PRELIMINARY DRAFT FOR DISCUSSION ONLY

RURAL POVERTY AND LAND DEGRADATION: WHAT DOES THE AVAILABLE LITERATURE SUGGEST FOR PRIORITY SETTING FOR THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH?

A Report prepared for the
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by

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Understanding of the intricate processes of poverty and land degradation is extremely limited. Definition, in each process, is driven largely by the perceptions of those analyzing the phenomenon. Each group brings its own strong perceptions to bear. The lack of clear conceptualization, the observed heterogeneity and the perceptions of those attempting the exercise exacerbate attempts at measurement. Statistical problems in the available measurements of each phenomenon, arising, among other things, from lack of representativeness, reduce the confidence that can be attached to extrapolations. Evaluating cause and effect with confidence implies ideally being able to observe the processes at different points in time for a large number of homogeneous situations. In most cases the lack of adequate data and the complexity of the relationships that need to be modeled seriously limits rigorous empirical verification. Since the fuller understanding of the complex interaction of the two processes leads on from a comprehensive understanding of the individual processes, it too suffers from all the problems impeding a fuller understanding of each.

The aggregate information available is not very useful for making judgements about poverty and land degradation. Evidence from the few available micro-level studies is mixed and contradictory. Most of the available technical literature relates to the controversy regarding the reasons for the adoption (or non-adoption) of conservation practices. This literature does not specifically address the behavior of poor except through the cost implications of different conservation technologies and the incentive structures that influence adoption.

There are theoretical considerations why the poor can be expected to behave in ways that are land degrading. However, these apply equally to the non-poor and can be explained by generally low levels of development. Pressures arising out of the processes of economic development that might induce people to degrade the land can be classified as those related to; increases in population, declines in common property resources, interest rate changes and technology transfers.

At the same time the theoretical considerations underlying the endogenous innovations models and the empirical evidence that is presented to support these indicate that the response to population pressures and market forces is an endogenous process of adaptation towards sustainable behavior.

Much more research in a variety of settings over a reasonable length of time is needed for fuller understanding of household decision making processes especially in terms of the relationship with land. Such research should ideally be built on detailed household-level longitudinal socio-economic surveys with specific land use and quality assessment modules. Only then will it be possible to differentiate behavior by poverty status. The CGIAR is ideally placed to support such research.

The CGIAR can also facilitate much greater interaction between the different "actors" to bring realism where perceptions prevail; especially in the area of land degradation. Such interactions will lend much greater reality to the understanding of issues that have extremely important implications for the present and future of mankind. These interactions should build on existing understanding so as not to reinvent the wheel. The research agenda on poverty and land degradation should only be defined after a reasonable period over which such interaction has been established.

Results from such research can only enhance the efforts within the CGIAR on integrating commodity research with natural resource management considerations. This emphasis is properly placed and relevant. The CGIAR is the correct forum for addressing the global dearth of knowledge about the implications of land degradation. A good example of a research agenda that makes the best use of the available information to focus on poverty alleviation through the integration of commodity research with natural resource management is that of ICARDA. Its relevance can be enhanced through the collection and use of more dis-aggregated information.

BACKGROUND

Based on an extensive evaluation of available information, the study on CGIAR Research Priorities on Marginal Lands[1] [Nelson et al. (1997)] concluded that neither the global and regional quantification of marginal land areas (based on biophysical data) nor the assessment of CGIAR projects and expenditures assignable to these various land areas are relevant to the CGIAR's decision on strategy for poverty alleviation. The report stated that the concept of "marginal areas" (MA) is more relevant[2]. These are areas, where "there are concentrations of marginal rural people and where the definition of geographic area would derive from a set of relatively homogeneous variables deemed to generate rural poverty. Biophysical characteristics would be one element in the equation". It thus put rural poverty at the center of the stage. The report concluded that the assessment of the appropriate balance between CGIAR research investment targeted to MA and to non-MA could only follow from a clarification of where marginal people are located, why they are marginal and the options open to the system for addressing poverty in the MA.

Within this overall sharper focus on understanding the causes and consequences of rural poverty with a view to identifying the options open to the system for addressing it; the report stated that "there is [also] a need to improve our understanding of land and water degradation processes[3]. There appears to be little hard evidence linking the poor, in contrast to the non-poor, to accelerated resource degradation. Degradation processes need to be understood and linked to poverty processes" [Nelson et al. (1997)].

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[1] This study had started with the "four tenets of conventional wisdom", namely: 1)Marginal lands are defined in biophysical terms which establish them as: having low inherent productivity for agriculture; being susceptible to degradation; and involving high risks for agricultural production; 2)They support a high proportion of the rural poor, particularly the poorest of the poor;
3) 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, 4)The impact of CGIAR research on agricultural productivity increase, environmental protection and above all, poverty alleviation has been limited in these areas.

[2] Lack of comfort with the definition of marginal areas purely in terms of climate, soils and terrain was obvious for several years [see Crosson and Anderson (1993)]. These authors had suggested an alternative definition based on productivity potential. Their discomfort also extended to the allocation of research resources for such areas. From a purely economic point of view they state research resources should only be allocated to marginal areas when concerns with equity in the distribution of productive opportunities outweighs productivity gains as the criterion for research focus amongst areas. This is basically a political choice and to the extent that cost free migration is an alternative, equity might be much better served by focusing on the areas with more productive potential and encouraging non agricultural activities in the less favored ones. Focusing on less favored areas may not be the most cost effective way to promote equity.

[3] The widespread reports of land degradation in Africa; soil erosion on sloping lands in South Asia; and the extensive deforestation of agricultural landscapes in formerly forested parts of South Asia and Ethiopia have brought an increased focus on issues of natural resource management in agriculture. [Scherr and Yadav (1995)].

By highlighting the lack of rigorous evidence and calling for a greater understanding of the interaction of the two processes the Marginal Lands Study has called into question the strong perception that poverty is both a consequence as well as a cause of resource degradation[4]. This perception is strongly evident in the writings of the multilateral development agencies such as the World Bank[5] and the International Fund for Agricultural Development[6] (IFAD).

The present study is the first step towards addressing the concerns raised by Nelson et al. (1997) with regard to poverty and land degradation. In reviewing the available literature on rural poverty and land degradation and evaluating the implications of the current state of knowledge for priority setting for the CGIAR system; an attempt is made to look beyond the generally held perceptions of poverty and land degradation processes. Such an effort is inherently fraught with all the problems that a study of the interaction of two complex and diverse processes is bound to face. These problems are further compounded by the fact that the understanding of these processes is still limited and shrouded in numerous issues ranging from difficulties in conceptualization and definition to measurement and empirical verification. The lack of a clear testable theory on the interaction of the two processes and the vast heterogeneity of what is observed coupled with the limited and inadequate range of what is actually measured of the numerous diverse elements of this interaction underlies these problems.

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[4] Such statements aggregate over many diverse situations and lead to confusion. Generally societies are composed of poor as well as non-poor individuals and poverty is characterized by differential access to resources especially land. Stating that the poor in a particular region behave differently from the non-poor in terms of their relationship to land and are impacted differentially by it is not the same as saying that generally low levels of development in a region are both a cause as well as a consequence of resource degradation. While areas with low levels of development may have a larger proportion of poor, regions with relatively better levels of development can also contain significant proportions of poor. In order to evaluate conclusively if the poor behave differently from the non-poor it is crucial to be able to maintain conceptual and analytical rigor. For this it is important to control for general levels of development, institutions, markets, infrastructure, resource quality and quantity and relationships that govern the use of resources.

[5] "Increasing numbers of poor people live in areas that have little agro-climatic potential and are environmentally fragile...population pressure in these areas has decreased the productivity of land and increased its vulnerability to flooding and soil erosion. This raises the question of the links between poverty and environmental degradation.....These regions need a special development strategy for three reasons. First there potential for growth is limited. Second they are increasingly occupied by poor people with the fewest skills and the least access to infrastructure and supplies. Third environmental degradation in these regions adversely affects both the immediate area and regions downstream or downhill...Poor farmers are being marginalized and pushed to frontier areas. In addition population growth and the commercialization of agriculture have forced farmers who once relied on environmentally sustainable forms of cultivation to use their land more intensively... But the intensification of traditional farming methods such as slash and burn agriculture has damaged the productivity of these marginal areas. Over grazing and unmanaged irrigation and an ever widening search for fuel wood all accelerate decline...Insecure land tenure and encroachments on common and state lands encourage soil mining practices that diminish the long term productivity of the land [World Bank (1990)].

[6] When peoples survival is at stake they are forced to farm increasingly marginal soils, to reduce fallow periods which would permit the soil to renew its fertility, to cut vital forests in their search for arable land or fuel and to overstock fragile range lands [IFAD (1992)].

Within both processes the debate is less than clear; and, especially on land degradation issues it is generally perceptual. This lack of clarity is born out of the complexity of the phenomenon and further clouded by the lack of adequate information. There are numerous difficulties associated with definition, measurement and maintenance of analytical rigor. Attempts at rigorous analyses generally gloss over the underlying assumptions and the inherently weak statistical basis. The emotionalism associated with images of severely denuded hillsides or starving malnourished children tend to take over. The debate looses further clarity through the involvement of several intellectual disciplines that do not speak a common language.

"While there may be some consensus in the available literature on what constitutes land degradation; its short- and long- term implications are not very clear" [Scherr and Yadav (1995)][7]. Similarly while knowledge about poverty is expanding rapidly, thanks in large parts to the massive international focus and resources brought to bear on its understanding in the last ten years or so; the existing state of knowledge is still far from providing a comprehensive understanding of all the complex dimensions of its processes[8]. Even less clear and limited is the understanding of the interactions of poverty and land degradation[9].

This study is organized as follows: Initially the understanding on each process is evaluated. Issues connected with definition and measurement are highlighted and current empirical estimates are presented. Next the relationship between poverty and land degradation is evaluated at the conceptual level. The empirical evidence is presented and attempts to explain observed behavior are analyzed. The implications of the current understanding for policy research generally and for the CGIAR in particular are presented in the last section.

