Soil Conservation as Development Policy

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Introduction

The issue of soil conservation, or its counterpart, soil degradation, has become an important one in recent years, in the discussion about sustainable agriculture. After the Green Revolution, questions have emerged about the current conditions of land to achieve the objective of increasing food production without destroying natural resources such as soil. Especially, in developing countries, it is very important to design a soil conservation policy in order to achieve sustainable agricultural production as part of the general objective of sustainable development. Soil conservation is an essential component of any national plan for sustainable development. Conservation is not an end by itself, but an integral part of the land and water management needed to sustain productive land use.

What are the issues to be addressed in designing such a development and conservation policy? I will examine in this paper the following. First, I show what is going on in the theoretical debate about the magnitude of the problem and define soil erosion as a real problem for sustainable agricultural production. Second, I present a brief description of today's land situation. Third, I discuss the determinants of soil erosion in developing countries. Fourth, I analyze the idea of dealing with soil conservation as an input for agricultural production. Finally, I discuss the issue of policymaking process related to soil conservation showing both policy failures and some possible alternatives to reduce the negative impact of soil erosion particularly, in developing countries.

I. Is soil degradation a real problem?

At a first glance, it would seem that soil degradation is an unquestionable problem today. Environmentalist movements around the world have pointed out the risk for the present and future generations to survive if there is not a real change in agricultural practices as well as a significant reduction in forest depletion.

However, there does not seem to be a consensus among agricultural scientists and environmentalists at this point. Rather, two perspectives have dominated the debate about soil erosion in the last years. Simon (1981) argued that arable land in some places was going out of cultivation because of erosion and other forces. But taken as a whole, the amount of arable land in the world was increasing year by year. In that sense, the idea behind this reasoning is that the land is considered as any other resource which far from being finite actually becomes cheaper and more plentiful as technology finds and creates new resources and uses the existing ones more efficiently. In this context, soil degradation exists but, taken as a whole, is unimportant. This is an amazing affirmation. From the same perspective, others argue

> the vague counter argument that more intensive cultivation will ruin the soil is hardly convincing from the fact that soil has been farmed with increasing intensity in Western Europe for about 2000 years and there is still no sign that it is exhausted (Beckerman 1981).

The importance given to the technology by those who believe that soil erosion is not a big deal today is crucial to understand their point. Thus, Ruttan cites the contrasting examples of the USA and Japan by saying that:

In USA, it was the process of mechanization first with animals and later tractor motive power that facilitated the expansion of agricultural production and productivity by increasing the area operated per worker, while in Japan where land was the scarce resource, it was progress in biological technologies leading to increased responses by varieties of paddy to higher levels of fertilizer application (Ruttan 1982).

The ability of modern technology to manage the problem of soil erosion can be summarized as follows. It is true that the population growth may in part have destroyed more land than they improved. But it does not make sense at all to try to project past tendency to the future since human beings now, know more about methods of land preservation (Boserup 1981).

This has been the «optimistic» face of the coin. On the other hand, there are hundreds of scientists who, with justified reasons, have tried to alert us about the dangerous situation that human beings will have to face related to soil erosion and food production unless, from now on, both the state and the people involved in agricultural production adopt policies and practices, respectively, to reduce the negative impact of soil erosion. What is more, some argue that technological progress has generated more damage than benefits in the agricultural sector. They take into account, for instance, the indiscriminate use of fertilizers and pesticides. There is a belief that the loss of top soil and its nutrients can be offset by modern fertilizer technology. However, Walker (1982) has argued:

> fertilizer technology can not replace topsoil because of lost organic matter and moisture-holding capacity, increased runoff, reduced infiltration, and poorer seedbed qualities. The decline in yields is not the only problem that stems from land degradation. The runoff is deposited elsewhere, often along the beds and banks of waterways, where the effects of such sedimentation reduce the efficiency of irrigation practices and cause ecological damage to traditional fishing and recreational sites, reduction in effective reservoir storage, and increase flooding.

An associated problem can be a decline in the quality of water due to the contamination of the runoff with agricultural chemicals (Anderson and Thampapillai 1990).

Those who talk about technology as an instrument to reduce soil erosion or as an argument to reduce its importance often forget that technology is not always accessible for developing countries. In addition, assuming that developing countries can access technology, there is still a restriction in terms of whether this technology is appropriated or not, that is, developing countries adapt this technology to their own physical and social characteristics.

