TIM McCABE: USDA SOIL CONSERVATION SERVICE

In Eastern Washington severe erosion has exposed the subsoil layer on many hillsides. Here the lighter subsoil can be seen in contrast with the winter wheat.

Soil Conservation

It's Not the Farmers Who Are Most Affected by Erosion

by Pierre Crosson

The increase in erosion associated with the farm export boom of the 1970's spurred not only concern about soil erosion itself but also more research focused on erosion. This research confirms that erosion increased. But, in addition, it raises serious questions about policies and programs focused on soil erosion.

Here are the soil conservation issues that I consider to be the most important:

- Soil erosion is highly concentrated in a few crop-growing regions of the United States. Yet soil conservation funds are and always have been widely dispersed. Can anyone seriously interested in erosion control continue to openly support this traditional approach?
- Traditionally, tons of soil loss associated with erosion have been used as criteria to judge if erosion is excessive. However, focusing on the economic value of the soil loss, on the damage caused by eroded soil when it leaves the farm, or costs of controlling erosion provides sharply different answers as to when soil erosion is excessive. Can erosion control policy continue to ignore these economic issues?
- Traditionally, loss of soil productivity has been perceived as the major threat of erosion. However, costs of off-farm erosion damage are far greater. What are the policy implications?

In responding to these questions, people interested in soil conservation increasingly say:

- Erosion control expenditures should not be dispersed but focused.
- More research is needed in the on-farm and off-farm costs of erosion as well as on the costs and benefits of controlling it.
- Erosion control policy should give more attention to reducing off-farm costs relative to reducing on-farm costs.
- Giving more attention to off-farm costs will greatly complicate the policy problem. It is very difficult to trace damaging sediment back to its place of origin. Consequently, we cannot be sure where erosion control structures should be installed.
- Because of this problem it may pay

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to put more emphasis on trapping sediment before it reaches places where it does damage and less on controlling erosion from farm fields.

• The traditional policy of providing farmers incentive to voluntarily conserve soil erosion may need modification. The large off-farm costs of erosion make a case for greater reliance on regulatory approaches to erosion control. The argument is that sediment and associated chemicals are pollutants similar in nature to pollutants emitted by industry. We regulate industry. Why not agriculture?

Shifts in policies in these ways will give more effective control of erosion costs than current policies do.

Erosion Concentration

Soil erosion in the United States is concentrated in two ways. First, nearly two-thirds occurs on cropland (table 1). Second, cropland erosion is concentrated geographically (table 2).

Table 1: Two-thirds of the soil erosion in the United States occurs on cropland

Land use	Annual soil loss: Billion tons	Annual soil loss: Tons per acre
Cropland	3.1	7.4
Rangeland	1.2	2.9
Forestland	.4	.9
Pastureland	.2	1.4
TOTAL	4.8	5.7

Note: Non-Federal lands. Wind, sheet and rill erosion combined.

On a per acre basis the major problems are in the Corn Belt, Appalachia, Southern Plains and the Mountain States. Wind erosion is especially important in the Southern Plains where wind accounts for 10.6 of the 13.1 tons per acre lost per year and in the Mountain States where wind accounts for 6.7 of the 8.8 tons per acre loss.

The erosion problems are concentrated within regions as well. For example, the Western Corn Belt states of Illinois, Iowa and Missouri have 16 percent of the nation's cropland and 31 percent of the sheet and rill erosion. Appalachia has only 5 percent of the cropland and 10 percent of the sheet and rill erosion. It is concentrated in Kentucky and Tennessee.

Time For Targeting?

If we are serious about reducing erosion damages, we should focus control efforts on those relatively small areas where damage is most severe. Traditionally, erosion control resources have been widely dispersed nationally in order to serve a variety of purposes, not just erosion control.

Since the 1930's, federal soil conservation funds have been used to support farm income and to induce farmers to control erosion. To qualify for the funds, farmers were supposed to shift land from row crops to some less erosive use, but standards of compliance have been generous.

Apart from the mixing of income and erosion control objectives, the organization of soil conservation programs are guaranteed to ensure dispersal of effort. Programs are delivered through soil conservation districts, represented by the National Association of Conservation Districts (NACD) in Washington, D.C.

The system has all the management virtues of decentralized organization, and it ensures grassroots support for soil conservation. However, it also ensures political pressure to provide each district with some portion of soil conservation resources with little regard to the severity of the district's erosion problem.

