Diverging Interests in Soil Conservation and Water Quality: Society vs. the Farmer

by

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Introduction

That farmers impose uncompensated costs on other members of the society is not news. The list is familiar: water quality impaired by eroded soil, fertilizers and pesticides and, in irrigated areas, salts carried by irrigation return flow; air pollution from wind erosion; and, perhaps, diminished productivity because of erosion.

Simple awareness that these costs exist is not very interesting analytically nor is it very useful for policy. For both purposes we need specific information about the nature of the costs, their magnitude, and the location of the activities which cause them and where they are felt. In the absence of such information we are unable to understand the processes which generate and transmit the costs nor can we formulate sensible measures for reducing them. Indeed, since all control measures cost something, we cannot be sure that we should do anything at all. Conceivably the social costs of the most economical control measures exceed the uncompensated costs farmers impose on the rest of us.

In this paper I am not going to solve the problems of unsatisfactory information about the uncompensated costs. My purpose is to analyze the conditions under which the principal costs arise, briefly assess what we currently know about them, and discuss the implications of our knowledge, or lack of it, for policies to deal with the costs.

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I confine the discussion to costs of erosion by water. Wind erosion is not considered although the amount of soil moved by wind is high in the Plains states. The effects of this on water quality probably are negligible, however, and the effects on productivity of the land quite obscure. Wind erosion moves the soil around, but it is not clear that it causes a permanent net reduction in productivity. For reasons given elsewhere (Crosson and Brubaker 1981) I believe damages to water quality by fertilizers, pesticides and salinity are and will be secondary compared to the damages of erosion to water quality and to productivity.

Social Costs of Erosion

Eroded soil carried by run-off may shorten the economic life of reservoirs, cause increased flooding, reduce recreational values of water, and impose dredging costs and costs of cleaning up the water to make it usable for human and industrial consumption. Since the farmer pays little if any of these costs he has little incentive to abate them by controlling erosion. The situation is clearly one of an enduring difference between the public and private interest in the use of the land. The case for public intervention to eliminate the difference is indisputable in principle.

The case for intervention to reduce erosion-induced losses of productivity is not so clear. The reason is that, unlike off-farm damages, the farmer bears the cost of erosion-induced losses of productivity. Why should he give less weight to these costs than society? To make the case that he does it is necessary to show that the price of the land does not reflect its full present social value; or that farmers fail to adopt erosion control practices which would serve both the private and the public interest in the productivity of the land. The first condition states that the private interest in conserving the productivity of the land is less than the public interest. The second condition states that even though the private interest and the public interest are the same, farmers nonetheless do not adopt conservation practices on the indicated scale.

Why the market may undervalue the land. There are five main reasons: (1) a general lack of knowledge of the effects of erosion on future yields resulting in a systematic underestimate of the effects; (2) the market misjudges the strength of forces affecting the future demand for food and fiber and so underestimates future prices;[1] (3) the market overestimates the rate of emergence of economical land-saving technologies; (4) the social cost of investments in erosion control measures is less than the private costs; (5) the market gives less weight than society to maintenance of the productivity of the land as a hedge against future demand for food and fiber.

The first three sources of error arise because of ignorance among those in the society who make the market for agricultural land. To make the case for intervention it is necessary to show that those acting in society's interest are less ignorant than those who make the market about the effects of erosion on productivity, future prices of food and fiber, and the rate of emergence of economical land-saving technologies. I'm not persuaded that those acting for society are smarter than the market with respect to any of these three factors. Studies of the effects of erosion on yields under the great diversity of soil and climatic conditions under which American

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[1] The market may also misjudge the future trend of the interest rate, e.g. failing to reflect a long-term decline. Should this occur the present price of land will be too low. The interest rate is a kind of price. I take the instance given here as a case of market failure to properly reflect future prices and do not discuss it further.

farmers actually operate are relatively few (more on this below). Each farmer, however--at least the sizable percentage who are owner-operators--has long experience and detailed knowledge of his particular situation, and most farmers will be well informed also about their neighbors' experience. Farmers moreover have a direct economic interest in informing themselves about the yield effects of erosion. It would surprise me if under these circumstances non-farmers, no matter how technically competent, were more knowledgeable than farmers about the effects of erosion on yields.