The debate about the magnitude and the real impact of soil erosion has not closed. On the contrary, it still remains and presents two lines of thought. The first one reflects the problem of proving it. What constitutes proof, and is it possible? The matter of proving something is related to the idea of measurement. This is precisely one of the main difficulties in dealing with soil erosion, even in developed countries. In that sense, there are few resources in developing countries to measure soil loss. Quite sophisticated equipment and trained workers are required to make reliable estimates (Blaikie 1985).

The second, one deals with the question of ideology in assessing the importance of soil erosion. The idea behind this is whether future agricultural technology can generate «tolerable» soil losses or not. And then, another question emerges: can developing countries access this technology? The experience of the Green Revolution showed that «the access of farmers of lesser developed countries to this package of new inputs, as now, is abundantly clear, was limited» (Blaikie 1985). Some beneficiaries of the Green Revolution were the transnational companies that sell fertilizers, pesticides, tractors and so on, as well as larger farmers. Small farmers also benefitted but in a marginal proportion.

I think the two lines of this debate are quite relevant. On the one hand, it is important to improve the techniques to measure soil erosion because, otherwise, it would be difficult to design any policy without knowing the magnitude of the problem. On the other hand, ideology is important because it helps to understand the political economy of soil erosion, by doing so, one can realize why soil conservation policies fail or, in some cases, why there is not any policy to deal with soil erosion.

In turn, the lack of information in developing countries is a limit in evaluating the magnitude of the problem. At the same time, it makes it difficult to figure out which of those lines of thought are closer to reality. In this latter regard, as I will discuss later on, the lack of information can respond to a deliberate intention which, in turn, reflects particular interest in keeping things as they are to maintain rent-seeking opportunities.

II. Soil erosion: what is going on today

Although the debate about the importance of soil degradation continues, in this paper I am going to assume that, in fact, soil erosion is a real problem for today's agricultural economics and it is also a limit to achieving sustainable development. This assumption is based on the following facts.

Over the past 45 years, the soils of a significant portion of the world's productive lands have been degraded by human and natural activities (Table 1).

> [Thus], water and wind erosion, land compacting, loss of nutrients and chemical contamination are limiting productive capacity and making it more difficult and expensive for farmers to increase production of food (World Resources Institute 1992).

Table 1 presents a general view of the human-induced soil degradation accumulated during the period between the years 1945 and 1990. Thus, 17 percent of the total land for agriculture and vegetated natural areas in the world shows some degree of degradation formed by 10.5 percent of moderate, severe and extreme degradation. This kind of degradation means that original biotic functions are damaged and reclamation may be costly or in some cases impossible. Light degradation represents 6.5 percent. According to these figures, Central America and Mexico present the highest proportion of degraded land

Table 1 Human-Induced Soil Degradation 1945-1990		
Region	Total Degraded Area (Million He)	Degraded Area % of Vegetab.Land
World		
Total Degraded Area	1964.4	17.0
Moder,Severe,Extrem	1215.4	10.5
Light	749.0	6.5
Europe	218.9	23.1
Africa	494.2	22.1
Asia	747.0	19.8
Oceania	102.9	13.1
North America	95.5	5.3
C.America, Mexico	62.8	24.8
South America	243.4	14.0

Source: WRI. World Resources 1992-1993. p.112.

(24.8 percent) while North America shows the lowest proportion (5.3 percent). In addition, one can see that developing countries put together present the highest indicator of soil degradation, particularly those located in Africa and Asia. Farming activities are major contributors to soil erosion, salinization and loss of nutrients. Agricultural activities accounted for 28 percent of this degradation; overgrazing, about 34 percent, and deforestation, another 29 percent (WRI 1992).

In regard to deforestation as a cause of soil erosion, specialists talk about both conversion of forestland to agriculture and urban use and large-scale logging. Deforestation accounts for 579 million hectares, 30 percent of the world's degraded land area. Deforestation occurs in all continents but is most severe in Asia, where it caused the degradation of 298 million hectares (WRI 1992). In South America, in the Amazon region, most of the soil shows relatively low deterioration rates except for areas of extensive deforestation such as southwestern and northeastern Brazil and Paraguay.

