Chapter 2

LITERATURE REVIEW

2.1 Introduction

This study embarked from the "four tenets of conventional wisdom," namely: (i) Marginal lands are defined in biophysical terms which establish them as: having low inherent productivity for agriculture; being susceptible to degradation; and involving high risk for agricultural production; (ii) They support a high proportion of the rural poor, particularly the poorest of the poor; (iii) The combination of fragility and high density of poor people who place a premium on current consumption (resulting in over-exploitation of natural resources) is leading to accelerated erosion or vegetation destruction; the consequence is a downward spiral of poverty and resource degradation with significant negative externalities; and (iv) the impact of agricultural research on agricultural productivity increase , environmental protection and above all poverty alleviation has been limited in these areas. Within this framework focus on the need to understand more fully the causes and consequences of rural poverty with a view to identifying the options for meaningful intervention, and to improve our understanding of land degradation processes, are obvious.

2.2 Defining Land Degradation and Sustainability

There are several definitions of land degradation. Land degradation is generally defined as the reduction in the soil's ability to contribute to crop production (Blaike and Brookfield, 1987) and as a change to land that makes it less useful for human beings (Wasson, 1997). Examples of land degradation can be found in erosion, salinisation, waterlogging, vegetation depletion, fertility loss, soil structure change, and pollution of soil. In each case, the focus is on the physical or biological effects with land-use methods seen as the ultimate causes of degradation. Land degradation can take many forms and its effects are often cumulative. The off-site effects (sedimentation of reservoirs and depletion downstream fields through siltation), both positive and negative can also be considerable. A formidable problem exists because there is no simple relationship between these physical processes and the human perceptions of land resources. What is observed in the present, is the result of the interaction of several complex processes over long periods of time. For more comprehensive detection and measurements of land degradation, a system is needed for monitoring change in physical, biological and social phenomena. The heterogeneity of the situations, the complexity and changing interactions (over time) of the interacting processes have negative implications for precise and conclusive measurement.

Concern with land degradation has heightened due to the increasing focus in policy circles on sustainability. There are several definitions in use for sustainability in agriculture, which leads to some confusion. There is a need for a clear and widely agreed-upon perspective. Existing definitions can be broad and all encompassing. For example, sustainability is defined as "meeting the needs of the present generation without compromising the ability of the future generations to meet their own needs" (WCED, 1987). Sometimes sustainable development in agriculture means more efficient use of arable lands and water supplies. It requires avoiding over use of chemical fertilizers and pesticides so that they do not degrade rivers and lakes, threaten wildlife and contaminate human food and water supplies. It means careful use of irrigation to avoid salinisation or water logging of croplands. It means avoiding the expansion of agriculture to steep hillsides or marginal soils that would rapidly erode (World Resource Institute, 1992).

Sustainability is often confused to imply zero depletion of the natural resource base or zero environmental costs. However, as Crosson and Anderson (1993) point out "agricultural production that imposes some resource depletion and environmental damage are consistent with rising per capita welfare". From an economic perspective, degradation only occurs beyond the socially defined optimal use level. Such degradation occurs where individuals cannot or do not optimize returns to their resources (e.g. due to inadequate information) and/or because there is a divergence between private and social interests (e.g. externalities or inappropriate public policies) [see for example Scherr and Yadav (1995) and Binswanger (1989)]. This lack of an agreed perspective on sustainability has implications for how land degradation is defined, measured, and analyzed.

There is general recognition that data on the physical processes of land degradation as well as on its economic and social consequences are sparse (Scherr and Yadav, 1995). Earlier reviews of the evidence for land degradation around the world have also found this evidence to be "extraordinarily skimpy". "No country has comprehensive estimates of the productivity consequences of land degradation or the rates of degradation from current practices" (Crosson and Anderson, 1992). Several authors, including Biot et al. (1995), recognizing this inadequacy, have called for a thorough review of experimental and field data and a sharper focus, particularly on robust and cheap methods of measurement in order to improve the understanding of the physical process(es) involved.

