws prohibit enforcement of compliance measures unless the state has authorized sufficient funds to support implementation costs for conservation work.

Enforcement procedures and penalties for noncompliance are also similar among the various state statutes. In general, the penalty provisions specify that violators will be subject to fines and found guilty of petty offenses and misdemeanors. Most state laws require forfeiture of cost-sharing funds if a landowner does not follow prescribed conservation practices. Enforcement proceedings are initiated by a neighbor's complaint or by the local SCS office. As reported above, orders to comply do not have to be followed unless technical and financial assistance is available. In Michigan, enforcement proceedings include regular on-site inspection and monitoring.

Model State Law

A "Model State Act for Soil Erosion and Sediment Control" developed during the 1973 National Symposium on State Environmental Legislation for the Council of State Governments contains many provisions similar to existing and proposed state laws. The thrust of the model legislation is directed toward the state SWCD's. Amendments to existing SWCD enabling legislation would give the districts authority to establish erosion and sediment control programs. Soil erosion control policy would be implemented through the state SWCD and the local districts.

Under the model law, sedimentation would be controlled by requiring the filing, approval, and implementation of a proper conservation plan. The implementing agency would make periodic inspections to monitor areas with soil erosion problems. Inspections would also be made to review complaints and appeals by landowners whose property is damaged by a neighbor's eroding soil. Violations of the soil erosion control law would be deemed a misdemeanor and the violator would be subject to a fine not to exceed $500 or one year's imprisonment.

Agricultural activities carried on in accordance with an approved conservation plan would be exempt from earthmoving permits and required plans. According to the model law, state agencies and districts should be eligible to receive and dispense funds for implementation of the law's provisions. Legislatures should provide landowners with 50% cost-sharing funds and technical assistance if the landowners are expected to comply with established conservation standards.

Existing State Laws

Iowa. This state was one of the first to propose a law (the Soil Conservancy Law) promulgating rules and regulations for soil erosion control. The law was adopted by the state in 1971.

The new law actually amended Iowa's existing SWCD law to place a tonnage limitation on soil loss. Under this law a landowner is required to implement soil conservation practices if his property is shown to be the source of excessive sediment pollution to another person's property. Only the owner or occupant of the land damaged by the sediment can file a complaint initiating such a requirement. The local conservation district, however, must bear the burden of proving that a nuisance exists, and the state must provide cost-sharing funds in an amount equal to 75% of the conservation remedy. Additional provisions include the promotion of land-use planning and the coordination of district conservation activities. (Note that for a conservation program pursued voluntarily, the state will pay only 50% of the cost. The law thus tends to encourage "friendly complaints" which make the higher 75% rate available to the landowner.)

Hawaii. The state enacted soil and sediment control legislation early (it was passed in 1968 and revised in 1975). The tilling and clearing of land come under the jurisdiction of the act. The law directs county governments, in cooperation with SWCDs, to promulgate soil control ordinances. If the counties fail to enact such legislation, the state will intervene and establish local standards and regulations.

Pennsylvania. The enabling law for Pennsylvania's sediment and erosion control program is the "Clean Steams Law" passed in 1937 and amended in 1972. This law is one of the exceptions to the earlier generalization that the purpose of most state erosion control statutes is to maintain productivity rather than to preserve water quality. Rather than concentrating on the primary prevention of soil erosion as a means to reduce sedimentation, this legislation calls for preventing additional pollution of state waters and for the reclaiming and restoring every polluted stream in the state to a clean, unpolluted condition. Responsibility for implementation of the bill is delegated to the local SWCDs. The bill also recognizes that achievement of water-quality goals requires a comprehensive program of watershed management.

Agricultural activities are within the overview of the Pennsylvania law and may be exempt only when such activities are carried out under the guidelines of a conservation plan. Although persons engaging in any earth-moving activity must obtain a permit for such action, plowing and tilling for agricultural purposes are exempted. However, agricultural activities must be so conducted as to prevent erosion and sedimentation. The control devices specifically mentioned in the law are catch basins, interceptor channels, and diversion terraces. High rates of soil erosion are permissible if a catch basin or similar structure is provided to prevent soil from leaving the property and entering a waterway. Even though these methods may keep streams free of silt, they do not have the added affect of protecting the land's productive potential.

The law requires each landowner to prepare a conservation plan by July 1, 1977. These plans need deal only with sediment reduction and thus do not represent a complete and formal soil conservation plan.

Michigan. The state legislature enacted its soil erosion and sedimentation control act in 1972. The law is applicable to all activities that involve "earth changes" and that contribute to soil erosion or sedimentation.

In the law as originally enacted, control provisions were applicable to agricultural practices. Two years later the law was amended to include special provisions for plowing and tilling for crop-production purposes. Agricultural activities, however, do come within the scope of the law. Persons engaged in agricultural production who have entered into a formal agreement with a soil conservation district to carry out practices in accordance with rules and regulations of the law will not be subject to the law's requirements for land-use plans or to its earth-disturbance permit system but will be subject to enforcement procedures after January 1979. The state Department of Agriculture has been given the authority to set guidelines for agricultural practices when controls take effect in 1979.

New York. The state legislature recently passed a bill which became effective on July 1, 1976, amending that state's soil and water conservation district law.

The New York law controls only sediment and animal waste pollutants, not fertilizers. Agricultural landowners are required to apply to local SWCDs for assistance in developing a conservation plan by January 1978. During or before January 1980, the districts must, in return, provide a conservation plan for each of these applicants. The law does not require implementation of the plan, but all plans are to be reviewed every five years.

The law originally proposed for New York state contained provisions for limiting the rate (in pounds per acre) and methods of fertilizer application. The bill would also have prohibited tillage and fertilization of lands having slopes greater than 20%. Strong public objections led to defeat in favor of the present law.

South Dakota. In 1976, South Dakota passed an act titled "To Regulate Land-Disturbing Activities within the State Resulting in Soil Erosion and Sediment Damage." While applications of the law are broad, the provisions for implementation are rather specific.

The State Conservation Commission must develop erosion control guidelines within 12 months. Like other state soil erosion control laws, South Dakota has mandated that these guidelines be based on relevant watershed and drainage-basin data. Surveys of areas with critical erosion and sediment problems are to be utilized. Conservation standards are to be developed by conservation districts and are to include criteria, techniques, and methods for erosion and sediment control. Guidelines must include recommended soil-loss limits and alternative conservation practices. The law provides for public participation in the development of the control guidelines.

Another similarity between the South Dakota law and other laws is the reliance placed on a permit system to monitor land-disturbing actions. As with the Iowa law, an enforcement provision directs the conservation districts to accept, investigate, and validate petitions from persons whose property has been adversely affected by soil erosion from neighboring land.

New Jersey. The state's "Soil Erosion and Sediment Control Act" (1975) provides that conservation standards are to be established by a state soil conservation committee subject to the approval of the state secretaries of agriculture and environmental protection. As in the South Dakota law, these standards are to be based on relevant watershed data. The major provisions of the law concern municipal activities; agricultural activities, however, are included in the general mandate of the law.

Montana. The Natural Streambed and Land Preservation Act of 1975 was enacted primarily for control of proposed projects affecting streams. Recognizing the need for agricultural use of rivers and the needs to preserve the water for beneficial uses, the Montana legislature passed this bill to establish a policy of preserving the natural or existing form and course of streams and keeping soil erosion and sedimentation to a minimum.

In addition to provisions for agricultural activity control, the law includes regulations for river dredging and stream channelization activities. Conservation districts are the implementing organization and must adopt rules and establish standards and guidelines in accordance with standards set by the State Board of Natural Resources and Conservation, overseer of the law. If the Department of Fish and Game is notified of a proposed project, a review team aided by SCS technical assistants may be appointed to examine plans on-site. If an acceptable plan cannot be agreed upon, an arbitration board is appointed. If the arbitration panel requires modification of the original plan, cost-sharing must be provided for those additional measures needed.

If a project has not received prior approval, it will be declared a nuisance and subject to legal action. Violators (those initiating projects before approval) will be guilty of a misdemeanor and may be subject to costs of restoring damaged streams.

Virgin Islands. The Virgin Islands' law on soil and shore erosion exempts lands under approved cultivation methods for agricultural purposes. Presumably those agricultural lands that are not cultivated under an approved conservation plan must at some time come under an enforcement policy for erosion control.

Proposed State Legislation

In a number of states, soil erosion control bills which encompass agricultural activities are currently undergoing legislative review. Several of these proposed acts are expected to become law in the spring of 1977.

Illinois. The proposed Illinois bill differs from the model law by designating the Illinois Department of Agriculture rather than the state SWCD commission as the administrating agency of the state erosion and sediment control program. The implementation and enforcement of the law, however, is to be performed by the SWCDs, as provided in the model law.

Each district is to develop a technically and economically feasible program consistent with agriculture department guidelines. To aid in developing the state program, an advisory commission must be created with at least half of the members deriving 50% of their income from farming.

Indiana. A bill proposed in the Indiana legislature would require a conservation plan to be approved prior to any prohibited land-disturbing activity. An individual who has developed and is abiding by an approved conservation plan but who cannot receive the technical and financial assistance necessary for implementation of a formal control program would not be penalized.

Ohio. An "Agricultural Pollution Abatement Standards and Regulatory Act" is expected to be adopted in the spring of 1977. The first version of this bill did not pass. It is believed that the new version, which provides for greater cost-sharing and expanded appeal opportunities, should pass during the spring legislative session. Under the law, the Division of Soil and Water Districts in the state Department of Natural Resources would recommend abatement practices for sediment and animal wastes in accordance with state standards and would develop regulations in cooperation with the local SWCDs.

A unique feature of the proposed Ohio legislation is the inclusion of a soil-loss limitation timetable* based on the USDA-SCS Technical Guide on soil-loss tolerances or "T" values, which are site specific. These tolerances do not consider the amount of soil loss that would degrade water quality. The Ohio law, however, is written in such a way that if the water quality standards are not met, the accepted level of conservation practices will be revised. Another feature is that tillage is prohibited adjacent to a ditch, stream, or lake where soil would readily erode into these bodies of water.

Cost-sharing for the improvements necessary to meet standards is also provided for in the proposed legislation, but the extent of compensation has yet to be determined.

Kansas. Like Illinois's proposed soil conservation law, the Kansas law is a direct descendent of the model law. Kansas is also one of the first states to propose soil legislation in direct response to the mandates of the FWPCA. In 1974 a Kansas Task Force was formed to further consider how the FWPCA might be implemented in that state. Since then the group has recommended specific legislation and has also recommended that the state (1) develop a land treatment and management program that meets unique conservation needs in Kansas; (2) draft legislation which will comply with federal requirements but recognize public and private rights of citizens; and (3) involve citizens in the design of regulations. To initiate such involvement, the state Cooperative Extension Service in cooperation with other groups and agencies has developed an extensive public education program on soil erosion problems.

Highlights of the suggested legislation include limitations on land-disturbing activities, compliance with the law through an approved conservation plan, an arrangement for cost-sharing for land treatment practices, provision to control by conservation districts for abatement programs, and authorization of the state conservation commission to set guidelines.

During the 1975 legislative session a first draft of the proposed bill was introduced but did not pass. The bill is now being redrafted with revisions to reflect current Section 208 policy and planning.

Minnesota. In the proposed Minnesota bill, land-disturbing activities are defined to include tillage on agricultural land. The state SWCD Commission will sponsor the erosion control program and will develop standards and regulations with the assistance of an advisory board. To be in compliance with the law, a person engaged in a land-disturbing activity must have an approved

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*Average annual soil loss limited to:

Phase I - 2 times T value until 1980
Phase II - 1.5 times T value from 1980 - 1985
Phase III- T value after 1985

(T value taken from Technical Guide developed by the Soil Conservation Service, U.S. Department of Agriculture; if guide does not apply, practices approved by SCS District will be used.)

conservation plan for erosion and sediment control.

This bill was introduced during a previous legislative session and is now expected to be reintroduced as a response to the federal requirement for Section 208 planning.

County Soil Erosion Ordinances

There are many counties which have enacted ordinances for the control of soil erosion, but most of these laws do not include control of agricultural practices. In Walworth County, Wisconsin, however, a zoning ordinance was passed in 1974 which permits tillage on some soil types only if done in accordance with county conservation standards (derived from SCS standards). The county zoning administrator is responsible for putting the ordinance into effect.

In Vernon County, Wisconsin, the local SWCD has proposed an ordinance specifically directed toward management of agricultural land for conservation of soil and water and for the control of erosion and sedimentation. The ordinance, entitled "Soil and Water Conservation District Land Use Regulations for Erosion and Sediment Control," is to be implemented by the district.

All agricultural land would be subject to the ordinance except that having a slope of less than six percent. To comply with the ordinance, a landowner must contour plow, employ other conservation management practices acceptable to the district, or manage the land to meet standards in the SCS Technical Guide. If technical assistance and/or public cost-sharing funds for the management practices specified in a conservation plan are not available, then compliance is waived.

Enforcement of this ordinance includes investigating citizen complaints and filing those complaints with the district attorney for prosecution if the violation is not halted or remedied. Violators would also forfeit cost-sharing funds if conservation measures are not put into effect.

Other Laws

Several types of laws not considered in the preceding discussion could be applied to the control of agricultural NPS pollution. Such laws may be of value in developing alternative control policies.

Laws dealing with stream pollution are based on riparian rights and the right to protection against nuisances. Both types of law rest on the concept that a landowner whose property borders a stream not only has a right to clean water but also has a responsibility not to degrade the water quality and thereby cause a nuisance to downstream neighbors. Most states have statutes that cover such rights. Iowa's Soil Conservancy Law, for example, is based on the nuisance doctrine.

Most states also have water pollution statutes (environmental protection laws and regulations) which prohibit the discharge of any contaminant at concentrations which may cause water pollution (as defined by state standards) and the deposition of any contaminant upon the land in such places and manner as to create a water-pollution hazard.

Finally, as described previously, each state has a Soil and Water Conservation District Law. Most of the SWCD statutes were enacted in the 1930s but have been continuously amended to reflect changes in soil technology and in the general outlook on soil conservation. One important amendment adopted by a number of states is the authorization to promulgate land-use regulations with enforcement mechanisms to control soil and water resources.

A number of other laws could be applicable to agricultural NPS pollution control programs: statutes on fertilizers, planning and zoning ordinances on the local and county levels; and floodplain and flood protection laws. While the miscellaneous statutes and proposed bills discussed in this section do not specifically refer to agricultural nonpoint sources of pollution the scope of some may be broad enough to cover certain agricultural activities.

COSTS OF EXISTING PROGRAMS

In assessing the relative merit of alternative programs for NPS pollution control it will be necessary to evaluate the costs of implementing each program. Detailed cost estimates for administering selected representative programs will be presented in Chapter 5. To provide a background against which to interpret and compare those estimates, this section provides information on the administrative costs of existing governmental programs in the area of soil conservation and erosion control.

It should be recognized that a wide range of techniques is potentially applicable to the control of NPS pollution. The costs summarized here are those for the only two general approaches currently being applied on a major scale: assisting farmers in developing soil conservation plans (the task of the SCS and the SWCDs) and providing farmers with financial assistance for the cost of implementing soil conservation measures (a function of the Agricultural Conservation Program (ACP) administered by the ASCS). Because very little has been done to date toward implementing other approaches to NPS control, cost data for other techniques are unavailable.

Costs of SCS Programs

Data on the costs of SCS operations--the development and revision of soil conservation plans--in eleven states are presented in Table 1. Although a knowledge of the planning costs for each type of conservation measure (such as contouring, terracing, etc.) would be helpful in estimating costs for NPS control policies, the available data unfortunately did not permit such a breakdown. If the number of acres that would be treated by the various practices as a result of a given policy were known, it would be possible to develop an estimate of the cost of the policy. Because of the lack of detailed information, however, it was not possible to make such estimates. Note that Table 1 includes only the *planning* costs; the costs of the conservation structures are excluded.

The per-acre SCS costs in actual dollars range from a high of $4.81

Table 1

SCS Costs per Acre for Planning and Plan Revision in Selected States, 1970-74

		IL	IN	IA	KS	MI	MN	MO	NB	OH	SD	WI
1970	Actual	1.84	2.68	1.31	.53	2.10	1.78	1.77	.34	4.77	.39	2.59
	Real*	2.50	3.64	1.77	.72	2.85	2.42	2.40	.46	6.48	.53	3.52
1971	Actual	2.00	2.52	1.28	.59	2.89	1.77	2.03	.42	4.41	.48	2.56
	Real*	2.60	3.28	1.66	.77	3.76	2.30	2.64	.54	5.73	.62	3.33
1972	Actual	2.46	3.27	1.36	.69	3.25	2.08	2.18	.40	4.70	.53	2.59
	Real*	3.09	4.10	1.71	.87	4.08	2.61	2.74	.50	4.95	.67	3.25
1973	Actual	2.56	3.57	1.54	.96	4.09	1.78	1.79	.49	4.16	.44	2.52
	Real*	3.04	4.25	1.83	1.14	4.87	2.12	2.13	.58	4.95	.52	3.00
1974	Actual	3.09	4.13	1.51	.89	4.76	2.22	1.91	.58	4.81	.51	2.95
	Real*	3.33	4.45	1.63	.96	5.13	2.39	2.06	.63	5.18	.55	3.18

*Inflated to 1975 values using the U.S. Government implicit price deflator.
Source: *Conservation Costs and Accomplishments* (USDA, various years).

(Ohio, 1974) to a low of $.39 (South Dakota, 1970). In real dollars* the high is $6.48 (Ohio, 1970) and the low is $.46 (Nebraska, 1970). Whether we look at real or actual dollars it is evident that a wide range of present SCS costs exists among these eleven states.

Iowa, which enacted its "Soil Conservancy Law" in 1971, shows a relatively low planning cost (real dollars averaged over 1970-74) of $1.75 per acre. Even though the control program relies on the SCS to develop soil conservation plans, the per-acre cost of planning did not increase significantly from 1970 (prior to policy implementation) to 1974 (after the policy had been functioning for several years). This fact may indicate that the program has resulted in changes in SCS activities which, in turn, have kept planning costs from increasing. The program may have improved the efficiency of some SCS work by allowing the staff to devote less time to convincing farmers that they need a program, thus leaving more time for soil conservation plan development.

Costs of Black Creek Watershed Project

The USEPA has sponsored an advanced sediment control program in Indiana's Black Creek Watershed since June 3, 1974. The accomplishments and costs of that program are shown in Table 2. The cost of planning conservation programs (technical assistance costs) for acres under contract is $16.99/acre in actual 1976 dollars. In real dollars (base year 1975) the cost is $16.30 per acre. This price is considerably higher than the state SCS planning costs.

The higher cost of the Black Creek Project probably results from the special care and emphasis given to this experimental project and from the initial lack of cooperation on the part of the Amish farmers. The cost was also inflated by initially concentrating on stream-channel stabilization, which cost $90,341. Most of that amount was spent on streams during the first year, but the project then switched to other less expensive methods which have proven more effective. Therefore, it is reasonable for the Black Creek costs to be higher than statewide SCS costs. For these reasons, it does not seem appropriate to use these cost data as a basis for estimating the costs of achieving soil erosion control under an expanded voluntary-subsidy program.

The subsidy payments included in some present agricultural policies could also form a part of a nonpoint-source pollution control program. The administrative costs of the ASCS/ACP program were therefore analyzed to gain insights into the costs of subsidy programs. The cost data used cover the years from 1969 to 1975 for the states of Illinois, Indiana, Minnesota, Ohio, Wisconsin, Iowa, Missouri, and Nebraska. These data include only the administrative costs associated with the payment of subsidies and omit the actual subsidies paid.

The cost data were broken into the 35 categories of accomplishments listed in Table 3. The following ratios were computed for each state for each

*Conversions to real dollars with 1975 as the base year were based on the government implicit price deflator as given in *Economic Report to the President*, Washington, D. C.: U. S. Government Printing Office (1976).

Table 2

Accomplishments and Costs of Black Creek Watershed Project: September 1976

	ACCOMPLISH-MENT (acres)	TOTAL COST	UNIT COST ($/acre)
Total incentive payment for acres under contract	10,795	$444,702.89	41.20
Technical assistance costs for acres under contract	10,795	183,432.87	16.99
Total cost of land treatment including technical assistance on acres under contract	10,795	628,135.76	58.19
Total incentive payments for acres adequately treated	5,986	444,702.89	74.29
Cost of technical assistance for acres adequately treated	5,986	183,432.87	30.64
Total cost for land treatment including technical assistance for acres adequately treated	5,986	628,135.76	104.93

NOTE: District cost share for all practices averaged 70%.

Source: Lake, J.G., 1976. An institutional approach to implementing best management practices. In *Best management practices for non-point source pollution control*. Report No. EPA-905/9-76-005. Chicago, Ill.: USEPA Office of the Great Lakes Coordinator. p.88.

Table 3

Agricultural Conservation Program Practices

PRACTICE NUMBER	DESCRIPTION
1	Establish Permanent Cover
2	Improve Permanent Cover
3	Planting Trees and Shrubs
4	Timber Stand Improvement
5	Construction of Dams and Reservoirs
6	Strip Cropping
7	Terrace Systems
8	Construction of Diversions or Spreaders
9	Stream Bank Stabilization
10	Develop Permanent Wildlife Cover
11	Sediment Retention Structures
12	Sediment or Chemical Runoff Control Measures
13	Reorganizing Irrigation Systems to Control Erosion
14	Rotational Type Cover
15	Tillage Operations on Pasture
16	Livestock Watering Facilities to Protect Vegetative Cover
17	Construction of Stock Trails
18	Control Noxious Weeds
19	Establish Orchards and Perennials
20	Drainage to Permit Conservation Farming
21	Subsoiling
22	Temporary Cover
23	Stubble Mulching
24	Contour Farming
25	Wind and Erosion Control Operations
26	Mulching to Control Wind Erosion
27	Animal Waste Storage and Diversion
28	Non Burning Disposal of Residues
29	Disposal Pits for Solid Wastes
30	Conservation Practices for Natural Beauty
31	Shrub Control on Pastures
32	Land Leveling
33	Install Livestock Watering Pipelines
34	Fences to Protect Vegetative Cover
35	Lining Irrigation Ditches

Source: *Agricultural Stabilization and Conservation Service 40-Year Summary, 1936 - 1975.* (USDA).

year: ACP administrative cost per farm participating in ACP; ACP administrative cost per unit of accomplishment; and ACP administrative cost per dollar paid out (subsidy, cost-sharing, etc.). The results are presented in Appendix B.

The ACP cost per farm on the average (in real dollars, 1975 base year) ranges from $220.95 for Illinois in 1974 to $30.03 for Minnesota in 1970. The ACP cost per unit of accomplishment (real dollars, 1975 base year) ranges from $19.14 for Illinois in 1974 to $.19 for Minnesota in 1970. The ACP cost per dollar paid out (real dollars, 1975 base year) ranges from $.23 for Ohio in 1974 to $.08 for Minnesota in 1970.

The above ratios show that the costs of present conservation programs vary greatly among corn-belt states.

Since these ratios involve many different conservation activities, an analysis of the contribution of the activities to the total cost of the ASCS was undertaken. If it were possible to explain this cost variation in terms of the extent to which specific conservation activities were implemented, it would then be possible to use the results in estimating the costs of possible NPS pollution control policies involving those practices. A statistical (regression) analysis was therefore carried out. SCS and ASCS administrative costs were regressed on the units of conservation activities conducted, on the characteristics of farms, and on other descriptive statistics such as rainfall. The analysis was applied to data for the corn-belt states for 1969 through 1975. The results were not of value. In most cases they were not statistically significant, and even where significant results were obtained, the combination of variables was not meaningful for estimating the costs of alternative policies.

CHAPTER 3

POLICY DEVELOPMENT AND SELECTION

As originally planned, the approach to be followed for this research effort was to investigate initially a wide range of existing policies applicable to the control of nonpoint sources of pollution from agriculture and then to select six representative policies for intensive analysis. As indicated in Chapter 2, however, existing policies do not represent a wide variety of approaches to the problem.

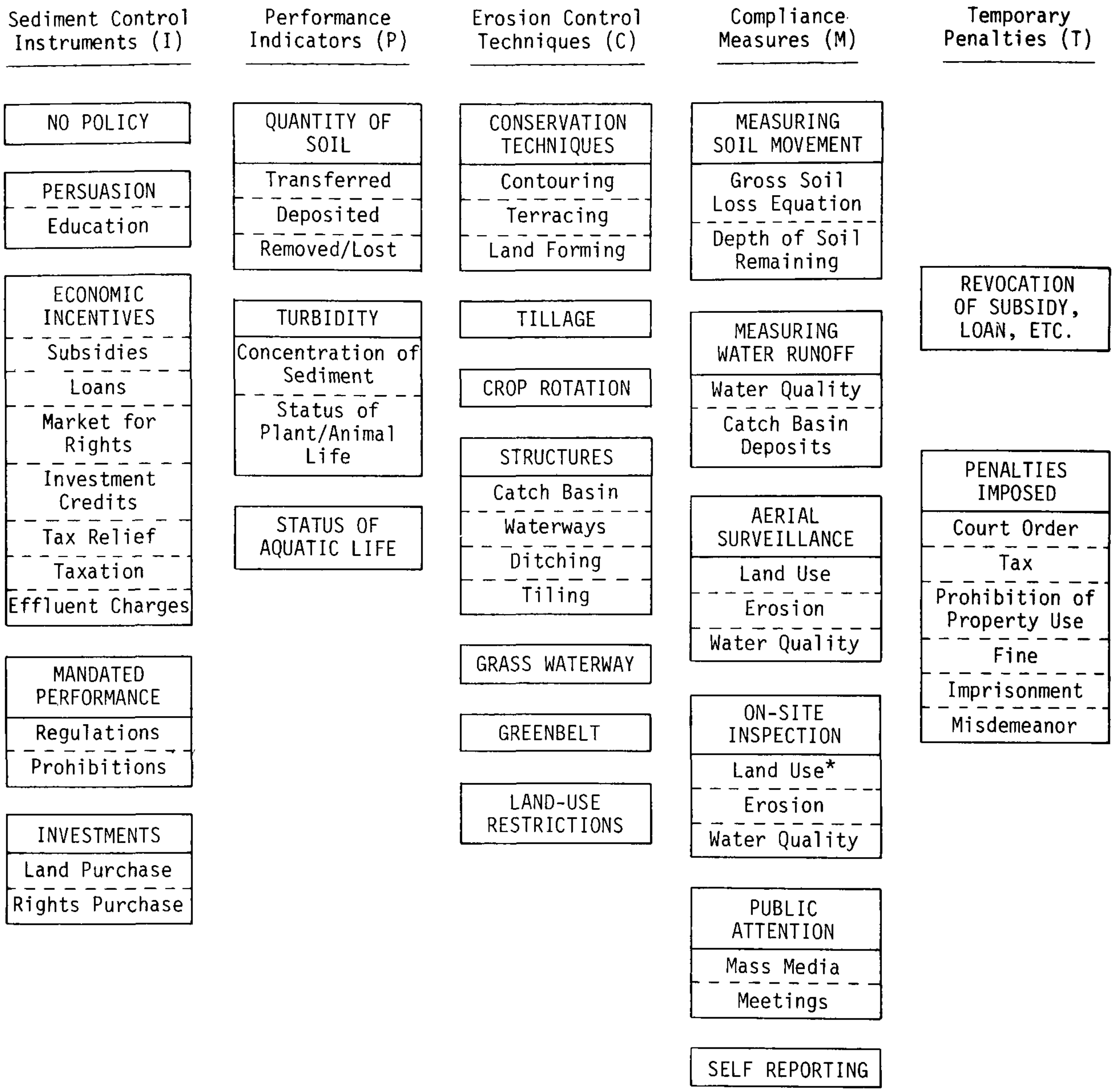
To ensure that a broad range of potential NPS control measures could be considered prior to selecting the six policies, the research team developed the schematic diagrams shown in Figures 1 and 2. Figure 1 pertains primarily to measures for controlling erosion and sedimentation, while Figure 2 relates primarily to the control of soluble nutrients.*

Each diagram lists a large number of activities, practices, and techniques which are potential elements of NPS control policies. These items are grouped into five categories which form the principal components of such policies:

Control Instruments (I)
Performance Indicators (P)
Control Techniques (C)
Compliance Measures (M)
Temporary Penalties (T)

A policy is developed from the diagram by selecting one or more appropriate items from the five different categories. The particular items chosen, of course, are those which can be combined to make a policy which is workable and internally consistent. Note that some policies might use several items from a particular category and that not all policies will require all five components. Before demonstrating the use of the schematics in policy development, it will be helpful to describe in more detail the functions of the five principal components.

*To the extent that phosphorus moves with sediment, the schematic diagram in Figure 1 would be pertinent to the control of phosphorus. Since nitrogen is believed to move through the soil primarily in solution with water rather than in association with sediment particles, there is little overlap between the two schematics for the control of that nutrient.



*Land use includes crops produced, conservation practices, and tillage practices.

Figure 1. Schematic for the development of policies to control erosion and sedimentation.

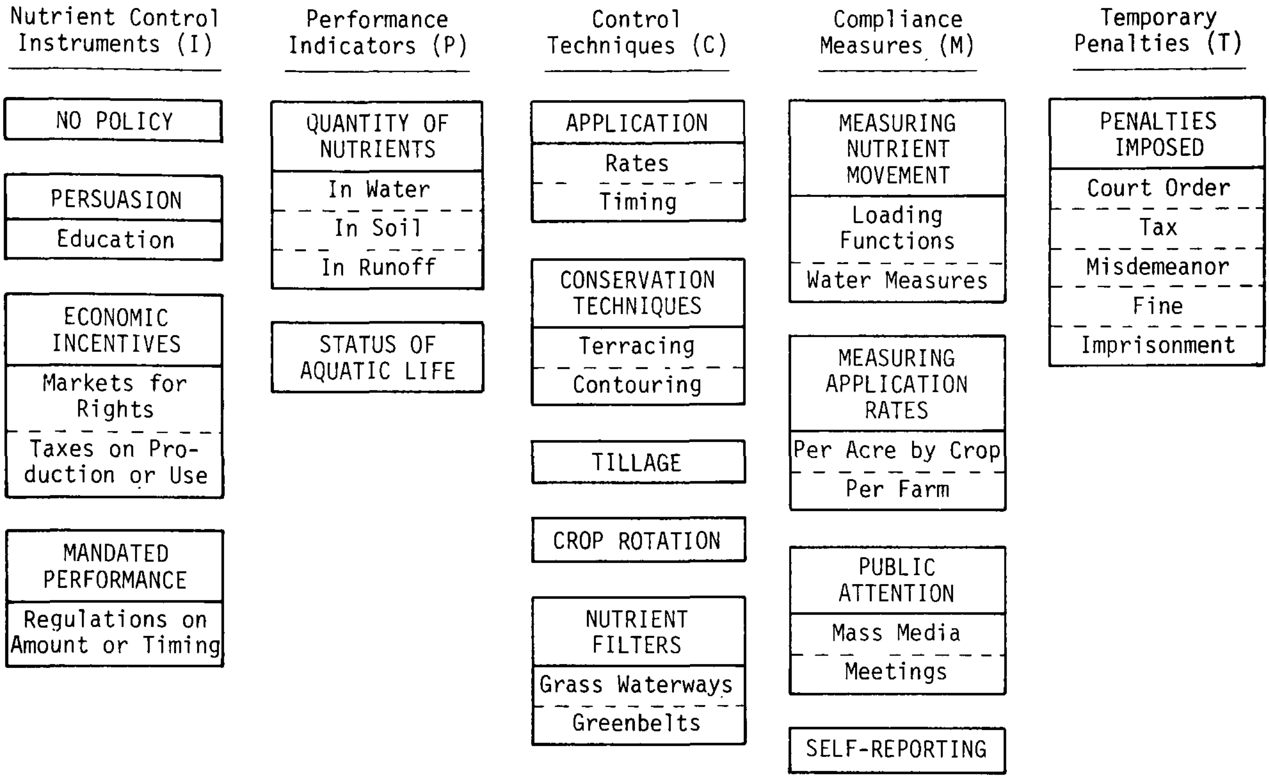


Figure 2. Schematic for the development of policies to control plant nutrients.

POLICY COMPONENTS

Control instruments are the various methods which can be used to induce farm operators to modify their operations so as to achieve the desired objective; for example, to reduce soil losses. These methods range from voluntary programs, in which persuasion is the only tool for promoting compliance, to programs providing economic incentives and to mandatory policies, in which compliance would be obtained, if necessary, through legal enforcement actions. For still other methods, compliance would be promoted by providing economic incentives. Examples of instruments for the control of erosion include educational programs to inform farmers of sound soil conservation practices, cost-sharing subsidies for the terracing of sloping land, and a regulation prohibiting the loss of more than five tons of soil per acre per year.

Performance indicators are the means of assessing the amount and type of damage occurring and hence of determining to what extent the policy is successful. The performance indicators operate in two ways. First, they can be used to determine whether the new policy is achieving the desired results. For erosion and sediment control the most likely indicators would be either the amount of soil lost or a measure of the water quality. It should be noted that although the emphasis of the FWPCA is on water quality, a lack of adequate knowledge about sediment delivery ratios will likely lead to the development of a policy in which the principal measure of compliance will be the quantity of soil removed or lost from an agricultural field. As more information on the movement of sediments and other materials is acquired, the development of water-quality-oriented policies will be possible.

Control techniques are the means of achieving the objective of the control policy. Often these are physical changes in the way that the land surface is managed. The exact technique to be used may be specified as a part of the policy or it may be left to the farmer to select a technique which will achieve the required level of performance. In the case of erosion control, for example, a particular policy might require terracing on all land having a slope greater than specified, while another policy might prohibit a soil loss of more than a specified number of tons per acre per year, leaving the choice of control technique to the individual farmer. Note that in addition to specifying techniques or performance levels it is also possible to establish policies which would prohibit the use of certain techniques (such as moldboard plowing on some or all soil types).

Compliance measures are used to determine whether the individual is conforming to the requirements of the policy, as indicated by the performance indicators. For education-oriented policies, a check on the number and type of educational activities could be made. Under other policies, the means of determining whether an individual is in compliance would range from the individual's own report of his action to on-site inspections of actual practices in use. In USEPA terminology, measuring compliance would involve determining whether BMPs are in effect. Estimates of soil loss would likely be made through techniques such as the Gross Soil Loss Equation, but conceivably the actual depth of topsoil remaining or the water quality could be measured directly. Clearly, the method selected for assuring compliance will significantly influence both the cost of the policy and the reaction of farm operators to it.

It is important to distinguish performance indicators from compliance measures. Performance indicators are used in determining the success of a policy, whereas compliance measures are methods for examining the actions of the individuals who are subject to the policy. For some policies, performance indicators and compliance measures are directly related. If, for example, a policy is established which limits the rate of soil loss from land and if the compliance measure for that policy involves assessing the rate of soil loss from an individual farm, then the performance indicator would also likely involve the measurement of soil movement and hence would be closely linked to the compliance measure. In contrast, a policy established to reduce the average rate of erosion to some acceptable limit by subsidizing changes in conservation or tillage practices involves differing measures of performance and compliance. Compliance measures would indicate whether the individual has carried out the specified action required and is eligible to receive a subsidy payment, whereas the performance indicators would deal with the average change in sedimentation resulting from the subsidy policy.

Temporary penalties, used only in policies which mandate performance, are the means of assuring that individual farm operators follow the prescribed action. They include the full range of sanctions which may be employed to assure compliance with the law. The penalties are temporary in that a violator is only penalized if his actions are not consistent with the policy's requirements, and the penalty ceases when he complies. The purpose of the penalties is to ensure that all operators comply with the policy so that performance goals can be met and so that all individual operators are treated consistently.

EXAMPLES OF POLICY DEVELOPMENT

The following examples illustrate the use of the schematic in Figure 1 for developing alternative policies for the control of erosion and sedimentation.

Mandatory Sedimentation Control Policy

This sediment policy would regulate the quantity of sediment leaving a specified area of land. To avoid exceeding this limit, the individual would be allowed to use any appropriate method of erosion control. An on-site inspection of the land use would be made to determine whether or not the individual was in compliance with the policy limitation. Since this policy is mandatory, any violators would be subject to a temporary penalty: prohibition of the use of their property as long as the violation continues. Schematically, the policy would comprise these components:

I	P	C	M	T
Mandated Performance	Quantity of Soil	Individual's Choice	On Site Inspection	Penalties Imposed
Regulation	Transferred		Land Use	Prohibition of Property Use
			and	
			Measuring Soil Movement	
			Gross Soil Loss Equation	

Policy Prohibiting Fall Plowing

In this policy, which would prohibit fall plowing, aerial surveillance could be used to determine if any operator has violated the prohibition. No performance indicator is required directly since the absence or presence of fall plowing determines whether or not a farmer is in compliance. However, the status of aquatic life could be used as an indication of the success of the policy in achieving social objectives. Since the policy would be mandatory, violators would be subject to a penalty, in this case a fine.

I	P	C	M	T
Mandated Performance	Status of Aquatic Life	Tillage	Aerial Surveillance	Penalties Imposed
Prohibition		No Fall Plowing	Land Use	Fine

Subsidy Policy

This policy would be directed toward reducing sedimentation by offering an economic incentive for erosion control efforts. The incentive would be a subsidy paid to the farmer to help pay the cost of such measures as building terraces. In this case the performance indicators (based upon on-site inspections) would be used to determine whether or not the terraces are necessary. After the terraces have been built, the farmer would be responsible for their maintenance. A compliance measure, on-site inspections of the terraces, would be used to determine their condition. If the farmer allowed the terraces to deteriorate, the government would penalize him by revoking his subsidy. This case is one where performance indicators and compliance measures are not directly related.

I	P	C	M	T
Economic Incentives Subsidies	Quantity of Soil Removed or Lost	Conservation Techniques Terracing	On-Site Inspection Other Land Use	Revocation of Subsidy

Education Policy

An education policy would promote erosion control through persuasion. Citizens would be informed of the damage being caused by nonpoint-source pollution and instructed about the various erosion control techniques which could be used to decrease the amount of pollution. Improved understanding of the problem would hopefully result in voluntary improvements. Performance indicators would be used, first, to determine if the educational program is necessary, and second, to determine if any change occurs as a result of the policy. Because a persuasive policy involves no penalties, compliance measures are not necessary to determine if violations have occurred. Compliance measures could be used, however, to help assess any change in the performance indicators.

I	P	C	M	T
Persuasion Education	Performance Indicators Choice	Erosion Control Techniques Individual's Choice		

The plant nutrients schematic in Figure 2 shows the various ways of attempting to control nitrogen and phosphorus pollution. The alternatives range from having no policy to establishing a very definite policy regulating the amounts of fertilizer applied. This schematic is used in the same way as the sediment schematic (Figure 1).*

As the above examples illustrate, it is important to select those components which will operate in conjunction with each other to achieve the policy objectives. It should be recognized that the use of these schematic diagrams to formulate policies is but one part of the overall policy-making process. The schematics aid only in developing ideas for policies. Before it

* Because of the associations between water runoff, soil loss, and nutrient loss, policies developed to control one pollutant will have impacts on pollution from the remaining sources.

reaches the implementation stage, each policy must be examined for its political and legal implications, its level of execution, its social acceptability, and its equity.

SELECTION OF POLICIES FOR ANALYSIS

Using the available information on existing policies and laws (see Chapter 2) and the schematic diagrams, the research team formulated a wide range of NPS control policies. After some discussion the team decided to concentrate on the six general policies described below. Policies 1 through 5 were selected because they range from a completely voluntary educational policy to a very restrictive policy in which the implementation of a soil erosion control plan would be mandatory. Policy 6 was added because of the finding that streamside management may be an important component of effective water quality control.

These policies were then subjected to detailed analysis. The remaining chapters of this report present the results of the social, legal, economic, and equity analyses of the policies and of other relevant policy components.

In the following discussion of the six policies the *general nature* of the policy is specified without indicating the exact elements to be used. Specifying in detail the policy provisions was not felt to be necessary or appropriate in this type of analysis. For example, temporary penalties to be used with mandatory policies are not specified. The general description is adequate for the analysis to follow and individuals in the policy arena are more qualified to set the specifics.

Policy 1: Education

The education policy envisioned is in essence a public promotional program. Because it is a voluntary program and represents a positive approach to reducing soil erosion, the likelihood of its acceptance is high. Through public meetings, seminars, and publications, the program would provide information on the benefits of reducing agricultural NPS pollution, on methods of reducing the damage by controlling erosion, and on the associated effect of maintaining soil productivity. The policy would rely on voluntary cooperation to correct the problem, and thus its effectiveness cannot be guaranteed. It would be relatively simple to implement, however, since it need only involve expanding the existing education program of local SWCD offices and county SCS offices. If, in addition, the Cooperative Extension Service were involved in the educational effort, the impact would be strengthened.

Policy 2: Tax Credit

Under a tax credit policy, a farm operator would be allowed a deduction on his income tax for the cost of implementing erosion control practices, which would be classified as pollution control mechanisms or capital investments. The policy would have greater impact if the credit could be accumulated and carried forward over years until the farm operator had sufficient income to take advantage of the credit. Such a policy could be adopted simply by modifying federal or state tax laws to permit such deductions. For this policy to be effective it would be necessary to continue providing technical and planning assistance through the SCS and SWCDs. Making the tax credit contingent on the approval of (or an inspection by) such an agency would likely increase the effectiveness of the program, since the number of instances in which support was provided for unnecessary practices would be reduced. Also, the success of the program would improve as the amount of the permissible tax credit increases, although the cost to the government would also increase.

Policy 3: Fifty-percent Cost Sharing

Under a 50% cost-sharing policy, half the cost of implementing soil erosion control practices on a particular farm would be borne by the government under a contractual agreement with the farmer. This policy was selected for analysis because of its expected implementation feasibility and its assumed capability for inducing the desired performance. It would essentially be an extension of the existing SCS technical assistance program and the ASCS financial disbursement function. Implementation would involve such activities as informing the public of the availability of cost-sharing arrangements and integrating the administrative, financial, and monitoring functions of the SCS, the ASCS, and the SWCDs.

Cost sharing would provide an incentive to implement more and better conservation practices. Such a policy should ensure some improvement in erosion control and hence in water quality because of its predominantly positive approach. It would be relatively easy to adjust the rate of cost sharing in an attempt to achieve the desired results. It would also be possible to combine this policy approach with others to develop a more sound approach. A negative aspect from the farmer's point of view is that failure to properly implement and maintain the practices or structures could lead to forfeiture of government payments.

Policy 4: Required Conservation Plan Development

A policy requiring the development of a soil conservation plan is one step beyond an educational or strictly voluntary program toward mandated performance. Note, however, that the policy described here does not require *implementation* of the plan and hence can be expected to have limited effectiveness. The thrust of the policy is therefore largely educational, since developing a plan would make the farmer aware of what should be done on his land to reduce erosion. The policy was selected for analysis because it presented an opportunity to estimate the costs of conservation plan development and because it should be quite feasible to implement, inasmuch as the tasks it would involve are already being performed by the SCS and the SWCDs.

A unique feature of the policy is that its implementation would bring each farmer into direct, one-to-one communication with an SCS technician. This individual, on-farm attention would help induce positive responses and cooperation from the farmers. The effectiveness of this approach might be limited, however, at the outset by a temporary shortage of trained personnel, contractors, and equipment, and in the long run by the fact that the implementation of conservation plans is not mandatory.

Policy 5: Required Conservation Plan Implementation

A policy requiring not only the development but also the implementation of a soil conservation plan is an extension of Policy 4. It is the most comprehensive policy alternative. It provides an opportunity for individual, onsite planning technical assistance and could be combined with financial assistance for the implementation of the plan. It also offers the most promise for soil erosion control by allowing choice among the full range of alternative control techniques. Analysis of this policy provided an opportunity to compare the costs of making conservation plan implementation mandatory with the costs of simply requiring the development of such a plan (Policy 4).

Policy 6: Development of Greenbelts

As described in the following section of this chapter, greenbelts may be very effective in controlling the movement of eroded soil into waterways. In fact, to achieve desired water quality levels it may be necessary to establish these vegetated buffer strips along streams in addition to employing more conventional soil conservation techniques to agricultural fields. A policy requiring the development and maintenance of greenbelts was therefore selected for analysis.

The development of greenbelts of varying widths and cover types along streambanks represents an attempt to prevent nutrients and sediment from entering streams once erosion has occurred. Selection of this practice as one alternative policy is not intended to suggest that greenbelts by themselves are an adequate management technique; rather, they should be regarded as a supplement to other conservation techniques in and near channel areas, thus contributing to the improvement of water quality.

The main administrative component for the greenbelt policy would be surveillance (most likely by air) of the installation and maintenance of vegetative buffer acreage along the streambanks. Penalties would be imposed for noncompliance and could lead to court action. Obviously, this policy would apply directly only to those landowners whose property borders streambanks. Since in many cases soil eroded from land distant from streams and on the property of other farm operators would be deposited along a greenbelt, some mechanism to spread the costs of greenbelts over a wider segment of society would likely be desirable.

LAND-WATER INTERFACE AND STREAM GREENBELTS

Research reported by Karr and Schlosser (1977) and summarized in Appendix C suggests that in addition to reducing soil erosion through effective land management it may be necessary to allow the development of a more "natural" aquatic ecosystem if the water quality objectives of Public Law 92-500 are to be met. That research indicates the value of emphasizing the link between terrestrial and aquatic environments and the dynamics of stream behavior.

Greenbelts, along with soil conservation practices and the maintenance of "natural" stream morphology, may produce substantial improvements in water quality in areas of intensive agriculture. Furthermore, such management enhances the quality of fishery resources and should provide a variety of recreational benefits. The magnitude of these benefits must be weighed against the costs. The data available at present are not adequate for a detailed presentation of costs and benefits. An early attempt to consider such costs and benefits is presented here and summarized in Table 4. Before the economic, social, and environmental costs and benefits can be evaluated, research at the individual drainage system and watershed levels must be completed. This research must integrate relevant knowledge from the agricultural and engineering sciences, especially the universal soil-loss equation and unit stream power concept, along with increased knowledge of the dynamics of sediment and nutrient transport at the land-water interface.

To illustrate the possible impact of a greenbelt policy, used alone or in combination with erosion control policies, we can compare six hypothetical, identical watersheds under different management programs. We can then indicate how amounts and sources of sediments would be expected to vary among watersheds under these policies (see Table 5). In a natural forested watershed (Table 5, line 1), the concentration of suspended solids will be low because sources of sediment will be minimal in both terrestrial and aquatic areas. When land is cleared for row-crop agriculture (line 2), sources of sediment will be increased. Water quality will decline because of the combination of increased sediment availability and surface runoff. A channeled stream flowing through a forested watershed (line 3) may have high sediment loads because of higher unit stream power and unstable channel bottom and slopes. The source of sediments is the channel itself. Simultaneous clearing of the land (without employing conservation measures) and channeling of streams (line 4) produces high sediment loads since both the land and channel are unstable. The latter situation is common throughout much of the U. S., especially in the heavily agricultural areas of the Midwest.

Another common managment strategy is the use of conservation practices on the land with continued maintenance of channelized streams (line 5). With careful managment in fields (through techniques such as minimum tillage and rotational practices), the effects of the terrestrial disequilibrium can be reduced. However, because instabilities in the channel continue, sediment loads may be from medium to high. For the long term, the best management option in many areas is to continue row-crop agriculture with effective soil erosion control but with a more natural (equilibrium) channel management (line 6).

Table 4

Potential Costs and Benefits of More Effective Management of Near-channel Areas*

Costs	Benefits
1. Land taken out of production to maintain a vegetative filter and to allow meandering channel.	1. Reduced sediment, nutrient, and pesticide inputs into streams.
2. Reduced drainage rates.	2. Increased shading and decreased water temperature will reduce problems associated with release of nutrients from sediments and algae blooms. Also will increase the oxygen-carrying capacity of the stream.
3. Maintenance of greenbelts.	3. Improved habitat for fisheries and terrestrial wildlife.
4. Reservoir areas for various pests.	4. Increased recreational opportunities.
5. Need for management of recreational areas.	5. Decreased cost of channel construction and maintenance activities since natural processes will provide the vegetation along streambanks via succession and the stream itself will initiate meandering and pool-riffle formation.
6. Loss of water due to phraetophytes.	6. Reduced downstream flooding.
	7. May allow more intensive agriculture with reduced effects on the aquatic ecosystem when best land management practices (i.e., minimum tillage) are not feasible.

*This is not meant to be a comprehensive list. Furthermore, the magnitudes of the suggested costs and benefits have not been adequately evaluated.

Table 5

Effects of Various Management Practices on Equilibria of Equivalent Watersheds*

MANAGEMENT PRACTICE	RELATIVE AMOUNT OF SEDIMENT FROM		SUSPENDED SOLIDS LOAD IN STREAM	SOURCE OF SEDIMENT
	Land Surface	Stream Channel		
1. Natural watershed	None	None	Low	---
2. Clear land for row-crop agriculture; maintain natural stream	High	Low†	Medium	Land surface
3. Channelize stream in forested watershed	None	High	High	Channel banks
4. Clear land and channelize stream	High	High	Very High	Land surface and channel banks
5. Best land surface management with channelization	Low	High	Medium-High	Channel banks
6. Best land surface management and "natural" channel	Low	Low	Low-Medium	Equilibrium between land and channel

*These are best estimates of relative effects for a variety of watershed conditions, including sources and amounts of sediment.

†Will increase if hydrograph peaks (floods) are more severe.

CHAPTER 4

ECONOMIC IMPACTS OF EROSION CONTROL POLICIES

One of the central factors determining the acceptability of policies such as those discussed in previous chapters is their economic impact on the agricultural sector. To obtain as much information as possible on the nature of those impacts, two large linear programming models were used. These models provided a wealth of information on the possible economic effects of a reasonably wide variety of policy options. While the options addressed in this analysis are not completely consistent with the six policy alternatives examined in other sections of this report, the reader can extrapolate the results to determine such impacts. An attempt to structure an economic analysis of those six policies would have required developing new analytical methods, a task which was beyond the scope of this project and which might have produced methods less powerful than those already available.

The linear programming models were used to analyze the economic impacts of selected restrictions on soil loss, nitrogen application rates, and specific production techniques in the corn belt. One of these models is a large, aggregate model, used here to project at the corn-belt level the producers' surplus, consumers' surplus, and net social costs resulting from the application of NPS control techniques. The second model includes several representative farms in an individual watershed and is structured to suggest the variation in the impacts of several NPS control policies among individual farms and over a long time period.

The corn-belt model measures at the aggregate level the impacts of soil-loss and nitrogen restrictions through the solution of a large linear programming model which 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 producers' and consumers' surplus, solutions to the model indicate changes in soil loss, nitrogen use, crop production, acreage, pesticide use, and crop prices.

The watershed model is based on a single watershed in Illinois which is representative of the corn belt and the surrounding areas. The model is structured to analyze (1) the impacts of farms having different soil characteristics and (2) the long-term impacts of continued production under the existing institutional framework and under soil-loss restrictions. The impacts of soil-loss and nitrogen restrictions on production, farm income, nitrogen use and soil loss are all measured for the several representative farms. The implications of continued production for soil loss are analyzed over a 100-year planning period with an estimate of the discounted and undiscounted farm-level income impacts.

THE CORN-BELT MODEL

The model used for this analysis is a linear programming model of the production and marketing of corn, soybeans, wheat, oats, hay, and pasture in the corn belt for a single year. The production of corn and soybeans in this area accounts for about 70 percent and 60 percent, respectively, of the total U.S. production of these commodities. The model was originally developed by C.R. Taylor to analyze the impact of nitrogen and pesticide restrictions on agriculture (Taylor and Frohberg, 1977).* Much of the following description of the model is taken from that source. Under the present USEPA contract, Taylor revised the model so it could be used to analyze the impact of soil-loss restrictions.

The objective function of the model is consumers' plus producers' surplus in the corn and soybean markets less the total variable costs of producing a specified amount of small grains, hay, and pasture. Small grains are constrained for the corn belt as a whole; hay and pasture constraints are set by Land Resource Area (LRA). As is well known, the maximization of surplus gives a competitive equilibrium solution (Takayama and Judge, 1964).

The demand functions for corn and soybeans were incorporated into the model in a stepwise fashion, with steps in two-cent increments. The demand functions used in the model were:

$$\begin{aligned} Q^c &= 5613712245 - 763775100P^c \\ Q^s &= 1469981594 - 130224637P^s \end{aligned} \qquad \text{[Eq.1]}$$

where

Q^c = bushels of corn demanded

Q^s = bushels of soybeans demanded

P^c = per-bushel price of corn

P^s = per-bushel price of soybeans

At the mean, the elasticity of demand for corn is -.50 and the corresponding figure for soybeans is -.64. These demand functions were subjectively specified after reviewing recent demand analysis, as summarized in Taylor and Frohberg (1977). The quantities of wheat, oats, hay, and pasture demanded were treated as constants in the model because these are relatively minor crops in the area (wheat and oats account for 11 percent of the acreage in the area; hay and pasture, 26 percent) and also because the inclusion of stepped demand functions for these crops would have increased the size of the model to the point where the cost of obtaining a solution would have been prohibitive. Fixing the quantities demanded of the minor crops will cause a *slight* over- or

*The model was developed under a grant from the Rockefeller Foundation to the Agricultural Experiment Station, University of Illinois at Urbana-Champaign.

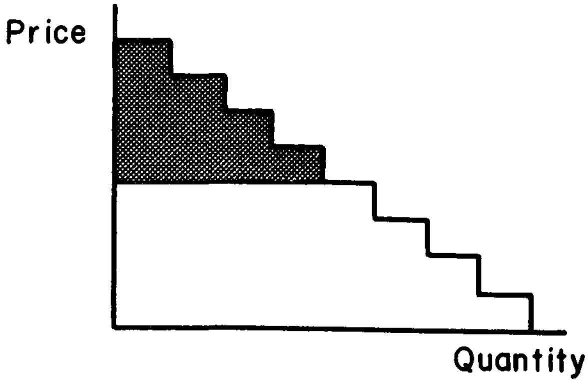
underestimation (depending on the policy) of the change in surplus resulting from the policies.

The land base for the area modeled 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 USDA Soil Conservation Service (see Figure 3). For each LCU within each LRA, 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 planting, contouring, and terracing), and tillage methods (fall plowing, spring plowing, and chisel plowing). Rotations, rather than just single crop activities, were included in the model to reflect the influence of the previous crop on the fertilizer and pesticide requirements of the current crop.

Estimation of Changes in Producers' and Consumers' Surplus and Net Social Cost

The results of this model include an estimate of the changes in producers' and consumers' surplus and in net social costs. These changes are determined by comparing the results of a benchmark solution of the model to a solution under which certain constraints (such as a specified maximum allowable soil loss per acre) are imposed. The measure of producers' surplus can be defined as the gross revenue of corn and soybeans less the nonland production costs for all crops (including soil-loss taxes) and less the costs of terracing; or it can be defined as the land rents from production and terracing. The estimate of producers' surplus is the gross revenue of corn and soybeans minus the nonland costs of production for corn and soybeans, to which are added the shadow prices* for other crops multiplied by the quantity produced and from which are substracted their nonland production costs and the difference between terrace subsidies and terrace costs, if any. Terrace subsidies set on a fixed, per-acre basis ($40/A) generate a contribution to producers' surplus when the subsidy is greater than the annualized cost of construction at the farm level. Changes in producers' surplus are calculated by determining the difference between the estimate for the benchmark run and for the constrained run in question.

Consumers' surplus is defined as the difference between what consumers are willing to pay and the market price they do pay for a product. It is represented by the shaded area in the following diagram:



*In a competitive equilibrium, price equals marginal cost; in this model the shadow price is defined to be marginal cost.

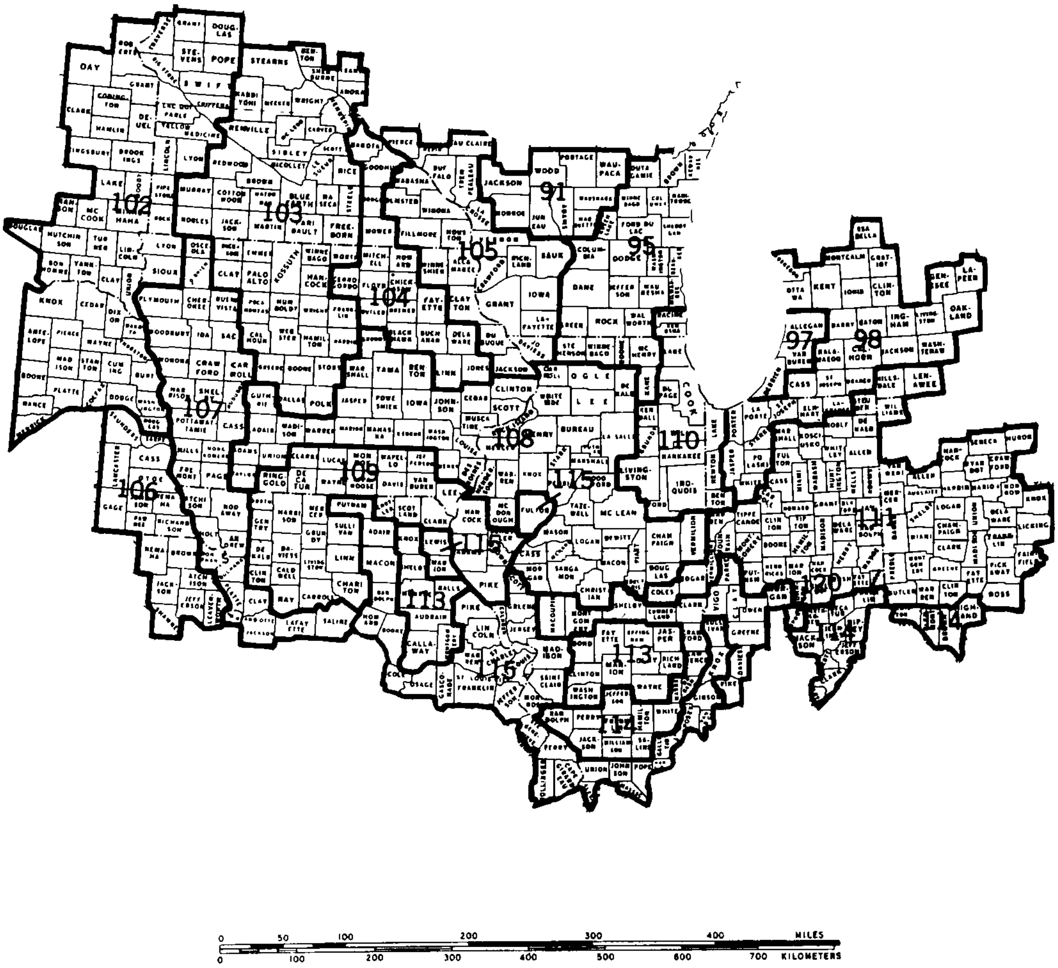


Figure 3. Major land resource areas of the corn belt.

To calculate the estimate of consumers' surplus, the price-quantity observations from the corn and soybean demand curves are summed and the gross revenue for corn and soybeans is subtracted. Model results are given in terms of estimated changes in consumers' surplus, which are calculated for corn and soybeans by the equation:

$$\Delta CS_1 = \frac{Q_B + Q_C}{2} \times P_B - P_C \qquad \text{[Eq.2]}$$

where CS_1 = consumers' surplus for corn and soybeans

Q_B = quantity produced in benchmark solution

Q_C = quantity produced in constrained solution

P_B = price generated in benchmark solution

P_C = price generated in constrained solution

and for all other crops by:

$$\Delta CS_2 = Q \times P_B - P_C \qquad \text{[Eq.3]}$$

where CS_2 = consumers' surplus for all other crops

Q = the constant quantity produced

P_B = price generated in benchmark solution

P_C = price generated in constrained solution

The total change in consumers' surplus is:

$$\Delta CS = \Delta CS_1 + \Delta CS_2 \qquad \text{[Eq.4]}$$

Thus, the change in consumers' surplus is a measure of the impacts on purchasers of agricultural products. This measure reflects both price and quantity impact.

In addition, the impact of governmental costs or receipts are calculated as the amount of subsidies paid or of taxes received. The sum of the changes in producers' surplus, consumers' surplus, and governmental costs relative to the benchmark solution is the estimate of net social costs.

Operating Principles of the Model

A simplified matrix representation of the model is given in Table 6. The first column of this matrix represents the set of 14,542 crop-production activities representing each region and each production alternative included in the model. The vector C represents the per-acre variable production costs exclusive of labor and fertilizer while the vectors Y^c, Y^s, Y^w, Y^o, and Y^h give the yields associated with each activity. Each production activity takes one acre of land from the appropriate LRA and LCU (see row set number 11). The vector (nsc) gives the carryover nitrogen supplied by soybeans to corn in a rotation and, similarly, the vector(nhc) gives the carryover nitrogen supplied by hay or pasture to corn in a rotation. The vectors (nw), (no),

Table 6

Simplified Matrix Representation of the Corn-belt Model

Row Description	1 Crop Production Activities (acres)	2 Sell Soybeans (bu.)	3 Sell Corn (bu.)	4 Corn Production Correction Activity for Step 2	5 Correct Corn Harvest Costs	6 Correct Corn P, K, and Labor Requirements	7 Transfer n from Soybeans to Corn (lbs.)	8 Transfer n from Hay-Pasture to Corn (lbs.)	9 Buy n for Corn (lbs.)	10 Buy n for Wheat (lbs.)	11 Buy n for Oats (lbs.)	12 Buy n for Hay-Pasture (lbs.)	13 Buy Labor	14 Buy P	15 Buy K	16 Bale Hay (tons)	17 Pasture	18 Constraint
1 Objective function	$-C$	$P_1^s\ P_2^s$	$P_1^c\ P_2^c$	0	HC				$-V_n^c$	$-V_n^w$	$-V_n^o$	$-V_n^h$	$-V_l$	$-V_p$	$-V_k$	$-C$		max
2 Base corn production 1 (sell)	Y^c		$-\frac{100}{Y_1}\ -\frac{100}{Y_2}$	$-\left[\frac{100}{Y_2}-\frac{100}{Y_1}\right]$														≥ 0
3 Base corn production 2 (correct harvest costs)	Y^c		$-1\ -1$		-1													$= 0$
4 Base corn production 3 (P, K, and labor correction)	Y^c		$-1\ -1$			-1												$= 0$
5 Soybean production	Y^s	$-1\ -1$																≥ 0
6 Wheat production	Y^w																	$\geq WD$
7 Oats production	Y^o																	$\geq OD$
8 Hay-pasture account	Y^h															-1	-1	≥ 0
9 Hay production																1		$\geq HP$
10 Pasture production																	aum	$\geq PP$
11 Land	1																	$\leq L$
12 Terraceable land	1 or 0																	$\leq LAT$
13 Labor	L					$-l_c$							-1			L		≤ 0
14 Potassium fertilizer	K					$-p_c$								-1				≤ 0
15 Phosphorous fertilizer	P					$-k_c$									-1			≤ 0
16 Corn nitrogen needs			$n_1\ n_2$	$(n_2 - n_1)$			-1	-1	-1									≤ 0
17 n supplied by soybean to corn	nsc						-1											≥ 0
18 n supplied by hay to corn	nhc							-1										≥ 0
19 Wheat n needs	nw									-1								≤ 0
20 Oats n needs	no										-1							≤ 0
21 Hay-pasture n needs	nh											-1						≤ 0
22 Soybean demand step 1		1																$\leq Q_1^s$
23 Soybean demand step 2		1																$\leq Q_2^s - Q_1^s$
24 Corn demand step 1			1															$\leq Q_1^c$
25 Corn demand step 2			1															$\leq Q_2^c - Q_1^c$
26 Corn transfer 2			1	$-(Q_2 - Q_1)/Q_1$														$= 0$

and (nh) give the nitrogen required for wheat, oats, hay, or pasture, respectively.