DEFINING LAND DEGRADATION AND SUSTAINABILITY

There are several definitions for land degradation. Land[10] degradation is generally defined as the reduction in the soil's ability to contribute to crop production [Blaike and

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[7] This study, part of the IFPRI 2020 exercise, presents the synthesis of discussions from a three-day workshop of 35 experts from 14 countries representing a cross section of disciplines. The discussions at this workshop were structured around four research paper prepared especially by IFPRI to address the land degradation and food production linkages namely 1) an extensive literature review comparing existing studies of the scale and effects of land degradation 2) a modeling exercise to simulate some of the effects of land degradation on global food production, trade and consumption [Agcaoili, Perez and Rosegrant (1995)], 3) a modeling exercise to simulate the process of land use intensification in the drylands of the Sahel to 2020 [Barbier (1995)], and 4) a review of ecological principles and natural resource degradation and improvements and microeconomic foundations for changes in land management in tropical hillsides and their implications for policy [Scherr, Jackson and Templeton (1995)].

[8] Conclusion of the World Bank's workshop on the "Future of poverty analysis in the Bank", March 16, 1997 reported in Malik (1997).

[9] Studies on the direct empirical verification of the relationship between poverty and land degradation are extremely scarce. Scherr and Yadav (1995) after their comprehensive survey of available literature conclude that no consistent relationship between poverty and land degradation can be established.

[10] The concept of land used in such studies is broad. It is the extensive system of physical and biological materials and processes associated with the interface of the solid earth, terrestrial water bodies and the

Brookfield (1987)] and as a change to land that makes it less useful for human beings [Wasson (1987)]. Examples of land degradation can be found in erosion, salinization, 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[11]. Land degradation[12] effects are cumulative. The off site effects (sedimentation of reservoirs and deposition of silt on downstream fields), both positive and negative, can also be considerable. A formidable problem exists because there is no simple relationship between the physical phenomena and the perceptions of land by human beings. What is observed in the present is the result of the interaction of several complex processes over long periods of time. For complete detection and measurement of land degradation, a system is needed for monitoring change in physical, biological and social phenomena[13]. The heterogeneity of the situations and the complex and changing (overtime) interaction of the several processes involved has negative implications for precise measurement[14].

Concern with land degradation arises out of the increasing focus on sustainability. There are several definitions in use for sustainability in agriculture. There is a need for a clear and widely agreed upon perspective[15]. Existing definitions can be broad and all encompassing. For example sustainability is defined as meeting the needs of the present generation

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air, and the works of human beings [Chisholm and Dumsday (1987)].

[11] Scherr (1998) classifies these to include: crusting, compaction, sealing, wind erosion, water erosion, devegetation, overtillage, impeded drainage, waterlogging, reduced waterholding capacity, reduced infiltration, salinization, alkalinization, acidification, nutrient leaching, removal of organic matter, burning of vegetative residues, nutrient depletion, overapplication of agrochemicals, industrial contamination, decline in vegetative cover, decline in biodiversity, decline in species composition, decline in availability of valued species. Land degradation involves aspects of physical soil management soil Water management, soil nutrient and organic matter management, soil biology management, vegetation management.

[12] Degradation and erosion are not the same although the terms are used interchangeably. Erosion is only one (though probably the most well known and significant) possible form of degradation.

[13] For an excellent discussion of detection and measurement issues of land degradation processes see Wasson (1987).

[14] Much of what we know about the extent and nature of land degradation is based on 1) anecdotal evidence 2) suspended sediment measurements and 3) plot level soil loss measurements. The anecdotal evidence, though generally visually spectacular, is often non-representative and does not control for the effects of other factors. The suspended sediment measurements are difficult to undertake and do not provide information on the effects on yields. The plot level soil loss measurements come from test plots. There are also serious issues of the representativeness of field conditions and practices associated with these. Measurements are generally carried out in short periods – whereas actual soil loss varies substantially because of changes on other conditions. What are needed ideally are estimates of long term average loss. Moreover, these measurements are generally limited to soil loss and not productivity loss. These measurements generally assume that soil moved from one field is soil lost whereas it might have moved from one field to another. Because of these data problems often it is very difficult to decide on the existence or severity of land degradation [Pagiola (1994)].

[15] The lack of an agreed perspective is brought out forcefully in the discussion on conceptual issues relating to sustainable growth of agriculture in Crosson and Anderson (1993). Given the increasing concern with the potential impact on the welfare of current and, in particular, future generations the need for an agreed perspective for identifying measures that can guide analysis of policies, approaches, and achievements in the field of poverty, natural resources and the environment is obvious.

without compromising the ability of the future generations to meet their own needs [The World Commission on Environment and Development[16], (1987)]. Sustainable development means more efficient use of arable lands and water supplies. It requires avoiding overuse 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 salinization or water logging of croplands. It means avoiding the expansion of agriculture to steep hillsides or marginal soils that would rapidly erode [World Resources Institute (1982)]. In the literature sustainability is often confused to imply zero depletion of the natural resource base or zero environmental costs. "Agricultural production that imposes some resource depletion and environmental costs can be sustainable as long as the costs of depletion and environmental damage are consistent with rising per capita welfare [Crosson and Anderson (1993)]. From an economic perspective, therefore, 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)" [Scherr and Yadav (1995)].

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 on 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 other 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 processes involved.

The problems associated with drawing representative samples for plot level measurement have meant that most aggregate estimates are based on non-scientific methods of "raising" the information. Most estimates of the impact of land degradation are based on 'objective assessments' by experts. Aggregate estimates of the cost of degradation have to be taken with even greater caution since they are based on standard formulas relating certain levels of degradation to estimates of yield losses. Attempts to go from the estimates of the effect of yield losses at the plot level to aggregate estimates of the socio-economic impact at the national or regional level have often been dubbed as "giant leaps of faith". Even at the plot level the problems associated with measuring the physical and social value consequences of alternative natural resource management practices and technologies are "big and complex" and not amenable to perfect solutions [Crosson and Anderson (1993)].

The inadequate basis of the available numbers is, however, generally lost in the emotionalism that pronouncements of the catastrophic extent of land degradation generally 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

[16] Generally referred to as The Brundtland Commission

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 an increasing focus on the negative consequences of the interaction of man and natural resources[17]. On the other hand complacency[18], based upon the phenomenal increase in agricultural (especially food) production during the last forty years or so, might well be misplaced.

There is thus a tremendous need to obtain a fuller understanding of the different aspects of soil degradation based on data generated through consistent definitions and scientific rigor. As already stated the studies of the impact of soil degradation are based, in one crucial aspect or the 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[19]. 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 Bank (1997)]. The land quality indicators (LQI) program[20] was setup 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 characterize the conditions of natural resources related to land. The program seeks to develop a set of standardized indicators (mainly focused on the local and district 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].

The Global Land Assessment of Degradation (GLASOD[21]) is the first major exercise that has sought to maintain some consistency in definitions in its endeavor to obtain aggregate estimates of land degradation [Oldeman, Hakkeling and Sombroek (1990)]. The comparative study of dry lands by Dregne and Chou (1992) represents another important effort[22]. While the GLASOD exercise was designed to study the problem at the

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[17] The Hardin study had brought the focus to bear on the tragedy of the global commons. The issues of land degradation relate more to local commons.

[18] This complacency has been likened by some to the misconception of the man hurtling headfirst from the top of a twenty story building stating merrily, as he falls past the ninth floor, that there is nothing serious to worry about because nothing has happened yet! The influential FAO study World Agriculture towards 2010 reflects this complacency on an aggregate level [Alexandratos (1995)]. It does however, highlight the seriousness of the problem in certain regions.

[19] For example U.S estimates of the magnitude of soil erosion and the effects of soil erosion on land productivity come from only two sample surveys [Crosson (1986)].

[20] This program involves agencies such as the Food and Agriculture Organization, the United Nations Development Program, the United Nations Environment Program, and the Consultative Group on International Agricultural Research (CGIAR). The World Resources Institute, the International Food Policy Research Institute and other CGIAR institution are also participating.

[21] The GLASOD estimates are also subjective because these are based on expert's estimation of land degradation since the Second World War.

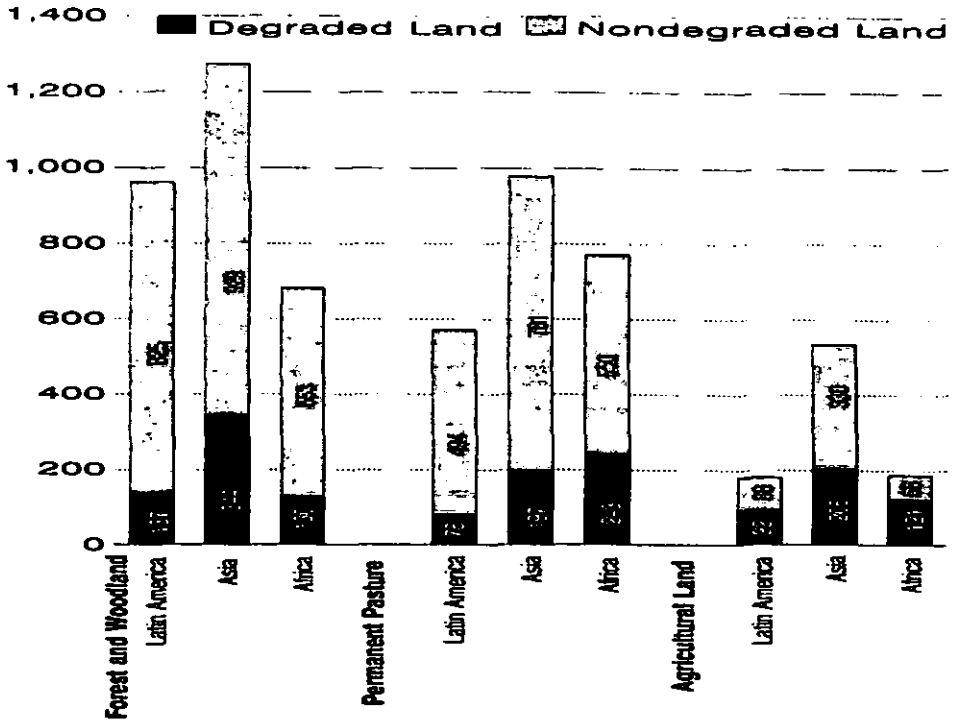
[22] Studies listed in Scherr (1998) by methods used for assessment of soil degradation impacts include:

continental scale, the latter study was designed for analysis at the national level but was limited by the availability of national studies. The study[ASSOD] by van Lynden and Oldeman (1997) represents a recent attempt at arriving at estimates of land degradation. While the methodology is basically the same as the GLASOD study it permits analysis at the national level while the GLASOD was focused on the larger regional level.