This situation is changing. USDA is slowly beginning to target erosion control programs, despite stiff resistance from the NACD and some elements in the Congress.

In the late 1970's, such targeting was supported by General Accounting Office and Agricultural Stabilization and Conservation Service reports that demonstrated and criticized the lack of focus in soil conservation funding.

National Resource Inventory (NRI) surveys from 1977 and 1982 are indisputable: Severe erosion in the United States is highly localized and cost-effective programs for erosion control must conform to erosion patterns.

Defenders of the traditional system run the risk of being perceived as advocates of a vested interest or as not being serious about erosion control. The defenders persist, but they cannot dispute the hard facts revealed by NRI. Targeting shows all the signs of an idea whose time has come.

How Much Is Too Much?

What is the maximum "tolerable" amount of erosion? The conservationists' answer is "the maximum annual number of tons of soil an acre of land can lose indefinitely without impairing the agricultural productivity of the soil." They call this number the "T value."

T values are 5 tons for most soils. However, for some thin soils with unfavorable subsoils T values are as low as 1 ton. Soil Conservation Service (SCS) technicians use T values when they advise farmers about the need for soil conservation and policymakers use T values as a guide in judging the severity of the national erosion problem.

T values rely on three assumptions: (1) that the principal goal of soil conservation policy is preventing soil productivity loss; (2) that each generation

Table 2: Soil erosion on cropland is concentrated

Regions	Annual soil loss: Billion tons	Annual soil loss: Tons per acre	Intensity*
Northeast	.06	3.9	.5
Lake States	.3	5.8	.8
Corn Belt	.8	8.4	1.1
Northern Plains	.5	5.5	.8
Appalachia	.2	8.0	1.1
Southeast	.1	5.4	.7
Delta	.1	5.7	.8
Southern Plains	.6	13.1	1.8
Mountain States	.1	8.8	1.2
Pacific	.1	4.4	.6
TOTAL	3.1	7.4	1.0

Note: Non-Federal lands, wind, sheet and rill erosion combined.

*Percent that regional erosion is of national erosion divided by percent that regional cropland is of national cropland.

Erosion in Idaho . . . another example of rill erosion. UNIVERSITY OF IDAHO EXTENSION

should avoid passing on higher production costs to future generations and that any loss of soil productivity will increase costs; (3) that soil loss standards can be specified in purely physical terms, i.e., without including an explicit economic dimension.

The 1982 Natural Resource Inventory showed that erosion (sheet, rill and wind combined) exceeded T on 44 percent of the nation's cropland. In some areas the percentage of threatened cropland was even higher—exceeding T on 72 percent of the land in Iowa, on 59 percent in Texas and on 50 percent in Tennessee.

Most people, including even many economists, accept the ethical precept that we should manage land to avoid passing higher production costs on to subsequent generations. But T values are not a reliable guide to when and where the precept is in danger of being violated.

Weak Scientific Basis

Soil scientists have long recognized that the scientific basis for T values is weak. The T value standards of 2 to 5 tons per acre per year were set by SCS technicians, but their reasons for those particular numbers are unclear.

There's plenty of scientific evidence that the T value standard is weak. If the criterion is rate of new soil formation, then even the 2-ton limit is much too high. However, if the criterion is the rate of formation of topsoil, then even the 5-ton limit is too low for many soils.

"The more fundamental weakness of the T value standard is its failure to include an economic dimension."

Research by soil scientists at the University of Minnesota and by USDA scientists developing the Erosion Productivity Impact Calculator (EPIC) model show that the relationship between erosion and productivity loss varies greatly among soils and across regions. The T values as standards for judging when erosion reduces soil productivity are largely arbitrary.

Lack of an Economic Dimension

The more fundamental weakness of the T value standard is its failure to include an economic dimension. Farmers and policymakers must both be able to compare the costs of erosion with the costs of control if they are to make wise decisions about soil conservation. The T value standard conveys no information about either kind of cost.

Nor does the T value standard admit time as a variable in deciding when to invest in erosion control. Traditional policy says that, on any soil where erosion exceeds T, the time to control is "now." Yet research shows that erosion from deep soils with favorable subsoils may exceed T for many years before the cost of productivity loss exceeds control costs.

