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Reducing Poverty through Cutting-edge Science

CGIAR Research Priorities for Marginal Lands

Attached is the Report of the TAC Study on CGIAR Research Priorities for Marginal Lands, together with the Transmittal Letter from the Chair of TAC to the Chairman of the CGIAR. The Study comprises the *Report of the Study on CGIAR Research Priorities for Marginal Lands,* the *Framework for Prioritizing Land Types in Agricultural Research,* the *Rural Poverty and Land Degradation: A Reality Check for the CGIAR*, and TAC's Commentary on this study.

This report will be discussed in plenary session under Agenda Item 4(a)(ii): *Integrated Natural Resources Management – Study on Marginal Lands.* The Panel Chair of the Study will summarize the findings, and a TAC Member will present the TAC commentary prior to discussion and decision-making by the Group.

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TECHNICAL ADVISORY COMMITTEE
Donald Winkelmann, Chairman

September 30, 1999

Dear Mr. Serageldin,

I am pleased to transmit to you the reports of TAC's Study on Marginal Lands. The Study comprises four papers: the first was prepared by a Panel chaired by Dr. Mike Nelson and is entitled *Report of the Study on CGIAR Research Priorities for Marginal Lands*; the second was prepared by Dr. Ted Henzell and the TAC Secretariat and is entitled *A Framework for Prioritizing Land Types in Agricultural Research*; the third was prepared by a Consultant to the TAC Secretariat, Dr. Sohail Malik, and is entitled *Rural Poverty and Land Degradation: A Reality Check for the CGIAR*; TAC's Commentary on this Study is the fourth paper.

This is an especially rich mixture of papers, the last two of them stimulated by the ideas emerging from the first. The collection has strong implications for the way the System prioritizes its efforts on less favoured environments. The overall conclusion of the Study is that the information available is insufficient to support the presumption that the character of marginal lands can be used to set research priorities that meet CGIAR objectives. In its commentary, TAC refers to a number of immediate implications of the results of this Study for Centre and System research planning. The Committee also raises a number of issues which will guide analysis of future resource allocation decisions.

On behalf of TAC, I would like to sincerely thank Dr. Mike Nelson and the members of his Panel, and Drs. Ted Henzell and Sohail Malik for their excellent work.

I look forward to a stimulating discussion at ICW'99.

Kind regards,

Sincerely Yours,

Donald L. Winkelmann

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TAC Chair

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TAC Commentary
on the CGIAR Study on Marginal Lands

I. Motivations for the Marginal Lands Study

CGIAR research is driven by the objectives of reducing poverty, enhancing food security, and promoting sustainability in the management of natural resources such as biodiversity, land, and water. The instruments it uses to achieve these goals are the provision and diffusion (particularly through training) of technological and institutional innovations to enhance the productivity and the sustainability of use of land and other natural resources. The technological innovations which the CGIAR generates tend to be specific to particular biophysical contexts: while some innovations are broadly generic, particularly if they pertain to fundamental research, most are applicable to specific contexts defined by a broad set of biological and physical features. For rural poverty reduction, contextual specificity then raises the possibility of targeting the rural poor by focusing research on the geographical areas with biophysical features where the poor are most heavily concentrated. Poverty concentration would mean not that there is a high incidence of poverty among the population in that area (where population may be very scarce), but that there is a high percentage of all rural poor located in the area. If, as conventional wisdom has it, most of the rural poor are located in areas characterized by marginal lands, then focusing CGIAR research on technological innovations for marginal lands would be an effective way of achieving the goal of rural poverty reduction. If, in addition, marginal lands are more susceptible to resource degradation, then the objective of sustainable natural resources management (NRM) would also be well served by focusing research on these areas. Also, if the poor themselves are a source of environmental degradation, and as poverty shortens time horizons and constrains the adoption of instruments that would enhance conservation, then technological innovations for marginal lands can help achieve win-win outcomes, with synergy between the goals of poverty reduction and sustainable NRM. Finally, if we suspect that there has been an initial under-investment by the CGIAR in research for marginal areas, i.e., over-investment in Green Revolution varieties that favoured the complementary input package found mainly in areas of high quality land, then a high uncaptured potential return to research on marginal lands may exist.

Because this argument apparently offered much promise, TAC took initiatives to address the issue through systematic analysis of existing evidence. Interest in the issue was prompted by recommendations derived from the February 1995 ministerial-level meeting held in Lucerne, and the IFPRI 2020 Vision paper, that the CGIAR should "ensure that its research programmes address the problems of the poor in less-endowed areas, in addition to continuing its work on high potential areas". This international concern for the less-endowed areas was driven by perceptions that the CGIAR's research efforts have done little for the poor in biophysically marginal lands, that most of the poor live in areas which are ecologically fragile, and that they are a cause and consequence of a downward spiral of resource degradation and deepening poverty.

TAC appointed a distinguished panel of experts, chaired by Dr. Mike Nelson, to look into the validity of the presumptions. The Committee also appointed a separate consultant, Dr. Sohail Malik, to review specifically what is known about the relationship between rural poverty and land degradation. These two documents prompted a response by Dr. Ted Henzell who proposed an alternative framework for prioritizing land types for the allocation of CGIAR research funds. These studies, sponsored by TAC, constitute a strategic initiative designed at improving the CGIAR's ability to set priorities and allocate resources to research. Marginal or fragile land was defined as land that is sensitive to degradation as a result of human intervention, and degraded land as land that has lost part of, or its entire, productive capacity as a result of human intervention.

The overall conclusion of this effort is that information is generally lacking to support the presumption that the character of marginal lands could be used to set research priorities that focus clearly on poverty alleviation. This, in itself, is an interesting conclusion since it calls into question conventional wisdom, which if followed, would lead to erroneous decision-making in allocating research resources. The evidence neither confirms nor rejects the conventional wisdom; it is simply inconclusive. This in turn suggests fertile areas for future research which the CGIAR and others concerned with poverty should address.

II. Results from the Marginal Lands Studies

The Nelson Panel concluded that there is "an abysmal lack of data" to validate the two presumptions that motivated the study, i.e., (1) that marginal lands support a high proportion of the rural poor, particularly the poorest of the poor, and (2) that the poor are the prime cause of resource degradation in marginal agricultural lands. In addition, it does not appear correct to say that the CGIAR underinvested research funds for these lands, even though there is no impact analysis showing whether these investments were effective for the goal of rural poverty reduction. We note too that there is still some confusion in characterizing poverty in marginal lands between incidence of poverty (it does not appear to be higher in these lands relative to favourably endowed lands) and number of poor (it appears to be higher in more favoured lands simply because population densities are so much higher than in marginal lands). Clearly, as far as the CGIAR is concerned, the second type of measure is the relevant one. Data, however, remain inconclusive on both measures of poverty and the Panel concluded that further research using available evidence could not disentangle these issues. It concluded that the focus on marginal lands may not be appropriate in guiding the CGIAR's strategy toward poverty alleviation.

In seeking an alternative concept to help target CGIAR research using a geographical criterion, the Panel proposed the idea of "marginal area". Such area is defined as a geographical unit characterized by a high incidence of "marginal people" and relatively homogeneous determinants of poverty. As TAC understands it, "marginal people" refers to marginalized people, with poverty as the dominant common consequence of marginalisation. Starting hence from marginality, the question is whether one can identify relatively homogeneous regions in terms of causation of poverty, whether the region is characterized by marginal lands or not.

It would seem correct to start the analysis from poverty, identifying the many determinants of poverty, and potentially singling out the quality of the biophysical environment as one of these determinants. If the biophysical determination of poverty turned out to be sufficiently strong, then a research effort to generate technological innovations for these areas would be justified. On the other hand, among the other determinants of poverty, there may be indicators that could prove to be more powerful than land type in setting research priorities to reduce rural poverty. Since data are generally not available, the validity of the Panel's proposed alternative criterion remains to be tested.

Lack of data may seem surprising since the World Bank has run extensive Living Standard Measurement Surveys with the objective of tracking poverty. These data, however, were not collected in association with relevant biophysical characteristics. Hence, statistical representation is not achieved over geographical units that can be characterized as marginal lands, and geographical representation is over regions that are in general too broad and heterogeneous to usefully fit a biophysical

characterisation.

Based on these findings, the Nelson Panel made four recommendations. The first recommendation is that "the CGIAR needs to sharpen its strategic focus on poverty alleviation, particularly in setting priorities for research related to marginal rural areas. A prerequisite is development of a geo-referenced database linking land conditions with poverty and the processes that produce it (i.e., the dynamics of poverty)". TAC endorses this recommendation. The CGIAR should in particular use the expertise in the now operational Consortium on Spatial Information (CSI) which TAC was instrumental in helping organise. This consortium has as one of its major objectives the improved mapping of the locus and level of poverty. TAC consequently intends to be a conscientious observer and potentially an active participant in the work of CSI and to play a role in using results from this work to guide the CGIAR toward better spatially targeted resource allocations.

Recommendation 2 is that "Centres should establish new forms of partnership in order to effectively address their role in a broader poverty alleviation strategy related to those who live in marginal areas". TAC concurs with the Panel that the determinants of poverty are multiple, that poverty reduction consequently requires focusing on an array of sources of income that go beyond agriculture, and that this should be achieved via partnerships with organizations engaged in combating poverty with other instruments. The CGIAR is partially addressing this recommendation through its ecoregional approach to research and also through the Systemwide Programme on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation, but greater efforts clearly need to be made toward implementing this recommendation, e.g. with those studying income from off-farm employment.

Recommendation 3 is that the CGIAR System should "develop improved mechanisms by which Centres can be involved with other partners in generating and interpreting improved scientific evidence on (1) the extent and magnitude of the impacts of agriculture, forestry, and fisheries on the degradation or enhancement of natural resources and the consequences for production, and food security; and (2) the linkage between poverty and observed resource degradation". TAC is indeed concerned that insufficient resources are devoted to problems of soil and water degradation apart from the corresponding Systemwide undertaking. This recommendation deserves further consideration by TAC. Meanwhile, IAEG is undertaking a special study to identify the determinants of these gaps and opportunities for intervention.

Finally, recommendation 4 is that "expanded collaborative mechanisms and activities should be developed among Centres and between Centres and their non-CGIAR partners, to help focus research and institution strengthening on issues related to adoption, adaptation, and utilization of research results that so far have remained unused". Existence of a continued backlog of un- or under-used research results has indeed been a long-standing concern, and most particularly in the field of NRM. This issue is addressed in the Review of Systemwide Programmes with an Ecoregional Approach (SDR/TAC:IAR/99/8).

Because the Nelson Panel was unable to fully address the question of links between rural poverty and land degradation, TAC asked Dr. Sohail Malik to review available literature on the subject. His report concluded with a note of caution about our ability to verify this relationship. He wrote that "understanding of the intricate process of poverty and land degradation is extremely limited. Definition,

in each process, is driven largely by the perceptions of those analysing the phenomena. The lack of clear conceptualization, the observed heterogeneity, and the diverse perceptions of those attempting the exercise complicate attempts at measurement. 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. Much more research in a variety of settings over a reasonable length of time is needed for deeper understanding of household (and community) decision-making processes, especially in terms of the relationship with land. The CGIAR is well placed to support such research". TAC agrees with this observation and recommendation. There is clearly no simplistic characterization of the link between poverty and natural resource degradation. What is needed is a set of conditional statements on this link that establish when the relation may hold or not and why. This defines an important research area which the CGIAR is well placed to address.

III. Toward a Framework for Prioritizing Land Types in Agricultural Research

Developing methodologies for the allocation of resources to research is a fundamental responsibility of TAC. In its own approach to resource allocation, TAC uses a formula that considers the poverty weighted value of commodities and sectors, subjectively weighted by the probability of success in research, themselves based on an assessment of changes in science. The Nelson Panel addressed the issue of how to take into account the category of land (particularly marginal versus favoured agricultural lands) in allocating resources. It proposed a two-way classification of lands, with the present value of land use on one axis and the potential for expansion of production through research on the other. Marginal agricultural lands with high potential to expand production based on research would thus deserve attention. This framework was generalized by Dr. Ted Henzell using as classification dimensions the value of present use of a land type and the potential benefits from investment in agricultural research. Benefits from and value of use can thus go beyond production to include, for example, total factor productivity, poverty reduction, and indicators of natural resource management.

These frameworks present ways to consider the problem. Their implementation is still far beyond what can be done at the moment, for the very same reasons that prevented the Nelson Panel and the Malik study from reaching conclusions about the meaning of marginal lands for targeting CGIAR research in fulfilment of its objectives. Data on the mapping between land types and poverty are largely missing, and studies of the potential impact of research on each land type are incomplete. Hence, developing and implementing a framework for prioritizing land types in agricultural research will have to wait for the required information to become available. To a large extent, the type of information that becomes available will determine the framework that can be used.

IV. Conclusions and Future Research

The TAC study on marginal lands has shown that more research, sometimes specific to a target area, is needed before those marginal areas can be targeted to achieve CGIAR objectives and before research resource allocation schemes are developed that take land types into account. The Committee consequently recommends that such decisions be deferred until further information becomes available. At the same time, Centres and others should be encouraged to engage in research that accelerates

generation of this information since it remains a fundamental issue for the CGIAR. TAC itself has a direct interest in accessing this information in order to improve its instruments for resource allocation in the CGIAR. It will consequently be looking for opportunities to expedite the generation of this information within the limits of its role and resources. Meanwhile, TAC underlines the need for broadly based agricultural growth as a prerequisite for poverty reduction.

The study on Marginal Lands has several immediate implications for Centre and System research planning.

- At the global level, the lack of correlation between land resource endowments and poverty, based on available data, has led TAC, with Member approval, to propose a logframe classification that does not separate outputs by land type at the System level. However, Centres are encouraged to consider specific targeting at the ecoregional level where evidence supports the belief that the correlation between the ecoregion and poverty may hold.
- Given the lack of proof of causal effects between poverty and land degradation, it is logical to proceed on the assumption that threatening land use practices and technologies cause resource degradation irrespective of who employs them. The targeting of degraded land does not selectively target poverty in most instances.
- The analysis indicates that there are areas of marginal land that may, in fact, have a significant potential for research-driven productivity increases, and that the returns on investment in these areas may equal or surpass short-term potential on more favoured areas. Targeting of resources on these lands should consequently help the allocation of resources in terms of productivity gains.
- To optimize the allocation of research funds between marginal and favoured agricultural lands for the purpose of poverty reduction, the key criterion is the marginal effect of research expenditures on poverty in each type of land. To date, there is little evidence of the measurement of these marginal effects and this issue deserves urgent attention.
- Lessons should be drawn from CGIAR success stories in marginal areas, specifically, in identifying those factors (e.g., technical assistance, access to credit) which complement centre research to enable poor farmers to adopt technological innovations in marginal areas.
- Investment in GIS applications would have significant payoff in assisting the targeting of marginal resource ecoregions with potential for productivity increase, and in identifying areas of poverty and marginal lands.

TAC closes its report by raising four key issues which will guide future research and resource allocation decisions for reducing poverty directly and indirectly:

1. <u>Potential of biotechnology and agroforestry for the marginal lands</u>

One of the defining features of the Green Revolution was that the new seeds fared better with complementary input packages including water, fertilizers, and chemicals for crop protection. Hence, there was complementarity between the new technologies and quality of the resource endowment. For this reason, Green Revolution innovations were better suited for favoured agricultural lands, and research for marginal lands appeared to offer a lower rate of return. Subsequent innovations, with a perspective on the poor and marginal lands, sought to help substitute for resources rather than pursuing

complementarities. These innovations can, for example, complement pesticide use (genetic resistance), fertilizers (nitrogen fixation), tillage practices, and water (drought resistance). Biotechnology, e.g., genetic maps and markers, possibly GMOs, now offers the promise of making it faster and less costly to achieve these goals. Following this logic, technological innovations derived via biotechnology and applied to particular contexts through GIS mapping may promise higher rates of return for marginal areas than earlier technology did. How this potential will materialize thus deserves significant attention.

In deciding on research investments for marginal lands, the comparative advantage of these regions needs to be carefully established. Some evidence from Asia points at the potential of agroforestry and of the production of cash crops as activities that have such a comparative advantage. In its efforts to reduce rural poverty, the CGIAR could consider extending its current portfolio to include activities with high potential for poverty reduction in marginal lands.

2. Determinants of poverty

Poverty in marginal lands is a complex phenomenon, where access to productive assets, public goods investments, institutional arrangements, and cultural and social factors are all important determinants. Hence, a cautious analysis of the determinants of rural poverty in marginal areas needs to be made, with a full accounting of the role of different factors including the biophysical context and the technological practices used. Caution, however, must be exercised as a technological solution may not be the cost effective answer. It is quite possible that other constraints are more limiting on welfare than productivity in resource use as determined by technology. Hence, a comprehensive effort needs to be made to identify the specific determinants of poverty in marginal lands as well as the return from investing in agricultural research compared to other types of interventions such as infrastructure, improved control over assets (human capital in particular), and designing the institutional framework. Understanding the potential of agricultural technology for the marginal areas consequently deserves a broad interdisciplinary effort before resources are committed to research on technological innovations specialized to these areas. Given the large degree of heterogeneity of situations, this research needs to be done at the local and regional level, followed by comparative analysis to seek broader generalizations.