The estimates based on the GLASOD study indicate that of the 8.7 billion hectares of vegetated area (agricultural land, pasture, forest and wood land) nearly 2 billion hectares (22.5 %) have been degraded since the mid century. Some 3.5 percent of the total have been degraded so severely as to be reversible only through costly engineering measures if at all. Just over 10 percent has been moderately degraded and is reversible only through significant on farm investments. Another nearly 9 percent is lightly degraded and easily reversible through good land management.

Qualitative assessments: Pagiola and Dixon (1997), Oldeman, et al (1991), van Lynden and Oldeman (1997), Seghal and Abrol (1994) and Dregne (1990, 1992). Biophysical models of degradation-yield relationships: Aune, et al (1997); Kilasara, et al (1995); Stocking and Benites (1996), Cassman, et al (1995) with secondary price data to obtain estimates of value: Aune (1995), Pagiola (1997), Littleboy, et al. (1996). Aggregate, gross valuation of economic losses due to degradation and cost benefit analysis: Pimentel (1995),Young (1993), Lutz, et al. (1994), McIntire (1994), White and Jickling (1994). Econometric models: Byringiro and Reardon (1996), Rozelle, et al. (1997), Lindert (1996), Bojo (1991), Rozelle, et al. (1997), Byringiro and Reardon (1997), Alfsen et al (1997), Agcaoli, et al. (1995), Higgins, et al. (1983). Comprehensive Assessments based on disaggregated data (by soil type, farming system, crop): Stoorvogel, et al. (1993), Smaling and Stoorvogel (1993), Repetto, et al. (1989), Lal (1995)

Figure 1. Land degradation by type of land use: A regional perspective (million hectares)



Source: Scherr and Yadav (1995) based on GLASOD estimates.

The GLASOD estimates indicate that nearly half of this vegetated area is under forest of which about 18 percent is degraded; 3.2 billion hectares are under pasture of which 21 percent is degraded and nearly 1.5 billion hectors are in crop land of which 38 percent is degraded. Water erosion is the principle cause of degradation. Wind erosion is an important cause, particularly in dry lands and areas where landforms are conducive to high winds. Chemical degradation such as salinization and nutrient loss, is the result of cropping practices. It accounts for a smaller over all proportion of degraded lands but more than 40 percent of cropland degradation. Physical degradation such as compaction accounts for a smaller proportion of degraded area. According to the GLASOD estimates degradation of cropland appears to be most extensive in Africa, affecting 65 percent of cropland area compared with 51 percent in Latin America and 38 percent in Asia. Degradation of pasture is also most extensive in Africa, affecting 31 percent, compared with 20 percent in Asia and 14 percent in Latin America. Forrest land degradation is most extensive in Asia affecting 27 percent of forestland compared with 19 percent in Africa and 14 percent in Latin America [GLASOD estimates reported in Scherr (1998)].

The most important on-farm effect of land degradation is declining potential yields. However, fertilizer use or changing the land use can mask land degradation for long periods. Because of this it is almost impossible to establish a one to one relationship between the amount of degradation and the effect on yields. Moreover, the level at which

yields are affected by changes in land quality can differ by the type and variety of crop grown and by type of soil and its depth etc. While measurements on land degradation generally cover short period of time, any measurable effect on crop yields could however, take long periods of time to appear because of the cumulative nature of land degradation.

The literature on land degradation in developing countries 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[23]. The lack of knowledge on the effects of degradation on social welfare is especially glaring. "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 a natural resource, somewhere between nonrenewable and renewable; and the effects of land degradation on common property resources and externalities" [Anderson and Thampapillai (1990)]. The social welfare consequences of land degradation are generally not analyzed. There are no available studies at the household level that empirically verify differences in behavior between the poor and the non-poor with respect to land. Such studies require improvement in basic data and development of the socio-economic analytical aspects[24]. Given some of the problems described above such an agenda would have to be based on building up from a large number of case studies. In order to ensure common perspectives such a research program should involve the biophysical scientists, the socio-economic experts and the land users working closely together. Use of consistently defined household level socio-economic panel (longitudinal) surveys that have specific land quality assessment modules in several of the "hot spots[25]" could provide effective answers[26]. Such surveys would also be extremely useful for studying the dynamics of poverty.

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[27] concludes that

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[23] 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) leads some studies to use site parameters from specific developed country locations [see for example Veloz et al. (1985)].

[24] Careful analysis requires disaggregated and detailed data. The availability of disaggregated data on population, incidence of poverty, land use and infrastructure is essential for rigorous analysis. Such data for India enabled Fan and Hazell (1997) to show that public investments in low potential rain fed areas, [coupled with high yielding varieties, irrigation and education] would increase agricultural productivity and reduce rural poverty. And, that the resultant gain per unit of additional investment would be higher than similar investments in irrigated or high potential rain fed areas. Similarly a study using the detailed 1992 -93 World Bank Living Standards Measurement Survey data for Vietnam found that the highest impact on net crop income would occur in Vietnam's two poorest regions: the Northern Uplands and the North Coast [van deWalle (1996)].

[25] These "hot spots" in land degradation based on the recent assessment of an international group of experts are presented in Annexure 1.

[26] The IFPRI Pakistan panel survey of rural households collected information on land quality in 1993. However, this information, has not been analyzed to date.

[27] Scherr (1998) contains the most comprehensive review of studies showing the impact of land degradation. At the global level she reviews UNCOD (1977), UNEP (1980), Higgins et al (1983), Harrison (1984), Mabbutt (1987), Buringh and Dudal (1987), Dregne and Chou (1992), Oldeman et al.

"many studies examine the gross impact of degradation on crop production[28] [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 (1998)]. Scherr could find only three studies that provided data relevant to the assessment of human welfare impacts. These welfare assessments use different indicators to assess the impact at national or international levels[29]. A detailed review of the results and methodological aspects of these studies is available in Scherr (1998) and is therefore not attempted here. However, the results from the IFPRI simulations are reproduced below.

Simulations based on the global food production and trade model developed at IFPRI under different scenarios for degradation indicate that by the year 2020 an additional seven to nine million children will be mal-nourished under the assumptions of severe degradation. The base line estimate from this model is two hundred and six million malnourished children (so that this would imply approximately one to three percent increases in the baseline). The results indicate that land degradation may not be as severe a problem during the next two decades or so, as many believe. According to the simulations a decline in investment in agricultural research and infrastructure will produce downturns of a similar magnitude.
However, these results a problem of some concern; while the global picture may not be as bleak the regional effect of land degradation can be expected to be quite severe in some countries, for example China and Pakistan.

CLASSIFYING THE APPROACHES TO LAND DEGRADATION

Biot et al (1995) have classified the main approaches to land degradation into three groups. These they term as: the classic; the populist revolution that shares characteristics with the neo-Marxist or world systems diagnosis of problems of land degradation and the neo-liberal counter revolution embodied in the approach taken by the World Bank. The authors find that these approaches are neither sequential nor mutually exclusive. The present emphasis of poverty as both a cause and an effect of environmental degradation is shared by both the neo-Marxist and the neo-liberal approaches. Concern with the issue of population pressures on natural resources which was a popular theme of the classic

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(1992), Pimentel et al (1993), Steiner and Herdt (1993), Crosson (1994), Agcaoli et al (1995), WOCAT (1995), Dyson (1996), Stocking and Benites (1996), Crosson (1997) and Scherr and Yadav (1995)

[28] Oodit and Somonis (1992) estimated that salinity has reduced the yield of major crops by 30 percent in the fifteen million hectares of irrigated lands in Pakistan are significant. Repetto (1994) states that the land lost through badly managed irrigation schemes has negated the advantages gained through the green revolution. The study by Crosson (1995) indicates that the average productivity losses in the dry lands between 1945 and 1990 were in the range of 11.9 to 13.4 percent. Globally he calculated that if all strongly and extremely degraded lands were restored there would be a 15 percent yield increase. Given the spectacular growth in global food production and the secular declines in grain prices over this period it is obvious that other factors must have compensated for the effects of degradation on aggregate performance.

[29] The CGE model for Nicaragua, one of these three studies, finds a counter-intuitive positive effect of degradation on peasant consumption [Alfsen et al. (1996) reported in Scherr (1998)].

approach has also reemerged in the neo-liberal counter revolution literature. These approaches differ basically in terms of the role of the State and in their emphasis on the structural and immediate causes of land degradation. They also differ in terms of the assumptions regarding peasant behavior and in the diagnosis of the problem. This classification emphasizes the *perceptual* nature of the problem identification and underscores the inability of the available innovations to address the issue. Biot et al. (1995) state the basic dilemma as follows: "Land degradation is *perceived* to be a problem, there are *perceived* to be many technological and institutional innovations that can solve them and these have been promoted by aid organizations - and yet these innovations seem not generally successful. Why?"

Answers to this dilemma lie in getting to the reality behind these perceptions to develop common perspectives. Detailed evaluation of the factors underlying these perceptions. should bring together all the actors; the international and national research systems - the bio physical and social scientists, the donor/development agencies, governments at all levels and those who eke out a living from the land in the diverse situations around the world.

The main characteristics of the three approaches as summarized by Biot et al (1995) are presented below:

Main Approaches to Land degradation

Variable	*Classic*	*Populist*	*Neo-liberal*
Structural causes of land degradation	over-population, backwardness, lack of foresight, ignorance	resource distribution, inappropriate technol-ogies	inappropriate property rights institutions, prices and rapid populn. Growth
Immediate Causes	mis-management by users	mis-management by State, capitalists, TNCs big business	poor government policies and bureaucratic rules and regulns
Academic discipline; profession	science;bureacratic	sociology;activist	economics; development professional
Research framework	systematic empiricism	Rapid/Participant rural appraisal, community as unit of analysis	methodological individualism
Technology	soil conservation works particularly terracing	agronomic techniques of conservation	not specified
Peasant behavior	ignorant, irrational traditional	virtuous, rational community minded	rational, egocentric
Diagnosis of problem	environmental solution	socio-political solution	economic solution

Source: Biot et al. (1995)

DEFINING POVERTY

Poverty is defined as the inability to attain a minimal standard of living[30]. Generally a consumption-based[31] poverty line is used and estimates are made of the head count index

[30] Three questions are relevant to operationalizing this definition: How to measure the standard of living? What is meant by a minimal standard of living? And having thus identified the poor how to express the overall severity of poverty in a single measure or index? [Lipton and van der Gaag (1993)]

[31] Expenditures are found to be better measures of welfare than incomes especially at the lower ends of

and the poverty gap ratio[32]. The World Bank supplements the consumption-based poverty measure with others such as nutritional status, life expectancy, under five mortality and school enrollment rates in what it terms the Priority Poverty Indicators[33] (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 data it is impossible to conduct rigorous analysis of the decision-making processes of poor households.