To control erosion on these soils "now" would waste the farmer's and society's resources. The fact that erosion now exceeds T on so many soils suggests that farmers understand this.

New T Value Concept?

If they are to guide erosion control decisions, T values must incorporate economic criteria. For reasons given below, these criteria alone will not suffice, but they clearly have a key role to play.

Establishing the economic costs of erosion is a first step. These costs occur on the farm by reducing, or threatening to reduce, the productivity of the soil. They also occur off the farm when sediment silts up reservoirs, lakes and harbors, reduces recreational values and otherwise impairs water quality.

On-Farm Costs

Recent research at the University of Minnesota, USDA and Resources for the Future (RFF) has laid the ground-

work for adding the missing economic dimension to judging the severity of erosion on soil productivity.

The research considers only sheet and rill erosion and deals only with cropland erosion. As will be shown, however, these limitations do not seriously impair the conclusions that can be drawn. So far the work is not applicable to individual farm situations, but it permits some rough first estimates of the national costs of sheet and rill erosion on soil productivity.

These erosion costs fall into three categories: (1) costs of preventive measures like grassed waterways and strip cropping; (2) costs of the production loss which occurs despite prevention efforts; and (3) costs of compensating for erosion damage by adding fertilizer to replace lost soil nutrients, liming to maintain adequate soil pH and tilling to restore soil tilth.

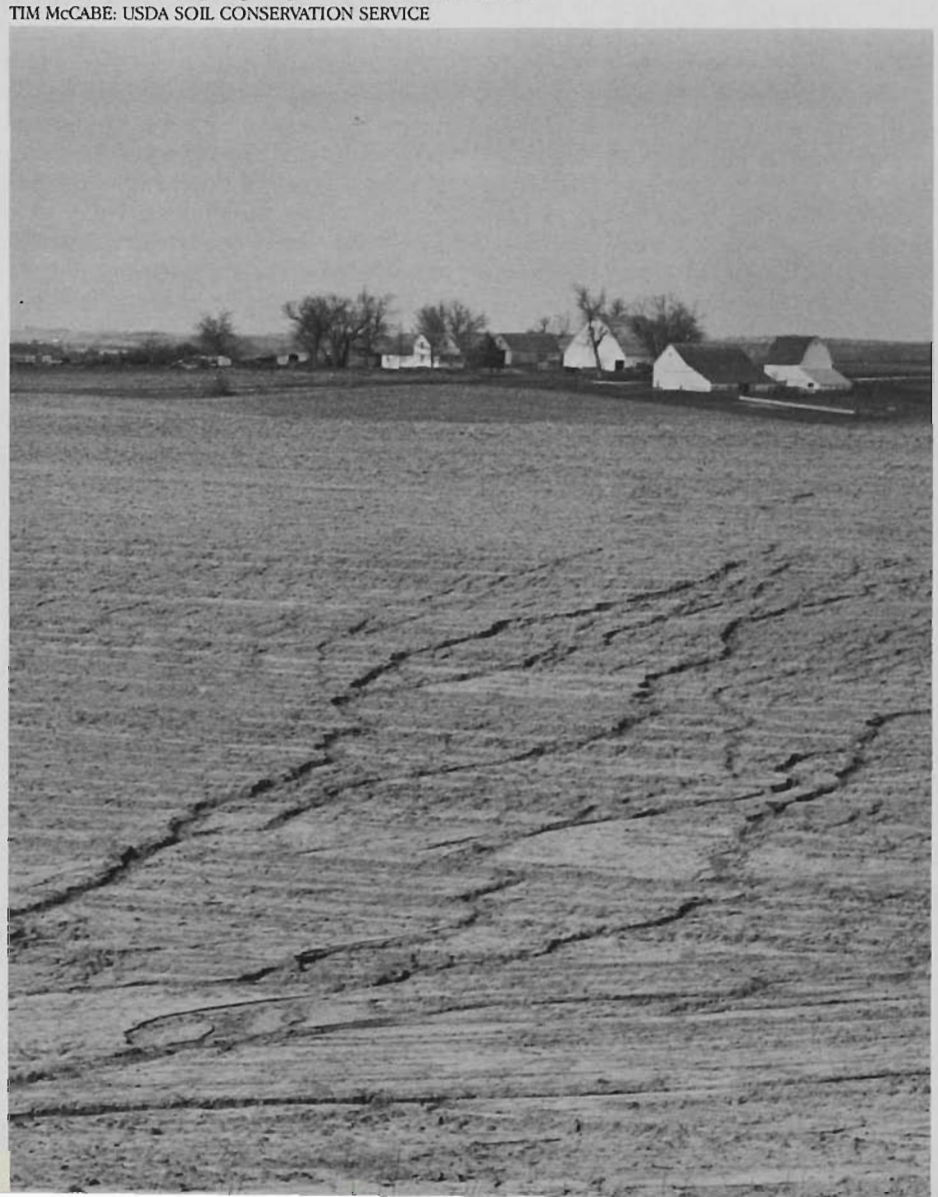
Based on work by USDA's George Pavelis, I estimate that annualized costs of prevention are about $1.2 billion, expressed in 1983 prices.