Furthermore, according to the FAO report 1991, tropical deforestation has accelerated dramatically. This report found tropical deforestation to be almost 17 million hectares per year compared to an early 80s estimate 11.3 million which represents an increase of 50 percent. The annual rate of deforestation in 76 tropical countries, which own 97 percent of the total tropical forest, increased by 0.9 percent per year during the 80s compared with 0.6 percent in 1976-80 (WRI 1992).

This brief description has been to show why it is important to analyze soil conservation as a development policy, particularly in developing countries which are rich in natural resources. Now, it is worthwhile to discuss what is behind this picture and what are the limits to adopt conservation policies.

III. Determinants of soil erosion

The causes of excessive soil erosion are complex and are deeply rooted in forces such as market and institutions. Further, some argue that soil erosion can also be explained by the social and cultural behavior of the people involved in agricultural activities. Blaikie (1985) says:

> conservation is as much about social processes as physical ones, and that the major constraints are not technical (in the agricultural engineering sense), but social.

I am going to discuss more about this important consideration later on. In this section, I am going to focus on the market and institutional aspects.

A. Economic reasons

The increase in demand for agricultural products and the capability for the agricultural sector to respond such a demand can explain to a large extent the increase in soil erosion in the last decades. Table 2 shows how agricultural production, exports and imports have increased in the last years all over the world. In fact, agricultural production increased 24% between 1981 and 1992. At the same time, the worldwide market of agricultural production has presented a parti-

Table 2 Agricultural Activity Index 1979-81=100						
Region	Production		Trade			
			Imports		Exports	
	1981	1992	81	92	81	92
World	103	127	105	129	106	129
Africa	103	128	112	153	105	78
North,Cen.America	106	115	109	156	104	100
South America	105	132	101	119	116	114
Asia	104	152	104	144	107	188
Europe	100	105	101	115	109	160
Oceania	101	116	100	172	99	101
Former USSR	98	116	123	106	95	45

Source: FAO. Production and Trade. Yearbook. Vol 46. 1992.

cular dynamic in the last years by increasing 24 percent of exports and imports. The response of the agricultural sector to the increase in demand can be observed in several ways:

- Production can be intensified on existing acreage, new output increasing technologies can be adopted if available and the total acreage of cropland can be increased (Van Vuuren 1986).

Certainly, the increase of agricultural production due to the increase in demand has been followed by an increase in soil erosion and also by a more dynamic market of fertilizers and pesticides.

B. Institutional reasons

In addition to the economic forces, there are also institutional impediments for farmers to develop soil conservation practices, particularly in developing countries. These institutional restrictions include credit, tax structure, unclear property rights and lack of research and development, among others.

The narrow capital market in developing countries represents a limit for the people involved in the agricultural sector to access credit. Limited access to credit can also put a constraint on farmers' incentives to prevent or repair erosion damage. However, there is no empirical evidence for how much of the credit would go to conservation practices rather than machinery or other input purchases (Van Vuuren 1986).

Similarly, the tax structure on the agricultural sector has been an impediment to improving the performance of this sector as well as to implementing conservation practices. Both direct and indirect taxation have discouraged agricultural production. As it is well known, those countries which followed a development strategy based on imports substitution model, which is the case of most countries in Latin America, developed an industrialization process at the expense of the agricultural sector. There was a significant transfer of resources from agriculture to industry and, of course, to urban areas. In other words, in many developing countries there has not been a consistent long-term agricultural policy, much less a conservation policy. At the same time, some policies which have tried to improve productivity in the agricultural sector have had a perverse effect. Thus, there is growing consensus that certain government policies which directly affect farm income have also been instruments in contributing to the problem of land degradation (Anderson and Thampapillai 1990). Such policies include input subsidies, guaranteed prices and income assistance programs.

The case of subsidies for fertilizers is a typical case of perverse effect. There is a belief that the use of fertilizers can off-set to a certain extent the effect of productivity losses caused by soil loss (Dumsday 1971). This may lead the farmer into a false sense of security, and the excessive use of fertilizers (due perhaps to the low cost because of the subsidy) can have other adverse effect as well.

> For example, Costin and Coombs (1982) have criticized the superphosphate subsidy in Australia on the premise that this subsidy has led to the application of large quantities of superphosphate, and that such heavy application may damage the structure and reduce the overall quality of the soil (Anderson and Thampapillai 1990).