The World Bank has, therefore, mandated that detailed poverty assessments be undertaken for all countries. In 1990 such assessments were available for eleven countries, which together accounted for forty percent of the total population of the developing world and for fifty percent of the poor. The older surveys were less reliable than the more recent ones. The World Bank first began conducting poverty assessments in 1989. Since then a total of eighty-four (seventy-five countries and nine updates) assessments have been completed covering approximately ninety percent of the world's poor. Although, the overall robustness of the poverty profiles has improved there is, however, still considerable variability in quality[34]. This variability was confirmed by a recent report of the *Operations Evaluation Department of the World Bank (1996)*[35].

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the income distribution because these reflect the household's ability to borrow to smooth consumption.

[32] The Forster-Greer-Thorbecke (1984) class of decomposable indices which are generally used as measures of poverty are presented in Annexure 2.

[33] Non-income measures of welfare can include anthropometric measurement especially of vulnerable groups such as children under the ages of five an pregnant and lactating mothers. The World Bank augments these direct income and non-income measures of poverty with information on socio-economic aggregates that indicate for example the access to social services. Access to social services denote the "public" incomes that the poor enjoy from the provision of health, education and other services that governments provide; consumption of which generally does not show up in household surveys. The Living Standards Measurement Surveys LSMS of the World Bank are especially designed to measure such access in addition to the other information that is generally required for computing the poverty measures. Moreover, the LSMS provide an element of consistency in the information that is available. However, these LSMS surveys generally require enormous resources, which restrict the ability of the developing countries to institutionalize them. The lack of such institutionalization implies that the information is sparse. There are very few countries for which comparable data are available over time.

[34] 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? Why are they poor? A poverty profile is a simply instrument for making poverty comparison. 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 pattern of economic change is likely to affect aggregate poverty. 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 reform which improves farmers terms of trade is very likely to reduce aggregate poverty. [Kanbur (1987, 1990)].

[35] 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 bench-marks for evaluation: 1) inclusion of a profile of Priority Poverty Indicators (PPIs) 2) diagnosis of poverty 3) set of prescriptions for poverty reduction and 4) operational content of the prescription.

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 what 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 the national level for the countries for which these have been collected. This limits the usefulness for understanding specific processes related to poverty and the relationship to other processes such as land degradation.

The existing information indicates that of the world's 5.6 billion people about 1.4 billion live in absolute poverty. A further 1.1 billion are living at subsistence levels. One in every five children lives in absolute poverty. About six hundred and thirty four million poor rural households are living on fragile lands of which three hundred and seventy five million (59 percent) are in Asia. The World Bank statistics indicate that 75 percent of poverty is rural in nature. It is higher in Asia than in Latin America. In Asia the poor are predominantly the rural landless. In Africa it is the rural smallholders. There is a higher incidence of poverty in the regions of poor resource endowments (northeast Brazil and rural Savannah's of Ghana). Larger families and women and children are more vulnerable to poverty.

IFAD (1992) remains to date the most detailed analysis of its kind available in the literature on rural poverty. Based on data for the late 1980s, this study found that over 80 percent of the poor people in the 114 countries for which it analyzed available data were based in the rural areas. In the 42 least developed countries the study found that as much as 69 percent of the total rural population lives in poverty. This figure was 31 percent for Asia, (46 percent if China and India are excluded), 60 percent in sub-Saharan Africa, 61 percent in Latin America and the Caribbean and 26 percent in the Near East and North Africa. In absolute terms these percentages translate to 633 million in Asia, 204 million in sub-Saharan Africa, 27 million in the Near East and North Africa and 76 million in Latin America and the Caribbean.

Substantial improvement in aggregate global welfare has been achieved over the past few decades. For example between 1965 and 1990, world food production grew by 90 percent[36] while population rose by 60 percent. This growth has, however, not been uniformly distributed[37]. The increase in food production has resulted largely from yield increases. It is estimated that 93 percent of the incremental cereal output is due to intensification alone. Area expansion remains important in Africa and Latin America accounting for 40 percent and 32 percent, respectively, of cereal production increases over

[36] The growth in agricultural production has resulted from the expansion of the agricultural systems; use of chemical fertilizers, pesticides, tools and machinery; improved seeds; and, land-improving investments particularly irrigation and drainage.

[37] In sub-Saharan Africa cereal production increased by only 60 percent while population increased by 105 percent.

this period [Mink (1993)]. Average consumption per capita in developing countries has also increased by about 70 percent in real terms; average life expectancy has risen from 51 to 63 years; and primary school enrollment rates have reached 89 percent. If these gains were evenly distributed, much of the world's poverty would be eliminated.

Poverty is 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[38]. Introducing several such dimensions can seriously complicate the measurement problems. That is why, most measurement is based on material deprivation[39] generally linked to the inability of incomes to meet basic nutritional demands.

Poverty measurement is difficult at the 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. Increasing attention is only now being paid to the systematic collection of socio-economic information through household income and expenditure surveys that are representative. The heavy costs involved generally imply that the data that such surveys yield are only representative 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 come from entirely different samples and have generally been collected for entirely different purposes. The problems of the reliability and non-availability of the basic information are compounded by problems associated in the 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 cutoff so fashionable in previous studies, for example, masked tremendous

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[38] Isolation is defined in terms of lack of physical access to roads and mass communication. Alienation can be both functional and educational. Domination and dependence arise from tenurial relations. Agricultural families that are tenants and sharecroppers can be dominated by and be dependent on rural elites. Lack of participation in decisions involving their own well being result from the rural poor seldom belonging to formal groups or organizations. Lack of assets both physical and social, and vulnerability are important characteristics of the poor. There are several inter-linked socioeconomic processes that both create and perpetuate rural poverty. Amongst these policy induced processes that have a bias, which excludes the rural poor from the benefits of development generally, accentuate the impact of other poverty processes. Dualism as an important poverty perpetuating process. In most ex-colonial societies small and marginal farmers are hurt because resources starting with the best land are preempted by large, primarily export oriented commercial farms [IFAD (1992)].

[39] Material deprivation can be reflected in serious protein energy malnutrition. However the evidence is mixed on the relationship between levels of poverty and levels of malnutrition. Studies in Pakistan find high levels of malnutrition amongst children whereas corresponding levels of poverty in other countries do not display the same levels of malnutrition [Malik and Malik (1992)].

differences in minimum calorie requirements across regions due to differences in body structures, climate and levels of physical activity[40]. In the case of estimates of rural poverty, for example, such estimates generally ignored incomes in kind from home production and to that extent may have been significantly biased upwards.

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 this study, found in the marginal areas. Material deprivation arising from population pressure and limits on resources will breed alienation and overcrowding poverty. Vulnerability to natural calamities (e.g., drought) labor 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[41]. According to the IFAD (1992) study environmental degradation leads to both transitory and chronic poverty (IFAD terms these as peripheral and endemic poverty) and affects small holders, landless, nomadic pastoralists, ethnic groups, artisanal fishermen, refugees and household 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 42 of the least developed countries. While this classification is extremely helpful; given the nature of the data on which it is based, it is only indicative of the types of aggregate patterns. Furthermore it does not help in answering specific questions or in furthering the understanding of the interaction of the poverty and land degradation processes.

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[40] The use of the parity adjusted expenditure of $1/day/person, currently in vogue at the World Bank, has its own problems [see Ravallion (1994, 1992)].

[41] This classification assumes that the international processes produce traumatic/sporadic poverty which affects small holders, refugees, and households headed by women. Domestic policy biases produce interstitial, peripheral, overcrowding, traumatic/sporadic and endemic poverty these processes affect small holders, landless, nomadic pastoralists, ethnic groups, artesinal fishermen, refugees and households headed by women. Dualism produces interstitial and peripheral poverty and affects small holders, landless, nomadic pastoralists, ethnic groups, artisanal fishermen, refugees and households headed by women. Population pressure leads to peripheral and over crowding types of poverty. It affects smallholders, landless, nomadic pastoralists and households headed by women. Environmental degradation leads to peripheral and endemic poverty and affects small holders, landless, nomadic pastoralists, ethnic groups, artisanal fishermen, refugees and household headed by women. Natural cycles produce peripheral, traumatic/sporadic and endemic poverty and affect small holders, landless, nomadic pastoralists, ethnic groups, artisinal fishermen, refugees and households headed by women. Gender biases lead to endemic poverty and affect households headed by women. Cultural/ethnic biases produce interstitial and endemic poverty and affect ethnic groups exploitative intermediation produces interstitial, peripheral and endemic poverty and affects small holders, landless, nomadic pastoralists, ethnic groups, artisinal fishermen and women. Internal civil strife leads to traumatic/sporadic poverty and affects smallholders, landless, nomadic pastoralists, ethnic groups, refugees and women [IFAD (1992)].

In summary the aggregate information available indicates that poverty is largely rural (80 percent of all poor are located in the rural sector). It is much higher in the least developed countries (about 69 percent of the rural population of these countries lives in poverty). In terms of its proportion to the region's population it is highest in Latin America and sub-Saharan Africa followed by Asia and the Near East and North Africa. The largest absolute numbers of rural poor however, reside in Asia followed by sub-Saharan Africa, Latin America and the Caribbean and the Near East and North Africa. Population growth is the single most important poverty perpetuating process[42]. Rural poverty and especially that caused by environmental degradation afflicts small holders, landless, nomadic pastoralists, ethnic groups, artisanal fishermen, refugees and household headed by women[43]. This heterogeneity makes any analysis of the poverty land degradation relationships all the more complex. The aggregate trends indicate that tremendous growth in income has occurred in the last forty years and it is the inequality in the distribution of the gains from this growth that leads to the differential impacts on poverty. Population growth is the single most important poverty perpetuating process. Even in situations where the percentage of poor people has declined the absolute numbers can continue to increase. In aggregate regional terms rural poor comprise mainly the landless in Asia and the small holders in Africa.