3. Locus and mapping of the poor

Having access to reliable and well-documented data on the number and location of the poor is essential in identifying viable strategies to alleviate poverty. Several institutions are already engaged in activities to identify specific areas of poverty concentration and to map their agroecological characteristics. CGIAR Members should actively support their efforts and ensure that a coordinated and comprehensive plan is followed.

4. Marginal Lands and Water

Inadequate attention has been given to research issues related to marginal lands potential, defined in relation to water, cost of trade supporting infrastructure, and distance to markets. The CGIAR is well positioned to address water/land/poverty linkages beyond irrigation. Water insecurity appears to be a main poverty feature in marginal lands of arid areas and hillsides. Improvement efforts for marginal lands should continue to recognize explicitly the scope for supply and demand of water, the management of its use, and access to water especially by the poor.

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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

REPORT OF THE

STUDY ON CGIAR RESEARCH PRIORITIES

FOR MARGINAL LANDS

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

March 1997

Casilla 209-12
Santiago
CHILE

3 March 1997

Dear Dr. Winkelmann,

I am pleased to submit the report on CGIAR Priorities for Marginal Lands. The earlier version discussed at TAC 71 has been revised in light of that discussion and further exchange of views among members of the Panel. The revision is based exclusively on clarification of the concept of "marginal land" which changed drastically between Phase I and II and was modified further in the final report as a result of the above discussions. In consequence, Chapters 1 to 3 of the Phase II report were changed. However, the strategic elements (Chapters 5, 6 and 7) and the overall conclusions remain essentially unchanged.

At the outset I would like to trace the evolution of the Panel's thinking, starting from four tenets of conventional wisdom on: the nature of marginal lands; the concentration of rural poverty on such lands; the linkage between poverty and accelerated resource degradation; and the role of CGIAR research in poverty alleviation on these lands.

This line of thinking holds that:

> 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;
>
> they support a high proportion of the rural poor, particularly the poorest of the poor;
>
> 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;
>
> the impact of CGIAR research on agricultural productivity increase, environmental protection and, above all, poverty alleviation, has been limited on these areas.

.../2

Dr. Donald Winkelmann
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These ideas underlie the terms of reference (TOR) for the study and was fully adopted by the Panel and the TAC Secretariat in the initial stages of their work. It provided the basis for design of the extensive data collection and analysis undertaken by the Secretariat to quantify marginal biophysical characteristics, rural population and rural poor living on these areas, and CGIAR expenditures devoted to research on productivity increase (agriculture, forestry and fisheries), post-harvest activities and options for removal of institutional constraints, all of which were expected to contribute to poverty alleviation on "marginal lands" as defined by their biophysical characteristics.

The Panel subsequently rejected the first three tenets, but in defining marginal agricultural lands (MALs) relevance and credibility are implicitly assigned to both the concept that such lands can be defined solely by biophysical characteristics, and the project characteristics and expenditures (applied to MALs so defined) can be derived from the CGIAR project database.

The bottom line is the Panel's conclusion 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. In the final report, the marginal land issue is clarified by introducing the concept of “marginal areas” (MA) as being those 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.

This definition of marginal lands led the Panel to diverge from the original TOR. It clearly did not have the data to quantify the numbers of rural poor on areas specified by the sets of elements which explain why they are marginal. Thus the conclusions, in contrast to the expected output of the study, are general. No specific inferences are drawn on potential poverty alleviation gains from research investment on MAs to develop new technologies, understand farm and off-farm linkages in family survival strategies, and assess constraints and opportunities for change in the policy and institutional environment which may be seen as hindering poverty alleviation. Further, the Panel felt it was not in a position to assess the appropriate balance between CGIAR research investment targeted to MAs and to non-MAs. This step would follow from a clarification of where marginal people are, why they are marginal, and the options open to the System in addressing poverty in MAs.

On behalf of myself and the Panel I would like to express appreciation once again for the opportunity to address a small but challenging segment of the issues faced by the CGIAR, and for the chance to work with the Secretariat and members of the Committee.

Sincerely yours,

Michael Nelson

Michael Nelson
Panel Chair

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TECHNICAL ADVISORY COMMITTEE

REPORT OF THE

STUDY ON CGIAR RESEARCH PRIORITIES

FOR MARGINAL LANDS

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TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

March 1997

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CGIAR RESEARCH PRIORITIES FOR MARGINAL LANDS

EXECUTIVE SUMMARY

This study was expected to address CGIAR priorities for research on marginal lands. The final point in the terms of reference called for suggested priorities for research on these lands and an assessment of the appropriate balance of effort between marginal and favoured lands (FL). As it delved into the issues, the Panel discovered there was: considerable confusion on definitions and concepts of marginality; a strong body of conventional wisdom on the relationship between poverty, marginal lands (ML) and resource degradation, the role of the CGIAR in poverty alleviation, and the potential of ML to produce food; and an abysmal lack of data to validate this conventional wisdom. As a consequence the study has focused exclusively on strategic questions bearing on how the CGIAR might more systematically address poverty alleviation. In the process the Panel felt obliged to diverge from the initial hypothesis that research strategy would be determined primarily by the biophysical characteristics of ML.

Perceptions Driving International Concern with ML

The concern of the Lucerne Declaration that the CGIAR ensure that its research programmes address the problems of the poor in less-endowed areas derives from widely held views on the nature and scope of the issue. The axis is that research efforts by the System have done little for the poor on biophysically marginal lands. The view that most of the poor live in these fragile areas and are a cause and consequence of a downward spiral of resource degradation and deepening poverty, lends urgency to corrective action. Definition of strategy with respect to overall allocation of resources within ML and between ML and FL would require: forecasts of the poor, and the rate of resource degradation with associated yield decline and externalities; and an estimation of the potential poverty alleviation impact and the related environmental protection impact of research options applicable to both ML and FL. These premises and requirements were taken as the point of departure for the study.

Definitions and Concepts

Marginal lands: In order to provide a basis for mapping ML by biophysical characteristics, from which one could go on to determine numbers and incidence of rural poor and production potential for each area, the TAC Secretariat undertook an extensive analysis of existing data leading to a six-quadrant matrix of three land types: FL, ML and lands in low or zero intensity use (LZI), each sub-divided into two areas - those with a high expectation of a productivity response to research and those with a low expectation of response. The results from this exercise did not provide operationally relevant criteria for CGIAR decisions. Accordingly, a second approximation was made whereby biophysical characteristics establishing marginality were qualified by their current use in agriculture. This yielded estimates for favoured agricultural lands (FAL) - 800 million ha - and marginal agricultural lands (MAL) - 1,800 million ha.

Location and incidence of rural poverty: From the above figures estimates were made of rural population on the two land types - 930 million on FAL and 1,760 million on MAL. No data are available for rural poor on each land type. However, from examination of data on poverty

incidence in countries with high and low proportions of MAL and available case studies, there is no evidence that poverty incidence is higher on MAL than FAL. Applying available estimates of rural poverty incidence to rural population on these two land types results in 325 million poor on FAL (35%) and 630 million (65%) on MAL.

Role of the CGIAR in MAL: A review of the project portfolio suggests that about two-thirds of the System´s resources are invested in research relevant to MAL. But there are no data on what may be targeted to poverty alleviation. The centres have had many successes on marginal lands. If one accepts the above proportion of investment in MAL as well as the view of limited research impact on poverty, then a question of cost-effectiveness clearly arises. However, there is no evidence to support or refute the latter view. It is nevertheless a key question which can only be addressed by progressive accumulation of information along the lines proposed in Recommendation 1 discussed below.

Poverty and resource degradation: There is no evidence to support the view implying that the poor are the prime cause of resource degradation on MAL. Again, clarification of this issue would derive from data assembled in response to Recommendation 1 and the study called for in the TAC Soil and Water Study to address "myths" on linkages between poverty, resource degradation and externalities.

From Marginal Lands to Marginal People

In reviewing the data presented above on the location of poverty, poverty incidence and the allocation of CGIAR resources to MAL and FAL, the Panel came to the conclusion that the inconsistencies and lack of data on the underlying site-specific forces driving the poverty process were such as to invalidate their usefulness in guiding strategy towards poverty alleviation on marginal lands.

The concept identified as relevant to evaluation of strategy was "marginal area" (MA), which is defined firstly by presence of high numbers and high incidence of marginal people, and secondly is subject to a relatively homogeneous set of conditions which explain **why** they are poor - institutions, policy, infrastructure, human capital, biophysical characteristics of land, etc. This definition of the "unit of account" for analytical purposes poses two problems for the CGIAR:

> by redefining the issues in terms of MA which may incorporate any combination of ML and FL, poverty alleviation is being placed in a **global** context, thus moving away from the original intent to deal **only** with poverty on ML
>
> MAs, by definition, will be site-specific and likely to be heterogeneous, and subject to more internal diversity, complexity and institutional constraints than would be expected for non-MAs. This is information-intensive and clearly presents a challenge in structuring research to provide international public goods. It also establishes a context for poverty alleviation which goes beyond what the System is now doing or is likely to do.

The Panel is aware that over the past two years the CGIAR has fully adopted poverty alleviation as **the** objective of its research efforts and the MA approach proposed may be regarded as merely a restatement of this commitment. Nevertheless, it is felt that working through the ML/MAL/MA sequence has highlighted a number of dimensions which clarify strategic questions on

approach - the data gaps (poverty/resource degradation linkages, poverty processes), targeting marginal rural people and site-specific characteristics of MAs which condition the relevance of research. The Panel is convinced that the System must come to grips with the site specificity and both the biophysical and non-biophysical elements which explain poverty if it is to design research in expectation that poverty impact can be evaluated.

The entry point to an evolving strategy derives from **Recommendation 1: The CGIAR needs to sharpen its strategic focus on poverty alleviation, particularly in setting priorities for research related to marginal rural areas. A prerequisite is development of a geo-referenced database linking biophysical land conditions with poverty and the processes that produce it (i.e. the dynamics of poverty).**

The focus on poverty alleviation in marginal areas involves challenges in identification, development and organization of research. Chief among these is the need to develop new forms of partnerships with NARS, NGOs, developed country institutions and multi and bilateral agencies. The CGIAR´s role will be restricted, albeit important. The key to success is establishment of the right kinds of partnerships, hence:

Recommendation 2: The centres should establish new forms of partnership in order to effectively address their roles in a broader poverty alleviation strategy related to those who live in marginal rural areas.

System Research on MAs

The research thrust on poverty alleviation is seen to be in three inter-related areas:

Institutional and policy change: Work in this area has been covered by other TAC studies on social science, institutional, policy and management research. The main focus is on analyses of: poverty processes; opportunities and constraints to institutional change; and viable options for improving welfare within existing constraints.

Generating new and improved technologies: Technologies need to fit the institutional and socio-economic characteristics as well as biophysical conditions of MAs.

Diversifying land use systems and income opportunities: Research will follow lines already established for natural resource management and clarification of linkages between resource degradation and poverty. The focus would incorporate diversification of production from renewable resources and off-farm income opportunities.

Two recommendations derive from the above research agenda:

Recommendation 3: The CGIAR System should develop improved mechanisms by which centres can be involved with other partners in generating and interpreting improved scientific evidence on (i) the extent and magnitude of the impacts of agriculture, forestry and fisheries on the degradation or enhancement of natural resources and the consequences for production and food security; and (ii) the linkage between poverty and observed resource degradation.

Recommendation 4: Expanded collaborative mechanisms and activities should be developed among centres and between centres and their non-CGIAR partners, to help focus research and institutional strengthening on issues related to adoption, adaptation and utilization of research results that so far have remained unused.

Implications of a Broader Research Focus

The Panel recognized that it is recommending a broadening of the research focus to include non-traditional (for the CGIAR) types of research related to off-farm employment, postharvest technology, niche opportunities, and forestry, agroforestry and fisheries. Such expansion implies a possible readjustment in use of existing resources. On the question of whether there should be an increase in resources, the Panel is fully aware of the constraints. In this era of donor fatigue and contraction of funds for both national and international R&D for agriculture, any expansion may seem unrealistic. The nature of research to target poverty alleviation on MAs dictates the forging of new linkages between the CGIAR and other actors. High transaction costs are inevitable. However, there is an urgent need for an expanded innovative research effort to address poverty alleviation for those who live on MAs. These marginal people have been disregarded in the past. There appears to be a unique opportunity for the CGIAR to contribute towards correcting this neglect.

CHAPTER 1 - BACKGROUND

This study of research priorities for marginal lands comes as a sequel to the TAC study *"Priorities and Strategies for Soil and Water Aspects of Natural Resource Management in the CGIAR"*. That report highlighted the importance of "strengthening natural resource management (NRM) [with] explicit linking to ... the CGIAR contribution to poverty alleviation." In its review of the TAC report at the Mid-Term Meeting (May 1996), members of the CGIAR concluded that there should be a much greater sense of urgency given to soil and water research due to the centrality of the environmental issue.

The focus on poverty alleviation in marginal rural areas does not imply that the System is uninterested in the poor who live on the prime lands or in urban areas. It merely reflects a conviction that the CGIAR has an opportunity not readily available to other suppliers of research, and an obligation to address a rural poverty group which has been left behind

In moving ahead to articulate a strategy for achieving the overarching goal of sustainable poverty alleviation and associated food security, the next step specifically with respect to rural poverty is identification of **where** these people live and their present numbers. From this information base, one may move to characterize the current status of the lands from which they derive part or all of their livelihoods. From the optic of technology to increase productivity of resources used in agriculture, this status may be initially expressed in terms of biophysical potential, i.e. biophysically favoured versus marginal lands. However, the determinants of poverty (marginal people) lie mainly with the socio-economic and institutional aspects (markets, policies, physical infrastructure, human capital) which govern the choice sets of the population in using natural resources to which they have access and in obtaining off-farm income.

With specification of the biophysical, institutional, policy and socio- economic characteristics which explain **why** the various target groups are poor, one is in a position to explore research options whose output and outcomes may be expected to have an impact on sustainable poverty alleviation. From that point one can go on to examine **what** the CGIAR might do, i.e. the entry points where there is expectation of significant impact from research through output of international public goods.

The decision to start the process of assessing possible avenues for change in direction with an examination of research options for marginal lands derive from a perception that marginal populations - the rural poor - are likely to be concentrated in these areas, and further, that the incidence of extreme poverty will be higher than on favoured lands. These areas are seen to be fragile and occupying the major part of lands already settled or in process of expansion (clearing of tropical forest). Accordingly there is a concern with the prospect of large-scale resource degradation and attendant externalities. In addition, there is a presumption that CGIAR research has had little impact on the poor in these areas except by indirection, i.e. by providing employment on favoured lands which have benefited from research, or by lower food prices to those who purchase part of their needs.

All land types - marginal or favoured - need research related to environmental protection and sustainable productivity which can to a greater or lesser extent help in the quest for poverty

alleviation and expanded food security for the poor. On the favoured lands, expanded production can result in lower prices for urban consumers, as well as to increased jobs and food for the rural poor in both areas. To the extent that the poor live on the marginal lands, research that leads to

productivity increases on those lands also can help to alleviate poverty and increase food security. Thus, in and of themselves, the twin objectives of poverty alleviation and environmental protection do not provide useful guidance in terms of allocation of research resource *between marginal and favoured lands.*

Thus, while "marginal lands" still provide a reference point, the Panel concluded that the study should focus on research issues and strategies related to marginalized people - those whose poverty and food insecurity may be caused by not only their association with biophysically low productivity or impoverished (marginal) lands, but also with, for example, lack of access to inputs, or lack of access to markets (effective demand for their production), off-farm means for earning income and related institutional constraints.

In its terms of reference (Annex I) TAC made it clear that the System should not be investing in research on marginal lands just because they are currently considered low potential areas for agriculture, and it "favours allocating resources such that the balance between high and low potential environments emerges from the concern with poverty alleviation and resource conservation, rather than being introduced a priori."

1.1. The Change in Focus Between Phase I and Phase II

Phase I of this Study started from the premise that poverty alleviation is the primary gaol of the CGIAR and that the means by which the System would have an impact is through sustainable productivity enhancement embodied within natural resource management. In order to address the issues of research priorities, it was assumed:

> marginal lands are a definable research target (areas, population, beneficiaries, and externalities);
>
> research requirements are qualitatively different from favoured lands;
>
> strategic or tactical questions will be conditioned by trade-offs among poverty alleviation, food production and environmental protection.

As a result of exchange of views with TAC, the centres and further discussion within the Panel, the following modifications have been introduced.

> The concept of multiple objectives and the inherent trade-offs associated with poverty alleviation, food production and natural resource management is modified. Poverty alleviation is accepted as the single strategic objective. Environmental protection may also be an objective, but not for the CGIAR in situations where there may be trade-offs with poverty alleviation. Rather, productivity enhancement within the context of natural resource management (NRM) or environmental management is seen as the means to poverty alleviation. Further, food security is seen as a question of income. Thus, in the case of rural poverty alleviation on marginal lands, productivity applies to food and non-food activities derived from the renewable resources to which the poor have access, and

off-farm income opportunities.