The second set of columns of the matrix in Table 6 represent two steps on a stepped demand function for soybeans. These steps are:

$$P_1^s \text{ if } 0 \leq Q^s \leq Q_1^s$$
$$p_2^s \text{ if } Q_1^s \leq Q^s \leq Q_2^s \qquad \text{[Eq.5]}$$

where p_i^s = price of soybeans for the i^{th} step

Q_i^s = maximum total quantity of the soybeans that will be purchased at the i^{th} and higher prices

with $P_1^s > p_2^s$

Each of these activities draws from the soybean production, as indicated by the -1 coefficient in row 5. The soybean demand step constraints (rows 22 and 23) reflect the inequality shown in equation 4. For simplicity, only two steps were indicated in the matrix in Table 6, whereas the model actually contains 75 such steps.

The fourth, fifth, and sixth set of columns in the matrix together represent steps on a demand function for corn and, for each respective corn/nitrogen fertilizer price ratio, represent steps on a fertilizer response function for corn; that is, the model calculates the optimal fertilization rate and associated yield for each market price.

Before considering this matrix formulation, let us consider the special class of nitrogen-yield response functions for which it applies. This class, which is used by Illinois agronomists to tailor fertilizer recommendations to individual situations (Illinois Cooperative Extension Service, 1974), is one for which the optimal per-acre nitrogen fertilization rate is given by multiplying the maximum yield obtainable (for a given level of nonfertilizer management) times a factor which varies with the price ratio but does not vary with the basic soil productivity level. The figures used as a basis for this study are given in the second column in Table 7. These optimal nitrogen factors imply points on a response function. The points, which are expressed on the basis of percentage of maximum yield, are shown in the fourth column of Table 7. The phosphorus and potassium fertilizer application rates are assumed to be equal to the amounts of these nutrients removed in the grain, thus approximately maintaining the P and K levels in the soil (Illinois Cooperative Extension Service, 1974).

The steps on the demand function considered here are:

$$p_1^c \text{ if } 0 \leq Q^c \leq Q_1^c$$
$$p_2^c \text{ if } Q_1^c \leq Q^c \leq Q_2^c \qquad \text{[Eq.6]}$$

Table 7

Economically Optimal Nitrogen Rates for Corn

Corn Price / Nitrogen Price	Optimal n Factor (pounds n per bushel of maximum yield)	(n_i)* Optimal Pounds of n per Bushel of Actual Yield	(Y_i) Implied Yield as a Percentage of the Maximum Yield
∞	1.3382	1.3382	100.00
40	1.2931	1.2937	99.95
30	1.2780	1.2792	99.91
25	1.2659	1.2677	99.86
20	1.2479	1.2507	99.78
15	1.2178	1.2226	99.61
10	1.1575	1.1680	99.10
5	0.9766	1.0132	96.39
2	0.4341	0.5608	77.40
0	0	0	50.49

*The index increases as one goes down the column of figures.

where P_1^c = price of corn for the i^{th} step

Q_i^c = maximum total quantity of corn that will be purchased at the i^{th} and higher prices

with $p^c > P_1^c$

To follow the logic of the matrix formulation used to incorporate the above type of response function and stepped demand function into the model, first suppose that the supply price is less than P_1^c and thus that it is profitable to produce some amount of the product. With a positive price of nitrogen, V_n^c, the maximum per-acre corn yield, which is given by the vector Y^c in the production activities set, will not be obtained if the optimal nitrogen rate is applied. Rather, at a price ratio of P_1^c/V_n^c), only Y_1 percent (from Table 7) of the maximum per-acre yield will be obtained. This condition is reflected in the model by the first sell corn activity taking for each unit sold an amount $(100/Y_1)$ of the maximum per-acre yield (row 2 of Table 6). To reflect the stepped nature of the demand function, the amount of the product which can be sold at P_1^c is constrained by the corn demand step row to be less than or equal to Q_1^c. The optimal nitrogen level at a price ratio of P_1^c/V_n^c is n_1 pounds per unit of the product (from column 2 of Table 7). The total nitrogen requirement will thus be n_1 times the quantity sold at P_1^c. The cell of the matrix given by the corn nitrogen needs row (row 16 of Table 6) and the first sell corn column (column 14 of Table 6) will thus give the total quantity of nitrogen required.

Supposing that the maximum quantity that can be sold at P_1^c, Q_1^c, is sold, let us next consider selling an additional quantity at the next highest price, P_2^c. Since P_2^c should be used in calculating the optimal nitrogen rate on the intramarginal production as well as the marginal production, the per-acre yield and nitrogen rate used in producing the quantity sold at P_1^c must be adjusted if any production is sold at P_2^c. In the model this adjustment is effected by the addition of a correction activity (Table 6, column 6) that must enter the basis if the second sell corn activity enters. Suppose now that P_2^c enters the solution at its limit of $(Q_2^c - Q_1^c)$. The constraint on row 26 will force the correction activity given by column 6 to enter the solution at a level of Q_1^c. This activity does not incur any direct cost; it does, however, reduce the amount of the maximum production that can be sold by $Q_1^c[(100/Y_2) - (100/Y_1)]$. Also, it corrects the optimal amount of nitrogen by an amount equal to $Q_1^c(n_2 - n_1)$. If both P_1^c and P_2^c are at their limits, it can be seen that only Y_2 percent of the maximum possible production will be sold. This production will require n_2 pounds of nitrogen per unit of corn.

If P_1^c enters the solution at its limit, and P_2^c enters at a level less than its limit, it can be seen that the model will give a linear interpolation for yield between Y_1 and Y_2 and a linear interpolation for the nitrogen level between n_1 and n_2 pounds per unit of the product.

There are seventy-eight additional steps on the corn demand function that are not shown in Table 6. These additional steps function in the same way as the second step.

Since some harvest costs are proportional to yield, a correct corn harvest cost activity (Table 6, column 8) is inserted into the model to reduce harvest costs by an amount equal to the per-bushel harvest costs, HC, times the difference in the maximum production and the actual production. Similarly, column 9 in Table 6 corrects labor requirements that are proportional to yield as well as the phosphorus and potassium fertilization rates for the difference in the maximum production and the actual production.

Additional activities are included in the model to: (1) subtract from corn nitrogen needs the amount of nitrogen added by legumes in rotation with corn; (2) purchase the required amount of inorganic nitrogen fertilizer for the crops; (3) purchase labor; (4) purchase phosphorus; (5) purchase potassium; and (6) allow hay to be baled at a cost of C dollars per ton or to substitute for pasture with the baling cost.

Data Sources

The basic set of crop budgets used for the study were obtained by updating the prices and input levels in the 1970 USDA budgets (Worden, 1971) for the North Central Region. Since a different regional delineation was used, budgets for LRA's were obtained by weighting with crop acreages the budgets for the USDA regions. These updated budgets for each crop and LRA were then modified to reflect the different yield levels of LCU's, tillage methods, conservation practices, and rotations. Terracing costs used are given in Table 8. Yield adjustment coefficients for LCU's were obtained from unpublished SCS data. The budgets were also modified to reflect cost differences not related to yield for the alternative tillage methods, conservation practices, and rotations. These latter cost adjustment factors were obtained from many sources, including farm management manuals, Experiment Station bulletins, and unpublished data. All coefficients are for 1974 technology and price relationships.* The model represents the optimal allocation for a single year. Thus, any reductions in productivity resulting from soil loss that would occur over a number of years are not incorporated in this model. These reductions are addressed in the next section.

The land acreage base for the model was obtained from the 1967 Conservation Needs Inventory. The land constraint in the model for an LCU within an LRA was the 1967 total of acreage devoted to the six crops, of idle land, and of land in conservation programs.

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 the policy runs were repeated using these coefficients. As will be indicated in the discussion of the results, the revised soil losses may be somewhat low. If so, the two sets of results

*Specific coefficients will be furnished upon request to C.R. Taylor, Texas A & M University.

Table 8

Annualized Terracing Costs in $ per Acre

LAND RESOURCE AREAS	LAND CAPABILITY UNITS[a]										
	1[b]	2E[c]	2W[d]	2S[e]	3E	3W	3S	4E	4W	4S	5-8S
91	f	9.41			10.82						
95		9.41			10.82						
97		13.29				13.29					
98		13.29				13.29					
102		5.61			5.61	5.61		5.61			
103		9.21			12.01			13.89	9.20		16.67
104		9.83			19.13	12.61		22.78			
105		9.91			10.97						
106		2.83			4.29			5.45			
107		6.62			13.43			17.92			
108		11.48	14.35	22.23	14.35			22.20			
109		6.14			8.18			8.18			12.24
110		20.53			24.60			27.13			
111		18.45			25.32			32.98			
113		16.60			24.40			25.92			
114		11.16	14.56		20.16			26.35			
115		6.14			8.18			12.24	8.18		12.24

[a]In each case, higher numbers represent more significant limitations.

[b]LCU 1 soils do not have limitations.

[c]E soils have predominantly erosion limitations.

[d]W soils have predominantly wetness limitations.

[e]S soils have other limitations.

[f]Where no terracing costs are given, terracing is assumed to be an inappropriate technique for the LRA-LCU combination.

bracket the actual soil losses to be expected.

Model Results

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

High Soil-loss Coefficients:

1. Benchmark
2. Soil-loss constraints of 2, 3, 4, 5 tons/acre
3. Soil-loss taxes of $4, $2, $1, and $.5/ton
4. Terracing subsidies of $4, $10, $15, $20, and $40/acre
5. Prohibition of chisel plowing
6. Prohibition of fall plowing
7. Prohibition of straight-row cultivation
8. Soil loss of 3 tons/A and terracing subsidies of 50% of cost, $15/acre, and $20/acre
9. Nitrogen restriction to 50 lbs/acre
10. Nitrogen restriction to 50 lbs/acre and soil-loss constraints of 2, 3, 4, 5 tons/acre
11. Nitrogen restriction to 100 lbs/acre
12. Nitrogen restriction to 100 lbs/acre and soil-loss constraints of 2, 3, 4, 5 tons/acre

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/acre
5. Soil-loss tax of $4/ton
6. 100% cost sharing for terracing
7. 100% cost sharing for terracing and soil-loss constraint of 2 tons/acre
8. Nitrogen restriction to 50 and 100 lbs/acre

Complete results of these runs are presented in Appendix D. In the following discussion, selected results 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 the results obtained under each of the constrained runs. Table 9 gives the actual acreages of crops planted in the several regions of the corn belt and the crop acreages developed in the benchmark solution of the model using the high soil-loss coefficients. The two sets of acreages are reasonably consistent. The regions with large acreages tend to be more accurately reflected in the model results than are some of the regions with fewer acres.

Table 10 indicates the acreages of crops by Land Resource Areas and Land

Table 9

Actual Acreages of Crops Planted in 1969 (thousands of acres) 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
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
	ALL	41,047	41,700	21,493	24,859	13,419	13,488	29,925	31,816

Table 10

Acreages of Crops by Land Resource Area and Land Capability Unit Determined by the Benchmark Solution of the Corn-belt Model Using Low Soil-loss Coefficients

(thousands of acres)

Crop	LRA 91	LRA 95	LRA 97	LRA 98	LRA 102	LRA 103	LRA 104	LRA 105	LRA 106	LRA 107	LRA 108	LRA 109	LRA 110	LRA 111	LRA 113	LRA 114	LRA 115	Total
LCU 1																		
Corn		163	4	138	1460	1342	279	175	116	410	3495	247	260		33	395	1010	9527
Soybeans		163			730	671	279		116	410			260		33	395		3057
Wheat	11																	11
Oats		163			730													893
Hay														617				617
LCU 2E																		
Corn				368	2325	1673	612	1100	237	854	2519	423	395	1382	71	255	481	12695
Soybeans				115	1162	1673	612		237	854	2519	423	395	583		255	481	9309
Wheat	182	279		115												255		831
Oats		1056	81	138	1162										71			2508
Hay	45	753		415										477	214	314		2218
LCU 3E																		
Corn				93		553	7	260	519	436	32				526		145	2571
Soybeans						553	7		259	436	32						145	1432
Wheat																	145	145
Oats			43	93			7								65			201
Hay	169	669		279	2264		534	1292	950	1452	2173	1530	177	772	194	369	850	13674
LCU 4E																		
Corn				24											39			63
Soybeans																		
Wheat	124																	124
Oats			7	24					382						39			452
Hay		298		73	726	151	75	779		554	574	560	29	338	116	404	522	5199

Table 10 (continued)

Crop	LRA 91	LRA 95	LRA 97	LRA 98	LRA 102	LRA 103	LRA 104	LRA 105	LRA 106	LRA 107	LRA 108	LRA 109	LRA 110	LRA 111	LRA 113	LRA 114	LRA 115	Total
LCU 2W																		
Corn		548	40	1537	1785	1431	393	270	123	304	2727	31	774	2740	100	715	613	14131
Soybeans		548				1431	393		123	304	1364		774	2740		715	613	9005
Wheat	170									304				2740				3214
Oats			16			1431	393								100			1940
Hay			47		75	396						665			299			1482
LCU 3W																		
Corn		50	63	319			62		30		85	188	97		423	542		1859
Soybeans		50		319			62		15		85	188	97		423	542		1781
Wheat														664	401			1065
Oats																		
Hay	57				727	953		28		317							683	2756
LCU 4W																		
Corn		31		85				4					15		11			146
Soybeans		31		85									15					131
Wheat																	3	3
Oats															11			11
Hay	73		24		13	38	1			4	25	41		31	33			283
LCU 2S																		
Corn				123				76							1			200
Soybeans				123														123
Wheat										19	117			210			63	409
Oats		201	21		718										1			941
Hay	39					222	232		69			24	130		3	93		812
LCU 3S																		
Corn				98	146		9	15							7			275
Soybeans					146		9	15										170
Wheat											130		56	86			99	371
Oats		108	43	98			9	15							7			265
Hay	105			294		165			3	30		27			21	23		668

Table 10 (continued)

Crop	LRA 91	LRA 95	LRA 97	LRA 98	LRA 102	LRA 103	LRA 104	LRA 105	LRA 106	LRA 107	LRA 108	LRA 109	LRA 110	LRA 111	LRA 113	LRA 114	LRA 115	Total
LCU 4S																		
Corn				31														31
Soybeans																		
Wheat																	27	27
Oats				31														31
Hay	187	25	45	93	66	188	101	119	3	24	111	12	30	13	2			1019
LCU 5-8																		
Corn				24											8			32
Soybeans																		
Wheat																		
Oats				24											8			32
Hay	106	184	20	72	273	165	70	426	87	232	444	411	29	82	23	157	283	3064

Capability Units in the benchmark solution using low soil-loss coefficients. These data indicate that (1) the expected general tendency of allocating row crops to the more productive soils, and pasture and small grains to less productive soils is observed and (2) the model probably produces a more efficient allocation than would be observed if the data were available to make comparisons. In several LRA's, all acreage of LCU 1 is in row crops and all of LCU 3 and 4E is in pasture. Partially because of farm operators' preferences for certain crops and partially because of the existence of several LCU's in a given field, the results will not be as clear-cut as indicated here. This factor will tend to give model results that would produce crops more efficiently, with higher net farm income and less soil loss, than is actually observed.

The LCU designations are based on the Conservation Needs Inventory. Thus, conservation practices that were in effect at the time of the inventory (1967) are reflected in the model. Terracing and other conservation practices carried out since that time are not reflected. Since the annual costs of crop production are higher in all cases when terracing costs are included, there is no terracing in the benchmark solution. Similarly, since spring plowing is more economical in almost all cases, this technique was used for almost all acreage in the benchmark run. Use of the model to analyze the effects of prohibiting fall plowing is therefore not revealing. Chisel plowing is a technique which provides lower production costs on approximately 70 percent of the corn belt acreage and is therefore included in the benchmark model at that level.

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 the comparisons among solutions since the same relationships can be expected.

There are some discrepancies between the two benchmark solutions using different soil-loss coefficients, as indicated by the data in Table 11. Crop prices, except for corn, are higher when the low soil-loss coefficients are used. Corn production is also higher for that case. Of course, the quantity of soil lost differs substantially between the two solutions; the average loss is 2.96 tons per acre planted using the low coefficients as compared to 5.3 tons per acre with the higher ones. Since no constraint is imposed on soil lost, this difference does not explain the differences in crop prices and production. The price and production differences must be due to the random choices possible in a model of this size and complexity and to rounding errors. These differences should remind the reader of the need to interpret all results with care; minor differences among model runs may not be significant.

Restriction of Chisel Plowing

The runs in which varying levels of chisel plowing are permitted are summarized in Table 11. When chisel plowing is used in all situations where it is profitable, as reflected in the two benchmark solutions, over 77 million acres are chisel plowed, resulting in substantial reductions in soil loss. The magnitude of the impact can be appreciated by comparing the runs

Table 11

Effects of Restricting Chisel Plowing

	Benchmark (High SLC)*	Benchmark (Low SLC)	Chisel Plowing Prohibited (High SLC)	Chisel Plowing Prohibited (Low SLC)	Chisel Plowing on 33 Million Acres Only (Low SLC)
Social Cost (mil. $)	0	0	-270.8	-281.55	-269.14
Consumer Cost (mil. $)	0	0	210.51	269.60	222.60
Producer Cost (mil. $)	0	0	-481.31	-551.15	-491.74
Government Cost (mil. $)	0	0	0		
Crop Prices					
Corn ($/bu.)	2.46	2.46	2.46	2.46	2.46
Soybeans ($/bu.)	5.26	5.28	5.22	5.22	5.22
Wheat ($/bu.)	4.97	5.00	4.80	4.84	4.84
Oats ($/bu.)	2.33	2.34	2.29	2.28	2.28
Hay ($/bu.)	56.15	56.37	54.39	53.61	54.69
Pasture ($/ton)				23.83	24.08
Production					
Corn (mil. bu.)	3744.2	3760.2	3736.6	3740.3	3738.4
Soybeans (mil. bu.)	785.0	784.5	792.3	792.3	792.3
Acres Terraced (mil.)	0	0	0	0	0
Reduced Tillage (mil. acres)	77.33	77.33	0	0	33.22
Gross Soil Loss (mil. tons)	595.81	330.58	2275.85	578.07	478.19
Gross Soil Loss (tons per acre planted)	5.3	2.96	20.35	5.17	4.27
Insecticide Expenditures Index	100	100	92	97	98
Herbicide Expenditures Index	100	100	86	87	93
N Load (bil. lbs.)	4.19	4.19	4.19	4.19	4.19
N Load (lbs./acre)	100.58	100.96	100.93	100.24	101.21

*SLC denotes soil-loss coefficients used in the model.

in which chisel plowing is prohibited to those in which chisel plowing is restricted to 33 million acres, the latter area being the estimated acreage on which the practice is currently used (See Figure 4). With the high soil-loss coefficients, the use of chisel plowing wherever profitable reduces soil loss to 26 percent of the more than 20 tons per acre lost when chisel plowing is prohibited. With the low soil-loss coefficients, the use of chisel plowing on 33 million acres reduces losses from 5.33 to 4.27 tons per acre, while use on 77 million acres holds soil losses to an average of 2.96 tons per acre. Since chisel plowing is the more profitable method on 77 million acres and since farmers are continuing 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 constraint runs in this analysis are compared to the benchmark solutions in which the use of chisel plowing is 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 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 as is evident from the information contained in Table 11.

Soil-loss Limitations

The results presented in Figure 5 illustrate the impact of restricting soil losses to 2, 3, 4, and 5 tons per acre in the cornbelt. If the low soil-loss coefficients are correct, the costs to society will not be large. If the high coefficients are accurate, the 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 SCS. These tolerances generally vary between 2 and 5 tons, so the 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, since 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.

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 for some restrictions and lose for others. We expect that the mixed impact on producers results from idiosyncrasies of the model (related to steps on the demand function). Allowing for these idiosyncrasies, it would seem that the effect on producers is either very small or beneficial. Although the restrictions increase the prices of the major crops and the cost of production, producers benefit because the effect on costs is smaller than that on prices. The crop price and production impacts using the low soil-loss coefficients are not shown in Figure 5 because they are insignificant.

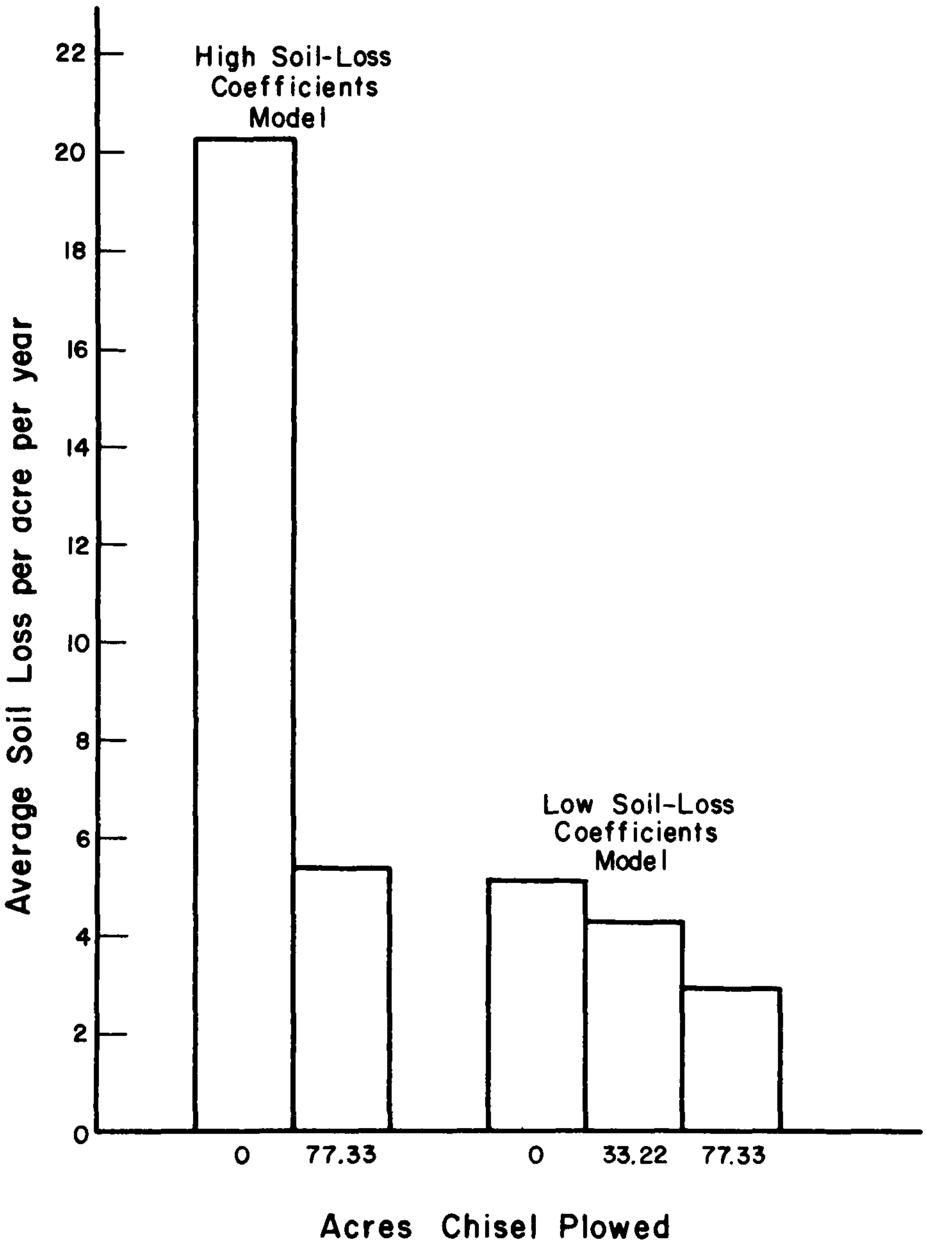


Figure 4. Average soil loss per acre per year with and without chisel-plowing constraints.

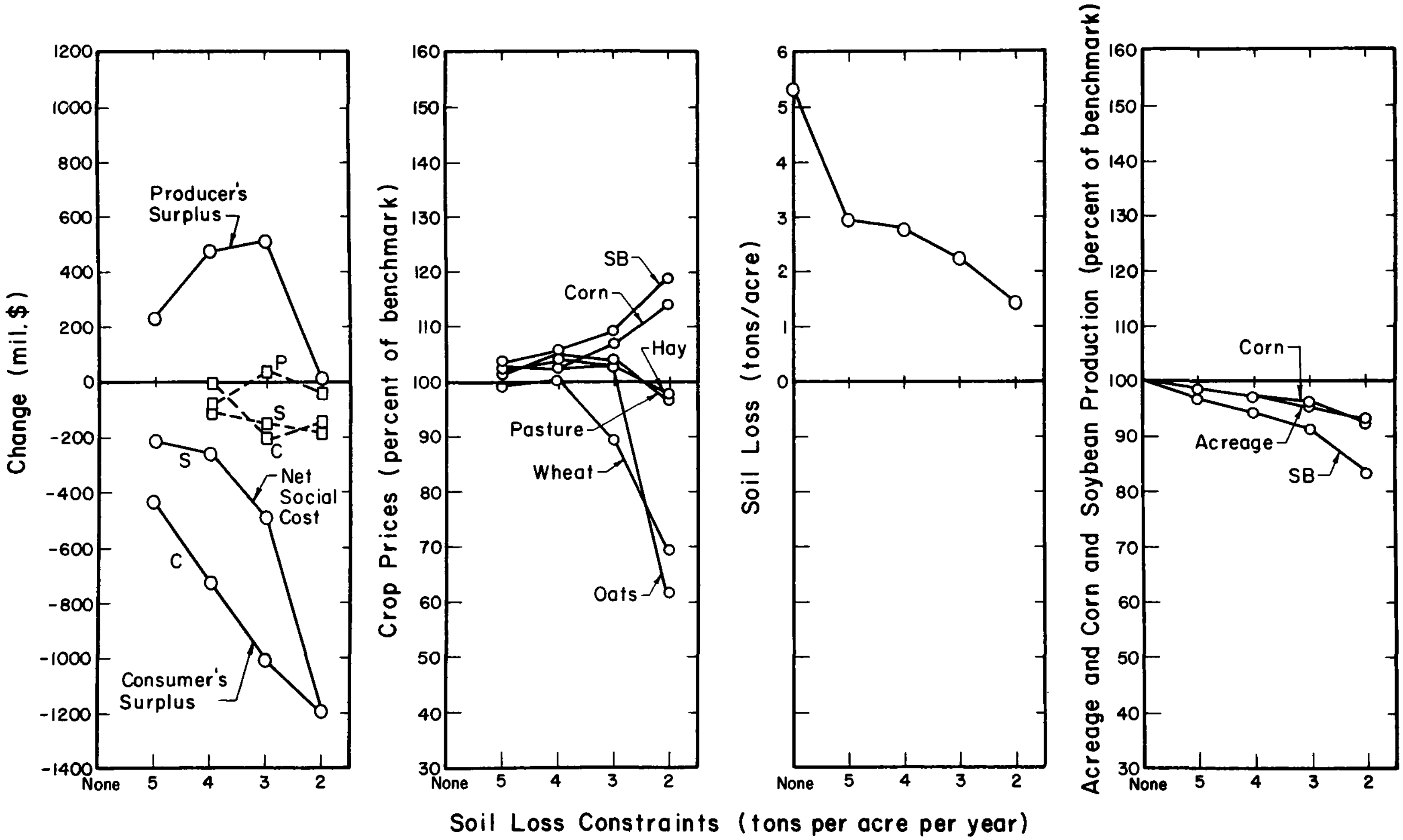


Figure 5. Impacts of soil-loss limits.

For example, soybean production drops only 3 percent with a 2-ton-per-acre limit. Logically, those producers who now have high soil-loss rates would earn lower profits if a restriction were imposed and 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.

Although consumers would pay more for food, some of them 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 use occur in those runs in which the acreage chisel plowed changes). With increasingly stringent soil-loss limits, the nitrogen use per acre increases slightly, but the total amount used decreases as a result of reduced corn acreage.

The information in Tables 12 and 13, generated using the low soil-loss coefficients, indicate that the impacts on producers by region would vary considerably. Table 12 indicates for each land resource area the direction of the impact on producers' surplus resulting from changes in soil-loss restrictions. The first column (B-4), for example, indicates the direction of the impact produced by a change from the benchmark solution (no soil-loss restriction) to a situation in which a 4-ton-per-acre restriction is imposed. These data indicate that as increasingly stringent soil-loss limits are imposed, only one region (LRA 115) experiences the consistently negative impacts that would generally be expected. Producers in five regions are better off with a two-ton restriction than they are in the benchmark (unrestricted) case. These shifts occur because of several factors: changes in total acreages planted and thus in production and prices, shifts of crops among regions, and, in certain regions, the removal of acreage from production if that land cannot meet the soil-loss limits.* Since hay and pasture are constrained by region, dropping the least productive areas because the soil-loss limits cannot be met may result in hay and pasture being moved to more productive land with some present hay and pasture land also dropping out of production.

Table 13 summarizes changes in crop acreages with changes in soil-loss limits and, thus, also reflects the variation in impacts among regions. In the case of corn, almost every possible pattern of change occurs as the soil-loss restriction shifts progressively from the unrestricted (benchmark) case to 2 tons per acre. There are also numerous shifts in crop acreage among producing regions. The manner in which the model is constructed may have resulted in underestimating the shift from corn and soybeans to other crops so as to meet the soil-loss limits imposed. Since the production of other

*The model is structured in such a way that acreage which cannot meet soil-loss requirements is dropped, and it is then assumed that neither production nor soil loss occurs on that land. This method of calculating soil loss would be appropriate only if the land reverted to a "natural" state *and* if that state did not generate soil loss. Thus, this feature of the model tends to overestimate the effectiveness of soil-loss restrictions in reducing soil losses.

Table 12

Direction of Impact on Producers' Surplus with Changes in Soil-Loss Limits

	Soil-Loss Limit (tons/acre)					
LRA	B* → 4	4 → 3	3 → 2	B* → 3	B* → 2	4 → 2
91	-	+	-	+	-	-
95	+	+	-	+	+	+
97	+	+	-	+	+	+
98	-	+	+	-	+	+
102	+	+	-	+	-	-
103	-	+	-	+	+	+
104	+	+	-	+	-	-
105	-	+	-	-	-	-
106	-	+	-	-	-	+
107	-	+	+	-	-	+
108	-	+	-	+	-	-
109	+	+	-	+	+	+
110	+	+	-	+	-	-
111	+	+	-	+	-	-
113	-	-	+	-	-	-
114	+	+	-	-	-	-
115	-	-	-	-	-	-
Σ	-	+	-	+	-	-

*B denotes the benchmark solution (no soil-loss restriction)
+ denotes an increase in producers' surplus
- denotes a decrease in producers' surplus

Table 13

Direction of Change in Crop Acreages with Changes in Soil-Loss Restrictions

	Soil-Loss Limit (tons/acre)														
	Corn			Soybeans			Wheat			Oats			Hay		
LRA	B→4*	4→3	3→2	B→4	4→3	3→2	B→4	4→3	3→2	B→4	4→3	3→2	B→4	4→3	3→2
91	0	0	0	0	0	0	-		+	0	0	0	+		-
95			+			-	+	-	$-_0$	-	+	+	+	-	+
97	+			0	0	0	0	0	0	-			+		
98	-	-	+	-	-	-	-	+	$-_0$	-	+	-	-	+	-
102	+		-	-	+		0	0	0	+	-	+	+		+
103	-	+	+	-	-	+	0	0	0	+	+	-	-	-	-
104	+		+	-		-	0	0	0	+		-	+		-
105	-		-	$-_0$	0	$+_0$	0	0	0	+		+	+		-
106	-	+	+	+	-	+	$-_0$	0	0	0	0	0	+		-
107	-		+	-	+	-	+	-	+	0	0	0	-		
108			-			+			-	0	0	$+_0$			+
109							0	0	0	0	0	0			
110		+	-		+	-		$-_0$	$+_0$	0	0	$+_0$		+	-
111	+	+	+	-	-	-		-	-	0	0	$+_0$		+	
113	-	-	-	+	-	-	$-_0$	0	0	+	-	-	+	-	-
114	+	-	+	-	-	+	-	+	-	0	0	0			
115	-	-	-	-	-	-	-	+	+	0	$+_0$		+	+	+
Σ	-	-	+	-	-	+	-	+	-	+	+	-	-	-	-

*B denotes the benchmark solution (no soil-loss restriction)
+ denotes an increase in acreage planted
- denotes a decrease in acreage planted
blank denotes no change in acreage planted
0 denotes that none of this crop was planted under either soil-loss limit
$+_0$ denotes an increase from zero acres
$-_0$ denotes a decrease to zero acres

crops is constrained at a given level, the only change in the total acreage of wheat, oats, and hay occurs as a result of including higher- or lower-yielding acreage in the solution. If returns from these crops were included in the objective function, they could be substituted for corn and soybeans under some restrictions, modifying model results to some degree.

While crop acreage shifts can only be summarized in terms of differential impacts on regions (because the model was constructed on that basis), the same type of variations would occur among farmers on soils with varying capabilities.

Soil-loss Taxes

The information in Figure 6 summarizes the impact 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 is somewhat less with soil-loss taxes than with soil-loss limits, and consumers fare somewhat better. The impact on producers is also reversed. Soil-loss taxes 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, is increased dramatically while corn prices hold about constant and the prices of nonrow crops decrease significantly. The increase in soybean prices is consistent with the significant reduction in soybean production in the cornbelt. It is also worth noting that the acreage in production decreases somewhat with the higher soil-loss tax rates, implying that on some acreage it is more profitable to cease production than to pay the soil-loss tax or to incur the costs of applying erosion control techniques. This situation reflects one assumption of the model; namely, that the operator does not pay taxes on soil losses from land not involved in production. If this assumption were modified, production would continue on such land.

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

Terracing Subsidies

Figure 7 summarizes the impacts of terracing subsidies ranging from $5 to $40 per acre. In the model, the costs of terracing given in Table 8 are annualized to reflect the annual impact on farm income of an investment in a terrace system. In these runs, a terracing subsidy at a fixed number of dollars per acre is paid to encourage the installation of terraces.* It is assumed that the total amount is paid regardless of the annual cost of the terrace. Thus, in the $40-per-acre run, the farm operator would receive more compensation than the actual annual cost of installing the terraces. Since

*The payment would need to continue for several years because the estimates of terracing costs are annualized.

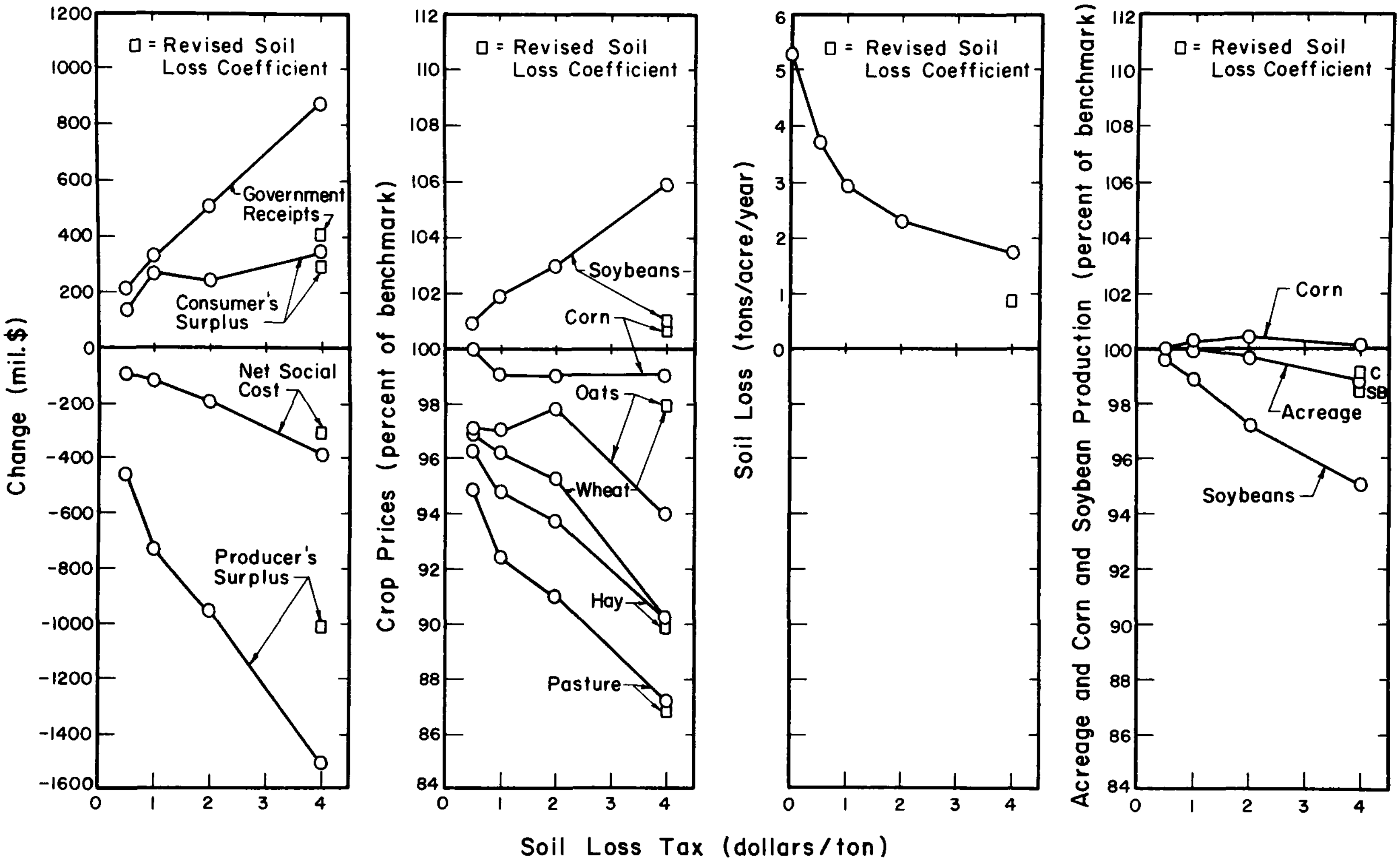


Figure 6. Impacts of soil-loss taxes.

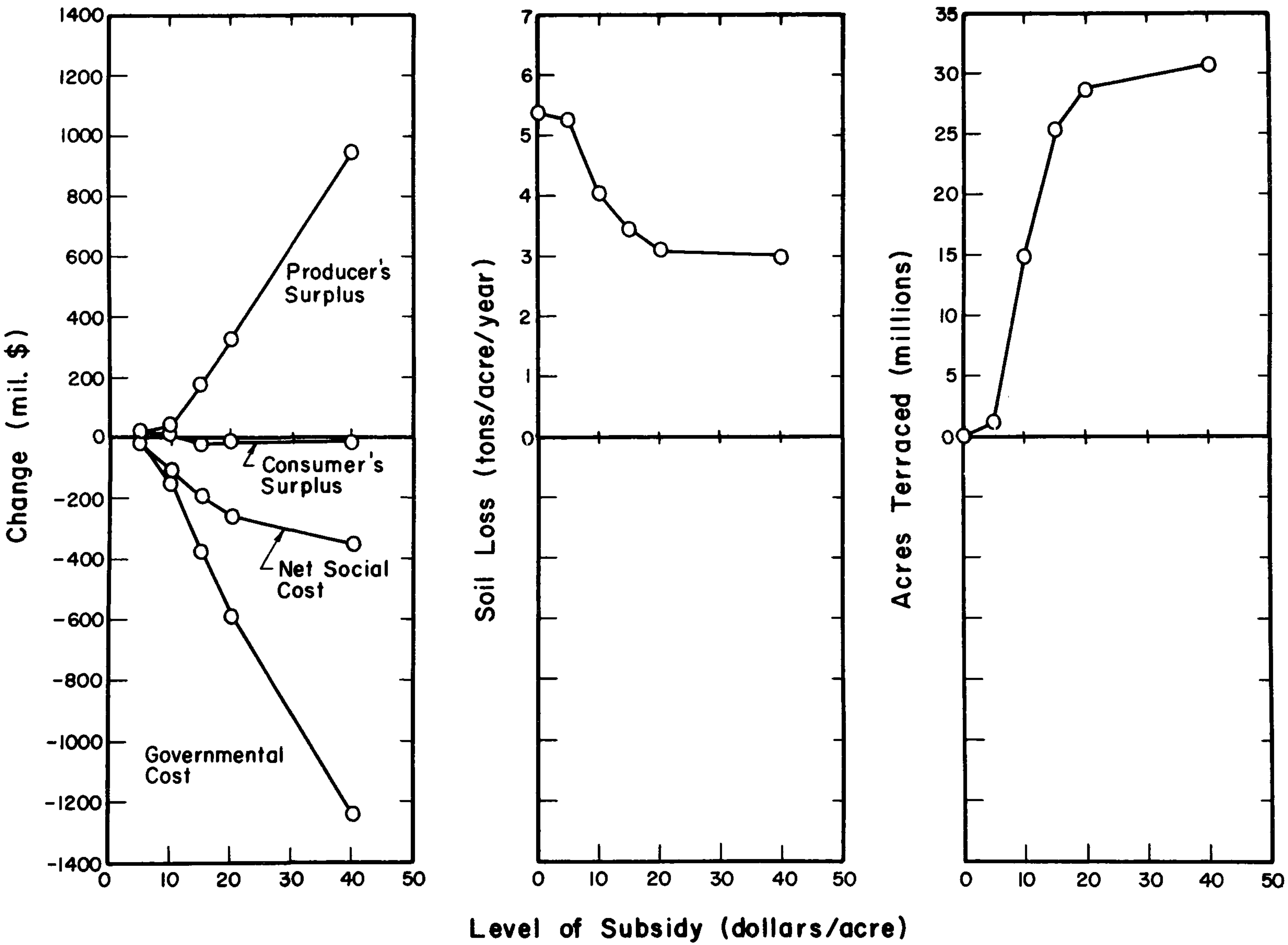


Figure 7. Impacts of terracing subsidies.

the $40-per-acre-per-year subsidy is higher than the actual annual cost of terracing on any of the land where the technique is assumed to be possible, the $40 run indicates the maximum possible impact from a terracing program.

The prices and acreages under the several runs are not summarized in this figure because (as shown in Appendix D) there are no significant changes from the benchmark solution. The high government cost and the high levels of producers' surplus under the larger terrace subsidies are a result of the way in which the subsidies are assumed to be paid; that is, more funds are paid to producers than would be necessary to induce them to incur the terracing costs. Since the governmental costs and producers' surpluses cancel where overpayment occurs, however, the net social cost of 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 reduction in soil loss or increase in acres terraced improves very little when the subsidy is increased from $20 to $40 per acre.

Prohibition of Straight-row Cultivation

As summarized in Appendix D, the model was run once with straight-row cultivation prohibited using high soil-loss coefficients. Under this condition, producers' surplus is reduced approximately $145 million, net social costs are increased approximately $133 million, and the difference is a small increase in consumers' surplus of slightly over $11 million. Again, there is no significant impact on acreages or prices, and soil loss is reduced from 5.33 to 3.01 tons per acre per year.

Prohibition of Fall Plowing

The results of a run in which fall plowing was prohibited are also summarized in Appendix D. As noted earlier, prohibiting such plowing does not have a significant impact because very little of the acreage is fall plowed in the benchmark run, a result of the fact that the production costs included in the model show spring plowing to be somewhat less expensive.

Combinations of Soil Erosion Control Policies

Figure 8 gives the results of combining selected approaches to the control of soil losses. Policy D combines a soil-loss restriction of three tons per acre with a 50 percent reduction in the cost of terracing through a government cost-sharing program. Policy E combines a soil-loss restriction of three tons per acre with a $15-per-acre terracing cost subsidy, the full amount of which is paid regardless of the cost of terracing to any farm operator who installs terraces. In policy F, a soil-loss restriction of three tons per acre is imposed and cost-sharing at $20 per acre is provided; that is, a farmer who terraces his land is 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 provides a $15 terracing subsidy alone; and Policy C, which includes only a soil-loss restriction of three tons per acre.

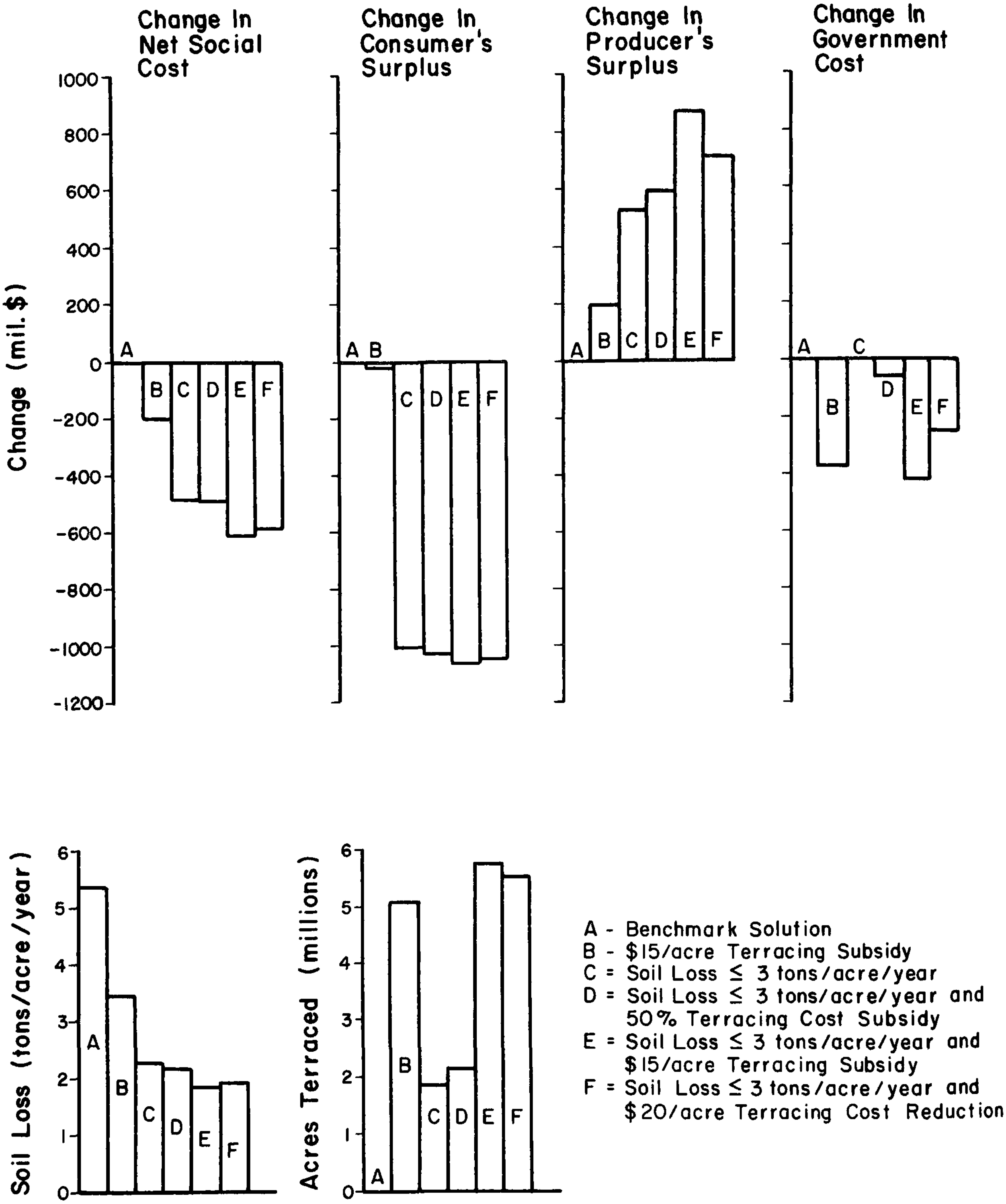


Figure 8. Impacts of terracing subsidies and soil-loss constraints.

From these results it is apparent that the impacts of the three combination policies, in terms of the soil-loss rates achieved and economic effects, are approximately equivalent to those of a three-ton-per-acre soil-loss restriction. They are also equivalent in terms of acreage planted, production of corn and soybeans, and commodity prices. The social costs for all of the combination policies are higher than for the terracing subsidy alone, reflecting primarily the higher cost to consumers in the form of reduced consumers' surplus. Producers' surplus is positive for all of these policies, but the combination policies generate a higher level of producers' surplus than do the soil-loss limits alone or the terracing subsidy alone. The difference is greater when compared to the terracing subsidy alone. The combination policies and the soil-loss restrictions all generate lower levels of soil loss than does the terracing subsidy alone. The $15-per-acre terracing subsidy reduces soil losses from 5.3 to 3.46 tons per acre. A soil-loss restriction of three tons per acre generates an average soil loss of 2.25 tons per acre, and the most effective of the combination policies, that which combines the soil-loss limit with a $15-per-acre subsidy, reduces soil losses to 1.87 tons per acre. Thus, the terracing subsidy alone reduces soil losses by 35 percent, soil-loss limits alone reduce it by 58 percent, and the most effective of the combination policies reduces it by 65 percent of the gross soil loss occurring in the corn belt in the benchmark solution.

Relative Efficiency of Soil-loss Control Policies

Figures 9, 10, 11, and 12 indicate the relative economic efficiency of the several policies tested in 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 that three additional categories of costs and benefits are not included in these calculations: the costs of administering the policies in question, the environmental benefits associated with adopting the policies, and the long-run impacts on soil productivity. When comparing the results generated by the model using the high soil-loss ceofficients, it is clear that the soil-loss tax is the most economically efficient overall, as would be expected from economic theory. However, while the net social costs of achieving a given reduction in soil loss are lowest in the case of taxation, it is important to realize that such a policy causes significant reductions in producers' surplus as a result of the taxes paid. These governmental tax receipts are, of course, reflected in the net social cost, giving rise to the overall estimation that the policy is highly efficient. The taxation policy, then, is the only one that generates a significant reduction in producers' well-being with benefits to both the government and to consumers. It is also likely that the administrative costs--primarily for tax assessment--would be quite significant under a policy of this type, at least with the present technology.

The soil-loss restrictions, except for the two-ton-per-acre limit, approximate the tax solution reasonably well when the high soil-loss coefficients are used. That is, a soil-loss limit policy is not significantly less efficient than the tax policy. The distribution of benefits and costs, however, is quite different. If a policy which limits soil loss to three tons per acre per year results in a $500 million increase in cost over the benchmark solution, but because producers gain $500 million, the total negative

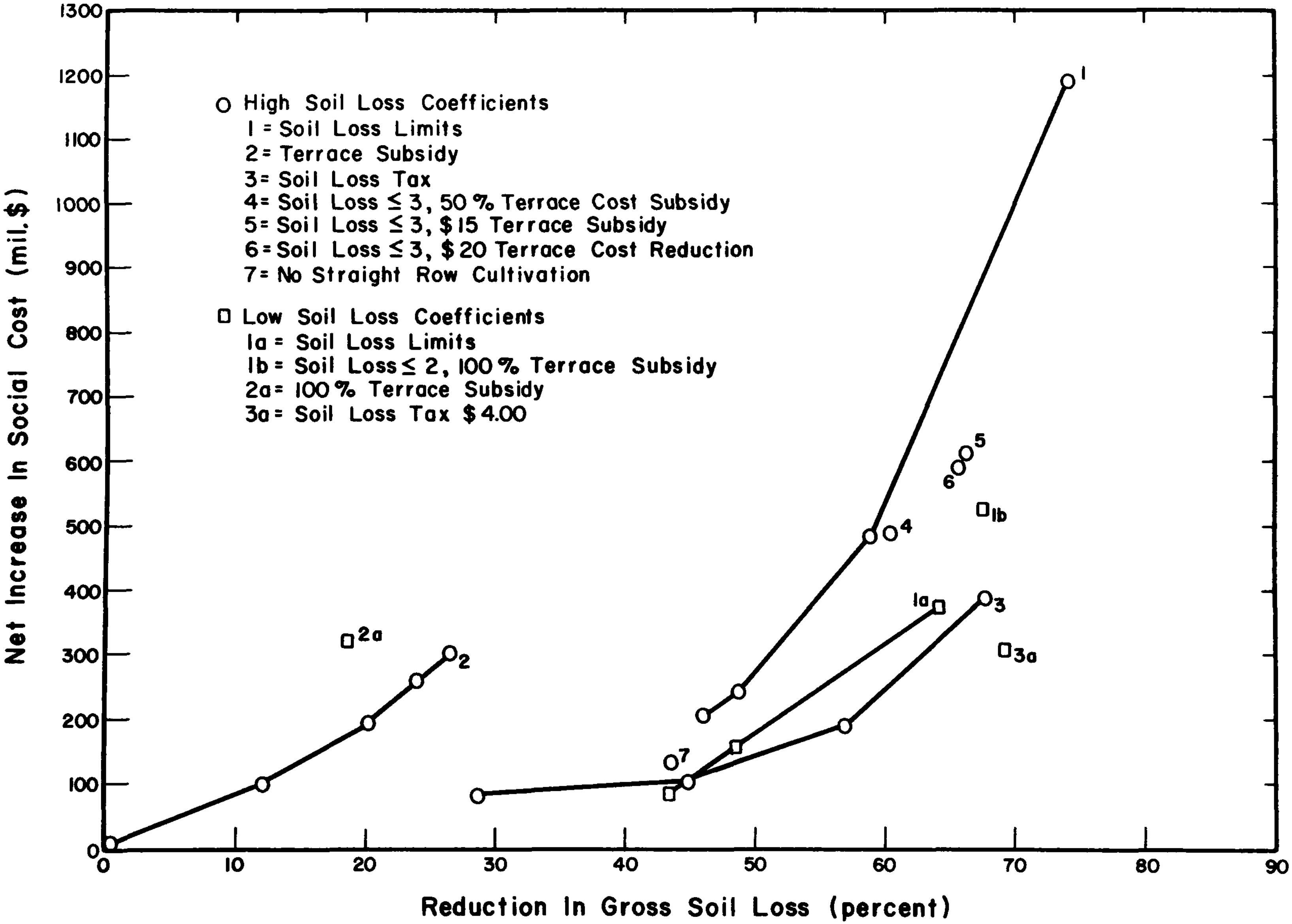


Figure 9. Change in net social cost and percentage reduction in gross soil loss.

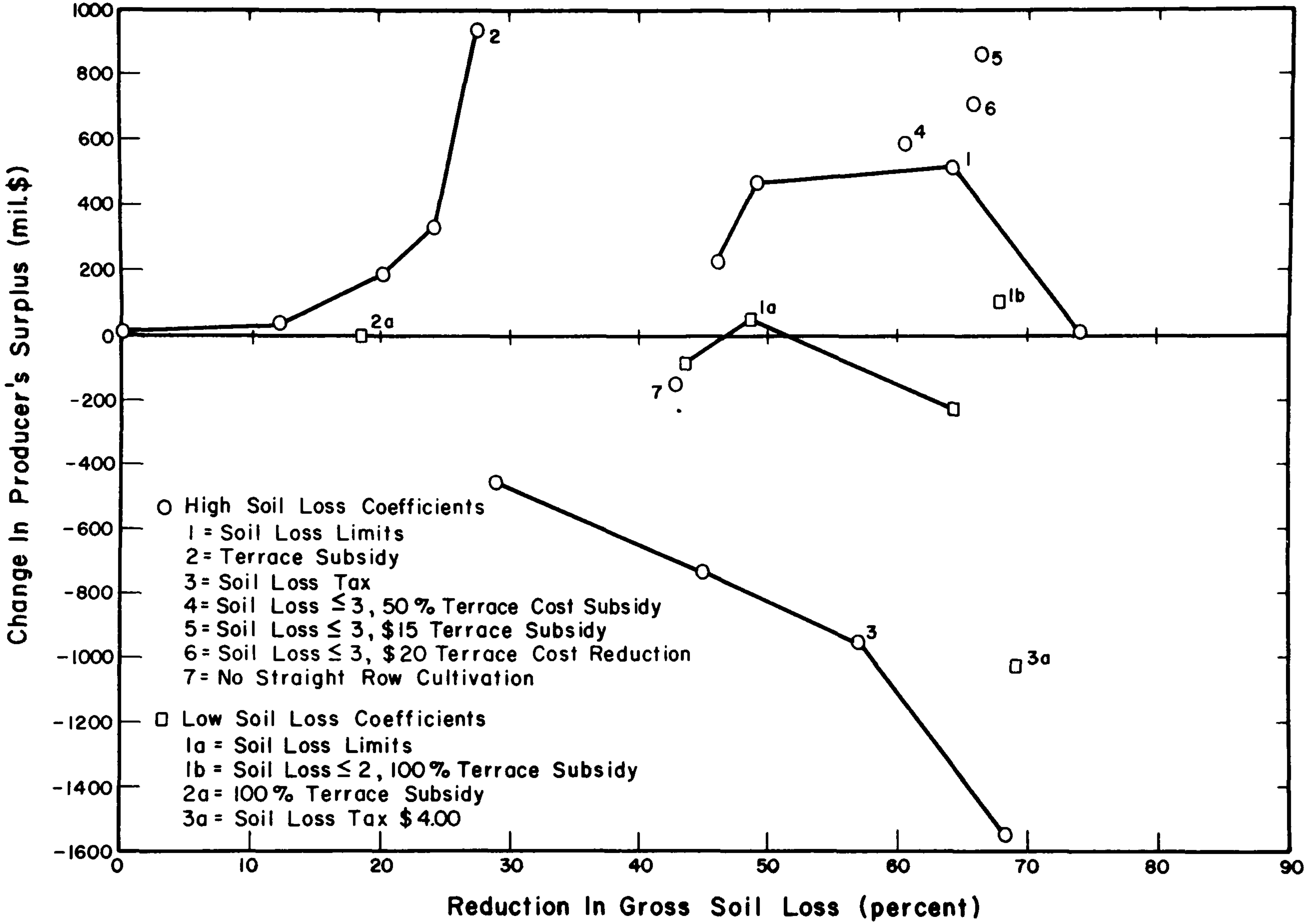


Figure 10. Change in producers' surplus and percent reduction in gross soil loss.

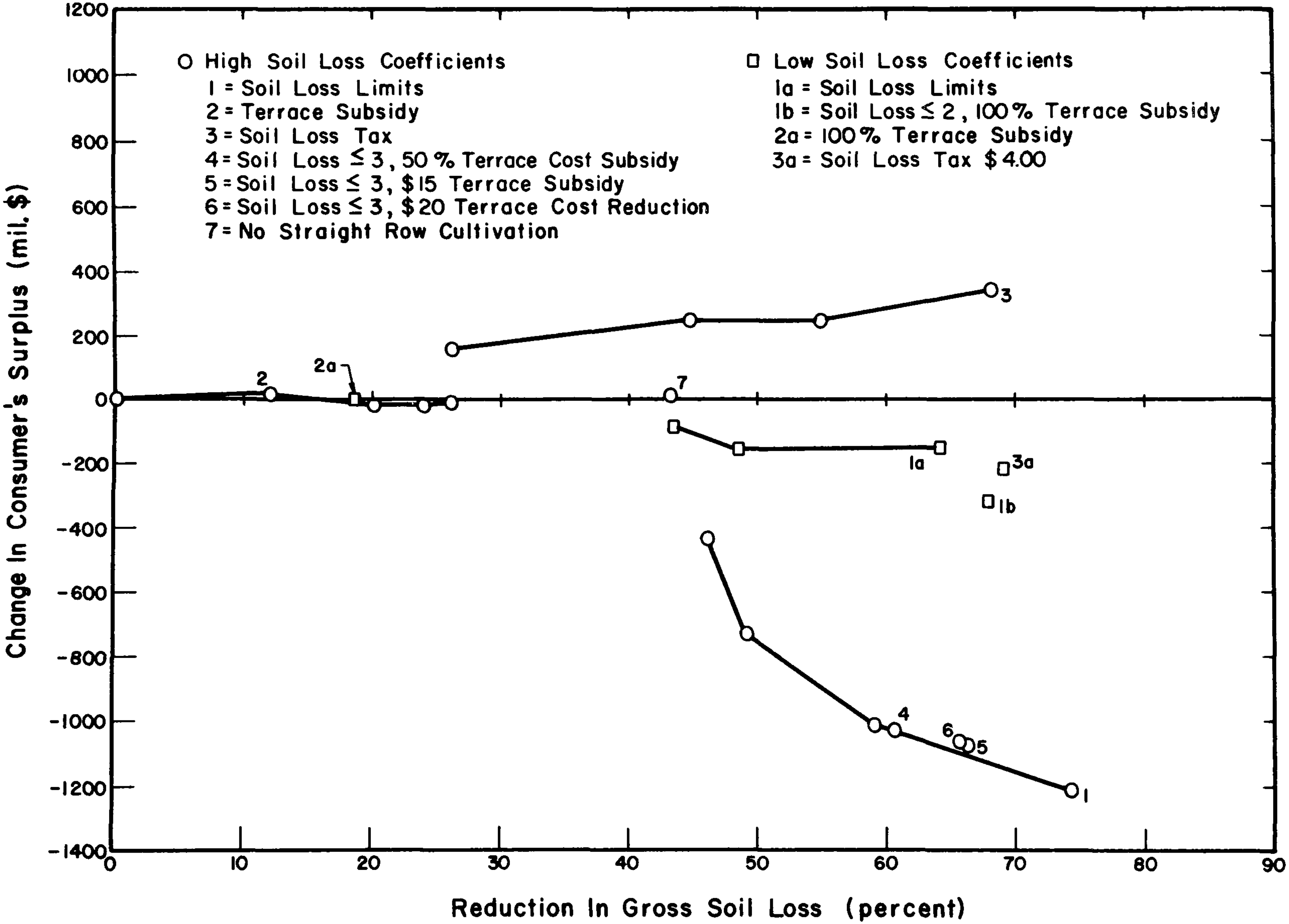


Figure 11. Change in consumers' surplus and percent reduction in gross soil loss.