The lack of comparable estimates of poverty overtime makes it difficult to evaluate trends. However, based on whatever data are available the consensus appears to be that even when growth has been associated with rising inequality, it appears that poverty has typically fallen [Fields (1981), World Bank (1990, chapter 3) and Squire (1993)]. Ravallion and Datt (1994) estimate that the historical elasticity of the poverty head count measure to mean consumption is about minus 1.5 for India; the only country where a reasonably long time series of poverty measures is available. Bell and Rich (1994) estimate that the rural poverty head count responds to real agricultural output per head with an elasticity of minus 1.5 to minus 0.8, depending on model specification.

Nearly all studies agree that agricultural growth (especially growth and stabilization of food staples production) is likely to benefit poor people[44]. The trends indicate that agricultural performance has been bad in all those countries that have remained poor. The evidence is that globally times and places of relatively high (growing) farm output have also featured relatively low (falling) rural poverty. While the evidence is mixed on the relationship of growth to inequality there is some evidence to indicate that the level of

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[42] Population growth is assumed to impact on poverty through increased pressure on land and other resources, social services and employment, as well as, in some cases, through a shortage of labor due to out migration.

[43] For an excellent discussion of the problems inherent in the existing knowledge on poverty see Miller (1996).

[44] Some examples where agricultural growth is not necessarily pro poor also exist [see Cohen (1980)]. However, the general experience is that agricultural growth works in several ways to improve the welfare of the poor. Its large direct and indirect multipliers on income and employment open up avenue for the poor to participate in the growth process.

initial inequality of incomes and of assets determines the degree to which growth is translated to reduction in poverty.

High yielding cereal varieties have benefited the poor by restraining food prices, providing rural employment and raising incomes of small farms.

In arable areas, lack of land is a clear correlate of poverty, but it is an imperfect one [Ravallion and Sen (1994)]. Generally three forms of interventions are suggested to improve the access of the poor to land [IFAD (1992)]. These are redistribution of ownership rights, regulation of tenancy contracts and the role of land titling[45]. Land redistribution is generally advocated on the basis of potentially improved equity and efficiency. Implementation of such programs has been strongly affected by political realities. From the point of view of the impact on land degradation the redistribution should imply increasing intensification. At the same time the redistribution should improve access to credit so necessary for the use of inputs that can correct for the soil depleting effects of the intensification and at the same time for investments in land improving technologies. However, it should be noted that in cases where such redistribution has occurred there is greater likelihood that the poorer lands are redistributed to the landless.

Tenancy reforms also have a basis in the equity and efficiency arguments. Such reform can however, increase landlessness by large scale eviction as was evidenced in South Asian experience. Amongst the different forms of tenancy arrangements share cropping arrangements are increasingly looked upon in the literature as mechanisms for risk sharing. Moving away from such arrangements can imply unintended negative effects through a reduction in traditional risk sharing arrangements that such contracts implied and to the resultant pressures for resource degradation.

The experience with land titling in the African case in particular has shown that the benefits can be both positive and negative. Theoretically, land titling is considered important for increasing tenure security with a view to improving investment in land and water conservation and capital inputs and adoption of permanent crops and for providing the collateral for ensuring increased access to institutional credit and for promoting landmarkets deemed to be so essential for the development of commercial agriculture. Lack of title can bias the farmer's decision towards short-cycle crops. However, operationally the wealthier farmers can exercise their influence to obtain greater rights. Such titling is also supposed to have considerable negative effects on women.

The relationship of poverty and land is intimate given the links to agriculture and rural areas. Countries that are classified as low income have much higher shares of agriculture in GDP and even higher shares of rural labor force as compared to the industrial market economies [World Bank (1990)]. The share of agriculture in gross domestic product in the

[45] There is a belief that traditional tenure systems can achieve development objectives under low population density but are not compatible with rapid economic change and large increases in population pressure.

low-income countries was about 30 percent while the proportion of total labor force in agriculture was about 68 percent. The corresponding figures for the industrial market economies were 6 and 2 percent respectively [Dasgupta (1993)].

Quibria and Srinivasan (1991) in a comparative study of seven Asian developing countries in the late 1980's showed that rural poor depended more on agriculture than the rural non-poor did. This has also been observed in West Africa [Reardon et al. (1992)]. While one third of rural income and one quarter of employment typically derive from non farm activities, the prosperity of these people also depends substantially on the forward and backward production linkages - and even more on consumption linkages - from farmers [Chuta and Liedholm (1981), Hazell and Haggblade (1993), and Hazell and Ramasamy (1991)]. Given the high labor intensity and relevance to local food availability and prices of agriculture most anti rural poverty strategies for production activities are based substantially on agriculture.

Income derived from common property resources is much more important to the rural poor than to the non-poor especially in the arid and semi arid regions. The studies by Jodha (1985, 1986, and 1991) show that common property resources accounted for 20 percent of the income of households cultivating less than two hectares (including landless households) and between 1 –2 percent amongst the non-poor households in 21 groups of villages in India. These studies also show that common property resources declined sharply in area and productivity between the mid 1950s and the mid 1970s. However, "it is the combination of more people, high interest rates and other "short-termist" incentives, scarce land and inadequate technical progress that threatens to validate the claim that population growth in rural areas causes resource degradation – and to do so whatever the structure of property rights" [Lipton (1997)].

Rural poverty 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 the soil than cereals and root crops. Most export crops grow on trees and bushes and have a continuous root structure and provide canopy cover. Repetto (1988) shows that with grasses planted underneath such export crops the rate of soil erosion is substantially less than with food crops[46]. 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 draught and the possibility of greater mortality amongst the herds. These extra animals can lead to overgrazing and land degradation.

Mechanization, that is labor displacing, (especially if is subsidized) can have negative impacts on poverty [Binswanger and van Braun (1993), Mellor and Desai (1985), Bell and Rich (1994), Ravallion and Datt (1994), Lipton and Longhurst (1989)]. Lack of alternative sources of employment can lead displaced families to scavenging off the land

[46] However, the fact that women control food while men control cash crops can generally translate into reduced incomes of women with increasing commercialization and resultant deterioration in the nutritional status of the families [see for example von Braun and Kennedy (1986)]

and common property resources leading to land degradation. The impact of irrigation on poverty is much less clear and depends on the technical features of the type of system used [Narian and Roy (1980)] However, the processes through which irrigation leads to increasing soil salinity are well documented in the ecological literature [see for example Ehrlich, Ehrlich and Holdren (1977)].

Rigorous analyses of the differential behavior of poor versus non-poor households in terms of land degradation are sadly not available. Such analyses require specifically collected data 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 the obvious questions of the generalizeability of the results. There is a strong need to replicate such studies in as many situations as possible to be able to build up a body of knowledge for which conclusions can be generalized.

MAPPING RURAL POVERTY AND LAND QUALITY

The marginal lands study [Nelson et al. (1997)] had noted the great limitation in the understanding of the nature and distribution of marginal lands and the lack of readily available data in a geo-referenced framework, in particular with respect to the incidence and nature of poverty and probability of land degradation by land type. The World Resources Institute under a contract with UNEP/GRID/Arendal is conducting such a study [Henninger (1997)]. This work is part of the ongoing project to strengthen the use of geographic information systems in agricultural research[47] and extends the previous work done by the World Resources Institute in mapping indicators of human development for West Africa. The set of poverty indicators used by the World Bank have been expanded to include accessibility (i.e. the degree to which people have access to resources) and vulnerability (low income groups who face high income uncertainty because of natural resource degradation). By including vulnerability defined in this way the researchers are hoping to identify a large proportion of people who can be easily pushed into poverty when the natural resource sector they depend on for their basic needs is being degraded.

Henninger (1997) notes the degree to which individual or geographic factors are causing poverty has implications for developing a strategy for agricultural research, which tends to improve the situation of the poor. If geographic factors play an important role then geographic targeting of agricultural research to the poor in these areas can become a useful tool to address poverty issues. This of course assumes that the ability of individuals to migrate out of these marginal areas is restricted. There is some evidence to support this assumption. The work by Ravallion (1994) shows significant spatial effects on living

[47] The idea of defining and mapping major regions of the world in terms of climate, soils and natural vegetation as an aid to agricultural planning is not new. Systems of classification date back to the 1930s. [Koppen and Giger (1936), Troll and Paffen (1965), and Papadakis (1975)]. These have proved useful in the work of the international centers for agricultural research.

standards after controlling for non-geographic characteristics. These he terms as spatial poverty traps. Under Ravallion's geographic model, the mobility of individuals is restricted and poverty has a causal link to geography. Local factors (climate, soil type, infrastructure and access to social services etc.) change the marginal returns of investment, for example, to a given level of education.

The data limitations for mapping marginal lands in most developing countries were highlighted by the Marginal Lands Study [Nelson et al (1997)]. The soil and length of growing period maps used to define the marginal agricultural lands and the favored agricultural lands included no information on land cover or use. Population data were only available at the first sub national level and a constant poverty rate was applied for all areas within a country. Such data limitations were also evident in the IFPRI study by Broca and Oram (1990). These shortcomings will however, remain till more detailed data become available. The World Bank's Living Standards Measurement Surveys and the Macro International's Demographic and Health Survey data sets which are the most likely sources of data for the socio-economic aspects of such endeavors were originally designed to yield results representative at the national level. These were originally not intended to be broken down by sub national units.

The usefulness of these exercises is constrained by the aggregate level of the available comparable information. Ranking of countries and territories according to the rural poverty dimension need to be strengthened with more disaggregated information from several sources to make such exercises more effective for prioritizing research activities. Where the research mandate already has a clear natural resource mandate such rankings can assist in effectively prioritizing activities [ICARDA (1997].

POVERTY AND LAND DEGRADATION

Lipton (1997) puts it forcefully when he states 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[48] unless very strong pressures to do so are present[49]. Four such pressures are discussed in the literature[50]. These include (1) increases in population as

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[48] Often the problems of poverty, population and the environment are intertwined: earlier patterns of development and the pressure of rapidly expanding population mean that many of the poor live in areas of acute environmental degradation [World Bank (1990)].