The problem associated with drawing representative samples for plot-level measurements has meant that most aggregate estimates are based on non-scientific methods of "raising" the information. Experts base most estimates of the impact of land degradation on "objective assessments". Available aggregate estimates of the cost of degradation have to be interpreted with even greater caution since they are based on standard formulas relating certain levels of degradation to estimates of yield losses. Attempts to extrapolate from the estimates of the effects of yield losses at the plot level to aggregate estimates about the socio-economic impact at national or regional level, have often been dubbed as "giant leaps of faith".

The inadequate basis for the available figures is, however, generally lost in the emotionalism that pronouncements about catastrophic extent of land degradation stir up. Statements such as "over the last thirty years alone, the world has lost nearly one fifth of the top soil from its crop land, one fifth of its tropical rainforests and tens of thousands of plant and animal species" (Brown, 1990), stir up visions of imminent and impending doom. The literature associated with the "Tragedy of the Commons" (Hardin, 1968) has brought focused deliberations on the negative consequences of the interaction between humans and natural resources. On the other hand, complacency - based upon the phenomenal increase in agricultural (especially food) production during the past fourty years or so - might well be misplaced, particularly when viewed against recent declining food production patterns in Africa.

There is thus a tremendous need to obtain a fuller understanding of the different aspects of land degradation based on data generated through consistent definitions and scientific rigor. As already noted, studies about the impacts of land degradation are based, in one crucial aspect or other, on the assessments of experts. In most countries the data used for such estimates generally comes from a few studies that were not originally designed to generate estimates for the whole country, this is also the case with South Africa. Moreover, the capacity to monitor changes over time is limited by the weak statistical foundations and the lack of comparability in the available data.

Attempts are being made to address some of these concerns through research on land quality indicators (World, 1997). The land quality indicators (LQI) programme[1] was set up under a coalition of international agencies in 1994. Its objective was to better understand the problems of land degradation. This program seeks to "develop a set of natural resource indicators: statistics or measures that help characterise the conditions of natural resources related to land. The programme seeks to develop a set of standardised indicators (mainly focused on local and districts levels) to provide concise, reliable information about the condition of land, including the combined resources of soil, water, vegetation and terrain that provide the basis for land use"(Pieri et al. 1995).

Land degradation can lead to declining potential yields on farms. However, fertilizer use or changing the land use can camouflage the effects of this degradation for long periods.

[1] This programme involves agencies such as the Food and Agriculture Organization, the United Nations Development Programme, the United Nations Environment Programme, the World Resources Institute, while IFPRI and other CGIAR institutions are also participating.

As such it is almost impossible to establish a one-to-one relationship between the amount of degradation and the effects on yield. Moreover, the level at which yields are affected by changes in land quality can differ according to the type and variety of crop grown the soil type and its depth etc. While measurements of land degradation generally cover only limited periods of time, measurable effect on crop yields could, take longer to materialise because of the accumulative nature of land degradation.

For developing countries the literature on land degradation is even more qualitative and less rigorous than that available for developed countries. The difficulty of modeling complex farming systems and the lack of necessary data both contribute to this paucity[2]. Most glaring is the lack of knowledge about the effects of degradation on social welfare. "Most of the technical literature on the socio-economic aspects of land degradation can be classified into three broad categories: soil conservation as an input in agricultural production: top soil as natural resource, somewhere between nonrenewable and renewable; and the effects of land degradation on common property resources and externalities"(Anderson and Thampapillai, 1990). Studies at the household level that attempt to rigorously verify difference in behaviour between the poor and the non-poor with respect to land are generally difficult to find.

Most of the available literature looks at the impact of land degradation in terms of crop production. Scherr (1998), based on her detailed review of this literature, concludes that "many studies examine the gross impact of degradation on crop production [but] very few examine the net effect, taking into account price effect, substitution of supply by other producing areas, or other secondary impacts. [And moreover] very few studies incorporate into their analysis any active farmer response to degradation". Scherr could find only three studies that provided data relevant to the assessment of human welfare impacts.

[2] The lack of technical information such as rates of soil loss and physical parameters such as those required for the definition of the universal soil loss equation (USLE) led some studies to use site parameters from specific developed country locations [for example Veloz et al, (1985)].

These welfare assessments use different indicators to assess the impact at national or international levels. A detailed review of the results and methodological aspects of these studies is available in Scherr (1998) and is therefore not attempted here.