> It is recognized more explicitly that marginal lands constitute a moving target. There are drawbacks to defining them in terms of biophysical and economic yields since both their physical and economic yields can be altered by on-site investments and exogenous

institutional factors affecting markets, prices, resource entitlements, etc. Further, due to spatial variability, farmers may have access to both marginal and favoured lands which could clearly modify their management systems. Thus, soil and climatic domains, although relevant, in most cases are likely to be outweighed by qualifying variables in determining the research approach.

The point of departure is marginal poor not marginal lands. The implication is a more explicit focus on the human capital, physical capital and institutional constraints faced by these people, as well as the biophysical constraints of their natural capital. All constraints are considered candidates for research, including integrated approaches to target the rural poor in definable geographic areas. In mapping marginal rural populations for the purpose of defining research options and decision on priorities, criteria for establishing the boundaries will be weighted to the non-biophysical rather than the biophysical determinants of poverty.

1.2. Presentation of the Analysis

The terms of reference for the study carry a strong inference that marginal lands (ML) are biophysically defined. The corollary is that with a scientifically solid definition one can map these areas together with existing and forecasted numbers of rural poor in each. From there, the primary point of entry for the CGIAR would be research to overcome the biophysical constraints, in association with socio-economic, policy and institutional research which would facilitate the diffusion and application of technology in on-farm and off-farm activities affecting the welfare of the poor. Given this framework, Chapter 2 deals first with the statistical implications of the biophysical definition of ML; second, with the derivation of marginal agricultural lands (MALs) as a more operational concept enabling plausible estimates of rural poor located on these lands and the resources allocated by the CGIAR to such areas; and third, with the move away from biophysical criteria (as the prime criterion for determining marginality) to a more comprehensive definition of "marginal areas" (MA), based on concentration of marginal rural people and why they are marginal, as the operationally relevant concept for decisions by the CGIAR. Chapter 3 examines the options open to the CGIAR in addressing poverty in MAs. Chapters 4, 5 and 6 assess research requirements bearing on removal of constraints on knowledge, resources and incentives to poverty alleviation in the areas of:

change in institutions and policy

generation and diffusion of improved technologies

diversification of land use and income sources.

CHAPTER 2 - DEFINITIONS AND CONTEXT

In responding to the Phase I report of this study, most of the centres raised questions on: the interpretation of "marginal lands"; the advisability of using very coarse-grained indicators of biophysical capability of land as one basis for programming the System´s activities; the credibility of estimates relating to rural population and land types; and, what is meant by poverty alleviation with respect to its links to research delivered by the CGIAR.

2.1. Marginal Lands

Many different names are used to designate lands in terms of their production capacity - favoured, fertile, marginal, low potential, resource poor, high potential, fragile, vulnerable or degraded. Terms which relate to "marginal" areas are frequently used interchangeably and often without definition. The difficulty in formulating a clear definition stems from the fact that "productivity" varies according to the type of land use. A tract of land that is "marginal" for crop production may be well suited for grazing. "Fragile" lands may be sensitive to degradation under cultivation but may be sustainably used for forestry. Further more, productivity is not only based on the biophysical characteristics of land, but also depends on the socio-economic parameters of a specific environment. Technologies may be known but the necessary incentives, institutions or inputs may be missing. Farmers are generally aware of the physical benefits of improved seeds and of mineral fertilizers, but may not have access to inputs or be unwilling to accept the climatic and price risks. The range of possible uses of land is so wide and socio-economic conditions are so diverse that no definition can encompass all the relevant factors. However, in order to ensure a common understanding, the general terms used in this study are briefly described below.

Attention is drawn here to the concept of "land" which is broader than just soil or terrain. Although soil is an important and relatively stable element of land it is only one component. Land is an area of the earth´s surface which comprises the major biophysical attributes which influence its use. These include the atmosphere, soil, geology, hydrology, plant and animal populations, and the results of past and present human activity such as terracing, drainage or irrigation. The evaluation of land does not only refer to its productive potential, but also to the sustainability of its use, that is the maintenance or enhancement of its productivity over the long term, while at the same time conserving its potential as a resource base.

Table 2.1 lists the four terms - favoured, marginal, fragile and degraded land - which are commonly used in this study. It should be noted that the constraints of a biophysical and socio-economic nature may apply separately or simultaneously. Marginality can be the result of different combinations of constraints. For instance, biophysically "good" land can be marginal on account of its isolation from markets, the unavailability of inputs, or the small size of holdings. The nature, composition and interaction of the factors which determine land marginality differ widely.

Table 2.1: Proposed Definitions of Land Types

Definition	Biophysical Constraints	Socio-Economic Constraints
Favoured land: Land having no, or moderate limitations to sustained application under a given use. Moderate limitations will reduce benefits but an overall advantage will be gained from the use of inputs. Wide options for diversification. With proper management, risk of irreversible damage is low.	No or moderate constraints related to soil, climatic and terrain conditions. Soil fertility, if adequately maintained, is favourable. Relatively reliable rainfall and/or irrigation water.	The level of yields depends not only on favourable biophysical conditions, but on accessibility to inputs, market and credit facilities, and beneficial output/input ratios.
Marginal land: Land having limitations which in aggregate are severe for sustained application of a given use. Increased inputs to maintain productivity or benefits will be only marginally justified. Limited options for diversification without the use of inputs. With inappropriate management, risks of irreversible degradation.	Soil constraints (low fertility, poor drainage, shallowness, salinity), steepness of terrain, unfavourable climatic conditions[1].	Absence of markets difficult accessibility, restrictive land tenure, small holdings, poor infrastructure, unfavourable output/input ratios.
Fragile land: Land that is sensitive to land degradation, as a result of inappropriate human intervention[2]. Sustained production requires specific management practices. Land use is limited to a narrow choice of options.	Soils of low fertility, erodible, steep terrain, high groundwater levels, flood-prone.	Population pressure, food deficits, competition for land from other sectors, unavailability or high cost of inputs.
Degraded land: Land that has lost part or all of its productive capacity as a result of inappropriate human intervention. Various forms and degrees of degradation, both reversible and irreversible, may occur. Rehabilitation of reversible forms of degradation requires investment.	Erosion, salinization, fertility depletion, lack of adequate drainage on soils and terrain prone to deterioration.	Population pressure, land shortage, inadequate support to agriculture, lack of institutional framework, high cost of rehabilitation, lack of investment.

[1] The soil, terrain and climatic constraints applicable to marginal lands are described in Annex II. The constraints may apply separately or cumulatively.

[2] A distinction needs to be made between reversible and irreversible forms of degradation. Some soils are vulnerable to nutrient depletion, but are sufficiently resilient for soil fertility to be restored through good management.

2.2 Initial Framework for Evaluating the Issues

The nature and extent of the challenge faced by the CGIAR in addressing poverty alleviation on marginal lands may be illustrated from Table 2.2. Three broad land types are identified:

(i) favoured lands with high present agricultural use values (HPUV),
(ii) marginal lands with low present agricultural use values (LPUV) and
(iii) lands at low or zero intensity of agricultural use (LZI).

For each land type one may speculate that there are those with a high potential for expansion of production based on research (HPEPR) and those with a low potential for expansion of production based on research (LPEPR). Thus; there is a six-quadrant matrix which may be addressed by research. It is generally held that research undertaken to date, focused on land types in quadrant I and quadrant II, has largely benefited quadrant II, particularly the wheat and irrigated rice lands. As it stands this table is an approximation of potential to expand agricultural production through research. It does not reflect options for research on forest systems, coastal fisheries related to terrestrial systems or the dynamics of movement of land types among the quadrants (see Annex II).

In their response to the Phase I report, most of the centres commented on the criteria used in establishing area estimates for each quadrant, and approximating rural population and rural poor associated with each. In addition, a concept was introduced for marginal lands which identified those areas where both the numbers and proportion of rural poor were low, in contrast to what might be considered "poverty dense" areas. In general, the centres do no design their programming to address soil/climatic domains or rural populations classified by geographic area. Rather they tend to target problem areas or specific land use regimes. In spite of the difficulties in defining terms used to characterize the biophysical productivity of lands and in estimating "poverty density", the Panel considered the six-quadrant approach to be a useful concept in sorting out the issues and priorities in allocating research resources between high productivity areas and marginal lands associated with persistent poverty. It is a particularly appropriate framework in light of the following widely held views which characterize thinking on rural poverty and the role of the CGIAR:

> ML are defined in biophysical terms which establish them as: having low inherent productivity for agriculture; fragile and therefore susceptible to degradation because of slope and/or climate; and subject to high agricultural risk due to climate and disease;
>
> ML support a high proportion of the rural poor, particularly the poorest of the poor;
>
> 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 and vegetation destruction; the consequence is a downward poverty spiral with significant negative externalities because of the large areas classified as ML relative to those considered favoured;
>
> the impact of CGIAR research on poverty alleviation and related productivity increase and environmental protection in ML has been low.

Table 2.2: Present Use Value (PUV) of Lands and Potential to Expand Production Based on Research (PEPR)

Present Use Value	High PEPR	Low PEPR
Favoured Agricultural Lands (PUV High)	**QUADRANT I** Irrigated Lands Rainfed Lands	**QUADRANT II** Irrigated Lands Rainfed Lands
Marginal Agricultural Lands (PUV Low)	**QUADRANT III** Rainfed Lands	**QUADRANT IV** Rainfed Lands
Lands at Low or Zero Intensity of Use (LZI)	**QUADRANT V** Forest and Woodland	**QUADRANT VI** Dry and Arid Lands

2.3. Marginal Lands as a Moving Target

It is recognized that lands do not neatly define themselves in the above quadrants and that their classification is not definite. In practice, there is a **continuum** among the quadrants with changes in economic conditions, improvement of infrastructures, innovative research, fluctuations in population pressure. For example, the existence of a continuum is particularly common between quadrant V (forest), quadrant III, and quadrant I. Defining the LZI type is a hazardous exercise where one is moving from the extensive desert margins in quadrant VI to potential opportunities for intensification of forestry in quadrant V. In addition, the definition of lands which are responsive or unresponsive to research (in production terms) is a static concept. In practice, research innovation should enable LPUV lands in quadrants III and IV to be transferred to HPEPR lands in quadrant I and LPEPR lands in quadrant II.

Any number of factors may lead to shifts of land from one category to another. These shifts may be upward, through applications of improved techniques, or downward as a result of land degradation or inappropriate development of lands formerly at low use levels. Hence, marginality is not a static concept.

When dealing with issues of natural resources management, it is essential that these spatial and temporal dimensions be taken into account. Therefore, "marginality" has to be assessed in terms of specific types of land use. Land that is marginal for a crop requiring a long growing period could be highly productive for more drought tolerant, short-season crops. What is marginal land for cropping may be very suitable for livestock production. The severity of soil constraints may vary with the climatic conditions under which they occur. For instance, under low rainfall, lighter soils may be more productive than heavier soils on account of easier tillage and more rapid uptake of available water. Shifts between quadrants may also result from management practices. Infertile soils which are marginal can become highly productive through judicious application of organic and mineral inputs.

A key characteristic of marginal, as distinct from favoured lands is the location specificity of terrain, climate, soils and socio-economic conditions. Many technologies to remedy biophysical marginality are well-known. The dynamic dimension is critical - marked shifts of land quality will result from the use of resources with the necessary incentives to apply results of research, i.e., overcoming the policy and institutional constraints.

In summing up, the Panel found that the definition of "marginal" depends on so many qualifiers that it becomes meaningless in an operational sense. This is illustrated by the fact that land can be "marginal" depending on:

- its **use** (what is marginal agricultural land may be highly productive forest land);
- its natural biophysical **characteristics** (which can be altered by investment);
- its **location relative to infrastructure** such as roads, railroads, harbors, and cities (a road into a region can completely alter the economic returns from land near the road);
- **the institutional and policy context which influences access of inhabitants to land, water, credit, markets, outside inputs** (development of market access can completely alter the economics of land use);
- **population pressure** (e.g., size of land holdings; from a cattle rancher's perspective, his or her large area of land is not "marginal", even though the biophysical yield per ha is low; at the same time, a farmer with only one ha. in the midst of the most favoured agricultural area may feel that he or she is on "marginal land");

- **technology development** (Jojoba development in arid environments; acid tolerant rice in the Cerrados of Brazil);

- taking advantage of **niche opportunities** (spices, flowers, vegetables, special fibres)

Lands move out of and into marginal status depending on which of the above dimensions are applied in the definition. *It only makes sense to define "marginal land" in terms of a clearly defined, specific situation.*

2.4. Contexts in which the Term "Marginal Lands" is Used

Because of the wide variety of ways in which "marginal" lands can be defined, the term is used to mean quite different things, depending on the context. In fact, the Panel reached the conclusion that the concept, in a biophysical sense alone, is not adequate to identify operational responses by the agriculture, forestry and fisheries sectors to poverty alleviation - the fundamental goal of the CGIAR.

The Panel identified three common threads that run through the documentation on "marginal lands," broadly defined. They are:

- A concern with poverty - under the assumption that most of the rural poor live on "marginal" lands; thus a concern for "marginal" lands is a proxy for concern with poverty alleviation for those who happen to live on the myriad forms of less favoured areas of the world; and a further concern for the fact that the CGIAR may somehow have missed these poor people, because it has not targeted poverty in the "marginal" lands areas. (This concern dominates in the development literature)

- A concern with vulnerable and fragile lands and the problems of irreversible destruction or degradation of sensitive natural areas - the problems of desertification; deterioration of mountain environments; the destruction of other natural environments such as mangroves and natural forests, and pollution and destruction of biodiversity in coastal zones. (This concern dominates in the environmental literature)

- A concern that the more favoured rainfed lands, the irrigated lands, and some of the "rice" and "wheat" baskets of the world, as well as highly productive bottomlands and hillsides, were being "marginalized" through overuse or misuse. (This concern shows up in the agricultural development literature, as well as in the environmental literature)

The Panel further noted that, even within each of the interpretations of why "marginal lands" are important, there is uncertainty over what the term means, how lands can be classified as "marginal", and how they can move out of marginal status into productive lands contributing to sustainable development.

2.5. From Biophysically Marginal Lands (ML) to Marginal Agricultural Land (MAL) Based on Existing Use

In light of the above reasoning, the Panel came to the conclusion that, although the soil/climatic domains specified in Table 2.2 provide a scientifically coherent basis for identifying land capability with respect to its agricultural potential and its expected productivity response to agricultural research, it was not an operationally relevant concept. While retaining the biophysical criterion for classification, it was considered that a better approximation of the marginal land issues faced by the CGIAR would be provided by qualifying biophysical characteristics of lands according to their current use in agriculture (See Table 2.3). This enabled a specification of a scientifically defensible area of favoured agricultural lands (FAL). Thus, they excluded forest and woodland areas with high agricultural potential. FALs were considered to be in rainfed and irrigated agriculture (800 million ha) in areas which are fertile (with or without chemical subsidies), well-drained, with even topography and (if unirrigated) with adequate rainfall. They are in comparatively intensive use, and generally within their use-capability. They are at risk of degradation if mismanaged but risk of externalities from mismanagement is low, as is vulnerability to irreversible damage.

Marginal agricultural lands (MAL) were identified as those areas which are currently used for agriculture, grazing or agroforestry (1.8 billion ha). Such areas typically encompass mountains and tropical and sub-tropical lowlands or plateaux with low, unstable rainfall or higher rainfall areas in intensive use relative to use-capability under existing population densities, traditional technologies and institutional structures. In most cases, in absence of external inputs, they have reached or exceeded the threshold limits to maintenance or enhancement of agricultural performance. They are characterized by: poor soil fertility (nutrient deficiencies, acidity, salinity, poor moisture holding capacity, etc.), inaccessibility (poor communications, immobility with all its social and economic implications); fragility (low input absorptive capacity, high input-output ratios, limited capacity to withstand disturbance, vulnerable to irreversible damage); and heterogeneity (physically and culturally diverse with site-specific constraints and opportunities which restrict applicability of general technological or institutional measures to remove constraints or exploit opportunities). Aside from the above inherent characteristics, marginal low-productivity lands may also result from degradation of non-marginal lands or inappropriate development of lands formerly at low or zero use levels. All areas are at risk of further degradation with high expectation of negative externalities.

The quadrants V and VI were redefined in Table 2.3 such that quadrant V was considered forested area regardless of its agricultural potential and quadrant VI was classified as arid with very limited rural population regardless of its irrigation potential. Because of the dynamics of movement among quadrants, both of these - particularly quadrant V - are relevant to rural poverty alleviation for the current and future generations in marginal areas.

2.6. Location and Incidence of Rural Poverty on MAL

A second modification in the conceptual ML approach centred on the location of rural poverty. Since there are no data for rural population in forest or arid areas, estimates were made for FALs and the residual population was assigned to quadrants III - VI (Table 2.4) with the expectation that the majority would be located on MALs.

