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CONSERVATION AND DEVELOPMENT OF NATURAL RESOURCES

by

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Soil conservation can be thought of loosely as a redistribution of resource use into the future relative to the present and is the opposite of depletion. Soil conservation is, in effect, a problem in capital theory whose operational implementation is the management of soil resource over time. Since soil conservation is inherently dynamic, a number of thorny issues arise in the intertemporal specification of the problem. Soil conservation is most certainly a multidimensional problem which encompasses far more than just loss tolerance levels. The trade-offs faced are similar to most capital theory problems but in the case of soil conservation are compounded by the lack of knowledge, measurement problems, and important distinctions between quantity and quality dimensions.

In the above setting, a number of perspectives are possible. Seitz and Swanson (hereafter referred as S-S) provide us with two perspectives. They begin their paper with a public policy perspective arguing that an understanding of farmers' behavior is essential in the development of policy instruments that will achieve social objectives. However, they end their paper with an educational function perspective in which we are charged the responsibility of developing optimal private strategies that might be pursued by farmers who fail to have adequate knowledge or know their own best interest. In these comments, we focus on the first perspective since it subsumes the second insofar as farmer behavior is crucial to properly gauge the effectiveness of alternative policies.

This perspective requires some clarity of thought in terms of the nature, extent, and basis for market failure. Market failure here will be interpreted broadly in terms of both conventional exchange markets, contract markets, and political markets. In some quarters, the perception is that existing institutional and incentive structures result in suboptimal management of soil resources. A view seems to exist that divergences between social and private net benefits are caused by tenure, taxes, credit, and uncertainty features of the agricultural sector. It is a simple matter to construct a framework, for example, which shows that a credit rationing will lead to underinvestment in soil conservation and, as a result, overexploitation of the soil. Others hold that the societal planning horizon is far longer than the myopic planning horizons of individual farms. For example, tenancy arrangements may change structure of the owner-operator optimization problem in several fashions—by altering the planning horizon, the degree of risk aversion, or even the structure of the objective function. Similar problems may arise in the case of farm managers. Such agents may fail to maximize rents over time.

The distinction between social and private soil conservation may simply result from nothing more than the indeterminancy of the appropriate discount rate. Farmers' time preferences and interest rates may not coincide as may be the case as well between interest rates and the true social rate of time preference. Recent advances in the theory of justice and intergenerational choice problems suggest that we can expect the private parameters to fall within a subset of the social ones; and thus, at best, private optimization programs will not generate social optima.

The private and social optimization problems may also diverge due to externalities. Most certainly, there is little, if any, incentive for runoff and sedimentation to be fully taken into account in private calculations. In this context to be sure the private costs of soil exploitation are much less than the true social cost. The distinction between public and private risk preferences also assumes some importance in this context. The pervasiveness of uncertainty, with respect to future demand and future available technology, also makes the social optimum indeed difficult to determine. Such uncertainty may, in effect, lead risk-averse farmers to overexploit the soil resource. The "cake eating" literature on the other hand suggests that additional caution and greater conservation would be in the social interest.

An important issue that is often neglected in the context of soil conservation relates to the joint product goods and bads associated with a number of important inputs, e.g., water, chemical pesticides, and certain types of machinery (Rausser and Lapan). Here the soil quality assumes utmost importance. Unfortunately, soil quality in not easily monitored. Improvements in cultivation practices over time, for example, may mean that yields increase even if soil quality falls; hence, yields are not an unequivocal signal of the state of soil quality. Such effects may mean that soil quality is not incorporated in land values in an easily discernible manner; and, thus, information related to soil quality is not reflected by land markets. As long as this is the case, the land market may assume some of the characteristics of Akerlof's "market for lemons"; poor quality land will come to dominate the market as the "bad land drives out the good."

The market, in effect, creates incentives for the overexploitation of the soil. Other determinants of land value may compound this difficulty by driving up land prices even as soil quality falls. These determinants include, inter alia, the holding of land as a hedge against inflation, and governmental farm price supports. Both of these influences tend to inflate land values as well as distort current price signals, creating incentives for nonoptimal intertemporal use rates of the soil.