Input subsidies are not only for fertilizers. Water pricing has been used as a means of encouraging land settlement and regional development. Some have argued that irrigation water has been underpriced. As a result,

> the amount of water drawn for irrigation tends to be extravagant and contributes to the problems of erosion, sedimentation and salinity (Anderson and Thampapillai 1990).

C. Topsoil as a nonrenewable resource

Theoretically, all natural resources are renewable, but fossil fuels and minerals are considered nonrenewable because their rate of regeneration is extended over a large period of time. A specific concern in the management of natural resources is that some of the so-called renewable resources are being transformed into the category of nonrenewable resources through mismanagement. This consideration applies to the topsoil management. Thus,

> under natural conditions, the topsoil that is lost is largely replenished from the subsoil's. Ciriacy-Wantrup (1968) thus defined topsoil as a renewable resource with a threshold level below which resource use renders it nonrenewable (Anderson and Thampapillai 1990).

Many of the land use practices in developing countries seem to be consistent with measures that transform topsoil in a nonrenewable resource. In that sense, the extraction of a natural resource in the current period reduces net benefits for future generations. This loss is defined as the user cost. This concept of user cost is relevant for those places with heavily eroded environments «where the net returns with conservation are higher than those without conservation» (Pearce and Markandya 1985). To postpone the conservation decision imposes an extra cost on future generations that is likely to be higher. This extra cost also represents the reduction in future consumption. Burt (1981) has developed an interesting model that explains the intertemporal allocation of topsoil as a nonrenewable resource. The model is specified as follows:

$$\mathbf{Max.}\ G(u_t, x_t, y\ t)/(1+r)^t$$

subject to:

$$x_{t+1} = x_t - k(u_t, x_t, y_t)$$

$$y_{t+1} = y_t - h(u_t, x_t, y_t)$$

Where:

$\mathbf{G(u_t, x_t, y_t)}$ is an annual net return function, and $\mathbf{k(u_t, x_t, y_t)}$ and $\mathbf{h(u_t, x_t, yt)}$ are soil loss and organic matter loss functions, respectively, and r is the social rate of discount. $\mathbf{X_t}$ is Depth top soil; $\mathbf{Y_t}$ is a percentage of organic matter and **Ut** is all possible cropping practices.

The most important feature of this model is that net returns for farmers depend on the level of reduction in topsoil. This means that farmers have to take good cultural practices in order to achieve positive and increasing flow of benefits through time.

IV. Soil conservation as an input in agricultural production

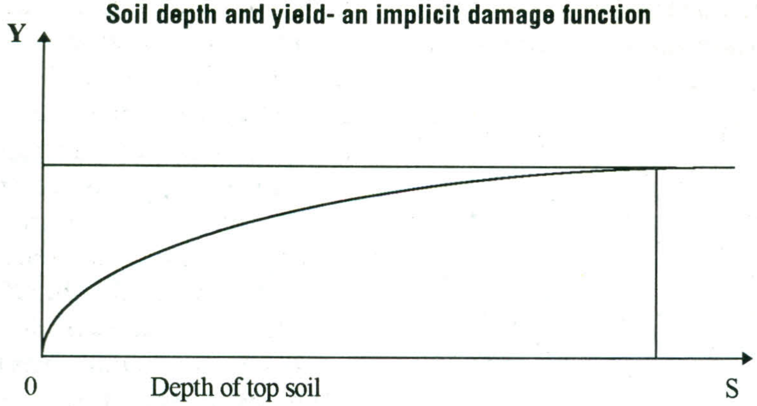
A. The effects on output and income

In general, one way to deal with negative externalities generated by environmental problems such as pollution or soil degradation is to include them in the production functions for any economic activity which is generating them. By including them, it means that the ecological damage generated by any economic activity should be internalized by the agent or sector responsible for such an externality by first, measuring it somehow. Second, once measured, it should be taken as any other cost of production, either as a tax or as an input.

Considering the case of agricultural production some argue that soil conservation should be taken into account as an input for such a production. This consideration leads to two concepts:

Figure 1

Soil depth and yield- an implicit damage function



the effect of soil conservation on output an income, and the factors influencing the adoption of soil conservation, such as technology, use of fertilizers, education and policy incentives (Anderson and Thampapillai 1990).