The other two factors concern future events--prices of food and fiber and technological change--about which everyone is ignorant. The record does not demonstrate that those acting for society are more skillful than anyone else in forecasting these events.

If the rate of interest appropriate for public investments is less than that for private investments then the social cost of investment in erosion control will be less than the private cost, an argument for public intervention. There is no need to review here the large literature on differences between public and private rates of discount. It is enough to note that there is an argument, although a weak one in my judgment, for using a lower rate in calculating costs of and returns to public investments. The key element in the argument is that the taxing power of government means that government debt is not secured only by performance of public investment projects. Consequently the risk of default on government debt is less than on private debt, so governments can borrow more cheaply. The point is <u>not</u> that for a given project the risk of failed performance is less if it is publicly financed than if it is privately financed. The difference is in the ability to repay in the event of failure. This being the case, does the lower rate indicate that social costs are less than private costs? I am skeptical that it does.

The fifth reason why the market price of land may understate the social value of the resource is that society may want to give more weight than the market to maintenance of the productivity of the land as a hedge against future demands for food and fiber. The point here is not simply that the future is uncertain. Both those who make land markets and those acting for society's interest in the land know that future demand-supply conditions affecting the land are uncertain. Both may agree perfectly on the bounds within which these conditions will fall with, e.g., 95 percent probability. But the market will respond to the most probable set of conditions while those acting for society may feel obliged to respond to those reflecting a "worst case" outcome. With respect to future demands on the land, for example, society may give more weight to possible high demand outcomes than the market. Within the range of generally agreed rates of land-saving technological change, those acting for society may feel constrained to give more weight to low rates of change.

Among the various arguments for the failure of the price of agricultural land to measure its full social value this last strikes me as most persuasive. It does not assume that those acting for society's interest in the land know more than anyone else about future conditions affecting the value of the land. Rather the basis of the argument is that the responsibilities of those acting for society require them to give more weight than the market does to the probabilities of unfavorable outcomes with respect to the growth of demand for food and fiber or the emergence of economical land-saving technologies.

With this perspective they will assign a higher value than the market to the present productive capacity of the land, thus justifying efforts to limit the impact of erosion on yields beyond what the market would induce the farmer to undertake.

Note that this argument does not rest on the notion that society has a longer time horizon than the farmer in land management decisions. The difference between society's interest and the farmer's interest in soil conservation practices occurs because society assigns higher value to the annual net benefits of these practices, not because the period over which the benefits are discounted is different. In calculating the effect of the benefits on the price of land both society and the market discount them into perpetuity. If the market's perception of the value of the benefits comes into line with society's perception, the market price of land will rise. Whatever the farmer's time horizon he will have incentive to adopt the conservation measures, or to sell his land to some other farmer who will. Otherwise he foregoes a clear opportunity for economic gain.

Why farmers may not react. The statements just made about farmer behavior assume that farmers are economically rational in the usual sense; that if the effects of erosion and of the costs and benefits of erosion control are reflected in the value of their land, they will know it; that they bear the long-term costs of not controlling erosion as well as the costs and benefits of control; and that they are not constrained by lack of capital from adopting erosion control practices. If these conditions are not met farmers will not undertake erosion control practices even if the price of land reflects the full social value of the practices.

I am comfortable with the assumption of economic rationality. This of course does not mean that farmer behavior is shaped only by economic criteria. It does mean that in making farm management decisions farmers give heavy weight to economic criteria and that they will not knowingly forego net economic gain whenever the gain exceeds whatever non-economic costs may be incurred. The belief that farmers do not adopt erosion control measures because they are economically irrational is a bad guide to policy.

I also am comfortable with the assumption that if the market price of the land captures the effects of erosion and of the benefits and costs of erosion control farmers will know it. Land is easily the most important single asset of most farmers. They are certain to be sensitive to changes in its value and to seek information about the factors affecting value, particularly those which the farmer himself can influence if not control. If farmers fail to respond to erosion and erosion control measures, the reason is far more likely to be because these are not reflected in the price of the land rather than because of farmer ignorance of their effect on price.