[49] The World Bank maintains a similar position. "The poor do not willfully degrade environment but poor families often lack the resources to avoid degrading their environment. The very poor, struggling at the edge of subsistence, are preoccupied with day to day survival. It is not that the poor have inherently short horizons; poor communities often have a strong ethic of stewardship in managing their traditional lands. But their fragile and limited resources, their often poorly defined property rights, and their limited access to credit and insurance markets prevent them from investing as much as they should in environmental protection. When they do make investments they need quick results [World Bank (1992 PP 30)].

[50] According to the World Bank the main source of pressures generating problems of degradation is thought to lie in rapid population growth. Other pressures come from the widespread use of natural

mortality falls but fertility declines lag 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 was discussed in terms of "carrying capacity[51]." Conceptually, if nothing else changes, then 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 continues 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 similar to 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 labor scarce developed countries and generally reflect the factor endowments of these countries.

IMPACT OF DEGRADATION ON THE POOR[52]

The poor generally have access only to areas, which have higher risk for health and income generation[53]. And they generally lack the resources to reduce the exposure to the 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

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resource intensive technologies; ineffective regulation of common property resources; land tenure systems that do not secure long terms rights to land use; and policies that distort the prices of non-renewable resources [World Bank 1991, in Biot et al (1995)].

[51] Attempts to compare current and projected populations to potential population supporting capacities (PSCs) at certain levels of technology have found that with low input technologies typical of current production practices 1975 populations had already exceeded carrying capacities in several West African countries. The study by Higgins, Kassam and Miken (1983) predicted that 7 of the 8 Sahelian countries will exceed population-supporting capacities by the year 2000. Regional imbalances and environmental damage were greatest in the Sahelo Sudanian zone despite low population densities.

[52] Much of the discussion in this and the following subsection draws heavily from Mink (1993)

[53] The most debilitating risk is that of drought in semi arid tropical areas. The combination of poverty and drought can have serious environmental consequences that threaten future agricultural productivity and the conservation of natural resources. Poor people are induced to scavenge more intensively during droughts, seeking out wood and other organic fuels, wild life and edible plants, both to eat and to sell. This scavenging aggravates deforestation and damage to watersheds and soil already under stress from the drought. The problem is aggravated in common property pastoral farming where farmers carrying extra cattle as insurance against drought may exploit and over burden the carrying capacity of the land increasing the likelihood of permanent damage. Small ruminants can be exceptionally damaging to sources. Poorer households are generally responsible for raising small ruminants, which are allowed to graze low quality resources especially on open access and common property land [IFAD (1992)].

happen both directly through, for example, lower yields per unit of labor per acre because of reduced soil quality and indirectly through the reduced physical capacity of labor to produce because of malnutrition and poor health. Even in cases where the poor are healthy labor productivity can be low due to increased time being allocated to less-productive activities such as fuel wood collection and away from agriculture and other income generating activities [Kumar and Hotchkiss, 1988]. 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[54]. Non-replenishment of soil nutrients leads to soil exhaustion as fuel food 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 or artificially with fertilizers. A homogenous crop, usually a cash crop, grown repeatedly on the same piece of land can lead to soil exhaustion[55]. 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.

POVERTY IMPACT ON RESOURCE MANAGEMENT

Poverty imposes short time horizons[56]. Theoretically this would result 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 rates. Similarly farmers are less likely to make natural resource investments where returns are expected after a number of years. These factors combine to lead to a wide divergence between private and social discount rates[57]. The empirical evidence on whether the poor really do have high rates of time preference is limited and sketchy[58].

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[54] The loss in grain production as a result of diverting dung from fertilizer to fuel use in Africa, the near east and Asia has been estimated at up to 20 million tons per year [Redclift and David (1990)].

[55] Given the declining yields on the land and the inability to find the institutional support in terms of fertilizer and access to credit and technology, poor farmers are forced to sell their land and become land less peasants or to encroach on new forest lands [de Graaff (1993)].

[56] This is not to say that short time horizons are exclusive to the poor.

[57] Veloz et al. (1985) in their analysis of a soil conservation project in the Dominican Republic show that soil conservation is profitable on only 20 percent of the land area using private analysis. Alternatively social analysis based on discount rates that reflect the society's inter temporal preferences,

Risk aversion can lead to a short time horizon. To the extent that outcomes in the future become less certain than outcomes closer to the present, people will prefer to trade the more uncertain outcomes for the more certain ones. Risk aversion amongst farmer is widely documented [Binswanger (1980), Walker (1981), Grisley (1980) and Sillers (1980)]. The results of these studies generally indicate that attitudes of the poor to risk are not distinguished from those of the non poor by innate or acquired characteristics but by the higher levels of risk faced by the poor and by the greater constraints to coping with these risks. Deteriorating land quality brings not only poorer yields but also greater yield fluctuations and hence higher risk[59]. To the extent that access to common property resources serves as insurance for the poor in times of setbacks to the primary sources of income the decrease in access can increase the risk. Migration can benefit the environment through mitigating risk[60]. Individual migration is increasingly seen as an outcome of family decision making, particularly in response to uninsured risks [Stark (1991)].

The poor face greater constraints to managing their risks. Their assets and stored production are generally minimal. Their access to credit and insurance is generally limited and or non-existent. Rural credit and insurance markets in developing countries are notoriously fragmented. In most cases there is also a gender bias so that poor women have far less access to mechanisms for managing risk than their male counterparts. If risk is allowed for, the interest rate incentive to deplete is probably sharpened. "Higher interest rates reduce the present value burden of long term future risks relative to that of near term risks (and costs). The land use patterns are therefore shifted towards activities with long-term risks such as possible long-term resource degradation. There is thus a powerful resource depleting incentive created by rising interest rates. Costly credit undoubtedly shifts the composition – of inputs, outputs, techniques, investment, consumption and savings – sharply in a resource depleting direction" [Lipton (1997a)].

THE LINKS BETWEEN POVERTY AND LAND DEGRADATION – EMPIRICAL EVIDENCE

The study by Scherr, Jackson and Templeton (1995) found no consistent relationship between population density or the frequency with which land is used for productive purposes and degradation of the land. 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 of poverty and a host of other factors that need to be

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indicate that soil conservation is viable in nearly 70 percent of the land area.

[58] The ICRISAT study by Pender and Walker (1990) which estimated high rates of time preference through experimental games for a small sample of poor farmers in India is generally cited as an example.

[59] Reardon and Vosti (1997) note that generalized poverty erodes traditional community risk sharing or insurance institutions by over taxing them: forcing the poor to fend for themselves often turning to resource mining and commons dependant strategies.

[60] Remittances are an important coping strategy for rural poor [Alderman and Paxson (1992)].

controlled for. Such data are not available at the present time. Reliance therefore has to be placed on studies from which the relationships can be inferred.

Most of the available studies study the problem in terms of the behavior of small farmers and land degradation. Southgate (1988) maintains that small 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 has not provided incentives for the small and poor farmers to conserve their land. In some cases this has led to the mining of resources for maximum output. Mortimore (1989) on the other hand finds evidence of small farmers' willingness to forgo short-term income gains even under price and famine pressure to persue long term sustainable management strategies. The existence or non-existence of secure land tenure systems might explain the contradiction of results about small farmer behavior. Several studies cite the lack of secure land tenure as the primary reason for poor farmers cultivating their land excessively to exhaustion for the simple reason that they have no vested interest in conserving an asset which they do not own [see for example Southgate (1988), Mink (1993), Repetto et al. (1989)].

INDUCED INNOVATIONS IN NATURAL RESOURCE MANAGEMENT

Induced innovation theory a la Hayami and Ruttan (1984) and Boserup (1965) suggests that degradation 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.

This Induced Innovation Model in Natural Resource Management assumes that, with increasing population density or market demand, four distinct phases/time periods of management response can be identified. In the model the total supply of services and products from a given resource are a function of its quantity, quality and productivity of use. The first phase is characterized 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 characterized by dependence on human managed resources (agro-forestry, forest plantations and managed reserves). The innovative responses of period three or four may not occur or may be delayed due to a number of conditions.

Such "Farmer-based innovation" describing the evolutionary process of adapting production technology to changes in factor scarcity is reported in a number of studies [Pingali and Bingswanger (1984), Bingswanger and Ruttan (1978), Hayami and Ruttan (1985)]. These explanations draw their inspiration from the experience of the land scarce agricultural economy of Japan, where by the late 1800's biological innovations had begun to increase yields per unit of land while the United States which had many times more land

per head of agricultural labor, had adopted a mechanized form of agricultural technology. It was, in response to rising land values in the 1940's, that biological innovations were adopted widely in the United States.

The evidence presented in *Farming Systems in the Tropics* documents a large literature showing that agricultural innovations are historically associated with increasing population density or increasing market integration in different agroecological zones [Rutenberg (1980)]. This study strongly suggests that most innovation in the tropics was either endogenous or resulted from transfer/adaptation between trading partners. Similarly much of the technical change in crop management and landscape management was a consequence of the crises in soil management. Others [Pingali, Bigot and Binswanger (1987) and McIntire, Bourzat and Pingali (1992) also document similar association of farm management in the area of mechanization.

Other examples of largely endogenous transformation to local land- use innovations and local institutional development include the widely cited experience of the Machakos district in Kenya [Tiffen, Mortimore and Gichuki (1993)]. This heavily degraded area with its very low agricultural productivity and income had a population density beyond its "carrying capacity" in the 1930s. Yet over a 60-year period, although the population increased five-fold and the resource base has not been rehabilitated, the estimated value of agricultural production at constant prices has increased threefold. Despite considerable movement into more marginal agricultural zones, there is widespread tree-growing, most agricultural land has been terraced; and many new agricultural technologies are in use. The availability of good roads, opportunities to grow high value-added products for the Nairobi market and access to capital for land-related investments (terracing, tree growing, live fencing, water harvesting) enabled this change. The opportunities to generate off farm incomes aided in the process.

Several other examples available in literature deserve to be mentioned. A study by Scherr (1993) documents the case of two districts in the mid- altitude region of Kenya near Lake Victoria where degradation of land and reduced crop yields and subsistence scarcities led to agroforestry strategies oriented towards intensification. The studies by Migot-Adholla et al. (1991) and Place and Hazell (1993) document endogenous change in property rights in Africa[61].

However, there is controversy over the adoption of conservation strategies. One school of thought maintains strongly that adoption of land conservation technologies is low across all agricultural environments despite major support and investment in research and development on the problem. Instances where land degradation management have been successful are known[62] but analysis of these instances have not yet provided clear

[61] The study by Place and Hazell (1993) found that the binding constraints on agricultural productivity were, in fact, lack of improved technology and inadequate access to credit.

