PROCESSES OF SOIL DEGRADATION AND DETERIORATION: AN ECONOMICS POINT OF VIEW

by

G.C. Van Kooten

Assistant Professor

Dept. of Agricultural Economics

University of Saskatchewan

Saskatoon

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Introduction

Unlike the physical sciences, agricultural economics deals with human behavior and, consequently, might be considered by some to be less scientific than the other disciplines in agriculture. However, economics is important because agricultural activities are ultimately concerned with human welfare, and economics alone attempts to measure changes in individual and societal welfares. For example, research aimed at finding varieties of wheat with higher yields (e.g., HY320) cannot be justified unless the net aggregated (social) benefits of the higher yields exceed the research costs. How are these benefits to be measured? Unfortunately, welfare measurement, or determination of the social benefits and costs, is not only difficult from a conceptual and empirical standpoint, but it is also an ethically-loaded proposition. Yet, without a measure of social welfare, it is not possible to determine if policies such as research to develop a higher yielding variety of wheat (or use of public funds to retain a particular rail branch line) are worthwhile undertaking.

It is the contention in this paper that economics deals with issues from a social, not an individual, point of view. Therefore, economists are primarily concerned with the impacts of agricultural activities on society, not just farmers as individuals. This does not imply that individuals are unimportant;

rather, it implies that it is necessary to take into account interactions among individuals. In particular, it is necessary to recognize how actions by individuals in one sector of the economy (e.g., agriculture) affect those in other sectors, and vice versa.[1] Finally, the social costs and benefits may need to be suitably modified to take into account equity considerations.

The economics' view of processes of soil degradation and deterioration is presented in this paper. In the next section, soil conservation and soil depletion (degradation and deterioration) are defined in an economic sense. This is followed by a discussion of the individual attitude toward soil conservation and depletion. Then it is argued that there is a divergence between the socially and privately optimal rates of soil conservation. This divergence is considered to be a rationale for public intervention in private decision-making. Finally, intervention mechanisms are briefly considered.

Definitions of Soil Conservation and Depletion

Gafney (1965) has argued that any meaningful view of land must encompass both a Ricardian and a capital component. The Ricardian component is the perdurable, permanent and indestructible

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[1]Perhaps this explains why, in the past few years, there has been a diffusion of agricultural policy making, primarily at the expense of Agriculture Canada (see Brinkman 1983). For example, agricultural freight rates and the branch line rehabilitation program are administered by Transport Canada, the Wheat Board has its own ministry, and the Western Grain Stabilization Act falls under Industry, Trade and Commerce.

component of the land (soil) matrix which includes such factors as location, climate, drainage, macro-relief and inexhaustible supplies of particular nutrients. The capital component of the soil matrix consists of the "conservable flow", the "revolving fund" and the "expendable surplus". The conservable flow element is that which takes some pain (i.e., expense or investment) to maintain in its original state. However, it is worth these expenditures because they are less than the present value of the future income derived from this particular element of the soil matrix. The revolving fund, on the other hand, is that component of the soil matrix which is not economical to conserve but is economical to replace or renew with materials imported from offsite. Finally, when land is first broken, there may be so much nitrogen in the soil that the farmer views it as a free good. This is an example of an expendable surplus and there is no reason for the farmer to ever conserve this component of the soil matrix. It is included as a capital component only because it is a finite stock. Once depleted, or nearly depleted, it can be treated the same as either the conservable flow or revolving fund component of the soil matrix.

The Ricardian component of land is neither conservable nor depletable and, therefore, it is not this factor to which agricultural scientists refer when they speak of soil depletion or conservation. Rather, it is the capital component, namely, the conservable flow and revolving fund components. Unfortunately, agricultural producers frequently are unable to adequately distinguish between those elements which are properly a part of conservable flow and those which constitute the revolving fund. The reason for this is twofold. First, there may be a lack of knowledge regarding soil physiology and the effects of chemical additives on conservation and soil degradation. Second, the problem may be one of economic incentives, particularly problems due to vagaries in economic parameters such as the interest rate and output prices.

Three definitions of conservation can now be identified. (1) Gaffney defines conservation as the "effort effectively devoted to reduce the loss of virgin flow resources that may be, but need not be, deteriorated by use" (p. 546). For example, contour plowing on steep slopes may require more effort (e.g., operator time), but it does reduce water erosion of the soil.

(2) Ciriacy-Watrup (1968) defines conservation as a redistribution of use rates into the future, while depletion is a redistribution of use rates to the present. Notice that this definition requires some benchmark distribution of use rates, and that benchmark may not be an easy thing to obtain a consensus about. With this definition, "conserving agricultural land occurs whenever the soil is depleted more slowly or converted into other uses less rapidly" (Hedlin and Kraft 1985, p. 11) than currently. It is implicitly assumed, therefore, that soil degradation and

deterioration are inevitable, unlike in the first definition.[2]