Tenants are not likely to bear the long-term costs of erosion nor to capture all the benefits should they invest in erosion control. To the extent that tenants rather than owners make land management decisions, investment in erosion control may be less than socially optimal, and less than optimal from the owner's standpoint as well. Why would owners accept such an outcome? Most absentee owners have other, perhaps non-farm, interests which occupy their time and attention. Indeed that is why they are "absentee." Requiring that tenants adopt erosion control practices as a condition of tenancy, or investing in these practices directly, may be more costly of the absentee owner's time and other resources than he thinks justified.

Whether tenancy in fact results in under-investment in erosion control practices is an empirical question which, so far as I know, has been little researched. Lee (1980) found no statistically significant relationship between erosion per acre and various kinds of tenure, including tenancy. But other variables may have obscured the relationships. For example, tenants may farm less erosive land. Perhaps we will hear more in this symposium about the effect of tenancy on incentives to invest in erosion control.

Farmers may under-invest in erosion control measures because of capital constraints. In an economically perfect world capital will be available for all investment projects which earn at least the socially optimal rate of return. The world is not perfect, however, economically or otherwise, and some farmers may be denied the capital necessary for privately and socially optimal investment in erosion control. Where this occurs a case can be made for public intervention to remove the capital constraint.

Summary. Farmers will not be sensitive to off-farm damages of erosion. Where these damages exist there is a clear case for public intervention to reduce the damages. Devising the most economical means of intervention and allocating their costs are important issues, but they are separate from that addressed here.

The price of agricultural land may undervalue the net social benefits of erosion control to reduce productivity losses. Where this occurs private investment in erosion control will be less than the socially optimal amount. The strongest argument for this situation is that society gives more weight than the market to the probabilities of relatively high future demand for food and fiber and relatively slow development of economical land-saving technologies. With this perspective society will give higher value than the market to measures which protect the productivity of the land.

Put differently, the argument is that society feels a stronger responsibility for stewardship in management of agricultural land than the market. The argument does not rest on the dubious assumptions that those acting for society's interests have better knowledge than the market of the effects of erosion on yields or are better able to predict future trends in prices of food and fiber or in technology. Nor does the argument assume that society has or ought to have a longer time horizon than farmers in judging the present value of erosion control practices. In calculating either the social or the private value of the land future returns are discounted in perpetuity. Society may discount returns from public investment in erosion control practices at a lower rate than the farmer would if he made the investments because governments can borrow at lower rates than the farmer. The reason, however, is less risk of default on government debt. There is no reason to expect the risk of failed performance to be less with publicly funded measures than with privately funded ones.

Even when it would be in their perceived economic interest, farmers nonetheless may not adopt erosion control practices on the socially optimal scale because of capital constraints. Where this occurs there is a case for public intervention to remove the constraint. Tenancy also may result in less than socially optimal erosion control. However, arguments that control is socially inadequate because farmers are ignorant of erosion's effects on productivity or because they are economically irrational provide a poor basis for public intervention.

What Do We Know?

Off-farm costs of erosion. There are no reliable estimates of the costs of off-farm damages of erosion. Pimentel et al. (1976) cite an estimate of $500 million annually as the cost of dredging rivers and harbors ($250 million), the loss of reservoir capacity ($50 million) and other sediment related damages ($200 million). These estimates are for the 1960s or earlier. In current dollars they probably would be $1 billion to $1.5 billion. The figures do not include the loss of recreational values caused by dirty water or the costs of cleaning the water to make it usable for human or industrial consumption.

According to the National Resources Inventory (Soil Conservation Service, 1980) sheet and rill erosion from cropland, pasture, forest and range was about 4 billion tons in 1977 (about one-half from cropland). Streambank erosion added about 550 million tons and gullying, road building and construction an equal amount. Sheet and rill erosion from agricultural land thus is about four-fifths of total erosion by water. However, erosion from agricultural land accounts for only a little over half of the sediment delivered to water bodies (RCA, 1980, p. 3-82) because sediment delivery ratios for this land are lower than for other sources of sediment. Streambank erosion, for example, accounts for about 25 percent of total sediment delivered (RCA, 1980, p. 3-82) but for only about 10 percent of total erosion.