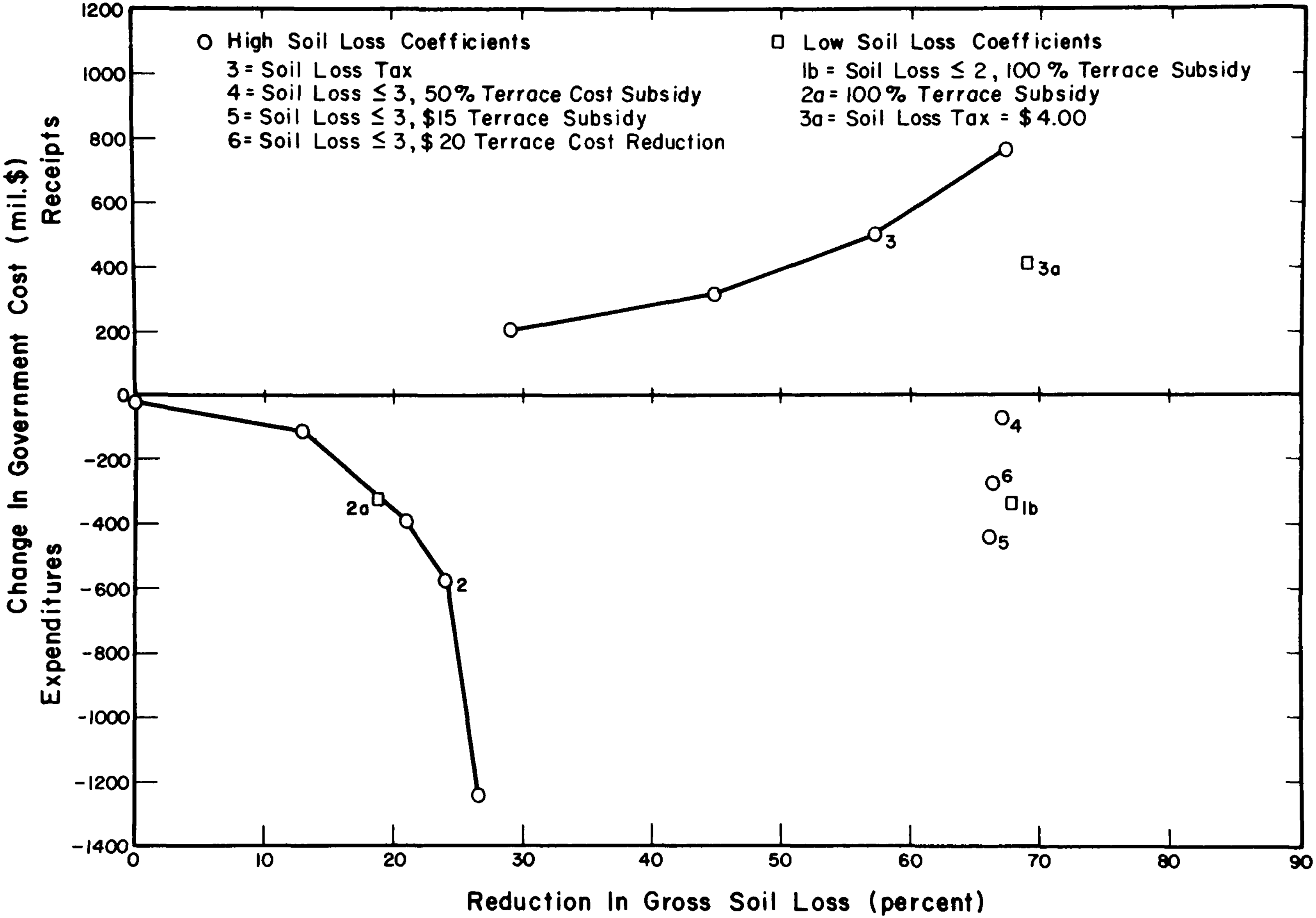


Figure 12. Change in government cost and percent reduction in gross soil loss.

impact on consumers is approximately $1 billion. As noted earlier, using the low soil-loss coefficients, the impacts are significantly lower, with all of the economic changes being less than 200 million dollars. The small negative or rather significant positive impact on producers (depending on which set of soil-loss coefficients is assumed to be correct) is a rather surprising result. It occurs because the model includes a supply and demand function for the major crops, allowing the impact of the soil-loss restriction to be translated into higher prices which generate higher gross receipts at the farm level. Such results will not be demonstrated by a model which is limited to fixed commodity prices.

As previously discussed, the higher net social cost generated by soil-loss restrictions is due in part to the fact that some land must be taken out of production to meet the soil-loss limits, which are applied on a uniform per-acre basis. Hence, the 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. Equity questions such as this are addressed in Chapter 7.

The policy of banning straight-row cultivation appears reasonably efficient, but it is important to realize that the means of achieving reduced soil loss is quite different from a soil-loss restriction. In this case, all land remains in production; on some of the land soil loss is reduced to very low levels through contouring or terracing, but on other land high levels of soil loss continue. As an example, with a three-ton-per-acre soil-loss limit, all land must either meet the limit or be dropped from production. With the banning of straight-row cultivation, however, some land would move from a two-ton-per-acre soil loss to one ton or less, while other acreage might move from 20 to 10 tons per acre. While the two policies may produce equivalent average rates of soil loss, the impacts on long-term productivity and water quality would be quite different.

The terracing policies are not as effective in reducing soil losses as the soil-loss restriction and taxation policies. With a terracing subsidy providing a fixed number of dollars per acre there is a significant shift of funds from the taxpayers to the 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 is the present practice.

Combining terracing subsidies with soil-loss restrictions produces a more efficient result than can be achieved by a soil-loss restriction alone. In these cases, benefits flow to the producers from both consumers and taxpayers.

Soil-loss and Nitrogen Restrictions

Figure 13 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 constraint level. The con-

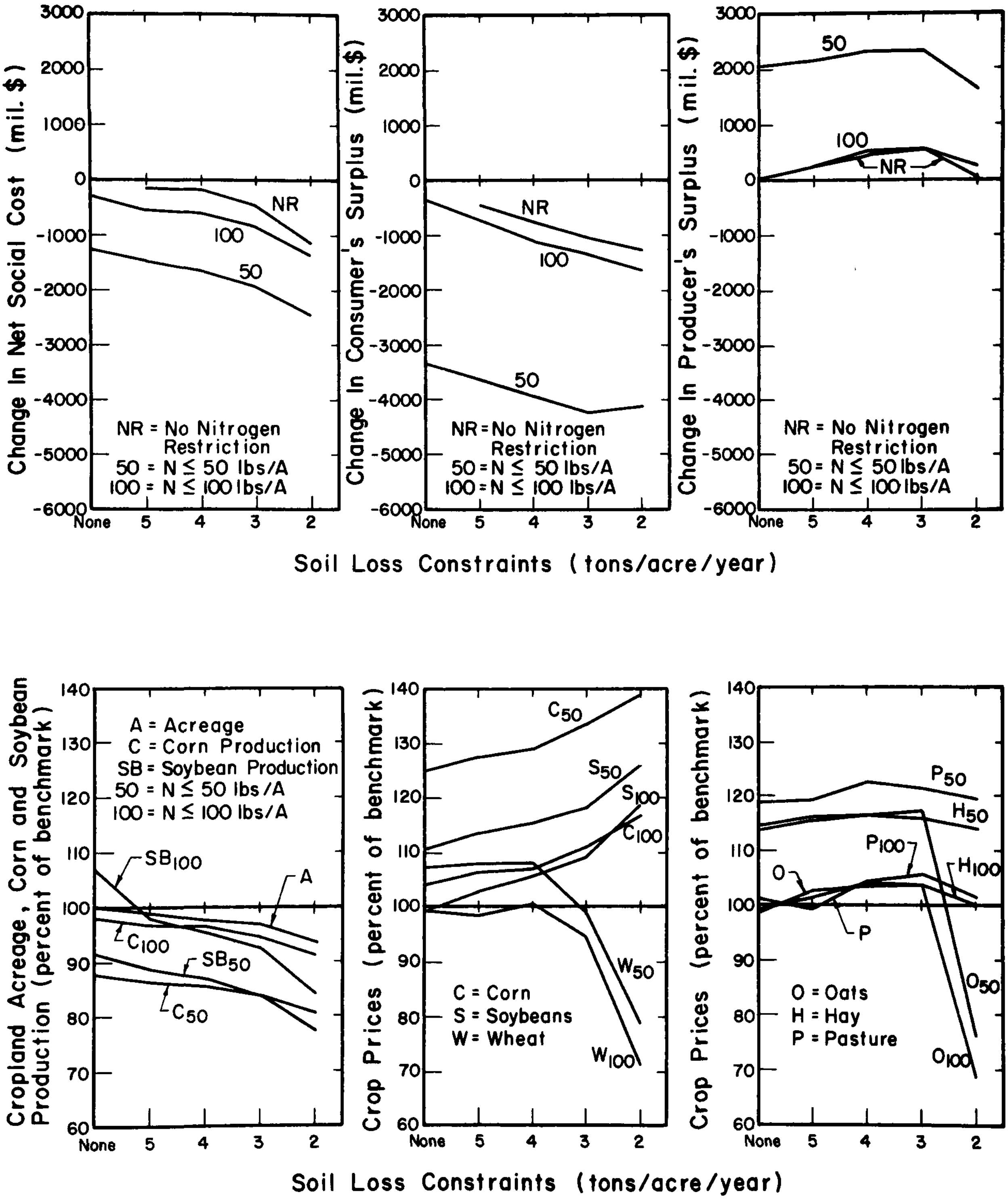


Figure 13. Impacts of restrictions on nitrogen application and soil loss.

straints are assumed to apply to all sources of nitrates including those added by legumes and are, therefore, quite restrictive. In general, it is clear that the 50-pound-per-acre nitrogen restriction has a significant impact when applied alone and that as more stringent soil-loss limits are added, the impact generally increases. The impact of a 100-pound-per-acre nitrogen restriction is not significantly different from the impact of a soil-loss restriction alone; the impact on producers is almost exactly the same. Another significant result is the increase in producers' surplus when nitrogen applications are restricted. Thus, while farm income would be reduced by a restriction at the individual farm or regional level (realization of this fact explains the negative farmer reaction to nitrogen restrictions), restrictions at the national level improve farm income. The difference is explained by the price-increasing effect of a national restriction.

The nitrogen restrictions alone have a reasonably strong impact on the agricultural sector. Reducing the level of nitrogen applied reduces the yield and the profitability of corn, making soybeans a relatively more attractive crop. At the 50-pound-per-acre nitrogen limit, the reduction in yield is great enough so that even though the acreage of corn and beans is increased relative to that of other crops, the total production declines. When the increased prices for corn and soybeans are combined with the lower production costs resulting from the use of less nitrogen, the result is a $2 billion increase in producers' surplus. The 100-pound-per-acre restriction does not significantly influence producers' surplus. Both the 50- and 100-pound restrictions generate reductions in consumers' surplus, with the 50-pound-per-acre restriction having a much more significant effect.

When soil-loss restrictions are applied along with nitrogen restrictions the impacts are increased. The direct impact of the soil-loss restrictions is to force some acreage out of production entirely because the soil-loss limit cannot be met, as discussed above. In addition, at the more restrictive soil-loss limits the use of intensive row-crop production is reduced in favor of less intensive crop rotations, giving rise to significant reductions in the prices of wheat and oats. The reductions in yield resulting from fertilizer restrictions and from reductions in row-crop acreage combine to reduce production and increase prices for corn and soybeans. This combination leads 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 flexibility to meet these constraints as would be expected in the real world. The fact that the constraints for hay and pasture are determined on an LRA basis while the constraints for wheat and oats are determined on a corn-belt basis may also bias the results. 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 consequent higher prices for these crops resulting in improved farm income, a negative impact on consumers, and an overall negative impact in terms of net social costs.

WATERSHED ANALYSIS

This section reports the results of an analysis of the long-term (100-year) impacts of soil erosion control policies at the watershed and the individual farm levels. While it is not possible to actually combine the results with the aggregate impacts reported in the previous section, it is important to recognize that the aggregate model does have such implications. It is also important that, while it is not possible to reflect the findings of the aggregate model in the watershed examined here, such impacts would occur in actual applications.

This section includes a description of the watershed selected, the model and data used, and the results generated. The results include the implications of an erosion control policy, or the lack thereof, when viewed in terms of the impact on the soil and its productivity over a 100-year period. The variation in impact among farms with differing soil types is also discussed in some detail. It was not necessary to analyze as wide a range of policy alternatives with the watershed model as with the corn-belt model to determine the nature of the impacts expected.

Watershed Selection

For this analysis, it was necessary to select a watershed that is representative of the corn belt.* With the advice and consultation of soil specialists, it was determined that the watershed should:

1. Include soil types that reflect the soil associations common throughout much of the corn belt
2. Have predominant soil slopes ranging from zero to seven percent
3. Contain between 5,000 and 25,000 acres or contain natural subdivisions of that size
4. Exhibit a wide variety of sediment damages, both on-site and off-site
5. Contain a reservoir
6. Have available detailed soils data, structure costs, and damage estimates for the watershed area
7. Be oriented primarily toward agriculture
8. Be located in Illinois

A watershed used in a previous study by Seitz *et al.* (1975)--the Big Blue Watershed located in northeastern Pike County, Illinois--met these criteria and was therefore selected for the present project.

*The following descriptions of the watershed are taken from Seitz *et al.* (1975) and USDA Soil Conservation Service (1959).

Description of the Watershed

The Big Blue Watershed covers 26,690 acres. It is approximately 13 miles long and 4½ miles wide, with Big Blue Creek flowing southeasterly through its length.

This watershed is naturally divided into three drainage sections:

1. An area associated with a relatively large, multipurpose reservoir
2. An area associated with a smaller reservoir intended only for flood control
3. An area located downstream from the two structures.

To facilitate analysis and construction of the linear programming model, only the part of the watershed associated with the larger reservoir was used in this study. Unless specifically indicated, subsequent references pertain only to that part of the watershed which is located in the western one-third of the watershed and contains the headwater area of Big Blue Creek. It is characterized by gently rolling hills interspersed with a few level ridgetops and a broad, flat valley with gently sloping valley walls. The gradients of the main stream and its tributaries are moderate.

Using the 1972 plat map of Pike County, hypothetical farm units approximating the size and location of actual major farms were developed. These units are representative of the entire watershed. Relatively small land holdings, such as rural residences, were generally omitted from the representative farm structure by combining them with larger farm units. Actual farm boundaries were generally modified to conform to existing soil-type, slope, and erosion-class boundaries. This adjustment resulted in somewhat irregularly shaped farms but offered the advantage of reducing the number of instances in which small acreages of a particular soil class had to be divided between adjacent farms. The procedure also reduced the number of activities and hence the size of the linear programming model but is not expected to alter the results of the analysis. The hypothetical farm structure was transferred to the watershed map to identify soil data (type, slope, and erosion class) for each farm.

Because time and resources were limited, it was necessary to select a sample of farms for the detailed analysis reported here. Nine farms were selected to represent the physical and topographical characteristics of the watershed.

Watershed Soil Types

A major portion of the watershed's soils are moderately thick loess. Except for an area of prairie soils in the northern part of the drainage area, a majority of the soils have developed under timber vegetation. The bottomland soils are generally cumulative types developed chiefly from silty deposits resulting from erosion of the upland areas. The soils in the watershed may be grouped into four general classes:

1. Upland timber soils: Light-colored, silt loam soils with moderately slow permeability occurring on slopes ranging from 1 to 15 percent. Typical Illinois soil types within the group are Bogota, Clary, and Fayette.
2. Upland prairie soils: Dark-colored, silt loam soils with moderate permeability occurring on nearly level to gently sloping land. These soils were developed under prairie vegetation in eight feet or more of loess. Typical Illinois soil types within the group are Muscatine and Tama.
3. Steeply sloping timber soils: A heterogeneous group of soils developed on exposures of weathered glacial till, limestone outcrops, or thin loess. They generally occur on slopes exceeding fifteen percent and are not cultivated. They are utilized as pasture or woodland. Typical soil types are Hickory and Elco.
4. Bottomland soils: Dark to moderately dark-colored silt loam soils with moderate permeability occurring on nearly level valley floors adjacent to Big Blue Creek. These soils are moderately to highly productive if adequately protected from overflow. Typical soil types within this group are Arenzville and Radford.

A breakdown of soils by type and erosion class is given in Table 14.

The Watershed Linear Programming Model

This model is structured as a profit-maximizing model subject to land contraints. The crop production activities included in the model are framed in terms of crop rotations.* These crop production activities are diagrammed in Figure 14. Note that each farm unit contains a number of land types (slope-erosion combinations). The conservation practices possible on each type of land are up-and-down tillage, contouring, and terracing. The alternative tillage methods available are conventional tillage, the plow-plant method, chisel plowing, and, in the case of rotation 5 (double-crop option), zero tillage. Nitrogen-use rates of 50, 100, or 150 pounds per acre are possible under each rotation with the exception of rotations 7 and 8, woodland and pasture, where only a 50-pound-per-acre rate is allowed.

Cost and Yield Data

Production cost data for the crop rotation components were developed from the *Illinois Farm Management Manual* (Hinton, 1976). Total production

*See the section, "Rotations, Tillage and Conservation Practices, and Crop Prices" presented later in this chapter for a description of each rotation.

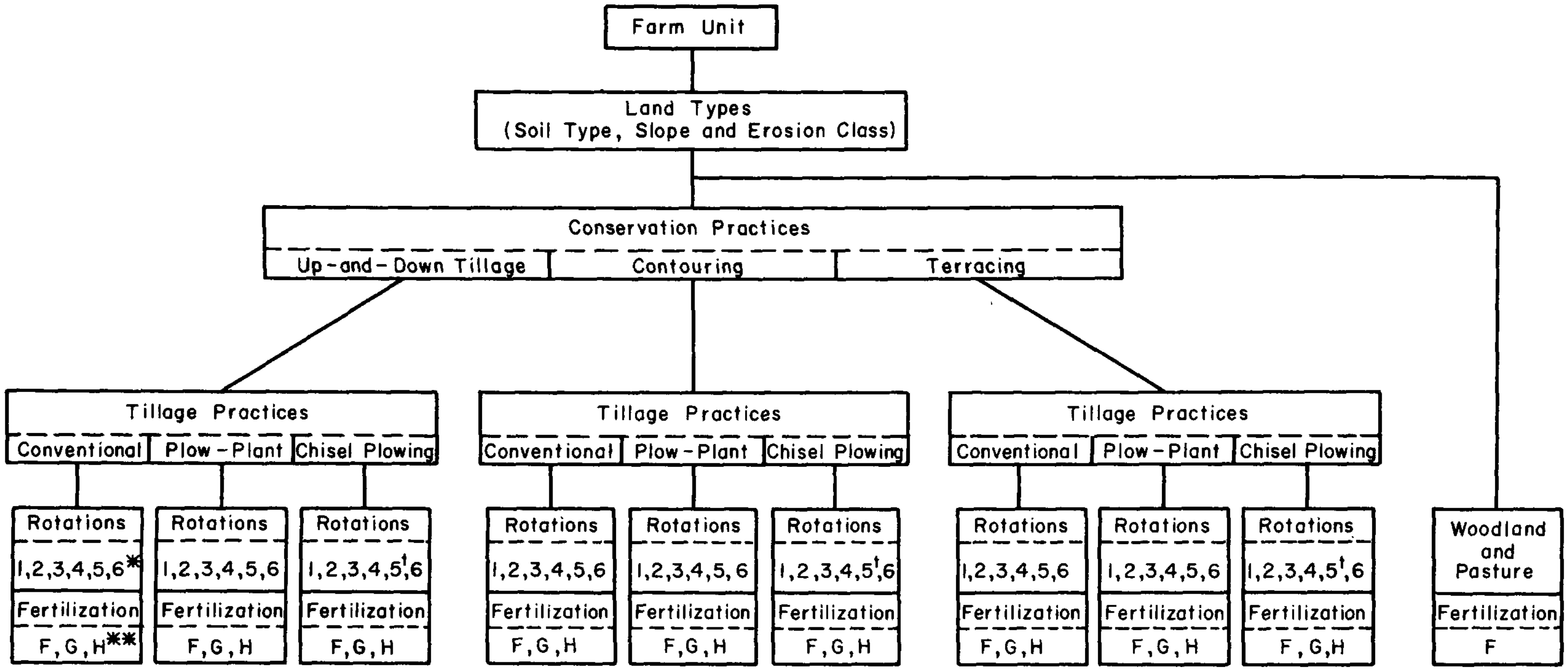
Table 14

Soil Type Acreages in Selected Farms in the Big Blue Creek Watershed by Slopes and Erosion Classes*

Soil Type	A	B1	B2	C1	C2	C3	D1	D2	D3	E2	E3	F2	F3	G2	Total	% of Total Nine-farm Area
Hickory (8)												134.4		20.0	154.4	7.2
Keomah (17)	29.4														29.4	1.4
Clinton (18)	33.8	341.2	36.2	101.2	113.8	1.9	17.5	54.2	116.2	13.1	28.8	166.8		8.1	1032.8	48.4
Tama (36)	13.8	55.0			21.9										90.7	4.3
Muscatine (41)	50.0	34.4													84.4	4.0
Atterberry (61)		6.9													6.9	.3
Sable (68)	19.4	4.4													23.8	1.1
Drury (75)		28.8		5.0	5.0			5.6							44.4	2.1
Sicily (258)	5.0	24.3		17.5											46.8	2.2
Stronghurst (278)	9.3														9.3	.4
Rozetta (279)		32.6		6.2	76.9	10.0		12.5	40.6		19.4				198.2	9.3
Fayette (280)		9.4	13.1	5.0	56.8			32.5	24.4	26.9	78.1	20.0	5.0		271.2	12.7
Wakeland (333)	39.3														39.3	1.8
Downs (386)		10.0			15.0			8.8							33.8	1.6
Orion (415)	70.1														70.1	3.3
TOTAL	270.1	547.	49.3	134.9	289.4	11.9	17.5	113.6	181.2	40.0	126.3	321.2	5.0	28.1	2135.5	100.1
% of Total Watershed area	12.7	25.6	2.3	6.3	13.6	.6	.8	5.3	8.5	1.9	5.9	15.0	.2	1.3	100	

*Letters designate slopes:
A = 0 to 2%
B = 2 to 4%
C = 4 to 7%
D = 7 to 12%
E = 12 to 18%
F = 18 to 30%
G = over 30%

Numbers designate erosion classes:
1 = 7 to 14 inches of topsoil remaining
2 = 3 to 7 inches of topsoil remaining
3 = 0 to 3 inches of topsoil remaining



* The Rotation Numbers Refer to the Patterns Described in the Section "Rotations, Tillage and Conservation Practices, and Crop Prices."

** These Letters Designate Nitrogen Application Rates:

F = 50 lbs/acre
G = 100 lbs/acre
H = 150 lbs/acre

† Rotation 5 Is Planted With Zero Tillage Rather Than Chisel Plowing.

Figure 14. Diagram of crop production activities included in the linear programming model.

cost comprises direct*, labor, and fertilizer costs.

Direct costs include preplanting soil preparation, seeding, harvesting, conditioning, machinery depreciation, repairs, fuel, seed, spray, seasonal hired labor, and other materials. Labor is valued at four dollars per hour. Fertilizer cost is based on the estimates given in the *Illinois Farm Management Manual*.† The total cost of crop production is a summation of these components.§ A general total cost calculation of the following type was estimated for corn, soybeans, wheat, oats, and meadow:

$$TC = D + F + L \qquad \text{[Eq.7]}$$

where TC = Total cost

D = Direct cost

F = Fertilizer cost

L = Operator labor cost

The individual cost components included in estimating production costs for the different crops are related to yield levels. Based on information from Hinton (1976), the cost functions (1976 costs) are developed as follows (cost values are in dollars per acre, yield values in bushels per acre).

Corn

For corn production, the direct costs, D_c, in dollars per acre are a discontinuous function of the yield, Y_c, expressed in bushels per acre:

$$\begin{aligned} D_c &= 54.4 \text{ for } Y_c \leq 80 \qquad \text{[Eq.8]} \\ D_c &= 54.4 + 5.6/20(Y_c\text{-}80) \text{ for } 80 \leq Y_c \leq 100 \\ D_c &= 54.4 + 6.00/20(Y_c\ \text{-}100) \text{ for } 100 \leq Y_c \leq 120 \\ D_c &= 54.4 + \ .13(Y_c\text{-}120) \text{ for } 120 \leq Y_c \leq 150 \end{aligned}$$

The fertilizer cost, F_c, is a linear function of yield:

$$F_c = \$.11{*}Y_c \qquad \text{[Eq.9]}$$

*Direct crop costs are based on a 260-339 acre farm.

†Prices, including spreading cost, were based on these values:
15 cents per pound of N
20 cents per pound of P_2O_5
8 cents per pound of K_2O
A charge of $2.00 per acre was added for limestone maintenance.

§The fertilizer cost component of total cost does not include the cost of nitrogen. Nitrogen cost for each farm and for the watershed is treated in the model as an activity. This approach was taken to facilitate revision of the model when considering policy alternatives such as a nitrogen-use limit for the watershed or on a per-farm, per-acre, or per-tillable-crop-acre basis.

and the labor cost, L_c, is again a discontinuous function of yield:

$$L_c = 4.4*\$4.00 \text{ for } Y_c \leq 80 \quad [Eq.10]$$
$$L_c = 4.5*\$4.00 \text{ for } 80 \leq Y_c \leq 100$$
$$L_c = 4.6*\$4.00 \text{ for } 100 \leq Y_c \leq 120$$
$$L_c = 4.7*\$4.00 \text{ for } 120 \leq Y_c \leq 150$$

Soybeans

For soybeans, direct costs, D_{sb}, and labor cost, L_{sb}, are again a discontinuous function of yield, Y_{sb}; and fertilizer cost, F_{sb}, is again a linear function:

$$D_{sb} = \$42.50 \text{ for } Y_{sb} \leq 33 \quad [Eq.11]$$
$$= \$42.50 + 4.00/17(Y_{sb}-33) \text{ for } 33 \leq Y_{sb} \leq 50$$
$$F_{sb} = \$.27(Y_{sb}) \quad [Eq.12]$$
$$L_{sb} = 4.5*\$4.00 \text{ for } Y_{sb} \leq 33 \quad [Eq.13]$$
$$= 4.6*\$4.00 \text{ for } Y_{sb} \leq 33$$

Wheat

The relationships are similar for wheat:

$$D_w = 26.70 \text{ for } Y_w \leq 40 \quad [Eq.14]$$
$$= \$26.70 + \$2.00/15(Y_w-40) \text{ for } 40 \leq Y_w \leq 55$$
$$F_w = \$.23*Y_w \quad [Eq.15]$$
$$L_w = 2.0*\$4.00 \text{ for } Y_w \leq 40 \quad [Eq.16]$$
$$= 2.1*\$4.00 \text{ for } Y_w \leq 40$$

Oats

The direct and labor cost functions for oats are fixed, but fertilizer cost varies with yield:

$$D_o = \$25.00 \text{ at all levels of yield, } Y_o \quad [Eq.17]$$
$$F_o = \$.12* Y_o \quad [Eq.18]$$
$$L_o = 2.00*\$4.00 \text{ at all levels of } Y_o \quad [Eq.19]$$

Meadow

For meadow, the cost and yield values for alfalfa are assumed. The cost functions for alfalfa are:

$$D_m = \$20.00 \quad [Eq.20]$$
$$F_m = \$3.85*Y_m \quad [Eq.21]$$
$$L_m = 5.60*Y_m \quad [Eq.22]$$

In rotations where oats are used as a nurse crop for meadow, a direct cost for seed of $5.60 is added to the cost function.* The resulting yield of the combination, oats plus alfalfa, is valued in terms of the oats; the value of the catch crop is disregarded.

Pasture and Woodland

The cost functions for pasture and woodland activities are viewed as long-term investments rather than as annual costs. These costs are, however, annualized to make them compatible.

The costs of the pasture activity can be expected to vary with the initial physical condition of the area to be planted or reseeded. Actual costs depend on the amount of brush or tree removal, gully repair, or fertilization required. The cost function developed for this activity is based on average estimates.

Pasture costs are separated into two types: (1) those related to initial establishment, such as seedbed preparation, seeding, seed costs, and herbicides, all of which are treated as an investment; and (2) the recurring fertilizer and management costs. The coefficients used here for pasture, however, include only the annual fertilizer and management costs ($20.00 per acre per year).

The woodland activity can be viewed as a composite of two activities, tree planting and timber-stand improvement. The coefficients are formed in terms of timber-stand improvement. The cost estimates related to the woodland activity are applicable on an average situation based upon published data combined with the opinions of forestry specialists (USDA Soil Conservation Service, 1959; Seitz *et al.*, 1975). The woodland activity costs include fire control, livestock grazing control, improved forestry and sustained yield practices, and replacement planting. The initial investment costs annualized over an average rotation of 60 years plus the annual maintenance costs are estimated at $3.73 per acre per year. Land-conversion costs, such as clearing existing woodlots for pasture or crop production, are not included.

The specified costs and yield functions were modified for alternative tillage systems and conservation practices as set forth in Table 15. Generally, the cost adjustments occur in the direct costs for row and grain crops.†

*The seed costs shown here are not those given in the *Illinois Farm Management Manual* but reflect the seed costs required in the above combinations according to the opinion of University of Illinois Agronomy Department personnel.

†Computationally, these adjustments are made without modifying the cost functions.

Table 15

Row and Grain Crop Cost and Yield Adjustments Relative to A System of Up-and-down Cultivation and Conventional Tillage Under Specified Alternative Conservation and Tillage Practices[a]

	CROPS PRODUCED IN TRADITIONAL ROTATIONS		SOYBEANS IN DOUBLE-CROP ROTATION	
	COST CHANGE ($/acre)	YIELD CHANGE (%)	COST CHANGE ($/acre)	YIELD CHANGE (%)
Conventional Tillage	b	b	b	-40
Plow-plant Tillage	+1.05	None	+1.05	-35
Chisel-plow Tillage	-1.00	c,d	b	b
Zero Tillage	b	b	-1.50	-30
Contouring	+0.75	None	+0.75	None
Terracing	+4.50	None	+4.50	None
Conventional Tillage and:				
Contouting	+0.75	None	+0.75	-40
Terracing	+4.50	None	+4.50	-40
Plow-plant Tillage and:				
Contouring	+1.80	None	+1.80	-35
Terracing	+5.55	None	+5.55	-35
Chisel-plow Tillage and:				
Contouring	- .25	c,d	b	b
Terracing	+3.50	c,d	b	b
Zero Tillage and:				
Contouring	b	b	-0.75	-30
Terracing	b	b	+3.00	-30

[a]For a detailed account of adjustments see: Seitz, W. D. *et al.* 1975. *Evaluation of agricultural policy alternatives to control sedimentation,* Research Report No. 99, Water Resources Center, University of Illinois at Urbana-Champaign.

[b]Not applicable.

[c]Yield on well-drained soils reduced by 5 percent.

[d]Yield on poorly drained soils reduced by 15 percent.

Table 16

Yield Responses to Nitrogen Fertilization by Soil Groups
(yields in bushels/acre)

CROP HARVESTED	ROTATIONS	NITROGEN (lbs/acre)	SOIL GROUPS I	II	III	IV
	Continuous Corn	50	95	85	75	60
		100	120	110	100	85
		150	140	130	118	100
	Corn-Soybeans	50	110	100	90	85
		100	132	122	112	100
		150	145	130	118	100
CORN	Corn*-Corn-Soybeans-Oats (Catch Crop)	50	111	101	91	76
		100	133	123	112	95.5
		150	144	130	118	100
	Corn*-Soybeans-Corn-Wheat-Meadow	50	120	115	103.5	92
		100	138.5	125	115	100
		150	145	130	118	100
	Corn-Wheat-Meadow-Meadow	50	140	130	118	99
		100	145	130	118	100
		150	145	130	118	100

*The yield given in these rotations are the averages of corn yield in the rotation.

Group I: Tama, Ipara, Sable, and Muscatine Soils

Group II: Atterbury Soil

Group III: Keomah, Clarksdale, Sicily, Stronghurst, Rozetta, Haymond, Wakeland, Downs, and Orion Soils

Group IV: Clinton, Sylvan, Drury, and Fayette Soils

Table 16 (continued)

CROP HARVESTED	ROTATIONS	NITROGEN (lbs/acre)	- - - - - SOIL GROUPS - - - - - I	II	III	IV
	Corn-Soybeans-Corn-Wheat-Meadow	25	41	36	29	
		50	52	48	40	
		75	52	49	43	
		25	45	39	32	
WHEAT[†]	Wheat-Soybeans	50	55	50	43	
		75	58	54	49	
	Corn-Wheat*-Meadow-Meadow	25	47	43	37	
		50	52	49	43	
		75	52	59	43	
OATS[††]	Corn-Corn-Soybeans-Oats (Catch Crop)	25	59	53	47	
		50	75	69	60	
		75	80	72	61	

†Legume seeded in wheat except where followed by soybeans.

*Assumed 20 lbs of nitrogen from alfalfa.

††Assumed stiff-strawed varieties.

Yield value changes occurring as a result of soil types and soil drainage characteristics were handled in the computation process by changing crop prices. Yield adjustments needed as a result of alternative tillage systems were made by changing the crop yield data shown in Table 16.*

Yield estimates for crops produced on different soil conditions were obtained from published research results (Odell and Oschwald, 1968) and from Prof. F. Welch, University of Illinois Department of Agronomy. The estimates are presented mainly by a grouping of soils with respect to native productivity and response to nitrogen fertilization. These estimates assume a high level of management. The soybean yields by soil type are given in Table 17.

TABLE 17

Soybean Yields by Soil Type†

SOIL	YIELD (bu/acre)
Hickory	--
Keomah	35
Clinton	34
Sylvan	24
Tama	42
Muscatine	46
Ipava	47
Atterberry	40
Sable	46
Drury	33
Clarksdale	39
Sicily	37
Stronghurst	38
Rozetta	36
Fayette	33
Haymond	39
Wakeland	38
Downs	37
Orion	37

†from Odell and Oschwald (1968) on an individual soil basis.

The high management level is based on high input levels thought to be near those required for maximum profit. This level is based on present technology and is used by about 10 percent of the farmers.

High-level management, as defined by Odell and Oschwald (1968) implies that a number of conditions have been met: (1) those drainage improvements

*These modifications are also accounted for in the computation process.

which are consistent with soil properties and which will maximize profits have been made; (2) limestone applications have been sufficient to maintain a soil pH of 6.0 or above for cash grain-cropping systems and a pH of 6.5 for cropping systems with alfalfa or clover; (3) available phosphorus test levels have been maintained at 40 to 50 and available potassium test levels at 240 or higher; (4) crop residues have been returned; (5) corn-plant populations are 20,000 to 24,000 stalks per acre (lower for drouthy soils); (6) erosion control practices have held soil losses below amounts considered to cause serious soil damage; (7) weed and insect control have been adequate and timely; (8) tillage operations have been fitted to the soil and requirements of the crops; (9) excessive tillage has been avoided; (10) high-yielding, good-standing crop varieties are used; (11) timely harvesting and other crop-production operations are carried out as conditions permit; (12) flexibility is maintained in the crop-production system so that adjustments can be made for changes in climatic conditions and the economic situation (Odell and Oschwald, 1968). Nitrogen is applied at rates of 50, 100, and 150 pounds per acre. As shown in Table 18, the nitrogen application rates were adjusted according to the make-up of each crop rotation. For example, in Rotation 2 (corn-soybeans) only 25 pounds of nitrogen need be supplied per acre to achieve a nitrogen level of 50 pounds per acre because of the nitrogen supplied by the soybean crop. Table 19 gives the nitrogen supplied by alfalfa, which was used in appropriate rotations.

Table 18

Adjustment in Nitrogen Application Rates
for Different Crop Rotations
(Pounds per Acre)

Rotation	50 lbs/A	100 lbs/A	150 lbs/A
1. C	50.00	100.00	150.00
2. C-Sb	25.00	50.00	75.00
3. C-C-Sb-Ox	31.25	62.5	93.75
4. C-C-Sb-W-M	25.00	50.00	75.00
5. W-Sb (dbl crp)	12.50	25.00	37.50
6. C-W-M-M	18.75	37.50	56.25

Rotations, Tillage and Conservation Practices, and Crop Prices

A set of crop rotations was developed for use in the model. The rotation patterns included in the set represent a range of land-use intensities so as to reflect the differing capabilities of various land types to support crop production activities with varying levels of soil losses. These crop rotations are:

Table 19

Nitrogen Supplied by Alfalfa*

SOIL	ALFALFA PRODUCED (tons/acre)	N FROM ALFALFA (lbs/acre)
Hickory	2.2	44
Keomah	4.6	92
Clinton	4.4	88
Sylvan	3.7	74
Bold	2.9	58
Tama	5.4	108
Muscatine	5.6	112
Ipava	5.5	110
Atterberry	5.1	102
Sable	5.1	102
Drury	4.2	84
Clarksdale	4.8	96
Sicily	4.6	92
Stronghurst	4.8	96
Rozetta	4.6	92
Fayette	4.4	88
Haymond	4.7	94
Wakeland	4.6	92
Downs	4.8	96
Orion	4.2	84

*Source: Prof. Fred Welch, Agronomy Department, University of Illinois at Urbana-Champaign

1. C
2. C-Sb
3. C-C-Sb-Ox
4. C-C-Sb-W-M
5. W-Sb (double crop)
6. C-W-M-M
7. Pasture
8. Woodland

where C = corn

Sb = soybeans

Ox = oats with an alfalfa catch crop

W = wheat

M = meadow or alfalfa

In the model these rotations may be produced on all but two land types: (1) on land with slopes less than four percent permanent pasture and woodland activities are not permitted; (2) on land types with slope gradients exceeding 18 percent, permanent pasture and woodland activities are the only alternatives. The reason for these modifications is that slope group E would not generally be used for continuous cropping activities.

Three tillage practices are considered: conventional, plow-plant, and chisel plowing. These tillage practices may be used for the six crop rotations noted above, the exception being that zero tillage replaces chisel plowing under the soybean-wheat double-crop rotation (Rotation 5). The permanent pasture alternative is assumed to use only conventional tillage. The woodland alternative does not use any of the tillage practices.

The conservation practices considered are up-and-down tillage, contouring, and terracing, but not all of these practices are available on each land type. The choice of conservation practices was based upon SCS recommendations concerning slope gradients.

The prices used in this analysis were: corn, $2.46 per bushel; soybeans, $5.26 per bushel; wheat, $4.97 per bushel; oats, $2.32 per bushel; alfalfa/pasture, $24.00 per ton; and woodland, $25.00 per 1,000 board feet (Seitz *et al.*, 1975). The above prices, with the exception of that for woodland, are 1976 minimum cost prices determined in the corn-belt model developed by Robert Taylor and others and described in the first section of this chapter (Taylor and Frohberg, 1977).

The net return coefficients for each crop activity are averages of ten-year periods with a five percent discount rate. The geometric mean, with the following form, was used to compute the discount rates.

In logarithmic form:

$$\text{Antilog of } \left(1/N \sum_{i=1}^{N} \log x_i\right) = \frac{\log_{x_1} + ..\log_{x_{N-1}} + \log_{xN}}{N} \qquad \text{[Eq.23]}$$

The geometric mean was used for several reasons: it is rigidly defined by a mathematical formula, it depends on the value of every item in the distribution, no single item can be changed in the least without affecting the value of the geometric mean, and its value is not as greatly influenced by extreme items as are the values of the quadratic, arithmetic, and harmonic means (Waugh, 1952; Spurr *et al.*, 1973).

Gross Soil-loss Coefficients

The soil-loss coefficients were obtained through the use of the Universal Soil Loss Equation (Wischmeier and Smith, 1965). The C and P factor values used in this study are given in Tables 20 and 21.

Results

The watershed model was used to calculate the impacts of selected restrictions on a number of representative farms in a watershed and to determine the long-term role of soil-loss limits in maintaining soil productivity. The complete results of the model runs for the farm comparisons, given in Appendix D, are summarized here, followed by an analysis of the long-term impacts of soil conservation practices.

Benchmark Solution

In the benchmark solution, the 2,135.5 acres of land which comprise the nine farms in the watershed are distributed among the crops as follows: wheat, 21.97%; corn, 32.22%; soybeans, 25.59%; pasture, 16.59%; and oats, 3.62%. The actual 1975 crop acreages for the county in which the watershed is located were: wheat, 8.8%; corn, 48.4%; soybeans, 32%; pasture, 7.9%*; and oats, 3%.

The percentage of land devoted to oats in the model solution is approximately equal to the actual value for the county. The percentage of land in pasture is appropriate since the model was forced to include either pasture or woodland on certain soil-type slope-erosion combinations and since it allocated all of this land to pasture. The actual pasture-plus-woodland acreage in the county is at about the level indicated in pasture by the model. The high figures for wheat acreage and the low values for corn and soybean acreage result from using the crop prices generated by the corn-belt model. The price of wheat specified by that model is higher than that observed in the market, thus affecting the crop distribution in the results of the watershed model.

*This percentage is an average over the previous six years. The 1975 Pike county average was not available at the time these percentages were calculated.

Table 20

Crop Management Factor, C, under Alternative Cropping Systems in this Study*

Crop Rotations	Tillage Practices			
	Conven-tional	Plow-Plant	Chisel Plowing	Zero Tillage
(1) Continuous Corn	.400	.240	.070	
(2) C-Sb	.560	.290	.084	
(3) C-C-Sb-Ox	.350	.210	.060	
(4) C-C-Sb-W-M	.220	.120	.006	
(5) W-Sb (double-crop)	.360	.336		.162
(6) C-W-M-M	.052	.024	.020	
(7) Pasture	.014			
(8) Woodland	.014			

*Minor adjustments were made to reflect the quantity of crop residue in those cases where heavy residues were expected as a result of heavy fertilizer use.

Table 21

Erosion Control Factor, P, under Various Conservation Practices

Erosion Class	Slope (%)	P Values			Slope Length Limits for Contouring (ft.)
		Up & Down Tillage	Contouring	Terracing	
A	0-2	1.0	0.6	0.12	400
B	2-4	1.0	0.5	0.10	400
C	4-7	1.0	0.5	0.10	300
D	7-12	1.0	0.6	0.12	150
E	12-18	1.0	0.8	0.16	70
F	18-30	1.0	0.9	0.18	60
G	30+	1.0	1.0	0.20	50

Conventional and zero tillage were the primary tillage practices actually used in the county. The model selected up-and-down tillage, contouring, and terracing conservation practices, with up-and-down tillage being predominant. In an earlier study of this watershed by Seitz *et al.* (1975), contouring and terracing were not observed in the optimal unconstrained solution. That study, however, was a single-period analysis and did not reflect the effect of soil loss on net returns in later years. The objective function of the model used here was formulated with a weighted average of net returns over a ten-year planning period, thus taking into consideration the effect of soil loss on net income. As a result, the model results specify contouring and terracing on some of the shallower soils. This result is consistent with the fact that on farms with deeper, more productive soils (Farm No. 2, for example) up-and-down tillage alone was used.

While there are some differences between observed conditions in the watershed and the benchmark solution of the model, these differences should not preclude analyzing the results of the model to determine the impacts of selected restrictions on the various farms and the long-term impacts. In reviewing the benchmark solution, it is important to note that this watershed was selected to represent the corn belt, broadly defined to include the surrounding areas. Since these surrounding areas are more sloping, the soil-loss rates are higher than the average rates indicated by the corn-belt model, and the income impacts in this watershed should be greater than in the corn belt as defined for the aggregate analysis.

Farm-level Analysis

In addition to the benchmark unconstrained solution, the model was run with soil-loss limits at the farm and watershed levels* and with farm-based soil-loss limits combined with nitrogen application limits of 50 and 100 pounds per acre per year.

The data on net income, soil loss per acre, and nitrogen per acre are summarized in Figures 15, 16, and 17 for the watershed and by the farm. In each case the average impact at the farm level is contracted with the average for the watershed. In Figure 15 the net income by farm and the total watershed income under each of the four constraints are given as a percent of the benchmark solution income. The most important result is the substantial variation in impact on the income of the different farms. Farm 2 realizes a very small income reduction while Farm 4 experiences an income reduction of almost 20 percent under the watershed soil-loss limit. Under the most restrictive case--a farm soil-loss limit combined with a nitrogen limit of 50 pounds per acre--

*The soil-loss limits were computed for the farms and for the watershed from the Soil Conservation Service tolerance ("T") limits which are based on soil type. The total soil loss that would result if erosion occurred at the tolerance limit for each soil type was set as the maximum allowable total loss at the farm or watershed levels. Thus, while the total loss equals the SCS tolerance limit, the loss *by soil type* within the farm or watershed will not necessarily equal the SCS tolerance limits. Some soils may exceed the limits while others may realize lower levels of loss.

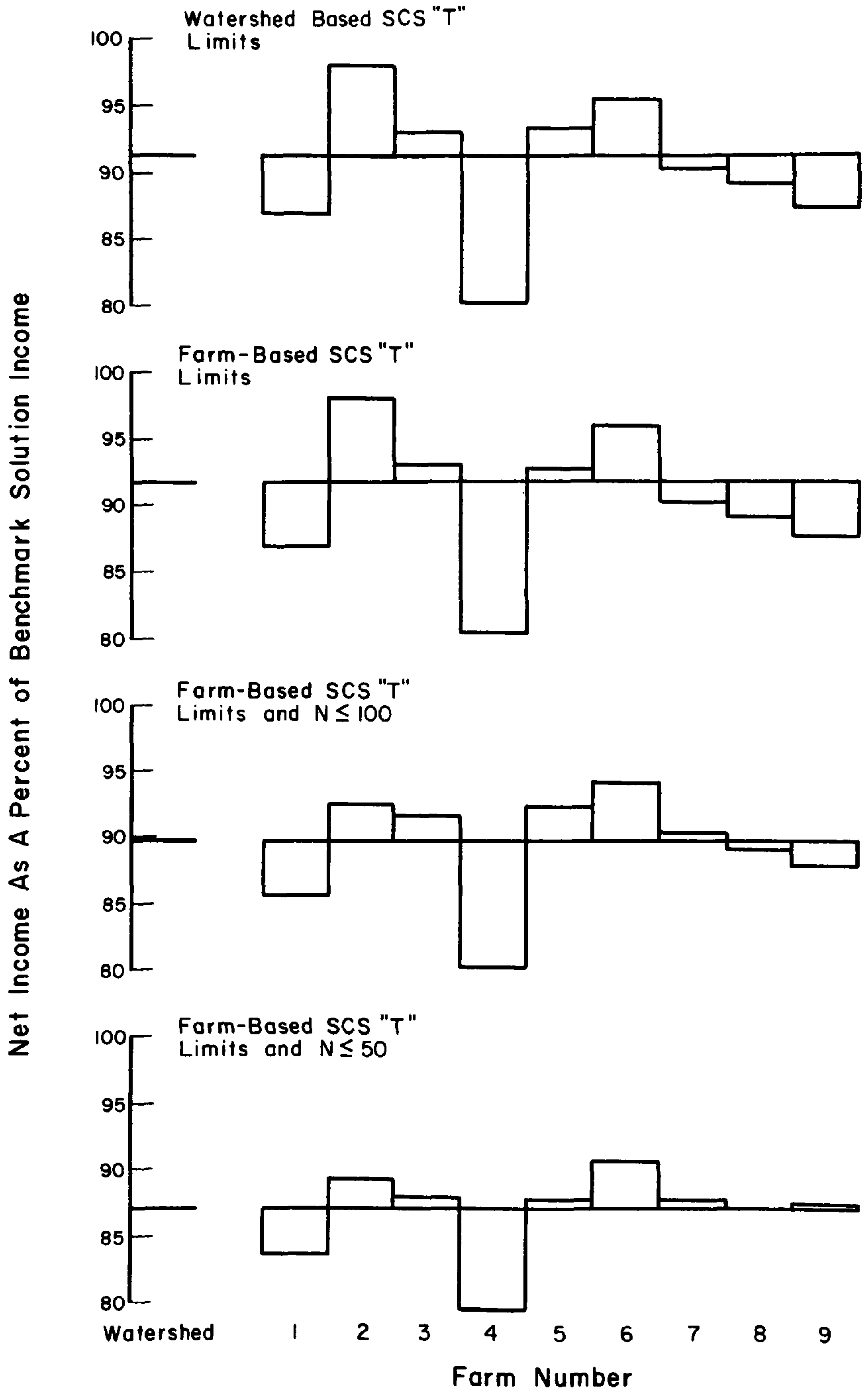


Figure 15. Net income as a percent of benchmark-solution income by farm.

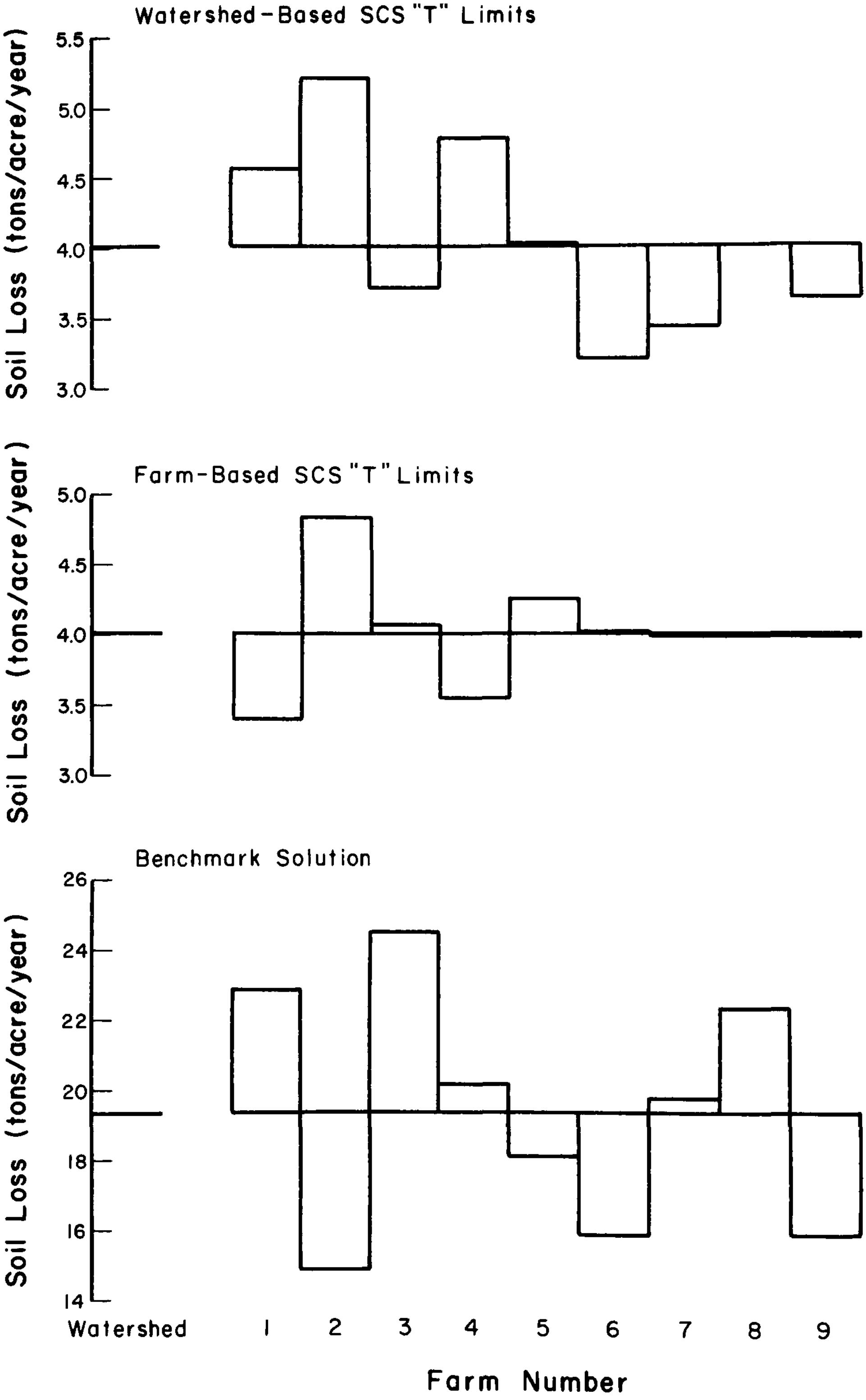


Figure 16. Average soil loss per acre per year by farm.

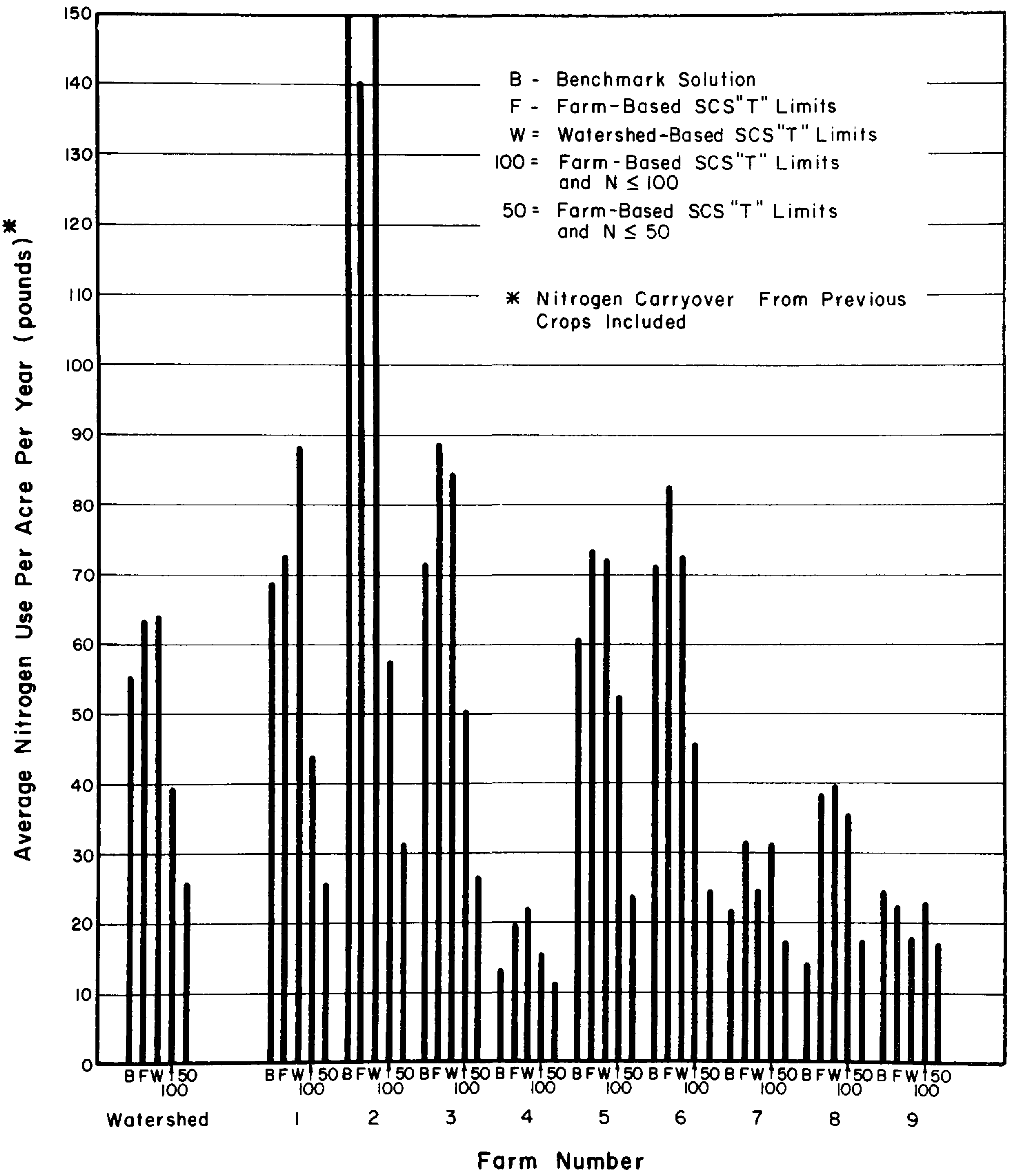


Figure 17. Average nitrogen utilization per acre per year by farm.

all farms are adversely impacted, but the difference among farms still exists.

The results of the corn-belt model discussed earlier indicated clearly that such soil-loss and nitrogen-use restrictions may generate price increases that would result in higher overall incomes for the farm sector. Such price increases, however, would not eliminate differences in income among farms; in fact, they may increase them. Highly productive farms such as Nos. 2 and 6 would likely realize substantial increases in income while farms such as Nos. 1 and 4 would benefit to a lesser degree from higher prices because their total output would be reduced. Thus, it is possible that the relative impact on individual farms may be more disparate than shown here. It is also possible to generalize these results: under reasonably uniform restrictions, farms in highly productive areas would benefit relative to farms in poorer areas.

The soil losses from individual farms and from the watershed also vary with the type of restriction imposed, as shown in Figure 16.* Under either the farm or the watershed limits, the average soil loss in this watershed falls from slightly over 19 tons per acre to approximately 4 tons per acre per year. It is interesting that Farm 2, with the lowest rate of erosion under the unconstrained solution (of about 14 tons per acre) shows the highest rate of erosion under the constrained solution (at less than 5.5 tons). This result is consistent with the objective of maximizing income, since the farm with the least erosive soil would tend to be "used" the most heavily in a constrained solution; that is, it is constrained the least. As expected, the variation in soil-loss rates is higher under watershed-based limits than under farm-based limits because in the former case the model operates under a more flexible set of constraints and increases income relative to that attainable under uniform farm-level constraints.

Figure 17 illustrates the average rate of nitrogen use per acre per year.† The small increase in nitrogen-use rates under the models run with soil-loss constraints is due to a shift from the wheat/soybean double-crop system to corn as a means of reducing soil erosion.§ Careful study of Figure 17 indicates that the five runs produced a wide range of conbinations of results. Only for Farm 9 is the nitrogen use higher in the basic solution than in any of the constrained runs. When nitrogen use is limited to 100

*The results obtained with a combination of soil-loss limits and nitrogen restrictions are not shown because, as reflected in Appendix D, the soil losses are the same as those obtained when the farm-based SCS tolerance limits alone are applied.

†The nitrogen constraint models were constructed by eliminating all rotations containing nitrogen application rates in excess of the limit rather than by setting a restraint on the total amount of nitrogen used, as in the case of sediments, in order to reduce the computational burden.

§As noted earlier, the wheat price in the model has resulted in a somewhat higher level of wheat production than observed. Thus, this shift may not be observed in practice, or at least not to the degree shown here.

pounds per acre and soil loss is constrained, the rate of nitrogen use on several farms is actually greater than when neither is restricted. The reason is that the farms shift from soybean to corn production as a part of the response to the soil-loss restrictions imposed. On Farm 2, the combination of a soil-loss restriction and a nitrogen limit results in higher levels of nitrogen use than with a soil-loss limit alone. Again, the significant price impacts shown by the corn-belt model cannot be produced in a watershed model of this type. The watershed model results can, however, be read as an indication that combinations of constraints on soil loss and nitrogen use, when applied to farms with soils of different production capabilities and using different crop rotations, can produce a wide variation in responses. Thus, it is not clear that the impacts will be as straightforward as is commonly expected.

A limitation on nitrogen application rates does, of course, reduce the variation in application rates among farms. If nitrogen presents a water-quality problem when applied at high rates, this result implies that a limit may be effective.

Long-term Analysis

This section presents the results of an analysis undertaken to determine the potential impacts on productivity of continuing to produce crops at high levels of erosion. The initial soil depths were estimated and the model was solved for the first ten-year period. Given the rates of soil loss experienced and based on the bulk density of the soil, the number of inches of topsoil remaining was adjusted to account for the soil lost in the ten-year period; that is, from year 11 to year 20. Again, the erosion rates and bulk densities were used to adjust the number of inches of topsoil remaining prior to the solution of the next ten-year model. This procedure was repeated ten times to cover a 100-year period. For the discounted solutions, the returns were discounted from the first year of the 100-year period at a rate of five percent, to a rate arbitrarily selected. While the analysis could be replicated with higher (or lower) discount rates, the nature of results can be extrapolated from those presented here.

Figure 18 indicates the percentage of acreage on which the topsoil erodes to zero inches over the 100-year period. Table 22 lists by farm, soil type, and erosion class the number of acres of those soils which completely erode within the 100-year period. It also indicates the number of years required for complete erosion to occur. Under the unconstrained solution, 1,217.3 acres completely erode in the 100-year period, as compared to 198.1 acres when farm-based SCS tolerance limits are imposed.

Figure 19 shows the net revenue for an average year during each of the ten-year periods. Two sets of results are presented. In one case it is assumed that pasture can be produced on soil after all topsoil is removed. In the other case it is assumed that no production can occur after the topsoil is gone. The income in the initial years is clearly higher under the unconstrained solutions. When SCS tolerance limits are followed, income is higher in the later years of the 100-year period. When these income streams are discounted, as shown in the lower curves, the differences are almost eliminated. Figure 20 indicates more clearly the impact of discounting. In that

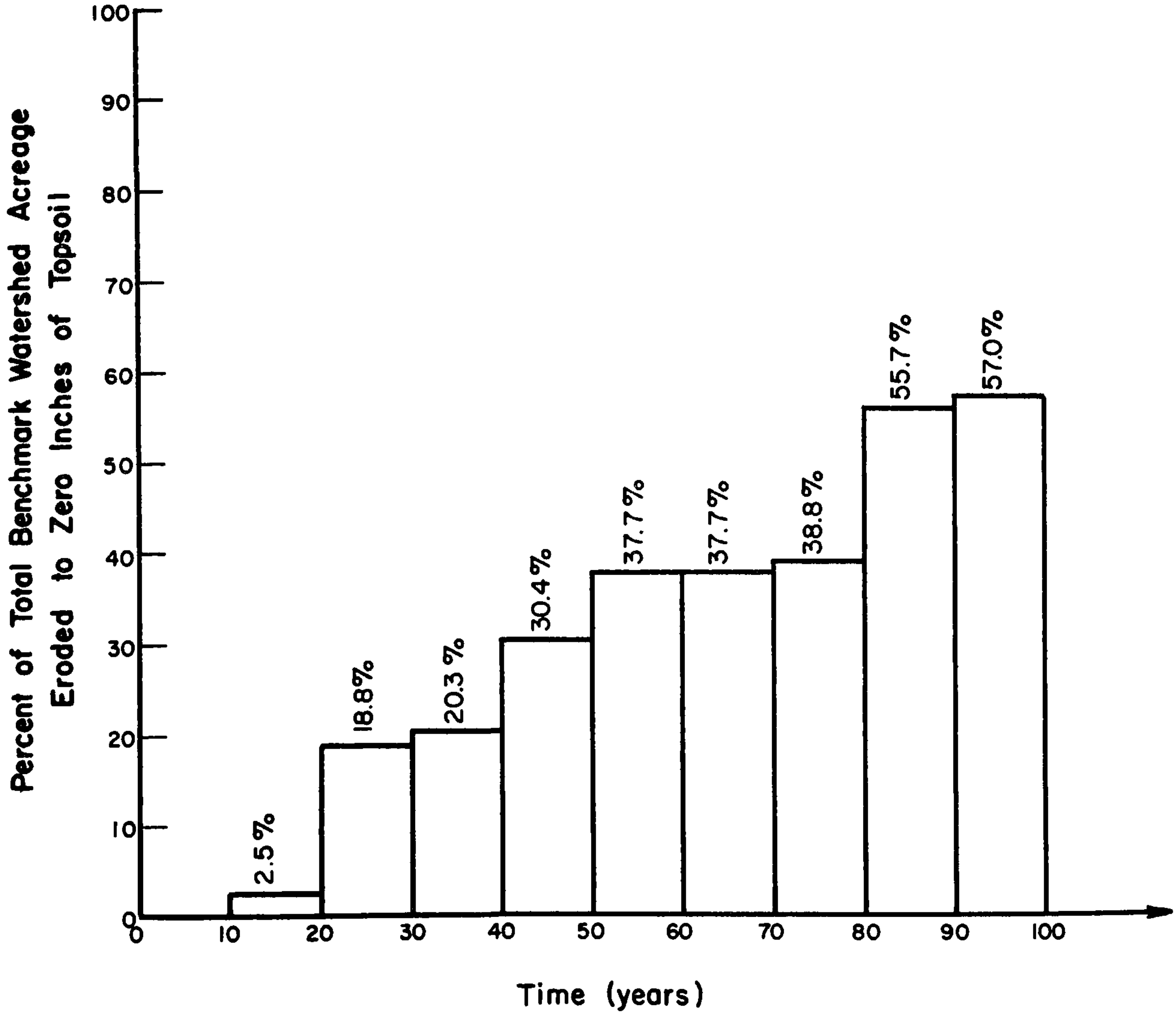


Figure 18. Percentage of total benchmark watershed acreage eroded to zero inches of topsoil remaining, unconstrained solution.