Failures resulting from the "political market" and other forms of governmental intervention (Rausser et al.) are often not recognized. To be sure prices reflecting the transfer of wealth via governmental intervention may enhance soil erosion problems. A number of agricultural policies since World War II have not made any differentiation among soils in terms of their vulnerability to erosion.[1] The political market failures resulting from grain price-support programs must be counteracted by special subsidy measures in high-erosion risk areas. It simply does not make sense to have farmers on highly vulnerable soils planting a large portion of their farms to grain due to the price-support program and, in addition, be encouraged to pursue erosive practices in order to augment their yield base to obtain a proportionally larger subsidy.

Research Agenda

Given the above issues, the research agenda to adequately address the problem of soil conservation is enormous. First, the social optimum must be determined. Given the intertemporal nature of the problem and issues of efficiency as well as intergenerational equity, this will require the specification of a multiattribute social utility function as well as a set of dynamic constraints characterizing the relevant environment. Second, a similar set of concerns must be addressed for the private sector. Given important differences between the two solutions, alternative institutions, as well as policy instruments, must be investigated as potential means of closing whatever gap exists between private and social intertemporal use rates of soil. The extreme heterogeneity and complexity of soil resources, in an operational setting, makes a general equilibrium formulation of intertemporal allocation unwieldy. Consequently, our research agenda should be restricted to "enlighten" partial analyses. Such simplifications, of course, have important implications in deriving the social worth of alternative allocations of soil resources but create fewer difficulties in the analysis of private decisions given the competitive structure of agricultural production.

A number of crucial issues arise in the specification of the dynamic constraints referred to above. At the crux of the these issues are the relationships among important variables of the soil resource which trace systematically through time the important factors affecting productivity. As S-S note, many of these relationships have not been empirically estimated. Nevertheless, an important first step in any empirical measurement is the conceptualization of the phenomenon to be measured. Here, we must recognize that soil is not a single resource but a set of individual interrelated components which have both stock and flow dimensions. The soil mantle cannot be considered a partially renewable resource within the practical planning horizon of mankind; and, thus, it must be treated as a stock resource. Other productive aspects of soil are at least partially renewable, such as organic matter and the levels of various nutrients. To be sure renewability is a relative concept and highly dependent upon the state of knowledge. Advancing technology can easily render obsolete any standards of renewability or for that matter existing soil maps.[2]

The specification of the dynamic constraints must first address the question of appropriate state variables. The potential number of state variables is, indeed, quite large; there are approximately eight basic sources of such state variables: the soil mantle, gullying, organic matter, soil structure, soil chemistry, fertility, soil water in arid and semiarid climates, and soil air where land is subject to frequent flooding. How should these state variables be decomposed spatially? Should they be decomposed in accordance with the type of operator, owner-operator, owner-renter, professional manager, and other agents who are actively involved in the agrarian structure? What role should technology play in the specification of the state variables? Must both learning by doing and the theory of induced innovations be included in the specification to recognize the important role that new technology has played in altering the potential effects of top soil depletion (Young et al.)? Finally, the simultaneous interactions among those state variables that refer specifically to the soil characteristics must be specified and measured.

The specification of the decision variables depends upon whether the public or private perspective is assumed. For the former, the institutions along with the mixed policy instruments that might be pursued must be delineated. For the latter, the specification of the decision variables will be limited only by technical knowledge and our imagination. Some of the obvious decision variables include the depth of organic soil removed during a specified period (determined by cropping and management practices); the amounts of chemical and organic fertilizers applied to the land; and a number of "lumpy" infrequently made decisions. In the latter category, we would include the construction of terraces and underground drainage tiles. These types of decisions are relatively permanent and in many respects the decisions are economically irreversible.