[62] Several successful farmer controlled soil conservation methods have been developed and implemented at reasonable cost: A century's old practice in India is being rediscovered, adapted and promoted. Deeply rooted, hedge forming vetiver grass, planted in contour strips across hill slopes, slows water run off

guidance to policy makers, researchers or developers to enable more general adoption of these technologies ["Towards a Research Agenda for the World Bank on Land Degradation", an informal workshop on land degradation held in January 1991].

The other school maintains that the lack adoption of conservation technologies results from a lack of incentives[63]. "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 who and how they reach decisions on resource use and environmental management [Biot et al (1995)].

HOUSEHOLD LEVEL EFFECTS OF DEGRADATION

Change in agricultural practices can have primary and secondary effects on the environment. von Braun (1997) describes this relationship between agricultural change and the eventual effects at the household level through these environmental effects. Such change has come about in the large part of the world through the adoption of the 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 decline. 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 the green revolution technology 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 and through indirect effects as well. For example, irrigation can lead to reduced water quantity or quality, salinization, increase in mosquitoes, aquatic snails and blackflies.

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dramatically, reduces erosion, and increases the moisture available for crop growth. A quiet revolution has taken place and today 90 percent of soil conservation efforts in India are based on such biological systems. In the Sahel simple technologies involving construction of rock bunds along contour lines for soil and moisture conservation in Burkina Faso have on average increased yields by 10 percent in normal years and in dryer years by almost 50 percent. The Central Visayas Regional Development Project in the Philippines couples the promotion of contour grass strips for erosion control with distribution of young animals. The cost of preventing soil erosion and degradation are comparatively small while the costs of rehabilitating degraded areas can be large [FAO (1992)].

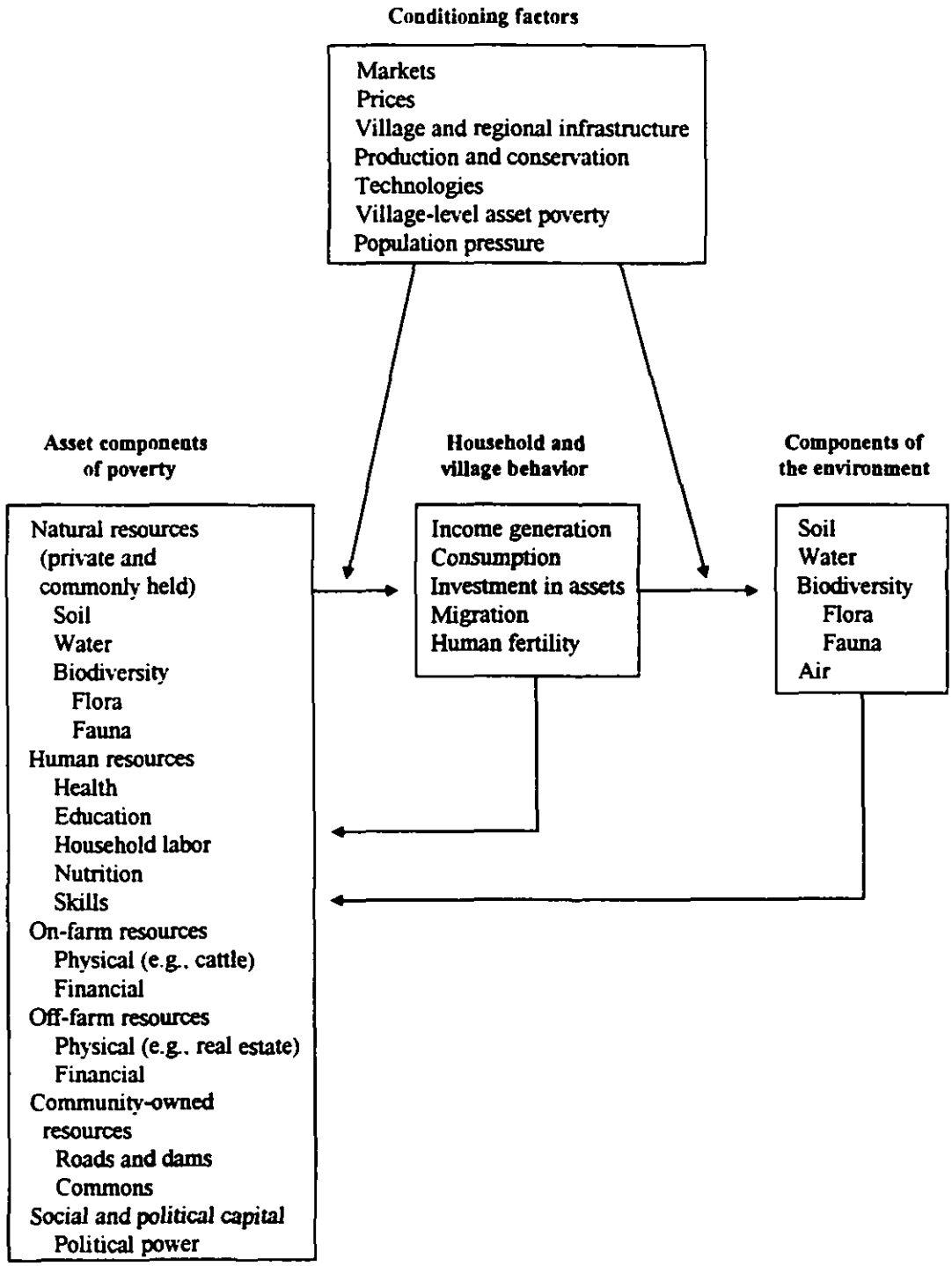
[63] Investment in land will depend on the importance of the farm vis. vis. non-farm incomes. There is considerable evidence that non-farm and off-farm incomes are relatively more important to livelihood security in areas with poor land. [See Adams (1995) for examples from fragile agricultural areas in Pakistan.]

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, sanitation deficiency, diet change 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 show up as such. That is why it is important to include the non-income measures of poverty such as anthropometric measurements in assessments of the poverty status.

CONCEPTUALIZING THE MANY COMPLEX LINKAGES 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 the relationships. Poverty is seen to be the product of "asset" components comprising natural resources (private and commonly held), human resources, on-farm resources, off-farm resources, community-owned resources and social and political capital. These links are shown in Figure 2.

Figure 2. Poverty and environment links



Source: Vosti and Reardon, 1997.

These determine household and village behavior 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 behavior and between the household and village behavior 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, fertilizer and modern seeds with conservation investments (such as bunds, terraces, windbreaks and practices such as organic matter application) the study finds 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: complimentary public infrastructure investments (such as culverts to divert waterflow from farm bunds) that make household investments more profitable to institutional innovations; that improve security and transferability of resource tenure; and, that modify community level arrangements to improve the management of the commons or watershed [Vosti and Reardon (1997)]. In the same book 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 poor on resource miming especially in response to draughts and floods.

Defining poverty in this way sets a much higher cutoff than the conventional poverty measures. 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. Estimates of the capital costs of prevention vary with the farming system, the methods used, and topography. Expenditures of $50-$150 per hectare (sometimes less) for such measures as farm forestry and contouring with vetiver grass or other vegetative barriers are typical; $200-$500 may be required per hectare for structural measures (terracing, land leveling, earth banks, and the like) on undegraded lands. Rehabilitation, in contrast, may cost from $500 to several thousand dollars per hectare, depending on the severity of the problem [FAO (1992)].

While this conceptual model provides an interesting tool for understanding some of the complexities involved; it highlights the trade-off between depth and detail of understanding and concomitant data requirements and the inadequate methodology and resources available for measurement. It also highlights the need for realism in attempts to introduce rigor in policy analysis.

Duraiappah (1996) presents an interesting conceptual model for analyzing the many relationships between poverty[64] and environmental degradation. For simplicity he postulates four possible, though not mutually exclusive relationships[65]. These are

R1: 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 it is caused by R1, R2, R3A, or R3B or various combinations of all four. Second, the presence of R4 can set into motion an R1 type of link but in this case it is indigenous poverty, which 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 sets into motion more environmental degradation by a R1FB relationship. The downward spiral of poverty leading to degradation leading to more poverty [Durning (1989)] is an R1FB type of relationship. The various permutations and combinations of these four relationships highlight the complexity of the relationships. 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 function 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. Firstly from within the sector due to decreases in agricultural productivity and secondly from the fuel wood manure relationship. In the first case evidence of declining agricultural productivity in degraded lands causing indigenous poverty which in turn forces many of the people to continue to degrade their land further to extract subsistence outputs. The R2 link in the forest sector can cause an R1FB affect in the land degradation category. R2, R3A, R3B and R1FB linkages can cause salinization. In the case of desertification, the primary links highlighted by Durriapah are R2, R3A and R3B.

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[64] He defines indigenous poverty as poverty caused by environmental degradation and exogenous poverty as that caused by factors other than environmental degradation.

[65] He postulates three crucial initial conditions: 1) no environmental degradation, 2) no indigenous poverty and 3) the possibility of the existence of exogenous poverty.

The author concludes that most environmental protection programs fail because they address only the symptoms while they ignore the causes i.e. they address only indigenous poverty while the other four factors are still present.

RESOLVING THE DILEMMA – THE ROAD AHEAD

In the hetrodox policy approach to land degradation currently in vogue the "solutions to land degradation are thought to lie in out-migration, training poor people in better techniques of farming, diversification and off farm employment, providing local user groups with rights to manage degraded communal lands...Policies to make land tenure more secure in areas in which traditional tenure systems have broken down...adoption of low cost, low input technologies that would increase and stabilize yields, diversify production and maintain the resource base... (e.g.) contour cultivation... vetiver grass... improved technology to terraced lands[66] and more appropriate land tenure policies... government subsidies to develop and improve low return farming activities maybe the only way to reduce poverty in these regions" [World Bank (1990)].

Agricultural research is pivotal to such an approach. The impact of agricultural research is larger where both the severity of poverty and the number of poor are accounted for [ICARDA (1997)]. The development community, as exemplified by the World Bank [Walton (1997)] and TAC [Nelson et al. (1997)], is seeking to move from counting the poor to understanding processes and relationships and to documenting strategies that work.