Table 22

Acreages of Soils by Type and Slope/Erosion Class which Completely Erode within the 100-Year Period by Farm

Soil Type - Slope/Erosion Class	Farm Number									Total Acres	Years to Completely Erode
	1	2	3	4	5	6	7	8	9		
280-B2			5.6		7.5					13.1	52.1
280-C2			21.2		35.6					56.8	29.8
280-D2			8.8		7.5			16.2		32.5	20.3
280-D3			9.4					15.0		24.4	50.0
280-E2			8.8					18.1		26.9	14.4
280-C1					5.0					5.0	43.1
280-F3								5.0		5.0	50.0
18-C1				23.1		55.8			22.5	101.4	50.6
18-D3				5.6		9.4	35.6	23.7	41.9	116.2	50.0
18-C3								1.9		1.9	83.3
18-B1	16.2		10.6	114.4		66.2	41.9	28.1	63.1	341.2	81.7
18-B2	30.0							6.2		36.2	52.1
18-C2	31.9			5.0		26.9		16.2	33.8	113.8	29.8
18-D2	26.2		1.2			20.6	6.2			54.2	20.3
18-D1			17.5							17.5	32.0
18-E2			5.6						7.5	13.1	14.4
75-B1					28.8					28.8	94.7
75-C1								5.0		5.0	55.6
75-C2					5.0					5.0	34.0
75-D2	5.6									5.6	23.2
279-C1								6.2		6.2	40.7
279-C2	17.5		1.9		12.5			45.0		76.9	26.9
279-C3								10.0		10.0	83.3
279-D2					12.5					12.5	18.2
279-D3					10.6			30.0		40.6	41.7
258-B1			13.1	11.2						24.3	77.9
258-C1			17.5							17.5	45.2
386-C2		8.8			6.2					15.0	32.1
386-D2		8.8								8.8	20.8
Total Acres	127.4	17.6	121.2	159.3	131.2	178.9	83.7	226.6	168.8	1217.3	

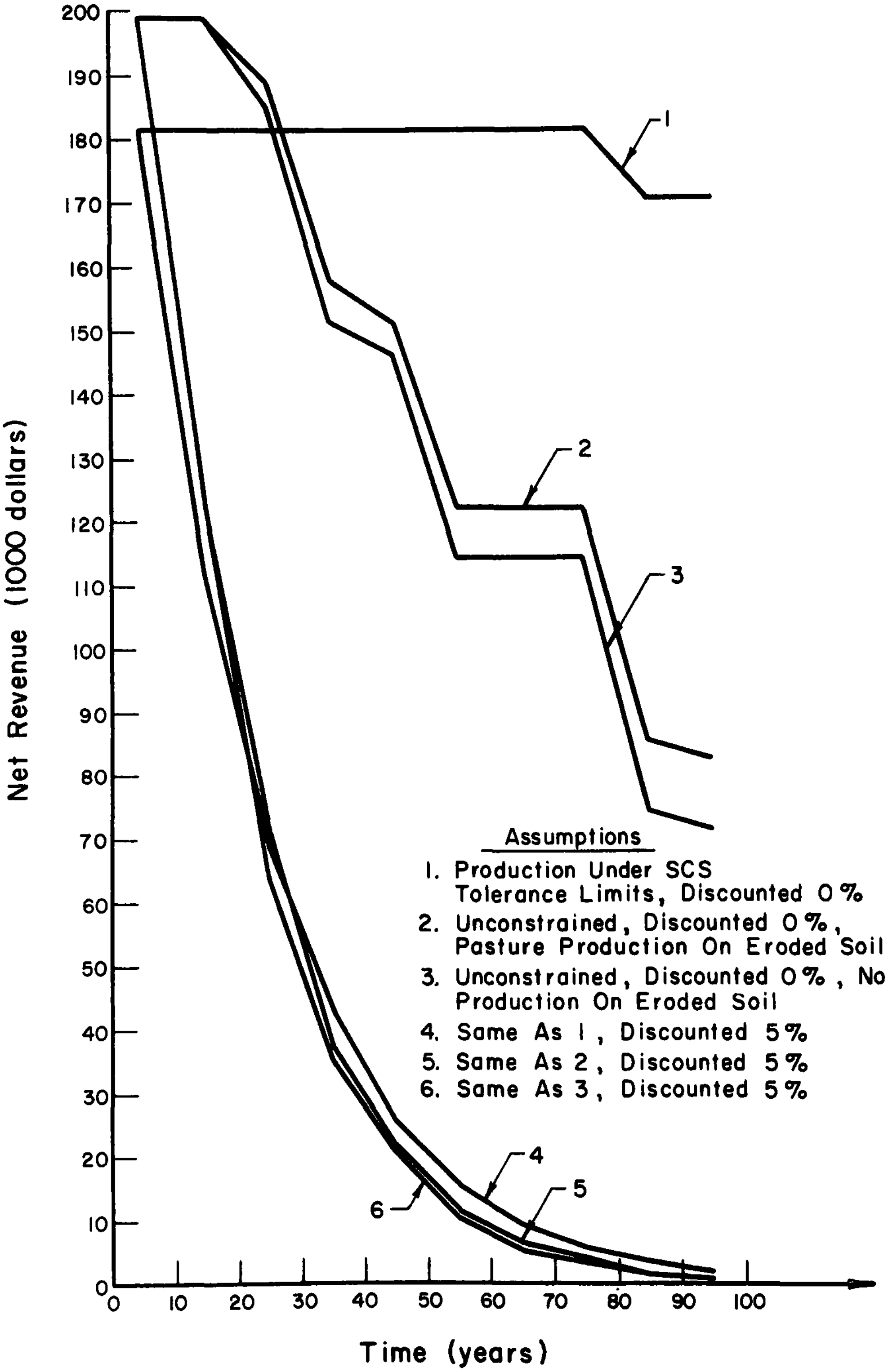


Figure 19. Net watershed income for an average year by ten-year periods for 100 years.

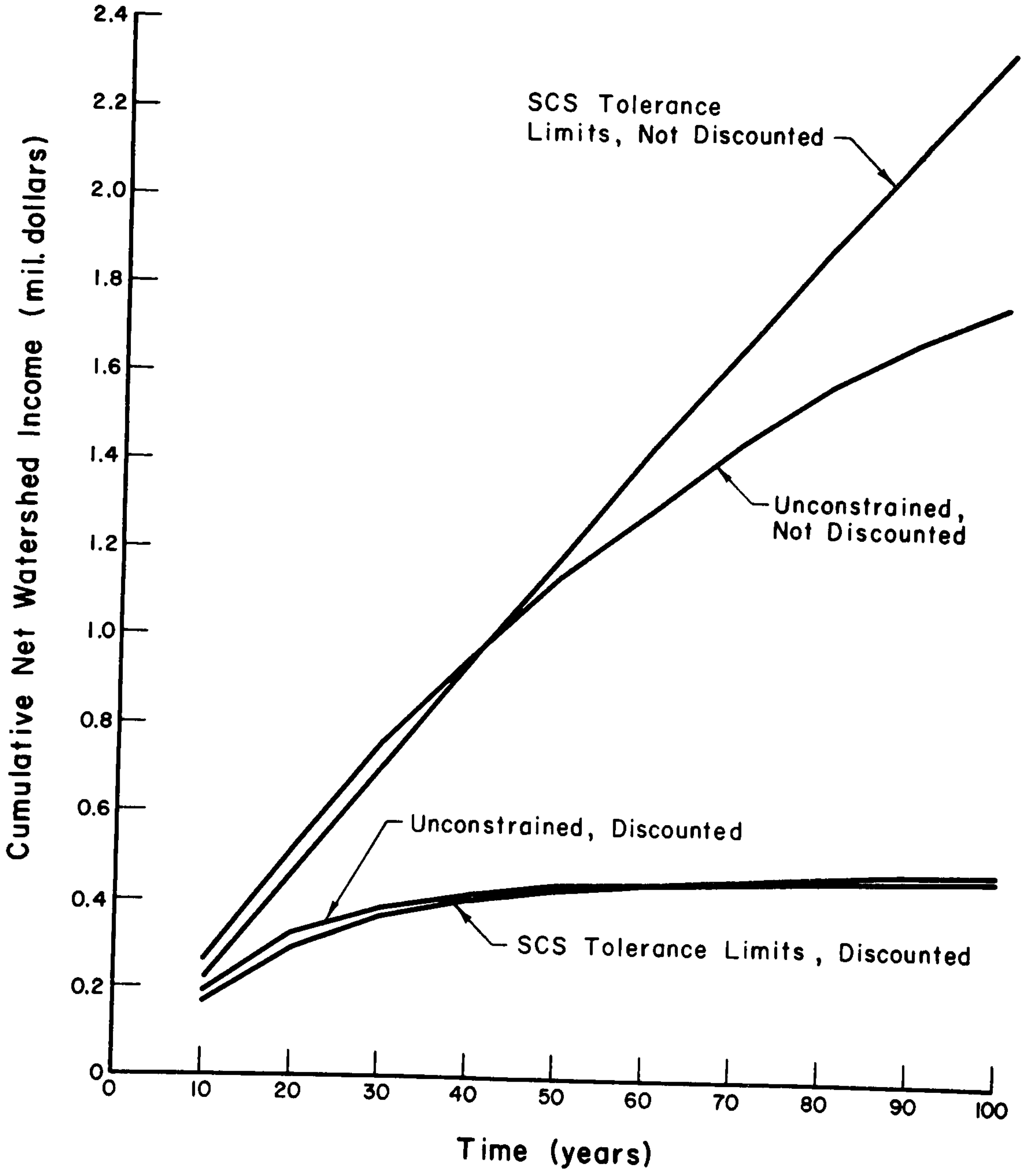


Figure 20. Cumulative net watershed income over ten-year periods for 100 years.

figure, the cumulative net income, discounted and undiscounted, is shown for the solution under SCS tolerance limits and under the unconstrained solution assuming that no production is possible after all topsoil has eroded. If the undiscounted or zero-discount-rate curves are considered, the unconstrained solution shows higher income through a 40-year period; after that, the SCS tolerance limits generate higher income. Under the five-percent discount rate, the SCS tolerance limit estimates generate slightly lower incomes over the first 50 years with negligible differences beyond that point.* Thus, even in a watershed where soil losses are high, the farm operator must have an unrealistically long planning horizon if he is to consider adopting soil conservation practices to generate higher incomes.

This set of results would also be significantly affected by an equilibrium solution that generated higher prices for crops produced under the constrained solutions. Thus, while the individual farmer is not able to adopt conservation practices individually, the imposition of soil-loss limits may generate higher incomes. The long-run projections on income would, of course, be modified as prices and price ratios between inputs and outputs changed.†

In interpreting these results, it is also important to realize that in a watershed where high levels of erosion are actually occurring the short-term income reduction required to achieve SCS tolerance limits may be greater than in those cases where the tolerance limits are exceeded only marginally. In this analysis it has been assumed that no soil regeneration occurs, given the short time period from a geologic perspective. Also, the loss of soil is assumed to occur evenly over space.

*if it is assumed that pasture production is possible after complete removal of the topsoil, then the farm operator would not choose the constrained solution even under a 100-year planning horizon.

†A more detailed analysis of the set of relationships is under way and will be published as a separate report.

CHAPTER 5

INSTITUTIONAL ARRANGEMENTS AND COSTS

The implementation of policies for the control of agricultural non-point-source pollution may require changes in existing political institutional arrangements--the interactions between the various governmental bodies which will be involved in administering and implementing the policies and between such agencies and private bodies and individuals. A particular policy might require simply an expansion or modification of existing governmental activities or functions, while another policy might require that additional functions be established.

This chapter will assess the institutional arrangements required for policy implementation in general and for implementation of the six policies described in Chapter 3 in particular. A detailed analysis of the institutional functions required for each of the policies serves as the basis for the estimates of the administrative cost of each policy. Detailed cost estimates for the policies and for the functions on which they are based are presented in Appendix E.

GENERAL POLICY ARRANGEMENTS

As discussed in Chapter 3, each prospective policy consists of some or all of these components: (1) performance indicators, (2) control instruments, (3) erosion control techniques, (4) measures of compliance, and (5) temporary penalties. Each component implies one or more institutional arrangements, existing or new, required to implement that component. No attempt is made here to determine the detailed organizational structure of or among such institutions.

Performance indicators are used to analyze the need for a policy before its implementation and the performance of the policy after it is implemented. A performance indicator normally implies measuring present conditions and the extent of NPS pollution and reporting that measurement to a decision-making central institution. The institution must then decide whether or not a pollution problem exists and whether action is appropriate. If so, a policy would be developed and implemented. After the policy is in effect, further measurements would be made to determine whether the policy is achieving the desired objectives. It might also be necessary to create institutions which can carry out these functions.

The development of control instruments--techniques for inducing compliance with a policy--will generally be undertaken by the legislative body which develops the policy. Since the necessary legislative system is already in existence on both the state and national levels, no additional institutional arrangements are required by this policy component. Some type of additional institution, however, may be required to report the physical, economic, or social impact of the control instruments, measured by the performance indicators, to the central NPS control agency.

To determine the type of erosion control techniques applicable to various farm situations, to select the management system for an individual farm, and perhaps to supervise its installation, local and/or regional agencies will be required. These agencies would also conduct inspections to ensure proper and continued performance of the practices. The results of these inspections would be reported to a central agency.

The types of compliance measures to be used would be determined by the legislators in developing the policy. After these provisions have been enacted, a separate agency (in order to assure control) would be assigned the responsibility of determining compliance. The purpose of such an institution would be to ensure compliance by farmers and report results to the central authority. If violations are discovered they would be reported to a disciplinary agency so that corrective action could be initiated.

Institutions responsible for handling temporary penalties would also be needed. The type and degree of penalization must be decided, and an institution responsible for enforcing the penalty must be designated or established. Once the violation is corrected, the appropriate institution must be notified so that the penalization may be terminated.

INSTITUTIONAL FUNCTIONS

The following paragraphs list and describe the types of functions that would typically be required of governmental agencies involved in administering NPS pollution control policies. The functions required by a specific policy will depend on the nature of the policy and its components; not all policies will involve all of these functions. Estimates of the costs for performing each function have been prepared and are presented in Appendix E. Once the functions required to implement a particular policy are known, the appropriate cost estimates can be combined to produce an estimate of overall policy implementation costs.

Function A: Monitoring is the inspection of some object or action over time, generally to determine whether a problem exists. In the case of NPS pollution control, monitoring is used to record a change in the quality of a particular body of water, to determine the rate of soil loss from a certain tract of land, or to determine whether certain practices are being followed.

Function B: Reporting is the process by which an agency is informed about the public's response to a policy. For example, if the policy provides that individuals are entitled to a subsidy for complying with a regulation, the controlling agency would be informed as to which individuals were or were not in compliance with the regulations. The agency would then award the subsidies to the complying individuals (or penalize those not in compliance). Reporting the impact of a policy can also be a part of determining the effectiveness of that policy. Reporting the quantitative change in a performance indicator after a policy has been in effect for some period of time will show if the policy has resulted in the reduction of NPS pollution.

Function C: Notification of Assessment of Penalty is the process by which an employee of the designated NPS control agency informs policy violators that there has been a violation and that prescribed penalties may therefore be imposed.

Function D: The Board of Review is formed if required under a given policy. The board is responsible for reviewing those cases of alleged policy violations which are appealed by the alleged offenders.

Function E: Court Action is the use of courts to rule on policy violation cases and to prescribe the execution of a penalty.

Function F: Subsidy/Tax Transfer is the payment or credit of money to an individual, usually granted when the individual fulfills some prescribed requirement. For example, a farmer may be granted a 50% cost-sharing subsidy for constructing terraces. The subsidy/tax transfer function must be established for this payment to be executed.

Function G: Maintenance of an Office is a function which may be required to accommodate the personnel needed to implement and enforce a policy. The costs include maintaining the physical structure in which the personnel are located as well as providing office equipment and salaries.

Function H: Individual Analysis of Farm Needs or Assessment is the process in which agency personnel contact individual farmers and survey or study their farms to obtain information relevant to the control of NPS pollution from the farm operation. For example, the agency's technician might inspect a terrace to see if it was properly installed and qualifies the farmer for a subsidy payment.

Function I: Contracting with Individual Farmers is simply making some type of agreement with the farmer. For a typical NPS control policy this activity might consist of the agency agreeing to formulate a conservation plan with a farmer.

Function J: Education is an activity which would form part of a program organized to better inform individuals about NPS pollution and alternative management strategies. An example would be weekly classes for farm operators conducted by soil conservation district personnel to discuss the causes of NPS pollution and methods of correcting it.

Function K: Training of Technicians is an activity required to provide qualified personnel to carry out various other institutional functions.

Function L: Reporting Need involves notifying the proper NPS control agency (depending on the policy) of the results of an analysis of farm needs. For example, if the analysis shows that a terrace is needed, the agencies responsible for planning and paying for the terraces must be notified.

Function M: Formation of a Program comprises the time and effort involved in deciding the type, degree of concentration, qualifications, limitations, and structure of various NPS control programs.

Function N: Construction includes not only the physical construction of a land management structure but also the design and planning which are prerequisite to such construction.

Function O: Publication and Notification of Legislation is the process of informing the public (especially those groups most affected) about new legislation, explaining the regulations and the possible costs and benefits. In most cases, this activity would include the publication of notices in local newspapers.

Function P: Administrative Organization is the process of establishing an agency responsible for administering the policy and for creating the other agencies necessary to implement the policy.

Function Q: Central Coordination comprises the correspondence and management activities which keep the implementing agencies functioning as one unit. A central coordinator would tie all of the other policy agencies together.

ARRANGEMENTS AND COSTS FOR SIX SELECTED POLICIES

The six policies selected by the research team for intensive study (see Chapter 3) were analyzed to determine the institutional functions required to implement each of them. The purpose of that scrutiny was to make possible an estimate of implementation costs based on the cost estimates for each of the functions involved. The analysis of the functions required by each policy component and the cost estimates for each policy are summarized in this section; detailed cost data for the policies are presented in Appendix E.

Policy 1: Education

The performance indicators for an education policy would require institutional functions H (individual analysis of farm needs or assessment), G (maintenance of an office--both county and central), L (reporting need), P (administrative organization), and Q (central coordination). Prior to policy development, the conservation practices presently in use would be analyzed by an agency to determine whether an education program is needed. Although such an agency would normally require an office, the SWCD offices could be used, thereby avoiding additional costs. The decision of need would be reported to the administrative organization and it, in cooperation with the central coordination staff, would make the proper arrangements. The state SCS center could be expanded to handle the administration and coordination of this program so that the costs could be kept to a minimum.

Once a policy has been established, its effectiveness must be measured, involving functions A (monitoring), K (training of technicians), and B (reporting impact). Technicians would monitor the farms after the policy has been in effect for some time, and the results would be reported. Comparing these results to data from the period prior to policy implementation would indicate the policy's effectiveness.

The control instruments of the education policy would require institutional functions J (education) and K (training of technicians). Once the program is laid out and its extent defined, the number of technicians needed could be determined and they could then be properly trained. If present SCS personnel are utilized in the training and if SWCD personnel are included in the education program, the cost could be reduced. The actual time spent educating and the materials used in the program must be included in estimating the costs. Some of the actual education time may be absorbed by the county extension service, the SCS, and the SWCD, thereby reducing the costs.

The cost of the erosion control techniques (i.e., construction equipment purchase, or any yield reduction) would be borne by the farmer under this policy. Since the policy would not be mandatory, no measures of compliance and no temporary penalties are involved; thus no costs would be incurred for those components. Of course, since the policy is voluntary, there would likely continue to be environmental damages, the cost of which would be borne by society at large.

Creating a slide program to be presented to groups of farmers by the SWCDs is an example of an education program using these institutional arrangements. The components of such programs might include problem assessment, alternative control strategies (BMPs), economic aspects, and benefits at the farm and societal levels. The intensity of the program could vary, depending on the funds available. Many other types of education programs could be formulated, of course. Examples include mailing educational materials to farmers or offering lectures in the agricultural department of local high schools.

Cost estimates for this policy are summarized in Table 23. A more detailed breakdown of the costs is presented in Appendix E.

Policy 2: Tax Credit

Institutional functions O (publication and notification of legislation) and F (subsidy/tax transfer) would be required for the performance indicators under a tax credit policy. An office must be set up and physically maintained. An administrative agency would also be needed to train the personnel necessary to make assessments of farm conservation needs and present structures. The SWCDs would fill the needs for an office, for management, and for inspection at a low cost compared to forming a new agency.

Table 23

Summary of Estimated Administrative Costs for Policy 1: Education

POLICY COMPONENT	INSTITUTIONAL FUNCTIONS	ANNUAL COST
Performance indicators (P)	G: Maintenance of county and central offices H: Analysis of farm needs L: Reporting need P: Administrative organization Q: Central coordination	$96,000
Control instruments (I)	J: Education K: Training of technicians M: Formation of program	56,600
Erosion control techniques (C)	N: Construction	0
Measures of compliance (M)	A: Monitoring B: Reporting K: Training of technicians	10,100
Total annual cost per county for a five-year program:		$162,700

The performance-indicator agency would certify whether planned structures will qualify for a tax credit. Under this policy, a loss in income caused by making some change in the farming operation to reduce erosion could be considered an expense to the farmer and could qualify as a tax credit although the administration of such a provision would be difficult. This income loss would also be determined by the performance-indicator agency.

The control instruments would require functions B (reporting impact), Q (central coordination), and F (subsidy/tax transfer). The formation of a tax program would not incur any substantial costs since the legislature would formulate the program when it establishes the policy. The reporting of impact could be borne by the farmer, since he would report to the central agency that he qualifies for a tax credit. If personnel from an outside agency, however, go from farm to farm and report tax credits, costs will be incurred which must be considered. Costs for a central agency to pay the tax credits would be greatly diminished if the Internal Revenue Service (IRS) performed that function. It might be necessary to hire additional personnel to handle the increased load, but the expense would be less than that of forming an entirely new organization.

The cost of all erosion control techniques would be borne by the farmer. The measures of compliance would require monitoring of the farms to see if the farmers do, in fact, qualify for the tax credits for which they apply. The operation can be performed by the IRS in cooperation with the SWCDs by checking a certain percentage of the tax returns, in a manner similar to the normal IRS procedure.

If someone were receiving credit but did not qualify for it (as determined by a board of review), the tax agency would be notified and the violator would be subject to legal action.

A basic program example for this policy is to assign the Internal Revenue Service the task of giving the tax credit as requested on federal income tax forms. The IRS would then work in cooperation with the SWCDs by having the districts check those farms receiving tax credits. The SWCD would verify whether the credits are legitimate and report to the IRS. Depending on whether or not the credits were justified, the IRS would take the appropriate action. This arrangement would create new responsibilities and costs for the IRS.

An estimate of the county-level costs for the policy is given in Table 24. More complete figures are presented in Appendix E.

Table 24

Summary of Estimated Administrative Costs for Policy 2: Tax Credit

POLICY COMPONENT	INSTITUTIONAL FUNCTIONS	ANNUAL COST
Performance indicators (P)	F: Subsidy/tax transfer	$30
Control instruments (I)	F: Subsidy/tax transfer	0
Erosion control techniques (C)	N: Construction	0
Measures of compliance (M)	F: Subsidy/tax transfer	0
Temporary penalties (T)	F: Subsidy/tax transfer	0
Total annual cost per county for a five-year program:		$30

Policy 3: 50% Cost Sharing for Terracing and Equivalent Modifications

The performance indicators for this policy would require institutional functions O, G (county), P, Q, G (central), H, K (for H), and L. The first step in making the policy effective is to inform the public about it (function O) so that individuals can take advantage of its provisions. Newspapers could be used for this purpose, and the cost would be minimal. It would be necessary to maintain a county office (function G); the SWCD offices could be used to avoid the expense of new structures. The administrative organization (function P) to oversee the policy and the training of technicians (function K) could be integrated with the present SCS organization. The technicians would be needed to inspect possible conservation modifications (function H) so that the cooperator can be assured that his modification will qualify for a subsidy. The technicians' decisions must be reported to a central agency (functions G and Q) so that the amount of money required for subsidy payments could be determined. If enough funds are available, the central agency would issue its approval of the subsidized modification.

The control instruments require only functions M (formation of a program) and B (reporting impact). The formation of a program represents little or no administrative cost since the legislation which establishes the policy will determine most of its details. The impact of the policy, however, must be reported to the central agency.

The erosion control techniques eligible for cost sharing involve construction (function N). The cost would originally be borne by the cooperator. Once the construction is complete, the modification must be inspected and monitored (functions A and K) by an agency to verify that the structure meets the required qualifications. If so, the central coordinating agency must be contacted (function B), and it, in turn, must see that the subsidy payment is made to the cooperator (function F). The SWCDs could do the monitoring, with the SCS acting as the central coordinator and the ASCS being responsible for the subsidy payment. Because these three organizations are presently engaged in these types of functions, utilizing them in an NPS control program would make the policy more efficient as well as less expensive to administer.

A temporary penalty would occur under this policy if the cooperator did not maintain the modification properly. The board of review (function D) would have to decide the case and then notify the subsidy agency (function F) to revoke any further subsidy payments and possibly regain the subsidy already paid.

An example of a program which could function under these arrangements is one which would require the local SWCD to plan or approve modifications and specify them as being eligible for cost sharing. The SWCD would notify the ASCS (the subsidy-paying agency), which would either grant or deny the subsidy depending on the funds available. The farmer would be notified of the decision. If the subsidy is available, the local SWCD would monitor the modification after completion to be sure it met the qualifications for subsidy payment.

Table 25 presents a cost estimate for this policy. Appendix E presents a more detailed cost evaluation.

Table 25

Summary of Estimated Administrative Costs for Policy 3: 50% Cost Sharing

POLICY COMPONENT	INSTITUTIONAL FUNCTIONS	ANNUAL COST
Performance indicators (P)	G: Maintenance of county and central offices H: Analysis of farm needs K: Training of technicians L: Reporting need O: Notification of legislation P: Administrative organization	$539,500
Control instruments (I)	B: Reporting M: Formation of a program	7,400
Erosion control techniques (C)	N: Construction	0
Measures of compliance (M)	A: Monitoring B: Reporting K: Training of technicians	10,100
Temporary penalties (T)	D: Board of review F: Subsidy/tax transfer	$424,200
Total annual cost per county for a five-year program:		$981,200

Policy 4: Required Conservation Plan Development

The performance indicator for this policy would be the number of approved conservation plans developed. The use of this performance indicator requires arrangements O, G (county), P, Q, G (central), H, and K (for H). As in the previous policies, the public must be notified about the new legislation (function O). Offices must be established (function G) to provide a base of operations for the technicians. The administrative organization (function P) must arrange to train the technicians (function K), who in turn formulate and approve conservation plans (function H). Since the SCS, in cooperation with the SWCDs, already performs the above tasks, it would be most feasible and least costly to assign these tasks to those agencies.

The costs for control instruments would involve function M (formation of a program), I (contracting with individual farmers), and B (reporting impact). The cost of program formation in this case would involve setting guidelines which all approved conservation plans must meet. A contract would be established between the farmer and the agency, with the agency agreeing to create an approved conservation program for the farmer. The plans formulated would be reported as the immediate impact of the policy. The SWCDs could perform these functions.

The erosion control techniques could be any of those included in an approved plan. The cost for construction (function N) would be zero, since the techniques would be implemented at the farmer's expense. The government, however, would have to bear the cost of forming the conservation plan.

Since the policy would only require that the farmers have an approved plan and would not require implementation of that plan, the measure of compliance would involve the farmer proving that he has a plan. Therefore, there would be no administrative cost to the government. In most cases the existence of a plan is a matter of public record, as the SWCDs presently keep plans on file.

A temporary penalty involves issuing a notice of noncompliance (function C), a task which could be handled by the SWCDs. The board of review (function D) would decide the case, which may result in court action (function E). The court action would not involve any new costs, since the case would be handled by the present court system and district attorney.

An example of a program in this case would be one in which the SCS cooperates with the SWCD to form conservation plans for all farmers requesting plans. The SWCD would keep records of the plans, and those records could be checked to prove compliance with the law.

A cost summary for this policy is presented in Table 26, based on the detailed estimates in Appendix E.

Policy 5: Required Conservation Plan Implementation

Except for the measures of compliance and the provisions for temporary penalties, this policy would be identical to policy 4. The implementation policy would require that the plan not only be formed but be put into practice. As a result, the farmers' land must be monitored (functions A and K) and the findings must be reported (function B) to determine if the farmer is actually in compliance. This responsibility could be executed with little cost by the SWCDs.

Table 26

Summary of Estimated Administrative Costs for Policy 4: Mandatory Conservation Plan Development

POLICY COMPONENT	INSTITUTIONAL FUNCTIONS	ANNUAL COST
Performance indicators (P)	G: Maintenance of county and central offices H: Analysis of farm needs K: Training of technicians O: Notification of legislation P: Administrative organization Q: Central coordination	$455,000
Control instruments (I)	B: Reporting I: Contracting with farmers M: Formation of program	26,900
Erosion control techniques (C)	N: Construction	0
Measures of compliance (M)		0
Temporary penalties (T)	C: Notification of penalty D: Board of review E: Court action	7,100
Total annual cost per county for a five-year program:		$489,000

The temporary penalty would involve a few more options but require the same agencies as policy 4. The court could call on the conservation agencies (SWCDs) to implement an approved plan on an individual's land and then charge that individual for the cost of implementation.

A possible program arrangement would be for the SWCDs to form conservation plans as requested and then monitor the farms to verify that the plans were being properly implemented. The results would be reported to the SCS, which would in turn notify the state's attorney of any violations.

Table 27 summarizes the estimated costs for this policy. See Appendix E for a more complete breakdown.

Policy 6: Development of Greenbelts

Performance indicators would not be required for a greenbelt policy since it is assumed that it would apply to all designated streams regardless of their present level of pollution. Therefore, no costs would be incurred for this category.

The control instruments would require functions O, G (county), P, Q, G (central), M. H, K (for H), and B. First, notice of the legislation must be published (function O). A new or existing agency (function G) would execute the policy. This agency would train personnel (function K) who, in turn, would advise property owners (function H) on establishing the proper greenbelt in accordance with the formulated program. The plans would be reported (function B) so that the farms could later be monitored or inspected for compliance. The SCS would seem to be a good agency for the overall direction of this program, while the SWCDs could handle the local requirements.

The erosion control technique is the development of greenbelts (function N) which the government would plan, but the cost of installation would be borne by the farmers. Compliance with this policy could be easily and inexpensively measured by aerial surveillance (functions A and K). An agency in charge of the surveillance would be needed. It may be possible for the SCS to undertake that function. Imposing penalties (functions C, D, and E) would involve the use of the present court system.

An example of such a program would be to assign the SWCDs the task of designing greenbelts in accordance with SCS standards. The farmers would then have to construct the greenbelts and the SCS would use aerial surveillance to check for compliance. Noncompliance would be reported to the courts by an enforcement agency.

Estimated costs for a greenbelt policy are shown in Table 28 and are given in fuller detail in Appendix E.

Analysis of Alternative Policies

The estimated administrative costs of each of the six policies discussed above are summarized in Table 29. Although this discussion of institutional

Table 27

Summary of Estimated Administrative Costs for Policy 5:
Mandatory Conservation Plan Implementation

POLICY COMPONENT	INSTITUTIONAL FUNCTIONS	ANNUAL COST
Performance indicators (P)	G: Maintenance of county and central offices H: Analysis of farm needs K: Training of technicians O: Notification of legislation P: Administrative organization Q: Central coordination	$538,000
Control instruments (I)	B: Reporting I: Contracting with farmers M: Formation of program	27,000
Erosion control techniques (C)	N: Construction	0
Measures of compliance (M)	A: Monitoring G: Maintenance of office K: Training of technicians	10,100
Temporary penalties (T)	C: Notification of penalty D: Board of review E: Court action	7,100
Total annual cost per county for a five-year program:		$582,200

Table 28

Summary of Estimated Administrative Costs for Policy 6: Greenbelt Development

POLICY COMPONENT	INSTITUTIONAL FUNCTIONS	ANNUAL COST
Control instruments (I)	B: Reporting G: Maintenance of county and central offices H: Analysis of farm needs K: Training of technicians M: Formation of program O: Notification of legislation P: Administrative organization Q: Central coordination	$256,500
Erosion control techniques (C)	N: Construction	0
Measures of compliance (M)	A: Monitoring K: Training of technicians	4,100
Temporary penalties (T)	C: Notification of penalty D: Board of review E: Court action	4,500
Total annual cost per county for a five-year program:		$265,100

Table 29

Estimated Annual County-level Administrative Costs for a Five-year Program

POLICY	ANNUAL COST
1. Education	162,600
2. Tax Credit	0
3. Cost Sharing	981,200
4. Plan Development	489,000
5. Plan Implementation	582,200
6. Greenbelt	265,100

functions and costs has treated the policies separately, it may be determined that a combination of policies or of policy components would represent the best strategy for NPS pollution control. If such a combination is used, it should not be difficult to determine the institutional arrangements needed. The total policy cost may be estimated from the data on the costs of institutional functions as presented in Appendix E.

CHAPTER 6

SOCIAL ACCEPTANCE

In selecting the most effective policies or practices for the control of nonpoint sources of pollution, decision makers will need to consider an array of economic, legal, political, and institutional issues. Also of importance is an assessment of the sociological aspects, since the ease with which the chosen control measures can be implemented and their ultimate success will depend in part upon their acceptability to those affected: principally, the farmers, who will have to alter their operations or make investments in control measures, and the public, which will directly or indirectly pay at least a portion of the costs.

The first section of this chapter is devoted to an analysis of the sociological aspects of NPS pollution control, based primarily on a review of the available literature. The second section presents the results of a sampling survey conducted among Illinois farmers to obtain an indication of the perceived acceptability and equitability of selected control alternatives.

SOCIAL FACTORS AFFECTING NPS POLLUTION CONTROL STRATEGIES

Excessive soil erosion is an environmental problem; inducing people to prevent it is in part a sociological one. This section will examine several erosion control policies to see what social factors may aid in or impede their success. While many elements such as technological feasibility, economic viability, and legality play a role in the success of a particular policy, the present discussion will consider additional factors frequently overlooked in technical, economic, and legal analyses. Specifically, this section will treat the following issues with respect to each policy: the administrative organization needed to carry out the policy, the response to the policy by farmers, and the response to the policy by members of the community other than farmers.

Administrative Organization

In considering the formal organizational structure necessary to implement a particular policy, we assume that any new policy will be implemented through an existing bureaucracy which already carries out compatible functions. The various policies will therefore be analyzed to determine which existing organizations could best perform the specific task required to implement the policies.

The decision-making process is a second important element of the administrative organization. As with many agricultural policies, erosion control practices will, in their selection, design, and implementation, need to be extremely sensitive to local conditions. If the decision makers are too far removed from the locale where the program will be implemented, they may be misinformed about local conditions and opportunities and, as a result, use inappropriate control measures.

The decision-making process is based in part on the information and measures used to determine when sediment control is necessary and what methods of control (BMPs) are most desirable for a given situation. If the policies are not technically competent, participants in the program will become disillusioned about their utility. Developing adequate and cost-effective policies to achieve the control of nonpoint-source pollution requires substantial analytical data about the impact of alternative control methods (Miller and Everett, 1975). If the implementing organization does not have the facilities to gather or analyze the necessary farm-level data, it may have to depend on other agencies over which it has no control, thus almost certainly resulting in reduced efficiency and credibility.

In addition to being sensitive to local conditions, the implementing organization will need to be responsive to new developments in erosion control technology. It must also be able to anticipate future developments, so that alternatives may be provided for in advance of a crisis situation. Many of today's problems are the unanticipated consequences of policies for attaining some other socially desirable goal (Wilkening and Klessig, 1976).

The dual need for responsiveness to local conditions and to technological developments appears to be met most adequately if the decision-making structure of the organization combines technical expertise with meaningful participation by local citizens in determining how to meet national goals.

Farmer Response

The response of farmers to any policy is affected by a number of factors, one of which is made up of economic considerations. Farmers generally try to maximize their profits within the economic, technological, and institutional constraints under which they operate (Schneider, 1976). However, research indicates that there may be a conflict between the motivation for maintaining resources (soil productivity) and the motivation to obtain immediate economic payoff (Wilkening and Klessig, 1976; van Es and Pampel, 1976). It is likely that the farmers most responsive to resource conservation programs are not necessarily the same ones most responsive to productivity-enhancing innovations (Kronus and van Es, 1977; Pampel and van Es, 1977).

In addition to economic factors, the farmers' responses must also be considered in the light of social factors. These factors have been shown to affect farmers' responses to attempts to change their behavior (Rogers and Shoemaker, 1968). For example, the nature of the source of information is quite important. Further considerations are the perceived necessity for and legitimacy of the policy as well as the extent to which the desired behavioral changes tie in with the farmers' existing behavior. In the area of pesticide pollution, for example, "integrated pest management" is a widely discussed policy, but it seems that the complexity of the approach as well as the attitude toward calculated risk is counter to the farmer's pyschological attitudes and previously learned behavior (Sewell, 1975).

Community Response

While individual farmers may currently be regarded as the basic decision makers affecting sedimentation control, they act within a social milieu that takes account of the interdependent interests and actions of many individuals (Ostrum, 1975). Community response to a proposed policy may be very difficult to anticipate. The "public interest" has long been a point of unending controversy whenever there is public involvement in private endeavors. The "public" or "community", whether it is regarded as or defined to be the people living in the area immediately surrounding the site affected by the policy or as the population of the state, nation, or world, is largely unorganized and frequently "represented" by persons who have a singularly vested interest in what is happening.

On the one hand, the public attitude toward scientific approaches to environmental problems is suspicious and simplistic--the public is not quite ready for the integrated complexity of solutions (Sewell, 1975). In general, too, concern for environmental problems changes as information about and concerns for competing issues like jobs, food, and energy become more salient (Wilkening and Klessig, 1976).

At the same time, community interest in water quality and the prevention of erosion may be favorable for esthetic reasons as well as in terms of preserving a natural resource for future use. However, maintaining water quality may well become an issue of balancing tangible costs to the farmer and less tangible benefits (or at least benefits which are more difficult to quantify) to the community (Schneider, 1976).

Evaluation of Alternative Policies

In evaluating the alternative policies an attempt will be made to identify factors which may facilitate the success of a policy or program or, alternatively, factors which may hamper its success. As stated previously, within that context the administrative organization, the farmer response, and the community response will be examined.

Three aspects of problem solving will be considered: creating awareness of the problem, developing a solution, and implementing that solution. It will become clear from the discussion that some proposed policies contain elements of all three problem-solving aspects, while others tend to concentrate on particular aspects.

Awareness of Problem

Creating an awareness of the problem includes the ability to develop among the public, both farmers and others, an understanding of the nature of nonpoint-source pollution directed toward finding and applying a solution to the problem.

The USDA Cooperative Extension Programs have a history of providing farmers with both information and leadership toward better farming practices. Their credibility is found to be generally high. A study on pesticide use by Iowa and Illinois farmers indicates that Extension Service information can have an effect on changing harmful practices that have become prevalent (von Römker and Horay, 1974). The Extension Service has a history of successfully introducing new technology to farmers, and it has the organization and decision-making structure which would make it appropriate for the type of programs discussed here. It combines expertise with local farmer input, and it has a geographically decentralized structure which enables it to respond to issues from a base of technical expertise yet with regard to local conditions.

As indicated previously, the Extension Service work is well accepted by many farmers. In the past, however, much of that work has focused on educational activities compatible with the efforts of most farmers to maximize profits or to increase productivity. While much of the technology introduced to farmers in the past has helped them to increase their productivity, sedimentation control practices now being recommended are primarily oriented toward resource conservation and may not be profitable to the farmer. While the Extension Service may be an excellent organization for mounting an educational campaign on erosion control, it should be understood that it may need to apply new approaches in this effort. Van Es and Pampel (1976) concluded that:

> Our findings indicate that environmentally sound practices farmers considered profitable had high rates of adoption. Environmental practices considered less profitable had low rates of adoption. Farmers weighed profitability heavily when considering the adoption of environmentally positive practices. This is less so for commercial practices, which were adopted by a sizable group of farmers even when considered less profitable.
>
> We suspect this variation results from the different communication patterns associated with environmental and commercial practices. A network of supporting institutions (commercial enterprises, mass media communication, advertising, etc.) which provides information at various stages of the farmers' decision-making process, advocates adopting commercial practices. Since it is unlikely that environmental practices will, at least in the near future, be similarly advocated, the degree of profitability will be more crucial to adoption. To introduce less profitable environmental practices will necessitate strong promotional activities.
>
> Any educational effort may be further complicated by the fact that what we know about the adoption of commercial practices may not be very useful in preparing campaigns oriented toward environmental innovations. The fact that the same farmer characteristics that relate consistently to the adoption of commercial practices don't relate well to the adoption of environmental practices, certainly argues against assuming that environmental campaigns demand nothing but another application

of the known strategies.

Like all campaigns, environmental quality campaigns must be designed initially to reach the most receptive farmers. We found that the current commercial and Extension clientele are most receptive to commercial practices. For environmental education campaigns to effectively reach the current clientele, Extension will have to devote special efforts to explaining the need for the adoption of environmental practices and their importance to the general welfare and the long-term welfare of the farming community. While the technical aspects of these practices must also be communicated, past campaigns have probably placed too much emphasis on the technical aspects at the cost of stressing the noneconomic need for the adoption of the practices.

The Soil Conservation Service (SCS) also does education work, although most of its efforts have been concentrated on problem solving rather than creating problem awareness. The amount of educational effort expended by the SCS appears to vary over time and locality, but much of what has been said about the Cooperative Extension Service can probably also be stated for the SCS. While the SCS does not have the strong, diverse educational program that is typical of the Cooperative Extension Service, it does have experience directly related to providing technical assistance for erosion control and resource preservation.

It appears that more effort will be needed to create awareness among the general public. While no scientific polls are available, personal observations indicate that the general public has very little understanding of soil erosion and the more complex issue of its control. The Extension Service could make a more concerted effort to reach the general public, as could other agencies, especially the Environmental Protection Agency. The generally low level of information among the public appears to leave the area wide open to those who might want to manipulate public opinion in support of a particular position.

Development of a Solution

Of the policies discussed here, two would require changes at the farm level where needed: policy 5, which would make the implementations of a conservation plan mandatory, and policy 6, which would require the development of greenbelts. The conservation plan would cover essentially all farms and potential erosion situations. The greenbelt policy is an example of one which would provide a specific solution to maintaining water quality (that is, through vegetative filtering). Farmers without streams on their property would not participate in the latter program, while those with streams would carry the main responsibility for maintaining water quality standards, thus raising the possibility of equity problems.

A comprehensive soil conservation plan would determine for each farm what steps need to be taken to achieve certain water quality or soil erosion control objectives. The plan's recommendations would be geared to the specific conditions found on a farm. Since the plan would in essence be the technical specification of the control practices needed in a given erosion situation, the expertise of persons who have experience in soil erosion contol is needed to evaluate those specifications and determine that the most appropriate control methods are being recommended.

The administrative organization that would bear the responsibility for helping farmers develop plans would most likely be the Soil Conservation Service. It, of all existing agencies, has the most experience in that area and would provide a much-needed foundation for any program that included planning for soil conservation. Because the present role of the SCS is mainly that of consultant to farmer-initiated projects, mandatory soil conservation planning would increase that function of SCS. This role would not change SCS's technical approach nor should it affect its relationship with farmer clientele.

The organizational structure of the SCS--technical expertise combined with local farm decision-making participation--should provide the best available guarantee that the planning is done both in a technically competent way and that it is maximally responsive to local farming needs. Effective farmer participation would aid in the efficiency of the program and help guard against "over-engineering" on the part of the experts.

It is assumed that the SCS does not presently operate on the scale necessary to provide soil conservation plans for all farms. Handling the required expansion of the system may not be without its problems. While additional public funds may be made available to enable an agency to carry out a specific task, it has often been very difficult to terminate the flow of these funds after the objective has been accomplished. Bureaucracies have been innovative in justifying new ways to continue to spend at a given level.

A possible solution may be to charge the farmers a fee for the service rendered. If the fee were collected locally, it could have a number of positive effects. It would allow local expenditures and revenues related to the soil conservation plan to be closely matched. It could also enhance local farmer control over the program, allow for flexible rate setting and, hopefully, increase efficiency. As the local efforts related to soil conservation plan development begin to taper off, local revenues would also decrease, thus avoiding the gradual diversion of these funds into other areas. Combining these separate local efforts into an effective national program, however, might be a major problem.

Clearly, the fee approach would meet with farmer resistance, especially if farmers perceive nonfarm interests to be the only beneficiaries. However, local control over the fee structure combined with the opportunity to decrease the impact of the fee through a tax deduction would probably do much to reduce farmer objections to such a policy.

Another issue of farmer response relates to the attitudes farmers may have toward a mandatory conservation plan policy. The agricultural community, although not alone in this respect, has been a very outspoken opponent of governmental regulation of its activities. Requiring development of a soil conservation plan actually represents a very minimal interference in the farm operators' freedom to make decisions. The farmers may well perceive it, however, as a first step toward mandatory implementation. A very extensive education effort would be necessary, including a special effort to obtain the cooperation of leaders in the agricultural sector, to guide farmers into accepting the policy. It is important to avoid overcommitment to a non-regulative program as a means of gaining farmer acceptance of the policy. It will be tempting to entice them with promises that there will be no further regulation. It may very well be necessary, however, to implement certain regulations at a future time.

It may be more useful to stress, in conjunction with the education effort which will make farmers aware of needed conservation practices, that the plan will actually be the application of expert knowledge to individual situations. It could also be stressed that the program would be especially helpful at the time of the transfer of land, since the prospective buyer could be given a plan indicating what had been done to conserve soil and maintain water quality as well as what might yet need to be done.

Of course, community response to the planning policy would vary depending on perceived costs and benefits. Some persons might think of increased government expenditures for the SCS as further bureaucratic expansion serving only a special-interest minority. However, the benefits to the community would be an improvement in water quality for recreation as well as the availability of quality water supplies and productive soil resources for both present and future generations. It would appear relatively easy to find public support for these objectives, given the proper educational effort.

Streambank protection through the development of greenbelts would also provide the same benefits for the community. As mentioned before, the main goal of streambank protection is to keep eroded soil out of the water through the use of a vegetative screen. While streambank protection could be included in a conservation plan, it need not *always* be a part of such plans. Many tillage and rotation practices reduce the amount of soil lost (to both wind and water), but with a greenbelt policy more attention would be paid to the loss of soil into waterways while the emphasis on overall soil loss would be reduced. This policy would require more investment in activities that are further removed from normal farming practices in many instances--activities such as seeding and maintaining a vegetative cover along a waterway. Thus, although greenbelt development could conceivably be a part of a farmer's total conservation plan, to the farmer it may well appear to be a separate activity.

Farmers have not responded enthusiastically to streambank protection programs recently, at least partly because these programs have permitted public access to the waterways that flow through their land. However, the idea of planting and maintaining a "free zone" between cultivated land and the water that flows through the property may be more acceptable to farmers, especially when divorced from the recreational access issue. However, since there is no generally accepted way of determining the cost of pollution (Schneider, 1976), a farmer may resent having to protect his streambanks to prevent soil from his or someone else's farm from running into the water.

The approach to a greenbelt policy would have to take into consideration the inequities that might arise from a blanket policy on streambank protection. The incorporation of greenbelt requirements into a total conservation plan might seem more equitable to most farmers than a separate greenbelt policy.

Community reaction to such an improvement might be very mixed, similar to the general response to a policy requiring conservation plan development. Some factions in the community might look upon a greenbelt policy more favorably and with more interest than they would on a conservation plan policy. Wildlife enthusiasts would appreciate the improved habitat for animals and fowl that could be developed by such programs. In general, the greenbelts might enhance the beauty of the rural countryside. The greatest benefits to the community would likely be those which accrue from improvement in water quality.

Implementation of a Solution

There are three ways of implementing a solution to the problem of agricultural nonpoint-source pollution: (1) relying on voluntary implementation, (2) coupling voluntary implementation of a conservation plan with incentives such as tax credits or subsidies and pollution charges, and (3) mandating implementation of a plan with or without some compensation to the farmer. In addition to concerns about costs, the probability of compliance is a significant factor of interest for each type of implementation.

The present effort to induce voluntary participation in erosion control programs has not been sufficient to avoid soil erosion in many instances, as indicated in the introductory section of this report. Many farmers use conservation practices on their farms and work with the Cooperative Extension Service, the Soil Conservation Service, or the Agricultural Stabilization and Conservation Service, but with purely voluntary implementation. The strength of the agencies involved in promoting that conservation program must lie in their ability to persuade farmers to engage in the practice. In a sense, agents must be salespersons for the conservation activities. Currently, the agencies often deal with farmers already interested in the idea of implementing some conservation practice; they do not deal extensively with those farmers not interested in conservation. As mentioned in the discussion of educational programs, a conflict exists between immediate profit concerns and resource conservation, making it difficult for many farmers to change their behavior.

Community response to the present voluntary conservation program is rather oblique. So far, the level of agricultural nonpoint-source pollution has rarely been considered a crisis situation, except occasionally for levels of agricultural chemicals in water. As mentioned previously, few people are aware of sedimentation as a real problem, and it appears that the voluntary approach to prevention will be considered adequate by the community until soil erosion and other nonpoint-source water pollutant problems become more of an issue.

Voluntary implementation of conservation practices with the support of economic incentives would reduce the conflict between profit and conservation motives. These policies have been somewhat successful, especially through the ASCS programs. The programs may be expanded and improved, but they do not remove the farmer's option to do nothing toward conservation.

Mandatory conservation plan development may provide a way to exert influence over farmers who might not have given soil conservation much thought or who may underestimate the need for soil conservation on their farms. The agency certifying the required plan could inform the farmer about various tax incentives, positive or negative, for the construction of pollution-reducing structures or could explain available tax options. The required plan becomes a useful "foot in the door" for the advocacy of needed conservation practices without the onus of appearing to force the farmer's hand.

Given their competitive positions, most farmers perceive that they have little choice but to fully utilize the resources under their control unless restrictions are imposed on all farmers (Wilkening and Klessig, 1976). For example, while in some instances shifts to conservation tillage methods permit maintenance of farm income and significant reductions in rates of erosion, further reduction of erosion rates comes at the cost of income (Narayanan and Swanson, 1972).

A farmers' view of a conservation plan will also depend heavily on the investment value the operator puts on the farm itself (Schneider, unpublished). If the land will leave the farmer's control in a few years (because of industrial encroachment or use for housing developments), then the value of the farm lies in the greatest immediate profitability. However, the farmer with an eye to the future productivity of the farm land for inheritance will realize more easily the value of the conservation plan, both as a concept which is profitable over the long term and as money in the pocket. Even then, though, the farmer has to operate within economic parameters over which he has little control. Economic incentives in the form of subsidies or tax exemptions may encourage those farmers already interested to undertake the necessary steps.

Making the implementation of a conservation plan mandatory (policy 5) is clearly the most demanding of the six policies in the sense that it involves the greatest degree of compulsory interference with farm operations. However, both the water quality problem (which is not evaluated in this report) and the necessity to bring all acreage in an area under an erosion control program in order to obtain water quality improvement and to maintain productivity are reasons that required participation may be necessary. The drawbacks of such programs are well known. They tend to be accompanied by cumbersome administrative machinery which may be costly and is likely to be resented by those affected by the regulations. Poor communications and misunderstandings between the regulatory agency and those regulated are a familiar part of most scenarios. Regulations are usually promulgated by a central authority, frequently causing inequities and inefficiencies.

As noted before, soil erosion/water quality programs may need to be more sensitive to local conditions than almost any other area in which activity is regulated. Requiring the implementation of soil conservation plans may be the most appropriate way of combining regulatory activity with sensitivity to local conditions and maximum allowance for local initiatives. General standards are often set by the political decision-making process, while public agencies are left to decide how to implement the policies. It appears that an approach of stating the criteria to be met while leaving implementation to local decision-makers, including farmers, would be most appropriate for erosion and water quality control programs.

The primary administrative organization could be the Agricultural Stabilization and Conservation Service, although the SCS and the USEPA might also be involved as cooperating agencies. The ASCS has been an enforcement agency for various soil conservation policies. It has experience evaluating compliance, and, to the extent that the program combines regulation with some policy of compensation, the ASCS appears to have the most appropriate available administrative machinery. The SCS could provide technical assistance, although such assistance could also come from private contractors. The USEPA might become involved especially in situations where farm land and nonfarm land need to be involved jointly in an erosion control program.

Problems are likely to arise when several agencies are involved, since cooperation is usually not very smooth in such cases, especially if each agency's role is not carefully defined and areas of responsibility are not specified. Those areas become ones for which no agency takes responsiblity. Careful consideration should be given to issues of organizational linkages; channels of communication between agencies should be established and it should be made very clear to the farmer which agency he must deal with at the local level when he has a particular problem.

It is clear that a mandatory conservation program is currently not popular with most farmers, partly because of the high premium farmers have placed on their autonomy in farm decision making and the high value they place on unrestricted property rights. At the same time, farmers have accepted regulatory activity interfering with their decision-making autonomy in such areas as grading standards for farm products, milk marketing orders, and many public health regulations. While the farmers have not cherished those regulations, there is little evidence that compliance problems have been widespread once the regulations have been introduced. Without an extensive educational campaign, however, and the active participation of farm leaders in the decision-making process, it appears that it will be costly to overcome the expected negative reactions by farmers.

In addition to the perceived threat to their autonomy, farmers will be concerned about the economic implications of the program. Under a program based on voluntary compliance, a farmer may find himself at a disadvantage because his economic competitors are not participating in the program. Under a mandatory program this particular problem is only partially alleviated, since the economic cost will vary depending on local conditions. To help cushion the economic impact, a policy of compensation could be instituted. As with the incentive program, this compensation could take the form of a tax credit, a subsidy, a tax, or a fine. As reported below, farmers appear to favor tax credits over subsidization programs. Subsidization is often associated with specific structures or technological approaches, and this categorical approach may not be the most efficient one.

In the absence of a perceived crisis situation, we may assume that the response from the community will largely be one of apathy combined with concerns about the government expenditures needed to suuport the conservation programs. Farm support programs have a reputation for benefiting the well-to-do while failing the small operator, and it is likely that those proposing future programs will be called upon by the general public to answer such a charge. In addition, the general public and special interest groups within it may argue that since private industry has been called upon largely to carry its own financial burden in pollution abatement, agriculture should be subject to the same rules. While the importance of food production, the inability of the individual farmers to pass costs on to consumers, and the benefits of erosion control to the nonagricultural community may well justify a compensation policy, these issues will need to be discussed in the general political decision-making debate that will precede policy formation.

Figure 21 schematically outlines the various policies discussed above and indicates their possible interrelationships. The policies have been divided according to whether participation is voluntary or mandatory. The past and current erosion control programs can be found on the left side of Figure 21, as they are voluntary approaches.

The voluntary or mandatory approaches have been treated here as being mutually exclusive. It is, however, possible to design policies which would incorporate a mix of voluntary and mandatory measures (Council on Agricultural Science and Technology, 1976). Farms or regions where nonpoint-source pollution poses the gravest threat to water quality may be chosen for the mandatory implementation of erosion measures, while in other regions it would be possible to rely on cooperation by farmers. This approach would place less of a burden on financial and technical resources and allow the most severe cases of nonpoint-source pollution to be treated with the urgency that is required.

Additional Factors

Several other issues which will affect the success and acceptability of erosion control policies have not yet been considered. While we will not cover these issues extensively, they should not remain unnoticed.

Time Dimension

The success and acceptability of any program can be affected greatly by timing. A program may become unusually expensive or extremely threatening if it is undertaken as a "crash" effort. It is difficult to draw up a time schedule for any of these policies, and the gravity of the problem or political pressure may call for immediate action. However, a well-developed timetable which indicates when various objectives need to be accomplished and which take into account the capabilities of the organization involved, the available financial resources, and the need to educate farmers and the general public may do much to increase the likelihood of success.

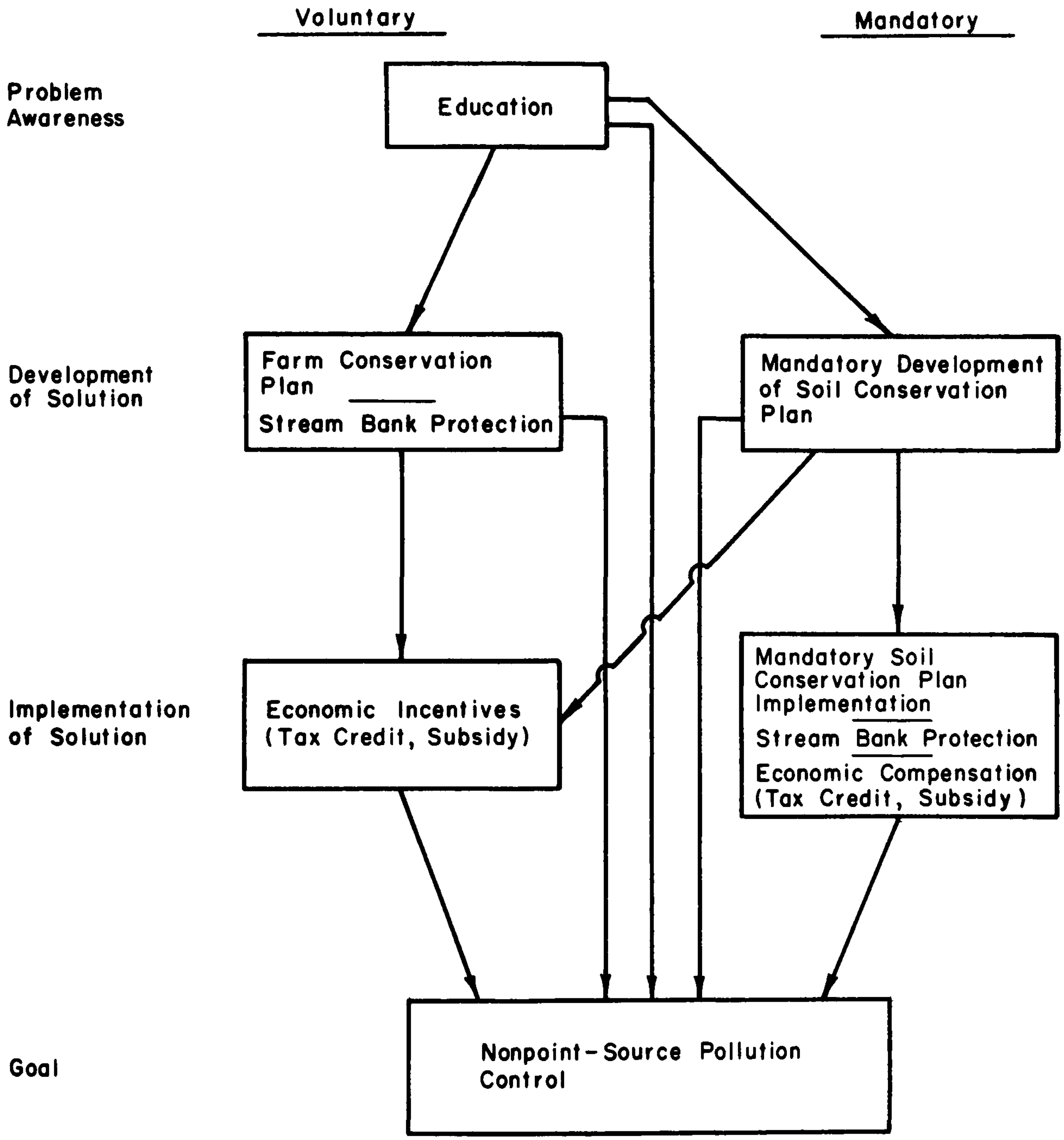


Figure 21. Interrelationships of selected policies for the control of nonpoint-source pollution.

The Impact on Small Farmers

In the present discussion we have assumed that farmers can afford to participate in any of the programs but need to be encouraged to do so, or, to equalize the different economic impact between them, they may need to be partially compensated. In considering any policy, however, it should be recognized that some farmers may be driven out of agriculture if they must make heavy investments in soil erosion control activities, must substantially change their farming operations through a system of crop rotation, or must take certain acreage out of row-crop production. While the equity analyses reported in the next chapter deal with these issues more directly, this aspect of policy development obviously deserves very careful attention.

Farmer Participation in Decision Making

As noted previously, effective participation by farmers in decision making will affect the implementation of policies at the local level. This is not the place to deal extensively with the problems involved in citizen participation in bureaucratic decision making. The literature on that subject is voluminous, although few studies have examined the nature of farmer participation in that bureaucratic decision making which affects their own enterprise. Research on citizen participation indicates that frequently neither the objectives of the citizen participation nor the role and power of the citizen participants have been defined well enough to allow a functional system to develop (van Es, 1976). New policies which incorporate elements of farmer participation in the decision-making structure will need to carefully specify the objectives to accomplished and the ways in which the participation is to be implemented.

FARMER ATTITUDE SURVEY

The purpose of the farmer attitude study was to explore the probable reaction of farmers, as inferred from their attitudes, toward several proposed policies.* A knowledge of farmer attitudes can be useful in estimating the likelihood that the farmers will cooperate with or adopt these policies. In addition, a study such as this may be successful in identifying the factors affecting attitudes. Therefore, insight may be gained into the kinds of educational programs which would have the highest likelihood of success.

Procedure

A questionnaire was designed to determine:

1. The perceived fairness of each of the proposed policies
2. The groups that would be unfairly treated by each policy

*This case study was supported by a grant from the Illinois Institute for Environmental Quality. It is included in this report to indicate the type of findings that would likely have been obtained had it been possible to conduct a survey covering the entire corn belt.

3. The likely rate of adoption of each policy and/or the cooperation rate

4. General experience and attitudes toward soil conservation practices.

The questionnaire was specifically designed to avoid reference to pollution control or "the environment."

After the questionnaire was reviewed by a number of ASCS staff members, it was pretested by sending it to a small convenience sample of central Illinois farmers who were then contacted by telephone for their responses. Following numerous changes, a second pretest was conducted with another group of central Illinois farmers.

Based on these pretests, the three questionnaires reproduced in Appendix F were developed for the study. The first two, titled "Farmer Attitude Survey," are identical except that the first contains nine policies while the second contains eight policies different from those in the first questionnaire. Pretests clearly indicated that farmers were both unable and unwilling to answer a questionnaire covering all 17 policies. By using only eight or nine policies in a single questionnaire, total interview time was limited to approximately 20 to 30 minutes. The third questionnaire contains all 17 policies but deletes several attitude and farming method questions. This questionnaire was sent to ASCS County Executive Directors in the counties from which the farmer samples were drawn.*

All interviews were conducted during the last two weeks of July and the first three weeks of August, 1976. The actual procedure for the farmer questionnaire was to send a letter to all farmers included in the sample informing them that they would be receiving a questionnaire from the University of Illinois (see Appendix F). Several days later the questionnaires were sent to the farmers with an appropriate cover letter (see Appendix F). Within seven days after receiving the questionnaire, each farmer was telephoned by a trained interviewer. If the farmer could not complete the questionnaire at the time he was called, the interviewer attempted to make an appointment to call back at a time convenient for the farmer. If a farmer could not complete the questionnaire by telephone, he was urged to fill it out and return it by mail. All farmers who had not been contacted by telephone after four attempts were sent a letter asking them to complete the questionnaire and return it by mail.