Table 2.3: Extent of Different Land Types in the Developing Regions (million ha and share within region)

	Land types	Favoured agricultural	Other land types	*BREAKDOWN OF OTHER LAND TYPES* *Marginal agricultural*	*Forest & woodland*	*Arid lands*	Irrigation in arid lands	TOTAL
Region	**Quadrant**	I/II	III-VI	III/IV	V	VI	(I/II)	
SUB-SAHARAN AFRICA		200	2155	*545*	*1030*	*580*	3	2355
40 countries	Share (within row)	8.5%	91.5%	*23.1%*	*43.7%*	*24.6%*	0.1%	100%
ASIA		305	1530	*550*	*635*	*340*	28	1835
20 countries	Share	16.6%	83.4%	*30.0%*	*34.6%*	*18.5%*	1.5%	100%
CENTRAL AND SOUTH AMERICA		190	1780	*400*	*1220*	*160*	4	1970
26 countries	Share	9.6%	90.4%	*20.3%*	*61.9%*	*8.1%*	0.2%	100%
WEST ASIA AND NORTH AFRICA		100	1185	*290*	*50*	*845*	12	1285
19 countries	Share	7.8%	92.2%	*22.6%*	*3.9%*	*65.8%*	0.9%	100%
TOTAL		795	6650	*1785*	*2935*	*1925*	46	7445
Total: 105 countries	Share	10.7%	89.3%	*24.0%*	*39.4%*	*25.9%*	0.6%	100%

Table 2.4: Rural Population and Rural Poor on Different Land Types (in million)

Region	Land types	TOTAL POPULATION	RURAL POPULATION			RURAL POOR	AVERAGE RURAL POVERTY
		All land types	Total	Favoured agricultural	Other land types	Other land types	
	Quadrant	I-VI	I-VI	I/II	III-VI	III-VI	
SUB-SAHARAN AFRICA		530	375	101	274	176	64%
40 countries	Share (within row)		100%	27%	73%		
ASIA		2840	2044	755	1289	375	29%
20 countries	Share		100%	37%	63%		
CENTRAL AND SOUTH AMERICA		430	117	40	77	48	61%
26 countries	Share		100%	34%	66%		
WEST ASIA AND NORTH AFRICA		345	156	37	119	35	29%
19 countries	Share		100%	24%	76%		
TOTAL		4145	2693	933	1759	633	36%
Total: 105 countries	Share		100%	35%	65%		

The distribution is 35% (930 million on FALs) and 65% (1,760 million) on other lands (MAL, forest and arid lands).

The question then arises as to whether there is a greater incidence of rural poverty on MALs than FALs. National figures available for rural poor, as a percent of total rural population, were compared with the percent of rural population on MALs to assess whether countries with a high proportion of population on MAL also showed high incidence of rural poverty. No correlation was found. This conclusion also is suggested by the work of Kelley and Rao in India[1]. An IFPRI study, also in India, suggests that both the absolute numbers and incidence of rural poverty are greater on FAL than MAL[2]. Accordingly, rural poverty in the two areas was approximated by applying national percentages - the result 325 million poor on FAL and 630 million on MAL[3].

Similarly, in forecasting poverty on MAL, the only proxy for future numbers in the latter area would have to be derived from projections of overall rural poverty. Using trend estimates for the 1990-2000 period, one might speculate that, unless a major effort is made, numbers are unlikely to decline significantly at a global level in the near future. However, at the regional level, in sub-Saharan Africa the situation is likely to deteriorate such that its share of the world´s rural poor may increase from about 30% to 45% by early next century. Asia would continue to have the highest absolute number of rural poor, but its world share may drop from around 60% to 50%[4].

Introduction of the degradation and productivity dimensions to the poverty-marginal land linkages requires a focus on the dynamics of movement, from favoured agricultural lands downward to ML and the reverse through upgrading. It also requires considering the possibilities for: expanding the stock of favoured agricultural lands by transformation from the 2.9 billion ha of forests and development of irrigation on a small fraction of the 2 billion ha in arid land; or, expanding the stock of marginal lands, assumed to be driven largely by rural poverty, at the expense of forest lands. These dimensions are discussed below with respect to rural poverty alleviation (in MALs) linked to FALs.

2.7. Linkage of FAL to Poverty on MAL

There are three reasons for considering favoured agricultural lands (FALs) in a study of poverty alleviation on marginal lands:

Through degradation they can shift into the low productivity category (marginal) of either rainfed or irrigated lands. As pointed out in comments by several of the centres on the

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1 Kelley, T.G. and P.P. Rao. 1995. *"Marginal Environments and the Poor: Evidence from India"*. Economic and Political Weekly. Vol. xxx. No.40.

2 Fan, S. and P.B.R. Hazell. 1996. *"Should the India Government Invest More in Less Favoured Areas?"*. IFPRI, Washington D.C.

3 This figure contrasts with an estimate made in the mid 1980s - 370,000 poorest of the poor (using the criterion of the poorest 20% for each country) on low potential lands, in: Leonard, H.H. (ed.). 1989. *"Environment and the Poor: Development Strategies for a Common Agenda"*. Transaction Books. Oxford.

4 Pinstrup-Andersen, P. and R. Pandy-Lorch. 1994. *"Alleviating Poverty, Intensifying Agriculture, and Effectively Managing Natural Resources"*. Food, Agriculture and the Environment Discussion paper 1. IFPRI. Washington, D.C.

Phase I report of the study, the clearest example is salinization of irrigated lands. The impact of this process is increasing poverty on an increasing stock of marginal lands.

Through further productivity increase, particularly in quadrant I, they should provide employment opportunities for rural poor who would otherwise contribute to pressure (degradation) on MALs or to accelerated conversion of forest to MALs.

Similarly, the processes of reduction of pressure on natural resources as a means to poverty alleviation would also apply to employment opportunities generated in value-added or off-farm activities in FALs.

In addition to the role of favoured lands in poverty alleviation for present and future rural populations in marginal areas, there is also the question of research directed to the poor on favoured lands themselves. This is a fundamental strategic question for the CGIAR in terms of the balance among research investments which address a range of rural population target groups from a poverty alleviation perspective. There is also a major question of yield maintenance research in FALs. There is a continuum from investments designed to: rehabilitate the productive capacity of the resource, i.e. reverse the degradation process; conserve the "state" of resources, and implicitly their yield capacity; and enhance yields. The first two are land improving investments, the third is "technological change"[1].

It is evident that priority of research related to poverty alleviation in all areas (favoured and marginal) through changes in the cultivated area, employment and income generated on FALs by reducing shifts to lower productivity, investment in productivity increase, human capital, physical infrastructure and institutional change, should be judged by the cost-effectiveness of research expected to have poverty alleviation impacts for the various target groups. The Panel is aware that we are a long way from specification of these target groups. Nevertheless, the linkages and dynamics of movement among classes of land and changes in the numbers and location of the rural poor, dictate that any strategy of rural poverty alleviation on marginal lands take into account the social cost-effectiveness of research on favoured lands, and should incorporate the spillovers to other areas. The framework for cost-effectiveness analysis is discussed in Annex III.

The dilemma of research on MALs vis-a-vis FALs has been characterised by de Wit[2] - "well endowed regions are able to meet demands at relatively low prices ... this marginalizes less endowed regions because their terms of trade are eroding. Scarcity of funds, and the lack of political power of (these) regions makes it unlikely that the transfer of money that would be needed to revert such marginalization processes will occur in the foreseeable future..... Agricultural research which is oriented to improvement of least endowed regions may open up

new possibilities in some situations. However, in many cases its results are more readily applied in regions that are better off." Accepting this premise, a key issue for the CGIAR is the weighting of poverty in the formula discussed in Annex III.

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1 Scherr, S.J. and S.Yadav. 1996. *"Land Degradation in the Developing World: Implications for Food, Agriculture, and the Environment to 2020".* Food, Agriculture and the Environment. Discussion Paper 14. IFPRI, Washington, D.C.

2 De Wit, C.T. 1990. "Understanding and Managing changes in Agriculture" in J.W.G. Jones (ed.) *"System Theory Applied to Agriculture and the Food Chain"*, Elsevier.

2.8. Current CGIAR Activity in Poverty Alleviation on MAL

Based on the foregoing definitions of MAL and FAL, the CGIAR invests about one-third of its resources in the favourable agricultural lands of quadrants I and II (FALs), and the remaining two-thirds on the marginal agricultural lands of quadrants III and IV (see Annex IV). Considering, however, that targeted MALs include productive areas such as the cracking "black cotton" soils of India and western Africa, the poorly drained "inland valleys" of West Africa and the infertile "Cerrados" of Brazil, it would also seem appropriate to draw the conclusion that three quarters of CGIAR resources are being applied to increase the sustainable productivity of lands with high agro-ecological potential.

In terms of the three primary thrusts of research (see section 3.4), estimates of resource allocation indicate that around 30% support activities aimed at generating improved biological opportunities, close to 50% go to the intensification and diversification of production systems, and the remaining 20% to policies and institutional issues.

Current activity categories, however, are not sensitive enough to indicate actual resources allocated to alleviating constraints for the marginal poor. An assessment of objectives, outputs and beneficiaries of the 374 projects endorsed for 1997 showed that 25% are fully targeted at poverty alleviation on MALs and 7% in FALs (Annex IV).

2.9. From Marginal Lands to Marginal Population

In reviewing the figures presented in Sections 2.6 and 2.8 derived from a biophysical definition of MAL and FAL, the Panel came to the conclusion that the inconsistencies and lack of data on the underlying site-specific forces driving the rural poverty process were such as to invalidate their usefulness in guiding CGIAR strategy towards poverty alleviation on marginal lands.

On the surface, the existence of two-thirds of the rural poor on MAL would fully justify the CGIAR´s concern with poverty on these lands. This is further reinforced if one accepts an underlying hypothesis of the Lucerne Declaration, that Green Revolution techniques have had limited impact on productivity for poverty alleviation in MALs, so defined. However, on further reflection the Panel concluded there was no evidence to support this hypothesis. There are areas where CGIAR research has not contributed to rural poverty alleviation but they are not confined to MAL. In addition, there are MALs which have shown significant response to research by the System in terms of productivity and, by inference, poverty alleviation. MAL is simply not a good proxy for where the poor people live or where the CGIAR has had little impact. Under these circumstances it was decided to discard biophysical productivity of lands, whether in the pure sense of world soils and climate, i.e. ML, or in the restricted sense of those areas currently in agricultural use, i.e. MAL, as the point of entry for assessing CGIAR strategy

with respect to rural poverty alleviation.

The Panel had considerable difficulty in finding a substitute term for ML or MAL which respected an interpretation of the intent of the terms of reference to be that the study address strategic issues in research aimed at poverty alleviation on lands which were intuitively considered as biophysically marginal and which clearly were believed to support high concentrations of rural poor who had not benefited from Green Revolution research e.g. the Himalaya, Andes, desert margins of

WANA or tropical forest margins. In fact, the Panel believes that the above interpretation of the intent has been respected. For want of anything better the term adopted as the "unit" for evaluation of strategy was "marginal area" (MA), i.e. one with a high incidence of rural poor subject to a relatively homogeneous set of conditions which determine **why** they are poor (see section 2.10). This obviously includes biophysical conditions.

In spite of the fact that MA may be applied to any combination of biophysically marginal or favoured land, the Panel elected to use this term in Chapters 3 to 6 in examining options open to the CGIAR to address rural poverty through change in: policies and institutions; new and improved technologies and diversification of land use and income sources in MAs.

2.10. Poverty Processes on Marginal Areas

The Panel considered the forces driving the processes which retain people in poverty on MAs, in terms of the inter-relationships between the resources and knowledge available to these people and their incentive to use them for sustainable enhancement of livelihoods. This relates to the question of constraints to access of the poor to knowledge, natural resources, markets and off-farm income opportunities (including the options to migrate). Constraints are generally regarded as rooted in institutions and policies.

Marginal areas, because of characteristics such as their isolation, perceived low and risky productive potential, and the insignificant economic and associated political power of their inhabitants, typically have been neglected by central governments. As a result, only limited public investment has been made in education, health, infrastructure, etc. Little interest has been shown in determining the aspirations of marginal people or their knowledge of how to cope with harsh environments as a basis for focusing public action responsive to their capabilities and needs. In view of the high costs of providing quality services to such areas, it has been argued that accelerated development in other sectors - non-marginal rural areas, industry, services - would be sufficient to attract migration on a scale which would increase the resource base (and income) per capita for the residual population.

The "trickle down" theory of development and poverty alleviation in most marginal areas has not worked. Populations in many are increasing in absolute numbers in spite of migration, and increase is likely to continue, probably at a decreasing rate, for some decades. Without investment in the "resource base" of these people, with expanding populations the expectation can only be progressive extension of poverty and degradation of the soils and forests on which they depend for a large part of their sustenance.

In agriculture, inappropriate research has been blamed for not taking into account indigenous knowledge and the opportunities and constraints which apply to the site-specific characteristics of MAs. Thus, it is asserted that few research results have led to widespread or significant improvement in the welfare of marginal people. This is undoubtedly true in many instances but is merely one symptom of the underlying cause of marginality, i.e. the institutional and policy arrangements. Without any negotiating leverage by marginal communities on the decision.makers responsible for the amount and type of investment in MAs, these investments tend to be small and poorly adapted to the requirements of the people. This applies equally to agricultural research and extension investments (and other areas such as education, health or infrastructure) which have been

unable to respond to complex diverse requirements for sustainable exploitation of opportunities deriving from natural resources and value adding micro-enterprises.

However, the problem is not technology as such. Rather, it is the institutional arrangements which determine: what and how agricultural research and extension is carried out, together with the whole range of support services (credit, roads, communications, schools, etc.); resource entitlements; the functioning of markets; and local capacity to manage their own affairs[1]. A matter of concern is the breakdown of common property systems in some areas where they comprise an important part of the risk-sharing and survival strategies of poor farmers and herders on lands with highly variable rainfall (see Box 1).

It is evident that the institutions and policies which drive the poverty process are country-specific. Nevertheless, the CGIAR appears to have a role to play, albeit small, in helping to introduce poverty alleviation strategies for the poor living in MAs. Among the principal avenues open to the CGIAR are those already outlined in the TAC report on policy and management research[2].

2.11. Implications: Recommendations for the CGIAR

The Panel is fully aware that by discarding the biophysical criteria for defining ML or MAL, it is violating the spirit of the terms of reference. By redefining the issues in terms of MAs which may occur on any combination of FAL and MAL, the issue of poverty alleviation is being placed in a **global** context, rather than being confined to marginal lands and the rural poor who derive a large part of their livelihoods from them, and who a priori are believed to have been by-passed by the Green Revolution. Nevertheless, it is sustained that this is merely another way of cutting the pie. The key question is still **where are the concentrations of poor who have been by-passed by CGIAR research.** The criterion for distinguishing the by-passed from the non-by-passed rural poor is **different.** It carries the implications that conditions for marginality of people also exist on FALs as is implied in Table 2.1, e.g. landless and land poor (farm size issues).

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1 Jodha, N.S. 1995. *`Enhancing Food Security in a Warmer and More Crowded World: Factors and Process in Fragile Areas'.* In Climate Change and World Food Security (ed. T.E. Downing).

2 TAC. 1996. *`Perspectives on Policy and Management Research in the CGIAR'.* Document No. SDR/TAC:IAR/95/26.1. Rome.

Box 1: Common Property Resources and Marginal Lands

Rural common property resources (CPR) described simply are community resources where every member of the community has access and reciprocal obligation to help in their regulated use, without any exclusive private right to claim and sale any part of the resources. In the developing countries they include community grazing lands, forests, watering points, watersheds and (in a de facto sense) most of the public lands not assigned by the state for private use or public reserves. Much of these latter areas may be considered de facto "open access", i.e., there is no management by a community, individual or the state.

CPRs play an important role in: consumption by the rural poor as a source of supplies (e.g., fuel, fodder and food); incomes through collection as well as processing and sale of wild products - especially during the seasons and years when crop incomes are not available; and enhancing nutrient availability to draft animals needed for crop farming.

In some areas rural poor derive as much as 30 percent of their consumption from CPRs. Moreover, in villages with productive CPRs, they provide crop income as well. Thus, CPR-PPR (private property resource) based activities have significant complementarity. However, in most countries due to institutional, policy and demographic changes, CPRs are under severe stress. Area has declined due to legal or illegal privatisation and with weakening of the culture of group action productivity has deteriorated. In practice, CPRs have become open access. This suggests research aimed at rehabilitation of CPRs with two inter-related components: (i) technology oriented measures (in terms of germplasm, agronomic practices adapted to communal management) and (ii) institutional arrangements (which could help in promoting group action and better regulated use, including lands currently in open access exploitation. Research focused on enhancing the range of options for the poor in MAs should include the CPRs. Similarly, local level initiatives through participatory research could address the institutional dimension of CPR rehabilitation and management.

The above possibilities can be incorporated into the Systemwide initiative on property rights and collective action coordinated by IFPRI. As a part of this initiative, the question of selective privatisation of CPRs can also be examined. Especially in the African context, there is a push for land-titling supported by the donors. The justification is to ensure proper incentives for land users and create collateral for credit for the farmers using common lands. The CPRs - due to their wider spread in terms of access and spatial location, offer multiple options to the poor to cope with risk. By promoting individual land entitlements, the policy may tend to restrict the range of options and access to resources and opportunities available to the poor. There is room for research to examine the trade-offs.