2.3 Defining Poverty

Poverty is increasingly viewed as a multidimensional concept. It has social and psychological effects that prevent people from realizing their potential (IFAD, 1992). Measurement of poverty can include material deprivation, isolation, alienation, dependence, and lack of participation or freedom of choice of assets, vulnerability, and insecurity. Introducing several such dimensions can seriously complicate the measurement problems. This is why most measurements are based on material deprivation generally linked to the inability of incomes to meet basic nutritional demands.

Poverty is, thus, operationally defined as the inability to attain a minimal standard of living. Generally, a consumption-based poverty line is used and estimates are made of the head count index, the poverty gap ratio, and a severity of poverty index[3]. The World Bank supplements the consumption-based poverty measures with others such as nutritional status, life expectancy, under five mortality and school enrollment rates in what it terms the Priority Poverty Indicators (PPIs). The World Bank is currently considered to be the largest repository of information on poverty in the world. The research work at the Bank has confirmed that, in order to answer the question of how the poor have participated in the general improvements, it is necessary to move from aggregate data to more disaggregated survey-based household-level data. Without such disaggregated data, it is impossible to conduct a rigorous analysis of the decision-making processes of poor households.

[3] The Foster-Greer-Thorbecke (1984) class of decomposable indices that are generally used as measures of poverty are presented in Annex 2.

Poverty measurement is difficult at national level and even more so at the sub-national and household levels. The quality and reliability of the data, where available, are generally questionable. Census taking is generally in its infancy in developing countries - at least South Africa is doing better in this regard, with the last census dating to 1996. Increasing attention is only now being paid to the systematic collection of socio-economic information through household representative income and expenditure surveys. The heavy costs involved generally imply that the data that such surveys yield, are only representatives at the national or at most sub-national level. Given the nature and distribution of poverty, such aggregate estimates can often be misleading. The ability to match the quantitative information with more qualitative data is generally severely limited by the even greater scarcity of the latter. Even where such information is available, meaningful integration is limited because these are derived from studies with entirely different purposes. The problems of the reliability and non-availability of basic information are compounded by problems associated with measurement. The use of one cut-off point or poverty line for the country as a whole aggregates across tremendous heterogeneity and does not necessarily reflect the particular situation in a sub-region or segment. The use of a standard calorie requirement cut-off so fashionable in previous studies, for example, masked tremendous differences in minimum calorie requirements across regions due to differences in body structures, climate, and levels of physical activity.

While considerable headway has been made at improving the quality of the aggregate poverty information, there is still considerable variability in quality. Poverty profiles answer the questions such as, where are the poor? Who are the poor? Why are they poor and is it transitory or chronic poverty? A poverty profile is a simple instrument for making poverty comparisons. These can show how poverty varies across sub-groups of society, such as region of residence or sector of employment. A poverty profile can be extremely useful in accessing how the sectoral or regional patterns of economic change are likely to affect aggregate poverty measures. If the poverty profile shows that, for example, there is significantly more poverty in the rural farm sector than the non farm sector then a policy intervention which improves farmers terms of trade is very likely to reduce aggregate poverty

(Kanbur, 1987, 1990). This variability was confirmed by a report of the Operations Evaluation Department of the World Bank (1996)[4]. While considerable headway has been made in counting the poor, considerably less has been done to explain why they are poor and in particular to explain which strategies for poverty alleviation work and why? While the need to move towards more disaggregated data and analysis is keenly felt, there is no hard evidence available that shows that the poor, as opposed to the non-poor, behave differently in key aspects and especially in terms of natural resource management. The data available are generally at levels of aggregation that limit their usefulness for analysis of specific land degradation problems that generally have a locational dimension. The PPIs are available at national level for the countries for which these have been collected. This limits the usefulness for the understanding specific processes related to poverty and the relationship to other processes such as land degradation.

IFAD (1992) identifies five types of rural poverty. Material deprivation and alienation cause interstitial poverty or pockets of poverty surrounded by power, affluence, and ownership of assets. Material deprivation can combine with isolation and alienation to lead to peripheral poverty, which is, according to different studies, found in the marginal areas. Material deprivation arising from population pressure and limited resources will breed alienation and overcrowding poverty. Vulnerability to natural calamities, (e.g. drought, floods) labour displacement, and insecurity, produces traumatic or sporadic poverty, which can be transitory but often ends up being endemic. Isolation, alienation, technological deprivation, dependence, and lack of assets are also signs of endemic poverty.