(3) In more common parlance, soil conservation is seen as any action which prevents a deterioration of the soil beyond some critical point where irreversibilities set in.[3] That is, conservation is the avoiding of an irreversible loss, irreversible, "not because the soil cannot be rebuilt, but because it can never be rebuilt so cheaply as the cost of conserving the virgin soil" (Gaffney, p. 546). Let us illustrate what we mean by irreversibilities and conservation with an example. As the settlers moved into the Western United States, into the territory now known as eastern Washington, eastern Oregon, Idaho, Colorado, Utah and Nevada, they grazed their cattle on the long grasses which covered that semi-arid land. The land was treated as a common property resource and was quickly over-grazed; irreversibilities set in and sagebrush replaced the once abundant grasses. Although studies have indicated that it is possible to return to the earlier plant ecology, the costs of doing so far exceed the benefits (Stevens and Godfrey 1972). Had conservation been practiced to begin with, the discounted value of the stream of profits would have greatly exceeded the net benefits which resulted from the liquidation of this conservable flow.

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[2]In general, this definition is applied to a stock or non-renewable resource and not to a renewable resource. Soil is considered a renewable resource, due primarily to the conservable flow component.

[3]Ciriacy-Wantrup uses the term "safe minimum standard" to identify the point beyond which irreversibilities are probable.

Farmer Behavior Toward Soil Conservation and Land Degradation

Farmers are faced with a number of economic choices in their everyday production decisions, and many of these impact on soil conservation. For example, they have to decide how to cultivate their land, which crops to plant, what inputs to use, and when to sell the product. The constraints they face can be divided into three broad categories:

(1) Technological constraints are considered to be soil quality, seed quality, available machinery technology, and information on when and how to plant, when and how to harvest, and so on.

(2) Economic constraints include the prices of products and inputs, and time preference.

(3) Institutional constraints include zoning regulations and the underlying political infrastructure (e.g., trade and transportation regulations), although some of these may properly be included as economic constraints.

Within these constraints the farmer must choose how to use his land; he must decide how much soil conservation to practice and how much degradation to allow.

Farmers must make what economists refer to as a normal economic profit if they are to remain in business. Profit is generally considered to be the difference between total revenue and total cost. Included in total cost is the opportunity cost of employing a resource in its best alternative use. In farming, some inputs, such as family labour, management and soil depletion, are not included as a part of total cost although they should be. If these costs are taken into proper account, then farm operators must earn a return at least as great as what they could earn if they invested their capital elsewhere. This return is normal profit. Given the long-term trend toward lower wheat prices, farmers have often stayed in business--that is, earned a normal profit--by allowing the conservable flow component of the soil to deteriorate over time.

Is it beneficial from the individual's point of view to allow soil depletion by drawing down soil capital? The answer from an economic viewpoint is yes on two accounts. First, there may be some surplus that can be captured by the individual that will have no impact on current or future yields (i.e., expendable surplus). Second, since farmers must make a profit today and the future is discounted, they will pursue short-term gains rather than long-term conservation goals.

Farmers' decisions regarding the farm enterprise and, in particular, conservation practices are influenced by economic parameters. Consider first the impact of interest rates on farmers' decisions. Suppose a farmer is concerned about soil erosion and land degradation because these will reduce future yields. Conservation measures require a present sacrifice, usually financial, in order that a future benefit may be realized. In this case, the benefit is the prevention of soil productivity losses. Suppose such a benefit accrues ten years in the future and is worth $1,000 at that time. How much is the farmer willing to pay today so that he can get at least as must as he would if he put that sum of money (i.e., the amount needed to prevent soil deterioration) in the bank? That depends on the interest rate as indicated in the following table:

Interest	Amount Farmer is Currently Willing to Pay to Prevent Soil Depletion
0%	$1,000
5%	610
10%	390
20%	160

Obviously, the lower the interest rate, the more that the farmer is willing to pay for conservation. Given the high interest rates (and low commodity prices) experienced in the recent past, it is little wonder that farmers are not concerned with conservation to the degree that some would like, including perhaps themselves.

Soil Conservation: Externality in Agriculture

A question which needs to be addressed is: Why should society be concerned about an individual's conservation practices on his own farm? Economists argue that private decisions in agriculture may not always be in the best interests of society. Several views are relevant here. Three attitudes which are in the neoclassical economics tradition and provide a rationale for government intervention are considered.[4] However, the third attitude may be considered invalid, although it can be rendered valid by adopting an alternative (and valid) perspective of economics.

First, ownership externalities occur when the activities of one economic agent affect the profits or utility of another agent, but these external effects are not taken into account by the first agent in making his production or consumption decisions. Environmental pollution is an example of this type of externality; in agriculture, the factors which lead to land degradation also result in air and water pollution (e.g., wind and water erosion, and chemical pollutants entering water systems). Government intervention is often required in these situations to get economic agents to take into account the costs of their decisions on others.

Second, since the future is uncertain and an individual's life is finite, individuals may discount the future at a higher rate than society. As noted in the previous section, a higher discount (interest) rate implies less interest in conservation. Since society likely views risks differently than the individual, society likely uses a lower discount rate in valuing the benefits of conservation. If this is true, the socially optimal rate of conservation diverges from the privately optimal rate, and government intervention is required to get private decision-makers

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[4]That government has the right to intervene in private decisions pertaining to the use of land is established in law. See Hecht (1965) for a brief history of law in this area.

to make choices in line with those preferred by society.