One way to reduce the scope of a "marginal lands" study in the initial stages would be to exclude any consideration of MAs on the 800 million ha classified as FAL. One might justify this on the grounds that these are the areas which most clearly have benefited from the Green Revolution - if there is residual poverty on this area, this could be addressed as part of a global rural poverty study.

However, the conclusion was that, because of:

- heterogeneity of ML and FL (or MAL and FAL) in landscapes,
- the likely overriding importance of institutions in defining MAs,
- the linkages between MAs and non-MAs in poverty alleviation within MAs,
- the critical importance of income in poverty alleviation which dictates a research focus on: food and non-food products (and associated value added); opportunities and constraints to off-farm sources of earnings and productivity from forest areas, coastal zones and savanna woodlands (not incorporated in the definitions of FAL and MAL), and
- the likelihood that definition of MAs on non-favoured areas will probably spill over into definition of MAs on FALs, again because of country or region-specific institutions driving the poverty process,

it would be more efficient to specify MA without regard to an arbitrary distinction between biophysically favoured and marginal lands. Given the existing mix of work in the centres (see Chapters 3-6) it is not clear the extent to which this explicit focus on poverty alleviation would imply changes in the actual research project work done by the centres.

With the above in mind, the Panel puts forth the following first recommendation:

<u>Recommendation 1:</u> The CGIAR needs to sharpen its strategic focus on poverty alleviation particularly in setting priorities for research related to marginal rural areas. A prerequisite is development of a geo-referenced database linking biophysical land conditions with poverty and with the processes that produce it (i.e., the dynamics of poverty).

In order to meet this challenge, the System, and individual centres within it, will need to develop a database relevant to the design and assessment of options that lead to more effective impacts on income of the rural poor in highly diverse marginal areas. Elements of this database will be the soil, climatic and terrain conditions. However, as the centres have pointed out in their comments on the Phase I report, there are many other elements which are equally or more important - production systems, human capital, market access and infrastructure, institutional and policy constraints and the number and location of the rural poor with respect to any or all of the above characteristics. A logical place to start this activity would appear to be the centres´ expertise on the geographic areas with which they deal; perhaps initially by developing an intuitive Geographical Information System (GIS) which can be progressively improved by formal or informal methods. The issue of site specificity, diversity and complexity must be addressed to identify points of entry which are relevant and consistent with the CGIAR´s scale.

The question here is the extent to which centres may move towards targeting site-specific (or through a typology, situation-specific) rural poverty through research which meets the "international public goods" criterion.

Meeting this recommendation is regarded as a prerequisite to action on the three recommendations put forward in Chapter 3. The Panel is convinced that the centres´ scientific expertise, coupled with their field experience in most, if not all, of the diverse MAs, represent a unique resource in coming to grips with the information/analytical challenge. Thus the work should be undertaken in a coordinated fashion by the centres themselves. IFPRI and ISNAR could take leading roles in providing support to the activity. An opportunity exists to initiate this process in the up-coming MTP exercise.

CHAPTER 3 - POVERTY ALLEVIATION ON MARGINAL AREAS: THE ROLE OF THE CGIAR IN REMOVING CONSTRAINTS

The previous chapter made it clear that the nature and causes of the poverty found on marginal areas vary widely with the type of conditions which determine marginality of the rural population. Thus, there are significant differences between the poor farmer on the mountainous hillsides of the Andes or the Himalayas, the farmer surviving on the fringes of the Amazon forest or in the Zaire Basin, and the farmer on the drylands of the African savanna woodlands.

The solutions to alleviate poverty for the inhabitants of these diverse lands are as varied as the situations encountered. However, there are some common threads - some common requirements and opportunities - that relate to most of the diverse rural poverty situations encountered. These involve the actions that are necessary to deal with the resource, knowledge, and incentive constraints that are the fundamental barriers to poverty alleviation. Thus, the Panel has identified three types of requirements that all situations have in common:

- **Reforming policies and institutions.** This involves improving the social, institutional, and physical infrastructure (access to markets and market information; price policies; access to credit and essential purchased inputs; establishment and strengthening of markets; improved property rights; improved roads, communications, transportation, and so forth);

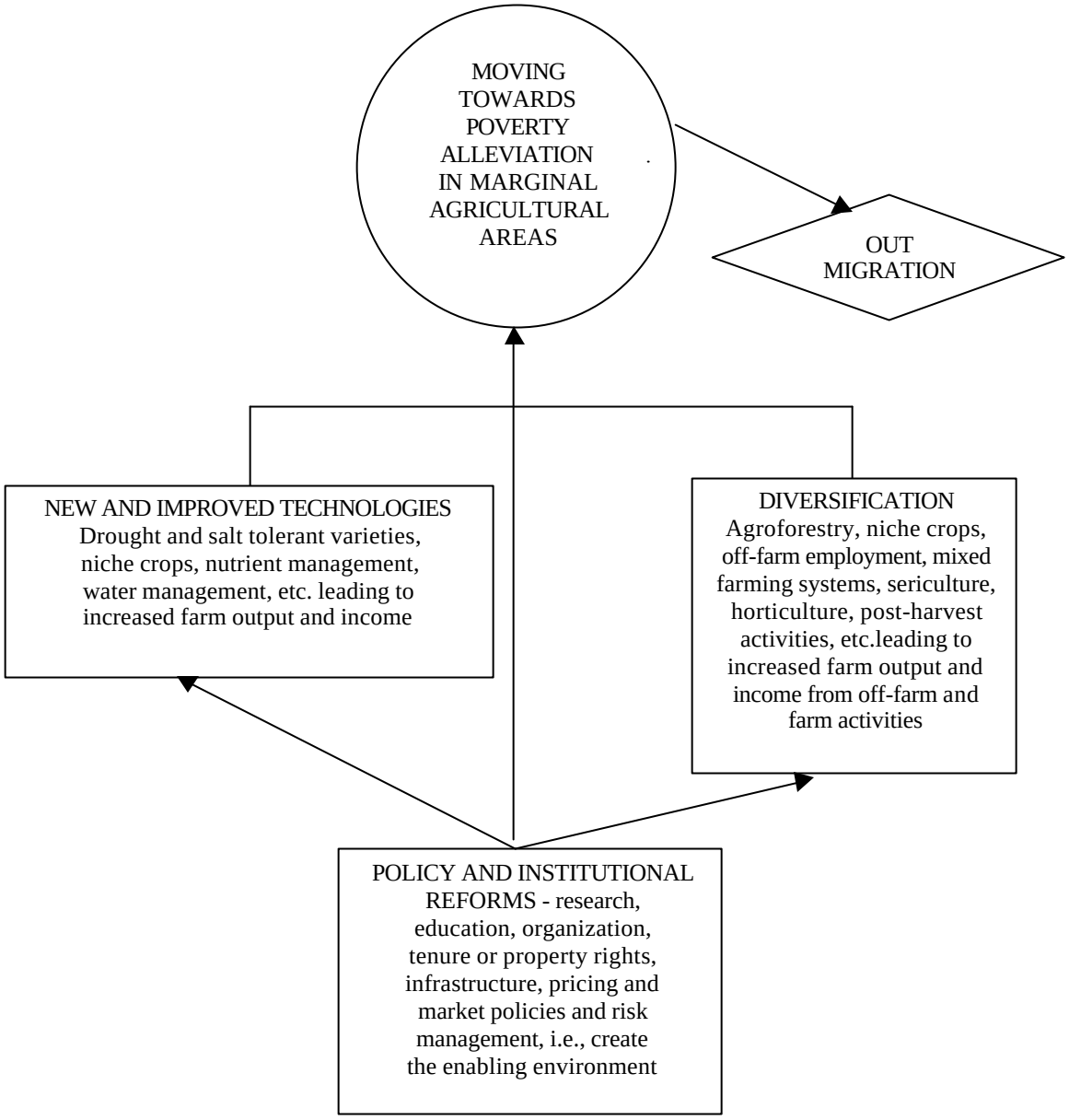
- **Generating and diffusing new and improved technologies**. This applies to crop, livestock, forestry, agroforestry, and fisheries. The new technologies need to fit the various biophysical and institutional characteristics and constraints of the diverse agricultural and associated lands;

- **Diversifying land use systems and income opportunities.** This includes increasing access to off-farm employment (e.g., through forestry, fisheries, and agro-industrial opportunities associated with improved postharvest technologies, small-scale enterprise development, etc.).

Figure 3.1 provides an overview of how these three categories of requirements/opportunities link to poverty alleviation for those who live in MAs. We emphasize the point that it generally takes integrated action in all three areas to break the `vicious circle' of poverty and to move a marginal population along the development path.

Because these three basic requirements are common in principle and concept (although not in operational detail) for nearly all marginal land-poverty types, they provide promising areas in which to search for the international public goods research opportunities, which are the focus of the CGIAR. Thus, we look at them in more detail in the following chapters, after elaborating the Panel's understanding of what the CGIAR focus should be in this area.

Figure 3.1: Poverty Alleviation on Marginal Agricultural Lands



3.1. The International Role of the CGIAR

In considering the CGIAR's role in poverty alleviation for the poor residing in the marginal areas of the world, the Panel took into account two basic facts: 1) the CGIAR accounts for only a small proportion of global agricultural, forestry and fisheries research; thus, the most that the CGIAR can hope for is to become an advocate and a catalyst, albeit a key one, for positive action; 2) the CGIAR's particular advantage - and its mandated role - is to provide international public goods that can contribute to sustainable poverty alleviation.

The Panel's interpretation of the role of the CGIAR System is based on TAC conclusions, confirmed by the CGIAR members. Thus, international research initiatives undertaken within the System should (TAC Soil and Water Study):

- Produce research results of an international public goods nature; they should provide benefits (either directly or through externalities) across national borders.
- Globalize (or standardize) methodologies used in local studies to ensure comparability of results across ecoregions, and for use in researching common themes or problems within ecosystems; this should include methodologies that integrate biophysical and socioeconomic research.
- Involve locally relevant and responsive research within ecoregions (or watersheds), but with a global perspective to (1) take advantage of economies of scale in research, (2) maximize use of spillovers from research, (3) reduce transactions costs in doing research, and (4) allow efficient movement up the learning curve.
- Be multisectoral and multidisciplinary in nature and scope, recognizing the different sectors and disciplines dealt with across the CGIAR System. (Thus, for example, the CGIAR Systemwide SWNM Programme, or the proposed Water Programme should be explicitly linked to ecoregional activities, to germplasm improvement and commodity research activities of selected Centres, and to various policy related research issues pursued by such Centres as IFPRI, e.g., in the area of water policy and common property resource management).
- Take advantage of complementary activities of different suppliers of research, both within and outside the CGIAR System and contribute to the work of others, both NARS and advanced institutions.

Keeping these priorities and criteria for CGIAR involvement in mind at all times, the Panel then considered the CGIAR current activity, role, and options for the future in each of the three areas described above.

3.2. Gender Considerations

The Panel recognized a general point that applies to most MA poverty situations -the importance of women and the importance that needs to be given to gender issues. According to FAO's latest statistics[1], women's contribution to agricultural production in Sub-Saharan Africa is some 60-80 percent of the total (compared with 50 percent in Asia and 40 percent in Latin America). Further, indicative figures for developing countries show, according to FAO, that no more than 5 percent of extension resources are received by women; yet in many areas more than 50 percent of household's are headed by women. Women's "invisibility" is further accentuated by their lack of political power and social representation. They are less educated and, thus, their contribution toward food security often is less than it could be. FAO concludes in its briefing paper

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1 FAO 1996. *`Women Feed the World'.* FAO Fact Sheet, World Food Summit, 13-17 November 1996, FAO, Rome.

to the World Food Summit that:

> Since the 1970s, the number of women living below the poverty line has increased by 50 percent, in comparison with 30 percent for their male counterparts. More than 70 percent of the 1,300 million poor people today are women.

And many of these poor women live in MAs of the world and thus are of prime interest to the present study. The Panel did not feel that it should single out the gender issue in a separate chapter or section, but rather treat the issue as an all pervasive one that applies throughout the discussion that follows; and should be a central consideration, regardless of the path taken towards poverty alleviation in MAs.

3.3 Scope for Research-Based Solutions to Rural Poverty

Rural poverty, particularly that associated with marginal areas, is a product of multiple factors, some of which fall outside the scope of research generated by the CGIAR and others. Nevertheless, the System does have a significant opportunity to bring to bear scientific objective analysis which could have an important catalytic impact on NARS, NGOs, the private sector and resource user communities.

Table 3.1 characterises some of the most critical gaps between the requirements for research and development (R&D) for MAs and the features of ongoing research efforts. Frequent reference has been made to the lack of information on MAs and the way their inhabitants gain a livelihood. This is no accident. Those responsible for decisions to collect information have considered it as either unnecessary, too costly, or a low pay-off investment. The approach requires targeting the MAs, the population groups living on these areas and the rural poverty sub-sector within the population. For any area or group, information required would include biophysical and social diversity, resource use patterns, survival strategies, sources of income and employment, migration and the dynamics of change. Focus of research based on this information should be aimed at increasing the range and quality of options open to the poor for:

- deriving income from the resources available to them;

- operating more effectively in the market for goods and services.

This option-centred approach would be based on analysis of constraints and opportunities[1] to systematically accumulate information on options and the types of MA poverty situations in which they may be applied. The challenge to the CGIAR is the generation of viable partnerships and formulation of a research framework to guide the work of NARS, NGOs, etc. in assembling diagnoses and innovative field experience which will be cumulative and enriched by comparative analyses.

3.4. The Way Ahead for the CGIAR - a Summary

The road to poverty alleviation for the poor living on MAs is a rocky and twisting one.

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[1] FAO, 1995. *`Special Programme on Food Production in Support of Food Security in LIFDCS: Advisory Note on Participatory Analysis of Constraints and Opportunities'.*

Negotiating it will require concerted effort by many parties, hopefully working in concert and in a coordinated and effective way together. The role of CGIAR will be a minor, but crucial one. There is not much that the CGIAR can do, but what it can do is essential to the process.

Basically, the Panel sees the CGIAR as being able to move further in three main directions:

(1) It can provide support to policy and institutional reforms, through its work on identification of poverty processes and constraints to its alleviation; work in the area of identifying, locating, and classifying the areas and types of poverty for which it is best equipped to address; and work in the area of policy and institution strengthening. Many of the critical needs in the latter area already have been explored by the panel producing TAC's recent strategic studies on policy research and institution strengthening research and service needs.

(2) It can continue with its mainstream work with commodity improvement in agriculture, forestry, agroforestry, and fisheries, but with added emphasis on breeding and agronomic work related to the needs of the MA conditions, e.g., need for drought tolerant varieties, work on integrated soil nutrient and water balances and utilization, work on IPM and other more environment friendly approaches to agricultural intensification and improvement.

(3) The CGIAR can continue on the path of increased support to natural resources management research, and research related to land use diversification and land use systems approaches to the problems of MAs. This trend was started some eight years ago, when the CGIAR diversified and expanded its mandate to take on forestry, agroforestry, and fisheries. More recently, the System has endorsed TAC's recommendations and centre initiatives with regard to greater focus on Integrated Natural Resources Management, soil and water research, integrated pest management, ecoregional approaches to research, expansion of work on postharvest technologies, and various policy and institution strengthening activities that contribute to more diversified land use and farming systems approaches.

Table 3.1: Imperatives for Poverty-Oriented R&D and Dominant Characteristics of Current Research for MAs

1. MA Contexts and R & D Imperatives	2. Dominant Features of R & D by CG/others and the Gaps between (1) and (2)
A. Imperatives of Soil and Slope Related Constraints (e.g., erodibility, fragility, low fertility, low depth, etc.): **Technology** for **Resource** building, stabilising, upgrading, protection, conservation; **Crop types:** shallow rooted, nitrogen fixing; annual-perennial compatibility, favouring intensive-extensive land uses; strengthening integrated farming systems including the use of CPRs.	Considerable R & D results on soil-moisture conservation measures; agroforestry, crops (coarse grains, legumes to suit MAL). But work less oriented to local situations; focus on intensification ignoring extensification and system context; not enough learning from indigenous systems; impacts in scattered pockets; domination of product-centred over resource-centred R & D.
B. Imperatives of Water-related Constraints (e.g., short and fluctuating growing season, frequent droughts etc.): **Moisture management**: small-scale water harvesting, moisture conservation measures; **Crops** resistant to moisture uncertainty and scarcity; flexible input regimes; potential for multiple usage and salvage value as well as diversification.	Considerable results on drought resistant varieties; water conservation. But not oriented to their role in farmers' overall strategies against moisture uncertainty, scarcity and diversification; water-harvesting/moisture conservation technologies developed but their adoption still limited both due to scale factor and need for group action, as well as inability to link them with total farming system.
C. Imperative of diversity based opportunities and constraints: Site-specific Technologies for crops and resource management to suit soil/slope/moisture and infrastructural diversity - involving crops/livestock/vegetation; focus on minor crops, niche opportunities, common property resources, etc., in a "systems framework".	Work focused on limited crops and their attributes (e.g. grain yield and not total biomass), ignoring the need for diversification, and harnessing location-specific niche with high pay-off; limited learning from traditional systems for adapting to limitations and opportunities of MAs.
D. Imperatives of biophysical conditions related to social processes: Strong agro-ecosystem social system linkages to shape choice and design of production options and practices as a part of diversified farming system; Institutional arrangements for resource-use regulation.	Despite good work on farming systems, research has been persistently top-down disregarding indigenous systems and participatory approaches, resulting partly from subsidiary role of social sciences; inadequate attention to institutional aspects.