When we talk about soil conservation as an input, implicitly we are talking about a kind of market of soil conservation. The difficulty arises when we try to distinguish between demand for and supply of this special input. This is due to the fact that the farm that «demands» soil conservation is, at the same time, the farm that provides it. In that sense, soil conservation as an input is no more than adopting soil conservation practices. Such practices have an effect on output, income and net returns as well. Thus, Walker (1982) has introduced a simple production function using depth of topsoil[1] as a proxy of soil conservation (See Figure 1).

If soil conservation practices are adopted to maintain soil depth at levels above **OS**, output will be sustained at **Y**. Conversely,

1 Topsoil depth refers to the depth of the mollic epipedon. This darker layer of surface soil material is high in organic matter content. The mollic layer is distinguished from underlying subsoil a marked change in color and soil structure (Walker and Young 1986).

productivity losses occur when land degradation results in topsoil depths below **OS** (Anderson and Thampapillai 1990).

Walker (1982) calculated a damage function for the states of Washington and Idaho. They called it damage function because it reveals the loss in output as depth of topsoil decreases. Sinden and Yap (1987) demonstrated a similar function for New South Wales and estimated the value of annual losses due to soil erosion to be about $50 million. Thus, a major effect of land degradation is sustained reductions that are translated into income losses.

On the other hand, among those factors influencing soil conservation practices, it is worthwhile to point out two of them. First, as I said before, is the matter of appropriate technology. Most technology transferred to the developing countries was originally developed for different environments and agricultural regimes, and the adoption and careless use of this technology frequently promotes land degradation (Milton and Farvar 1968). Second, is the effect of education on soil conservation practices. Some studies have showed that better soil conservation practices have been developed among young and well educated farmers. Ervin and Ervin (1982) hypothesized three steps that explain why: perception of soil erosion as a problem, decision to adopt soil conservation and soil conservation effort. In all of these steps the role of education was significant. Unfortunately, there have not been studies like these for developing countries.

B. Economic determinants of soil conservation practices

The adoption of soil conservation practices by farmers and peasants depends on several factors. First, they adopt profitable soil conservation decisions if they either have sufficient funds o their own or have access to credit. Anderson and Thampapillai (1990) have pointed out that there is a high correlation between soil loss reductions and access to credit for farmers. At the same time, some have argued that the farm size and the farm income have a strong influence on the adoption of soil conservation practices. However, the diversity of farm circumstances makes it difficult to generalize about the private profitability of conservation practices. In addition, it has been said the topographical location of farms also has an influence on the size of net returns.

Another important factor is the attitude to risk. Farmers' attitudes to risk also influence their willingness to invest in soil conservation. One could think that farmers see soil conservation practices as something which alters their operations and long-term plans, and this view could create additional uncertainties. However, Anderson and Thampapillai have argued:

> Dynamic extensions of the analytical frameworks for risk will assist planners in the reducing the cost of risk through diversification and accounting for the intertem-poral stability benefits of soil conservation (1990).

In addition, a farmer's wealth may influence the adoption of soil conservation practices, in part through expectation about future income.

> A farmer who expects the net returns with soil conservation to be lower than those without conservation is certainly likely to postpone conservation. (Anderson and Thampapillai 1990).

There is another important determinant for soil conservation practices in developing countries from a macroeconomic perspective. This is an improvement in living conditions in rural areas. Reducing the imbalance between rural and urban areas, that is, investing in human capital and improving income distribution for those who live off of agricultural activities, would contribute significantly toward implementing conservation practices.

V. Elements to design a sound soil conservation policy

We have seen that there are many factors involved in explaining soil erosion and soil conservation practices. Next, we should look at why it is difficult to design and implement conservation policies. In other words, why conservation policies have failed or have showed poor results. To start, I would say as Eckholm said:

> Land use patterns are an expression of deep political,

> economic and cultural structures; they do not change overnight when an ecologist or forester sounds the alarm that a country is losing its resource base (1978).

This consideration reaffirms the idea that in designing any policy related to the agricultural sector, or more generally, to the natural resources sector, one must consider all agents involved in those sectors. Thus, on the one hand, there is nature with all of the resources to be exploited by human beings. On the other hand, there is population which plays several roles, as consumers and producers defining the role of the market, and as government to deal with and control the activities developed by all agents in a determined territory. The key question should be how to reconcile different interests to achieve sustainable development.

A. Some explanations for conservation policy failures

1. The lack of an integral view of development. As an starting point, for many developing countries, particularly in Latino América, the agricultural sector has been seen as a residual rather than a complement to the industrial sector in achieving development.