This method of administering the questionnaire--mailing copies to the farmers and obtaining responses by telephone--was chosen on the assumption that the policies were too complex to be described accurately over the telephone. It was also assumed that the completion rate would be low without a telephone interview/follow-up. Disproportionate response rates were to be avoided if at all possible. Correspondence addressed to respondents used

*The questionnaires used were developed in consultation with the Survey Research Laboratory of the University of Illinois. The laboratory's role, however, was limited to advising on questionnaire design.

University of Illinois, Department of Agricultural Economics letterhead to insure neutral responses. An unpublished, exploratory study suggested that this approach introduced relatively low bias and would produce relatively high cooperation rates.

The procedure used to administer the questionnaire to ASCS County Executive Directors was identical.

The sample for this study was drawn from 11 counties within the state of Illinois. It was established that, if properly chosen, 11 counties would include all major soil types to be found in the state and hence would also include all major variations in farming practices, yield, and economic return. With the aid of the State of Illinois ASCS office, 11 counties were selected to be representative of the entire state. Selection criteria included that the counties be nonurban in their general makeup and that they have an up-to-date soil survey. The counties selected were:

Douglas	Montgomery
Greene	Richland
Lake	Stephenson
LaSalle	Wabash
Logan	Will
Massac	

The farmers to receive the questionnaire in each of the 11 counties were chosen by instructing the ASCS County Executive Director to select 20 names on a random basis from all farmers in his respective county. To achieve randomness, the director was instructed to draw from his files only names that appeared at prespecified intervals. For example, if his files were approximately 400 inches long, he was instructed to draw a name every twenty inches. The only restriction was to exclude very large and very small operators. Specifically, operators with less than 160 or more than 1500 acres were to be excluded. In all, one hundred thirty-five farmers and eleven ASCS County Executive Directors received questionnaires. To achieve a statistically valid sample, a larger sample would have been necessary. However, for the purposes of this case study, sufficient insights were obtainable without having a sample large enough to allow hypothesis testing and statistical inference.

The above procedures resulted in 87 completed farmer questionnaires (a 64.4% response rate) and ten completed ASCS County Executive Director questionnaires. The sample size and number of completed questionnaires were adequate for this case study type of investigation with its rather general objectives. The proportion of farms covered in each acreage category appears to be consistent with farm size in each of the counties. It is important to note, however, that while the counties sampled represent most of the soil structures and farming practices to be found in the corn belt, some caution must be used in extrapolating these data to the entire corn belt because of the physical, economic, and social differences that may exist within that region of the nation.

Results and Discussion: Background Data

To provide a background for understanding the farmers' attitudes toward soil erosion control policies, some general information derived from the survey about the respondents' beliefs and farming practices is presented here, followed by a discussion of the survey results for individual policies.

Table 30 presents the farmers' responses to several questions that reflect general attitudes on soil erosion control. It is encouraging to find that only 9.3% of the farmers indicated that soil erosion control is not needed to maintian soil productivity and that only 12.9% indicated that erosion control is not needed to achieve water quality. It should be noted, however, that 75.6% and 69.4%, respectively, responded with a clear "yes" to these two questions. One can conclude that appropriate policies designed to control soil erosion will be evaluated positively (at least philosophically) by most farmers. While positive evaluation is not the same as acceptance of the policies, these findings have important implications for the success of any enforcement program. If most individuals do not perceive that a problem exists, it is hard to enforce a law requiring a change.

A substantial proportion of farmers were skeptical that soil erosion can be measured on either a farm-by-farm or a watershed basis. Therefore, any policy based on the measurement of soil erosion will face difficulties unless farmers are educated to the practicality of soil erosion measurement.

In general, no clear relationship was found between farmer attitudes on soil erosion control and perceptions of the fairness of the policies examined. The data in Table 31, however, indicate that there is an apparent, though slight, positive relationship between the attitude that erosion control is needed to achieve water quality and the perceived fairness of requiring an approved soil conservation plan. Conversely, a negative relationship appears between the attitude that erosion control is needed to achieve water quality and the perceived fairness of the policy of prohibiting deduction of real estate taxes from federal income tax unless an approved soil conservation plan has been developed and implemented.

Table 32 contains farmer estimates of the effectiveness of several practices commonly suggested as being useful to reduce soil erosion. The results may seem surprising to some in that two widely discussed methods (terracing and contouring) are not considered to be as effective as the practices of conservation tillage (zero till, chisel till, and strip till), the elimination of fall moldboard plowing, and changing crop rotations. However, recognizing that much of the land in Illinois cannot economically benefit from terracing and contouring, these results are not unanticipated. The slope of the land is a major consideration in determining the effectiveness of these practices.

Another variable of interest is the farmers' descriptions of their own soil conservation practices. Table 33 indicates the responses. These data suggest that only 25 percent feel that they could improve. However, those who report their performance as "adequate," "average," or "best under circumstances" could be encouraged to improve their soil conservation practices. These self descriptions of farmers' soil conservation practices were compared

Table 30

Farmer Attitudes on Soil Erosion Control
(percentage of respondents)

QUESTION	YES	MAYBE	NOT SURE	NO
Is erosion control needed to maintain soil productivity?	75.6	12.8	2.3	9.3
Is erosion control needed for achievement of water quality	69.4	9.4	8.2	12.9
Can the amount of soil erosion be measured on a farm-by-farm basis?	44.7	20.0	18.8	16.5
Can the amount of soil erosion be estimated for a watershed?	42.9	19.0	22.6	15.5

Total sample, n=87

Table 31

Relationship Between Perceived Need for Erosion Control and Selected Policies

	FAIRNESS OF REQUIRING AN APPROVED SOIL CONSERVATION PLAN (Number of Respondents in Each Category)			
IS EROSION CONTROL NEEDED FOR ACHIEVEMENT OF WATER QUALITY?	VERY FAIR	SOMEWHAT FAIR	SOMEWHAT UNFAIR	VERY UNFAIR
Yes n=26	8	10	3	5
Maybe n=6	0	3	1	2
Not Sure n=1	0	0	0	1
No n=3	0	0	1	2

	FAIRNESS OF PROHIBITING TAX DEDUCTION (Number of Respondents in Each Category)			
IS EROSION CONTROL NEEDED FOR ACHIEVEMENT OF WATER QUALITY?	VERY FAIR	SOMEWHAT FAIR	SOMEWHAT UNFAIR	VERY UNFAIR
Yes n=32	6	9	5	12
Maybe n=2	0	1	0	1
Not Sure n=6	0	1	1	4
No n=8	0	0	2	6

Table 32

Farmer Estimates of Effectiveness of Practices to Reduce Soil Erosion (percentage of respondents)

PRACTICE	VERY EFFECTIVE	SOMEWHAT EFFECTIVE	NOT VERY EFFECTIVE	NOT AT ALL EFFECTIVE
Terracing	19.8	27.2	28.2	24.7
Contouring	19.5	39.0	17.1	24.4
Conservation Tillage	53.7	31.7	8.5	6.1
Elimination of Moldboard Fall Plowing	45.2	33.3	9.5	11.9
Changing Crop Rotations	60.5	29.1	5.8	4.7

Total sample, n=87

Table 33

Farmers' Descriptions of Their Own Soil Conservation Practices

Performance Category	Percentage of Respondents
Excellent	5.0
Adequate	25.0
Average	10.0
Best under circumstances	35.0
Should do better	25.0
Total	100.0

Total sample, n=87

to the farmers' own perceptions of the fairness of the various policies, but meaningful relationships were not found.

The number of farmers who reported having an approved soil conservation plan is shown in Table 34. A significantly smaller percentage of the farmers with between 200 and 300 acres in row crops report having an approved soil conservation plan than do those in other acreage categories.

As the data in Table 35 show, farmers who farm land with soil productivity indexes over 130 are more likely, by a small margin, to have a soil conservation plan. This difference is probably a reflection of the fact that farmers with higher soil indexes have either professional management or the economic incentive to achieve even higher yields, or both.

Results and Discussion: Policy Perception

Discussed below are nine policies that fall into four categories:

1. Cost sharing for terracing and equivalent modifications
2. Tax credits and loans
3. Required development and implementation of soil conservation plans
4. Greenbelts

Information on an additional eight policies covered in the survey is not reported here except for some general information presented in Appendix G. These policies were selected because they conform, in general terms, to the six policy alternatives being considered in this report. The following discussion presents an analysis of responses by farmers and ASCS County Executive Directors to specific questions about each of these nine policies and about associated attitudes concerning soil conservation practices and beliefs.

Three measures of farmer attitudes were the major focus of this investigation. The first is the respondents' perception of the *fairness* of the policies under investigation. Fairness is of interest because it reflects a basic attitude. It indicates what the respondents will tolerate based only on their conception of the problem as they see it now. Fairness is a general concept, and it does not imply that the farmers have analyzed the policy from a societal perspective. Rather, it deals with whether the farmer perceives a given policy to be fair or unfair. Pretests established clearly that farmers understood this concept.

Closely related to the question of fairness is that of *participation* or *cooperation rates*. This measure is of interest because it not only indicates attitude toward the policy but also indicates the approximate percentage of farmers who would voluntarily participate or cooperate without significantly expanded education or enforcement programs. Pretests also established that farmers understood this concept.

To round out direct measures of farmer attitudes toward proposed policies,

Table 34

Farmers Who Have Developed Approved Soil Plan Classified by Number of Acres in Row Crops

FARM SIZE (acres)	PERCENTAGE HAVING PLAN
Under 130	64.3
130 - 199	50.0
200 - 300	23.5
301 - 500	55.6
Over 500	82.1

Total sample, n=87

Table 35

Percentage of Farmers in Each Soil Productivity Index Range Who Have Developed a Soil Conservation Plan

	PLAN DEVELOPED	
PRODUCTIVITY INDEX	YES	NO
Under 115	56.5	43.5
115 - 130	53.3	46.7
Over 130	64.7	35.3

Total sample, n=87

a third measure was used. Respondents were also asked to identify groups that they felt would be unfairly treated if a given policy were in effect. This measure not only helps in predicting which groups would have difficulty cooperating or complying but also indicates the arguments that might be used by those not cooperating or complying. It does not, however, provide information on what farmers might do if they did not cooperate or comply, or, if they did, how they might alter their farming practices. Rather, this question only suggests politically sensitive groups to include in further analyses.

In addition to farmers, ASCS County Executive Directors (hereinafter called ASCS directors) were also asked for their perceptions of fairness, their predictions of participation or cooperation rates, and their estimates of what groups might be unfairly treated.

The following discussion of each group of policies focuses on these three measures.

Cost Sharing for Terracing and Equivalent Modifications

Fairness--Table 36 presents perceptions of the fairness of three policies in the category of cost sharing for terracing and equivalent modifications. Respondents were asked to indicate how fair each of these three policies would be. In general, this group of three policies was viewed by farmers as essentially fair. Between one-fourth and one-third of farmers rated these policies as very fair. ASCS directors, however, were evenly split on the fairness of the policies of full cost sharing for terracing and 50% cost sharing for slope modification.

Approximately 28% of the farmers viewed 50% cost sharing for terracing as in some way unfair, while only 10% of ASCS directors viewed this policy as unfair.

Views of the fairness of 50% cost sharing for slope modification are similar to those for the 50% for terracing policy. Approximately 55% of the responding farmers perceived it as in some way fair, while 33% thought it unfair and 11% said they did not know. ASCS directors tended to view this policy as less fair than did farmers.

Participation Rate--Estimates of participation rates by farmers, although subjective, are valuable in estimating the acceptance of individual policies. Table 37 shows the participation rates estimated by both farmers and ASCS directors when asked what percentage of farmers in their county would take advantage of such a policy if it were made available. For full cost sharing for terracing, the farmers responding indicated that approximately 43% of the farmers in their county would take advantage of this policy, while ASCS directors indicated that approximately 29% of the farmers would do so. Farmer respondents indicated that approximately 36% of farmers would take advantage of 50% cost sharing for terracing, while ASCS directors indicated that only approximately 12% of farmers in their counties would take advantage of this policy.

Cost sharing for terracing and other activities has been available for

Table 36

Perceived Fairness of Cost Sharing for Terracing and Equivalent Modifications

POLICY	VERY FAIR	SOMEWHAT FAIR	SOMEWHAT UNFAIR	VERY UNFAIR	DON'T KNOW
		(percentage of respondents)			
1. 50% Cost Sharing for Terracing					
(n=36) [Farmers]	33.3	36.1	16.7	11.1	2.8
(n=10) [ASCS]	20.0	70.0	10.0	----	---
2. Full Cost Sharing for Terracing					
(n=49) [Farmers]	30.6	46.9	8.2	8.2	6.1
(n=10) [ASCS]	10.0	40.0	30.0	20.0	---
3. 50% Cost Sharing for Slope Modification					
(n=36) [Farmers]	25.0	30.6	25.0	8.3	11.1
(n=8) [ASCS]	12.5	37.5	25.0	25.0	----

Table 37

Estimates of Percentage of Farmers That Would Participate in Cost-sharing Policies

POLICY	RESPONDENTS FARMERS	ASCS DIRECTORS
1. 50% Cost Sharing for Terracing (n=29)	11.8	36.1
2. Full Cost Sharing for Terracing (n=41)	29.2	43.4
3. 50% Cost Sharing for Slope Modification (n=26)	26.5	28.6

Table 38

Groups Perceived as Being Most Unfairly Treated by Cost-sharing Policies

POLICY/GROUP	PERCENTAGE OF RESPONDENTS	
	FARMERS	ASCS DIRECTORS
1. 50% Cost Sharing for the Cost of Terracing		
Farmers Not Needing Terracing	22.9	10.0
Small Farmer	11.4	10.0
Taxpayers	5.7	10.0
2. Full Cost Sharing for the Cost of Terracing		
Farmers Not Needing Terracing	27.7	40.0
Taxpayers	12.8	20.0
Small Farmer	6.4	----
3. 50% Cost Sharing for the Cost of Slope Modification		
Farmers Not Needing	21.9	----
Small Farmer	9.4	----
Taxpayers	6.3	10.0
Tenants	6.3	----

many years. The discrepancy between farmers' and ASCS directors' perceptions of the number of farmers who would participate in these two policies may be related to the experience of ASCS directors. Yet this explanation does not account for the farmers' greater optimism. A more detailed investigation would be necessary to explain this difference and to determine which perception is more accurate.

For 50% cost sharing for slope modification, responding farmers indicated that approximately 26% of farmers in the county would take advantage of this policy, but ASCS directors indicated that about 28% would do so.

Groups Unfairly Treated--Table 38 includes a listing of the three or four groups most often mentioned by farmers and ASCS directors as being unfairly treated under each of these three policies if they were adopted. For all three policies, farmers *not* presently using terracing or slope modification are seen by approximately 21 to 27% of farmers as being unfairly treated. ASCS directors felt particularly strongly about farmers who are not presently using terracing. They felt they would be unfairly treated under the policy of full cost sharing for terracing. The small farmer who cannot afford the cost of terracing or slope modification or of the extra resources used to maintain such a modification was perceived as being unfairly treated, as were taxpayers, who could be expected to bear much of the cost.

Tax Credits and Loans

Fairness--As Table 39 indicates, both the policy of interest-free loans and that of an investment tax credit were viewed by most farmers as being either very fair or somewhat fair. Most ASCS directors also rated both these policies as very fair or somewhat fair. More ASCS directors may have rated the investment tax credit as being fair because of their familiarity with this widely used industry practice.

Participation Rate--As the data in Table 40 clearly indicate, both farmers and ASCS directors anticipate that a rather large number of farmers would take advantage of both the interest-free loan and the investment tax credit. The estimates of the number of farmers who would apply is almost identical for the two groups of respondents (approximately 56% for interest-free loans and approximately 64% for the investment tax credit). These estimates are noticeably higher than those for the policies included in Table 38.

Groups Unfairly Treated--Neither farmers nor ASCS directors perceived any group except taxpayers as being unfairly treated under either of these policies. ASCS directors were more sensitive to the issue of taxpayers being unfairly treated. As shown in Table 41, 40% of the directors, as compared to 16.7% of the farmers, thought taxpayers would be unfairly treated.

Required Development and Implementation of Soil Conservation Plans

Fairness--The two policies considered in this category differ in the specification of punitive measures for noncompliance. The first policy is a regulation requiring the development and implementation of an improved soil conservation plan. (The respondents were given no indication of penalties for

Table 39

Perceived Fairness of Tax Credit and Loan Proposals

POLICY	VERY FAIR	SOMEWHAT FAIR	SOMEWHAT UNFAIR	VERY UNFAIR	DON'T KNOW
	(percentage of respondents)				
4. Interest-Free Loans to Cover Farmer Cost of Soil Conservation Work					
(n=49) [Farmer]	44.9	30.6	16.3	6.1	2.0
(n=10) [ASCS]	40.0	30.0	30.0	----	----
5. Investment Tax Credit for Farmer Cost of Soil Conservation Work					
(n=37) [Farmer]	54.1	37.8	5.4	2.7	----
(n=10) [ASCS]	70.0	20.0	10.0	----	----

Table 40

Estimates of Percentage of Farmers that Would Likely Participate in Tax Credit and Loan Proposals

POLICY	RESPONDENTS	
	FARMERS	ASCS DIRECTORS
4. Interest-Free Loans to Cover Farmer Cost of Soil Conservation Work (n=47)	57.2	55.8
5. Investment Tax Credit for Farmer Cost of Soil Conservation Work (n=34)	63.5	64.6

Table 41

Groups Perceived as Being Most Unfairly
Treated by Tax Credit and Loan Proposals

POLICY/GROUP	PERCENTAGE OF RESPONDENTS FARMERS	ASCS DIRECTORS
4. Interest-Free Loans to Cover Farmer Cost of Soil Conservation Work (n=48)		
Taxpayers	16.7	40.0
Farmers Not Needing	6.3	----
Nonfarmers	----	10.0
5. Investment Tax Credit for Farmer Cost of Soil Conservation Work (n=38)		
Farmers Not Needing	7.9	----
Taxpayers	5.3	----
Farmer Without Loan	5.3	----
Nonfarmers	5.3	----

noncompliance or subsidies for cooperation.) As the data in Table 42 indicate, approximately 18% of responding farmers perceived this policy as very fair and 34% as somewhat fair. The ASCS directors were evenly divided on this proposal's fairness. It is somewhat surprising that half of the directors reacted negatively to the policy, given their involvement in the current soil conservation program. An explanation of this finding would require additional investigation.

The regulation prohibiting the deduction of real estate taxes from federal income tax unless an improved soil conservation plan has been developed and implemented was not viewed favorably by farmers. Approximately 65% of farmers perceived that it was in some way unfair. ASCS directors were evenly divided as to whether this policy was fair or unfair.

Cooperation Rate--As the data in Table 43 show, farmer respondents indicated that only approximately 45% of farmers would likely formulate and implement a soil conservation plan even if such plans were required. ASCS directors were somewhat more optimistic, estimating that approximately 62% of farmers would cooperate with such a policy. Surprisingly, both farmers and ASCS directors felt that only approximately 62% and 68%, respectively, of farmers would likely develop and implement a soil conservation plan, even with the prospect of being unable to deduct real estate taxes from their federal income tax if they failed to do so. This result may indicate a feeling that many farmers would find the amount of foregone tax a rather small price to pay for not having to complete and implement a soil conservation plan.

Groups Unfairly Treated--Farmers as a whole did not perceive any one group as being unfairly treated. As Table 44 indicates, however, several ASCS directors felt that all farmers would be unfairly treated if either policy were implemented. Again, this is interesting given the ASCS involvement in soil conservation programs.

Greenbelts

Fairness--Two of the policies covered in the survey deal with regulations requiring greenbelts along streams to improve water quality. The first policy would require a recreational greenbelt while the second requires a nonrecreational greenbelt. Surprisingly, 50% of responding farmers indicated that a recreational greenbelt was to some degree fair, while only one out of ten ASCS directors indicated that such a recreational greenbelt was at all fair. As shown in Table 45, responses are slightly more favorable for a policy requiring nonrecreational greenbelts along streams and drainage ditches. Approximately 60% of both farmers and ASCS directors felt that such a policy was to some degree fair.

Cooperation Rate--Again, as shown in Table 46, it is surprising that farmers expressed an anticipated cooperation rate of 41% for a recreational greenbelt and an anticipated cooperation rate of 36% for a nonrecreational greenbelt. Anticipated cooperation rates given by ASCS directors are more in line with what would be expected. They expressed an anticipated cooperation rate of approximately 20% for the policy requiring a recreational greenbelt and approximately 49% for a nonrecreational greenbelt.

Table 42

Perceived Fairness of Requiring Development and Implementation of Soil Conservation Plan Policies

	VERY FAIR	SOMEWHAT FAIR	SOMEWHAT UNFAIR	VERY UNFAIR	DON'T KNOW
	(Percentage of Respondents)				
6. Required Development and Implementation of Approved Soil Conservation Plan					
(n = 38)	18.4	34.2	15.8	26.3	5.3
(n = 10) [ASCS]	30.0	20.0	30.0	20.0	---
7. Prohibition of Deduction of Real Estate Taxes from Federal Income Tax Unless Approved Soil Conservation Plan is Developed and Implemented					
(n = 49)	12.2	22.4	16.3	49.0	---
(n = 10) [ASCS]	20.0	30.0	10.0	40.0	---

Table 43

Percentage of Farmers That Would Likely Cooperate with Policies Requiring Development and Implementation of a Soil Conservation Plan

POLICY	FARMERS	ASCS
6. Required Development and Implementation of Approved Soil Conservation Plan (n = 38)	44.6	61.6
7. Prohibition of Deduction of Real Estate Taxes from Federal Income Tax Unless Approved Soil Conservation Plan is Developed and Implemented (n = 47)	61.7	68.0

Table 44

Groups Perceived as Being Most Unfairly Treated by Policies Requiring Development and Implementation of a Soil Conservation Plan

POLICY/GROUP	PERCENTAGE OF RESPONDENTS FARMERS	ASCS DIRECTORS
6. Required Development and Implementation of Approved Soil Conservation Plan (n = 37)		
Everyone	13.5	--
All Farmers	10.8	20.0
Small Farmers	8.1	--
Tenants	5.4	--
Farmers Not Needing	--	10.0
7. Prohibition of Deduction of Real Estate Taxes from Federal Income Tax Unless Approved Soil Conservation Plan Is Developed and Implemented (n = 48)		
All Farmers	16.7	30.0
Landowners	12.5	--
Everyone	6.3	--
Taxpayers	--	10.0

Table 45

Perceived Fairness of Greenbelt Policies

	VERY FAIR	SOMEWHAT FAIR	SOMEWHAT UNFAIR	VERY UNFAIR	DON'T KNOW
		(Percentage of Respondents)			
8. Required Recreational Greenbelt					
(n = 49)	18.4	32.7	20.4	28.6	--
(n = 10) [ASCS]	--	10.0	30.0	60.0	--
9. Required Nonrecreational Greenbelt Along Streams and Drainage Ditches					
(n = 38)	28.9	31.6	10.5	23.7	5.3
(n = 10) [ASCS]	--	60.0	20.0	20.0	--

Table 46

Estimates of Percentage of Farmers That Would Likely Cooperate with Greenbelt Policies

POLICY	FARMERS	ASCS DIRECTORS
8. Required Recreational Greenbelt (n = 46)	41.5	20.4
9. Required Nonrecreational Greenbelt Along Streams and Drainage Ditches (n = 36)	36.4	48.6

Groups Unfairly Treated--A very high percentage of ASCS directors felt that farmers with land along streams would be unfairly treated by policies requiring greenbelts, especially if those greenbelts were recreational. As indicated in Table 47, 80% of the directors indicated that farmers along streams would be unfairly treated by a policy making recreational greenbelts mandatory. Fifty percent felt that farmers along streams would also be unfairly treated if nonrecreational greenbelts were required. Farmer respondents also indicated that those farmers with land along streams would be unfairly treated, but this group was mentioned less often than by ASCS directors. Twenty-eight percent of those respondents felt that farmers along streams would be unfairly treated by requiring recreational greenbelts, while approximately 27% listed that group for nonrecreational greenbelts.

Tables 48, 49, and 50 summarize the reactions of farmers to all of the 17 policies evaluated. Table 48 presents the responses on policy fairness, Table 49 summarizes the expected participation or cooperation rates, and Table 50 indicates the groups of individuals who farmers feel would be unfairly treated by such policies.

Additional Analyses of Responses

To aid in interpreting the responses for the policies discussed above, the relationship between those responses and two other factors were examined. First, the farmer respondents were classified into three groups according to the soil productivity index of their land to determine whether there was any correlation between that index and the farmers' perceptions of the fairness of each policy. Second, the respondents were classified according to whether or not they had completed a soil conservation plan for their farms. The fairness evaluations and the listings of groups that the farmers felt might be unfairly treated under each policy were then compared for those who had and those who had not completed a plan. The results are discussed below.

Soil productivity indices were constructed for each county by weighting, on the basis of expert judgment, the productivity indices for the major soil types in each county by the approximate acreage of each type. For analysis, the data were collapsed into three soil productivity ranges, with an approximately equal number of the farmers surveyed falling into each range. From these data, summarized in Table 51, it can be seen that soil productivity of the farmers' land, on the average, does not differentially affect their perceptions of the fairness of those policies relating to terracing and equivalent modifications. Within these three policies, there are only minor variations among the responses in each soil productivity range.

For policies relating to tax credits and interest-free loans for soil conservation work, the data in Table 51 indicate that the perceived fairness varies somewhat with the soil productivity of the responding farmer. These differences are not major, but do indicate that further study is needed if the adoption of either of these policies is to be seriously considered. A higher proportion of farmers with soil productivity indices of 130 or over felt that interest-free loans were fair than those with lower productivity indices. A slight reversal is noted for the policy of granting an investment tax credit.

Table 47

Groups Perceived as Being Most Unfairly Treated by Greenbelt Policies

POLICY/GROUP	PERCENTAGE OF RESPONDENTS FARMERS	ASCS DIRECTORS
8. Required Recreational Greenbelt (n = 49)		
Farmers Along Streams	28.6	80.0
All Farmers	10.2	--
Landowners	8.2	10.0
Cattle Farmers	6.1	--
9. Required Nonrecreational Greenbelt Along Streams and Drainage Ditches (n = 37)		
Farmers Along Streams	27.0	50.0
Farmers Who Pay for It	10.8	10.0
All Farmers	8.1	--

Table 48

Perceived Fairness Summary Table

(Farmer Respondents Only)

POLICY	FAIR*	UNFAIR†	DON'T KNOW
	(Percentage of Respondents)		
Cost Sharing for Terracing and Equivalent Modifications			
1. 50% Cost Sharing for Terracing (n = 36)	69.1	27.8	2.8
2. Full Cost Sharing for Terracing (n = 49)	77.5	16.4	6.1
3. 50% Cost Sharing for Slope Modification (n = 36)	55.6	33.3	11.1
Tax Credits and Loans for Soil Conservation and Pollution Abatement Work			
4. Interest-free loans to Cover Cost of Soil Conservation Work (n = 49)	75.5	22.4	2.0
5. Investment Tax Credit for Cost of Soil Conservation Work (n = 37)	91.9	8.1	-
Development and Implementation of Soil Conservation Plans			
6. Required Development and Implementation of Approved Soil Conservation Plan (n = 38)	52.6	42.1	5.3
7. Prohibition of Deduction of Real-estate Taxes from Federal Income Tax Unless Approved Soil Conservation Plan is Developed and Implemented (n = 49)	34.6	65.3	-
Development of Greenbelts Bordering Waterways			
8. Required Recreational Greenbelt (n = 49)	51.0	49.0	-
9. Required Nonrecreational Greenbelt Along Streams and Drainage Ditches (n = 38)	60.5	34.2	5.3

*Total of very fair and somewhat fair.

†Total of somewhat unfair and very unfair.

Table 48 (continued)

POLICY	FAIR*	UNFAIR†	DON'T KNOW
	(Percentage of Respondents)		
Soil Losses, Tillage Practices, and Terracing			
10. Prohibition of Fall Moldboard Plowing (n = 49)	30.6	69.4	-
11. Required Conservation Tillage (n = 35)	42.8	57.2	-
12. Soil Losses Required to Be Less than 3 Tons per Acre (n = 44)	60.1	39.9	-
13. Soil Losses Required to Be Less than 5 Tons per Acre (n = 35)	57.2	42.8	-
14. Required Contouring or Terracing on Slopes Greater than 9% (n = 49)	67.4	32.6	-
Use of Nitrogen Fertilizer			
15. Nitrogen Application Limit of 100 lbs (n = 38)	34.2	65.8	-
16. Nitrogen Tax of 20¢/lb (n = 46)	10.9	89.1	-
17. Nitrogen Tax of 10¢/lb (n = 38)	5.2	94.8	-

*Total of very fair and somewhat fair.

†Total of somewhat unfair and very unfair.

Table 49

Participation/Cooperation Rates Summary Table (Farmers Only)

POLICY	PERCENTAGE OF FARMERS THAT WOULD LIKELY PARTICIPATE
Cost Sharing for Terracing and Equivalent Modifications	
1. 50% Cost Sharing for Terracing (n = 29)	36.1
2. Full Cost Sharing for Terracing (n = 41)	43.4
3. 50% Cost Sharing for Slope Modification (n = 26)	26.5
Tax Credits and Loans for Soil Conservation and Pollution Abatement Work	
4. Interest-free Loans to Cover Cost of Soil Conservation Work (n = 47)	57.2
5. Investment Tax Credit for Cost of Soil Conservation Work (n = 34)	63.5
Development and Implementation of Soil Conservation Plans	
6. Required Development and Implementation of Approved Soil Conservation Plan (n = 38)	44.6
7. Prohibition of Deductions of Real-estate Taxes from Federal Income Tax Unless Approved Soil Conservation Plan is Developed and Implemented (n = 47)	61.7
Development of Greenbelts bordering Waterways	
8. Required Recreational Greenbelt (n = 46)	41.5
9. Required Nonrecreational Greenbelt Along Streams and Drainage Ditches (n = 36)	36.4
Soil Losses, Tillage Practices, and Terracing	
10. Prohibition of Fall Moldboard Plowing (n = 49)	43.0
11. Required Conservation Tillage (n = 35)	39.7
12. Soil Losses Required to Be Less than 3 Tons per Acre (n = 44)	53.8
13. Soil Losses Required to Be Less than 5 Tons per Acre (n = 35)	55.2

Table 49 (continued)

POLICY	PERCENTAGE OF FARMERS THAT WOULD LIKELY PARTICIPATE
14. Required Contouring or Terracing on Slopes Greater than 9% (n = 49)	45.0
Use of Nitrogen Fertilizer	
15. Nitrogen Application Limit of 100 lbs/acre (n = 38)	40.7
16. Nitrogen Tax of 20¢/lb (n = 46)	58.9
17. Nitrogen Tax of 10¢/lb (n = 38)	47.1

Table 50

Summary of Groups Perceived by Farmers as Being Most Unfairly Treated

POLICY \ GROUP*	ALL FARMERS	FARMERS NOT NEEDING	TAX-PAYERS	FARMERS ALONG STREAMS	EVERY-ONE	FARMERS WITH FLAT LAND	ROLLING FARMS	NITROGEN USERS	THOSE DESIRE HIGH YIELD
	(Percentage of Respondents)								
1. 50% Cost Sharing for Terracing		22.9	5.7						
2. Full Cost Sharing for Terracing		27.7	12.8						
3. 50% Cost of Sharing for Slope Modification		21.9	6.3						
4. Interest-free Loans to Cover Cost of Soil Conservation Work		6.3	16.7						
5. Investment Tax Credit for Cost of Soil Conservation Work		7.9	5.3						
6. Required Development and Implementation of Approved Soil Conservation Plan	10.8				13.5				
7. Prohibition of Deduction of Real Estate Taxes From Federal Income Tax Unless Approved Soil Conservation Plan is Developed and Implemented	16.7				6.3				
8. Required Recreational Greenbelt	10.2			28.6					
9. Required Nonrecreational Greenbelt along Streams and Drainage Ditches	8.1			27.6					

*Only those groups which are perceived as being unfairly treated by 15% or more of the farmers under at least one policy are included.

Table 50 (continued)

POLICY \ GROUP*	ALL FARMERS	FARMERS NOT NEEDING	TAX-PAYERS	FARMERS ALONG STREAMS	EVERY-ONE	WITH FLAT LAND	ROLLING FARMS	NITROGEN USERS	THOSE DESIRE HIGH YIELD
	(Percentage of Respondents)								
10. Prohibition of Fall Moldboard Plowing†	12.2				2.0	32.7			
11. Required Conservation Tillage	11.4				5.7	17.1			
12. Soil Losses Required to be Less Than 3 Tons Per Acre	11.4				2.3		15.9		
13. Soil Losses Required to be Less Than 5 Tons Per Acre	14.3				8.6		17.1		
14. Required Contouring or Terracing on Slopes Greater than 9%	6.1						6.1		
15. Nitrogen Application Limit of 100 lb/acre	13.2				10.5			5.3	26.3
16. Nitrogen Tax of 20¢/lb	37.5				8.3			20.8	2.1
17. Nitrogen Tax of 10¢/lb	31.6				26.3			18.4	2.6

*Only those groups which are perceived as being unfairly treated by 15% or more of the farmers under at least one policy are included.

†A group "Farmers Who Need to Plow" was identified for this policy.

Table 51

Relationship Between Perceived Fairness of Policies and Respondent's Soil Productivity Index

	PRODUCTIVITY INDEX	VERY FAIR	SOMEWHAT FAIR	SOMEWHAT UNFAIR	VERY UNFAIR
		(Percentage of Respondents)			
1. Full Cost Sharing for Cost of Terracing	<115	38.5	53.8	0	7.7
	115 - 130	29.4	52.9	5.9	11.8
	>130	31.3	43.8	18.8	6.3
2. 50% Cost Sharing for Cost of Terracing	<115	25.0	50.0	12.5	12.5
	115 - 130	36.4	36.4	27.3	0
	>130	37.5	31.3	12.5	18.8
3. 50% Cost Sharing for Slope Modification	<115	28.6	28.6	28.6	14.3
	115 - 130	20.0	50.0	30.0	0
	>130	33.3	26.7	26.7	13.3
4. Interest-free Loans to Cover Farmer Cost of Soil Conservation Work	<115	46.2	30.8	15.4	7.7
	115 - 130	44.4	27.8	22.2	5.6
	>130	47.1	35.3	11.8	5.9
5. Investment Tax Credit for Farmer Cost of Soil Conservation Work	<115	66.7	33.3	0	0
	115 - 130	54.5	36.4	9.1	0
	>130	47.1	41.2	5.9	5.9
6. Required Development and Implementation of Approved Soil Conservation Plan	<115	22.2	33.3	22.2	22.2
	115 - 130	18.2	36.4	18.2	27.3
	>130	18.8	37.5	12.5	31.3
7. Prohibition of Deduction of Real Estate Taxes from Federal Income Tax Unless Approved Soil Conservation Plan Is Developed and Implemented	<115	14.3	28.6	14.3	24.9
	115 - 130	16.7	16.7	16.7	50.0
	>130	5.9	23.5	17.6	52.9
8. Required Recreational Greenbelt Along Streams	<115	14.3	28.6	14.3	42.9
	115 - 130	22.2	38.9	22.2	16.7
	>130	17.6	29.4	23.5	29.4
9. Required Nonrecreational Greenbelt Along Streams and Drainage Ditches	<115	33.3	44.4	0	22.2
	115 - 130	40.0	20.0	10.0	30.0
	>130	23.5	35.3	17.6	23.5

Neither of the policies relating to required soil conservation plans appeared fair to a large proportion of responding farmers, but the data in Table 51 indicate that there are no variations in perceived fairness based on the soil productivity of the respondents.

Farmers with either low- or high-productivity soil are more apt to perceive a policy requiring recreational greenbelts as unfair than are those with land of moderate productivity. Table 51 also clearly indicates that over one-half of the responding farmers in these two categories perceive this policy as unfair. A considerably lower but still substantial proportion (between 22% and 51%) of farmers view a nonrecreational greenbelt as unfair. Also, the more productive the land of the responding farmer, the more apt he is to view this policy as unfair. No data are available to indicate whether farmers who have streams and drainage ditches on their property perceive the fairness of greenbelts differently from those who do not.

Not reported in tabular form are the data for the perceived fairness of each policy versus the number of acres that the respondents have in row crops. Similar to the data reported in Table 51, those farmers with 200 to 300 acres in row crops are less apt to judge each policy as fair than farmers with either either more or less acreage in row crops. This seeming inconsistency may disappear, or be explained, with further research into basic causes of these judgments.

Of particular interest is the question of whether those farmers who have developed a soil conservation plan perceive the fairness of the policies under study differently from those who have not developed such a plan. Almost all farmers who have developed a plan have worked with the SCS and have been advised on the most appropriate soil conservation practices for their individual operations.

In Table 52, the perceived fairness of the nine policies is tabulated both for those respondents who have completed a soil conservation plan and for those who have not. It is apparent from these data that having developed a plan does not greatly affect the evaluation of fairness except for two of the policies. First, farmers who have completed a plan perceive the policy of providing interest-free loans as less fair than do those who have not completed a plan. Second, there are noticeable differences for the policy of requiring the development of a soil conservation plan. Approximately 66% of those who have not developed a soil conservation plan perceive this policy as to some degree fair, while only 44% of those who have such a plan think it fair. More dramatic, however, is the large percentage of those having a plan (39%) who perceive the policy as very unfair. This finding suggests that some serious objections might arise if this policy were adopted--not on the part of those who would be required to develop plans but from those who have completed their plan without the benefit of such a policy.* One possible explanation is that farmers may feel it is unfair to those who have personally paid for their own plan rather than unfair to farmers who would take advantage of the proposed policy.

*The categories of individuals who would be unfairly treated were quite general: all farmers, everyone, and small farmers.

Table 52

Evaluation of Policy Fairness by Farmers Who Have as Compared to Those Who Have Not Developed a Soil Conservation Plan

POLICY	SOIL CONSERVATION PLAN DEVELOPED?	VERY FAIR	SOMEWHAT FAIR	SOMEWHAT UNFAIR	VERY UNFAIR
		(Percentage of Respondents)			
1. Full Cost Sharing for Cost of Terracing	(Yes)	25.8	51.7	9.7	12.9
	(No)	46.7	46.7	6.7	0
2. 50% Cost Sharing for Cost of Terracing	(Yes)	33.3	44.4	11.1	11.1
	(No)	35.3	29.4	23.5	11.8
3. 50% Cost Sharing for Slope Modification	(Yes)	26.7	33.3	33.3	6.7
	(No)	29.4	35.3	23.5	11.8
4. Interest-free Loans to Cover Farmer Cost of Soil Conservation Work	(Yes)	37.5	34.4	21.9	6.3
	(No)	62.5	25.0	6.3	6.3
5. Investment Tax Credit for Farmer Cost of Soil Conservation Work	(Yes)	57.9	36.8	5.3	0
	(No)	50.0	38.9	5.6	5.6
6. Required Development and Implementation of Approved Soil Conservation Plan	(Yes)	22.2	22.2	16.7	38.9
	(No)	16.7	50.0	16.7	16.7
7. Prohibition of Deduction of Real Estate Taxes from Federal Income Tax Unless Approved Soil Conservation Plan is Developed and Implemented	(Yes)	15.6	18.8	18.8	46.9
	(No)	5.9	29.4	11.8	52.9
8. Required Recreational Greenbelt Along Streams	(Yes)	21.9	31.3	18.8	28.1
	(No)	11.8	35.3	23.5	29.4
9. Required Nonrecreational Greenbelt Along Streams and Drainage Ditches	(Yes)	41.2	23.5	11.8	23.5
	(No)	21.1	42.1	10.5	26.3

The data in Table 52 reveal some other noteworthy differences in perceptions of fairness both within and between policies depending on whether the responding farmer has or has not developed a soil conservation plan. For instance, for the policy of granting full cost sharing for terracing, farmers *without* a soil plan are almost unanimous in perceiving this policy as fair while over 20% of farmers *with* a plan find this policy unfair, but 35% of farmers *without* a plan also find it unfair.

The results reported here must be understood and interpreted in the context of a basic knowledge of farmer practices and of the discussions included in the remainder of this report. Depending on how the data are combined and interpreted, they can support several conclusions. It should be remembered, however, that these data are not intended to be definitive but rather to suggest directions for future work. Few of the results are sufficiently clear-cut to provide more than general guidance in the policy formulation process.

CHAPTER 7

EQUITY

Optimality in public finance and expenditure generally involves consideration of three aspects: (1) economic efficiency, (2) administrative efficiency, and (3) equity (Sandmo, 1976). The first aspect was analyzed in Chapter 4 and the second was discussed in Chapter 5. In each of these cases the social goal is to minimize costs and maximize benefits subject to political or technical constraints. Equity considerations, in contrast, involve judgments on the fairness of the distribution of benefits and burdens caused by public policies. Such judgments depend, by necessity, on criteria more complex than simple maximization or minimization of benefits or costs.

It is the purpose of this section to develop criteria for judging the equity of six alternative policies for the control of nonpoint-source agricultural water pollution. These criteria will be largely, but not wholly, subjective. The applicability of data such as those reported in Chapter 6 (the farmer attitude survey) are limited because of the difficulty of separating self-interest motives from equity motives in the respondents' judgments of "fairness." While the survey technique is well suited to gathering data on "perceived fairness," the results are better interpreted as a measure of the public's fondness of a particular policy than as a judgment on the policy's inherent equitableness.

The difficulty in interpreting the survey results as a measure of equity stems from the abuse of the words *equity* and *fairness* in common usage. A farmer may, for example, insist vehemently that a proposed policy would treat him unfairly. When asked, he will support his contention by showing how much he stands to lose in relation to others if the policy is implemented. This evidence in itself, however, is not sufficient cause for labeling the proposal "unfair." Others may gain more than he will lose. Or possibly the farmer's present income is in part the result of an unfair advantage over other farmers or water users, an advantage he would lose if the policy is implemented. If pressed, the farmer will likely defend his position by claiming that the proposal will affect him counter to some commonly accepted standard of justice: "A man is free to use his property as he pleases" is a typical argument against land-use regulation. "All citizens should contribute a fair share to provide for public services" underlies the complaint against "over"-taxation.

Ordinarily, however, one would not guide the farmer through such a theoretical discussion to determine the basis of his claim to unfair treatment. One would accept his contention that he thinks the policy is unfair. Without questioning the logic of each individual's assertion, we cannot be certain

(1) that the underlying criterion of fairness is one which is generally accepted or (2) that the proposal actually violates the criterion. Consequently, "unfair" is inappropriately applied to many situations.

If the farmer in the example did a thorough job of explaining his reasons for considering himself unfairly treated, he would probably present not merely one criterion of fairness but several. He might claim, from one perspective, that his share of the tax burden was disproportionate to the benefits he was receiving. He might then add, for example, that the interests of the country would be best served by allowing his enterprise to flourish without governmental interference. Some justifications would, of course, be emphasized more than others. The ones he would choose to emphasize more might be selected because of the intensity of his beliefs or because he thought they would be better received by his audience. In either case they would form an explicit justification of a position which the farmer would probably have seen as intuitively correct from the outset. The plausibility of his defense would depend on the audience's acceptance of his criteria and their knowlege of the facts.

This process of revealing the underpinnings of intuitive beliefs is especially important for policy makers. A "feel" for the fairness of a policy is not sufficient for evaluating the far-reaching effects of modern regulatory laws. Though an individual's unexamined use of the fairness concept may be tolerated, the promulgation of predictably unfair laws should not. The purpose of this section is to develop equity criteria capable of culling out in advance policies which would be regarded as reasonably unfair from a societal perspective.

EQUITY BASES

People act on the basis of experience. They learn from experience. With time they adjust their opinions to more adequately reflect their expanded knowledge. In this respect the fairness criteria are no different from any other opinions. They change with the accumulation of experience. If a person's beliefs change too rapidly--that is, on the basis of too little additional experience--the person is considered fickle or capricious. If they do not change fast enough, the person may be regarded as dogmatic or out of touch with reality. Ordinarily, people strike a reasonable compromise between consistency and relevancy.

This individual reaction to changed circumstances has its counterpart at the societal level. To the extent that people in a society are affected by the same sets of institutions--schools, churches, bureaucracies--and are subjected to the same natural events, it might be expected that they would share similar conceptions of fairness. With time, it would also be expected that their sentiments would change at somewhat similar rates, gradually adjusting to different circumstances. If the government does not react to the changing mood of society, its laws become outdated. If it is too quick to react to slight changes in public opinion, the laws will lack continuity. Once again, it is necessary to compromise between relevancy and consistency, this time at a policy-making level.

Just as it is inadequate to determine whether a policy is fair on the basis of intuition, it is also improper for policy makers to leave the compromise between relevancy and consistency to common sense or intuition. Equity criteria must be selected explicitly because they reflect an historical trend of the recent past or because they conform to a current ethical sentiment of particular significance. A proper selection of criteria will make it possible to anticipate the ethical trend of the near future, accepting a certain lack of specificity in exchange for increased longevity. With this approximated trend as a model, prospective policies can be compared to see how closely they parallel the sentiments of society. This final comparison will naturally involve subjective weightings of values; but, in contrast to the intuitive approach to policy making, these judgments should be constrained as a result of the analysis oulined here.

EQUITY CRITERIA

In a reasonably open political system, social values eventually become incorporated into social institutions. As a consequence, stable institutions generally reflect a set of similarly stable social ethics. Likewise, dynamic institutions usually imply the existence of social values with a growing popular base. By examining institutions, we should be able to determine both the durability and potency of certain equity criteria. It may be asserted that social values fall into a lexicographic hierarchy. Maintenance of public health, for example, could be held as uncompromisable regardless of economic or other considerations. In theory, such orderings have easily predictable effects, but in practice they tend to rely upon less rigid criteria of the type to be developed in this section. For this reason, we have excluded lexicographic value orderings from the analysis.

In our culture, the following three criteria for judging the equity effects of policies seem to be particularly influential:

1. Equality: Those policies which reduce income or wealth differences in the population are seen as equitable.
2. Earned Rewards: Those policies which improve the degree to which individuals pay for benefits received and are compensated for costs incurred are considered equitable.
3. Least Risk: Policies which increase conservation of resources for future generations or decrease dependence on technical processes that may have adverse future consequences are regarded as equitable.

Equality

In our society, democracy is the accepted form of government. Over the past two centuries the principle of political equality has been reaffirmed by continued efforts to make our system conform to that principle in practice as well as in theory. Democracy, or the equality norm in a political context, has shown itself to be both durable as a norm and dynamic in its influence.

As might be expected, the increased conformance to the political equality norm has been paralleled by increased demand for economic equality. Evidence of this phenomenon can be seen in the implementation of a progressive income tax, extensive public welfare programs, and an array of more specific anti-poverty measures. The purpose of these initiatives has been to compensate for disparities arising from differences in wealth and heritage. From a political point of view, the amount of economic inequality permissible has been declining since 1890 (Goode, 1976).

The use of an equality criterion of fairness in evaluating policy is justified by the pattern of institutional change outlined above. The version of the equality criterion to be considered here asserts that each individual is entitled to a similar economic status regardless of the comparative advantages he may possess. Any policy which in the short run diminishes the difference between high- and low-income groups in this country will be regarded favorably under this standard. Standing alone, out of context, this criterion seems extreme. Absolute equality is not an ideal situation. The use of "equality" when complemented by the remaining criteria in a policy analysis model, however, returns this criteria to an appropriate context.

Employing this criterion in pollution, those best able to bear the costs of control would be expected to finance the appropriate measures, irrespective of the pollution's source. Further, the elimination of the pollutant should most benefit the least advantaged.* A poor farmer with steeply sloped fields would, for example, benefit more from a subsidized terracing program to reduce erosion than would a wealthier farmer on level terrain. The subsidy's cost, on the other hand, would be supported in conformance with the equality doctrine through a progressive income tax.

It should be noted that while a policy may adhere to the equality criterion in a restricted situation, it may not be egalitarian when seen in a more general context. The "poor" farmer in the example may be better situated, financially, than the average income tax payer. Or it may be that the urban poor would be better served by a job training bill than would the rural poor by a terracing subsidy program of equal cost. Both of these situations would be undesirable following the equality norm since the policy would not bring the greatest benefit to the least advantaged.

Earned-rewards Principle

The nation's economic system is another enduring institution. The theoretical rationale associated with that system embodies another set of social values. One axiom typically aired is that individuals attempt to maximize utility. That is, a person uses his resources, be they land, labor, or capital, in such a way as to maximize his satisfaction. With the assumption that society as an aggregate holds the same values as its members do individually, we can deduce the even more important precept that a nation should achieve the greatest benefit or satisfaction for the greatest number of its citizens. If

*The notion that government should benefit the least advantaged most has been popularized by John Rawls as the "difference principle" (Rawls, 1971).

it does not, the government is promoting an inefficient distribution of benefits: the level of satisfaction would rise if appropriate policies were changed.

Since the satisfaction caused by eating food, for example, is difficult to measure and impossible to use in interpersonal comparisons, economic theorists have accepted the principle of market evaluation of utility or satisfaction. A good's (or a service's) value is its price in relation to other goods (or services) in the marketplace. An orange may be worth two apples, or 1,000 bushels of corn may equal the cost of installing a system of land terraces. By this rationale, people get as much satisfaction from receiving an orange (or 1,000 bushels of corn) as they do from two apples (or a system of teraces).

Individual economic inputs (i.e., land, labor, and capital) are valued in our economic system by their contribution to the total value of the final product. Thus a product's market value is the sum of its inputs' true costs, including reasonable profits. If an input, say labor, is increased by adding one more hour, the total value of the good produced increases. The difference between the original total value and the new total value is the worth of the additional hour's labor. In short, an individual's reward should be proportionate to his contribution.

Our second criterion of equity reflects this aspect of economic theory and is termed the earned-rewards principle. It states that those who receive the benefit of a good or service should pay its cost of production. It rests on the ethic of earned rewards. Forcing someone to accept a cost for which compensation is not received would be inequitable, as would bestowing a benefit on someone who will not pay its true cost.

The first of two critical factors in applying the earned-rewards principle is political scope, an element also important in the case of the equality criterion. The Benthamite goal of the greatest good for the greatest number can be applied to any convenient division of mankind (Bentham, 1823). For the present purposes, "greatest number" is presumed to refer to citizens of this nation. An overall evaluation of benefits and costs must then be made in a national context. Though farmland erosion into streams may, for example, prevent certain water uses, if a change in policy altering the situation would result in a loss to society greater than the gain to society, application of this principle implies that the alteration in policy would be unwarranted, since any redistribution of benefits and burdens would be less efficient in providing the greatest good for the greatest number.

This criterion, in addition to being applied on a national scale, can be, and commonly is, applied at a more micro level. A policy change can be evaluated in terms of whether individuals in society are impacted appropriately. For example, polluters may be expected to pay the costs of cleaning up, just as consumers are expected to pay the full costs of the products and services they purchase. To the extent that polluters are unable to shift the costs of pollution control through increased product prices or decreased wages for labor, the earned-rewards principle is synonymous with the "polluter pays" principle. The latter principle has definite intuitive appeal in that the polluter is, in some sense, the wrongdoer and is forced to bear the entire cost of his actions. In practice, however, pollution control is typically considered an additional cost rather than an unshiftable tax on the polluter's profits. Hence, some or all of the expense of pollution control will be shifted, depending upon the level of competition and mobility of capital and labor in the polluting industry (Pechman, 1977). For the purposes of this section, it has been assumed that, although shifting occurs, it is not complete: farmers and consumers share the cost of pollution control.

Time is the second critical factor affecting the earned-rewards principle. Farmland erosion may, for example, be filling up a reservoir with silt. Should the farmers pay the cost of dredging since the soil loss is one of the costs of producing the benefit (the crop)? Or should those who benefit from the reservoir pay the cost since, before the dam blocked the way, silt flowed harmlessly down the river (ignoring, for the moment, other ill effects)? One solution to this dilemma is to determine the situation before either the dam or agriculture affected the river and let that be the benchmark level of silt from which costs and benefits are calculated. If silt loss from a farmer's fields is equal to or less than it would be if the land were in a "natural" forest or grass state, dredging would be the reservoir users' responsibility. If it exceeded the "natural" level, the cost of dredging this excess would be assigned to the farmer (Mishan, 1971).

The time or priority issue is often analyzed in terms of property rights (Coase, 1960; Mishan, 1971). The crucial factor in this interpretation is the ownership of pollution rights. Simply put, the level of contamination will vary depending upon whether the polluter or the pollutee holds the property right to pollute (Mishan, 1971). If it is assumed that farmers have historically been allowed to drain their lands into neighboring streams regardless of the effect on water quality and have come to consider this a "right," any movement toward increased water quality will depend on the appropriation of some portion of the farmers' "right" to pollute. On the other hand, if reservoir users controlled the right to pollute, stream quality would equal or exceed the "natural" level mentioned in the previous paragraph. If it is judged that the natural level of pollution is the proper benchmark, equity under the earned-rewards criterion requires either that polluters pay the cost of sediment damage in excess of the benchmark or that reservoir users pay for the privilege of lower-than-natural silt deposition rates.

This earned-rewards approach to costs and benefits requires that we distinguish between overlapping groups of consumers. Forcing a farmer to pay for soil conservation may raise the price of his product--corn, for instance. Since everyone eats corn directly or indirectly, everyone will help pay the cost of this control measure in proportion to the amount consumed. If the erosion control were subsidized, taxes, not prices, would go up and, once again, everyone would be affected. The incidence, however, would be different. Unless the subsidy were financed by a sales tax or a production tax on corn, distribution of soil conservation costs would not be proportionate to the amount of benefit (corn) consumed. Though beneficiaries of subsidy and regulatory policies may be the same in the aggregate, the patterns of benefit and cost incidence differ. As a consequence, a regulation requiring farmers to reduce soil erosion would be considered superior to a subsidized soil conservation program. An effluent tax on soil loss, as a tax on production capable of being shifted to the consumer in the form of increased prices, would also be regarded favorably under the earned-rewards criterion.

Least-risk Criterion

The two previous criteria are nondeterministic. There is no blatant bias in their conception of the future: the equality and earned-rewards criteria can be espoused in relative independence of time factors. They do not implicitly predict the future course of social change. Though this characteristic may be regarded by some as a flaw, it is the basis of their durability. Concepts which attempt to predict the uncertain are generally short-lived.

Our third criterion, nevertheless, anticipates an historical trend. The fact that the anticipated trend is a physical rather than an ethical one, however, may make it less unpredictable. The earth has limited resources. Depletion of one resource means increased reliance on those remaining. This means less flexibility and higher costs in meeting the needs of society in the future, assuming a constant level of technology. As resources are depleted, the risk that the next shortage may not have an adequate solution is increased.

This viewpoint has had periods of wide popularity. In the late 18th century and again in the late 19th century, grim predictions were made about the effects of resource consumption, especially by the affluent British. In each instance, the power of technological innovation and the impact of new frontiers were underestimated. The recent resurgence of concern has occurred at a time when technological alternatives have become increasingly sophisticated. Because of what is perceived as the radical nature of those alternatives and because of their uncertain long-term effect, many believe that technological innovation can no longer safely handle the problems of resource depletion.

The criterion of fairness implicit in this belief is that of least risk to the majority. Risk could be minimized, for example, by postponing the implementation of an invention until there has been time to discover any adverse effects, even though the invention would be capable of increasing productivity. Those supporting this criterion demonstrate an aversion to risk, an aversion which is generally concentrated in those who are comparatively affluent. The same risk is often of less significance to those with less at stake. This follows from the assumption that those individuals deriving a higher-than-average standard of living from the earth's resources have a higher-than-average desire to maintain the status quo (Schumacher, 1973). "Average" may refer to an historical average or to a current national or global median. In a society supporting this criterion, any policy designed to accelerate resource use or employ radical technologies would be considered inequitable to the majority: the risk would outweigh the possible benefit.

While this rationale may be the prime motivating factor behind the least-risk criterion, there is another, more altruistic, aspect of the principle. By adhering to the least-risk ethic, today's society assumes a responsibility to preserve natural resources for future generations. In the case of soil erosion, the intensity of production may be reduced at present to assure a productive resource for future generations. The conservative approach to adoption of technology provides an aging process for radical innovations, curing them of potential long-term ill effects. In terms of equity between generations, this criterion favors a more even distribution of the earth's natural endowment.

When applied to environmental issues, this standard is characterized by a preference for low-risk, conventional technology and by a desire to conserve known resources. The unknown long-term effects of certain chemical fertilizers and pesticides should encourage a bias toward natural crop growth processes (Schumacher, 1973). The rising world population and the fragile constitution of many green revolution plant varieties may also reinforce preferences for more conservative methods of cultivation. The future cost of reservoir dredging or replacement and reductions in soil productivity motivates programs (such as that of the Soil Conservation Service) which are designed to keep sediment from reaching the reservoirs. Our state of comparative affluence makes risk avoidance, by this argument, imperative. This criterion might be called a maturity ethic encouraging, as it does, conservation and technological retrenchment (Georgescu-Roegen, 1975).

POLICY IMPLICATIONS OF CRITERIA

In Chapter 3 of this report six prospective policies for controlling nonpoint-source water pollution are presented. To analyze these six alternatives in terms of the criteria developed in this section, we have constructed three matrices (Tables 53, 54, and 55), highlighting the equity effects of the various policies on selected societal groupings. The categories within the "general" perspective offer the most general tests for conformity to the criteria. The more focused "agricultural" and "water users" perspectives present the equity effects on subgroups within the agricultural sector and on a number of groups outside agriculture affected by agricultural water pollution.

Each policy has been rated on conformity to a criterion as follows:

strongly consistent	++
consistent	+
no effect	NE
inconsistent	-
strongly inconsistent	--
consistency undertermined	U
mixed effects*	M

These ratings are done on a subjective basis. The value of the ratings is to show what can be accomplished in the analysis of equity issues. While there will be differences of opinion, addressing the issues should be instructive to policy makers.

*This designation can be interpreted as meaning either that some members of the group are affected "-" and some affected "+", or that the same member is affected both "-" and "+".

Table 53

Equity Effects of Alternative Policies Under the Equality Criterion

PERSPECTIVE \ POLICY	1 EDUCATION	2 50% COST SHARING FOR TERRACING	3 TAX CREDIT	4 SOIL CONSERVATION PLAN DEVELOPMENT	5 SOIL CONSERVATION PLAN IMPLEMENTATION	6 GREENBELT
GENERAL						
Consumers of Agricultural Products	U	+	+	U	- -	- -
Income Tax Payers	U	M	M	U	U	U
AGRICULTURAL						
High Soil Erodability/ Low Soil Erodability	+ / +	++ / ++	++ / ++	+ / +	- - / - -	- - / - -
Land Adjacent to Streams/ Land Away from Streams	U / U	U / U	U / U	U / U	U / U	U / U
Owners/ Renters	+ / +	+ / +	+ / +	+ / +	++ / ++	U / U
Current Owners/ Future Owners	U / U	U / U	U / U	U / U	U / U	U / U
CONSERVATION EQUIPMENT MANUFACTURERS		- -	-	-	- -	NE
WATER USERS						
Other Area Landowners	M	M	M	M	M	M
Municipal Water Supplies	+	++	++	+	++	++
Reservoir Beneficiaries (flood control)	M	M	M	M	M	M
Water Recreation Users	M	M	M	M	M	M
Industrial Water Users	-	- -	- -	-	- -	- -
Commercial Fishing Industry	M	M	M	M	M	M

++ = strongly consistent
\+ consistent
NE = no effect
\- = inconsistent
-- - strongly inconsistent
U = consistency undetermined
M mixed effects

Table 54

Equity Effects of Alternative Policies Under the Earned-rewards Criterion

PERSPECTIVE \ POLICY	1 EDUCATION	2 50% COST SHARING FOR TERRACING	3 TAX CREDIT	4 SOIL CONSERVATION PLAN DEVELOPMENT	5 SOIL CONSERVATION PLAN IMPLEMENTATION	6 GREENBELT
GENERAL						
Consumers of Agricultural Products	+			+	++	++
Income Tax Payers					++	++
AGRICULTURAL						
High Soil Erodability/ Low Soil Erodability	+ / NE	/ NE	/ NE	+ / NE	++ / NE	++ /
Land Adjacent to Streams/ Land Away from Streams	U / U	U / U	U / U	U / U	U / U	M /
Owners/ Renters	+ /	/	/	+ /	++ /	++ / +
Current Owners/ Future Owners	NE / NE	NE / NE	NE / NE	NE / NE	NE / NE	NE / NE
CONSERVATION EQUIPMENT MANUFACTURERS	NE	NE	NE	NE	NE	NE
WATER USERS						
Other Area Landowners	+	+	++	+	++	++
Municipal Water Supplies	+	+	++	+	++	++
Reservoir Beneficiaries (flood control)	+	+	++	+	++	++
Water Recreation Users	+	+	++	+	++	++
Industrial Water Users	+	+	++	+	++	++
Commercial Fishing Industry	+	+	++	+	++	++

++ = strongly consistent
\+ = consistent
NE = no effect
inconsistent
-- = strongly inconsistent
U consistency undetermined
M mixed effects

Table 55

Equity Effects of Alternative Policies Under the Least-risk Criterion

PERSPECTIVE \ POLICY	1 EDUCATION	2 50% COST SHARING FOR TERRACING	3 TAX CREDIT	4 SOIL CONSERVATION PLAN DEVELOPMENT	5 SOIL CONSERVATION PLAN IMPLEMENTATION	6 GREENBELT
GENERAL						
Consumers of Agricultural Products		+	++		++	-
Income Tax Payers		+	++		++	
AGRICULTURAL						
High Soil Erodability/ Low Soil Erodability	/ NE	+ / NE	++ / NE	/ NE	+ / NE	
Land Adjacent to Streams/ Land Away from Streams		+ / +	++ / ++		+ / +	++ /
Owners/ Renters	/ NE	+ / NE	++ / NE	/ NE	+ / NE	
Current Owners/ Future Owners	/ +	+ / +	++ / ++	/ +	+ / ++	
CONSERVATION EQUIPMENT MANUFACTURERS	NE	NE	NE	NE	NE	NE
WATER USERS						
Other Area Landowners	+	+	+	+	+	+
Municipal Water Supplies	+	+	++	+	++	++
Reservoir Beneficiaries (flood control)	+	+	++	+	++	++
Water Recreation Users	+	+	++	+	++	++
Industrial Water Users	+	+	++	+	++	++
Commercial Fishing Industry	+	+	++	+	++	++

++ strongly consistent
\+ consistent
NE no effect
inconsistent
-- strongly inconsistent
U consistency undetermined
M = mixed effects

Conformity to the Equality Criterion

Table 53 presents the results of using the equality criterion to judge the extent to which the policies diminish the difference between high- and low-income groups in this country in the short run. A short-run period of not more than about five years was chosen to simplify the analysis of policy effects. Technological, demographic, and other exogeneous changes are likely to have significant impacts in the long run, altering the importance of any policy in promoting or inhibiting equality. Those policies requiring conservation measures which would likely raise the cost of food production and consequently raise food prices to consumers, such as policies 5 and 6, rate negatively from this general perspective since the poor spend a greater proportion of their income on food than the rich. Policies 2 and 3 are rated favorably because of the cost-reducing effect of the subsidy or tax credit. The effects of policies 1 and 4 are "undetermined" since the educational program on which they rely may result in the adoption of both cost-reducing and cost-increasing measures. The effect of the cost-sharing policy on taxpayers is "mixed" since it will raise taxes progressively in accord with the equality criterion but will confer benefits on farmers who may or may not be the most disadvantaged. The tax credit plan similarly rates "mixed" with respect to taxpayers by progressively raising the income-tax level to provide relief for those wealthy enough to take advantage of it. For both the tax-credit and the cost-sharing plans, the cost to taxpayers is considered to be significant while the public costs, including administrative expenses, of the other policies are assumed to be minor.