Source: Adapted from Jodha, N.S. 1991. *`Sustainable Agriculture in Fragile Resource Zones: Technological Imperatives'*. Economic and Political Weekly. Vol. 26 (13).

The CGIAR System has been moving towards expansion of activities that relate directly or indirectly to the poverty issues encountered in the MAs. The Panel now is suggesting that this focus be strengthened and that some of the System's work be directly targeted to poverty alleviation for those living in MAs - always keeping in mind, of course, that the System should only be addressing those issues which have international dimensions and for which the international public goods constraint holds, and for which the System and its centres have a clear advantage vis-à-vis the many other actors involved.

It is clear to the Panel that a focus on poverty alleviation brings with it a number of challenges related to the identification, development and organization of research. Chief among these is that because of the heterogeneity and site-specificity of MAs and their internal diversity and complexity, there is a need to develop new forms of partnerships with NARS, NGOs, developed country institutions, and multi and bilateral agencies. Poverty alleviation as an over-arching objective implies a set of actors and a set of actions that go far beyond the areas in which the CGIAR has strengths. The Panel stresses this point and its firm conclusion that the CGIAR should not spread its efforts too thin. The three broad areas of activity discussed above are ones in which the CGIAR legitimately could become - or is - involved. However, its role will be narrow and small, albeit important. The key to success is establishment of the right kinds of partnerships. Its focus on systematic accumulation and dissemination of information and on methodology for addressing complex site-specific rural poverty situations should provide the necessary legitimacy to attract other actors. Thus, the Panel recommends that:

<u>Recommendation 2:</u> The centres should establish new forms of partnership in order to effectively address their roles in a broader poverty alleviation strategy related to those who live in marginal rural areas.

The Panel believes that the poverty alleviation focus can help provide impetus for development of innovative and effective approaches to partnership with NARS, NGOs and various other groups. Such partnerships will depend on finding complementary sources of funding for all partners involved. It will also imply development of incentives for long term collaboration and cooperation, since poverty alleviation is an evolutionary process. These activities will be facilitated once the eco-regional approach becomes operational.

Two additional points regarding the way ahead need to be stressed here:

Need to understand land and water degradation processes. As discussed in the TAC Soil and Water study, there is need to improve our understanding of land and water degradation processes. This is relevant to the purpose of the present study. 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 then linked to the poverty processes. In the case of MAs, reversal of their degradation processes will require resource-centred technologies beyond the crop-centred focus which has characterised much agricultural research to date.

Need to understand why research results on the shelf are not used for yield enhancement. Whether one is considering policy/institutions research, technology and systems research, or research on diversification options, there are many good results on the shelves of research centres which have never been used. As also suggested in the TAC Soil and Water study, the CGIAR System needs to understand better why good technologies are

not put to use.

There is considerable pressure to expand research designed to reduce the rate of resource degradation which has led to encroachment on forests, salinization, loss of wetland and erosion. Results are manifested in severe shortages of fuelwood, the drying up of springs and streams, loss of valuable and relatively unique sources of genetic diversity. For example, some of the richest areas of biodiversity in the East and Central African highlands are under threat of disappearing due to changes in land use management. The Panel debated developing new and separate recommendations regarding both degradation and productivity, and decided that it could make the points better by reaffirming the recommendations as they came out of the TAC Soil and Water study, but with the added emphasis on linking the resulting information with poverty processes related to marginal areas. Better information is needed on the degradation processes, couched in the context of issues related to fragility and resilience, and to consideration of issues related to pollution, biodiversity loss and loss of other environmental services. Thus, the Panel puts forth the following two recommendations:

Recommendation 3: The CGIAR System should develop improved mechanisms by which centres can be involved with other partners in generating and interpreting improved scientific evidence on: (i) the extent and magnitude of the impacts of agriculture, forestry and fisheries on the degradation or enhancement of natural resources and the consequences for production and food security; and (ii) the linkage between poverty and observed resource degradation.

Recommendation 4: Expanded collaborative mechanisms and activities should be developed among the centres, and between centres and their non-CGIAR partners, to help focus research and institutional strengthening on issues related to adoption, adaption, and utilisation of research results that so far have remained unused.

The Panel is concerned that its recommendations related to expanded research, particularly on technologies, should be realistic and should take into account the problems in dissemination and adoption of such research. In a poverty alleviation context, the poor would not benefit from more and more research if the results merely sit on the shelves of the scientists and their agencies. This recommendation links closely to the discussion in Chapter 4 related to developing a better understanding of the aspirations and incentives of the poor from MAs.

CHAPTER 4 - REFORMING POLICIES AND INSTITUTIONS: ROLE OF THE CGIAR

No matter how good the quality of land, poverty cannot be addressed effectively if a perverse set of policies keeps people from meeting their potentials and effectively keeps them from taking advantage of opportunities to better themselves economically. The poor in MAs in most cases are not poor only because of the biophysical quality of their land resources. In fact, in many MAs, there are large pockets of land that are of quite good quality for agricultural production; but institutional or policy barriers keep the poor farmers poor.

The conceptual and analytical framework developed in Chapter 4 indicated that reform of policies and institutions is one of the three major areas of need that cuts across nearly all poverty situations for those living on the MAs of the world. In the present chapter we address this area of concern in terms of a) what it involves; b) what the CGIAR currently is doing to deal with it; and c) what the Panel sees as the options for the future for intensification of CGIAR effort in this area.

It is clear that research is needed to identify the specific types of poverty situations, and the poverty processes encountered in different geographical areas. Once such information is in hand, then research is needed on the policy options that best can remove the barriers that exist in specific poverty situations. This type of information is also essential for design of other research targeted to poverty alleviation where policy or institutional constraints are expected to persist.

4.1. Nature of the Issues Involved

The Panel considers that there are three basic categories of barriers to poverty alleviation in MAs: those related to *availability of knowledge* (people knowing what is right and possible to do, and how to do it); those related to *availability of resources* (people having the ability to take action, purchase necessary inputs, and so forth); and those related to *existence of incentives* to take action toward poverty alleviation (people having the motivation to do it).

To deal with these constraints, governments have three basic types of policy instruments: *regulatory* mechanisms; *fiscal and financial* mechanisms; and *institutional* mechanisms. An effective policy and institutional reform program must deal with all three of these in the context of all the barriers encountered. A holistic approach is essential, since all the pieces have to fit together.

4.2. Current Activity and Future Options for the CGIAR

Examples of targeted activities here are IFPRI's research projects on: (i) sustainable development of fragile rainfed lands; and (ii) policy, technology and institutional options for arresting deforestation and resource degradation in the forest margins of the humid tropics.

The first project expects to generate knowledge about fragile land management for a

wide group of users including policymakers, aid agencies, development agencies, NGOs, researchers, farmers in Central American hillsides, East African highlands, Southeast Asian hillsides, West African Sahel and dryland India working on natural resources management and in promoting sustainable land management. The second project expects to produce a set of policy, technological and institutional insights of broad applicability to the problem of managing growth and resource use in the humid forest regions of developing countries. Those likely to use the knowledge include researchers and administrators in NARS and policymakers at all levels in developing countries and policymakers in aid and lending agencies. The ultimate beneficiaries of this research are small farmers and the communities they comprise, as well as larger farming operations and populations engaged in extractive activities.

As explored in Chapter 2, in many MA poverty situations, the key bottlenecks are related to weak institutions and perverse or ineffective policies. While the CGIAR System is addressing some of these issues, they need to be emphasized more, particularly in a poverty alleviation context.

However, a fundamental problem is lack of adequate data on the location, nature, extent, and causes of rural poverty in the MAL regions of the world. Thus, the Panel sees as a first priority the development of a useful data base that will help centres (and their partners in this poverty alleviation work) identify target populations and issues, assess which comparative situations should be addressed by CGIAR work, and design approaches to the research likely will be most productive. An example of CGIAR involvement in assembling baseline data and background diagnostic studies of institutional and policy issues in a broader problem-solving context is the Alternatives to Slash-and-Burn (ASB) programme. It is an example of how the System fits within the overall picture, focusing on the international public goods aspects (through the comparative studies of sites and through work with NARS that involves spillovers). It is also an example of how poverty alleviation, community stabilization, and environmental protection objectives can be brought together in an integrated fashion. Other Systemwide initiatives also have similar objectives for international comparative analysis of specific site studies, in some cases using the ecoregional approach, which the System presently is struggling to define and operationalize (cf. the ongoing Centre Directors' study to operationalize the approach).

The Panel believes that the added emphasis and focus on poverty alleviation as a direct target for research may help to add further focus, clarification, and logic to the ecoregional approach to institutional and policy research - an internationally productive and valid activity for CGIAR involvement, expected to lead to locally relevant results useful, both in terms of development of research processes and in terms of substance.

CGIAR research should be focused on understanding the processes by which poverty can be alleviated, particularly in the context of what is possible for the MAs on which the poor live. It should compare across countries the dynamics of MAs as they move in and out of that category; it should be comparing the potential contributions of crops, livestock, fisheries, forests and trees, of policy changes, of option for value added and off-farm employment, and of technology advancements under different country and regional conditions; and it should draw process oriented conclusions from such comparative research. Centres within the System should be working on improvements in the information base on poverty; they should be working on the means for improving constraint analysis on poverty, i.e., on the means for identifying the key constraints to poverty alleviation in given rural development contexts. Such process research (strategic or applied) should involve

consideration of changes over time, comparability of results across ecoregional production systems, and mechanisms for translating results through adaptive research done by NARS.

CHAPTER 5 - GENERATING NEW AND IMPROVED TECHNOLOGIES: ROLE OF THE CGIAR

Poverty cannot be addressed for those living on MAs if there is not some improvement in productivity on the MLs and FLs within the respective areas. Productivity increases depend to a great extent on improvement in the technologies available to meet the particular conditions found in the specific MA being addressed. Correcting policy and institutional distortions is only part of the picture; and which, in practice, have proved to be an intractable question in many countries. As indicated in Chapter 3, the poor in MAs regions in most cases are not poor only because of the biophysical quality of their land resources. In fact, in many cases, the significant areas of land within a MA may only be missing a few technical adjustments in order to take off in terms of production. Local knowledge, combined with research can often provide the answer on how to address the problems.

Marginal areas are marginal for many reasons. In some cases, technologies can be developed that move lands from marginal productivity to higher productivity. The most obvious example is irrigation of deserts - where such is economically feasible and desirable. However, there are other, less obvious, but just as important examples, e.g., greater integration of range livestock systems into mixed farming or agroforestry technologies that increase productivity and farmer incomes, while at the same time reducing risk through diversification.

Estimates from FAO suggest that over the next couple of decades, about 80 percent of the production expansion will be associated with yield increases and some 20 percent with agricultural land expansion[1]. There is no reliable breakdown for MAs and non-MAs. However, yield increases will be an important source of growth on both areas.

5.1. The New Green Revolution - Technologies for Marginal Lands

The past approach to solving the food crises of the sixties and seventies in developing countries was through the introduction of Green Revolution technologies. The result was agricultural intensification on those areas which were more favoured in terms of biophysical conditions, market access, infrastructure and supporting institutions or policy; heavy doses of fertilizers, - high-yielding fertilizer responsive varieties, fast maturing species, irrigation, improved soil and water management, and use of chemicals to control pests and diseases. There is criticism of the Green Revolution technologies, e.g., that they have resulted in increased income inequalities, in problems of salinization and waterlogging in irrigated areas, and in health problems due to heavy use of chemicals. The evidence on the seriousness of these criticisms is mixed (FAO 1996[2], and Freebairn 1995[3]).

While agriculture (including ranching) legitimately can be blamed for most of the deforestation that has taken place in the world, it also is the case that the Green Revolution technologies for agricultural intensification have had some positive indirect environmental impacts related to forests. For example, the CGIAR estimates that without the technological advances brought about by the

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1 FAO 1996. *`World Agriculture: Towards 2010'*. N. Alexandratos, ed. John Wiley & Sons.

2 FAO 1996. *`Lessons from the Green Revolution - Towards a New Green Revolution'*. FAO Technical Background Document 6, World food Summit, 13-17 November 1996, FAO, Rome.

3 Freebairn, D.K. 1995. *`Did the Green Revolution Concentrate Incomes? A Quantitative Study of Research Reports'*. World Development. Vol. 23, pp. 265-279.

Green Revolution, some 280 million ha more land would have been needed to produce the same amount of wheat, maize, rice and other food crops that are part of the CGIAR mandate. It is doubtful whether such a large area of land would have been available, particularly in the areas where needed to meet the food requirements. But if even part of the 280 million ha would have been converted for agricultural production, a great deal more forest and fragile land would have been cleared and degraded without the Green Revolution.

Despite the advances in technology and agricultural productivity, and land savings that have taken place due to increases in per hectare productivity, forest land clearing for agriculture continues. Almost two thirds of the forest land that is deforested every year goes into agricultural expansion, including cattle ranching, particularly in the case of Latin America. On that part converted to slash and burn agriculture the result is marginalization of the lands cleared after three years or so. A key point here is that most of the deforestation is done by those poor people who were not the direct target of the Green Revolution - the poor who either come from the MAs or from the MAs via the cities (the rural to urban migrants coming home to the land).

The way forward, in terms of reducing poverty and food insecurity and in terms of improving the environmental impacts of agriculture in MAs regions, will involve a complex of factors. It will involve taking the best from the old Green Revolution technologies and combining them with a new generation of ideas, technologies, and institutional arrangements - what FAO (1996, op. cit.) calls the Second Agricultural Paradigm:

> It takes the natural constraints largely as given and explores the possibilities for increased yields by improved genetic material and changes in management without recourse to large amounts of external inputs. It recognizes that there will be sizeable groups in the farming communities that are de facto excluded from the broader socio-economic enabling environment....Examples of approaches under this second paradigm include: breeding of crop varieties that are tolerant to adverse soil conditions;...soil nutrient cycling;...reliance on genetic pest and disease resistance to replace, either partially or fully, chemical and mechanical pest control; the active use of functional biodiversity, where predators and other natural control agents of pests and diseases are actively encouraged through the maintenance of complex ecosystems within and adjacent to farming activities; and increased production from naturally trypanosomiasis-tolerant cattle and small ruminants that can lower the need for large-scale tsetse fly eradication, with its many ecological implications (p.4).

5.2. Current Activity and Future Options for the CGIAR

In the recent review of CGIAR priorities and strategies, TAC concluded that for poor countries where much of the labour force is in the agriculture, forestry and fisheries sectors and much of the average budget is spent on food and non-food products from these three sectors, increases in the productivity of biological products (foodstuff, fodder, feed, fuelwood and raw material for people, livestock and industry) offers the best opportunity to stimulate economic growth. The rural poor engaged in the production process and/or the post-production processing activities benefit directly from such economic growth, whereas the urban poor benefit indirectly through lower prices.

A significant proportion of research by the centres has been oriented to production issues which have directly benefited the poor. A good example is the work by IITA and their NARS partners on the biological control of the cassava mealy bug. This work led to integrated control of striga for improving total factor productivity of small farmers in the moist and dry savanna of sub-Saharan Africa. This benefited the poor regardless of the type of land. There is evidence that tree fallows and fodder banks promoted by ILRI have benefited poor producers in a wide variety of marginal areas in the same region. Additional examples relate to ILRI's production systems research

in the semi-arid tropics in maintenance of land productivity for livestock farmers, and the streak virus-resistant maize and the mosaic virus-free cassava cultivars released by IITA. In Asia, there is evidence that farmers' incomes have increased in recent years as a result of the adoption of ICRISAT's cultivars of pearl millet, sorghum, groundnut, and pigeonpea. In the case of pearl millet, the aim is improved productivity and stability in semi-arid tropical environments through development of downey mildew and ergot resistant cultivars and hybrids with drought tolerance for poor farmers. Similar examples can be cited for Latin America, e.g. the acid-tolerant rice and sorghum cultivars. For the WANA region, ICARDA's work in the area of soil fertility and water management has provided direct benefit to the producers. In addition, its research on the rehabilitation of pasture lands has played an important part in control of degradation on grazed hillsides.

Development of new and improved technology has been, and likely will continue to be, the main strength of the CGIAR. In the area of technologies that can help in the battle to alleviate poverty for those living in the MAs of the world, the CGIAR has made significant progress. The need now is to shift somewhat the focus of selected strategic research on commodity improvement, land use management, and other subjects to fit within the (diverse, site-specific MA) poverty alleviation focus suggested here.

This means, among other things, more attention to drought resistance and varieties tolerant to salinity and focusing additional efforts on the problems of the acid soils, issues related to nutrient mining, water harvesting and other water management technologies, to name a few examples. The choice of focus should be made by the centres, in the context of the MAs to which their research applies, either individually or in concert with others.