This estimate probably is low because Pavelis' data do not include the value of the land taken out of production by devoting it to conservation uses. University of Minnesota research enabled me to estimate that the annualized cost of erosion-induced crop production losses over the next 100 years (discounted at 5 percent) is about $420 million, also in 1983 prices.

USDA studies show that in Iowa additional outlays on fertilizer and fuel to compensate for erosion effects were 25 to 40 percent of the erosion-induced production loss. Applying these percentages nationwide indicates annual costs of compensation in 1983 prices of $105 to $168 million.

In summary, the present annualized costs of cropland erosion on soil productivity are about $1.7-$1.8 billion. This takes into account the cumulative effect of yield loss over the next 100 years. Erosion control to prevent yield loss accounts for a little over two-thirds of total cost, yield loss for about 25 percent and costs of compensation for less than 10 percent.

Rill erosion on sloping cropland in western Iowa.
TIM McCABE: USDA SOIL CONSERVATION SERVICE



Off-Farm Costs

A study by the Conservation Foundation (CF) indicates that off-farm erosion damage currently costs the nation $3.4 billion-$13.0 billion annually, with the "best guess" estimate being $6.1 billion.

These estimates do not include the cost of controls to avoid or reduce the damage. They are comparable, therefore, to my combined estimates of $525-$575 million for production losses and compensating costs. The comparison indicates that the off-farm costs are 0.6 to 2.2 times greater than the soil productivity costs.

The CF estimates cover damages from all sources of erosion, not just cropland. However, since most of the threat to soil productivity is from cropland erosion, comparison of cropland erosion costs with the CF cost estimates is legitimate.

The CF study deals with both in-stream and off-stream erosion damages. In-stream damages include loss of recreational values, loss of lake and reservoir capacity, increased costs of keeping navigable waterways clear of sediment and other miscellaneous costs. Lack of information precludes including the costs of damage to biological systems such as sediment buildup in fish spawning areas.

Erosion Too Costly?

Should we spend more on erosion control? The annualized costs of yield loss and compensating outlays over the next 100 years are only about 1 or 2 percent of current annual costs of crop production.

Consequently, continuation of present rates of erosion would not likely impose significantly higher costs of food and fiber on future generations. If costs rise, it will be because technological advance fails to keep pace with rising demand for these products.

The best way to assure that this does not happen is to support research on technologies which keep yield growth ahead of demand and which farmers find profitable. Without such technologies, demand growth will raise future production costs even if we succeed in reducing erosion-induced costs to zero. The case for spending more to reduce these costs is weak.

"Continuation of present erosion rates would not likely impose significantly higher costs of food and fiber on future generations."

Should we spend more to reduce the high costs of off-farm erosion damage? Here we are in difficult territory. We have the CF estimates of these costs by major types of damage, but studies of the cost distribution among regions and groups of people (an equity issue) and of how much the costs would be reduced by spending another dollar on control (an economic issue) are only beginning.

Clearly, much work must be done before we will have the kinds of data and analyses necessary for soundly based judgments about whether erosion costs are too high. Meanwhile, several hundred million dollars are spent each year for erosion control.

We will have to wait on more research to decide if the amount now spent on soil erosion control is the socially correct expenditure. But the research reported here already is sufficient to provide perspective on how those several hundred million dollars per year should be allocated.

New Policy Perspectives

Most fundamental is the research indicating that off-farm erosion costs are substantially higher than the soil productivity costs. Since this has profound implications for soil conservation policy, it calls for a major shift in thinking and in allocating conservation resources. Indeed, how to accomplish this shift will likely be a major preoccupation of soil conservation policy for some time to come.