A third rationale for government intervention in private decisions is the public goods argument. A public goods externality occurs in the provision of open spaces, such as meadows and parks, and in ensuring the long-term sustainability of agricultural production. However, the latter argument is often invoked by those who are really interested in open space. As Hedlin and Kraft (1985) argue, there does not seem to be any impediment to maintaining high levels of agricultural output in Canada indefinitely. It is also unlikely that lack of open space is a problem in Western Canada. Hence, this argument for government intervention may not be a valid one.

The public goods argument retains its validity, however, if it is couched in an institutional economics, eco-philosophic framework. While few doubt the efficiency of the market, the market may be unable to deal with problems of environmental management and the intertemporal allocation of natural resources. Three positions can be adopted with respect to the environment. The first is the Jainist position of absolute nonviolence and noninterference which is evident in some ecological movements (e.g., Greenpeace). Second is the attitude of coevolutionary development which "contends that human welfare and tenure on earth depends on the maintenance of a harmonious relationship with the natural world" (Norgaard 1984, p.169).[5] Finally, one can adopt the position that man can transcend his environment and overcome any ecological problem with science and technology, whether the required technology currently exists or not.

Only the second position is considered valid in this paper. Since agricultural production provides a link between man and nature, many soil scientists and agronomists (e.g., Grant 1979, and Buttel and Gertler 1982) argue that society has a stake in the agronomic practices of the individual farmer. Hence, it can be argued that this view of farming considers agricultural production, including production of environmental "bads", to have public good characteristics.

Each of the above results in a divergence between the privately optimal rate of land or soil conservation and the socially optimal level of conservation. In this case, private decisions may be altered so that private actions are in accord with social desires and goals. This is the case because society may obtain a benefit, over and above the private gains to farmers, from soil conservation and from soil debasement prevention. The economics literature suggests a variety of economic and institutional incentives for bringing private actions in line with social desires. For example, the government could regulate the size of machines that could be purchased if soil compaction

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[5]Coevolutionary development is a coevolutionary process--a positive feedback in the cybernetic sense--that benefits man (Norgaard 1984, p.161). The concept of coevolutionary development is similar to that of stewardship.

was felt to be a major problem. Regulations regarding the use (or, perhaps, abuse) of fertilizers and other chemicals could be instituted. If heavy debt loads were perceived to be the problem, as suggested by Grant (p. 51), and by Buttell and Gertler (p. 111), financial and management counselling could be provided free of charge by the government, or subsidized farm mortgage rates could be made available. Some of these recommendations are already in place in one form or another, as well as others which have not been mentioned.

Economists, however, tend to shun such direct methods of intervention since they regard them as an additional source of inefficiency. Further, the benefits from subsidy-type programs frequently become capitalized in the values of fixed assets such as land and, therefore, do not ameliorate the problem the program seeks to address. Economic incentives, such as tax incentives for farmers who implement particular conservation measures and charges on undesirable runoff into waterways, are preferred as methods of modifying individual behaviour. That is, it is preferable to incorporate the public loss as a direct cost in the producer's decision calculus.

While we might agree that public intervention in agriculture is desirable, and the preponderance of government agricultural programs seems to support this notion, it should be evident that the determination of an optimal distribution of use rates lies with society, and is therefore beyond the purview of a single discipline. Indeed, we land right in the middle of an enduring debate about social choice, and whose opinions are to be counted in decisionmaking and how.

However, these traditional economic solutions may not address the problem of coevolutionary development potential. In order to adequately address the problem of stewardship, of man's relationship with his environment, government intervention may not by itself be appropriate. Rather, it is necessary to change the attitude of individuals toward the environment. Perhaps this requires education to make members of society aware of how their consumption, and the production techniques used in industry (including agriculture), adversely impact on the environment. It behooves scientists concerned with the production of food to work together in the study of this important problem. The first step in such a process is to take a broad look at our resource base and to decide how we are going to evaluate society goals and human needs.

Summary

Farmers will use the soil so as to maximize their own welfare. Since the future is uncertain, income in later periods is worth less than current income. Hence, the individual decisionmaker, the individual farmer, will likely deplete the soil at a rate incommensurable with society's preferences. If it can be argued that agricultural land is a public good--i.e., that private decisions result in a divergence between the socially and privately optimal rates of soil conservation--then there is a rationale for public intervention. Merely to demonstrate that private decisions regarding process of soil deterioration and degradation result in social inefficiencies may not, however, be an adequate justification for public intervention. It needs to be further demonstrated that government action will result in a "better" outcome; that is, that government intervention will indeed move society closer to its desired levels of conservation.

As mentioned, the social optimal toward which we focus our sights may be illusive. Unfortunately, economists are sometimes perceived as villains who seek to undermine the ethically-derived policies of their colleagues in the physical sciences. However, this is a misconception. Economists are as concerned about soil conservation and land degradataion as the soil scientists. But they are also reluctant to substitute one evil (excessive soil depletion) with another, namely, wasteful government intervention.

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