The analysis of the agricultural sector was made under the assumption that farms on erosive soil are less profitable (defined in terms of return to nonland inputs) than farms on soils without erosion problems and that soil erosion control measures are not profitable at the farm level, in the short run.

In our pairings (e.g., high and low erodibility; owners and renters; near streams and away from streams), we have rated each policy's efficiency in reducing the effect of erosion as a source of income inequality. If a policy reduces the difference in income between two paired groups, either by increasing low incomes or be reducing high incomes, the policy is given positive ratings on both entries. Mandatory policies 5 and 6 reduce the income of poorer farmers (high soil erodibility) without affecting the wealthier farmers' income, thus increasing inequality. Therefore, the policies are given a pair of strongly negative ratings. Policies 1 and 4 are assumed to educate farmers to opportunities to improve their operations and would thus have a weak positive effect. Policies 2 and 3 both subsidize the poorer farmers in the adoption of soil conservation practices on a voluntary basis. Thus, it is likely that practices which would minimize differences would be adopted.

Since the proximity to streams is not assumed to be correlated with income, all policies are rated U from that perspective. It is assumed that owners are generally wealthier than the renters who operate their farms, that owners incur the costs of soil erosion control (and receive any subsidy) but also benefit from long-term positive effects on land value, and that owners and renters share in any increase in income that might result from improved practices.* Under these assumptions, policies 1 and 4 are consistent with the criterion since the policies may result in some improvements, at the owner's expense, with shared benefits. Policies 2 and 3 are similarly rated because while the subsidy will reduce the cost to the owner, it will stimulate greater improvements, the benefits of which the renter will share. Policy 5 is strongly consistent because the owner is forced to incur the full costs and the renter, who is assumed to be poorer, shares in the benefits. Policy 6 reduces the land in cultivation for both and is therefore undetermined. Since the relative income position of current and future owners is not clear, the effects in this dimension are undetermined.

Water-user groups are considered affluent if, in general, their members have an income higher than the national average. Conservation equipment manufacturers and industrial water users are assumed to be comparatively wealthy on the premise that stockholders, not the employees or the consumers, are the primary bneficiaries of decreased water treatment costs or increased equipment sales. Thus, policies 1 through 5 are all rated inconsistent to some degree. Policy 6 is also inconsistent with respect to industrial users in that water quality would be improved, but the policy would not affect conservation equipment manufacturers since the improvements would occur through reduced land use. Given that the poor spend a greater portion of their income on water than the rich, it is assumed that any reduction in municipal water treatment costs as a result of increased water quality would be more significant to the poor than the wealthy. Hence, the erosion control policies are rated as consistent with the equality criterion from that perspective. Since there is no reason to expect that landowners in flood control areas and other area landowners are generally more or less wealthy than average, all policies are rated as mixed. For this analysis water recreation users and those in the commercial fishing industry are assumed to be neither more nor less wealthy than average, and thus the policies are rated "mixed" with respect to the equality criterion.

Variations in the strength of the ratings are due to variations in the effectiveness of the policies in reducing erosion. Measures which do not mandate or strongly encourage reduced soil loss receive weaker ratings than those which, evaluated intuitively or from modeling results, promise greater reductions in soil erosion.

Conformity to the Earned-rewards Criterion

Conforming to the earned-rewards principle demands a strict, positive correlation between costs and benefits. The degree of confomity of each of the six policies is indicated in Table 54.

The full cost of agricultural products, "benefits" produced on the land, should be reflected in their prices. Soil loss into streams is equivalent to waste disposal: its cost should be borne by the farmers directly and the consumers indirectly. Policies 5 and 6, whose effects are not primarily the result of tax-funded programs of persuasion or incentives, transfer the costs to

*The validity of this assumption will depend on the nature of the contract between the owner and the operator.

those receiving benefits, in accordance with the criterion. Policies 1 and 4 may encourage the adoption of some practices that result in transfers in the same direction but to a lesser degree. Policies 2 and 3 do not generate such transfers since the actions are compensated, and for this reason they are rated negatively both in terms of consumers and taxpayers. Policies 1, 4, 5, and 6 would all involve taxpayer costs, but under policies 5 and 6 this would be a minimal proportion of the total cost.*

In the agricultural sector, policies 1 through 5 are assumed to have direct effects on farms with low soil erodibility. Policy 6 will have negative effects to the extent that soils that are not erosive are removed from production to form greenbelts. The extent to which farmers on erosive soil are encouraged or forced to support soil erosion control determines their rating. Given the assumption that there is an equal distribution of erosive land near to and away from streams, it is not clear how policies 1 through 5 should be rated. Under policy 6, land adjacent to streams is rated mixed since erosive and nonerosive land would be removed from production, in part to control erosion from other areas. The land away from streams is given a negative rating because of the reliance on other land to provide the control of sediment losses. Given the assumed relationship between owners and renters, the policies are rated in terms of the extent to which landowners are encouraged or forced to incur costs of reducing soil loss from their land. Since renters are not assumed to share in the cost of pollution control but do share in any benefits, policies 1 through 5 are rated in terms of their efficiency in achieving erosion control. Under policy 6, the renters would share through reduced land available to farm. If one assumes that the land market will accurately reflect the value of the land, eroded or in good condition, the distribution of costs between present and future owners should not be affected. Similarly, there is no reason to expect effects on the conservation equipment manufacturers.

From the water users' perspective, any measure which decreases the users' input costs is consistent with the earned-rewards principle. This judgment is made on the premise that farmland erosion is higher than the natural or primitive rate. Those policies which decrease the unjustified costs expeditiously are rated higher to reflect this fact.

Conformity to the Least-risk Criterion

Invoking the least-risk criterion implies that a favorable rating will be received by policies that encourage the use of historically safe technology and are effective in conserving resources. The degree to which the six policies are consistent with this criterion is indicated in Table 55.

For society in general, we would expect food consumers to favor any policy which conserves arable land. As taxpayers, the general public should prefer those preventative measures designed to avert the more costly programs which could be required if erosion control were postponed. The public should

*An effluent tax policy would rate highly under this criterion and under the equality criterion unless the revenue generated was transferred to the wealthy.

also react negatively to policies they perceive as weak or ineffective in conserving resources.

In analyzing this criterion from the "agricultural" perspective, it is assumed that farmers would evaluate the policies in terms of a responsibility to maintain the productivity of the soil for future generations. They would likely believe, however, that society should incur the costs of doing so. They would rate policy 6 negatively because, except for land near streams, it does not achieve erosion control, it only improves water quality. Policies 1 and 4 also would be rated low, since they do not assure the maintenance of productivity. Policies 2 and 3 would be rated positively because incentives are provided to insure some action and a sharing of costs among taxpayers. Policy 5 would be positively rated because it reduces productivity, but only weakly since society does not share in the cost. These ratings hold for erosive soil, either adjacent to or away from streams, and for current landowners. Future landowners would be expected to rate policies strictly on their effectiveness.

Water users will also rate policies on their appropriateness to the risk involved. Here the concern would be to generate a high-quality aquatic ecosystem or to maintain reservoir capacity. Each of the policies are rated according to their assumed ability to achieve these goals. Education would likely get the weakest positive rating.

CONCLUSIONS

The equity criteria presented here are meant as guidelines for anticipating fundamental reactions to environmental control policies. To the extent that they reflect the society's ethical trend, they should be useful. The earned-rewards principle, as the norm of earned rewards, represents the perennial, conventional standard. The equality ethic, long an insurgent ideal, seems at present the most politically vigorous of the criteria. Finally, as the ethic of affluence and responsibility, the least-risk criterion anticipates the results of continued "profligate" resource consumption. Together they compose a model spanning a spectrum of diverse sentiments capable of predicting the equity impact of prospective policies.

Any attempt to summarize the ratings raises the problem of weighting the criteria and the groups. Since the criteria were generated subjectively, there is no legitimate basis for assigning weights to criteria. Even if weights were inferred, perhaps, from revealed preferences on a national scale, there would be little reason to believe that those weights would be valid in analyzing smaller groups. If weights could somehow be found for all the criteria for each group, it would still be necessary to formulate a rule for weighting the relative significance of each group's opinion before a summary ranking could be determined.

Though general conclusions are not possible because of conflicting ratings and the weighting problem, some comments can be made on the equity impact of certain policies on certain subgroups. Those who pay income taxes would likely regard the soil conservation implementation plan as fair under each of these criteria. From the standpoint of equity, municipal water users are expected to view all of the policies favorably, with the tax credit and conservation plan implementation programs seen as somewhat better than the others. The soil conservation plan implementation program appears acceptable, on the basis of equity, to farm owners in general.

The remaining policies are rated negatively for at least some groups by some criteria. If one analyzes these ratings, it becomes obvious that the policies could be improved somewhat before they are adopted and that combining the elements of more than one policy would, as least in some ways, be superior.

CHAPTER 8

LEGAL AND POLITICAL CONSTRAINTS

The alternative policy approaches discussed earlier raise varying constitutional and statutory issues. This section will examine these alternatives from a legal standpoint and discuss the relevant constitutional and statutory problems. For the purposes of this discussion it is helpful to divide the six alternative policies into two groups: those involving voluntary actions by farmers and those which compel certain actions. In general, compulsory programs are potentially more subject to legal constraints, since they raise the issue of whether such actions violate the protections of the U.S. Constitution.

In addition to these six alternative policies, other policies designed to minimize nitrogen levels in water will be discussed. In considering policy implementation and potential challenges to pollution-control legislation at the state level, the state of Illinois, its constitution, and its laws will be used as examples.

VOLUNTARY PROGRAMS

Educational Policies

There are few legal constraints to educational policies for the control of agricultural nonpoint-source (NPS) pollution. There is a long tradition of state and federal support of educational activities; one example is the combined state and federal support of the Cooperative Extension Service. Clearly, an intensification of such educational activity would be a legitimate function of either level of government.

Actions of the state or federal government to compel a farmer to attend NPS pollution education events would raise constitutional questions. This issue is not developed further, however, because such an attendance requirement is inconsistent with the principal objective of an educational policy: encouraging *voluntary* action on the part of farmers through a better awareness of NPS pollution problems and control practices.

Cost-sharing Policies

Although there are few legal constraints to federal cost-sharing programs, federal legislation in aid of agriculture is confined to that which may be enacted in the exercise of the limited powers of the federal government. Article 1, Sec. 8, Clause 1 of the U.S. Constitution gives Congress the substantive power to appropriate funds to provide for the general welfare of the

United States. Congress could also base such authority upon the commerce clause, U.S. Const. Art. I, 8. Although agriculture cannot be favored with public aid for individual private enterprise, a certain amount of discrimination intended to encourage agriculture has been allowed (Liberty Warehouse Co. v. Barley Tobacco Growers' Co-op Marketing Assoc., 276 U.S. 71 (1927).

The federal government has the authority to participate in subsidy programs to encourage soil conservation. Typically, these subsidy programs also include federal regulations which must be met as a prerequisite to receiving aid. As long as the regulations are reasonable, the federal government has the power to regulate in connection with its aid programs (Wickard v. Filbarn, 317 U.S. 111 (1942)).

State authority to provide a subsidy or cost-sharing program for soil conservation improvements such as terracing would arise from inherent sovereign powers. Although earlier court decisions often opposed recognition of farmers as a separate class on the grounds that this classification violated the equal protection of the laws (Kelleyville Coal Co. v. Harrier, 207 Ill. 624 (1904)), modern policy reflects a multitude of farm aid laws which have received judicial sanction. Farm land may be properly distinguished from other land within certain limits. It might not even be necessary to distinguish agricultural land from other land, depending on the type of conservation plan and subsidy used. Nevertheless, if it is necessary to make that distinction, the distinction should not cause serious equal-protection arguments.

The constitutionality of a state cost-sharing program could also be challenged because it would grant public money for an individual use. For example, several states have offered bounties for persons planting certain trees and hedges. At least two states, Colorado and Missouri, found these statutes to be unconstitutional. It seems unlikely, however, that such a result would be reached with soil conservation subsidies. Although the farmer would benefit from the improved conservation over a period of time, the immediate benefit would be to the general public who would enjoy cleaner water. The fact that the Iowa conservancy law has not been challenged tends to support this view.

Tax-incentive Policies

The federal government faces few constitutional constraints in effecting a tax-incentive policy. In fact, current tax law provides some incentive for soil conservation expenditures. Normally, capital expenditures which increase the value of farmland would not be tax deductible. To encourage conservation, however, investments in soil conservation projects could be made deductible. Expenditures in this category have included planting trees to prevent erosion and filling in gullies.

Under the Internal Revenue Code a farmer may elect to deduct nondepreciable capital expenditures incurred to conserve soil and prevent erosion. The availability of a current deduction is more advantageous than a capitalization of the expenditure. Other soil conservation expenses may be currently deductible because they are by their nature expenses of a currently deductible type rather than capital outlays. Such expenses have included terracing for the purpose of maintaining productivity where the terracing did not increase the value of the land.

A new federal income tax incentive policy would need to provide additional incentives beyond a mere deduction. Such a policy could involve tax credits; for example, a tax credit equal to 50% of the conservation practice or equipment costs could be allowed. Such a tax-credit policy would be, in effect, a cost-sharing policy implemented through the income tax system. Thus, the earlier discussion of legal constraints upon a cost-sharing policy generally would be applicable.

The manner of determining the tax credit could raise some legal issues. For example, if the tax credit is a percent of the actual expenditures on conservation practices, the calculation of the credit would deal with easily ascertainable facts. On the other hand, if the credit were based upon lost income resulting from a less intensive cropping pattern, the calculation of the credit would be based upon rather amorphous determinations. The latter approach would be more open to challenge as an arbitrary method.

There are also practical constraints upon a federal income-tax-credit policy. The Internal Revenue Service would actively resist the introduction of excessively complex sections into the code. The service would have a number of political allies among legislators supporting a streamlining of the tax system. The tax credit policy would therefore need to be as simple and straightforward as possible.

At the state and local level, there are also few constraints upon a tax policy. There are also fewer opportunities, however, to implement such a policy. For example, state sales taxes and local property taxes are major tax systems for state and local governments. Many states offer tax incentives in the form of sales- and use-tax exemptions for pollution control facilities. Such exemptions do provide some incentive for investments in pollution control equipment which would be subject to the tax in the first place. The technology for the control of NPS pollution, however, generally does not employ equipment. Rather, it involves conservation practices and the use of devices such as terraces, grass waterways, and structures. Because such technology is generally not subject to the sales and use tax, any exemption is inconsequential.

Special provisions in property tax laws can also provide some incentive toward the desired actions. For example, certain desirable improvements to land can be made exempt from the property tax--that is, the assessed valuation of the property is not increased even though the fair market value of the property increases because of the improvement. Such an approach is not readily adaptable to encouraging NPS pollution control because the type of improvements needed (e.g., terraces, waterways, and structures) do not significantly increase land value and hence there is no basis for an exemption. Such improvements generally do not increase net farm income in the short run, although they may in the long run.

If the state employs an income tax, there would be some opportunity to offer tax incentives for pollution-control expenditures. For example, the state could employ an income tax credit similar to the proposed federal one.

Such a policy would generally not face significant constitutional problems. However, since the amount of state income tax paid by a farmer is generally very small compared with the federal tax, such a policy at the state level would probably not be very effective. Furthermore, given the financial crises in many states, it is questionable whether such a policy would be politically acceptable.

MANDATORY PROGRAMS

The mandatory development and implementation of soil conservation plans would be very beneficial for a number of reasons. First, such a policy would force the owner of land to be aware of existing conservation problems and the role which he must necessarily play if those problems are to be solved. Secondly, a comprehensive conservation plan would, by its nature, involve evaluating the various alternatives available to control soil runoff and other environmental matters and hopefully would lead to a logical choice of control techniques best suited to the affected land. Finally, the requirement for conservation plans could be placed into the existing framework of soil- and water conservation districts so that advice, consultation, and aid could be given during the drafting and implementation of such plans.

Unfortunately, mandatory conservation plans imply a forced action. However, it is unlikely that such forced action would be found unconstitutional, assuming that the required action was expected to make farmers more aware of their role in reducing nonpoint-source pollution.

Mandatory Implementation of Soil Conservation Plans

Requiring the implementation of a soil conservation plan would be subject to some constitutional constraints. The constraints would depend upon whether the policy was implemented by the federal or the state government. A separate analysis will therefore be devoted to each level of government. The analysis assumes that the required implementation of a soil conservation plan would involve some limitation upon row-crop agriculture. (This assumption is made because such limitations would be the most severe of the requirements. Other means of achieving the plan would be less restrictive on the farmer.)

A most critical federal constitutional issue that would arise with any mandatory implementation policy would be the Fifth Amendment prohibition against the taking of property for public use without just compensation: "...nor shall private property be taken for public use without just compensation." Assuming row-crop agriculture to be one of the most productive techniques of agriculture, it might be maintained that legislation prohibiting the use of that technique amounts to a taking of the property in violation of the Fifth Amendment, since the most profitable use of the land would no longer be possible. This argument would raise a variety of distinct legal issues.

It is often assumed that the provisions of the Fifth Amendment extend to all actions by any level of government. Such is not the case, however. Although the Fifth Amendment contemplates proper compensation in situations involving the taking of property under the power of eminent domain, the "Constitutional provisions against the taking of private property for public use without just compensation impose no barrier to the proper exercise of the police power" (29A C.J.S. Eminent Domain 6 (1965)). To determine whether row-crop restrictions would violate the Fifth Amendment, it therefore becomes essential first to ascertain the distinctions between the power of eminent domain and the police power, and second to determine under which power the federal government would be acting if it were to impose restrictions on the use of row-crop agriculture.

Eminent domain has been defined as "...the right or power to take private property for public use; the right of the sovereign, or of those to whom the power has been delegated to condemn private property for public use, and to appropriate the ownership and possession thereof for such use upon paying the owner a due compensation" (29A C.J.S. Eminent Domain 1 (1965)). The power of eminent domain is "an inherent and necessary attribute to sovereignty, existing independently of constitutional provisions and superior to all property rights" (29A C.J.S. Eminent Domain 2 (1965)). In the United States, the power of eminent domain may be exercised by the federal government in furtherance of powers conferred on it in the U.S. Constitution, by the individual states within their territorial boundaries, or by various political bodies within the states to which the power has been properly delegated by the state legislature (29A C.J.S. Eminent Domain 18-19 (1965)).

The police power "is the exercise of the sovereign right to a government to promote order, safety, health, morals, and the general welfare of society within constitutional limits" (16 C.J.S. Constitution 174 (1956)). Though the police power, like the power of eminent domain, is a power inherent in all governments, in the United States it is a power reserved to the states by the Constitution. (It should be noted, however, that a comparable federal power is to be found in the general-welfare clause of the Constitution; Article I, Section 8.) But the police power is not an unlimited power. As a rule, the police power extends only to the governmental function of regulation; regulation for the welfare of society (16 C.J.S. Constitution 175 (1956)).

Obviously, it is often very difficult to establish whether a government is acting under the power of eminent domain or under its police power. No magic formula exists. The more severe the loss to an individual property owner--the more severely the use of private property is restricted--the more likely it is that a court will find that the regulating body has acted under the power of eminent domain and not under the police power; that is, the more likely it is that a court will find an improper exercise of police power, deem there to be a violation of the Fifth Amendment, and therefore require compensation.

In applying the eminent domain/police power dichotomy to restrictions placed upon row-crop agriculture, three particular issues arise: Is there a taking?; Are the restrictions reasonable?; Is there a public purpose for the regulations?

A crucial matter would be whether row-crop restrictions placed upon agriculture in certain areas would constitute a taking. It is therefore necessary to review how the judiciary has dealt with other situations in which regulations have been imposed. The most readily apparent parallel to the placing of restrictions on the cultivation of land is that of zoning. Since 1926, the United States Supreme Court has recognized the need for municipalities and states to regulate, by zoning, certain activities within their boundaries to protect the health, safety, welfare, and morals of their citizens (Euclid v. Ambler Realty Co., 272 U.S. 365, 71 L. Ed. 303, 54 A.L.R. 1016 (1926)).

It has since been stated frequently that there is a strong presumption of validity with zoning regulations (Van Alstyne, "The Search for Inverse Condemnation Criteria", 44 So. Calif. L. Rev. 1 (1970)) and there is little doubt today that most limitations placed upon the use of property under properly adopted zoning regulations, even if quite severe in their application, do not constitute takings. Certainly, it is equally clear that an ordinance which would deprive an owner of the entire use of his property would be an unconstitutional taking (Anderson, American Law of Zoning 66 (1972)). Thus, with zoning, most judicial analysis has by necessity been on a case-by-case basis.

Still, certain examples may be cited which give an indication of how courts view the taking issue in zoning: In Goldbladt *et al.* v. Town of Hampstead (369 U.S. 590 (1961)), the U.S. Supreme Court upheld a city ordinance which in effect prevented the owner of land which had been used as a quarry for years from continuing excavation, despite the fact that the ordinance prevented use of the land in the most financially rewarding way (the ordinance forbad future excavation to a depth below that of the water table, a practive which the plaintiff had been undertaking for years and which, as a result, had created a 25-acre lake). In Kopetzke *et al.* v. County of San Mateo, (396 F. Supp. 1044 N.D. Calif., (1975)), a county board's moratorium on the issuance of building permits to owners of land in certain areas of apparent soil instability was upheld and no taking was found, once again despite the fact that the value of the property was reduced considerably as a result. In Petterson v. City of Naperville (9 Ill. 2d 233 (1956)), city ordinances requiring the placement of curbs and sewers in roads built by private contractors within new subdivisions were not found to be takings. However, in Nashville, C. and St. Louis Ky v. Walters (297 U.S. 405 (1939)), a taking was deemed to have occurred when a town ordinance was passed which required railroads to pay one-half the cost of eliminating grade crossings (i.e., building overpasses and underpasses). And finally, in Kirby v. Rockford (363 Ill. 531, 2 N.E. 2d 842 (1936)), a drastic financial loss resulting from zoning was found to be too extreme, and thus a taking was held to have occurred.

Surely, there is ample reason to use the long-standing validity of zoning regulations to justify the implementation of row-crop restrictions. Both are sets of rules which presumably are meant to benefit the public health, safety, and welfare. Nonetheless, the zoning analogy is not a perfect parallel. Though cases exist where no taking has been found even when the ordinance in question has been imposed upon a previously unregulated party,* most zoning contemplates the granting of variances and exceptions for nonconforming uses existing at the time the ordinance is implemented. Since row-crop restrictions would not be effective if nonconforming uses were allowed (because those exceptions would literally "swallow up" the regulation), it must be assumed that little if any provision would be made for those individuals presently using their property in a manner which the proposed restrictions would prohibit (other than perhaps a time table for compliance). There is therefore a definite distinction between zoning and row-crop restrictions.

Very important parallels to the issue of taking as it applies to row-crop restrictions may be seen in other pollution-control areas. Numerous federal and state courts have upheld legislative restrictions placed on point-source pollutors (City of Monmouth v. Pollution Control Board, 57 Ill. 2d 482, 313 N.E. 2d 161 (1974); Chicago v. Metropolitan Sanitary District, 52 Ill. 2d 320 (1972); Illinois v. City of Milwaukee, 406 U.S. 91 (1972)). Significantly, Illinois courts have upheld restrictions in pollution matters aside from point-source pollution. One pertinent example is the Illinois Coal Operators Association v. P.C.B., 59 Ill. 2d 305 (1974). In that case, the appellant was unsuccessful in efforts to have the noise-pollution restrictions placed upon the operation of its facility declared unconstitutional as takings.

Reviewing the issue of taking, it would appear that the courts would not find there to be an unconstitutional taking by mere application of an otherwise proper row-crop-restriction law. Admittedly, there may be circumstances where the implementation of row-crop restrictions might be so onerous that a court would find these to be an unconstitutional taking as those restrictions are applied to a particular individual. It seems, however, that in light of the numerous zoning cases and pollution cases, most courts would be strongly disinclined to hold particular row-crop restrictions to be invalid as takings, preferring instead to allow such restrictions as a valid exercise of the police power.

Ancillary to the issue of taking is the issue of reasonableness. For any restriction or regulation to be justified under the police power or the power of eminent domain, it must be reasonable. As stated by the U.S. Supreme Court in Lawton v. Steele (152 U.S. 133, 137 (1894)),

> To justify the State in. . .interposing its authority on behalf of the public, it must appear, first, that the means are reasonably necessary for accomplishment of the purpose, and not unduly oppressive upon individuals.

The Illinois Supreme Court adopted a similar view in Sherman-Reynolds, Inc. (47 Ill. 2d 323, 327 (1970)).

> To be a valid exercise of the police power, the enactment of the legislation must bear a reasonable relation

*Two examples are the previously cited Goldbladt case and also Hadachrech v. Los Angeles (239 U.S. 394, 36 S. Ct 193, 60 L. Ed. 348 (1915)), a case where the City of Los Angeles annexed land including property used by Hadachrech to operate a brick yard and subsequently ordered the brick yard shut down because its operation violated city ordinances.

> to the public interest sought to be protected, and the means adopted must be a reasonable method to accomplish such objective.

The Illinois Supreme Court commented in the same case that it is firmly established that questions of doubt as to reasonableness will be resolved in favor of the body imposing the regulation in question.

> Even this rule is not applied with strict precision, for this court has often said that debatable questions as to reasonableness are not for the courts but for the legislative...Goldbladt *et al.*, v. Town of Hampstead, 369 US 590, 574. Where the reasonableness of the legislation is fairly debatable the courts *will not interfere with legislative judgment and will* not substitute their judgment for that of the legislative department.

Thus, if row-crop restrictions may be demonstrated to be even "debatably" reasonable, in theory, they would be upheld against attacks made on a reasonableness ground.

Reviewing the application of the standard set by the courts, it seems likely that row-crop restrictions would not be found to be invalid on the basis of unreasonableness. There seems to be clear congressional and legislative history establishing the need for control of nonpoint-source pollution from agricultural runoff. Limiting the use of row-crop agriculture in areas of high runoff potential would significantly reduce soil loss from runoff. Consequently, controls placed upon row-crop agriculture would be deemed reasonable as a matter of course.

The last issue which must be dealt with in this area is whether there would be found to be a public purpose behind the imposition of row-crop restrictions. This issue would appear to be the most easily resolved of all of those arising under the Fifth Amendment.

As shown earlier, both the power of eminent domain and the police power require that legislation applied under these powers be for a public purpose. Property may not be taken under eminent domain for the sole satisfaction of a private party 4 (Water and Water Rights, supra.) 56 (R.E. Clarke, ed). Likewise, a regulation may not be imposed under the police power for a nonpublic purpose (16 C.J.S. Constitution 174 (1956)).

With row-crop restrictions, there is little doubt that the purpose is solely one of a public nature. The whole theory behind any such restriction is not to benefit any individual but rather to help the population as a whole by regulating the amount of pollution entering the public waters via soil runoff and by preserving our soil resources for future generations. Indeed, it seems unlikely that a more "public" purpose for a particular bit of legislation could be found.

In summary, it does not appear likely that the Fifth Amendment prohibition on the taking of property without compensation would severely restrain the imposition of row-crop restrictions. Such legislation would fall within the police power of the state and would not be considered a taking. Additionally, it does not appear that the matters of reasonableness or public purpose would severely limit the applicability of row-crop limitations so long as the restrictions were kept within a rational framework.

Due-process Restraints Upon State Action

The second federal constitutional matter which might be expected to arise with the imposition of row-crop limitations *by the state* is that of the due-process clause of the Fourteenth Amendment.

> ...nor shall any State deprive any person of life, liberty, or property without due process of law.

Restrictions placed upon the use of row-crop agriculture by the state, the argument might run, result in a deprivation of property without proper consideration of due-process requirements.

Significantly, most of the issues which arise under the due-process clause of the Fourteenth Amendment are issues which also arise under the Fifth Amendment just-compensation clause. It has long been recognized by the U.S. Supreme Court and the state supreme courts that rules, regulations, or restrictions properly promulgated by exercise of the police power will not be found to violate due process (16 Am. Jur. Constitutional Law 295 (1964)), Thus, the very issue underlying attacks based on the due-process clause is whether there is a proper exercise of the police power; that is, whether the exercise of the police power is reasonable.

The standard of reasonableness used to decide a due-process argument is the same as that used to decide an initial challenge to the police power. When the courts decide that the use of the police power in a given situation is reasonable, it is routinely decided that no due-process violation has occurred. Once the hurdle of reasonableness is cleared as to the implementation of the row-crop restrictions by the state, arguments that such restrictions violate an individual's due-process rights will fail.

A final constitutional contention that might be advanced is that row-crop restrictions amount to a denial of equal protection in violation of the Fourteenth Amendment. It is a possible argument in a situation where a particular landowner is affected somewhat more severely by the restrictions than are other landowners. Placed in this framework, the basis of the argument would be that row-crop restrictions violate the Fourteenth Amendment because they do not treat all landowners equally and, in effect, tend to be discriminatory.

As with due-process considerations, the equal-protection clause is not meant to limit ordinances, rules, regulations, or restrictions properly enacted under the police power (16 Am. Jur. Constitutional Law 297 (1964)). Of course, "any attempted exercise of police power which results in a denial of equal protection of the laws is invalid" (16 Am. Jr. Constitutional Law 297 (1964)). Thus, the key question concerning equal protection becomes, How equal is equal? That is, how uniformly must a law be applied?

In the area of regulation, the answer to the above question seems to be rather clear. As long as the ordinance in question can be shown to have a reasonable relation to the people affected by the scope of its classification, and as long as the restrictions imposed are not arbitrary or irrational, the statute should not be found to violate the equal-protection clause.

Greenbelt Development

One unique approach to controlling soil runoff is to require the placing of greenbelts between cultivated fields and bodies of water. Though the resolution of the issues which would arise with implementation of this approach is not necessarily clear, the identity of those issues is rather apparent.

The first legal issue which would be argued if greenbelts were required is that the police power had been exceeded and that land had been taken without just compensation in violation of the Fifth Amendment to the U.S. Constitution. A greenbelt policy would place a definite restriction on the use of particular land.

A second legal issue which would arise is that of due process. For the farmer who has considerable acreage surrounding water, legislation requiring greenbelts passed without that farmer's active input into the legislative process would be quite harsh and would quite likely violate his due-process rights.

Equal protection considerations would also seem to limit the effectiveness of the greenbelt alternatives. If used as a sole method of runoff control, greenbelts would obviously have their most serious effect on the person with the most acreage surrounding water. Though legislation need not affect all people completely equally, the peculiar hardships which legislation such as this would impose on some people would arguably put greenbelt legislation into the realm of denying equal protection.

It must not be assumed, however, that greenbelts are a bad alternative for pollution control. If a significant relationship could be shown between the prevention of sedimentation and the need for a "buffer zone," certain legal objections would fail. It is interesting to note that a likening of greenbelts to pollution control devices might well be one way of overcoming constitutional objections to the implementation of greenbelt controls.

Still, it appears that the greatest strength of the greenbelt concept lies in either encouraging voluntary implementation or in including it as part of a total control concept. Greenbelts might be a very good alternative, and, if offered as part of a package upon implementation of gross-soil-loss restrictions or mandatory conservation plans, might prove valuable.

POLICIES DESIGNED TO CONTROL NITROGEN

Nitrogen Restrictions

One of the first points that should be determined when considering non-point-source pollution restrictions, whether at the state or federal level, is whether the restrictions should be statutory or administrative standards. Statutory restrictions would definitely be preferable from a legal standpoint. Courts have traditionally granted more deference to legislative determinations than to administrative regulations. This preference is especially important in the area of nitrogen fertilizer restrictions or taxes, since at this time there is only limited evidence that high levels of nitrogen in rural waters result primarily from nitrogen fertilizers or that those high levels present a health or pollution hazard.*

With the recent surge of environmental regulations, the courts have been examining agency actions more and more closely. This examination requires an analysis of the environmental consequences of both the action itself and a failure to act (122 U. Pa. L.R. 509, (1974)). The eighth circuit used a good-faith balancing of competing interests in Environmental Defense Fund, Inc. v. Corps of Engineers (470 F. 2d 289 (8th Cir. 1972), cert denied, 409 U.S. 1072 (1972)), and held that the action could be enjoined if the agency balance was arbitrary. Other circuits have refused to review good faith judgments and agency substantive decisions (Ely v. Velde, 451 F. 2d 1130 (4th Cir. 1971); National Helium Corp. v. Morton, 455 F. 2d 650 (10th Cir. 1971)). The balancing test, which is always subjective, is particularly so in this area, since environmental costs are more qualitative than quantitative and since the assessment methods are not refined.

Even after the court has determined that the regulations are within the zone of reasonableness, it will still refuse to enforce them if it feels there has been insufficient consideration of nonenvironmental factors. This aspect of review could be significant if an attempt was made to impose harsh nitrogen restrictions which would substantially reduce grain yields. In International Harvester Co. v. Ruckelshaus (478 F. 2d 615 (D.C. Cir. 1973)), the court scanned global economic consequences for the overall economy if the EPA maintained what the court viewed as an overly onerous auto-emission standard. While all courts might not be willing to go as far as the D.C. circuit, it would appear that the agency would have difficulties supporting nitrogen restrictions under any of the tests used unless it was possible to obtain more substantial data indicating that high levels of nitrogen in water supplies are dangerous.

The court of appeals for the eighth circuit granted, pending appeal, a stay of an injunction to stop any asbestos discharge unless the actual existence of, and not just the potential for, a health hazard was proven (Reserve Mining Co. v. U.S.A. (498 F. 2d 1073 (8th Cir. 1974)). The court felt that it was improper to take judicial notice of the unknown. The court suggested that it might be proper for the legislature to protect society from those unknown risks but that the court could not do so without the necessary proof.

*Aldrich, S.R. Perspectives on nitrogen in agriculture: food production and environmental implications. Paper presented at the American Association for the Advance of Science Meetings, 20 February 1976, Boston, Mass.

In other words, what the legislature could simply *say* was a health hazard the administrative agency would be forced to *prove*.

While the eighth circuit probably represents the more traditional view, some courts, in response to recent public concern about the pollution problem, have cited legislative action such as the Federal Environmental Pesticide Control Act of 1972, the Federal Water Pollution Control Act Amendments of 1972 and the 1970 Clean Air Act as a clear statement of congressional intent to shift regulator emphasis to a more extensive consideration of *potential* health and environmental effects. A risk-benefit approach which allows a margin of safety has been emerging. This margin of safety compensates for any scientific lack of knowledge and allows regulations of products which are potentially harmful but whose harm is not presently provable.

The present trend is away from the nineteenth-century attitude that development should be encouraged at any cost and toward a more wary approach of weighing the risks of future injury against any benefits of present exploitation of property. One problem of putting this new philosophy into the old judicial framework is the requisite standard of proof. Causal relationships in environmental proofs get so technical and complicated that lay persons, including judges, tend to label them as merely speculative (48 S. Cal. L. Rev. 371 (1974)).

In contrast to the close examination to which administrative regulations are subjected, the courts tend to give complete deference to congressional determinations. As long as the end is legitimate (as unpolluted water certainly should be) statutory fertilizer control need only be a reasonable way of achieving pure water if it is to be upheld by the courts. As the United States Supreme Court stated in Berman v. Parker (348 U.S. 26 (1954)), ". . . when the legislature has spoken, the public interest has been declared in terms well-nigh conclusive. In such cases the legislature, not the judiciary, is the main guardian of the public needs to be served by social legislation, whether it be Congress legislating concerning the District of Columbia or the states legislating concerning local affairs."

If it is established that nitrogen in the water supply is determined to be a health hazard and that a major source of such nitrogen is fertilizer runoff, then a per-acre restriction or nitrogen should be a legitimate regulation at either the state of federal level.

Restrictions at the State Level

Regulation of nitrogen application should be within the police powers of the state. The states have the power to impose reasonable regulations to protect the safety, health, morals, and general welfare of the public. First, the corn-belt model analysis reported in Chapter 4 indicates that limiting the nitrogen applied per acre to 100 pounds only decreased corn yield by an estimated three percent, while limiting application to fifty pounds/acre, a severe nitrogen restriction, decreased corn yield by only an estimated 13 percent. Second, even though limiting the amount of nitrogen applied decreased the corn yield by 13 percent, the estimated yield of soybeans was only cut by nine percent. Third, while the fifty pounds/acre restriction reduced corn yield by 13 percent, this reduced yield increased the price of corn per bushel by an estimated 20 percent. Instead of reducing the profitability of farmland and being an unjust taking, the nitrogen restriction might actually increase profitability because not only would the farmer receive a higher price for his corn, but he would save money by using less fertilizer.

These estimates by yields and prices were based on the assumption that restrictions would be placed on the whole corn belt; the price increase per bushel of corn would be less if the restrictions were limited to a single state. Even so, the economic consequences of a fifty pounds/acre restriction would not be great enough to be considered by the court as a taking of property which would require compensation. In the present atmosphere of abundant land-use regulations, as long as there is a legitimate public purpose, a taking is found only in extreme situations where the regulations render the land almost totally worthless. These nitrogen restrictions do not even approach that extreme.

Once the state legislature decides to use its police power to regulate nitrogen application, the legislation still must satisfy the requirements of the state constitution. Challenges to the validity of the statute can be minimized by careful drafting. It should be precisely stated that the purpose of the statute is the protection of the public health and welfare, because the purpose is the first thing that courts consider when a statute is challenged. Using Illinois as an example, three aspects of legislation which are frequently challenged under the state constitution are due process, equal protection, and special legislation.

Due process should no longer be a problem to environmental legislation in Illinois. In 1974, an Illinois appellate court said that the due-process guarantee is modified by reasonable exercise of the police power by the legislature to regulate or prohibit anything harmful to the welfare of the people (Freeman Coal Mining Corp. v. Illinois Pollution Control Board, 21 Ill. App. 3d 157, 313 N.E. 616 (1974)). Unless the Supreme Court of Illinois rules to the contrary, that statement is a favorable precedent for environmental legislation in Illinois.

The equal-protection clause of the Illinois Constitution should not create problems for the proposed legislation either. The courts have generally used the 'conceivable basis' standard for reviewing statutes. A person challenging a statute must show that the classification is arbitrary and that *no* set of facts support that classification (People *ex rel.* Vermilion County Conservation District v. Lenover, 43 Ill. 2d 209, 251 N.E. 2d 175 (1969)). The court has said that classification is primarily a legislative function with which there should be no judicial interference except to determine whether the legislative action is clearly unreasonable (DuBois v. Gibbons, 2 Ill. 2d 392, 118 N.E. 2d 295 (1954)). The only foreseeable problem with the per-acre nitrogen restriction would arise if animal waste runoff was determined to be the major source of nitrogen in the water (as suggested by Smith in Agriculture and the Quality of Our Environment, 173, 180, and 185) while the only burden for nitrogen control was placed on crop farmers. A pollution control permit system is in effect for large, confinement livestock operations. The crop farmers might then have an equal-protection argument, but if the courts follow their precedent, the law should still be considered a valid legislative determination.

Article 4, Sec. 13 of the Illinois constitution prohibits the General Assembly from passing any special or local legislation. This provision is similar to the equal-protection clause. Discussing the limitations which the special-legislation clause imposes, the Illinois Supreme Court has said, "A Statute may be constitutional though the legislature did not extend its provisions to all cases that might be reached" (Youhas v. Ice, 56 Ill. 2d 497, 309 N.E. 2d 6 (1974)). The court then cited an earlier opinion which stated, "if the law presumably hits the evil where it is most felt, it is not to be overthrown merely because there are other instances to which it might have been applied" (Union Cemetery Association v. Cooper, 414 Ill. 23, 33 (1953)). The feedlot versus fertilizer situation previously mentioned would again be the only foreseeable complication.

In conclusion, a properly drafted per-acre nitrogen restriction should be a valid assertion of Illinois's police powers and should not violate the due-process, equal-protection, and special-legislation provisions of the Illinois Constitution *provided* it is established that nitrogen in water is a major source.

This type of law apparently does not violate any existing legislation. The new Illinois Environmental Protection Act may even provide authority for a law restricting the amount of fertilizer applied. Title III: Water Pollution - Acts Prohibited says: "no person shall: . . . (d) deposit any contaminants upon the land in such place and manner so as to create a water pollution hazard." If proof is available that excessive nitrogen application creates a water-pollution hazard, then limitations on fertilizer application could be set up under the existing law.

Restrictions at the Federal Level

Although technically the federal government does not have the police powers which were reserved for the states in the Tenth Amendment, in practice the federal government exercises powers in the nature of police powers. The U.S. possesses whatever power is appropriate to the exercise of any attribute of sovereignty specifically granted it by the Constitution. Some of the federal regulatory measures have been sustained as arising under the general welfare provision of the federal Constitution or under Article IV, Sec 3 granting Congress the power to make all needful rules and regulations respecting the territory or other property belonging to the United States. Whatever the authority relied on, previous congressional legislation in the area of environmental control has been upheld and enforced by the courts.

A White House administrative order created the U.S. Environmental Protection Agency (USEPA) to handle the details and technical decisions of its campaign for a cleaner environment. Although criteria such as the per-acre nitrogen restriction would probably be issued by the USEPA and not voted on by Congress itself, the regulation would be within the scope of P.L. 92-500. The Federal Water Pollution Control Act Amendment mandates that state action be taken at all levels (federal, state and local) so as to eliminate water pollution by 1985. Sec. 304(e)(2) requires the administrator to issue processes, procedures, and methods to control pollution resulting from agricultural activities including runoff from fields and crops. The courts have been very cooperative in enforcing the various regulations imposed as a result of P.L. 92-500, and in fact have read the law more expansively than the administrator in several instances (People of the State of California v. E.P.A., 511 F. 2d 963 (1975); National Resources Defense Council Inc. v. Train and the E.P.A., 396 F.A. 1386 (1975)). It is very unlikely that a per-acre nitrogen restriction would be held invalid at the federal level because Congress lacked the power to regulate such a substance.

Congress has imposed a similar type of restriction on farmers under P.L. 86-139 as a means to control certain insecticides. The nitrogen limitation should be a relatively small burden because it only restricts *excessive* nitrogen application--it is not a complete prohibition of use as in the case of insecticides.

There is a presumption that all legislation passed is constitutionally valid. A law restricting the amount of nitrogen applied per acre could be challenged as an interference with property rights. The United States Constitution protects property rights, but all property is held subject to such reasonable restraints and regulations as the legislature has established to protect the safety, health, and general welfare of the public. Invasion of property rights can only be justified by the presence of a public interest (Newland v. Child, 93 Idaho 530, 254 P, 2d 1066 (1953)). Since there is clearly a public interest in unpolluted water, this law should be a valid regulation of property rights.

The other possible challenges to this regulation would be a denial of due process and equal protection or an uncompensated taking. The due process and equal protection agruments would be handled at the federal level in a manner similar to that used at the state level. Those arguments should not be a real threat to the validity of this law as long as it applies to all land equally. Since the law would be applied nationally and not to an individual state, it would be less of an economic burden if imposed at a federal level than at the state level and, as previously discussed, it might actually generate higher farm income.

While this law would not violate any existing legislation, it would mean a policy change for the Congress and the Department of Agriculture. The U.S. government has a history of encouraging the development and use of fertilizers. The Soil Conservation and Domestic Allotment Act provides for payments and grants-in-aid for enhancement of soil fertility and the purchase of fertilizers. The Internal Revenue Code provides a tax deduction as a business expense for expenditures on fertilizers. The TVA is empowered to develop, manufacture, and sell fertilizer. The War and National Defense Law has special provisions for the development of fertilizers in relation to ammunition.

In 1973, low-income persons in California brought suit against the Secretary of Agriculture, Secretary of the Interior, and other officials to require them to take action to control water pollution caused by agricultural users of pesticides and fertilizers. The plaintiffs were concerned with the dangerous after-effects of these substances which caused a high level of nitrate in the well water used for consumption and bathing. The plaintiffs were denied the remedy they sought, which was to prohibit federal agencies from giving subsidies and loans to users of agricultural chemicals (Kings County Economic Community Development Association *et al.* v. Hardin, 478 F. 2d 278 (1973)). This case points out the anomaly involved when the government, on the one hand, encourages the use of fertilizers and, on the other hand, discourages, or even makes illegal, the pollution resulting from that use.

Federal Nitrogen Tax

The imposition of excise taxes is generally held to be within the power of the legislature unless specifically restrained by the constitution. Article I, Sec. 8(1) of the U.S. Constitution gives Congress the power to lay and collect taxes, duties, imposts, and excises. The federal government has presently imposed several taxes of a regulatory nature, similar to the proposed nitrogen tax.

The federal excise tax on fuels has essentially a regulatory function. The fuel tax is truly a use tax, since for some uses a fuel, such as for tractors, credit is allowed for taxes paid while for other uses, such as car travel, it is not. The gasoline tax is imposed at the manufacturer's level.

A federal tax on nitrogen would be preferable to a state tax for several reasons. First, implementation would be easier because it could be applied at the manufacturer level on all nitrogen fertilizer produced. Second, if all nitrogen produced were taxed, the problem of smuggling across state lines would be avoided. The state cigarette taxes and alcohol taxes are evidence of the problems which arise when adjacent states tax a product at different rates (81 Yale Law Jrn., July (1972)). Third, it would be more equitable if all farmers functioned under the same burden. Fourth, the short-term effect of a state tax on nitrogen may have only a very minimal effect on the amount of nitrogen applied with a tendency for the farmers in that state to absorb the increased cost, while a federal tax would have a tendency to reduce the application with the knowledge that the national production will drop and prices should increase. Also, the long-term response to nationally increased nitrogen fertilizer prices may be a technological advance.

As with the per-acre nitrogen restriction, the nitrogen tax imposed at the federal level would involve a policy change. In this instance the government would be imposing an excise tax on a substance which actually qualifies as a legitimate expense deduction. The same is partially true, however, for the fuel tax. That tax is imposed on diesel fuel which is used by truckers and which is a legitimate business expense for them. Also, research and development benefits are given to oil investors, a situation comparable to that of providing benefits for fertilizer development.

Nitrogen Tax at the State Level

Another proposal is to impose a state tax on nitrogen. The character of the tax imposed depends on the legislative intent, the practical operation, and the actual effect. Since the purpose of the tax is to impose an economic limitation upon the amount of nitrogen used, rather than to raise revenue, the tax would technically be an exercise of the state's police power and not its taxing power. The constitutional restrictions applicable to the taxing power are not imposed upon a regulatory tax (16 Am. Jur. 2d sec. 265, p. 519 (1964)). The public purpose required for the police power is less than that required for state taxing power. In this sense the same requirement that the means be reasonable would apply to the nitrogen tax as it would to the nitrogen restriction. The expense imposed should be taken into consideration in estimating the reasonableness of a statute enacted under the police power. Presumably the nitrogen tax, however, would be set at a level which would discourage *excessive* use of nitrogen rather than all use. The U.S. Supreme Court has said that the cost and inconvenience would have to be very great before these factors would become elements in considering whether such an exercise of police power is proper (Erie R. Co. v. Williams, 233 U.S. 685 (1913)). The 14th amendment provisions do not interfere with the proper exercise of a state's police power (Durant v. Dyson, 271 Ill. 382, 111 N.E. 143 (1916)).

If the revenue collected from the nitrogen tax went into the general fund, the police power would be the only authority required. If, however, the money collected was earmarked for removing nitrogen from water or for some other type of effort to correct pollution, then the taxation would constitute a mixture of the state's police power and its taxing power and the regulation would have to conform to the tax-power requirement.

There is no historical precedent in Illinois for a regulatory tax under the state's taxing power because prior to 1969 the courts interpreted the 1870 constitution as limiting the General Assembly's taxing power to those taxes, which were specifically enumerated: property taxes, occupation taxes and franchise taxes. The 1970 constitution authorized the General Assembly to raise revenue . . . except as limited or otherwise provided in the constitution. The only apparent limitations are reasonableness of the classifications and uniformity of taxes within a class.

The states have wide discretion in making classifications to produce reasonable systems of taxation. The only two constitutional standards which the state must meet are equality and uniformity. The U.S. Supreme Court has said that the equal-protection clause does not impose an iron rule of equality, which would prohibit the flexibility required for state taxation schemes. Rather, a state may vary the rate of excise upon various products and will not be required to maintain a precise scientific uniformity with reference to use or value (Lehnhausen v. Lake Shore Auto Parts Co., 410 U.S. 356, 35 L. Ed. 351, 93 S. Ct. 1001 (1973)).

In this respect the tax on nitrogen and not other fertilizers should be a reasonable classification. In 1952 a use tax imposed by the state of Illinois was determined to be reasonable and not a violation of the equal-protection clauses even though it classified cigarettes apart from other tobacco (Johnson v. Halpin, 413 Ill. 257, 108 N.E. 2d 350 (1952)). From the standpoint of water pollution, nitrogen is distinguishable from other fertilizers because it readily leaches from the soil.

The requirement of a public purpose under the state taxing power refers to the use made of the revenue, not the motivating purpose of the legislature (A. Magnano Co. v. Hamilton, Washington, 292 U.S. 40 (1933)). Hence, if the money collected from the nitrogen tax were earmarked for some special purpose, then that purpose must qualify as a legitimate effort to directly promote the welfare of the community.

The nitrogen tax in Illinois would probably be in the form of a selective sales tax for Illinois retailers plus a selective use tax for all nitrogen bought in other states and brought into Illinois. The state has inherent power to enact sales and use tax laws.' Illinois has, in fact, enacted both a general sales tax (Chapter 120, sec. 440 Ill. Rev. Stat.) and a general use tax (Chapter 120, sec. 439). Both of these statutes have been upheld by the courts. Illinois also has selective sales and use taxes on cigarettes (Chapter 120, sec. 453) which have been upheld by the courts.

The problem with a nitrogen tax would be a practical one of enforcing it rather than a legal one of having the authority to enact the tax. The Buck Act (4 U.S.C., sec. 105-110) does deny the states the right to levy or collect any tax on or from the United States or any instrumentality thereof. The state, in drafting its legislation, need only exercise care that the statute does not expressly require that the tax be passed on to the ultimate purchaser in circumstances where the purchaser may be an instrumentality of the federal government (29 Tax Lawyer 377 (1976)).

The nitrogen tax should not conflict with any rulings under the interstate-commerce clause. This tax would be imposed by the state legislature on the people of the state and would not burden citizens of other states. The interstate-commerce clause has traditionally been used to invalidate laws passed by one state which burden those citizens of another state who carry on some kind of business with the state imposing the law.

The existing sales-tax and use-tax statutes in Illinois exempt farm chemicals from being taxed (Ch. 120, sec. 439.3 and 441). These exemptions should probably be left unaltered if the special tax is imposed, avoiding the ambiguity and pyramiding effect of double taxation.

Two states presently have some type of provision for an environmental tax, but neither is analogous to a nitrogen tax. Iowa Statute 467. A 20 provides for a special annual tax, the proceeds to be used for repayment of expenses incurred in organizing subdistricts, for acquisition of land or rights, or for improvements within the subdistrict boundaries. An Ohio provision, 1515.28, provides that if the county commissioners resolve that a tax is needed, then the people will vote on it. The proceeds of the tax would go to employ assistants, purchase materials and equipment, and construct and maintain improvements.

CHAPTER 9

CONCLUSIONS

1. While it is possible to identify a reasonably wide range of alternative policies for controlling agricultural NPS water pollution, the range of those that appear practical (economically and institutionally) is likely to be much more limited. Perhaps this fact is reflected in the findings that, while there is considerable activity in the policy development arena, the policies being developed are not highly varied.

2. The aggregate corn-belt model suggests that the agricultural sector may not be adversely affected by soil-loss restrictions and would be positively impacted by nitrogen-application restrictions. These effects result from a rise in crop prices which more than offsets reductions in crop production and increases in costs.

3. The corn-belt model indicates that reductions in soil loss were to be achieved through a tax on soil losses, the tax burden would generate adverse impacts on the agricultural sector.

4. The watershed and aggregate models suggest that the impacts on farmers would not be uniform. Farmers on nonerosive land would benefit significantly while farmers on erosive land might be forced to remove land from production.

5. The consumer and tax costs of erosion control will depend on the extent of control desired and the means of achieving the control selected. An accurate estimate of these impacts must await more precise estimates of soil-loss coefficients. The high estimate of impacts on social cost is roughly approximated at $1.2 billion, excluding governmental administrative costs and reductions in environmental damages.

6. The continued adoption of the chisel-plow technique would result in substantial reductions in soil loss with some associated increase in pesticide use according to the results of the corn-belt model.

7. Adopting soil-loss controls would result in changes in the proportions of the various crops produced and in their prices. Generally the prices of row crops increase as their production decreases in favor of production of grain crops, hay, and pasture. With increasingly stringent soil-loss limits, the nitrogen use per acre increases slightly but the total amount used decreases as a result of reduced corn acreage.

8. A terracing subsidy policy alone is not as cost effective as other approaches, but it can be combined with soil-loss restrictions to reduce the negative impacts on some farm operators.

9. It may be necessary to use greenbelts along flowing waters in addition to controlling runoff from the level surface to achieve desirable levels of water quality.

10. The watershed long-term analysis suggests that continued use of current practices can result in the loss of all topsoil on significant acreage over a 100-year period. When projections are made on the basis of constant prices and a 5-percent discount rate, the producer cannot economically control the erosion. Even at a zero discount rate, the farm operator's planning horizon would need to be 50 years long before soil loss would be controlled.*

11. The costs of developing an institutional framework *de nuvo* for policy implementation will be a significant addition to the economic impacts projected in the aggregate analysis. The annual costs of a five-year program to accomplish the goals established range up to $980,000 for a typical county. The costs of a program to implement soil conservation plans were estimated at about $1/2 million per county for a five-year program. Costs savings would be possible if existing agencies were used to carry out appropriate functions.

12. An analysis of the social acceptance of conservation practices by farmers suggests that the voluntary approach (unless combined with economic incentives) will not be highly successful. The use of existing agricultural agencies will result in a more favorable reaction by farmers and the farm community than if new agencies were created.

13. In a related study of Illinois farmers, it was determined that a majority of farm operators feel soil erosion to be a problem both from the perspective of maintaining soil productivity and from that of water quality. This study also suggests that there are a number of policy approaches to the control of soil erosion that a majority of the farmers feel are "fair." Further, nitrogen-restriction policies are viewed as "unfair" by a substantial majority of farmers. This finding is consistent with the reduction in income that would be experienced if an individual farmer reduced fertilization rates but inconsistent with the substantial increase in producer income projected by the cornbelt model if a nitrogen restriction were placed on all farmers.

14. It is possible to determine the nature of the impacts on various segments of society under several equity criteria. No single policy is

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*A more comprehensive analysis of this problem is under way and will be reported in a separate document.

consistently more equitable than all others, however, under all equity criteria and for all social segments.

15. When the policies considered here are compared to commonly accepted land-use controls, it appears that policies for the control of soil loss or those which impose nitrogen limits can legally be developed.

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APPENDIX A

SUMMARY OF EROSION AND SEDIMENTATION LAWS

AREA	HAWAII
IDENTIFICATION	Act relating to Soil Erosion and Sediment Control
STATUS	Enacted in 1968; revised in 1975
LIMITATIONS	County governments in cooperation with SWCDs are mandated to enact ordinances for the control of soil erosion and sedimentation. If a county fails to promulgate rules and regulations the State Department of Health will do so. Criteria, techniques, and methods for erosion control are to be based on relevant watershed and drainage basin physical data. Inclusion of surveys of land and water with critical erosion problems.
ENFORCEMENT	Compliance is based on evidence that an acceptable conservation program is being implemented in accordance with the SWCD.

AREA	ILLINOIS
IDENTIFICATION	Illinois House Bill 962 as amended, to develop and coordinate a comprehensive State soil erosion sediment control program.
STATUS	Proposed to Assembly Committee Session, 1976.
POLLUTANT	Sediment
LIMITATIONS AND PERFORMANCE	1. Ill. Dept. of Agriculture obligated to develop comprehensive state erosion and sediment control program, including minimum guidelines to be used in implementation by SCS districts, and to submit same to Governor and

General Assembly, sixty days after which the latter could disapprove or adoption would be automatic. It must be consistent with objectives of Federal Water Pollution Control Act of 1972, PL 92-500, and any amendments, and finance the increased Dept. and SCS work load.

2. Each SCS district has one year from above adoption to develop a technically feasible and economically reasonable program consistent with the Department's program and guidelines.

3. Dept. and Districts must hold public hearings during development of its program, and to organize an Advisory committee representing nine different interest groups with at least half being persons deriving half their income from farming.

4. SCS must make available upon request adequate technical information for any installation recommended in above planning, and also provide cost-sharing for any such installation of any costs in excess of the likely economic benefits to the user.

5. All users of land-disturbing activities (excepting home gardens and landscaping) shall comply with above guidelines.

ENFORCEMENT

1. Any alleged violation of this policy may be passed to the Dept. or SCS for investigation, attempted resolution, or eventual referral to State's Attorney or Attorney General.

2. Violator is guilty of petty offense, subject only to unspecified fine.

AREA	INDIANA
IDENTIFICATION	A proposal for Soil Erosion and Sediment Control.
STATUS	Proposed possibly for 1977 General Assembly; endorsed by Directors of the Indiana Association of Soil and Water Conservation Districts on September 22, 1975.
POLLUTANT	Sediment
LIMITATIONS AND PERFORMANCE	1. No prohibited land-disturbing activity shall be pursued without an approved plan for erosion and sediment control. 2. SCS district establishes standards and guidelines (as stringent or more so than those in item 3 below) for erosion and sediment control, reviews and approves user plans, and acts on violation complaints filed internally, by the State Committee, or by a citizen using the enforcement procedure below. 3. State Soil and Water Conservation Committee develops guidelines and standards using as one measure "T" values in SCS technical guide, and also specifies financial assistance to be made available. 4. Any user is deemed in compliance if he has an approved plan, or is using practices conforming to standards (and not found otherwise), or has no technical or specified financial assistance available.
ENFORCEMENT	1. District enforcement as follows: (a) Alleged damage inspected (b) Responsible party notified of valid complaint (c) District seeks voluntary solution and offers available technical and financial assistance (d) Uncorrected alleged violation referred to county prosecuting attorney. (e) Violation is misdemeanor, carrying possible fine up to $500/day of occurrence. (f) Appeal by convicted user may be made within 30 days 2. User destroying any installation involving cost-sharing funds shall forfeit same.

AREA	IOWA
IDENTIFICATION	Regulation by Conservation Districts of Sedimentation from Agricultural Land Use
STATUS	Adopted by State government, 1971; Conservancy Law 467.D
POLLUTANT	Sedimentation
LIMITATIONS	1. Regulation of soil erosion resulting in or contributing to damage by siltation to any internal improvement of a conservancy district, or resulting in or contributing to damage to property not owned by the owner or occupant of the land on which the erosion is occurring. 2. Maximum soil loss on agricultural land is specified in tons per acre per year, depending on the soil type, as specified by the "T" values in column 2, Table V, section IIIB, of the Work Unit Technical Guides.
ENFORCEMENT	1. Erosion fitting the above description is declared to be a nuisance. Amount of erosion determined by the "universal soil loss equation". Wind Erosion Equation, used by the states west of Iowa, has been adopted by Iowa. 2. Court order used to enforce conservation practices. 3. Iowa Natural Resources Council approves state plan. 4. Owner or occupant of land being damaged must file complaint against offender. 5. District SCS responsible for specific planning and implementation. Complaint filed with SCS, which investigates, notifies landowner and seeks voluntary solution. SCS commissioners review report, determine if nuisance exists, and issue administration order. Agriculture given 6 months to initiate correction which must be completed within one year of date order issued. User not in violation if specified funding absent. 6. If no correction, SCS may petition district court for immediate compliance and contempt judgment.

7. Order necessary for implementing cost-sharing and court enforcement and cost-sharing funds must be available for enforcement proceedings. For permanent practices, 75% of cost shared; for temporary practices, share set annually by State SCS; State SCS may authorize district to cover sharing over 75%; state may recover cost share if practice not maintained.

ADDED INFORMATION	1. July 1973 - first complaint handled by State Council 2. Cost-sharing funds of $2 million (both 1973 and 1974 provided); users eligible for only up to 50% of cost when applied for practice pursued voluntarily.

AREA	KANSAS
IDENTIFICATION	Kansas Task Force on Erosion and Sedimentation Proposal (patterned after Model State Act for Soil Erosion and Sediment Control)
STATUS	Legislation has been adopted to be in effect after Jan. 1, 1977.
POLLUTANT	Sedimentation
LIMITATIONS AND PERFORMANCE	The State Commission shall develop by 1978 guidelines for erosion and sediment abatement. Each SCS district shall develop an erosion and sediment control program consistent with these guidelines. Anyone engaging in a "land disturbing activity" (defined as including all agricultural tillage but not home gardening) must file plans for the control of soil erosion and sediment damage with the Soil Conservation district and obtain approval to proceed.
ENFORCEMENT	1. The district or Commission has the right to inspect the site for compliance. 2. If the district does not have financial assistance available for the landowner to install conservation methods, the landowner is not required to do so. 3. Anyone dissatisfied with initial decision of the district or Commission may obtain an appeal for reconsideration. 4. Violation shall be deemed a misdemeanor. Fine up to $500 or one year's imprisonment for each and every violation. Each day the violation continues shall constitute a separate offense.
ADDED INFORMATION	1. An elaborate educational effort of the citizenry about this policy has been mounted by the Kansas Cooperative Extension Service (see its Erosion and Sedimentation --Information Kit, 1974).

AREA	MICHIGAN
IDENTIFICATION	Soil Erosion and Sedimentation Control
STATUS	State Public Acts of 1972 (Act No. 347) and amended by Public Acts of 1974 (Act No. 197)
POLLUTANT	Sediment (1974 Amendment excludes land disturbance for crop production until 1978, then must have approved soil conservation plan)
LIMITATIONS AND PERFORMANCE	Any earth changes within 500 ft. of a lake or stream and involving more than one acre of land need a permit and conservation plan approved.
ENFORCEMENT	1. Water Resources Commission establishes rules and supervises. 2. County responsible for administration and enforcement of rules and notificational violations. 3. Commission or agent may inspect site for compliance. 4. Original act delegated State Department of Agriculture to submit soil erosion and sedimentation control program. Land user would enter into agreement with Soil Conservation District to pursue relevant agricultural practices. 5. Violation is a misdemeanor.

AREA	MINNESOTA
IDENTIFICATION	Soil Erosion Control Bill
STATUS	Proposed for this legislative session - spring 1977. This bill was introduced during a previous legislative session. It is expected to be reintroduced and passed with provisions directly relating to 208 planning.
LIMITATIONS	Land-disturbing activities include agricultural land. The state SWCD Commission will sponsor the erosion control program and with the assistance of an advisory board will develop standards and regulations.
ENFORCEMENT	To be in compliance with the law a person engaged in a land-disturbing activity must have an approved conservation plan for erosion and sediment control.

AREA	NEW YORK
IDENTIFICATION	"To Amend Soil and Water Conservation Districts' Law in Relation to Soil and Water Conservation Plans" (with special emphasis on agri. land)
LIMITATIONS	Every owner or occupier of agricultural land is required to apply to the local SWCD by January 1978, for a conservation plan. By January 1980, the SWCDs are to have provided a soil and water conservation plan for every landowner. These plans are to be reviewed every five years after development. There is no provision for implementation of the plans.
ENFORCEMENT	There is no requirement for an owner/occupier to follow the conservation plan prepared for his land.