Whatever the cost of sediment damages, erosion from agricultural land presumably contributes about one-half. If, as indicated above, annual costs of dredging rivers and harbors, lost reservoir capacity, and other such costs currently are $1 billion-$1.5 billion, the contribution of agricultural land to this is roughly $500 million-$750 million.

These estimates are for the nation. For both analytical and policy purposes we need much additional information indicating specifically (1) where the costs are incurred, e.g., where dredging is done and what the annual costs are; (2) where the erosion from agricultural land originates; and (3) coefficents (sediment delivery ratios) linking sources of erosion with places where costs are incurred. The first two sorts of information are available. The Corps of Engineers could provide much of the first sort, and the National Resources Inventory (NRI) contains data showing erosion, calculated with the Universal Soil Loss Equation, from about 200,000 precisely located points all around the country.

Data for sediment delivery ratios, however, are deficient except for estimating delivery within small watersheds. For areas as large as the 105 Producing Areas (PAs) used in the Iowa State University model of U.S. agriculture sediment delivery ratios are unreliable.[2]

Erosion-induced productivity loss. There are three ways to assess what we know about the effects of erosion on productivity. One is to examine the literature reporting studies done around the country on the effects of erosion on crop yields. A second, which builds on the first, is to estimate the effect of erosion in reducing the present value of land rent. And a

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[2]Leonard Gianessi, Resources for the Future, verbal communication. Gianessi, with Henry Peskin, has built a water quality model which allocates sediment and other pollutants delivered to surface water bodies all around the country.

third is to seek evidence that the effects of erosion are reflected in prices of agricultural land.

There recently have been a number of surveys of the literature dealing with effects of erosion on crop yields (Shrader, no date; Shrader and Langdale, to be published; Science and Education Administration, 1981). These surveys suggest to me that while we are by no means ignorant of the quantitative effects of erosion on yields the information is not available in a form useful for policy purposes. There are several reasons. One is that much of the data show the difference in yields if there are, say, 6 to 8 inches of topsoil and if all the topsoil is removed. Since the social interest might require intervention before all the topsoil is lost, what we need is the function relating increments of topsoil loss to increments of yield loss. The "before and after" studies give us only the two limiting points on the needed function.

The usefulness of the studies is limited also because they generally do not allow for effects on yields other than erosion. Shrader (no date) argues that by reducing soil organic matter and damaging soil structure cropping may adversely affect yields quite independently of erosion. One might respond, alright, but one problem at a time, please. However, if the effects of less soil organic matter and weakened soil structure are present but unrecognized on the same land studied for erosion effects, estimates of the latter will be biased. Shrader sees this as an important limitation of many existing studies of yield-soil loss relationships.

A related and more important limitation is that the studies do not adequately account for the effects of technological change on yields. Typically the studies hold technology constant to isolate the yield effects of erosion. This is respectable scientific methodology but it limits the usefulness of the results for policy purposes since technology can substitute for land in maintaining or increasing production. From a policy standpoint technology is an alternative to erosion control. It would be useful, therefore, to have studies showing the separate effects over time of erosion and technology on yields.

Our knowledge of erosion-yield relationships is inadequate also because relative to the great diversity of soil, climatic and cropping conditions under which American farmers operate the number of studies is small. Shrader (no date) asserts that "A representative sampling of the studies that deal directly with the effect of erosion on crop production under modern conditions ...(shows that)...only a few soils under a very limited number of climate and cultural conditions have been studied." (p. 34). Shrader believes that the best estimates of the relationship between yields and soil depth are those in the various county soil surveys published by the Soil Conservation Service, of which there were about 1,300 in early 1980. These estimates are given for uneroded, moderately eroded and severely eroded soils on slightly-to-steeply sloping land. While useful, these estimates are subject to all the limitations previously discussed.

The most ambitious attempt to use existing data on erosion-yield relationships to explore conservation policy issues was done in connection with the USDA's work on the Resource Conservation Appraisal (RCA, 1980). These data were drawn together in a yield-soil loss simulator which was linked with Iowa State University's model of U.S. agriculture. It then was possible to incorporate yield effects of erosion on farm income and therefore on cropping patterns, tillage practices and regional location of production. In addition