In the measurement of the above specifications, we must recognize, as pointed out by S-S that the necessary physical science information to properly address the intertemporal allocation problem is not available. Nevertheless, what information is available can be employed under uncertainty, utilizing the advancements that have been in stochastic models over the last decade. Contrary to the implications we were left with from S-S, models have been constructed which recognize stochastic environments and "noisy measurements" (Rausser and Hochman). These formulations not only recognize that state variables cannot be accurately measured but, in addition, allow us to formally account for (1) monitoring and inaccurate measurements of soil quality and (2) evaluating the potential economic benefit of sequential experiments with the purpose of generating more physical science information.[3]

S-S Survey

In the above setting, what does the survey by S-S offer us? The results that they summarize certainly make a case for governmental intervention by substantiating the weakness of private incentives for soil conservation. By themselves, however, these results do not necessarily imply a problem; if farmers are operating at or near an optimum, incentives for change ought to be weak. Only by testing properly formulated hypotheses can we hope to accumulate evidence of market failure and inefficient behavior of private agents. The principal message of the S-S survey is that we need far more conceptual and empirical work to formulate more accurate models characterizing social and private optimal behavior.

The directions for future modeling efforts outlined by S-S can be seriously challenged. To be sure, farm LP models can only be of limited value in understanding soil conservation. Management of soil resource is inherently dynamic; and, thus, strictly static constructs modified by various bells and whistles provide little insight into the aspects of soil resource utilization. Moreover, the "have model will travel" and technique perspective implied by such recommendations as goal and quadratic programming methods strikes us as inappropriate. Similarly, the addition of soil loss constraints to static models most likely detracts rather than enhances our understanding of the basic trade-offs that must be evaluated. Arbitrary levels of soil loss have no real economic meaning and most certainly such measures should be generated endogenously in any sufficiently accurate modeling approximation to the soil conservation problem.

While some areas of investigation suggested by S-S appear promising, others should be simply dismissed. For example, the argument that farm owners over 65 years old are not particularly concerned about the long-run impacts of their land utilization practices runs contrary to available empirical evidence and our intuition. Owners certainly place some value on their heirs; and, since the quality of the land transferred from one generation into another constitutes a portion of inherited wealth, sound judgment suggests that this argument should not weigh heavily in our specifications of the relevant state variables. It seems far more likely that land values which fail to reflect soil quality accurately contribute more as a source of this problem than the age of landowners. Similarly, it seems unlikely that the appearance of fields would outweigh economic considerations unless, of course, the benefits of curved rows and the like do not exceed the associated cost by a sufficient amount.

The objective of modeling efforts, of course, is not simply to capture the "true representation" of social and private decision patterns and the behavioral rules they imply. There is a widespread conviction that our soil resources are inadequately conserved under existing institutional, political, and economic structures. The basic reason for investigating the question of soil conservation from an economic standpoint is to assist in formulating measures of the form and shape of governmental intervention which will partially correct existing institutional and market failures and thus result in a "policy improvement." It is in this setting that it becomes necessary to understand both farmers' behavior and the relevant technical constraint structure within which all agents must operate.

Footnotes

[1]Some policies have encouraged summer fallow and even summer fallow in two consecutive years which is widely known to increase wind and water erosion as well as directly accelerate organic matter losses.

[2]To appreciate this fact, Burt has called our attention to the early 1940s when Ibach focused on top soil in the cornbelt as the critical resource determining value of agricultural land and used pounds of nitrogen per acre in the top soil as a measure for estimating land values. With cheap sources of inorganic nitrogen made available by modern technology in its widespread use, this attention to top soil as a source of nitrogen is obsolete. In a sense, top soil was transformed by technology from a primarily stock resource into a renewable resource for purposes of practical decisions.

[3]The problem addressed by these formulations is to properly characterize the unknown parameter probability distributions after the research or additional data are available but before such efforts are undertaken. These formulations recognize that attempts to obtain more reliable estimates of various interactions, delayed effects, and causal mechanisms themselves present a resource allocation problem. One way of formally dealing with problem is preposterior analysis for the two-period planning horizon or adaptive control for the multiperiod horizon with the result of providing guidelines for the design for experiments to capture the information content of additional sample data.

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