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ECONOMICS OF SOIL CONSERVATION FROM
THE FARMER"S PERSPECTIVE

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Examination of the private economics of soil conservation is particularly germane at this time of policy reassessment under the provisions of the Soil and Water Resources Conservation Act of 1977. An understanding of farmers' perceptions of their economic interests is essential in the development of policy instruments that will achieve social objectives.

We classify the evidence on the farmer's perspective into (a) what farmers say about soil conservation as indicated in surveys of opinion, (b) the record of what they are doing, and (c) the results of models which purport to show what farmers are, should be, or are going to do. A final section of the paper deals with modeling needs.

What Farmers Are Saying

Four recent surveys of farmer opinions provide a limited sample of farmers' perceptions relative to the soil erosion problem and the appropriate means to deal with it. Seitz et al., Pollard, et al., and Fisher, et al., conducted surveys in Illinois, Wisconsin, Nebraska, and the United States, respectively. While each of these surveys has some shortcomings, they provide a basis for understanding farmers' beliefs on soil erosion questions. They indicate, directly or indirectly, that farmers perceive the existence of a soil erosion problem and many believe they should improve soil conservation on their farms. Young farmers, new owners, and conservation-practicing farmers were the most likely to recognize the need for additional practices. Changing tillage practices and crop rotations were more popular with farmers than contouring and terracing. A joint effort between government and farmers is the approach most favored to address the soil conservation problem. Policies that allow flexibility in the means of achieving conservation are preferred by farmers.

Fisher found that 62% of farmers favored taking away farmers' benefits provided by the Department of Agriculture if farmers do not properly protect the soil and water. He adds, (p. 87) "It is clear that it is not mandatory programs per se that farmers reject. They reject mandatory programs that do not provide some compensation or cost-sharing."

In summary, these opinion surveys indicate a recognition of the gap between conservation levels provided by private economic incentives and social objectives. There is a continuing need to explore how various policy instruments modify the levels of private economic incentives.

What Farmers Are Doing

Although not a perfect operational conservation goal, especially when both productivity and off-site damage are considered, we accept the soil loss tolerance (T-value) as a standard of performance to judge what farmers are doing. The average T-value on cropland, pasture, and forest land is about 4 tons per acre per year.

The 1977 Natural Resources Inventory indicated that approximately 34% of the nonfederal cropland experienced sheet, rill, and wind erosion at rates exceeding the tolerance level (U.S. Dept. of Agr., Summary, p. 8). The Comptroller General's report indicated that both cooperators and noncooperators have soil losses above T-values (p. 16). It is difficult to estimate national historical trends in these estimates. However, Timmons (p. 5) has estimated that erosion losses have increased in Western Iowa since the early 1970s. There is reason to believe that similar patterns characterize much of the Corn Belt and perhaps the rest of the nation.

Another form of information on farmer actions, and one which may be an important factor in changing farmer opinions is anecdotal evidence from the popular farm press. We frequently find stories of individual farmers adopting conservation practices and they have indicated, within their accounting framework, that the conservation systems have increased returns (e.g., Cole, Gogerty, Kentucky Farmer, and Vogel). While their accounting systems may be suspect, they indicate the economic potential that may exist by increasing the level of soil conservation.

Modeling Farmer Decisions

Whether the results of modeling efforts can be introduced as evidence of the farmers' perspective on the economics of soil conservation depends, of course, on the degree of correspondence of the model with reality. In the limited sampling of results which follows, we find that the private economic incentives for soil conservation are weak.

Fifteen years ago Held and Clawson appraised the strength of the economic incentive for soil conservation as follows:

> In the absence of public subsidy, much proposed soil conservation has a low profit potential, some is even negative, and only comparatively little promises to be highly profitable.... If this general conclusion is true, then it goes far toward explaining the modest progress of past soil conservation, both in many regions and nationally, and it has great significance for the future. (p. 265)

Much of the literature Held and Clawson reviewed consisted of studies of actual farms (e.g., North Central Farm Management Research Committee). Since that time there has been a shift from the use of forage crops to the use of a wider variety of practices, with emphasis on conservation practices which do not require rotation changes. Erosion control by use of crop rotations with forage implies the adoption of livestock to make soil conservation profitable. Thus the study of actual farms, whether by budgeting or regression methods, encountered considerable difficulties in isolating the consequences of the specific practices reducing soil erosion from such factors as the variability among farmers in the efficiency of livestock production. Further, these studies could not explicitly incorporate such critical relationships as those among crop yield, depth of topsoil, and optimal level of fertilization. These, and other features such as discounting future costs and returns, awaited the use of the more formal planning models discussed below.

One of the reasons for the shift from the statistical study of actual farms to some form of optimization modeling was the difficulty in interpreting results of analyses of actual farms due to the confounding of the effects of soil conservation with other practices. One of the simplest modeling efforts is to use the capital budgeting model with the Universal Soil Loss Equation and to examine the profitability effects of the discount rate and the planning horizon (Swanson and Harshbarger). A large number of studies using linear programming methods, often at the watershed level, have contributed to our understanding of the problem as one of profit maximization constrained by soil loss tolerance levels (for a recent example, see White and Partenheimer). In general, these studies support the weak private economic incentive hypothesis.

Control theory has been used to a limited extent. Burt has illustrated the use of control theory in analyzing the economics of soil conservation in the Palouse area of the Northwest. His analysis suggests that, when compared to rotations with lower percentages of wheat, intensive wheat production with good cultural and fertilization practices is economically justified. In another control theory application, Frohberg and Swanson solved for the optimal levels of soil erosion considering off-site damage, various discount rates and demand scenarios. They found that, from a societal view, the soil tolerance levels in the watershed studied provided reasonably good guides for determining appropriate soil conservation levels.