The role of biotechnology in genome mapping and the development of cultivars resistant to abiotic and biotic stresses also is of importance when looking at the potential contributions of the CGIAR to marginal lands research. There are many opportunities to develop "...technologies that can be usefully employed given the existing, often adverse, conditions"[1] found in the MAs. Such technologies can be of immense benefit to the poor; and, if coupled with activity in the other areas discussed here - institutional and policy reform, diversification and niche opportunities - they can provide one important input for poverty alleviation.

Within the context of working on poverty alleviation for those living in MAs, the Panel believes that the centres and their various partners in research should be developing new and improved technologies that respond to site conditions found in MAs, e.g., varieties resistant to a variety of abiotic stresses.

This should not be interpreted to mean the centres should engage in research on genetic improvement or management systems for hundreds of speciality crops and animals which may offer niche potentials in an equal or greater number of site-specific (or site-type) situations. As mentioned above, the CGIAR is already doing research on a wide range of products which are relevant to the poor in MAs. The new dimension may imply a few additional products, but the main thrust is on research (biophysical and social science) aimed at increasing the income options available to the poor. A prerequisite is research to clarify the capabilities, constraints and range of options (agriculture and non-agriculture) available in a set of MA situations, into which it is expected to apply the System's research results - species, management, value added, etc.

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[1] Ravenborg, H.M. 1993. *`Targeting International Agricultural Research Towards the Rural Poor'.* CDR Working Paper 93.4 (Centre for Development Research in cooperation with IFPRI).

The ingredients introduced through the CGIAR will be research in the mandated biophysical area, responsive to constraints and opportunities in MAs, plus interrelated social science research aimed at new institutional arrangements which will enable the poor to mobilize their indigenous knowledge on niches and value added. The role of the CGIAR in the latter area is in the development of approaches to constraint analysis and assessment of options.

CHAPTER 6 - DIVERSIFYING LAND USE SYSTEMS AND INCOME OPPORTUNITIES: ROLE OF THE CGIAR

The Director General of FAO, in commenting on the marginal lands issue, points out that:

> In marginal areas, farmers often spread the risk by engaging in mixed systems that combine agriculture with other economic activities. We need to draw upon such ancestral wisdom and encourage combined activities in their appropriate ecological and socio-economic setting. They are an expression of sustainable agricultural development, successfully merging cropping, stock raising, poultry farming, fish culture, forestry, hunting and gathering, the sale of produce on local markets, seasonal migration and all sorts of activities that mark the rhythm of a farming household's working year. (Statement of the DG on the occasion of World Food Day, Rome, 16 October, 1996)

Poverty is associated with significant risks for the poor. They do not have the "safety net" that richer people have through their savings and, most commonly, through the social systems to which they belong. The poor often are on their own - in fact that is a major factor associated with their poverty, which derives from the institutional and policy context. However, correcting policy and institutional problems is only part of the picture. Diversification of land use and farming system activities and income opportunities cuts across nearly all poverty situations in MAs.

The Panel recognizes that some of the diversification options mentioned below are merely part of a "holding pattern" - stop-gap measures that will maintain rural poor, but not lead to poverty alleviation and economic development. For that to happen, broader markets need to develop for non-agricultural products, education and technology development need to come to the forefront; and access for the poor to various social services and income generating opportunities needs to be improved. These changes are far beyond the scope and mandate of the CGIAR in its present form. It can help in terms of what it knows best - the institutional and technological change related to agriculture, agroforestry, forestry, and fisheries.

6.1. Diversification: Nature of the Needs and Opportunities

Diversification can involve a number of things - and the type of diversification that best fits a situation in MAs will depend very much on the nature of the poverty issues in that particular region. Where diversification is to be based on natural resources available to the poor, it is evident that knowledge of the biophysically marginal and favoured lands within any specific MA will be critical.

In general, the most promising types of diversification opportunities include the following:

- increased integration and further intensification of **livestock** in mixed farming systems - expansion of on-farm activities;
- introduction or improvement of **agroforestry** systems that provide various products both for home consumption and for markets, and that improve agricultural productivity in some cases;
- increased integration of **forest-based activities** into overall farming systems development and into poverty alleviation programmes for the landless;
- increased blending of **off-farm employment and income** generating activities with farm

system management and increased **vertical integration of farm activities from field to consumer** using new developments in postharvest technologies;

- increased use of **niche opportunities** - using exotic and indigenous, often underutilized, plants and animals; and taking advantage of small areas of good land, or other unique attributes, to produce high value crops such as flowers, herbs, spices, rabbits, honey, etc.

6.2. Livestock: Expansion of On-Farm Activities

Animal products are generally characterized by a high consumer preference. Given this, and the "walking bank" role of animals in small farms, farmers tend to respond favourably to opportunities for increasing the numbers of small or large animals to improve farm income. Thus, diversifying production into mixed crop-livestock systems or intensifying livestock production is often of strong interest to farmers in most parts of the world.

At the farm level, livestock can contribute to sustainability with its various interfaces with cropping and with the farming household (sales can be year-round sources of cash income, animals serve as mobile assets, supply of fuel material, supply of nutrient rich food). The integration and intensification of livestock keeping is a reliable way to stimulate income or consumption growth at the farm level, especially when farm-based inputs can be used in this process. In diversification, farm animals play an important linkage role between different sub-sets of the farming system as means of draught power for recycling nutrients and enhancing land productivity. Crop by-products and refuse can be fed to monogastric as well as ruminant animals. Under diversified land use coarse grains and (sown) pastures, fodder trees, and fodder shrubs on marginal lands can provide feed and can also restore soil fertility.

The year-round increase of livestock production is, furthermore, an ideal way to increase labour productivity. While cropping is characterized by peak labour demands, the steady work needed for livestock husbandry can spread requirements more evenly over time, thereby increasing labour efficiency. On-farm processing of animal products (butter, ghee, cheese) and local self-marketing are other possibilities to add value by linking available labour with production resources to obtain the larger benefits. Examples of expansion of on-farm activities involving livestock are given in Box 2.

Box 2: Expansion of on-farm activities through livestock

Example 1: Stall Feeding

In Kenya a small farm of 0.3 hectare supports Thomas Nzaywa, his wife, three children and grandmother by a system of no-graze dairy production. Thomas converted the farm from the typical crops such as maize, beans and cash crops to a stall feeding dairy byproducts farm. The fodder from a hybrid of Leucaena leucocephala and Calliandra calothyrsus is used as feed. Flowers from the trees provide nectar for side production of honey. The manure from the cattle is abundant enough to fertilize his field. The field is cropped with rows of the hybrid and spinach and other greens. Fuelwood is always abundant. The excess milk and manure are sold. Complimentary feeds are purchased and extra money is reinvested. Thomas purchased a shredder that mixes the fodder to an optimal nutritional formula and put his children through school.

Prinsley, R.T., 1990. Agroforestry for Sustainable Production: economic implications. Commonwealth Science Council, London 1990.

Example 2: Desertified Land Reclamation:

Desertification is a serious problem in many regions of the world. A project in northwest Peru, covering 1000 hectare, is attempting to reverse the tides. The area is characterized as semi-desert sand dunes. Three varieties of trees have been planted: Prosopis chilensis, P. limensis and P. juliflora, with a spacing of 10 m x 10 m, five seeds to a hole. The trees are intercropped with beans from year 1 to year 4, from year 4 to year 30 pods from the trees will be used for animal feed, food, molasses and honey, sheep grazing and bird hunting will be introduced during this time period. At year 30 timber will be harvested and regeneration initiated. In addition, the stand will provide woodfuel. Two years into the project trees are producing fruit at about US$25 per hectare and pods at US$200 per hectare.

Tran van Nao, 1983. Agroforestry Systems and Some Research Problems, In: Huxley, P.A., 1983. "Plant Research and Agroforestry." ICRAF, Nairobi, Kenya.

6.3. Agroforestry: Making Marginal Lands More Productive

Agroforestry is widely practised and has been for centuries in most countries. In major parts of the developing world, it is the main form of land use and a major contributor to sustainability. Yet, because agroforestry lies in the hazy area somewhere between the fields of forestry and agriculture, it does not have the constituency, nor receive the attention it deserves in the policy arena in terms of its potential to contribute to poverty alleviation for those who live in MAs.

Agroforestry to a great extent evolved in response to needs and to sustainability concerns related to resiliency, flexibility, and avoidance of negative side effects of agriculture. Because of its blending of production with protection, it fits nicely with the concept of conservation and forces divergent views to focus on sustaining the overall productivity of land in MAs.

By design agroforestry should provide both environmental and productivity benefits. At the same time, farmers have to be aware that the use of trees in agricultural systems is not always positive in terms of sustainability and income generation. For example, trees can be introduced in such a way that they compete for space, light, nutrients, and water with other crops, thus possibly reducing the overall value of production.

Experience and careful study are needed to find those combinations of trees and other land uses that maximize overall sustainable production. The need for careful research on agroforestry is most pronounced in relation to biophysically marginal areas, where sensitivity to misuse tends to be greater. In some cases, it might mean no trees; in other cases, it might mean total forest cover. In between are the productive agroforestry systems.

Based on ICRAF's experience these systems can contribute to poverty alleviation and sustainability of farming in MAs in three important ways:

- building in flexibility to deal with uncertainty and the dynamics of changing needs;
- improving the resiliency of a land use; and
- creating positive externalities and linkages among land-use practices and their impacts.

6.4. Forests and Diversification of Land Use Activities for Poverty Alleviation

The links between forests, trees, food security and deforestation shown in Figure 6.1 indicate that there is a two-way relationship between agriculture and forests. On the one hand, the major source of deforestation is agriculture (particularly slash and burn agriculture and large scale cattle ranching). On the other hand, agroforestry systems and forests contribute to increased food security, income generation and poverty alleviation.

Packages of new options for diversification in MAs include improved use of forests and trees. It has been estimated that a significant part of rural poor people depend in a major way on forests for their benefit flows. The Panel recognizes that improvement and expansion of forest and tree related activity by the poor in MAs is only one small part of the diversification needed. However, in some areas it can be an important part in solving the poverty alleviation puzzle.

Some promising areas of forest and tree related diversification - at least in the early stages of development - include the following:

Forest foods for subsistence and as sources of income. Outputs from the forest (bushmeat and fish, fruits, nuts, gums, resins, and so forth) supplement agricultural outputs in many parts of the world. Studies by IFPRI, CIFOR and others indicate that farmers in many forest regions of the world, e.g., Zaire Basin and the Amazon, depend as much on the surrounding forest as the farm for their food and other products, both those used on the farm and marketed. A study for over 60 countries showed that game and fish contribute 20 percent or more of the animal protein in the average human diet. Another study estimated that around 1974 some 75 percent of sub-Saharan Africa depended largely on traditional wildlife sources of

protein. Many similar studies confirm these general orders of magnitude[1]. The ASB research programme is addressing the potentials for improved linkages between forest fringe farming, use of forests, poverty alleviation, and reductions in deforestation.

Bioenergy from trees. Fuelwood grown on farms, or taken from forests, provides the major source of cooking and heating energy for a majority of people in most developing countries. Adequate fuel is an essential ingredient in any poverty alleviation programme. Fuelwood, particularly converted to charcoal, provides a significant source of income for many rural people. It provides another link in the diversification of rural activity in many MAs. However, much research is needed to understand the various linkages between use of fuelwood, deforestation, and health issues (mainly from the inhalation of smoke).

Protecting watersheds. Forests and use of trees in land use systems can contribute to downstream agriculture, e.g., through regulation of water flows and quality that directly affects irrigation options. Furthermore, it is well known that forests have a beneficial and regulating impact on the hydrological conditions of a watershed, such as the presence of springs, higher groundwater level, creeks with water for longer time periods.

6.5. Expansion of Off-Farm Employment and Vertical Integration of Farm Activities

In many parts of the world, e.g., in the middle Himalayas, parts of the highlands of Africa and Latin America and drylands, population growth is such that expansion of off-farm sources of employment will become a necessity. The land in those areas just will not support the growing numbers of people.

We can illustrate the potentials with some numbers from the small scale enterprise sector involving trees and forest products. FAO estimates, for example, that India currently has some 30 million persons working in forest-related enterprises. In Brazil, more than two million people earn a significant part of their income from activities associated with extraction of various products from the wild babassu palm. Similar stories abound from around the world. Many of these activities involve women and provide them with a supplemental source of income, often used to purchase food.

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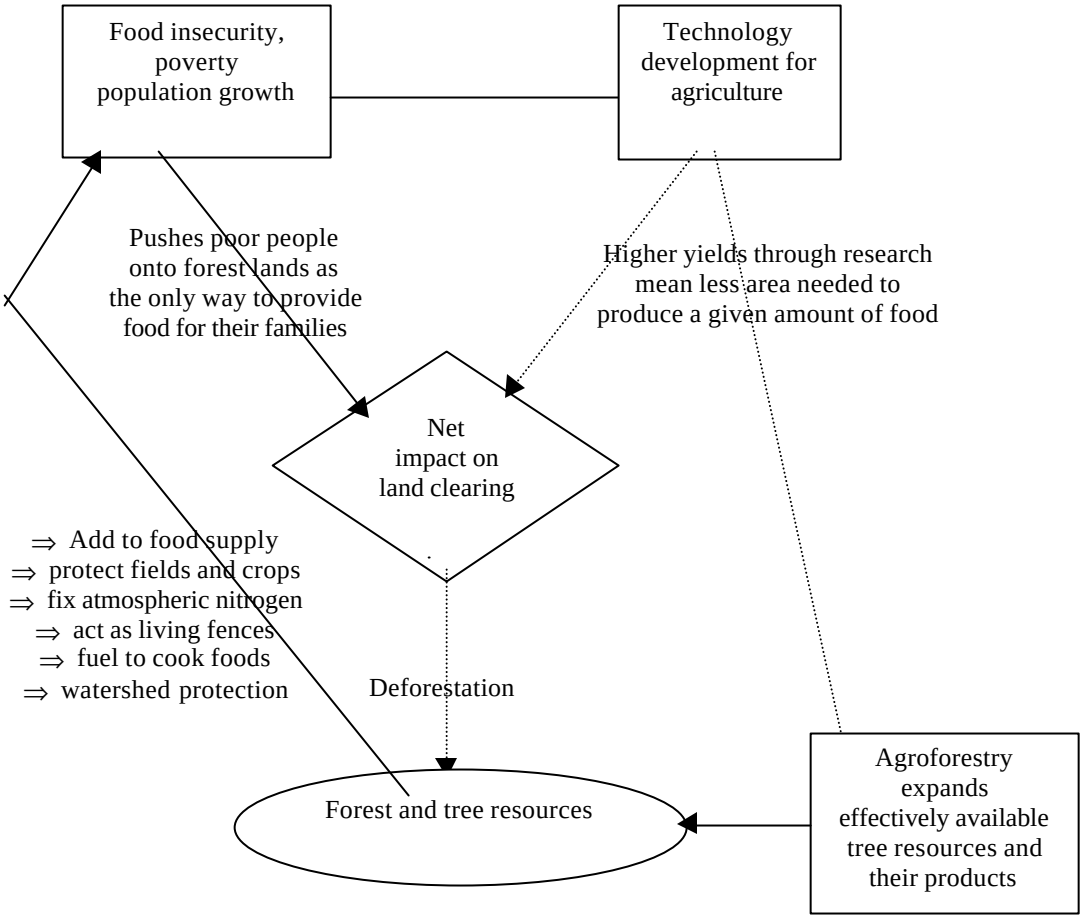
[1] Redford, K., R. Godshalk and K. Asher. 1995. *`What about Wild Animals? Wild Animal Species in Community Forestry in the Tropics'*. FAO Community Forestry Note 13. FAO. Rome, Italy. 96pp.

Figure 6.1: Links Between Forests and Food Production



Many other important sources of off-farm income exist. Their development often becomes the first step in evolving a balanced economy that goes beyond nearly total dependence on agriculture for income. Yet, the Panel recognizes the problems involved in generating markets. Most commonly, the products produced in these small scale enterprises are not of the quality where they can be exported out of the region; and the local markets, because of the depressed nature of much of the agriculture, are not large enough to support significant off-farm activity. The CGIAR has a limited role in this area. However, in some instances, it might be a catalyst in linking increased farm activity to off-farm opportunities.

Another area which recently was reported on by a TAC panel is that of postharvest technologies. That study[1] recommended that the CGIAR give greater emphasis to the harvest and postharvest components of the production-to-consumption continuum. In MAs, postharvest losses can be great; value added to crops can go outside the regions; and opportunities to generate added off-farm employment can be lost. Thus, the Panel endorses the recommendations of the TAC postharvest technology study as being relevant to improvement in conditions in MAs and, ultimately, can contribute to poverty alleviation. An example is CIAT's work on storage, processing and marketing of cassava in the Andean region.

6.6. Increased Emphasis on Niche Opportunities and Underutilized Plants and Animals

Closely related to livestock, agroforestry, postharvest technology and vertical integration options, is the opportunity to diversify on the basis on "niche" opportunities. These generally are crops that currently are underutilized, for which promising technologies and defined markets exist, and for which there is suitable pockets of land within the MAs. Examples include, spices, herbs, mushrooms, honey bees, various tree crops, flowers, fruits and vegetables. Experience to date indicates that individual opportunities, with a few exceptions, are not large. However, on a cumulative basis, niche crops can be an important element in an overall diversification and poverty alleviation programmes (see Box 3).