This classification is important for linking the types of poverty processes to the types of poverty produced and the segments of the population affected. According to the IFAD (1992) study, environmental degradation leads to both transitory and chronic

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[4] Only 54% of the 46 poverty assessments evaluated in this study met with the requirements. Most were five years old and some were based on data that were more than ten years old. The report used the following benchmarks for evaluation: (1) inclusion of a Priority Poverty Indicators (PPIs), (2) diagnosis of poverty, (3) set of prescriptions for poverty reduction and (4) operation content of the prescription.

poverty (IFAD terms these as peripheral and endemic poverty) and affects smallholders, landless, nomadic pastoralists, ethnic groups, refugees and households headed by women. The IFAD study contains an extensive classification of different types of poverty processes, the type of poverty that is produced, and the segments of the rural population affected by these, for at least 42 of the least developed countries. While this classification is helpful, given the nature of the data on which it is based, it is only indicative of the types of aggregate patterns. Given the heterogeneity of poverty types that it indicates and the extremely aggregate available data that it marshals, the study does not help in rigorously answering specific questions or in furthering our understanding of the interaction between poverty and land degradation process.

Rural poverty also implies that the "wrong crops" may be grown. In sub-tropical conditions, most export crops (except cotton and groundnuts) tend to be less damaging to soil than cereal and roots crops. Most export crops grown on trees and bushes have a continuous root structure and provide canopy cover. Reppetto (1988) shows that, with grasses planted underneath such export crops, the rate of soil erosion is substantially less than with food crops. However, the fact that women control food while men control cash crops, can generally translate into reduced incomes for women with increasing commercialization, resulting in the deterioration of the nutritional status of families (see for example Von Braun and Kennedy, 1986). Moreover, poor people are constrained in their access to credit, insurance, and capital markets. These conditions get translated into larger herd sizes especially in times and places that have a high risk of drought and the possibility of greater mortality amongst the herds. These extra animals can lead to overgrazing and land degradation.

Rigorous analyses of the differential behaviours of poor versus non-poor households in terms of land degradation are sadly deficient. Such analyses require data specifically collected and detailed modeling of the household decision making processes. Collecting such data is a resource-intensive process and often requires skills that are not generally available in developing countries. Cost constraints generally imply small and often "non representative" samples. This leads to obvious questions about the generality of the results. There is a strong need to replicate such studies in as many situations as possible in order to be able to build up a body of information from which conclusions can be generalized.

2.4 Poverty and Land Degradation

In Africa, with still relatively sparse population levels, the productivity of the drylands steadily declined during the 1980s while forests were being cut 17 times faster than they were being replanted (Norgaard, 1994). Norgaard continues to state that due to ineffective or exploitive social organization, poor terms of trade, inappropriate technologies and bad weather, food production did not keep pace with population growth. Furthermore that fertility rates, nearly twice that of the rest of the world, will result in a population by the year 2025 roughly equal to the combined populations of Europe and North and South America. Lipton (1997a) states forcefully that it is irrational to expect people to knowingly behave in ways that destroy resources necessary for their survival or that of their future generations unless very strong pressures to do so are present. He lists four such pressures generally discussed in the literature. These include: (1) an increase in population as morality falls but fertility declines, and (2) declines in common property resources (CPRs). In addition there are international pressures, including (3) interest rate changes and (4) technology transfers (Lipton, 1997a).

Poverty generates significant incentives to have large families. Traditionally the impact of population growth on natural resources is discussed in terms of “carrying capacity". Conceptually, if nothing else changes, it is assumed that the increasing population will put demands on the resources that can no longer be met without damaging the ability of these resources to support human life. Social and economic factors such as trade, technology, consumption preferences, and levels of inequality can alter the carrying capacity. Poor people will often use migration as a coping strategy. However, migration may not always benefit rural environments since the absolute numbers of rural people may continue to increase.

Lipton (1997b) notes that technology generation in agriculture remains exogenous to most of the developing countries and is not driven significantly by their resource saving or other requirements. This is the classic choice of techniques problem highlighted in the literature on industrial development during the 1970s that first made popular terms such as technological determinism. This argument holds that the technically efficient techniques are generally developed in the capital-abundant labour scale developed countries and generally reflect the factor endowments of these countries.