The study by Young et al. is an example of the use of a simulation model to analyze the long-run incentives for adoption of soil-conserving tillage systems in the Palouse. They conclude (p. 55) that if soil conservation researchers develop farming systems that save soil but which decrease yields and/or increase costs, while at the same time agricultural scientists as a whole continue making advances that increase yields in spite of topsoil depletion, economic incentives will continue for many years to favor the use of more erosive systems.

Another simulation study predicted adoption rates for minimum tillage to increase from its 1974 level of about 10% to slightly more than 80% by the year 2010 (U.S. Senate). These rates were based, in part on the patterns of adoption of other technologies and are perhaps higher than they might have been had the economic behavior been modeled in the same level of detail as in the study by Young.

Modeling Needs

If we can model the farmer's soil conservation decision process more completely we can better understand the process and communicate more effectively with decision makers. We could begin with simple farm LP models with alternative crop and practice combination budgets. To these models one could add variables and constraints or use goal programming methods until we have identified more of the relevant features (Willis and Perlack). While such an oversimplified annual profit maximization model, with a few constraints, may miss a great deal, it may be effective in encouraging the choice of profitable soil conservation practices. But such simple models are not adequate to represent the more complex choice process, so let us explore some of the additional factors of concern to the farm operator.

Long-term time considerations. The topic of the farmer's perspective is on today's agenda in part because of the implications of soil loss on productivity over time, so perhaps we should start with the need to stretch the modeling period to cover the farmer's planning horizon (Frohberg, Guntermann, et al., and Nelson and Seitz). To do so, we need to know the impact of practices on soil losses and, in turn, on yields and incomes.

Within-season considerations. The choice of conservation practices affects the timing of farm operations. For example, fall plowing reduces the number of field operations in the spring when time is of the essence. Contours and terraces are inconvenient with today's large machinery. Some conservation practices reduce the number of trips required for seedbed preparation. Recommended pesticide application methods requiring incorporation often result in more tillage operations than desirable for soil conservation.

Investment decisions. The switch to a new form of tillage generally requires the purchase of new equipment. In some cases, two sets of planting and tillage equipment must be maintained. Additional financial resources may be required to purchase this equipment. Other conservation alternatives require a considerable investment (some terrace systems can approach $1000 per acre). Recognizing the impact of the uncertain nature of farm income on this decision process would further enhance the reality of the modeling effort.

Resource control arrangements. The modeling effort also needs to capture the important patterns of the acquisition and control of resources. With respect to land, we not only have the more common owner-operator, and the owner-renter situations, but with the advent of the professional manager explicit recognition needs to be given to the owner-manager-renter. Further, there are part-owners who rent land from various landlords some of whom hire professional managers. Such a farm operator is likely to need to maintain several types of tillage equipment in order to satisfy preferences of all involved and match the conditions found on the several farms. In general, the optimal level of soil conservation is likely to vary among parties in the land-control arrangements and a reconciliation of these diverse objectives is important.

Influence of public policy. Another element influencing the adoption of conservation practice is the public policy environment in which the firm operates (Seitz, et al, Nelson and Seitz). This environment includes the current federal and state programs and recognition of the uncertainty generated by the continual development of new programs. Our understanding of the general stance currently being taken by federal and state officials is that voluntary programs will be expanded and operated for the next five years or so. If this approach proves to be inadequate, movement will be toward a regulatory approach, which will provide an interesting challenge for the bureaucrats, and for modelers.

<u>Environmental interactions</u>. Soil erosion is not the farmers' only environmental concern. They are also faced with recommendations or regulations on the appropriate use of pesticides. These choices are not independent of the soil erosion control practices chosen. For example, the shift from the conventional plowing to no-till operation involves the increased use of herbicides and perhaps insecticides, fungicides and rodenticides and changes in application techniques.

<u>Stochastic considerations</u>. A number of the physical phenomena involved are not deterministic. The weather pattern in a given year may impact the yields of each tillage practice differently. For example, the weather will influence the movement of plant nutrients through the soil, the effectiveness of herbicides and insecticides, as well as planting and harvesting dates. Some systems are well adapted to dry years, others to wet years, etc. While the previous elements of our modeling enterprise may be handled by artful adaptations of the linear programming process, here we need to shift other types of models including quadratic programming with risk considerations. This may be a particularly fruitful area in that yields are more variable with some conservation tillage practices.

As economists we recognize, but only occasionally model, the stochastic market environment in which the firm operates. We need to know the farmers' reaction to changes in prices of inputs and outputs and whether soil conservation choices will impact market prices (Seitz, et al.).

<u>Beyond economics</u>. Thus far, we have concentrated on translating the

various factors relevant to the soil erosion control decision into economic terms. It is important to recognize that this class of decision is not made solely on the basis of economics (Seitz, et al., forthcoming). There is currently discussion about the need for a conservation ethic. The operator may feel peer pressure, pressure from owners, or may have a strong personal preference for certain practices over others. Many farmers have a preference for a cleanly tilled field and straight rows. To deliberately shift to methods resulting in a trashy field and curved rows may be difficult.

In essence we are painting a picture of a farm decision process that is much more complex than represented by the models we find in the literature. As we construct more appropriate models of the overall farm planning process, we may be able to improve our explanation of soil conservation decisions made by the farm operator. We may also identify changes needed in these decisions. We still have a long way to go to develop the types of models needed to characterize the full range of considerations that impact on farmers' decisions regarding soil conservation and to enable us to perform our educational function more effectively.

FOOTNOTES

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