AREA	OHIO
IDENTIFICATION	Agricultural Pollution Abatement Standards and Regulations
STATUS	Proposed: Bill is expected to pass in January, 1977.
POLLUTANT	Sedimentation and animal wastes
LIMITATIONS AND PERFORMANCE	1. Average annual soil loss limited to: Phase I - 2 times T value until 1980 Phase II - 1.5 times T value from 1980-1985 Phase III - T value after 1985 (T value taken from Technical Guide - developed by the Soil Conservation Service, U.S. Dept. of Agr.); if Guide does not apply, practices approved by SCS District will be used.) 2. No tillage adjacent to ditch, stream, or lake which will allow soil to readily erode into them is permitted. 3. Ohio Division of Soil and Water Districts shall recommend methods and practices to meet standards. 4. The Division will develop cooperative agreements with district SCS for implementation.
ENFORCEMENT	1. Land user considered to be in compliance if land managed according to plan approved by local SCS district. 2. Violation complaints against offending party may be filed with district SCS by their own surveillance, by the Division, by any property owner suffering damage, or by citizens of the State. 3. SCS district upon finding violation will proceed to seek solution through voluntary cooperation with its cost-sharing program. 4. Alleged offender has right to meet with Board of Supervisors. 5. If violation continues, state EPA reviews and may issue an administrative order.

6. Order not permitted unless technical and cost-sharing assistance available.

7. State will pay any residual not paid by federal cost-sharing of a combined maximum up to 75% of cost of approved practices or repair of deterioration from natural causes.

8. If violation is not corrected some type of action developed with Ohio EPA will take place. This action was not specified in the proposal.

AREA	PENNSYLVANIA
IDENTIFICATION	The Clean Streams Law, Act 222 of 1970, supplemented with "Erosion Control Rules and Regulations" adopted by Environmental Quality Board, 1972
STATUS	Adopted 1970, 1972
POLLUTANT	Sediment, fertilizers, pesticides
LIMITATIONS AND PERFORMANCE	1. Whenever Environmental Quality Board, Environmental Hearing Board, and Department of Environmental Resources finds pollution or danger of pollution resulting from a land condition, the agency may order the condition corrected or implement correction itself. 2. Plowing and tilling for agricultural purposes are exempted from a required permit system of all earthmoving activity, as are all earthmoving activities where a control plan has been developed by SCS or it involves less than 25 acres. 3. All earthmoving activities, including agricultural, must be conducted so as to prevent erosion and sedimentation according to a plan to be available upon inspection at all times; plowing and tilling provision in effect July 1, 1977. Sediment can be reduced by proper catch basin.
ENFORCEMENT	1. Any violator may be guilty of summary offense and subject to a fine up to $1000 for each offense, or imprisonment if such defaulted, and guilty of a misdemeanor

for second violation, if occurring within 2 years of previous violation.

2. Each day of violation constitutes a separate offense.

3. Civil cost penalties may also be assessed.

4. Penalties may be assessed to recover costs of correction unless problem resulted from nature or during compliance with a conservation district plan.

ADDED INFORMATION	1. Although not stated, there is an implication that agricultural land users would obtain "proper" plans from SCS or similar agency. 2. No cost share funds are provided by the state.

AREA	SOUTH DAKOTA
IDENTIFICATION	Act to Regulate Land-disturbing Activities within the State Resulting in Soil Erosion and Sediment Damage
STATUS	Bill was adopted in 1976
LIMITATIONS	Development of control guidelines including recommended soil loss limits and conservation practices by SWCD districts. Development must provide full opportunity for citizen participation. Specific agency must be designated to issue permits for land-disturbing activity; not SWC districts
ENFORCEMENT	District receives petitions from persons adversely affected by land-disturbing activity and must investigate/determine validity of complaint. On own volition a district can initiate court action for injunctive relief from damaging land-disturbing activity.

AREA	NEW JERSEY
IDENTIFICATION	Soil Erosion and Sediment Control Act
STATUS	Enacted in 1975
LIMITATIONS	State Soil Conservation Committee must establish standards based on relevant topographical and physical watershed data. The Committee must include criteria, techniques, and methods for control of erosion and sedimentation in accordance with different soil types and slopes. Standards and regulations must be approved by the State Secretary of Agriculture and the Commissioner of Environmental Protection. Implementation in rural sector will be under direction of SWCD. The districts are to certify erosion and sediment control plans. The State Soil Conservation Committee may make grants to the districts to assist soil erosion control activities.
ENFORCEMENT	Violators are subject to fine and injunctive relief may be sought.

AREA	MONTANA
IDENTIFICATION	Natural Streambed and Land Preservation Act of 1975.
STATUS	Legislation adoption in 1975
LIMITATIONS	Preserve and prohibit unauthorized activities in natural rivers and streams and lands and property adjacent to them. Standards and guidelines are established by the conservation districts. Landowner must give notice of proposed project to SWC districts. Such notice is to be reviewed by Department of Fish and Game and a special review team. If an acceptable project plan cannot be agreed upon, an arbitration board is appointed. If this board requires modification of landowner's project cost-sharing must be provided for the cost of alterations.
ENFORCEMENT	If commencement of a project begins prior to approval it will be declared a nuisance and subject to legal action. Initiating a project without consent is a misdemeanor and subject to monetary penalties from $25-$500. Violators may also be subject to payment of costs for restoring damaged stream.

AREA	WALWORTH AND VERNON COUNTIES, WISCONSIN
IDENTIFICATION	
STATUS	Walworth County: Soil erosion ordinance passed in 1974 Vernon County: Soil erosion proposed in 1976
LIMITATIONS	Walworth - zoning ordinance passed permitting tillage on some soil types only if such tillage practice meets county conservation standards which are in turn based on SCS standards Vernon - proposed ordinance specifically directed toward management of agricultural land for control of erosion and sediment. All agricultural land is subject to provisions of ordinance except land less than 6% slope.
ENFORCEMENT	Walworth - Enforcement of acceptable tillage practices is carried out by county zoning administrator. Vernon - If a landowner is to comply with ordinance he must employ conservation management practices acceptable to the local SWCD or manage his land according to standards set forth in the SCS Technical Guide. Conservation districts may investigate and file citizen complaints against polluting neighbor. Violators forfeit cost-sharing funds.

AREA	MODEL LAW
IDENTIFICATION	Model State Act for Soil Erosion and Sediment Control
STATUS	Only to use as a model; developed by The Committee on Suggested State Legislation (published 1973), The Council of State Governments, Iron Works Pike, Lexington, Kentucky 40505.
POLLUTANT	Sediment
LIMITATIONS AND PERFORMANCE	1. Require filing and approval by the soil conservation district of plans for control of sediment associated with any land-disturbing activity (defined in detail and including all agricultural land uses involving tilling, soil moving, and clearing, excepting home gardens and landscaping). 2. Conservation standards for various soil types, land uses, land-disturbing activities must be cleared drawn up, first, at the state level, and then consistent with it, at the district level.
ENFORCEMENT	1. Responsibility for sediment control would rest with existing Soil Conservation Districts that already have relevant responsibilities under the laws of 50 states, acting in conjunction with the appropriate state agency, and additional policies concerned with water quality and environmental problems would appear as amendments to existing conservation districts enabling laws of individual states. 2. Review by state agency or district of submitted plans by land users may result in mandated modification. 3. Land users must have at least 50% cost-sharing assistance or adequate technical assistance in order for public enforcement of approved practices. 4. As applicable above, implementing agency shall periodically inspect the compliance of the land-disturbing activity with the approved plan; violations continued after due notice (for agricultural users, remedy must

commence within 6 months and be completed within 12 months) of remedies required shall be subject to conviction and penalties permitted in the enabling legislation.

5. State agencies and districts are eligible to receive and dispense either private or public funds for purposes of implementation of this policy. State funds should finance activities of this policy.

6. Decisions of state agencies and districts subject to court review if appeal filed within 30 days.

7. Violations deemed misdemeanors and subject upon conviction to fine not to exceed $500 or one year's imprisonment for each and every violation (each day of violation considered separate offense.

8. Legal actions for state or district will be pursued by state or county attorney.

APPENDIX B

ADMINISTRATIVE COSTS OF EXISTING SCS/ASCS PROGRAMS IN CORN-BELT STATES

Table B1

Administrative Costs of Existing ASCS/ACP Subsidized Conservation Programs in Illinois

ADMINISTRATIVE COSTS	1969	1970	1971	1972	1973	1974	1975
TOTAL Actual Dollars	1,018,932	930,950	810,426	757,815	942,543	518,545	782,189
Real Dollars (base=1975)	1,445,294	1,264,878	1,053,870	952,029	1,122,075	558,777	782,189
Actual Dollars/Farm	41.46	40.99	47.03	40.42	94.79	205.04	155.26
Real Dollars/Farm	58.81	55.69	61.16	50.78	112.84	220.95	155.26
Actual Dollars/Unit of Accomplishment	2.12	2.19	5.46	4.43	12.06	17.76	4.01*
Real Dollars/Unit of Accomplishment	3.00	2.97	7.10	5.57	14.36	19.14	4.01*
Per Dollar of Subsidy Payment	.14	.13	.14	.10	.13	.19	.17

*This low figure results from a change in recording the accomplishment units for variable 12 from "acres formed" to "acres served".

Source: The values in this table are derived from data taken from the <u>ACP-Practice Accomplishments by States</u> (USDA) and data obtained from the ASCS Budget Division (Holmes, written communication).

Table B2

Administrative Costs of Existing ASCS/ACP Subsidized Conservation Programs in Indiana

ADMINISTRATIVE COSTS	1969	1970	1971	1972	1973	1974	1975
TOTAL Actual Dollars	788,202	712,667	690,380	684,672	839,549	410,446	666,207
Real Dollars (base=1975)	1,118,017	968,298	897,763	860,141	999,463	442,291	666,207
Actual Dollars/Farm	31.64	31.71	45.27	35.43	149.17	152.58	114.82
Real Dollars/Farm	44.88	43.09	58.86	44.51	177.59	164.42	114.82
Actual Dollars/Unit of Accomplishment	1.41	1.48	3.08	2.26	10.26	9.69	5.53*
Real Dollars/Unit of Accomplishment	2.00	2.01	4.01	2.84	12.21	10.44	5.53*
Per Dollar of Subsidy Payment	.19	.15	.20	.12	.18	.21	.17

*This low figure results from a change in recording the accomplishment units for variable 12 from "acres formed" to "acres served".

Source: The values in this table are derived from data taken from the <u>ACP-Practice Accomplishments by States</u> (USDA) and data obtained from the ASCS Budget Division (Holmes, written communication).

Table B3

Administrative Costs of Existing ASCS/ACP Subsidized Conservation Programs in Iowa

ADMINISTRATIVE COSTS	1969	1970	1971	1972	1973	1974	1975
TOTAL Actual Dollars	1,087,580	1,194,934	994,544	903,364	1,132,477	443,343	890,342
Real Dollars (base=1975)	1,542,444	1,623,552	1,293,295	1,134,879	1,348,187	477,740	890,342
Actual Dollars/Farm	24.75	27.62	37.39	29.84	107.16	157.49	123.08
Real Dollars/Farm	35.11	37.52	48.62	37.49	127.57	169.71	123.08
Actual Dollars/Unit of Accomplishment	1.51	1.71	3.25	1.91	4.90	10.83	4.54*
Real Dollars/Unit of Accomplishment	2.14	2.33	4.23	2.40	5.83	11.66	4.54*
Per Dollar of Subsidy Payment	.14	.14	.15	.11	.14	.13	.14

*This low figure results from a change in recording the accomplishment units for variable 12 from "acres formed" to "acres served".

Source: The values in this table are derived from data taken from the <u>ACP-Practice Accomplishments by States</u> (USDA) and data obtained from the ASCS Budget Division (Holmes, written communication).

Table B4

Administrative Costs of Existing ASCS/ACP Subsidized Conservation Programs in Minnesota

ADMINISTRATIVE COSTS	1969	1970	1971	1972	1973	1974	1975
TOTAL Actual Dollars	525,027	485,012	621,846	608,686	742,952	287,946	770,041
Real Dollars (base=1975)	744,719	658,984	808,642	764,681	884,467	310,287	770,041
Actual Dollars/Farm	28.01	22.10	44.96	35.54	66.88	79.63	111.73
Real Dollars/Farm	39.73	30.03	58.47	44.65	79.62	85.81	111.73
Actual Dollars/Unit of Accomplishment	.75	.69	1.37	.87	3.28	4.13	3.49*
Real Dollars/Unit of Accomplishment	1.06	.93	1.78	1.09	3.90	4.45	3.49*
Per Dollar of Subsidy Payment	.10	.08	.16	.09	.12	.11	.18

*This low figure results from a change in recording the accomplishment units for variable 12 from "acres formed" to "acres served".

Source: The values in this table are derived from data taken from the <u>ACP-Practice Accomplishments by States</u> (USDA) and data obtained from the ASCS Budget Division (Holmes, written communication).

Table B5

Administrative Costs of Existing ASCS/ACP Subsidized Conservation Programs in Missouri

ADMINISTRATIVE COSTS	1969	1970	1971	1972	1973	1974	1975
TOTAL Actual Dollars	1,581,119	1,560,745	1,082,600	1,123,149	1,368,318	359,992	1,078,709
Real Dollars (base=1975)	2,242,722	2,120,577	1,407,802	1,410,991	1,628,950	387,922	1,078,709
Actual Dollars/Farm	30.68	30.51	29.17	33.12	79.84	77.52	63.28
Real Dollars/Farm	43.52	41.45	37.93	41.60	95.04	83.53	63.28
Actual Dollars/Unit of Accomplishment	1.88	1.87	3.15	3.24	5.54	4.68	4.17*
Real Dollars/Unit of Accomplishment	2.67	2.53	4.10	4.07	6.59	5.05	4.17*
Per Dollar of Subsidy Payment	.20	.21	.17	.15	.17	.12	.17

*This low figure results from a change in recording the accomplishment units for variable 12 from "acres formed" to "acres served".

Source: The values in this table are derived from data taken from the ACP-Practice Accomplishments by States (USDA) and data obtained from the ASCS Budget Division (Holmes, written communication).

Table B6

Administrative Costs of Existing ASCS/ACP Subsidized Conservation Programs in Nebraska

ADMINISTRATIVE COSTS	1969	1970	1971	1972	1973	1974	1975
TOTAL Actual Dollars	604,007	476,292	522,795	602,360	717,428	324,793	716,833
Real Dollars (base=1975)	856,748	647,136	679,837	756,734	854,018	349,992	716,833
Actual Dollars/Farm	42.22	37.90	51.72	50.50	88.47	110.59	143.14
Real Dollars/Farm	59.89	51.50	67.25	63.45	105.33	119.17	143.14
Actual Dollars/Unit of Accomplishment	1.45	1.37	3.76	2.05	4.12	3.95	3.73*
Real Dollars/Unit of Accomplishment	2.06	1.87	4.89	2.57	4.90	4.26	3.73*
Per Dollar of Subsidy Payment	.13	.09	.12	.11	.13	.15	.18

*This low figure results from a change in recording the accomplishment units for variable 12 from "acres formed" to "acres served".

Source: The values in this table are derived from data taken from the ACP-Practice Accomplishments by States (USDA) and data obtained from the ASCS Budget Division (Holmes, written communication).

Table B7

Administrative Costs of Existing ASCS/ACP Subsidized Conservation Programs in Ohio

ADMINISTRATIVE COSTS	1969	1970	1971	1972	1973	1974	1975
TOTAL Actual Dollars	691,481	609,370	580,573	583,764	692,126	239,516	697,803
Real Dollars (base=1975)	908,824	827,948	754,971	733,372	823,960	258,099	697,803
Actual Dollars/Farm	30.07	31.22	47.33	40.68	95.19	95.20	131.49
Real Dollars/Farm	42.66	42.42	61.55	51.11	113.32	102.58	131.49
Actual Dollars/Unit of Accomplishment	1.60	1.53	.77	2.75	5.62	9.32	7.07*
Real Dollars/Unit of Accomplishment	2.27	2.08	1.00	3.46	6.69	10.05	7.07*
Per Dollar of Subsidy Payment	.14	.13	.14	.10	.14	.13	.23

*This low figure results from a change in recording the accomplishment units for variable 12 from "acres formed" to "acres served".

Source: The values in this table are derived from data taken from the ACP-Practice Accomplishments by States (USDA) and data obtained from the ASCS Budget Division (Holmes, written communication).

Table B8

Administrative Costs of Existing ASCS/ACP Subsidized Conservation Programs in Wisconsin

ADMINISTRATIVE COSTS	1969	1970	1971	1972	1973	1974	1975
TOTAL Actual Dollars	663,973	649,735	491,193	529,683	664,536	365,204	650,612
Real Dollars (base=1975)	9,411,806	882,792	638,743	665,431	791,114	393,539	650,612
Actual Dollars/Farm	39.12	42.77	38.79	38.73	66.11	89.95	106.90
Real Dollars/Farm	55.49	58.11	50.45	48.66	78.70	96.93	106.40
Actual Dollars/Unit of Accomplishment	1.71	2.00	2.25	1.94	4.15	9.48	5.98*
Real Dollars/Unit of Accomplishment	2.42	2.72	2.93	2.43	4.94	10.21	5.98*
Per Dollar of Subsidy Payment	.13	.14	.11	.10	.13	.18	.20

*This low figure results from a change in recording the accomplishment units for variable 12 from "acres formed" to "acres served".

Source: The values in this table are derived from data taken from the ACP-Practice Accomplishments by States (USDA) and data obtained from the ASCS Budget Division (Holmes, written communication).

APPENDIX C

THE LAND-WATER INTERFACE

Attempts to improve water quality by controlling nonpoint sources commonly focus on standard erosion control techniques. However, many processes affect the transport and deposition of eroded materials between initial movement on the land and movement into and within a channel.

This discussion examines the value of greenbelts in reducing the delivery of eroded materials to stream channels. In addition, it examines how stream channel characteristics affect the ability of water to transport sediment. This attempt to integrate results of studies by engineers, agriculturists, hydrologists, foresters, and ecologists addresses the practicality of maintaining a more natural in- and near-stream ecosystem as a means of improving water quality.

VEGETATION AS A NUTRIENT AND SEDIMENT FILTER

Early observations documenting the use of vegetation as a sediment filter* in channels are primarily descriptive. More recently, both field (Wilson, 1967) and laboratory (Trollner *et al.*, 1976) studies have documented the ability of real and simulated vegetation to filter sediments from shallow-channel flow. Data from field studies indicate that:

1. Filter efficiency varies with type of vegetation; efficient species remove 50% of initial sediment concentration (5000 ppm) in 300 ft and 99% in 1000 ft.
2. An inverse relationship exists between particle size and the vegetation length required to remove a given precentage of the particles.
3. The rate of sediment deposition in the filter is constant over a range of slopes. After a critical slope is reached, the filter efficiency decreases to zero.

Therefore, several variables determine the effectiveness of real vegetation in removing sediments from shallow-channel flow. These variables, which act in an interrelated manner, include filtration length, slope of the filter,

*In this discussion the word *filter* will be used as a shorthand to indicate the process by which the sediment content of water flowing through vegetation or surface litter is decreased. This decrease results from changing velocity, turbulence, and other characteristics of flowing water in association with vegetation and/or surface litter.

grass characteristics, size distribution of incoming sediment particles, degree of submergence of the filter, application rate of the water to be filtered, and initial conditions. Many of these same variables were judged important on the bases of laboratory studies by Trollner *et al.* (1976) and of minimal amounts of field data. Unfortunately, little quantitative information is available on how these variables are interrelated when real vegetation is used as a filter under runoff conditions encountered in agricultural watersheds.

Since most nutrients (especially phosphorus) in surface runoff are attached to the clay fraction of sediment (Sommers *et al.*, 1975), the usefulness of vegetation for reducing nutrient loads will depend on its ability to filter sediments from surface and shallow-channel runoff. Studies of natural vegetation to filter sediments from surface runoff come from the forestry (Trimble and Sartz, 1957; Haupt, 1959) and agricultural literature (Mannering and Johnson, 1974). These studies show that the sediment-trapping capacity of vegetation varies with the slope and slope length before the water reaches the filter. In one trial Mannering and Johnson (1974) found a 54% reduction in sediments in a 15-m strip of bluegrass sod. Another study of surface runoff through heavy cornstalk residue on the lower 10 ft of a 35-ft erosion plot carried only 3 to 5% of the sediment expected from a bare surface (G. R. Foster, hydraulic engineer, USDA-ARS, personal communication).

Clearly, vegetation can serve as an effective sediment filter. However, the width of the filter required to remove a given fraction of incoming sediment and the duration of its effectiveness is dependent on the interaction of physical factors, biological factors, and specifications of water quality standards, all of which have not been thoroughly evaluated under normal agricultural conditions. Land-use practices for land adjacent to streams in typical agricultural watersheds indicate that these relationships should be investigated and the subject given more effective consideration in ongoing planning programs.

CHANNEL MORPHOLOGY AND WATER QUALITY

The concept of unit stream power was developed to predict total suspended sediment concentration of a stream based on channel morphology (Stall and Yang, 1972; Yang and Stall, 1974). The rate of sediment transfer is directly related to unit stream power (USP)--the rate of energy expenditure by a stream as it flows from a higher to a lower point. It is defined as the time rate of potential energy expenditure by a stream as it flows from a higher to a lower point. It is defined as the time rate of potential energy expenditure per unit weight of water in an alluvial channel. USP can be expressed mathematically in terms of average water velocity, V, and, under steady uniform-flow conditions, the surface slope of the water, S*:

*More complex considerations of lift force, critical velocity, drag force, and particle diameter have been added to this basic concept. For a detailed discussion of these considerations, consult the publications by Stall and Yang cited above.

$$\text{UNIT STREAM POWER} = \frac{dY}{dt} = \frac{dX}{dt}\,\frac{dY}{dX} = VS$$

where

t = time

Y = elevation above a given point, equivalent to the potential energy per unit weight of water

X = longitudinal distance

The effect of stream morphology on USP was demonstrated by a study of the Middle Fork of the Vermilion River (Stall and Yang, 1972). Measurements of area of flow, roughness coefficients, width, depth, velocity, and slope were made on a 3360-ft test reach containing three riffles and two pools. Measurements were made at low, medium, and high discharges, and USP was calculated for the natural stream and an "equivalent" channel without pools and riffles. USP was reduced by 23 to 26% in a pool-and-riffle stream during medium- and low-flow conditions when compared to an equivalent uniform channel of the type normally formed by present channelization practices. Pools and riffles served as an effective means for the channel to reduce USP and therefore reduce its erosive energy and sediment-transporting capability during low and medium flows. At high flows the pools and riffles were obscured and had no effect on USP.

Data collected at Black Creek (Karr and Gorman, 1975) relating suspended sediment concentrations to stream morphology correlate well with the results of Stall and Yang (1972). Karr and Gorman measured suspended solids concentration in a channelized section above a forest, in a meandering pool-riffle sections within a forest, and in a channelized section below a forest. The meandering pool-riffle section acted as a "sediment trap" during low- and medium-flow conditions, resulting in a decrease of 28% in suspended solids by the time the flow reached the lower end of the forest, as shown in Figure C1. This reduction is very similar to the reduction in USP caused by pools and riffles. As the flow left the forest, suspended solids concentrations attained the same level as in the channel above the forest. An increase in the roughness factor in the woodlot is the likely factor responsible for the decreased sediment loads since the slopes are lower (.25) above and below the woodlot than in the woodlot (.40). During periods of high runoff, however, the forest or other vegetation along the stream acts in conjunction with stream morphology to improve water quality.

Therefore, allowing streams to maintain their natural morphology to reduce USP and suspended sediment concentrations is a feasible management alternative for improving water quality, especially during periods of low and intermediate flows. During such periods the erosive energy of the stream is reduced, and pools act as sediment traps to reduce suspended sediment concentrations and increase the suitability of the water for human uses and aquatic organisms.

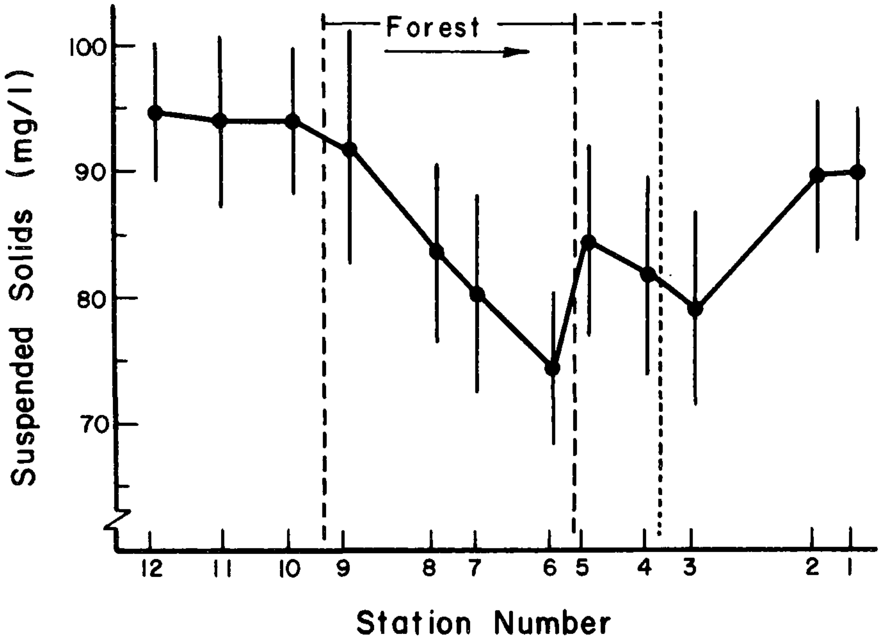

Figure C1. Mean and standard error of suspended solids load in Wertz Drain study area.

EFFECTS OF STREAMSIDE VEGETATION ON WATER TEMPERATURE AND NUTRIENT DYNAMICS

Temperature is important in regulating the physical and biotic characteristics of streams. A number of studies have documented the effect of streamside vegetation on water temperature. In one study, stream temperatures were measured throughout the year on a farm that was originally forested but which had been farmed for several years following clearing of the forest (Greene, 1950). Weekly maximum temperatures of streams in cropland ranged from 5.0° to 12.8°C (average, 6.4°C) above a nearby forested stream. During the coldest month (February) the temperature of the forest stream frequently ranged as high as 3.9°C above the farm stream. In another study, stream temperatures inside a small woodlot (19°C) were much lower than in unshaded areas (28°C) nearby (Karr and Gorman, 1975). These data indicate that vegetation serves as an effective buffer against temperature extremes; shaded streams are cooler in the summer and warmer during the coldest periods.

A detailed analysis of the use of "buffer" strips (near-stream vegetation) to control temperature has been made in the field of forestry (Brown and Brazier, 1972). Net thermal radiation in relation to stream discharge was the primary determinant of stream temperature. When strips of brush or trees were left along the stream, no increase in temperature occurred. Examination of temperature in various streams with different types of vegetation indicated that angular canopy density (ACD, a measure of the shading ability of the vegetation) is the only buffer-strip parameter correlated with temperature. Buffer strip width is not important. Furthermore, buffer effectiveness decreased with increasing stream size. Small streams have the greatest temperature problem but are the easiest to control because of the inverse relationship between temperature change and stream discharge for a given input of thermal radiation. Finally, if temperature control is accomplished in the upper reaches of drainages, temperature-associated problems will be reduced both in upstream areas and in downstream areas, including small lakes and reservoirs.

The importance of temperature in determining various water quality parameters and in regulating biotic communities cannot be overemphasized. As temperature increases, the capacity of the water to hold oxygen decreases. Since oxygen is utilized during the decomposition of organic matter, at elevated temperatures the ability of the stream to assimilate organic wastes without oxygen depletion is reduced. This effect exaggerates the impact of each additional unit of waste added to the system.

Even more important with respect to water quality and eutrophication is the effect of temperature on the rate at which insoluble (attached) nutrients are converted to soluble and readily available forms (Sommers *et al.*, 1975). In a laboratory study, Sommers *et al.* showed an exponential increase in phosphorus released from sediment with an increase in temperature. Slight increases in temperature above 15°C produce substantial increases in the amount of phosphorus released.

These data, along with those previously discussed, indicate that by removing vegetation which shades agricultural drainages, several detrimental patterns will develop: (1) increases in temperature (from 5.5 to 6.5°C) will occur during summer periods, resulting in increased rates of phosphorus disassociation from sediments; (2) increases in phosphorus concentrations in the drainages result in higher nutrient concentrations in receiving bodies such as lakes and reservoirs; (3) increasingly large blooms of nuisance algae and periphyton will appear because of elevated nutrient concentrations, temperature, and light availability. The effect of all these factors will be to decrease water quality and the quality of biotic communities.

The importance of streamside vegetation goes beyond its use in reducing sediment and nutrient transport to streams. Its potential for controlling temperature, enhancing the oxygen-carrying capacity of the stream, and reducing nutrient availability and utilization is evident. Its significant economic impact on fishes is discussed below.

IMPACT OF NEAR-STREAM VEGETATION (GREENBELTS) AND CHANNEL MORPHOLOGY ON BIOTA

A review of the abiotic needs of fishes indicates that any attempt to improve the quality of those resources will have to use a multipurpose approach to the problem. Eliminating only one of the factors deterimental to fish populations will result in little improvement. For example, if nutrients are prevented from entering streams but channelization is still performed, no improvements in fisheries resources will occur. Similarly, if sediments and nutrients no longer enter streams but vegetation is removed from stream banks, elevated temperatures will probably prevent any substantial increase in the quality of the fish community. For this reason it is important to maintain both near-stream vegetation and natural channel morphology. Data collected at Black Creek (Karr and Gorman, 1975) and in forested areas where buffer strips were left between clear-cut areas and streams (Hall and Lantz, 1969), indicate that these factors acting together not only result in improved water quality but also in more diverse and stable fish communities. Furthermore, significant improvements in other segments of the aquatic biota (benthic insects, etc.) can also be expected (Hynes, 1975; Minshall, 1967).

OTHER ADVANTAGES OF GREENBELTS

The earlier discussion has addressed several major advantages which might accrue from the use of greenbelts along streams. A number of other *potential* advantages have not been explicitly addressed. These advantages include:

1. Suspended sediments can cause considerable damage, including wear and tear on metal parts wherever machinery contacts flowing water. Reducing sediment loads by using greenbelts could reduce the magnitude of this problem.
2. Changes in water temperature and in sediment and nutrient loads can precipitate major shifts in algal communities. These shifts can affect the taste and appearance of water.
3. High water quality and the associated rich biotic communities can reduce the problem of pathogens surviving in water supplies.
4. The frequency and cost of removing sediment from drainage ditches or streams could be decreased by filtering sediments from surface runoff.
5. Costs for removing the excess turbidity from water used for human consumption could be reduced.
6. Flood damage--that is, the cost of cleaning up the sediment deposited--could be reduced.
7. The probability of flooding could be reduced because the greenbelts would lead to less clogging of the channel by sediments and because the release of runoff would be better controlled.
8. Costs for storage space destroyed by the silting-in of reservoirs would be diminished.

LAND-WATER INTERFACE

While the primary emphasis of this project was to analyze alternative policies for the reduction of soil loss from agricultural land, the current state of knowledge about sediment transport and effects in the aquatic environment was also assessed. To understand the dynamics of water quality and biological communities of streams one must recognize the relationships between water bodies and the land and atmosphere which surrounds them. A complex interplay of biological, geological, chemical, and physical phenomena in both the terrestrial and aquatic environments are of major importance in determining stream characteristics, including water quality (Hynes, 1975; Likens and Bormann, 1974; Janzen, 1974; Sioli, 1975).

In undisturbed watersheds both terrestrial and aquatic environments are in an equilibrium, albeit a dynamic equilibrium. Drastic fluctuations in water levels are uncommon in relatively humid regions. Rainfall is absorbed by the land surface and released from the soil to the stream over a long period (Hewlett and Nutter, 1970) and there is little surface runoff. Nutrient cycles are "tight" in natural watersheds with few nutrients being lost to the drainage waters (Likens and Bormann, 1974). The small amounts of nutrients lost from the terrestrial environment are readily assimilated by the biotic communities of the stream and erosion in this equilibrium state is minimal (Hobbie and Likens, 1973).

When the natural vegetation is removed, instabilities in the terrestrial environment result, especially if conservation practices are not employed. These instabilities have repercussions which affect the aquatic environment and disturb the equilibrium in that section of the "ecosystem" (Tansley, 1935). Often, the response is to modify the stream channel to: (1) improve drainage of the land surface, and (2) reduce natural bank erosion and other bank instabilities stimulated by the modification of the land surface with the advent of agriculture and urban development. These channelization activities create more instabilities in the aquatic environment. The combined effects of modifying the land and restructuring the channels result in disequilibria in both the aquatic and terrestrial areas. Readily observed signs of these disequilibria include:

1. Rapid runoff resulting in drastic fluctuations in the water levels of streams, with flooding during heavy rains.
2. Large volumes of nutrients and sediment are lost from terrestrial ecosystems to aquatic ecosystems, often over short time periods (Hobbie and Likens, 1973; Likens and Bormann, 1974).
3. Increased fluctuations in stream temperature (Likens, 1970).
4. Increased streambank erosion as the stream attempts to reestablish its equilibrium by forming pools, riffles, and meanders (Yang, 1971a, 1971b).
5. Decreased diversity and stability in the biotic component of the aquatic ecosystem. This change results from the less stable physical environment produced by a complex of sediment, nutrient, and temperature effects (Margalef, 1968; Odum, 1969; Karr and Gorman, 1975; Gorman and Karr, 1977).

A more detailed presentation can be found in Karr and Schlosser (1977).

APPENDIX D

MODELING RESULTS

Table D1

Corn Belt Model Results: Effects of Soil-loss Constraints (High Soil-loss Coefficients Used)

	BENCH MARK	SOIL LOSS 2t/A	SOIL LOSS 3t/A	SOIL LOSS 4t/A	SOIL LOSS 5t/A
Net Social Cost (mil. $)*	0	-1190.57	-480.29	-248.79	-202.05
Change in consumers' surplus (mil. $)	0	-1205.74	-1007.13	-728.61	-433.63
Change in producers' surplus (mil. $)	0	15.17	526.84	479.82	231.58
Government cost (mil. $)**	0	0	0	0	0
Crop prices:					
Corn ($/bu.)	2.46	2.80	2.62	2.54	2.52
Soybeans ($/bu.)	5.26	6.26	5.76	5.58	5.44
Wheat ($/bu.)	4.97	3.45	4.51	5.04	4.93
Oats ($/bu.)	2.33	1.45	2.40	2.39	2.40
Hay ($/ton)	56.15	55.33	58.07	58.36	57.13
Pasture ($/ton)	24.99	24.27	25.98	26.30	25.39
Production:					
Corn (mil. bu.)	3744.2	3483.9	3621.7	3682.9	3698.3
Soybeans (mil. bu.)	785.0	654.9	721.6	743.3	762.8
Acres in production (mil.)	111.86	104.2	107.9	108.7	110.2
Acres terraced (mil.)	0	23.63	9.19	2.18	2.04
Reduced tillage (mil. acres)	77.33	77.97	79.06	76.24	77.34
Gross soil loss (mil. tons)	595.81	154.63	242.58	304.10	323.31
Gross soil loss (tons per acre)	5.33	1.49	2.25	2.80	2.94
Insecticide expenditures index	100	89	103	93	93
Herbicide expenditures index	100	89	93	97	100
Nitrogen load (bil. lbs.)	4.19	3.99	4.10	4.15	4.16
Nitrogen load (lbs./acre)	100.58	102.13	101.17	100.71	100.52

*Excluding Environmental Benefits
**Cost of Program Administration Not Included

Table D2

Corn Belt Model Results: Effects of Soil-loss Constraints and Other Restrictions (Low Soil-loss Coefficients Used)

	BENCH MARK RUN	NO CHISEL PLOW	CHISEL PLOWING RESTRICTED	SOIL LOSS ≤2t/A	SOIL LOSS ≤3t/A	SOIL LOSS ≤4t/A	SOIL LOSS TAX $4.00/TON	100% TERRACE COST SHARING	100% COST-SHARING PLUS SL≤2t/A
Net Social Cost*		-281.55	-269.14	-374.13	-151.32	-87.22	-301.21	-322.07	-529.49
Change in consumers' surplus (mil. $)	0	+269.60	+222.60	-150.33	-197.29	-6.06	+300.39	0	-314.09
Change in producers' surplus (mil. $)	0	-551.15	-491.74	-223.8	+45.97	-81.16	-1008.86	0	+106.67
Government cost (mil. $)** (receipts or direct expenditures)	0	0	0	0	0	0	+407.26	-322.07	-322.07
Crop prices:									
Corn ($/bu.)	2.46	2.46	2.46	2.52	2.50	2.48	2.48	2.46	2.52
Soybeans ($/bu.)	5.28	5.22	5.22	5.44	5.40	5.34	5.32	5.28	5.42
Wheat ($/bu.)	5.00	4.84	4.84	4.96	5.07	5.02	4.90	5.00	5.05
Oats ($/bu.)	2.34	2.28	2.28	2.34	2.40	2.35	2.30	2.34	2.37
Hay ($/ton)	56.37	53.61	54.69	53.72	55.39	54.77	51.25	56.37	55.64
Pasture ($/ton)	25.13	23.83	24.08	23.49	24.30	23.94	21.73	25.13	24.83
Production:									
Corn (mil. bu.)	3760.2	3740.34	3738.4	3698.3	3706.5	3717.0	3728.9	3740.2	3695.3
Soybeans (mil. bu.)	784.5	792.30	792.3	763.0	768.9	776.7	775.6	784.5	765.6
Acres terraced (mil.)	0	0	0	12.76	3.34	2.31	10.05	30.84	30.84
Acres in production (mil.)	111.861	111.86	111.86	110.86	110.86	111.86	111.86		
Reduced tillage (mil. acres)	77.33	0	33.22	75.91	77.21	77.90	77.51	77.33	74.65
Gross soil loss (mil. tons)	330.58	578.07	478.19	118.01	170.38	186.53	101.81	268.75	106.48
Gross soil loss (tons per acre planted)	2.96	5.17	4.27	1.06	1.54	1.68	0.91	2.41	0.95
Insecticide expenditures index	100	97	98	98	99	99	102	100	99
Herbicide expenditures index	100	87	93	101	99	99	102	100	101
N load (bil. lbs.)	4.19	4.19	4.19	4.16	4.17	4.17	4.18	4.19	4.16
N load (lbs./acre)	100.96	100.24	101.21	100.72	101.51	101.38	100.24	100.96	100.72

* Excluding Environmental Benefits

**Costs of Program Administration Not Estimated

Table D3

Corn Belt Model Results: Effects of Soil-loss Tax (High Soil-loss Coefficients Used)

	BENCH MARK	SOIL LOSS TAX $4.00/t	SOIL LOSS TAX $2.00/t	SOIL LOSS TAX $1.00/t	SOIL LOSS TAX $0.50/t
Net Social Cost (mil. $)*	0	-389.64	-192.21	-107.82	-85.19
Change in consumers' surplus (mil. $)	0	+344.19	+251.78	+286.33	+160.85
Change in producers' surplus (mil. $)	0	-1505.56	-959.31	-722.49	-457.79
Government cost (mil. $)**	0	+771.73	+515.32	+328.34	+211.75
Crop prices:					
Corn ($/bu.)	2.46	2.44	2.44	2.44	2.46
Soybeans ($/bu.)	5.26	5.56	5.44	5.34	5.30
Wheat ($/bu.)	4.97	4.57	4.74	4.79	4.82
Oats ($/bu.)	2.33	2.19	2.28	2.26	2.28
Hay ($/ton)	56.15	51.01	52.67	53.21	54.15
Pasture ($/ton)	24.99	21.79	22.76	23.11	23.73
Production:					
Corn (mil. bu.)	3744.2	3750.1	3759.6	3751.3	3744.2
Soybeans (mil. bu.)	785.0	746.4	763.1	776.7	781.5
Acres in production (mil.)	111.86	110.7	111.6	111.86	111.86
Acres terraced (mil.)	0	18.53	7.74	1.25	1.02
Reduced tillage (mil. acres)	77.33	81.20	79.82	78.27	78.21
Gross soil loss (mil. tons)	595.81	192.93	257.66	328.34	423.51
Gross soil loss (tons per acre)	5.33	1.74	2.31	2.94	3.79
Insecticide expenditures index	100	92	93	94	94
Herbicide expenditures index	100	100	99	101	100
Nitrogen load (bil. lbs.)	4.19	4.20	4.20	4.20	4.19
Nitrogen load (lbs./acre)	100.58	99.64	99.88	100.00	100.24

* Excluding Environmental Benefits
**Cost of Program Administration Not Included

Table D4

Corn Belt Model Results: Effects of Prohibitions on Tillage Practices and of Combined Soil-loss Limits with Terracing Subsidies (High Soil-loss Coefficients Used)

	BENCH MARK	NO CHISEL PLOW	NO FALL PLOW	NO STRAIGHT-ROW CULTIVATION	SOIL LOSS 3t/A PLUS 50% TERRACING COST-SHARE	SOIL LOSS 3t/A PLUS $15/A SUBSIDY FOR TERRACING	SOIL LOSS 3t/A PLUS $20 TERRACING COST REDUCTION
Net Social Cost (mil. $)*	0	-270.80	-7.02	-133.23	-495.65	-612.62	-597.83
Change in consumers' surplus (mil. $)	0	210.51	56.95	+11.66	-1023.38	-1060.02	-1050.70
Change in producers' surplus (mil. $)	0	-481.31	-63.97	-144.89	594.75	876.65	713.97
Government cost (mil. $)**	0	0	0	0	67.02	429.25	261.10
Crop prices:							
Corn ($/bu.)	2.46	2.46	2.46	2.46	2.60	2.60	2.60
Soybeans ($/bu.)	5.26	5.22	5.24	5.28	5.72	5.72	5.70
Wheat ($/bu.)	4.97	4.80	4.95	4.97	4.80	4.83	4.85
Oats ($/bu.)	2.33	2.29	2.32	2.33	2.44	2.44	2.44
Hay ($/ton)	56.15	54.39	55.73	55.97	58.52	58.82	58.84
Pasture ($/ton)	24.99	23.84	24.67	24.89	26.36	26.68	26.69
Production:							
Corn (mil. bu.)	3744.2	3736.6	3744.2	3744.2	3626.4	3630.2	3627.0
Soybeans (mil. bu.)	785.0	792.30	789.3	784.5	727.18	727.18	728.40
Acres in production (mil.)	111.86	111.86	111.86	111.86	107.9	107.9	107.9
Acres terraced (mil.)	0	0	0	0	12.44	28.62	27.42
Reduced tillage (mil. acres)	77.33	0	76.41	77.34	78.17	78.06	78.08
Gross soil loss (mil. tons)	595.81	2275.85	596.29	337.16	235.62	201.90	204.02
Gross soil loss (tons per acre)	5.33	20.35	5.33	3.01	2.18	1.87	1.89
Insecticide expenditures index	100	92	101	100	102	99	98
Herbicide expenditures index	100	86	100	99	94	93	93
Nitrogen load (bil. lbs.)	4.19	4.19	4.19	4.19	4.11	4.11	4.11
Nitrogen load (lbs./acre)	100.58	100.73	100.64	100.69	101.27	102.02	102.06

* Excluding Environmental Benefits
**Cost of Program Administration Not Included.

Table D5

Corn Belt Model Results: Effects of Terracing Subsidies (High Soil-loss Coefficients Used)

	BENCH MARK	SUBSIDY $5/A	SUBSIDY $10/A	SUBSIDY $15/A	SUBSIDY $20/A	SUBSIDY $40/A
Net Social Cost (mil. $)*	0	-5.20	-105.53	-198.52	-256.64	-300.44
Change in consumers' surplus (mil. $)	0	+0.28	+6.78	-11.29	-11.29	-9.41
Change in producers' surplus (mil. $)	0	0.11	+37.90	+194.24	+333.04	+942.35
Government cost (mil. $)**	0	5.59	150.21	381.47	578.39	1233.38
Crop prices:						
Corn ($/bu.)	2.46	2.46	2.46	2.46	2.46	2.46
Soybeans ($/bu.)	5.26	5.26	5.26	5.28	5.28	5.28
Wheat ($/bu.)	4.97	4.97	4.97	4.99	4.99	4.99
Oats ($/bu.)	2.33	2.33	2.33	2.34	2.34	2.34
Hay ($/ton)	56.15	56.14	56.05	56.21	56.21	56.19
Pasture ($/ton)	24.99	24.99	24.93	25.01	25.01	24.99
Production:						
Corn (mil. bu.)	3744.2	3744.2	3744.2	3744.2	3744.2	3739.0
Soybeans (mil. bu.)	785.0	785.0	785.1	784.5	784.5	784.5
Acres in production (mil.)	111.86	111.86	111.86	111.86	111.86	111.86
Acres terraced (mil.)	0	1.19	15.02	25.43	28.92	30.83
Reduced tillage (mil. acres)	77.33	77.33	77.40	77.41	77.41	77.47
Gross soil loss (mil. tons)	595.81	594.45	522.46	475.27	452.55	437.83
Gross soil loss (tons per acre)	5.33	5.26	4.12	3.46	3.21	3.07
Insecticide expenditures index	100	100	100	102	102	101
Herbicide expenditures index	100	100	100	99	99	99
Nitrogen load (bil. lbs.)	4.19	4.19	4.19	4.19	4.19	4.19
Nitrogen load (lbs./acre)	100.58	100.58	100.57	100.84	100.84	100.81

* Excluding Environmental Benefits
**Cost of Program Administration Not Included

Table D6

Corn Belt Model Results: Effects of Restricting Nitrogen Application Rate to 100 lbs/Acre and Imposing Soil-loss Limits (High Soil-loss Coefficients Used)

	BENCH MARK	NITROGEN RESTRICTION N 100 lbs/A	NITROGEN RESTRICTION N 100 lbs/A PLUS SOIL LOSS 2t/A	NITROGEN RESTRICTION N 100 lbs/A PLUS SOIL LOSS 3t/A	NITROGEN RESTRICTION N 100 lbs/A PLUS SOIL LOSS 4t/A	NITROGEN RESTRICTION N 100 lbs/A PLUS SOIL LOSS 5t/A
Net Social Cost (mil. $)*	0	-300.28	-1376.88	-804.22	-564.84	-524.99
Change in consumers' surplus (mil. $)	0	-320.88	-1604.63	-1358.36	-1102.56	-772.04
Change in producers' surplus (mil. $)	0	20.60	227.75	554.14	537.72	247.05
Government cost (mil. $)**	0	0	0	0	0	0
Crop prices:						
Corn ($/bu.)	2.46	2.56	2.88	2.72	2.64	2.62
Soybeans ($/bu.)	5.26	5.24	6.24	5.74	5.58	5.42
Wheat ($/bu.)	4.97	4.87	3.54	4.46	4.99	4.91
Oats ($/bu.)	2.33	2.30	1.59	2.42	2.41	2.39
Hay ($/ton)	56.15	56.07	56.31	58.20	58.53	56.99
Pasture ($/ton)	24.99	25.03	24.84	26.10	26.43	25.39
Production:						
Corn (mil. bu.)	3744.2	3658.0	3408.3	3545.2	3602.9	3621.7
Soybeans (mil. bu.)	785.0	789.7	659.5	722.7	745.4	764.3
Acres in production (mil.)	111.86	111.86	104.1	107.9	108.7	110.2
Acres terraced (mil.)	0	0	24.11	8.54	1.94	2.04
Reduced tillage (mil. acres)	77.33	79.72	81.81	79.40	77.64	78.76
Gross soil loss (mil. tons)	595.81	586.2	154.2	244.34	307.09	325.46
Gross soil loss (tons per acre)	5.33	5.24	1.48	2.26	2.82	2.95
Insecticide expenditures index	100	95	89	103	92	93
Herbicide expenditures index	100	101	91	92	97	100
Nitrogen load (bil. lbs.)	4.19	3.19	2.92	3.13	3.18	3.18
Nitrogen load (lbs./acre)	100.58	75.83	74.33	76.80	76.90	76.36

* Excluding Environmental Benefits
**Cost of Program Administration Not Included.

Table D7

Corn Belt Model Results: Effects of Restricting Nitrogen Application Rate to 50 lbs/Acre and Imposing Soil-loss Limits (High Soil-loss Coefficients Used)

	BENCH MARK	NITROGEN RESTRICTION N 50 lbs/A	NITROGEN RESTRICTION N 50 lbs/A PLUS SOIL LOSS 2t/A	NITROGEN RESTRICTION N 50 lbs/A PLUS SOIL LOSS 3t/A	NITROGEN RESTRICTION N 50 lbs/A PLUS SOIL LOSS 4t/A	NITROGEN RESTRICTION N 50 lbs/A PLUS SOIL LOSS 5t/A
Net Social Cost (mil. $)*	0	-1288.19	-2489.10	-1907.74	-1627.67	-1497.46
Change in consumers' surplus (mil. $)	0	-3324.79	-4163.30	-4212.14	-3960.57	-3677.06
Change in producers' surplus (mil. $)	0	2036.6	1674.2	2304.4	2332.9	2179.6
Government cost (mil. $)**	0	0	0	0	0	0
Crop prices:						
Corn ($/bu.)	2.46	3.08	3.42	3.26	3.18	3.14
Soybeans ($/bu.)	5.26	5.82	6.64	6.24	6.08	5.98
Wheat ($/bu.)	4.97	5.34	3.92	4.92	5.38	5.37
Oats ($/bu.)	2.33	2.67	1.78	2.74	2.72	2.71
Hay ($/ton)	56.15	63.73	62.25	65.22	65.31	64.23
Pasture ($/ton)	24.99	29.65	28.58	30.41	30.54	29.78
Production:						
Corn (mil. bu.)	3744.2	3266.3	3001.6	3131.7	3192.9	3222.9
Soybeans (mil. bu.)	785.0	714.2	605.29	657.91	679.55	693.03
Acres in production (mil.)	111.86	111.86	104.1	107.9	108.7	110.2
Acres terraced (mil.)	0	0	24.66	6.81	2.06	1.81
Reduced tillage (mil. acres)	77.33	78.87	81.65	81.04	79.46	79.68
Gross soil loss (mil. tons)	595.81	592.0	152.8	245.5	304.0	330.2
Gross soil loss (tons per acre)	5.33	5.29	1.47	2.27	2.80	3.00
Insecticide expenditures index	100	111	99	114	105	107
Herbicide expenditures index	100	102	91	93	98	101
Nitrogen load (bil. lbs.)	4.19	2.20	1.77	2.05	2.14	2.14
Nitrogen load (lbs./acre	100.58	48.73	42.53	47.48	48.59	47.92

* Excluding Environmental Benefits
**Cost of Program Administration not Included.

Table D8

Watershed Model Results by Individual Farm and Nine-farm Total with Nitrogen Application Rates of 50, 100, or 150 Pounds Per Acre and with No Soil-loss Restrictions
(Period: 1 to 10 Years)

	CROP ACTIVITIES					TILLAGE PRACTICES		CONSERVATION PRACTICES					
Farm No.	Row-crop (acres)	Two-crop[a] (acres)	Wheat (acres)	Total SGM[b] (acres)	Pasture (acres)	Conven-tional (acres)	Zero Tillage (acres)	Up & Down (acres)	Contouring (acres)	Terracing (acres)	Net Revenue[c] ($)	Total Soil Loss (tons)	Total N/Farm[d] (lbs)
1	187.50	110.60	110.60	110.60		76.90	110.60	168.70	18.80		21731.55	4168.92	12917.50
2	185.90					185.90		185.90			27241.86	2753.44	27885.00
3	152.30	79.30	79.30	83.20		76.90	79.30	127.50	13.10	15.60	16126.23	3824.03	11161.25
4	159.78	142.50	142.50	144.53	134.40	19.30	142.50	142.50	11.20	8.10	20083.03	3445.80	3967.50
5	184.40	98.80	98.80	106.30	14.40	93.10	98.80	149.40		42.50	20283.71	3462.76	12575.00
6	365.50	129.10	129.10	165.20	30.60	272.50	89.80	233.40	13.80	154.40	38157.19	6349.79	30836.25
7	176.63	126.90	126.90	143.48	74.30	66.30	126.90	126.90		66.30	20523.45	3811.25	5730.00
8	217.05	203.10	203.10	205.45	67.50	16.30	203.10	210.00		9.40	25912.94	4879.32	4161.25
9	74.80	48.10	48.10	57.00	33.10	35.60	48.10	48.10		35.60	8993.79	1270.27	2826.25
Total	1703.85[e]	938.40	938.40	1015.75[f]	354.30	842.80	938.40	1392.40	56.90	331.90	199053.73	33965.59	112060.00

[a]Two-crop denotes the double-cropping option of wheat and soybeans of rotation 5.
[b]SGM denotes small grain (wheat and oats) and meadow.
[c]The net revenue values are annual averages for the ten-year period discounted.
[d]Some acreage uses no nitrogen and some rotations use very little nitrogen.
[e]Components are: corn, 688.1; and soybeans, 1015.75.
[f]Components are: wheat, 938.4; and oats, 77.35.

Table D9

Watershed Model Results by Individual Farm and Nine-farm Total with Soil Losses Restricted to SCS Tolerance Limits on a Per-farm Basis and with Nitrogen Application Rates of 50, 100, or 150 Pounds Per Acre (Period: 1 to 10 Years)

	CROP ACTIVITIES					TILLAGE PRACTICES		CONSERVATION PRACTICES					
Farm No.	Row-crop (acres)	Two-crop[a] (acres)	Wheat (acres)	Total SGM[b] (acres)	Pasture (acres)	Conventional (acres)	Zero Tillage (acres)	Up & Down (acres)	Contouring (acres)	Terracing (acres)	Net Revenue[c] ($)	Total Soil Loss (tons)	Total N/Farm[d] (lbs)
1	120.06		21.43	67.45		187.50			106.30	81.20	18901.66	637.40	13915.72
2	176.05		.88	9.85		185.90			146.40	39.50	26793.28	901.90	26095.57
3	118.23		7.39	34.35		156.20			58.10	98.10	15013.56	653.60	13827.24
4	68.62		29.60	93.18	134.40	161.80			125.60	36.20	16117.45	1050.40	5835.23
5	143.38		8.58	48.52	14.40	191.90			77.60	114.30	18938.23	877.80	15144.76
6	299.70		22.60	101.90	30.60	401.60			140.50	261.10	36632.55	1761.90	35773.23
7	106.11		20.97	87.09	74.30	193.20			63.10	130.10	18524.63	1070.00	8373.18
8	149.89		17.93	69.51	67.50	219.40			106.90	112.50	23117.11	1147.60	10984.23
9	40.72		14.58	42.99	33.10	83.70			41.90	41.80	7896.83	467.20	2608.73
Total	1226.36[e]		147.15	554.84[f]	354.30	1781.20			866.40	914.80	181935.29	8567.80	132557.89

[a]Two-crop denotes the double-cropping option of wheat and soybeans of rotation 5.

[b]SGM denotes small grain (wheat and oats) and meadow.

[c]The net revenue values are annual averages for the ten-year period discounted.

[d]Some acreage uses no nitrogen and some rotations use very little nitrogen.

[e]Components are: corn, 1026.79; and soybeans, 199.57.

[f]Components are: wheat, 147.15; oats, 158.17; and meadow, 249.52.

Table D10

Watershed Model Results by Individual Farm and Nine-farm Total with Soil Loss Constrained to SCS Tolerance Limits on a Per-farm Basis and Nitrogen Application Rates Restricted to 50 or 100 Pounds Per Acre (Period: 1 to 10 Years)

	CROP ACTIVITIES					TILLAGE PRACTICES		CONSERVATION PRACTICES					
Farm No.	Row-crop (acres)	Two-crop[a] (acres)	Wheat (acres)	Total SGM[b] (acres)	Pasture (acres)	Conventional (acres)	Zero Tillage (acres)	Up & Down (acres)	Contouring (acres)	Terracing (acres)	Net Revenue[c] ($)	Total Soil Loss (tons)	Total N/Farm[d] (lbs)
1	111.30		20.6	76.20		187.50			106.30	81.20	18606.53	637.40	8327.47
2	145.02	22.38	22.38	63.26		185.90	22.38	22.38	124.02	39.50	25202.83	901.90	10779.37
3	107.15		5.11	49.05		156.20			58.10	98.10	14771.16	653.60	7910.36
4	66.99		29.64	94.82	134.40	161.80			125.60	36.20	16090.50	1050.40	4526.06
5	132.57		7.05	59.33	14.40	191.90			77.60	114.30	18731.20	877.80	10803.24
6	263.56		19.44	138.05	30.60	401.60			140.50	261.10	35953.40	1761.90	19638.05
7	106.11		20.97	87.09	74.30	193.20			63.10	130.10	18525.67	1070.00	8373.18
8	148.52		17.46	70.88	67.50	219.40			106.90	112.50	23074.83	1147.60	10252.57
9	40.72		14.58	42.99	33.10	83.70			41.90	41.80	7897.28	467.20	2608.73
Total	1121.92[e]	22.38	157.24	681.66[f]	354.30	1758.82	22.38	22.38	844.02	914.80	178853.39	8567.80	83219.02

[a] Two-crop denotes the double-cropping option of wheat and soybeans of rotation 5.

[b] SGM denotes small grain (wheat and oats) and meadow.

[c] The net revenue values are annual averages for the ten-year period discounted.

[d] Some acreage uses no nitrogen and some rotations use very little nitrogen.

[e] Components are: corn, 764.61; and soybeans, 357.32.

[f] Components are: wheat, 157.24; oats, 294.82; and meadow, 229.60.

Table D11

Watershed Model Results by Individual Farm and Nine-farm Total with Soil Loss Constrained to SCS Tolerance Limits on a Per-farm Basis and Nitrogen Application Rates Restricted to 50 Pounds Per Acre (Period: 1 to 10 Years)

	CROP ACTIVITIES					TILLAGE PRACTICES		CONSERVATION PRACTICES					
Farm No.	Row-crop (acres)	Two-crop[a] (acres)	Wheat (acres)	Total SGM[b] (acres)	Pasture (acres)	Conventional (acres)	Zero Tillage (acres)	Up & Down (acres)	Contouring (acres)	Terracing (acres)	Net Revenue[c] ($)	Total Soil Loss (tons)	Total N/Farm[d] (lbs)
1	109.42		27.56	78.08		187.50			106.30	81.20	18160.08	637.40	4840.07
2	139.43			46.48		185.90		23.81	122.59	39.50	24335.84	901.90	5809.38
3	103.46	6.79	24.72	59.35		149.41	6.79	6.79	51.31	98.10	14167.64	653.60	4164.49
4	65.37		34.89	96.44	134.40	161.80			125.60	36.20	15947.63	1050.40	3518.66
5	125.19	18.43	41.47	85.14	14.40	173.47	18.43	18.43	59.17	114.30	17779.86	877.80	4840.22
6	254.16	23.54	63.36	170.99	30.60	378.06	23.54	23.54	116.96	261.10	34596.95	1761.90	10518.20
7	110.03	6.62	45.16	89.79	74.30	186.58	6.62	6.62	54.48	130.10	17992.68	1070.00	4594.76
8	142.88	33.80	69.98	110.32	67.50	185.60	33.80	33.80	73.10	112.50	22572.72	1147.60	5046.47
9	45.50		17.43	38.30	33.10	83.70			41.90	41.80	7864.17	467.20	2006.50
Total	1095.34[e]	89.19	324.62	774.89[f]	354.30	1692.01	89.19	113.00	753.41	914.80	173417.57	8567.80	45338.75

[a]Two-crop denotes the double-cropping of wheat and soybeans of rotation 5.

[b]SGM denotes small grain (wheat and oats) and meadow.

[c]The net revenue values are annual averages for the ten-year period discounted.

[d]Some acreage uses no nitrogen and some rotations use very little nitrogen.

[e]Components are: corn, 693.78; and soybeans, 401.56.

[f]Components are: wheat, 324.62; oats, 145.98; and meadow, 304.29.

Table D12

Watershed Model Results by Individual Farm and Nine-farm Total with Soil Loss Constrained to SCS Tolerance Limits on a Watershed Basis and with Nitrogen Application Rates of 50, 100, or 150 Pounds Per Acre

	CROP ACTIVITIES					TILLAGE PRACTICES		CONSERVATION PRACTICES					
Farm No.	Row-crop (acres)	Two-crop[a] (acres)	Wheat (acres)	Total SGM[b] (acres)	Pasture (acres)	Conventional (acres)	Zero Tillage (acres)	Up & Down (acres)	Contouring (acres)	Terracing (acres)	Net Revenue[c] ($)	Total Soil Loss (tons)	Total N/Farm[d] (lbs)
1	142.32		10.88	45.19		187.50			106.30	81.20	19780.90	856.33	16501.25
2	185.90					185.90			146.40	39.50	27160.36	970.92	27885.00
3	113.09		11.02	38.42		156.20			58.10	98.10	14764.81	580.20	13171.25
4	102.94		24.91	58.86	134.40	161.80			125.60	36.20	17556.90	1420.28	6448.13
5	139.50		9.86	52.40	14.40	191.90			77.60	114.30	18774.35	830.77	14934.15
6	263.44		39.82	138.17	30.60	401.60			140.50	261.10	35571.88	1390.34	31458.75
7	98.54		37.07	94.67	74.30	193.20			63.10	130.10	17987.13	922.65	6480.00
8	151.65		15.59	67.76	67.50	219.40			106.90	112.50	23195.99	1168.51	11422.50
9	38.69		17.28	45.01	33.10	83.70			41.90	41.80	7753.28	427.80	2102.50
Total	1236.07[e]		166.43	540.45[f]	354.30	1781.20			866.40	914.80	182545.60	8567.8	130403.52

[a]Two-crop denotes the double-cropping option of wheat and soybeans of rotation 5.

[b]SGM denotes small grain (wheat and oats) and meadow.

[c]The net revenue values are annual averages for the ten-year period discounted.

[d]Some acreage uses no nitrogen and some rotations use very little nitrogen.

[e]Components are: corn, 1037.45; and soybeans, 198.62.

[f]Components are: wheat, 166.43; oats, 118.22; and meadow, 255.83.

APPENDIX E

POLICY IMPLEMENTATION COST ESTIMATES

This appendix presents cost estimates for each of the institutional functions required in implementing nonpoint source pollution control policies. As indicated in Chapter 5, not all of these functions will be required for some of these policies. Also presented are estimates of administrative costs for implementing the six policies selected for intensive analysis (see Chapter 3). These estimates are based on an assessment of the institutional functions required by each policy and on the cost estimates for those functions.

A complete list of the institutional functions is given in Table E1. Tables E2 through E22 present itemized cost estimates for the functions. The total cost for each function is the sum of the following items of expense:

1. Labor
2. Labor Support (e.g., travel, telephone, and mailing expenses)
3. Equipment
4. Building
5. Office Support (e.g., cost of office supplies and copying)
6. Program Support (e.g., training and publication costs)

In calculating the costs it was assumed that there are 1221 farms per county* and 93 counties per state. These values are averages for the corn belt, which includes the states of Illinois, Indiana, Iowa, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin. It was also assumed that the employee turnover rate would be 35% per year.

The administrative costs for implementing the six NPS control policies, summarized in Tables E23 through E28, were derived by summing the costs of the institutional functions required by each of the policy elements:

1. Performance Indicators (P)
2. Control Instruments (I)

***Agricultural Statistics, 1976*. Washington, D. C.: United States Department of Agriculture (1976).

The World Almanac and Book of Facts, 1976. New York: Newspaper Enterprise Association, Inc. (1975).