2.5 Impact of Degradation

The poor generally have access only to areas that have high a risk for health and income generation. They generally lack the resources to reduce their exposure to risk or to invest in alleviating the causes of such risk. Environmental degradation therefore can affect the health and nutrition status of the poor and lower their productivity. This can happen both directly through, for example, lower yields per unit of labour or land because of reduced soil quality, and indirectly through the reduced physical capacity of labour to produce because of malnutrition and poor health. Even in cases where the poor are healthy, labour productivity can be low due to increased time being allocated to less productive activities such as fuel wood collection and other pursuits away from agriculture and other income generating activities (Kumar and Hotchkiss, 1998). In terms of the productivity of the resources that the poor manage, the decline is intricately related to the poverty-population-environment interaction (Mink, 1993). Where the poor depend on biomass fuel and confront increasing fuel wood scarcity they often shift to using animal dung, fodder and crop residues for fuel. The quantities of these materials that are returned to the soil, are thus reduced and its fertility declines. Non-replishment of soil nutrients leads to soil exhaustion as fuel wood supplies diminish and animal manure is increasingly used as a fuel substitute. Poverty forces a trade-off between the immediate demands for fuel for cooking and heating and manure for the land. The time-preference argument suggests that the immediate and urgent needs be satisfied. Mortimore (1989) shows how soil exhaustion occurs when certain nutrients are taken from the soil, but are not replenished naturally of artificially with fertilizers. A homogenous crop, usually a cash crop, grown repeatedly on the same piece of land can lead to soil exhaustion. Increasing population pressures on land can also lead to shortened fallow periods and this coupled with the farmer's inability to apply variable inputs more intensively because of poverty, can lead to decreased soil productivity. Productivity, especially, in open-access natural resources or of resources under deteriorating common property management may often decline due to over-use.

2.6 Poverty Impact on Natural Resource Management

Poverty is generally assumed to impose short time horizons. Theoretically this results from the poor having high rates of pure time preference which lowers the ability to forego consumption today. This leads to using up savings previously set aside for later consumption and to borrowing if access to credit is available. The implications of a high subjective discount rate are rapid resource extraction to meet present income or consumption needs and low investment in natural resources to improve future returns. Overgrazing of pastures and shortening of fallow periods can result from the high subjective discount rate. Similarly, farmers are less likely to make natural resource investments where returns are expected after a number of years. These factors combine and lead to a wide divergence between private and social discount rates. The empirical evidence on whether the poor really do have high rates of time preference is limited and sketchy.

2.7 The links between Poverty and Land Degradation - mixed empirical evidence

The study by Grepperud (1997) concludes that in the relationship between poverty, land degradation and climatic uncertainty it is unclear whether poverty in general induces farmers to manage their resources poorly in the long run. The study by Scherr *et al.,* (1995) also found no consistent relationship between population density and the frequency in which land is used for productive purposes and land degradation. Population growth and poverty, they noted, create both incentives and disincentives for land degradation. There is an extreme dearth of studies that seek to rigorously test these relationships. The lack of appropriate data underlies this paucity. To do this effectively, information is required not only on the physical aspects of the land, but also on its availability. Reliance, therefore, has to be placed on studies from which these relationships can be inferred.

Most of the available studies look at the problem in terms of the behaviour of small-scale farmers and land degradation. Southgate (1988) maintains that small-scale farmers have been the main agents responsible for land degradation activities. He states that market and institutional failure were the primary causes for farmers adopting non-sustainable practices. Pagiola (1995) shows how government price controls on agricultural goods in Kenya failed to provide incentives for the small-scale and poor farmers to conserve their land. In some cases, this led to the mining of resources for maximum output. Mortimore (1989), on the other hand, finds evidence of small-scale farmers' willingness to forgo short-term income gains, even under price and famine pressure, to pursue long term sustainable management strategies. The existence or non-existence of secure land tenure systems might explain the contradiction regarding smallscale farmer behaviour. Several studies cite the lack of secure land tenure as the primary reason for poor farmers cultivating their land excessively to the point of exhaustion for the simple reason that they have no vested interest in conserving an asset that they do not own (Southgate, 1988; Mink, 1993; Repetto et al., 1989).