The work of the International Agricultural Research Centers can contribute significantly in several ways to poverty alleviation and simultaneous natural resource management. This is reflected in a recent working paper issued by ICARDA (1997) which identifies such strategies. These strategies include efforts to develop technologies that simultaneously improve productivity and natural resource management that use low cost inputs that the poor can afford and apply; continuing to focus on developing resource management practices that conserve soil, water and vegetation and do not decrease productivity. It includes strategies that focus on developing and disseminating more diversified farming systems that reduce economic risk, contribute to greater resource use efficiency and provide higher returns to the farm community and continuing to focus on improved vertical integration from producers to consumers, including enhanced quality and added value of farm products, improved post harvest processing and storage, and employment generation [ICARDA (1997)].

These strategies call for the integration of research on commodity improvement with the conservation and management of natural resources. This has long been recognized as one

[66] In dry land areas gains will commonly arise more from improvements in physical structure leading to enhanced soil moisture levels and retention [Shaxson (1992)] than from the reduction of soil nutrient losses, although the latter are important [Stocking (1986)].

of the major organizational challenges facing the future of international agricultural research[67].

Several lessons reported in the Crosson and Anderson (1993) study are relevant to the agenda setting for policy research within this framework of integrating research on commodity improvement with conservation and management of natural resources (NRM). Specifically:

- If input policies and institutions are weak and the success of commodity research depends on purchased inputs then NRM research might be a better investment than commodity research;
- If commodity research and NRM research are complementary then poor policies and weak institutions lower the return to both kinds of research;
- Research to find ways to reduce off-farm losses caused by on-farm practices will only be used if farmers benefit from the solutions developed;
- Attacking some problems such as downstream effects of soil erosion at the farm level may not be the most efficient solution. It may be more efficient to increase productivity on the farm and find other technical and institutional means to reduce the damages of sediment downstream.

Research can help to clarify several questions that underlie these issues. Specifically answers to questions such as:

> Who are the principal resource users? What are their actual (as opposed to theoretical) incentives for investment and disinvestment in important natural resources? What are the farmer's and the community's perceptions of resource degradation? What is their understanding of the ecological processes involved when production systems change or their strategies of adapting to degradation change? What is the empirical evidence of resource degradation at the farm, community and regional levels, and the realistic estimates of the costs and benefits of resource rehabilitation for the different actors?

can greatly facilitate in the understanding for effective policymaking [Scherr (1998)].

Effective policy agendas, as Crosson and Anderson (1993) stress, need to be built on realism and should avoid the tendency to "reinvent another wheel for which there is no demand".

Precise measurement and rigorous analysis are necessary to understand fully the processes of poverty and land degradation. For effective extrapolation and prediction it is important to build up from several rigorous case studies of household decision making based on multi-year panel data sets that include specific land quality and use modules.

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[67] see the March 1993 Report of the Center Director's Working Group on Ecoregional Approach (Annex1, p.3)

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ANNEXURE 1: Hot Spots of Land Degradation

Nutrient Depletion	Salinization	Constraints to Yield Increases	Erosion
South and West Asia			
Mid-altitude hills of Nepal(with decline in nutrient supplements from forests) Poor soil quality in areas of northeastern India in transition to permanent agriculture	Indus, Tigris, and Euphrates River basins	Rice-wheat region(unspecified stagnation) Lack of suitable technology for marginal arable lands in Syria, Jordan, and Iran	Foothills of the Himalayas Conversion of rangelands in West Asia to grain production, creating erosion
East and Southeast Asia			
Nutrient mining in sandy soils of northeastern Thailand and remote upland areas in the region Poor quality soil in Myanmar, degrading in transition to permanent agriculture	Northeastern Thailand and China	Stagnant yields of intensive irrigated rice in dense areas of Java, China, the Philippines, and Vietnam (waterlogging, nutrient imbalance)	Sloping areas in southern China and Southeast Asia
Africa			
Semi-arid croplands of Burkina Faso and Senegal (leading to outmigration) Large areas under transition to short fallow or permanent cropping Reduction of silt deposits in the Nile Delta following construction of the Aswan High Dam	Nile Delta	Unsustainability of annual crops in humid lowlands of West Africa Densely populated highlands in Rwanda, Burundi, and Kenya-no obvious source of productivity increase Lack of suitable technology for crops grown in areas below 300 millimeters of rainfall in North Africa Poorly developed seed industry in North Africa	Subhumid southeastern Nigeria on sandy soils Wind erosion in Sahel Mechanization in North Africa causing water and wind erosion Mechanization with inappropriate plowing techniques, leading to devegetation and loss of topsoil (for example, transition zone in West Africa)
Latin America			
Subhumid Central American hillsides Semi-arid Andean valleys Northeastern Brazil Santa Cruz, Bolivia Caribbean Basin lowlands	Northern Mexico Highland irrigation systems South American irrigation zones		Subhumid Central American hillsides Semi-arid Andean Valley Haiti Cerrados of Brazil

intensification			

ANNEXURE 1: Hot Spots in Land Degradation (contd)

Deforestation in Threatened Habitat	Vegetation Degradation	Water Scarcity or Conflict	Agrochemical Pollution
South and West Asia			
	Rangelands, trans-Himalaya, West Asia, Pakistan, Rajasthan and Himachal Pradesh in India Grazing land in mid-altitude hills of Nepal, India, and Pakistan	Conflict in arid and semi-arid regions, especially the Euphrates River (Turkey, Syria, and Iraq) and he Jordan River (Syria, Jordan, and Israel) Depletion of the water table due to overpumping of wells (Syria)	Heavy use of pesticides on cotton in Turkey
East and Southeast Asia			
Loss of biodiversity with forest clearing Forest frontier of Indonesia, Malaysia, Vietnam, Cambodia, and Laos	Expansion of Imperata grasslands in Indonesia, Vietnam, and the Philippines Grazing lands in mid-altitude hills of Myanmar Devegetation of mangroves and drainage problems in coastal peats and acid sulphate soils	Conflict in high density areas Urban water quality problems	Water pollutionin high density areas and coastal areas Pollution from periurban agriculture Coastal and delta degradation due to sedimentation
Africa			
Conflicts between farming and protected areas in Madagascar	Arid and semi-arid rangelands devegetation(for example, Ciskei), particularly near water sources Devegetation due to intensive collection of wood fuel Devegetation due to overstocking (for example, Morocco and Tunisia) Reduced yields due to Imperata and Chromlaena infestation in degraded soils	Water conflicts: Nile River, Niger River, Logone River, Chari River, and (pumpingfor irrigation) Senegal River Exhaustion of irrigation potential in North Africa by 2020 Nile and Senegal River systems problem of allocation of water between agricultural and urban growth	

Latin America			
Humid Amazon and Central American hillsides	Overgrazing in Haiti	Paramo water scarcity	Banana plantation pollution
Lower Amazon Basin	Northeast Brazil		Santa Cruz, Bolivia, intensive agriculture
Itapua, Paraguay	Lower Amazon Brazil		Periurban agriculture in Mexico City
Pacific rainforest of Colombia and Ecuador	Overgrazing in Caribbean Basin lowlands		
Chaco region			
Atlantic lowlands of Central America			

Source: Scherr and Yadav (1995)

Annexure 2

POVERTY INDICES

The selection of an appropriate level of welfare is reflected in the choice of a cut-off or poverty line. Apart from the selection of poverty line the measurement of poverty generally focuses on computing three indices. These reflect:

a) The prevalence or incidence of poverty as measured by the fraction in the total population living below the poverty line i.e. *the head-count*

b) The intensity of poverty reflected in the extent to which the income of the poor lies below the poverty line, as measured by the differences between the two i.e. *the poverty gap*;

c) The degree of inequality among the poor, in such a way that income transfers from the worse off among the poor to the less poor should raise measured poverty and vice versa i.e. *the severity of poverty index*.

Foster, Greer and Thorbecke (1984) have suggested a useful general index that meets these requirements. Their class of poverty indices takes the following form:

$$P = \frac{1}{N}\sum_{i=1}^{q}[(Z_p - Y_i)/Z_p]^{\alpha}$$

where Z_p denotes the poverty line, Y_i the expenditure or income of the ith poor household (or individual), N the total number of households and q the number of households whose expenditures or incomes are below the poverty line.

This index is based on measuring the gap between the poverty line and the expenditure or income of the poor as a fraction of the poverty line $[Z_p - Y_i]/Z_p$, raising it to a power α and then summing over all poor units. Not only does the index take into account the prevalence and intensity of poverty, it may also be used to reflect the degree of inequality among the poor by varying the value of the α parameter.

Thus, if α=0, index P_α becomes: $P_0 = q/N$, which has been referred to as the *head-count index*. It reflects the proportion of total population lying below the poverty line, i.e., the proportion of poor in the total population. This measure is indifferent to the extent of poverty of the poor. It is only sensitive to their number and reflects the prevalence of poverty.

Alternatively, with $\alpha = 1$, the poverty index P_α becomes:

$$P_1 = \frac{1}{N}\sum_{i=1}^{q}[Z_p - Y_i]/Z_p = IP_0$$

where I is the "income gap ratio", i.e., the mean income gap of the poor $(Z_p - \bar{Y})$ - where $\bar{Y} = \Sigma Y_i/q$ is the mean expenditure (income) of the poor expressed as a fraction of poverty line. Thus, P_1 is the income gap ratio multiplied by the head-count index. This index, gives a good measure of the extent or intensity of poverty as it reflects how far the poor are from the poverty line. It may also be used to show the amount of income,

under perfect targeting, that needs to be transferred to the poor to close the poverty gap in order to eradicate poverty. However, P_1 is insensitive to income distribution among the poor. Income transfers between the poor will leave P_1 unchanged. For this to be reflected in the index, greater weight has to be given to the poorest units. This can be achieved by setting $\alpha = 2$.

If $\alpha = 2$, the poverty index becomes[68]

$$P_2 = \frac{1}{N} \sum_{i=1}^{q} (Z_p - Y_i) / Z_p]^2$$

P_2 is the mean squared proportionate poverty gap. This index is not easy to interpret as compared to P_0 and P_1, however, it has the advantage of reflecting the degree of inequality among the poor, in the sense that the greater the inequality of distribution among the poor and thus the severity of poverty, the higher is P_2.

This class of poverty indices is additive, it permits the summing up of poverty indices for various subgroups in the population.

[68]Lipton M. and Jacques van der Gaag. 1993. *Including the Poor*. World Bank/IFPRI