3. Erosion Control Techniques (C)
4. Measures of Compliance (M)
5. Temporary Penalties (T)

In constructing the costs it was again assumed that each county contains 1221 farms and is in a state having 93 counties. The cost estimates cover a period of five years, a time period considered to be adequate to accomplish the policy objectives. The total cost listed for each policy is the implementation cost per county per year for the five-year period.

TABLES (continued)

Table E1

Institutional Functions Required to Implement Nonpoint-source Pollution Control Policies

FUNCTION KEY	DESCRIPTION	COST TABLE
A	Monitoring	E2
B	Reporting Impact	E3
C	Notification of Assessment of Penalty	E4
D	Board of Review	E5
E	Court Action	E6
F	Subsidy/Tax Transfer	E7
G	Maintenance of an Office	
	I. For One Administrator	E8
	II. For One Technician	E9
	III. For One Secretary	E10
	IV. State Central Office	E11
	V. County Office	E12
H	Individual Analysis of Farm Needs	E13
I	Contracting with Individual Farmer	E14
J	Education	E15
K	Training of Technicians	E16
L	Reporting Need	E17
M	Formation of a Program	E18
N	Construction	E19
O	Publication and Notification of Legislation	E20
P	Administrative Organization	E21
Q	Central Coordination	E22

Table E2

Estimated Cost for Function A, Monitoring

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	One technician can monitor 4 farms per day.[1] The average salary for a technician is $10,000/year with 250 working days per year.	$ 10.000/farm
(2) Labor Support	*(a)* Travel Based on the size of an average county and assuming that the monitoring office is located near the center of the county, the equation Miles Traveled = (nx10) + 10, where n = number of farms traveled to per day per car, is used to estimate travel for the monitor. The number of miles are multiplied by $ .15 per mile to compute cost. It is assumed that one monitor per car covers 4 farms per day.	$ 1.875/farm
	(b) Telephone and Mailing Assume that one technician spends $2/day on phone calls and mailing for monitoring arrangements. This amount is divided by four farms per day.	$ .500/farm
(3) Equipment	The equipment needed by one technician to monitor farms costs $60.00.[1] This cost is depreciated on a straight-line basis over ten years to compute a yearly cost of $6.00. This yearly cost is divided by the number of farms monitored per year.	$ .006/farm
(4) Building	None	-----
(5) Office Support	Assume that miscellaneous office supplies such as paper and envelopes used in recording monitoring results would cost $ .25 per farm.	$ .250/farm

Table E2 (cont.)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(6) Program Support	Assuming that the employee has the proper educational background, two weeks of additional training are needed for monitoring. Training costs are figured under function K. Using those costs, 2 weeks of training costs $751.20 per technician. Since there is a 35% employee turnover rate,[1] the number of new technicians needing training will depend on the length of the program. The following equation is used to take this training cost and turnover combination into account. Total Training Cost = ((1 + (.35(m-1))) x 751.20) x number of technicians needed, where m = the length of the program in years.	

TOTAL COST = ($12.63 x number of farms) + ((1+(.35(m-1))) x $751.20) x number of technicians needed

[1] Source: State Soil Conservation Service, Champaign, Illinois.

Table E3

Estimated Cost for Function B, Reporting Impact

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	Assume that the secretary can type and mail an average of eight reports per day. The secretary has a salary of $7500 per year[1] for 250 working days.	$ 3.75/report
(2) Labor Support	Cost of mailing reports	$ .50/report
(3) Equipment	The equipment required for a secretary is listed for function G, maintenance of an office.	----
(4) Building	None	----
(5) Office Support	Assume a cost of $ .50 per report for copying, paper, envelopes, etc.	$ .50/report
(6) Program Support	If the impact report involves violations which have occurred, these violations must be published in the form of an official notice. The cost of publication of violations is covered under function C, Notification of Assessment of Penalty.	----
	TOTAL COST:	$ 4.75/report

[1] Source: State Soil Conservation Service, Champaign, Illinois

Table E4

Estimated Cost for Function C, Notification of Assessment of Penalty

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	Assume that it takes a secretary one hour to type up the notification, send copies to the violators, and prepare the papers for publication. The secretary's salary is $7500/year,[1] which is equivalent to $3.75/hour.	$ 3.75/penalty notification
(2) Labor Support	Assume that mailing the notifications costs $ .50.	$ .50/penalty notification
(3) Equipment	Listed in G	----
(4) Building	None	----
(5) Office Support	Assume a cost of $ .50 per notification for office supplies.	$ .50/penalty notification
(6) Program Support	It costs $ .25 per line for publishing.[2] Assume that five lines are needed per penalty and that the notice is published in four newspapers within the county.	$ 5.00/penalty notification
	TOTAL COST:	$ 9.75/penalty notification

[1] Source: State Soil Conservation Service, Champaign, Illinois
[2] Source: The News-Gazette, Champaign, Illinois

Table E5

Estimated Cost for Function D, Board of Review

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	*(a)* Board Members The Board of Review has five members who donate the time they spend serving on the board. It is assumed that the board meets once a month for 2 hours every month and that it reviews 4 cases every month.	----
	(b) Clerical Official minutes of the board meeting must be taken by a secretary present for two hours during the meeting. It takes an additional hour to type the minutes. Three hours of clerical time at $3.75 per hour[1] for 4 cases.	$ 2.813/case
	(c) Technician Each case is presented by a technician who spends one hour preparing the presentation. The technician must also attend the two-hour meeting. A technician's hourly rate is $5.00/hour.[1]	$120.000/year + $ 5.000/case
(2) Labor Support	*(a)* Travel The board members are paid for their travel expenses to and from meetings. Assuming that there is one board per county with the meeting located at the county center, the estimated distance travelled is 25 miles per meeting per member. There is an annual statewide meeting held for board members. The travel distance for this meeting is estimated to be 200 miles per five members. $ .15 per mile is paid for mileage expense.	$255.000/year

Table E5 (cont.)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(2)	*(b)* Telephone and Mailing The telephone-mail expense is incurred in contacting the proper individuals about the meeting. This cost is estimated to be $2.50 per meeting plus $2.00 per case.	$ 30.000/year + 2.000/case
(3) Equipment	None	-----
(4) Building	Assume that the county office is used in the evening at no cost.	-----
(5) Program Support	A notice of the public meeting must be published. Assume that this notice requires ten lines per meeting at $ .25 per line[2] in four different sources (newspapers).	$120.000/year
	TOTAL COST:	$525.000/year + $ 9.810/case

[1]Source: State Soil Conservation Service, Champaign, Illinois.
[2]Source: The News-Gazette, Champaign, Illinois.

Table E6

Estimated Cost for Function E, Court Action

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	*(a)* Technician Assume that a technician spends eight hours on each case taken to court.	$ 40.000/case
	(b) Court Officials The court costs concerned with the public's side of the case accrue to the local governing body.	-----
(2) Labor Support	None	-----
(3) Equipment	None	-----
(4) Building	None	-----
(5) Office Support	None	-----
(6) Program Support	None	-----
	TOTAL COST:	$ 40.000/case

Table E7

Estimated Cost for Function F, Subsidy/Tax Transfer

EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(a) Subsidy According to the ASCS-ACP data for the corn belt states[1] (Tables B1 to B8) the average administration cost incurred in paying subsidies from 1969 to 1975, in real dollars, equals 14.5% times the amount of subsidy. According to the corn belt model, if terracing is provided everywhere it is needed in the corn belt (557 counties) it will encompass 30.84 million acres at a cost of 322.07 million dollars per year for ten years.[2] Multiplying the yearly cost by ten years and dividing that amount by 557 counties, a total cost of $5.782 million per county is obtained. Assuming that the subsidy payment will be 50% of the total cost, the government will be administering the payment of 2.891 million dollars per county. 14.5% times $2.891 million results in an administration cost of $419,195 per county for subsidy payment. Note that subsidies may also be paid on conservation projects other than terracing (and it's unlikely that all this terracing would be done) but the present cost information is limited to terraces and thus this figure is used in the estimate.	$419,195.00/ county
(b) Tax Transfer The tax transfer will be arranged as a standard deduction on the present tax form. Therefore, any increase in administration cost will be negligible.	----
TOTAL COST:	0.00

[1]Source: <u>Practice Accomplishments by States, Agricultural Conservation Program</u>. Washington, D. C.: U. S. Department of Agriculture (1976).

[2]The determination of areas "needing" terracing and the total cost are taken from the 100% subsidy run of the corn belt model. The 50% subsidy rate was used in determining this cost estimate because it is more likly to represent the policy adopted.

Table E8

Estimated Cost for Function G, Maintenance of an Office
(I. For One Administrator*)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	Janitorial services require five hours per week per 200 sq. feet of office space.[1] When supplies are included, janitorial services cost $6 per hour.[1] From figures given in <u>Space Planning</u>[2] a head administrator is assumed to require 150 sq. feet of office space. This figure includes cabinet space and a portion of a waiting area.	$ 1,170.00/year
(2) Labor Support	None	-----
(3) Equipment	The following items of equipment assumed to be required are listed with their respective costs.[3] *(a)* One desk, $180. *(b)* Three filing cabinets (4 drawer), $345. *(c)* One upright cabinet (78" x 36" x 18"), $90. *(d)* One swivel desk chair, $85. *(e)* Two standard desk chairs, $110. *(f)* One adding machine, $135 + $35/year maintenance. *(g)* One desk lamp, $20. Twenty-year, straight-line depreciation is assumed.	$ 83.25/year
(4) Building	*(a)* Space According to two sources in Champaign, office rent is approximately $5 per sq. foot per month. As already mentioned, an administrator requires 150 sq. feet.[4,5]	$ 9,000.00/year
	(b) Utilities Utilities average $ .75 per sq. foot of office space per month.[5]	$ 1,350.00/year

Table E8 (cont.)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(5) Office Support	Office support is assumed to average $100 per administrator per year.	$ 100.00/year
(6) Program Support	None	----
	TOTAL COST:	$11,703.25/year

*This tabulation includes those items and costs required by a head administrator, usually located in the central office.

[1]Source: AAA Janitorial Service, 515 Edgebrook, Champaign, Illinois.

[2]Source: Bareither, H.D., and Schillinger, J.L. 1968. University Space Planning. Urbana, Ill.: Univ. of Ill. Press.

[3]Source: Mr. R.J. Cheek, Purchasing Department, Business Office, University of Illinois.

[4]Source: State Soil Conservation Service, Champaign, Illinois.

[5]Source: Office and Desk Space Rental Service, Hunt and Associates, 201 West Springfield Ave., Champaign, Illinois.

Table E9

Estimated Cost for Function G, Maintenance of an Office

(II. For One Technician*)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	Janitorial services require 5 hours per week per 200 sq. ft. of office space.[1] Including supplies, janitorial services cost $6 per hour.[1] According to Space Planning,[2] one technician requires 135 sq. ft. of office space.	$ 1,053.00/year
(2) Labor Support	None	----
(3) Equipment	The following items of equipment assumed to be required are listed with their respective costs.[3] *(a)* One desk, $180. *(b)* Two filing cabinets (four drawer), $230. *(c)* One upright cabinet (78" x 36" x 18"), $90. *(d)* One swivel desk chair, $85. *(e)* One standard desk chair, $55. *(f)* One desk lamp, $20. Twenty-year, straight-line depreciation is assumed.	$ 33.00/year
(4) Building	*(a)* Space A technician requires 135 sq. ft. of office space and rent is $5 per sq. ft. per month.[4]	$ 8,100.00/year
	(b) Utilities Assume $ .75 per sq. ft. per month.[4]	$ 1,215.00/year
(5) Office Support	Assume $100 per technician per year.	$ 100.00/year

Table E9 (cont.)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(6) Program Support	None	----
	TOTAL COST:	$10,501.00/year

*This tabulation includes those items and costs required by one technician at a county or central office.

[1]Source: AAA Janitorial Service, 515 Edgebrook, Champaign, Illinois.

[2]Source: Bareither, H.D., and Schillinger, J.L. 1968. University Space Planning. Urbana, Ill.: Univ. of Ill. Press.

[3]Source: Mr. R.J. Cheek, Purchasing Department, Business Office, University of Illinois.

[4]Source: Office and Desk Space Rental Service, Hunt and Associates, 201 West Springfield Ave., Champaign, Illinois.

Table E10

Estimated Cost for Function G, Maintenance of an Office

(III. For One Secretary*)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	A secretary requires 75 sq. ft. of office space.[1] Janitorial services including supplies are $6 per hour per 200 sq. ft per week.[2]	$ 585.00/year
(2) Labor Support	None	----
(3) Equipment	The following items of equipment assumed to be required are listed with their respective costs.[3] *(a)* One desk, $180. *(b)* One typewriter, $545 + $46.32/year maintenance *(c)* One upright cabinet (78" x 36" x 18"), $90 *(d)* One swivel chair, $85. *(e)* One desk lamp, $20.	
	Ten-year, straight-line depreciation is assumed.	$ 138.32/year
(4) Building	*(a)* Space A secretary requires 75 sq. ft. of office space and rent is $5 per sq. ft. per month.[4]	$ 4,500.00/year
	(b) Utilities Assume $ .75 per sq. ft. per month.[4]	$ 675.00/year
(5) Office Support	Assume $100 per secretary per year.	$ 100.00/year

Table E10 (cont.)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	$ COST/UNIT
(6) Program Support	None	----
	TOTAL COST:	$5,998.32/year

*This tabulation includes those items and costs required by a secretary located at either a central or county office.

[1]Source: Bareither, H.D., and Schillinger, J.L. 1968. University Space Planning. Urbana, Ill.: Univ. of Ill. Press.

[2]Source: AAA Janitorial Service, 515 Edgebrook, Champaign, Ill.

[3]Source: Mr. R.J. Cheek, Purchasing Department, Business Office, University of Illinois.

[4]Source: Office and Desk Space Rental Service, Hunt and Associates, 201 West Springfield Ave., Champaign, Illinois.

Table E11

Estimated Cost for Function G, Maintenance of an Office
(IV. For State Central Office*)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	None	----
(2) Labor Support	None	----
(3) Equipment	The following items of equipment assumed to be required are listed with their respective costs.[1] *(a)* One tape recorder, $100. *(b)* One Xerox machine rented for $70/month, $840/year. *(c)* One adding machine, $135 + $35/year maintenance. *(d)* One overhead projector, $180 + $35/year maintenance. *(e)* One slide projector, $200. Seven-year, straight-line depreciation is assumed.	$ 997.95/year
(4) Building	None	----
(5) Office Support	None	----
(6) Program Support	None	----
	TOTAL COST:	$ 997.95/year

*This tabulation includes those items and costs which are required by a central office and which have not been included elsewhere.

[1]Source: Mr. R.J. Cheek, Purchasing Department, Business Office, University of Illinois.

Table E12

Estimated Cost for Function G, Maintenance of an Office
(V. County Office*)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION		COST/UNIT
(1) Labor	None		----
(2) Labor Support	None		----
(3) Equipment	The following items of equipment assumed to be required are listed with their respective costs.[1] *(a)* One tape recorder, $100. *(b)* One copying machine, $200 + $65/year maintenance *(c)* One adding machine, $135 + $35/year maintenance *(d)* One slide projector, $200. Seven-year, straight-line depreciation is assumed.	$	190.71/year
(4) Building	None		----
(5) Office Support	*(a)* Phone Assume that the phone cost for normal business operations averages $30 per month.[2]	$	360.00/year
	(b) Mail Assume that the mailing cost averages $100 per person (excluding secretaries) per year.[2]	$	100.00/person/year
	TOTAL COST:	$	550.71/year
		+ $	100.00/person/year

*This tabulation includes those items and costs which are required by a county office and which have not been included elsewhere.
[1]Source: Mr. R.J. Cheek, Purchasing Department, Business Office, University of Illinois.
[2]Source: State Soil Conservation Service, Champaign, Illinois.

Table E13

Estimated Cost for Function H, Individual Analysis of Farm Needs

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	*(a)* Technician One technician can inspect one farm and draw up conservation plans for this one farm in a period of three days.[1] The average salary for a technician is assumed to be $10,000/year.[1]	$120.00/farm
	(b) Secretary Assume it takes one secretary one day per farm to set up a mutual time for the on farm inspection and to type up and file the plan after the technician has completed it. The secretary's salary is $7,500/year.[1]	$ 30.00/farm
(2) Labor Support	*(a)* Farm Travel Based on the size of an average county and assuming the county office is located near the center of the county, the equation (nx10) + 10 = number of miles traveled, is used to estimate travel distance for the technician. In this equation n = the number of farms traveled to per day per car. The mileage is multiplied by $ .15 per mile to compute cost. Assume the technician in this case travels to only one farm in a day and only one trip is made for each farm analyzed.	$ 3.00/farm
	(b) Telephone - Mail Assume $ .75 is spent on phone calls and mailing for each farm analyzed.	$ .75/farm
(3) Equipment	The equipment needed by one technician to analyze farms costs $60.[1] This cost is put on a straight-line depreciation over ten years to compute a yearly cost of $6. This yearly cost is divided by the number of farms analyzed per year.	$ .072/farm

Table E13 (cont.)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(4) Building	None	----
(5) Office Support	None	----
(6) Program Support	Assuming the employee has the proper educational background, four weeks of formal training along with nine months of on-the-job training is needed.[1] Training costs are figured in section K. Using the costs from section K, 4 weeks of training costs $1,494.90 per technician. Since there is a 35% employee turnover rate,[1] the number of new technicians needing training will depend on the length of the program. The nine months of on-the-job training results in an experienced technician and the new technician working together but having an output equal to only one technician. The following equation is used to take employee turnover and on-the-job training into account. [number of trainees] [(1+(.35(m-1))) x ($1494.90 + $7500)] = total training cost. m = the length of the program in years. The 7500 is derived from the trainee's nine month salary during training. TOTAL COST = (153.82 x number of farms) + (total training cost)	

[1]Source: State Soil Conservation Service, Champaign, Illinois

Table E14

Estimated Cost for Function I, Contracting with Individual Farmer

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	*(a)* Technician Since the technician has already analyzed the farms, drawn up the plans, and has spoken to the farmer in section H, the only contracting left is to verify that the farmer agrees with the plans. Therefore it is assumed that a technician only spends one hour per contract.	$ 5.00/contract
	(b) Secretary Assume one secretary can type up ten contracts in one day.	$ 3.00/contract
(2) Labor Support	None	----
(3) Equipment	None	----
(4) Building	None	----
(5) Office Support	Assume clerical supplies cost $1 per contract.	$ 1.00/contract
(6) Program Support	Since the contract is made with a public agency it must be published. Assume seven lines are needed to publish notice of the contract being made and where it can be inspected. Assume the notice is published in four sources per county at $ .25 per line.[1]	$ 7.00/contract
	TOTAL COST:	$16.00/contract

[1]Source: The News Gazette, Champaign, Illinois

Table E15

Estimated Cost for Function J, Education

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	Assume one technician can instruct a class of thirty in a single session.[1] Assume that the sessions last 2½ hours and that 1½ hours of preparation time is required by the technician for each session. The technician's salary equals $5 per hour.[1]	$ 20.00/session
(2) Labor Support	*(a)* Travel Based on the size of an average county and assuming the county office is located near the center of the county, assume the technician travels 20 miles per session at a cost of $ .15 per mile.	$ 3.00/session
	(b) Telephone - Mail Assume the cost of communications in setting up a session is $5.	$ 5.00/session
(3) Equipment	The equipment needed to conduct these sessions will come from the county office (G).	----
(4) Building	In most cases local high schools or other public buildings will be used to conduct the session. Assume a $25 charge for this use.	$ 25.00/session
(5) Office Support	None	----
(6) Program Support	*(a)* Training Assuming the employee has the proper background, four weeks of formal training are required. Training costs are figured in section K. Using the costs from section K, four weeks of training costs $1,494.90 per technician. This figure must be adjusted using the following equation to take a 35% employee turnover into account.[1]	

Table E15 (cont.)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(6)	*(a)* Total Training Cost = ((1+(.35(m-1))) x 1494.90) x the number of technicians trained, where m = the length of the program in years.	
	(b) Presentation Packets Packets containing educational material used in educating costs approximately $5 per person.[2] Assume thirty people per session.	$150.00/session
	(c) Publication of Session Assume the public notice of the session will require ten lines in one local paper at $ .25 per line.[3]	$ 2.50/session
	TOTAL COST = $205.50/session + Total Training Costs	

[1]Source: State Soil Conservation Service, Champaign, Illinois
[2]Source: Champaign County Extension Service
[3]Source: The News Gazette, Champaign, Illinois

Table E16

Estimated Cost for Function K, Training of Technicians

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	*(a)* Instructor One instructor teaches a class of 30. Assume a salary of $10,000 per year.[1]	$ 1.60/day/trainee
	(b) Trainee Assume a salary of $10,000 per year for the trainee.[1]	$40.00/day/trainee
	(c) Secretary The secretary is estimated to spend 16 hours per session preparing the necessary material and making the arrangements.[2] The secretary's pay equals $3.75 per hour.	$ 2.00/trainee/session
(2) Labor Support	*(a)* Living Expense Assume every trainee is allowed $25 per day for living expenses during the formal training period.	$25.00/day/trainee
	(b) Travel To and From Training Assuming the training session is located near the center of the state and that trainees return home on weekends, the estimated mileage is 400 miles per week. Assume two trainees per car and $ .15 per mile for mileage.	$30.00/week/trainee
(3) Equipment	The equipment needed for the training program is included under the central office maintenance (G).	----
(4) Building	Rental for a conference room large enough for 30 trainees is estimated to equal $ .50 per day.[2]	$ 1.67/day/trainee
(5) Office Support	Mailing information about the training school is estimated to equal $ .50 per trainee.	$ .50/trainee/session

Table E16 (cont.)

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(6) Program Support	*(a)* Learning Packets Educational materials needed for the session are expected to cost $5 per trainee.[2]	$ 5.00/trainee/ session
	(b) Teaching Materials This includes miscellaneous supplies such as chalk, slides and charts.	$ .10/trainee/ session
	TOTAL COST = $68.37/day/trainee + $7.50/session/trainee + $30.00/week/trainee	

[1]Source: State Soil Conservation Service, Champaign, Illinois
[2]Source: Champaign County Extension Service

Table E17

Estimated Cost for Function L, Reporting Need

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	*(a)* Technician The labor provided by the technician in determining the need has already been accounted for in sections A or H, so no further cost is incurred here.	----
	(b) Secretary Assume it takes a secretary ten days to make up a county report. The secretary's salary is $7,500 per year.[1]	$300.00/report
(2) Labor Support	Assume it costs $1.00 per report for mailing.	$ 1.00/report
(3) Equipment	None	----
(4) Building	None	----
(5) Office Support	The miscellaneous office supplies used in compiling the report are estimated to cost $5.00 per report.	$ 5.00/report
(6) Program Support	None	----
	TOTAL COST:	$306.00/county report

[1]Source: State Soil Conservation Service, Champaign, Illinois

Table E18

Estimated Cost for Function M, Formation of a Program

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	*(a)* Central Administrator *(b)* Central Technician *(c)* Secretary The labor cost for *a*, *b*, and *c* is covered in central coordination so no cost is shown here.	
	(d) County Representative This is a county employee, probably the head technician, who meets with the central personnel to discuss the program to be pursued. Assume four meetings per year with each meeting lasting one day and a salary of $10,000.	$160.00/year
(2) Labor Support	*(a)* Travel The county representative is estimated to travel 200 miles for every meeting at $ .15 per mile.	$120.00/year
	(b) Food The county representative is allowed $10 per day for food expenses.	$ 40.00/year
(3) Equipment	None	----
(4) Building	None	----
(5) Office Support	Part of Central Coordination (Q).	----
(6) Program Support	None	----
	TOTAL COST:	$320.00/year

Table E19

Estimated Cost for Function N, Construction

Construction costs accrue to the farmer initially. Subsidies to support construction may be paid to the farmer but this is not an administration cost. The administration cost of paying the subsidies is recorded in section F. Therefore no administration cost is encountered in this construction function.

TOTAL COST = 0

Table E20

Estimated Cost for Function O, Notification of Legislation

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	None	----
(2) Labor Support	None	----
(3) Equipment	None	----
(4) Building	None	----
(5) Office Support	None	----
(6) Program Support	The general public must be notified about a new policy which may offer them some assistance in conservation efforts. The notification that a new policy exists and where it can be inspected is estimated to require 30 lines in each of four county area papers at $ .25 per line.[1]	$ 30.00/county
	TOTAL COST:	$ 30.00/county

[1]Source: The News Gazette, Champaign, Illinois

Table E21

Estimated Cost for Function P, Administrative Organization

The costs of the administrative organization functions are either included in the central coordination (Q) or the legislative body at the time the bill is formulated. Therefore no costs occur here.

TOTAL COST = 0

Table E22

Estimated Cost for Function Q, Central Coordination

EXPENSE ITEM	EXPLANATION OR METHOD OF CALCULATION	COST/UNIT
(1) Labor	*(a)* Administrator Assume the central coordination office has one administrator who is in charge of the state organization.[1] The administrator's salary is estimated to Be $35,000 per year.	$35,000.00/year
	(b) Technicians Three technicians are located at the central office.[1] They mainly consult with county technicians in helping with major conservation problems and keep the counties posted on new developments. Their salary is assumed to be $20,000 per year.	$60,000.00/year
	(c) Secretaries It is assumed the central coordination office requires three secretaries at an annual salary of $7,500.[1]	$22,500.00/year
(2) Labor Support	*(a)* Travel The four staff members are expected to travel 10,000 miles per person per year within the state at a cost of $ .15 per mile.[1] The administrator makes an annual trip to Washington, D.C.	$ 6,000.00/year $ 160.00/year
	(b) Room and Board The technicians are expected to average 90 days per year on the road.[1] The room and board allowance is $25 per day. The administrator is expected to travel 40 days per year in state plus an annual three-day meeting in D.C. The D.C. expense allowance is $50 per day.	$ 6.750.00/year $ 1,150.00/year
	(c) Telephone The commercial phone cost for the central coordination office is estimated to be $200 per staff member per year.[1] The FTS (government) line is estimated at $480 per member per year.[1]	$ 1,920.00/year
	(d) Mail Mailing expense is expected to be $200 per staff member per year.[1]	$ 800.00/year
(3) Equipment	This expense is in section G.	----
(4) Building	This expense is in section G.	----
(5) Office Support	This expense is in section G.	----
(6) Program Support	None	----
	TOTAL COST:	$135,080.00/year

[1]Source: State Soil Conservation Service, Champaign, Illinois

Table E23

Estimated Implementation Costs for Policy 1: Education

Policy Component	Institutional Function	Comments	Cost
Performance Indicators (P)	H: Individual Analysis of Farm Needs	In this policy the information needed has already been compiled in the Conservation Needs Inventory (CNI) so no cost is incurred.	----
	G: Maintenance of a County Office	Based on an estimate of the number of people one technician can educate, assume that only one technician is needed for each county. Each county also requires one secretary.	$85,750.15
	L: Reporting Need	In this policy the need is already reported in the CNI so no cost is incurred	----
	P: Administrative Organization		0
	Q: Central Coordination	Assume that one county bears 1/93 of the total cost.	7,262.34
	G: Maintenance of a Central Office (for Q)	Assume that one county bears 1/93 of the total cost.	3,344.04
		Total Cost for Performance Indicators:	$96,356.53
Control Instruments (I)	M: Formation of a Program		$1,600.00
	J: Education	Assume that one education session will be conducted per week during 50 weeks of each year.	51,375.00
	K: Training for Education (J)		3,587.16
		Total Cost for Control Instruments:	$56,562.76
Erosion Control Techniques (C)	N: Construction		0
		Total Cost for Erosion Control Techniques:	0
Measures of Compliance (M)	A: Monitoring	Assume that 10% of the farms are monitored once each year.	$7,704.30
	K: Training for Monitoring (A)		1,802.88
	B: Reporting Impact	Assume that a report is made for each farm monitored.	579.50
		Total Cost for Measures of Compliance:	$10,086.68
		TOTAL COST PER YEAR BASED ON A FIVE-YEAR PROGRAM:	$163,005.97

Table E24

Estimated Implementation Costs for Policy 2: Tax Credit

Policy Component	Institutional Functional		Cost
Performance Indicators (P)	O: Notification of Legislation		$ 30.00
	F: Tax Transfer		0
		Total Cost for Performance Indicators:	$ 30.00
Control Instruments (I)	F: Tax Transfer		0
		Total Cost for Control Instruments:	0
Erosion Control Techniques (C)	N: Construction		0
		Total Cost for Erosion Control Techniques:	0
Measures of Compliance (M)	F: Tax Transfer		0
		Total Cost for Measures of Compliance:	0
Temporary Penalties (T)	F: Tax Transfer		0
		Total Cost for Temporary Penalties:	0
		TOTAL COST PER YEAR BASED ON A FIVE-YEAR PROGRAM:	$30.00

Table E25

Estimated Implementation Costs for Policy 3: Fifty-percent Cost Sharing

Policy Component	Institutional Function	Comments	Cost
Performance Indicators (P)	O: Notification of Legislation		$ 30.00
	G: Maintenance of a County Office	Assuming that 1221 farms receive cost-sharing consideration, 3 technicians are needed in each county (function H). Assuming that 10% of these 1221 farms are monitored every year, one additional technician is required (function A). Assume that the county office has two secretaries.	274,756.75
	P: Administrative Organization		0
	Q: Central Coordination	Assume that one county bears 1/93 of the total cost.	7,262.34
	G: Maintenance of a Central Office (Q)	Assume that one county bears 1/93 of the total cost.	3,344.04
	H: Individual Analysis of Farm Needs		187,814.22
	K: Training for Analysis (H)		64,763.28
	L: Reporting Need	Assume that an annual report is made.	1,530.00
		Total Cost for Performance Indicators:	$539,500.63
Control Instruments (I)	M: Formation of a Program		1,600.00
	B: Reporting Impact	Assume that a report is made on each farm analyzed.	5,799.75
		Total Cost for Control Instruments:	$ 7,399.75
Erosion Control Techniques (C)	N: Construction		0
		Total Cost for Erosion Control Techniques:	0
Measures of Compliance (M)	A: Monitoring	Assume that 10% of the farms are monitored once each year.	$ 7,704.30
	K: Training for Monitoring (A)		1,802.88
	B: Reporting Impact	Assume that one report is made for each farm monitored.	579.50
		Total Cost for Measures of Compliance:	$ 10,086.68
Temporary Penalties (T)	D: Board of Review		$ 4,979.40
	F: Subsidy Transfer		$419,195.00
		Total Cost for Temporary Penalties:	$424,184.40
		TOTAL COST PER YEAR BASED ON A FIVE-YEAR PROGRAM:	$981,161.46

Table E26

Estimated Implementation Costs for Policy 4: Required Conservation Plan Development

Policy Component	Institutional Function	Comments	Cost
Performance Indicators (P)	O: Notification of Legislation		$ 30.00
	G: Maintenance of a County Office	Assuming that conservation plans must be made for 1221 farms, 3 technicians are needed in each county (function H). Assume that the county office has one secretary.	191,760.15
	P: Administrative Organization		0
	Q: Central Coordination	Assume that one county bears 1/93 of the total cost.	7,262.34
	G: Maintenance of a Central Office	Assume that one county bears 1/93 of the total cost.	3,344.04
	H: Individual Analysis of Farm Needs		187,814.22
	K: Training for Analysis (H)		64,763.28
		Total Cost for Performance Indicators:	$454,974.03
Control Instruments (I)	M: Formation of a Program		$ 1,600.00
	I: Contracting with Individual Farmers		19,536.00
	B: Reporting Impact	In this case, reporting impact involves reporting each contracted farm plan so that the contract will be on record.	5,799.75
		Total Cost for Control Instruments:	$ 26,935.75
Erosion Control Techniques (C)	N: Construction		0
		Total Cost for Erosion Control Techniques:	0
Measures of Compliance (M)		No cost to administration. The conservation plans are a matter of public record.	0
		Total Cost for Measures of Compliance:	0
Temporary Penalties (T)	C: Notification of Assessment of Penalty	Assume a 10% rate of penalty.	$ 1,189.50
	D: Board of Review		4,979.40
	E: Court Action	Assume that 20% of penalties are taken to court.	960.00
		Total Cost for Temporary Penalty:	$ 7,128.90
		TOTAL COST PER YEAR BASED ON A FIVE-YEAR PROGRAM:	$489,038.68

Table E27

Estimated Implementation Costs for Policy 5: Required Conservation Plan Implementation

Policy Component	Institutional Function	Comments	Cost
Performance Indicators (P)	O: Notification of Legislation		$ 30.00
	G: Maintenance of a County Office	Assuming that conservation plans must be made for 1221 farms, 3 technicians are needed in each county (function H). Assuming that 10% of the farms are monitored once each year, an additional technician is needed (function A). Assume 2 secretaries for each county.	274,756.75
	P: Administrative Organization		0
	Q: Central Coordination	Assume that one county bears 1/93 of the total cost.	7,262.34
	G: Maintenance of a Central Office (Q)	Assume that one county bears 1/93 of the total cost.	3,344.04
	H: Individual Analysis of Farm Needs		187,814.22
	K: Training for Analysis (H)		64,763.28
		Total Cost for Performance Indicators:	$537,970.63
Control Instruments (I)	M: Formation of a Program		$ 1,600.00
	I: Contracting with Individual Farmers		19,536.00
	B: Reporting Impact	In this case, reporting impact involves reporting each contracted farm plan so that future monitorings of various farms can be compared to this contracted plan for compliance.	5,799.75
		Total Cost for Control Instruments:	$ 26,935.75
Erosion Control Techniques (C)	N: Construction		0
		Total Cost for Erosion Control Techniques:	0
Measures of Compliance (M)	A: Monitoring	Assume that 10% of the farms are monitored once each year.	$ 7,704.30
	K: Training for Monitoring (A)		1,802.88
	G: Reporting Impact	Assume that a report is made on each farm monitored.	579.50
		Total Cost for Measures of Compliance:	$ 10,086.68
Temporary Penalty (T)	C: Notification of Assessment of Penalty	Assume a 10% rate of penalty.	$ 1,189.50
	D: Board of Review		4,979.40
	E: Court Action	Assume that 20% of penalties are taken to court.	960.00
		Total Cost for Temporary Penalties:	$ 7,128.90
		TOTAL COST PER YEAR BASED ON A FIVE-YEAR PROGRAM:	$582,121.96

Table E28

Estimated Implementation Costs for Policy 6: Development of Greenbelts

Policy Component	Institutional Function	Comments	Cost
Control Instruments (I)	O: Notification of Legislation		$ 30.00
	G: Maintenance of a County Office	Assume that 2 technicians are required for planning and monitoring the greenbelts. Assume that one secretary is needed.	138,255.15
	P: Administrative Organization		0
	Q: Central Coordination	Assume that one county bears 1/93 of the total cost.	7,262.34
	G: Maintenance of a Central Office (Q)	Assume that one county bears 1/93 of the total cost.	3,344.04
	M: Formation of a Program		1,600.00
	H: Individual Analysis of Farm Needs	Since this policy involves greenbelts only, assume that the effort required for H to be 1/3 of the normal total (1221 farms) for the entire county.	62,604.74
	K: Training for Analysis (H)		43,175.52
	B: Reporting Impact	Assume that one report is made for each unit monitored.	193.33
		Total Cost for Control Instruments:	$256,465.12
Erosion Control Techniques (C)	N: Construction		0
		Total Cost for Erosion Control Techniques:	0
Measures of Compliance (M)	A: Monitoring	Assume that 10% of the units are monitored.	$ 514.04
	K: Training for Monitoring (A)		3,605.76
		Total Cost for Measures of Compliance:	$ 4,119.80
Temporary Penalties (T)	C: Notification of Assessment of Penalty	Assume a 10% rate of penalty.	$ 399.75
	D: Board of Review	For this policy, assume 2 cases per month.	3,802.20
	E: Court Action	Assume that 20% of penalties are taken to court.	$ 320.00
		Total Cost for Temporary Penalties:	$ 4,521.95
		TOTAL COST PER YEAR BASED ON A FIVE-YEAR PROGRAM:	$265,106.87

APPENDIX F

SURVEY QUESTIONNAIRES AND COVER LETTERS

University of Illinois at Urbana-Champaign

COLLEGE OF AGRICULTURE · DEPARTMENT OF AGRICULTURAL ECONOMICS 305 MUMFORD HALL
URBANA, ILLINOIS 61801

[Letter sent to farmers]

I need your help. In a few days I will send you a questionnaire concerning soil erosion. This questionnaire is being sent to only a few farmers in your county. Therefore, your cooperation and answers are very important to me.

But why a questionnaire on soil erosion? There is continuing concern with soil erosion on agricultural land. Not only is valuable top soil being lost, but water quality may be affected by sediment and plant nutrients being carried into streams and water supplies. The questionnaire which I am going to send you will allow you to express your views about various policies that might be implemented by the Agricultural Extension Service, the Soil Conservation Service or some other governmental body. Your views are very important.

After you have received the questionnaire and have an opportunity to review it, we will call you long distance to obtain your answers. Of course, your answers will be strictly confidential and not released to any private or governmental group in any manner that would allow them to identify your answers.

If you have any questions, please call me collect at (217) 333-3155.

Sincerely,

Wesley D. Seitz
Associate Professor of
Agricultural Economics

University of Illinois at Urbana-Champaign

COLLEGE OF AGRICULTURE DEPARTMENT OF AGRICULTURAL ECONOMICS · 305 MUMFORD HALL
URBANA, ILLINOIS 61801

[Letter sent to farmers]

Enclosed is the questionnaire I wrote about several days ago. As I mentioned, we need your response since we are talking to only a very few farmers in your county.

Here is what I would like to have you do. First, read over the questionnaire. Then, put it near the telephone. We will call you sometime during the next week to get your answers. If the time we call is not convenient for you, we will make arrangements to call you back. If for some reason you do not want to wait for our call or will not be available, please call us collect at (217) 333-3155. If we have not been able to reach you within 10 days, please fill out the questionnaire and send it back to us.

Again, let me assure you that your answers will be strictly confidential and will not be released to any private or governmental group in any manner that would allow them to identify your answers.

We certainly appreciate your cooperation and interest in this project.

Sincerely,

Wesley D. Seitz
Associate Professor of
Agricultural Economics

enclosure

University of Illinois at Urbana-Champaign

FARMER ATTITUDE SURVEY [Version A]

1. To start with, we would like some information on the kind of farm you operate. How many acres do you have planted:
   a)_______acres in row crops
   b)_______acres in grain crops
   c)_______acres in permanent pasture

2. Do you practice contouring? _____Yes. How many acres are contoured? _______
   _____No

3. Is any of your land terraced? _____Yes. How many acres are terraced? _______
   _____No

4. Over the last 5 years, what was your average yield of corn? _______ bushels/acre.

5. Of the land you farm, do you own it, rent it, or do you own some and rent some? ____Own all
   ____Rent all
   ____Own some, rent some

6. a. How much nitrogen fertilizer per acre are you applying this year to your corn acreage? ______lbs/acre
   b. How many pounds of actual nitrogen is that per acre? ________lbs/acre
   c. Which fetilizer formulation do you use most often on corn (either singly or in combination)?
   ____Nitrogen solution (liquid nitrogen)
   ____Anhydrous ammonia
   ____Ammonium nitrate
   ____Urea

7. What sort of tillage practice do you follow for corn
   a. in the fall? ________________________________
   b. How about in the spring? ________________________________

8. Now to some questions on soil erosion control.

	Yes	Maybe	Not Sure	No
a. Do you think erosion control is needed to maintain soil productivity on farms like yours?	1	2	3	4
b. Do you think erosion control is needed for the achievement of water quality?	1	2	3	4
c. Do you think the amount of soil erosion can be estimated on a farm-by-farm basis?	1	2	3	4
d. Do you think the amount of soil erosion can be estimated for a watershed?	1	2	3	4

9. How effective do you think the following practices would be in reducing erosion on your farm and on others with similar conditions?

	Very Effective	Somewhat Effective	Not Very Effective	Not at all Effective
a. Terracing	1	2	3	4
b. Contouring	1	2	3	4
c. Conservation tillage (zero, chisel, strip, etc.).	1	2	3	4
d. Elimination of moldboard fall plowing	1	2	3	4
e. Changing crop rotations	1	2	3	4

10. Now we would like you to consider several possible policies which might be adopted to control erosion or nutrient losses. You may not be familiar with some of these policies or they may not apply to your particular farm and some may seem far-fetched. But we do need your reactions to EACH POLICY.

For each one, we would like you to tell us:

a. how fair you think the policy would be (very fair, somewhat fair, somewhat unfair, very unfair);
b. what group, if any, would be unfairly treated by the policy if it were adopted, and
c. supposing the policy were adopted, about what percentage of farms like yours would you guess would go along with each policy.

SOIL CONTROL PRACTICES

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
A. Full cost sharing for the cost of terracing.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ____________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would apply for full cost sharing for the cost of terracing? ______%				
B. A regulation requiring contouring or terracing on slopes over 9 percent.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ____________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would adopt the required practices on slopes? ______%				
C. A regulation prohibiting moldboard fall plowing.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ____________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would discontinue moldboard fall plowing? ______%				
NITROGEN REGULATIONS				
D. A regulation charging a tax on nitrogen of 20¢ per pound.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ____________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would reduce their usage of nitrogen? ______%				
LOANS/TAX CREDITS				
E. Making available interest-free loans to cover the farmer's cost of soil conservation work.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ____________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would apply for these interest-free loans? ______%				

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
F. A regulation prohibiting the deduction of real estate taxes from federal income tax unless an approved soil conservation plan has been developed and implemented.				
a. How fair would this policy be?	1	2	3	4

b. What group, if any, would be unfairly treated if this were adopted?

____

c. If this policy were adopted, about what percentage of farms like yours do you guess would implement a soil conservation plan? ______%

SOIL LOSS REGULATIONS

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
G. A regulation requiring soil losses to be less than 3 tons per acre (3 tons equal about 3 cubic yards).				
a. How fair would this policy be?	1	2	3	4

b. What group, if any, would be unfairly treated if this were adopted?

____

c. If this policy were adopted, about what percentage of farms like yours do you guess would achieve less than 3 tons of soil losses per acre? ______%

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
H. A regulation requiring a recreational green belt along streams to achieve increased water quality.				
a. How fair would this policy be?	1	2	3	4

b. What group, if any, would be unfairly treated if this were adopted?

____

c. If this policy were adopted, about what percentage of farms like yours do you guess would develop the required green belt? ______%

11. As you know, for a long time the Soil Conservation Service has helped farmers develop soil conservation plans for their land.

a. Have you developed such a plan for your farm? ____Yes
____No (If not, go to question 12)

b. How long ago did you develop your plan? ______years

c. How much of the plan have you implemented? ____All
____Most
____About half
____A little
____None

12. Do you think this approach of farmers developing their own conservation plan for their land with technical assistance from the Soil Conservation Service is reasonable? ____Yes
____No

Why or why not? ____

____

____

13. How could you be better assisted in <u>your own</u> soil conservation activities? (Please list)

____

____

____

____

(Over)

14. Which of the following statements best describe your soil conservation practices? Please state as many as apply to you by giving the number of the statement(s).

(1) I'm doing a better job than anyone else in the county.
(2) I'm doing an excellent job.
(3) I'm doing an adequate job.
(4) I'm doing an average job.
(5) I'm doing the best I can under the circumstances.
(6) I know I should be doing a better job.
(7) If I wanted to take the time, I could do a better job.
(8) If my landlord would cooperate, I would do a better job.
(9) If ______________________________, I would do a better job.
(please specify)

THANK YOU FOR YOUR TIME. WE CERTAINLY APPRECIATE YOUR COOPERATION.

We will attempt to reach you by telephone within 10 days. If you will not be available or if you prefer not to wait for our call, please phone us collect at (217) 333-3155 or mail your completed survey to:

Wesley Seitz
Department of Agricultural Economics
305 Mumford Hall
University of Illinois
Urbana, IL 61801

University of Illinois at Urbana-Champaign

FARMER ATTITUDE SURVEY [Version B]

1. To start with, we would like some information on the kind of farm you operate. How many acres do you have planted:
   a)_______acres in row crops
   b)_______acres in grain crops
   c)_______acres in permanent pasture

2. Do you practice contouring? _____Yes. How many acres are contoured? ______
   _____No

3. Is any of your land terraced? _____Yes. How many acres are terraced? ______
   _____No

4. Over the last 5 years, what was your average yield of corn? ______ bushels/acre.

5. Of the land you farm, do you own it, rent it, or do you own some and rent some? ____Own all
   ____Rent all
   ____Own some, rent some

6. a. How much nitrogen fertilizer per acre are you applying this year to your corn acreage? _____lbs/acre
   b. How many pounds of actual nitrogen is that per acre? ________lbs/acre
   c. Which fetilizer formulation do you use most often on corn (either singly or in combination)?
   ____Nitrogen solution (liquid nitrogen)
   ____Anhydrous ammonia
   ____Ammonium nitrate
   ____Urea

7. What sort of tillage practice do you follow for corn
   a. In the fall? ____
   b. How about in the spring? ____

8. Now to some questions on soil erosion control.

	Yes	Maybe	Not Sure	No
a. Do you think erosion control is needed to maintain soil productivity on farms like yours?	1	2	3	4
b. Do you think erosion control is needed for the achievement of water quality?	1	2	3	4
c. Do you think the amount of soil erosion can be estimated on a farm-by-farm basis?	1	2	3	4
d. Do you think the amount of soil erosion can be estimated for a watershed?	1	2	3	4

9. How effective do you think the following practices would be in reducing erosion on <u>your</u> farm and on others with similar conditions?

	Very Effective	Somewhat Effective	Not Very Effective	Not at all Effective
a. Terracing	1	2	3	4
b. Contouring	1	2	3	4
c. Conservation tillage (zero, chisel, strip, etc.).	1	2	3	4
d. Elimination of moldboard fall plowing	1	2	3	4
e. Changing crop rotations	1	2	3	4

10. Now we would like you to consider several possible policies which might be adopted to control erosion or nutrient losses. You may not be familiar with some of these policies or they may not apply to your particular farm and some may seem far-fetched. But we do need your reactions to EACH POLICY.

For each one, we would like you to tell us:

a. how fair you think the policy would be (very fair, somewhat fair, somewhat unfair, very unfair),
b. what group, if any, would be unfairly treated by the policy if it were adopted, and
c. supposing the policy were adopted, about what percentage of farms like yours would you guess would go along with each policy.

SOIL CONTROL PRACTICES

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
A. A 50% cost sharing for the cost of terracing.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ______________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would apply for 50% cost sharing for the cost of terracing? ______%				
B. A 50% cost sharing for the cost of slope modification (land leveling).				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ______________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would apply for 50% cost sharing for the cost of slope modification? ______%				
C. A regulation requiring conservation tillage (chisel, zero, plow plant, etc.) in place of conventional tillage (moldboard plowing, harrowing, disking, etc.).				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ______________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would adopt the required conservation tillage practices? ______%				

NITROGEN REGULATIONS

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
D. A regulation imposing an application limit of 100 lbs. of nitrogen per acre.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ______________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would apply 100 lbs. or less of nitrogen per acre? ______%				
E. A regulation charging a tax on nitrogen of 10¢ per pound.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ______________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would reduce their usage of nitrogen? ______%				

TAX CREDITS	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
F. An investment tax credit for the farmer's cost of soil conservation work.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ________________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would take advantage of the investment tax credit? ______%				
G. A regulation requiring the development and implementation of an approved soil conservation plan.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ________________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would implement a soil conservation plan? ______%				
SOIL LOSS REGULATIONS				
H. A regulation requiring soil losses to be less than 5 tons per acre (5 tons equal about 5 cubic yards).				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ________________				
c. If this policy were adopted, about what percentage of farms like yours do you guess would achieve less than 5 tons of soil losses per acre? ______%				
I. A regulation requiring a non-recreational green belt along streams and drainage ditches to achieve increased water quality.				
a. How fair would this policy be?	1	2	3	4
b. What group, if any, would be unfairly treated if this were adopted? ________________				
c. If this policy were adopted, about what percentage of farms like yours do guess would develop the required green belt? ______%				

11. As you know, for a long time the Soil Conservation Service has helped farmers develop soil conservation plans for their land.

a. Have you developed such a plan for your farm? ___Yes
___No (If not, go to question 12)

b. How long ago did you develop your plan? ______years

c. How much of the plan have you implemented?
___All
___Most
___About half
___A little
___None

(Over)

12. Do you think this approach of farmers developing their own conservation plan for their land with technical assistance from the Soil Conservation Service is reasonable? ____Yes

____No

Why or why not? ______________________________

____

____

13. How could you be better assisted in <u>your own</u> soil conservation activities? (Please list)

____

____

____

____

14. Which of the following statements best describe your soil conservation practices? Please state as many as apply to you by giving the number of the statement(s).

(1) I'm doing a better job than anyone else in the county.
(2) I'm doing an excellent job.
(3) I'm doing an adequate job.
(4) I'm doing an average job.
(5) I'm doing the best I can under the circumstances.
(6) I know I should be doing a better job.
(7) If I wanted to take the time, I could do a better job.
(8) If my landlord would cooperate, I would do a better job.
(9) If ______________________________, I would do a better job.
(please specify)

THANK YOU FOR YOUR TIME. WE CERTAINLY APPRECIATE YOUR COOPERATION.

We will attempt to reach you by telephone within 10 days. If you will not be available or if you prefer not to wait for our call, please phone us collect at (217) 333-3155 or mail your completed survey to:

Wesley Seitz
Department of Agricultural Economics
305 Mumford Hall
University of Illinois
Urbana, IL 61801

University of Illinois at Urbana-Champaign

COLLEGE OF AGRICULTURE · DEPARTMENT OF AGRICULTURAL ECONOMICS · 305 MUMFORD HALL
URBANA, ILLINOIS 61801

[Letter to ASCS directors]

I need your help. In a few days I will send you a questionnaire concerning soil erosion. This questionnaire is being sent to the Agricultural Stabilization and Conservation Service County Executive Director in only 11 counties. Therefore, your cooperation and answers are very important to me.

But why a questionnaire on soil erosion? There is continuing concern with soil erosion on agricultural land. Not only is valuable top soil being lost, but water quality may be affected by sediment and plant nutrients being carried into streams and water supplies. The questionnaire which I am going to send you will allow you to express your views about various policies that might be implemented by the Agricultural Extension Service, the Soil Conservation Service or some other governmental body. Your views are very important.

After you have received the questionnaire and have an opportunity to review it, we will call you long distance to obtain your answers. Of course, your answers will be strictly confidential and not released to any private or governmental group in any manner that would allow them to identify your answers.

If you have any questions, please call me collect at (217) 333-3155.

Sincerely,

Wesley D. Seitz
Associate Professor of
Agricultural Economics

University of Illinois at Urbana-Champaign

COLLEGE OF AGRICULTURE · DEPARTMENT OF AGRICULTURAL ECONOMICS · 305 MUMFORD HALL
URBANA, ILLINOIS 61801

[Letter to ASCS directors]

Enclosed is the questionnaire I wrote about several days ago. As I mentioned, we need your response since we are talking to only eleven Agricultural Stabilization and Conservation Service County Executive Directors.

Here is what I would like to have you do. First, read over the questionnaire. Then, put it near the telephone. We will call you sometime during the next week to get your answers. If the time we call is not convenient for you, we will make arrangements to call you back. If for some reason you do not want to wait for our call or will not be available, please call us collect at (217) 333-3155. If we have not been able to reach you within 10 days, please fill out the questionnaire and send it back to us.

Again, let me assure you that your answers will be strictly confidential and will not be released to any private or governmental group in any manner that would allow them to identify your answers.

We certainly appreciate your cooperation and interest in this project.

Sincerely,

Wesley D. Seitz
Associate Professor of
Agricultural Economics

enclosure

ASCS QUESTIONNAIRE

1. For____________county, how would you describe the land?

a. Is it primarily
___flat
___rolling
___sloping
___hilly

b. What is the approximate average length of the slopes? ______yards

2. How many acres in your county are terraced? ______acres

3. How many acres in your county are contoured? ______acres

4. Over the last 5 years, what was the average bushels per acre yield of corn in your county?

______bu/acre

5. What sort of tillage practices are most commonly used for corn in your county

a. in the fall?____

b. in the spring?____

6. Based on your contact with farmers, we need your impression on farmer attitudes about soil erosion control.

	Yes	Maybe	Not Sure	No
a. Do they think erosion control is needed to to maintain soil productivity on farms?	1	2	3	4
b. Do they think erosion control is needed for the achievement of water quality?	1	2	3	4
c. Do they think the amount of soil erosion can be estimated on a farm by farm basis?	1	2	3	4
d. Do they think the amount of soil erosion can be estimated for a watershed?	1	2	3	4

7. If farmers were asked, "How effective do you think the following practices would be in reducing erosion on your farm and on others with similar conditions--very effective, somewhat effective, not very effective, or not at all effective?", how do you think they would respond to the following?

	Very Effective	Somewhat Effective	Not Very Effective	Not at all Effective
a. Terracing..	1	2	3	4
b. Contouring.......................................	1	2	3	4
c. Conservation tillage (zero, chisel, strip, etc.)...................	1	2	3	4
d. Elimination of moldboard fall plowing...........	1	2	3	4
e. Changing crop rotations..........................	1	2	3	4

8. Please indicate the general attitude of farmers toward soil conservation practices in your county.

___A small percentage are vitally interested.
___Most would be interested if they were properly informed.
___At least 50% are very interested.
___Most think it is unnecessary.
Other comments____

9. Now we would like you to consider several possible policies which might be adopted to control erosion or nutrient losses. Some of these policies may not apply directly to farms in your county and some may seem far-fetched. But, we do need your reactions to EACH POLICY.

For each one, we would like you to tell us:
(a) how fair you think the policy would be (very fair, somewhat fair, somewhat unfair, very unfair),
(b) what group, if any, would be unfairly treated by the policy if it were adopted, and
(c) supposing the policy were adopted, about what percentage of farms in your county would you guess would go along with each policy.

SOIL CONTROL PRACTICES:

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
A. Full cost sharing for the cost of terracing.				
(a) How fair would this policy be?...............	1	2	3	4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would apply for full cost sharing for the cost of terracing?__________%

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
B. A 50% cost sharing for the cost of terracing.				
(a) How fair would this policy be?...............	1	2	3	4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would apply for 50% cost sharing for the cost of terracing?__________%

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
C. A regulation requiring contouring or terracing on slopes over 9 percent.				
(a) How fair would this policy be?...............	1	2	3	4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would adopt the required practices on slopes?__________%

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
D. A 50% cost sharing for the cost of slope modification (land leveling).				
(a) How fair would this policy be?...............	1	2	3	4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would apply for 50% cost sharing for the cost of slope modification?_____%

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
E. A regulation prohibiting moldboard fall plowing.				
(a) How fair would this policy be?...............	1	2	3	4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would discontinue moldboard fall plowing?__________%

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
F. A regulation requiring conservation tillage (chisel, zero, plow plant, etc.) in place of conventional tillage (moldboard plowing, harrowing, disking, etc.).				
(a) How fair would this policy be?...............	1	2	3	4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would adopt the required conservation tillage practices?__________________%

NITROGEN REGULATIONS

G. A regulation imposing an application limit of 100 lbs. of nitrogen per acre.

(a) How fair would this policy be?...............1 2 3 4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would apply 100 lbs. or less of nitrogen per acre?__________________%

H. A regulation charging a tax on nitrogen of 20¢ per lb.

(a) How fair would this policy be?...............1 2 3 4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would reduce their usage of nitrogen?__________________%

I. A regulation charging a tax on nitrogen of 10¢ per lb.

(a) How fair would this policy be?...............1 2 3 4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would reduce their usage of nitrogen?__________________%

LOANS/TAX CREDITS

J. Making available interest-free loans to cover the farmer's cost of soil conservation work.

(a) How fair would this policy be?...............1 2 3 4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would apply for these interest-free loans?__________________%

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
K. An investment tax credit for the farmer's cost of soil conservation work.				
(a) How fair would this policy be?...............	1	2	3	4
(b) What group, if any, would be unfairly treated if this were adopted? ______________				
(c) If this policy were adopted, about what percentage of farms in your county do you guess would take advantage of the investment tax credit?__________%				
L. A regulation requiring the development and implementation of an approved soil conservation plan.				
(a) How fair would this policy be?...............	1	2	3	4
(b) What group, if any, would be unfairly treated if this were adopted? ______________				
(c) If this policy were adopted, about what percentage of farms in your county do you guess would implement a soil conservation plan?__________%				
M. A regulation prohibiting the deduction of real estate taxes from Federal Income tax unless an approved soil conservation plan has been developed and implemented.				
(a) How fair would this policy be?...............	1	2	3	4
(b) What group, if any, would be unfairly treated if this were adopted? ______________				
(c) If this policy were adopted, about what percentage of farms in your county do you guess would implement a soil conservation plan?__________%				
SOIL LOSS REGULATIONS				
N. A regulation requiring soil losses to be less than 3 tons per acre (3 tons equal about 3 cu. yds.).				
(a) How fair would this policy be?...............	1	2	3	4
(b) What group, if any, would be unfairly treated if this were adopted? ______________				
(c) If this policy were adopted, about what percentage of farms in your county do you guess would achieve less than 3 tons of soil losses per acre?__________%				
O. A regulation requiring soil losses to be less than 5 tons per acre (5 tons equal about 5 cu. yds.).				
(a) How fair would this policy be?...............	1	2	3	4
(b) What group, if any, would be unfairly treated if this were adopted? ______________				
(c) If this policy were adopted, about what percentage of farms in your county do you guess would achieve less than 5 tons of soil losses per acre?__________%				

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
P. A regulation requiring a recreational green belt along streams to achieve increased water quality.				
(a) How fair would this policy be?...............	1	2	3	4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would develop the required green belt?______________________%

	Very Fair	Somewhat Fair	Somewhat Unfair	Very Unfair
Q. A regulation requiring a non-recreational green belt along streams and drainage ditches to achieve increased water quality.				
(a) How fair would this policy be?...............	1	2	3	4

(b) What group, if any, would be unfairly treated if this were adopted?

____

(c) If this policy were adopted, about what percentage of farms in your county do you guess would develop the required green belt?______________________%

THANK YOU VERY MUCH FOR YOUR TIME AND COOPERATION!

APPENDIX G

SURVEY RESULTS: FAIRNESS OF ALL POLICIES INCLUDED IN QUESTIONNAIRES

The following table reports the responses of farmers to the fairness questions for all policies included in both forms of the questionnaire. It includes a breakdown by whether the farmer has adopted a soil conservation plan. In general, those soil-conservation-oriented policies that involve blanket prescriptions on farm operations are less favorably received than those that constrain soil loss but allow flexibility in how the operator achieves the reduction. The nitrogen-focused policies are not viewed as fair.

Table G1

Survey Results: Fairness of All Policies Included in Questionnaire

	N	YES/ NO*	VERY FAIR	SOME-WHAT FAIR	***	SOME-WHAT UNFAIR	VERY UNFAIR
Full Cost Sharing for Cost of Terracing	31 15	Yes No	25.8 46.7	51.6 46.7	>	9.7 6.7	12.9 ----
50% Cost Sharing for Cost of Terracing	18 17	Yes No	33.3 35.3	44.4 29.4	>	11.1 23.5	11.1 11.8
Required Contour or Terrace on 9% Slopes	32 17	Yes No	40.6 29.4	37.5 35.3	>	6.3 23.5	15.6 11.8
50% Cost Share for Slope Modification	15 17	Yes No	26.7 29.4	33.3 35.3	>	33.3 23.5	6.7 11.8
Prohibition of Fall Moldboard Plowing	32 17	Yes No	15.6 11.8	18.8 11.8	<	31.3 17.6	34.4 58.8
Required Conservation Tillage	16 19	Yes No	25.0 10.5	25.0 26.3	<	6.3 42.1	43.8 21.1
100 Pounds of Nitrogen/Acre Limit	19 19	Yes No	21.1 26.3	5.3 15.8	<	31.6 15.8	42.1 42.1
Nitrogen Tax 20¢/Pound	31 15	Yes No	---- 6.7	6.5 13.3	<	16.1 6.7	77.4 73.3
Nitrogen Tax 10¢/Pound	19 19	Yes No	5.3 ----	---- 5.3	<	15.8 5.3	78.9 89.5
Interest-Free Loan Conservation Work	32 16	Yes No	37.5 62.5	34.4 25.0	>	21.9 6.3	6.3 6.3
Investment Tax Credit Conservation Work	19 18	Yes No	57.9 50.0	36.8 38.9	>	5.3 5.6	---- 5.6
Required Implementation of Soil Conservation Plan	18 18	Yes No	22.2 16.7	22.2 50.0	>	16.7 16.7	38.9 16.7
No Deduction of Taxes without Soil Conservation Plan	32 17	Yes No	15.6 5.9	18.8 29.4	<	18.8 11.8	46.9 52.9
Soil Losses <3 Tons/Acre	29 15	Yes No	13.8 13.3	51.7 33.3	>	17.2 20.0	17.2 33.3
Soil Losses <5 Tons/Acre	18 17	Yes No	33.3 17.6	33.3 29.4	>	5.6 17.6	27.8 35.3
Required Recreational Greenbelt, Streams	32 17	Yes No	21.9 11.8	31.3 35.3	>	18.8 23.5	28.1 29.4
Required Nonrec. Greenbelt, Streams & Drainage Ditches	17 19	Yes No	41.2 21.1	23.5 42.1	<	11.8 10.5	23.5 26.3

* Plan Developed?
** Percent
***> indicates that the sum of somewhat fair plus very fair exceeds the sum of somewhat unfair plus very unfair for all farmers.

APPENDIX H

METRIC CONVERSION TABLE

TO CONVERT	INTO	MULTIPLY BY
Acres	hectares	0.4047
Bushels	liters	35.24
Bushels	cubic meters	0.03524
Bushels/acre	liters/hectare	87.08
Bushels/acre	cubic meters/hectare	0.0871
Inches	centimeters	2.54
Pounds	kilograms	0.4536
Pounds/acre	kilograms/hectare	1.121
Tons (short)	kilograms	907.18
Tons (short)	metric tons	0.90718
Tons/acre	kilograms/hectare	2241.6
Tons/acre	metric tons/hectare	2.2416

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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4. TITLE AND SUBTITLE Alternative Policies for Controlling Nonpoint Agricultural Sources of Water Pollution		5. REPORT DATE April 1978 issuing date
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7. AUTHOR(S) W.D. Seitz et al.		8. PERFORMING ORGANIZATION REPORT NO.
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16. ABSTRACT

This study of policies for controlling water pollution from nonpoint agricultural sources includes a survey of existing state and Federal programs, agencies, and laws directed to the control of soil erosion. Six policies representing a variety of approaches to this pollution problem are analyzed. The aggregate economic impact of such policies is investigated using a state-of-the-art, market-equilibrium, linear-programming model of crop production in the corn belt. The economic effects of the policies at the level of individual forms and their impacts on long-term soil productivity are analyzed through the use of a watershed model.

The institutional arrangements needed to implement the policies are examined, as are the associated costs for a typical county. Literature on the social aspects of policy acceptance is reviewed, and the results of a survey of the reaction of farmers and ASCS directors in Illinois to different policies are presented. The equity of the policies is examined and legal precidents are reviewed.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Water pollution Soil erosion Economics	Nonpoint sources Agriculture Modeling	48B 68D 98B 98C

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