2.8 Household Effect of Degradation

Changes in agricultural practices can have primary and secondary effects on the environment. Von Braun (1997) describes the relationship between agricultural change and the eventual effects at the household level through these environmental effects. Such changes have come about in large parts of the world through the adoption of green revolution type technologies. Agricultural change can also occur where green revolution technologies have not been (as yet) adopted. In the case of the latter, the primary effects on the environment are generally stated to be in the form of desertification, deforestation, watershed degradation, soil erosion and soil fertility declines. The secondary effects can be droughts and floods. These environmental effects can translate into specific effects at the household level. These effects can take the form of impoverishment/productivity decline, migration–related health stress, vector borne disease (if the migration occurs into disease prone areas), communicable disease (when sanitation breaks down), chronic food insecurity, seasonal malnutrition and famines. In the case of green revolution technologies, potential environmental degradation can result from each element in the technology package. It can result from the direct use of each of the technology elements in the technology package or their indirect effects. For example, irrigation can lead to reduced water quantity or quality, salinisation, increases in mosquitoes, aquatic snails and blackflies. Inappropriate pesticide use can have harmful household effects. Fertilizer use can result in nitrates leaching into drinking water. At the household level these aspects of potential environmental degradation can translate into diseases such as diarrhea, cholera, typhoid, malaria, schistosomiasis, onchocerciasis, poisoning and diseases of the circulatory system in infants. The secondary effects of the use of such technology can be crowding, deficient sanitation, diet changes and vector control (through inappropriate pesticide use). These can lead to communicable diseases, nutritional diseases and poisoning etc. These household effects imply a reduction in welfare, which under the conventional consumption based methods of measuring poverty, might not emerge. That is why it is important to include the non-income measures of poverty, such as anthropometric measures in assessments of poverty status.

2.9 Conceptualizing Between Poverty and Land Degradation

Vosti and Reardon (1997) present an interesting conceptual model of the linkages between poverty and the environment that helps to highlight the complexity of such relationships. Poverty is seen to be the product of "asset" components comprising, natural resources (private and commonly held), human resources, off-farm resources, community-owned resources, social and political capital. The links between the components determine household and village behaviour in terms of income generation, consumption, investment in assets, migration and human fertility, which in turn has implications for use and management of the natural resource component that determines the asset components of poverty. How natural resources are used and managed, feeds back as a determinant of the asset components of poverty. A set of conditioning factors governs the relationship between the asset components of poverty and household and village behaviour and between the household and the natural resource components. These conditioning factors are markets (prices), village and regional infrastructure, technologies (production and conservation), village level asset poverty and population pressures.

This conceptualization leads to innovative policy implications. In comparing traditional productivity investments such as irrigation, fertilizers, and modern seeds with conservation investments (such as bunds, terraces, windbreaks, and practices such as organic matter application), the study concludes that the latter have different requirements and characteristics. Conservation investments need innovative policies beyond just "getting prices right". The three non-price policies suggested by the study are complementary public infrastructure investments (such as culverts to divert water flow from farm bunds) that: (1) make household investments more profitable to institutional innovations; (2) that improve security and transferability of resource tenure; and, (3) that modify community level arrangements to improve the management of the commons or watershed (Vosti and Reardon, 1997). In the same source, Von Braun (1997) also points out that poor communities lack resources for community level investments such as physical infrastructure, health and education. Policies that strengthen traditional institutions and make them more flexible (particularly in the face of increasing population pressure), can reduce poverty and the dependence of rural communities on resource mining especially in response to droughts and floods.