The policy task will be complicated. Targeting efforts to deal with off-farm damage is more difficult than targeting efforts to protect soil productivity. The increased pressure to rely more on regulatory approaches to erosion control and less on voluntarism adds to the difficulties.

Problems of Targeting

A major problem is linking areas suffering off-farm damages with the areas supplying the damaging sediment. Sediment moves through a watershed in a halting, complex process.

Given the initial erosion, the rate and amount of soil moved are determined by topography and drainage density of the watershed, kind of soil, patterns of land use, climate and the volume and velocity of water available to transport sediment.

If none of these conditions changes then after a number of years a kind of equilibrium would be established in which the amount of erosion upstream equals the amount of sediment delivered downstream. Hydrologists and others who study these matters conclude, however, that such equilibrium is seldom, if ever, found. Consequently, for most watersheds the amount of sediment delivered each year at various points in the watershed may have left farmers' fields upstream many years earlier and bears little relationship to current erosion on those fields. Controlling that erosion, therefore, would probably not reduce downstream sediment damage in the short run.

Compensating channel erosion also complicates the policy problem because such erosion may render futile efforts to control erosion on the land. The issue is not clear, however, because reducing erosion on the land often reduces water run-off velocity, if not volume. When that happens, reducing erosion reduces the sediment-carrying capacity of water, and hence weakens the tendency for compensating channel erosion.

More research is needed on sediment-delivery processes to improve our ability to link places where damage occurs with sources of the damaging sediment. More research is needed also to determine whether the value of reduced damage at specific sites is more or less than the cost of achieving the reduction. Until sediment-delivery processes are better understood, perhaps we should concentrate more on reducing sediment where it enters valuable water bodies and less on reducing erosion on the land.

A shift in emphasis from reducing erosion to reducing sediment delivered at the downstream point where it does damage would require a major change in thinking about soil conservation policy. That's because the main policy thrust always has been, and still is, reduction of erosion on the land.

Voluntarism vs. Regulation

Soil conservation policy has relied on farmers to voluntarily adopt conservation measures. The principal instruments have been education, moral persuasion, technical assistance and cost-sharing measures.

Some portions of the conservation community are beginning to question this exclusive reliance on voluntarism. A 1984 American Farmland Trust report asserted that the evidence of highly concentrated erosion will weaken both practical and political objections to greater reliance on mandatory approaches. About a dozen states, Illinois and Iowa among them, have adopted erosion and sediment control legislation which includes mandatory provisions.

Strengthening the shift away from strict dependence on voluntarism would require substantially increasing public awareness that the main threat of erosion is off-farm damage, not loss of soil productivity.

A Brief Definition of Sheet and Rill Erosion

Sheet and rill erosion are caused by rainfall and runoff. Sheet erosion removes the soil in layers. If the water moves fast enough it tends to scour the land unevenly, cutting small channels in the surface. The soil moved in this way is rill erosion.

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Following Spring rains, rill erosion appears in Obion Co., Tennessee.

The principle that a state can legitimately hold polluters to account is well established. When farmers are publicly perceived as the major contributors to off-farm water pollution, political obstacles to regulatory approaches in soil conservation policy will be weakened.

The political cost of overcoming these obstacles will be high. It will be necessary to show clearly the high costs of off-farm erosion and that the voluntary approach is not effective in bringing costs within socially acceptable limits.

We must also increase our ability to link damaging sediment with erosion sites on the land. We cannot know whom to regulate if we do not know who is responsible for the damaging sediment.

Despite these many obstacles, greater reliance on regulation in soil conservation policy increasingly looks like an idea whose time is steadily approaching, if it is not already here.

When this is combined with the overwhelming evidence for targeting and for radically modifying the T value concept to incorporate economics, the conclusion seems inevitable: soil conservation policy as it has been known since its inception in the 1930's is on the verge of a fundamental transformation. The social interest in control of soil erosion will be better served as a result.

More Information

For a more complete discussion of soil conservation issues and the related costs, see *Soil Erosion and Soil Conservation Policy in the United States. A Report Prepared by an American Agricultural Economic Association Task Force.* It is available for $2 a copy from AAEA, Dept. of Economics, Iowa State University, Ames, IA 50011, phone 515/294-8700.