> A number of theories of economic development have considered agriculture to be peripheral to the primary task of industrialization. The rural sector was thought to abound with surplus labor that could be transferred at little or no cost to the industrial sector. Agricultural producers could be taxed to provide resources for industrial development, receiving little or nothing in return for the government (James, Naya and Meier 1987).

Fortunately, recent experiences in Japan and Taiwan have showed a positive role for the agricultural sector. As a lesson for Latin America overall development would be difficult or impossible in those countries unless the agricultural sector were itself developed. The point here is that it is hard to think of conservation policies in developing countries where not even the agricultural sector is seen as an integral part of development.

2. Inherent difficulty in understanding soil as a natu-

ral resource. Soil is a special natural resource for its configuration as well as for soil to be used. Soil is something that is everywhere, even in urban areas. It is something so obvious that few take care of it. What is more important is that the benefits from adequate soil exploitation are not as visible as the benefits from other natural resources like oil or forests. In addition, the benefits from adequate soil exploitation can be seen only in the long-term. This characteristic conflicts with the idea of what economists have called rationality of individuals. By rationality economists mean the objective of maximizing benefits. But one can see that this objective has an implicit short-term perspective. The idea behind this rationale is, in very simple terms, that I can make the maximum amount of benefits, and it does not matter if I destroy everything around me. However, I think in many cases such a rationality does not work at all. Instead, I would say that what happens is that there is not such a rationality if we consider long-term implications because, if I destroy everything in a few years, I am not going to be able to benefit anymore.

3. Conservation is inhibited by existing land tenure conditions. In many countries with very unequal land holdings, land reform is considered an essential prerequisite to a successful soil conservation policy. In many cases larger farmers have displaced effect smaller land holders who move to low quality land and intensify soil erosion practices.

4. A lack of participation by land-users in governmental conservation programs if any exist. In many cases, there is a conflict of interests between government and local communities. «Presumably preliminary consultation by conservation agencies and institutional involvement of local people in plan formulation and implementation would avoid these clashes» (Blaikie 1985).

5. Institutional weaknesses. Several factors can explain such a weakness. First, in many developing countries there is a lack of technical capacity to detect and evaluate problematic areas. Second, it is also common that powerful economic groups impose their interests over social interests. Third, there is a lack of financial resources to invest in research and development.

B. What to do

After this overview of soil conservation, some policy recommendations can be suggested. First, it is important for developing countries to conceive conservation not as an end by itself but an integral part of the land management needed to sustain productive land use. At the same time, such a concept must be part of national agricultural strategy that considers the agricultural sector as a complement to the industrial sector in achieving sustainable development.

Second, Perrens (1984) has pointed out six elements that I consider valid and key to design a conservation policy. **a)** Inventory of land and water resources. Soil, geology, erosion types and severities, vegetation, climate, topography, water quality and quantity must be inventoried. **b)** Land capability assessment. This is to evaluate how land responds to a certain use. **c)** Potential land use. Once land capability assessment is done the nest step is to define potential use which must include long-term sustainable management practices. **d)** Soil erosion and sedimentation assessment. **e)** Conservation needs. Soil conservation practices must be cost-effective, returning income to the farmer through greater productivity or the minimization of off-site impacts. **f)** Matching needs with uses. At this point conservation should meet potential uses. In other words, at this point, there is a meeting between nature, population, the market and the state.

Third, who should pay for soil conservation? First of all, it must be recognized that soil erosion is a negative externality that has an impact on not only present but also future generations. Some argue that the state and the farmers are direct responsible for soil conservation by saying that soil conservation is a national concern and, as a consequence, national government should take major responsibility for protecting future productivity (Libby 1980). I would go further. I think everybody is responsible for soil conservation and, somehow, everybody has benefitted from soil erosion, particularly in developing countries where most people in urban areas have taken advantage of subsidized food and have contributed indirectly to the deterioration of rural areas. One can say that this is a kind of social debt that everybody has to pay. However, thinking of a Pigouvian tax in order to internalize the externality that soil degradation means is less feasible than introducing soil degradation as an input, i.e. as an additional cost of production.

Fourth, an effective conservation policy would require strong participation at all levels of government. The more decentralized the policymaking process, the more clear the relationship among nature, population, market and state.

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