Defining poverty in the Vosti and Reardon (1997) manner sets a much higher cut-off than conventional definitions. Implicit in this conceptualization is the assumption that sizeable resources, over and above meeting bare subsistence consumption and production, are required by the poor to address issues of resource degradation. While this model provides an interesting tool for conceptualizing some complexities, it also highlights the trade-off between the depth and detail of understanding, concomitant data requirements, and the inadequacy of available methodology and resources for measuring poverty. Duraiappah (1996) presents an interesting conceptual framework for analyzing the many complex inter-relationships between poverty and environmental degradation. For simplicity, he postulates four possible, though not mutually, exclusive relationships. These are:

RI: Poverty leads to Environmental Degradation

R2: Power Wealth and Greed leads to Environmental Degradation

R3A: Institutional Failure leads to Environmental Degradation

R3B: Market Failure leads to Environmental Degradation

R4: Environmental Degradation leads to Poverty

If only R1 is observed, then the poverty-induced environmental degradation argument can be accepted. However, based on the initial conditions, only exogenous poverty can cause this environmental degradation. On the other hand, if only R2 is observed, then policies adopted under R1 assumptions can be misleading and may in fact exacerbate the degradation process, as demonstrated by Binswanger (1989). In case of either R3A or R3B being responsible for environmental degradation, the solution is theoretically relatively simple – remove or correct the market or institutional failure. If R4 is present, two interesting observations arise. First, R4 can only be present if R1, R2, R3A, or R3B or various combinations of all four cause it. Secondly, the presence of R4 can set into motion an R1 type of link but in this case, it is indigenous poverty that causes the environmental degradation. This is the R1 feedback or R1FB link.

In the R1 - R4 link two outcomes are possible. The first scenario would be that R1 causes R4 and the causality link ends. On the other hand we can get a situation whereby the indigenous poverty caused by R4, can set into motion more environmental degradation by an R1FB relationship. The downward spiral of poverty leading to degradation, leading to more poverty (Durning, 1989), is typically a R1FB type of relationship. The various permutations and combinations of these four scenarios highlight the complexity of the problem. The model has four contributing forces, namely: the power greed and wealth factor; exogenous poverty; institutional failure; and market failure. It addresses two externalities, namely environment degradation and indigenous poverty. The fear of losing land by the poor is a direct implication of R2. R3A is also a primary contributor to land degradation in this manner. R1FB can be a contributory factor for soil exhaustion because of two reasons: first from within the sector due to decreases in agricultural productivity, and secondly from the fuelwood-manure relationship. In the first case, there is evidence of declining agricultural productivity in degraded lands causing indigenous poverty, which in turn forces many people to continue to degrade their land further to extract subsistence outputs. The R2 link in the forest sector can cause an R1FB effect in the land degradation category. R2, R3A, R3B, and R1FB linkages can cause salinisation. In the case of desertification, the primary links identified by Duraiappah (1996) are R2, R3A, and R3B. Duraiappah (1996) concludes that most environmental protection programs fail because they address only the symptoms while ignoring the underlying causes.

2.10 Sustainable Use Management

Much of the literature that simplistically assumes that poverty leads to degradation cannot explain instances of (materially) poor communities living sustainably with their environment for centuries. Induced innovation theory suggests that degradation at least in the long run may be self-correcting as resource scarcity and rising private and/or social costs from degradation induce the development and use of new agricultural and resource management practices (Hayami and Ruttan, 1985; Boserup, 1965). The Induced Innovation Model in Natural Resource Management assumes that, with increasing population density of market demand, four distinct phases/time periods of management response can be identified. The first phase is characterised by dependence on naturally occurring resources. The second stage marks the period of resource degradation. The third phase marking the onset of resource rehabilitation occurs with transition to intensive management because the benefits from the investment in resource rehabilitation outweigh the costs. The fourth phase is characterised by dependence on human managed resources (for example agroforestry, forest plantations and managed reserves). Most of the observed degradation can be explained by assuming that the innovative responses of phases three or four have not occurred. In many cases it can be shown that these have been delayed due to a number of conditions.

However, there is considerable controversy over the adoption of conservation strategies. One school of thought maintains that the adoption of land conservation technologies is low across all agricultural environments despite major support and investment in research and development in this area. Instances where land degradation management have been successful are known, but analyses of these instances have not yet provided clear guidance to policy makers, researchers or developers to enable a more general adoption of these technologies (World Bank, 1991a). An alternative school maintains that the lack of adoption of conservation technologies results from a lack of incentives. "The success of conservation measures is highly dependent on farmers receiving crop yield and economic benefits in the first or second season after implementation" (FAO, 1989). This debate highlights the need to understand more fully why resource users do what they do, and how they reach decisions on resource use and environmental management. This debate does not differentiate between the behaviour of the poor versus the non-poor.