Possibilities exist also to integrate aquaculture activities into farming systems in some parts of the world. Gains through research have led to some promising varieties of tilapia, carp, and so forth. ICLARM is in the forefront of this work.

6.7. Current Activity and Future Options for the CGIAR

With the introduction of agroforestry, forestry, and fisheries into the CGIAR, the System already had started on the road towards research on issues related to land use and farming system diversification. The strong emphasis on NRM, in an INRM context (cf. TAC's Soil and Water strategic study), has led a number of centres to emphasize

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1 TAC Secretariat. 1996. *`Harvest and Postharvest Problems in Agriculture, Forestry and Fisheries - The CGIAR Contribution to Research -'.* (SDR/TAC:IAR/96/5).

Box 3: Niche Opportunities

In the semi arid parts of India in small pockets people produce grapes and oranges and tamarind which not only have nationwide demand; but the products are exported as brand names such as Mahagrapes from the state of Maharastra; the same is true of onion, garlic and red chilly. In many MAL areas, vegetable seeds are produced for green revolution FAL areas, as the former's climate is disease and pollution free. This occurs more in hill areas where they not only produce disease free seeds, but off-season vegetables as well as flowers and fruits for the FAL and their urban centres. Sericulture and dryland horticulture are picking up even on small farms in areas as dry as Western Rajasthan in India. Recent trends in small-scale stall-fed goat raising, and angora rabbit rearing have helped the poor, as these enterprises do not need much land or investment; and they are highly productive both biologically and economically. ICRISAT generated high-yielding pigeonpea cultivars which, aside from commercial use, is also planted in courtyards by farmers and landless households for quick production and sale as green vegetable in villages nearer the towns. In most of these cases accessibility and nearness of market has played an important role. These processes recently have been encouraged by entry of organized private sector entities in rural areas following the liberalization of the economy. In some cases NGOs have helped. Replication of such small-scale initiatives can make a big difference to the situation of the poor in marginal areas.

both production and conservation objectives related to diversification. The latter objective is important to the CGIAR portfolio, since in some cases diversification can lead to even more rapid environmental degradation than currently exists.

Examples of targeted research activities for developing diversity are: ICRAF's work on small-holder agroforestry systems for the desert margins to alleviate fodder shortages and fence in livestock, enhance soil fertility and address problems of desertification; ICRISAT's work on short-season chickpea improvement and management for post rainy season production in dry and warm marginal environments to diversify existing cropping systems in Asia and East Africa; CIAT's programme for hillsides in Latin America; and ICARDA's work on low-cost improvement of native pastures in marginal lands and rangelands for increasing productivity of pastoralists and nomadic herders; and inter-centre work on developing alternatives to slash and burn agriculture.

The Panel emphasized the importance of keeping sustainability concerns uppermost in mind as diversification options are explored. In the context of *sustainable* poverty alleviation associated with MAs, the Panel reconfirms TAC's view, supported by the CGIAR members, that strengthening research on NRM and environmental issues is needed in the CGIAR, as is a more explicit linking of this area of research to the Lucerne "vision" of CGIAR contribution to poverty alleviation and sustainable food security. Because of their significance in relation to poverty alleviation, we repeat the pertinent TAC conclusions regarding NRM here:

* TAC reaffirms and emphasizes the point: *The System should with few exceptions only be doing environmental and NRM related research that is clearly identified with the impacts of agriculture, forestry and fisheries on sustainable poverty alleviation and food security.*

* TAC confirms that *research on both aspects of land use impacts - on-site and off-site - are priority areas for research in an integrated natural resources management (INRM) research framework such as is needed in the System.*

* TAC concludes that once the necessary condition has been met, i.e., the proposed research is identified in a positive way with impacts on sustainable poverty alleviation and food security, then adjustments in specific research may logically be made to take into account potential benefits in terms of other aspects of environmental improvement and health. Such adjustments should, of course, consider the cost implications. In fact, much of the research undertaken by the System does contribute to these other goals (even though such research was initiated in the System only because of its links to sustainable poverty alleviation and food security through agriculture, forestry and fisheries)[1].

The CGIAR has traditionally focused on the crop production end of the farming system. Taking more of a poverty alleviation focus, and realizing the importance to the poor of diversifying income generating activities, the Panel suggests that the CGIAR needs to pay more attention to mixed crop-livestock-tree systems. In other words, systems that simultaneously capture different elements of the MA resource potentials need greater attention. For example, integrated systems involving aquaculture, wetland rice, livestock, and agroforestry are likely to contribute to poverty alleviation and sustainable development of inland valleys of sub-Saharan Africa.

The Panel notes that the work by NGOs has shown that poverty alleviation in MAs often is identified with local action. Also poverty alleviation involves diversification of activities and of sources of income and opportunities for improvement (cf. recent speech by DG of FAO[2]). Research related to opportunity access for the poor is frequently situation specific. At the same time, the CGIAR by its nature must focus research on those areas where it is most cost-effective in providing international public goods.

The Panel believes that there are a number of potential areas related to poverty alleviation that fall within the international public goods category. They include such things as research related to: development of methods and processes for assessment of poverty alleviation constraints; poverty processes and the dynamics of poverty (mainly linked to the role of the agriculture, forestry and fisheries sectors); comparative analysis of location-specific linkages among environment, technology, agricultural development and poverty alleviation; off-farm employment opportunities; and post-harvest technology.

Any decision on broadening the research agenda along the above lines should only be taken after an examination of the options, potential poverty impacts and alternative suppliers of such research. The Panel recognises that precisely because of the international public goods requirement, the CGIAR must proceed with caution into an area of poverty alleviation which requires a site-specific MA focus. The System can only be a minor part in the total research effort devoted to the types of issues and topics arising from this focus. The challenge lies in investing scarce resources in

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1 Examples include: biological control undertaken primarily because of the rising costs of chemical control with increasing resistance, but benefiting also farmer health and the environment; trees grown on farms for food, wood and forage, but helping to control erosion and, if native species, helping also to conserve biodiversity.

2 Op. cit.

such a way as to catalyze further R&D investments by others. Hence the importance placed on implementing Recommendations 2, 3 and 4 once a first approximation has been made of the characteristics of MAs: **where** are the marginal rural people? **why** are they poor? and the scope and nature of options open to the CGIAR to effect change towards sustainable poverty alleviation (Recommendation 1).

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ANNEX I

TERMS OF REFERENCE

The terms of reference for the study are to:

(1) Examine concepts and definitions for use by the CGIAR.

(2) Examine potentials for research gains from inherently marginal lands (regardless of production potentials relative to other lands) in terms of: (a) the per hectare gains possible on the individual marginal land types (by ecosystem or region); and (b) the total area of individual marginal land types on which gains could be applied; (c) the policy gains (e.g., related to incentives) that might be derived from research. Indicate how such gains would be distributed among people/groups. Indicate how such gains would be distributed among people/groups, with a focus on how the poor would gain, both now and in the future.

(3) Development an assessment of how the marginal lands issue relates to: (a) common property issues and research (since a large proportion of marginal lands is in common property status); (b) links between marginal lands research and development of off-farm employment (looking at the marginal lands issue in a holistic context of how expanded off-farm employment could relieve pressures on the farm population that has to depend on the land for survival and income); and (c) development of new, more sustainable farm technologies. In each case provide a judgement on the role of CGIAR research in dealing with the issue.

(4) Make suggestions on future CGIAR priorities and strategies for research work on marginal lands, including whether the current level of effort is adequate in relation to that devoted to other land types.

ANNEX II

METHODOLOGY APPLIED FOR THE DATABASE

As part of the study a database was created to specify marginal and non-marginal lands and their characteristics including: land use and area, soil classes, moisture regime, total and rural population and rural poverty. The scope of the database was to indicate orders of magnitude of different land types in the developing regions, i.e. the extent of favourable and less favourable lands for agricultural purposes, the extent of forest and woodlands and of dry areas and the numbers of rural people and rural poor living on them.

1. Primary Data

The primary data used on land area and population was supplied by FAO/Land and Water Division. The countries land area by soil classes information was derived from the digitized FAO Soil Map of the World at a scale of 1:5 million, overlaid with agroclimatic maps. This data was georeferenced to cells of 5 square minutes, an area of about 30 km^2 at the Equator. For every country the output was a file with:

- soil/terrain - 11 classes characterized as follows:

  1 - sloping terrain: steeply dissected with slopes in excess of 30%;
  2 - shallow soils: with depth limitations within 50 cm of the surface caused by the presence of coherent and hard rock or hard-pans;
  3 - poorly drained soils: waterlogged and/or flooded for a significant part of the year;
  4 - coarse textured soils: coarse in texture or having gravel, stones, boulders, rock outcrops in surface layers or at the surface;
  5 - heavy cracking clays: with high clay content and deep cracks occurring at some point in time in most years (unless irrigated);
  6 - infertile soils: with deficiencies in major, secondary and minor plant nutrients when cultivated;
  7 - saline/sodic soils: with high salt content/exchangeable sodium saturation;
  8 - acid sulphate soils: soils in which sulphidic materials have accumulated;
  9 - organic soils/peat soils: composed to more than 50% of organic material;
  10 - no problem soils: no constraints to sustained agricultural production;
  11 - "miscellaneous" lands (mainly water bodies).

- moisture regime - 16 reference length of growing period (LGP) classes in 30 day intervals of "rainfed" moisture availability and temperatures that permit plant growth;

The resolution for the files extracted was at 0.1%, i.e., percentage values of the total surface or population of a country below a tenth of percent per cell were not recorded during the extraction. This fact can lead to a limited loss of land areas in the output files, especially for large countries.

A feature of the soil/land types constraints information is that they are mutually exclusive, i.e., these are used in a sieving approach with the sequence of soil characteristics above. In this way the

first land type, sloping, would have all the soils with more than 30% slope in the data irrespective of their further soil characteristics, including therefore also sandy and/or infertile soils in the sloping class. The sequence is somewhat arbitrary but geared towards agricultural purposes, i.e., the most limiting factor - or the most vulnerable aspect with regard to erosion potential - steepness, is excluded first. The sequence of the soil classes therefore influences the results for soil/terrain types 1 to 9, whereas the type 10 "no constraint" can be seen as the output of the sieving and their values are not affected by the order of sieving. With this method the surface area information is additive to 100%.

The countries' population data was estimated by a study team of Santa Barbara University in 1989. It was extracted in the same set-up as the terrain/soil data above, and a country's cell with land area information has a corresponding cell with population information in a second file. The sub-national level population data used by the Santa Barbara University was spread to the corresponding georeferenced land assuming an homogeneous population density across the administrative area.

Country values on percentages rural population and rural poor people were taken from data based on UNDP Human Development Report 1994.

2. Calculation of land type and population values

Country summary files were created which contain the information for land areas and population by soil characteristics and LGPs. The approach followed to derive from this data a breakdown for different land types and for population is shown graphically in Figure II.1.

By combining this data set on soil characteristics and LGPs with a further data source on the extent of forest and woodlands in the countries (FAO Forestry Statistics Today for Tomorrow, 1995), the land area could be grouped into three major categories (favoured lands, forest and woodlands, and arid area) to derive marginal agricultural lands, the fourth category, as a residue. First, the favoured lands were defined as soil type 10 (no constraints) with LGPs above 75 days, taken as a lower limit of rainfed cultivation and grazing, and significant forest and woodland growth. Assuming an even distribution of forests and woodlands in the countries, these favoured lands were reduced by the countries' share of forests and woodlands and the balance are the favoured agricultural lands (FAL). Arid areas (LGPs below 30 days) and the countries' residue of forest and woodlands are subtracted from the data for the other soil characteristics to determine the extent of marginal agricultural lands (MAL). These MALs are the land areas above 30 days of LGP on sloping, shallow, coarse, heavy cracking, etc., lands, but exclude the forest and woodlands and the arid areas of the country. They would, however, include grazing lands. The results of this assessment at regional level are given in Table 2.3.

To show the importance of irrigation in arid regions of the world a further column was inserted in Table 2.3. The values show the extent of irrigated areas in arid lands. This data is an estimate for country level irrigated lands (data from TAC 1992, Priorities and Strategies database) which was overlaid with LGP information. The physical area of the irrigated lands would be contained in the values for the arid lands, whereas the land type itself would be classified in the category favoured agricultural lands.

Rural population data is shown at the regional aggregate level in Table 2.4. The procedure applied stemmed from the above classification for the land areas but was essentially simpler and,

unfortunately, less refined. The population values on FAL were derived as the sum of the population figures for the favoured lands (soil class 10 with no soil constraints and with LGP >75 days), and the remainder was set as the country rural population on "other" land types, including marginal agricultural, forests and woodlands and desert areas. The information for forest cover could not be used to differentiate people living on good lands between agriculture and forestry, in this case the value was used as an estimate for rural population on prime lands only. Furthermore, country values for rural poverty (based on UNDP data) were used as factors to derive an estimate of rural poor living on less favoured lands.

Figure II.1: Organization of Database of Land Types for an Example Country

LGP	SOIL CLASSES								
	1	2	3	.....	8	9	10	@SUM	%
0	**7331**	**24438**	**1222**	**ARID**	**0**	**0**	**50098**	**106305**	**8.8%**
1-30	**1222**	**2444**	**0**	**LANDS (d)**	**0**	**0**	**10997**	**15885**	**1.3%**
30-60	24438	18329	0	. . . . .	0	0	171066	228495	18.9%
.	.	.	.	. . . . .	.	.	**FAVOURED**	.	.
.	.	.	.	. . . . .	.	.	**LANDS**	.	.
.	.	.	.	. . . . .	.	.	**(b)**	.	.
.	.	.	.	. . . . .	.	.		.	.
300-330	9775	1222	0	. . . . .	0	0	**12219**	29326	2.4%
330-365	1222	0	0	. . . . .	0	0	**3666**	6110	0.5%
@SUM	315250	85533	2444	. . . . .	0	1222	602397	**1212125**	**Land area (a)**
%	26.0%	7.1%	0.2%	. . . . .	0.0%	0.0%	49.7%		

DATA/CALCULATIONS PERFORMED

TOTAL LAND AREA	(a)	1212125
FAVOURED LANDS	(b)	344576
FOREST WOODLAND COVER (INPUT VALUE)	(c)	34.6%
FOREST/WOODLAND ON FAVOURED LAND	(bxc)	119370
FAVOURED AGRICULTURAL LANDS	(b - bxc)	225206
ARID LANDS	(d)	122190
MARGINAL AGRICULTURAL LANDS	(a-(b-bxc)-(axc)-d)	444819

ANNEX III

CONCEPTUAL FRAMEWORK FOR ANALYZING RESEARCH INVESTMENTS IN POVERTY ALLEVIATION IN A MARGINAL LANDS CONTEXT

The focus of this study is on the role of the CGIAR in research related to "marginal lands." However, TAC has made it clear that the System should not be investing in research on marginal lands just because they currently are considered low potential areas for agriculture. Thus, as stated in the proposal for the study, "TAC favours allocating resources such that the balance between high and low potential environments emerges from the concern with poverty alleviation and resource conservation, rather than being introduced a priori."

TAC's views regarding research priorities for marginal lands are based on the premise that a balance of effort is required between the marginal lands and the non marginal or "high potential lands". It is not an issue of research investments in one land type against the other, but rather of assessing research priorities against the criteria of poverty alleviation, protection of the environment (sustainability) and efficiency (productivity enhancement). As stated in the Lucerne Declaration, the CGIAR research agenda should address problems of the poor in both less endowed and high potential areas.

From an agricultural productivity and production perspective, a further implication of the focus on poverty alleviation is that the CGIAR is concerned not only with the per hectare potential of different classes of land (i.e., their maximum potential level of production), but also with the scope for overall improvement in poverty reduction and food security through its R & D. That means that the overall levels of production that can be achieved on the farmers' fields are directly relevant to investment decisions in research. We can think of those overall levels as being a product of the average attainable sustainable yield increase per hectare (Y) and the area on which that yield increase can be achieved (A). Thus, (A x Y) becomes the relevant focus.

Thus, it may be that one million ha. of land (A) with moderate productivity, with a feasible improvement of say 0.5 tonne per hectare (Y), is a better prospect for future R & D investment than a smaller area of say 50,000 ha. of already improved high productivity irrigated land, where the product of A x Y is lower. In other words, in this case, additional CGIAR research related to marginal lands can make a greater difference than spending the resources in a favored area.

We can put these thoughts in more expanded form as follows:

Targeting research investment to a given area of marginal land, A.

In a *sustainable poverty alleviation context*, but with a focus on production of crops (food, livestock, forest, or fish), the contribution of CGIAR research "i" to poverty alleviation can be formulated conceptually as follows:

$$\{(A_i) \times (Y_i)\} \times (I_{pop}) + OF_i + S_i = G_i \qquad (1)$$

where,

A_i = size of area that benefits from CGIAR research i.

Y_i = average *sustainable* net income (or net benefit or use value) increase per unit area due to CGIAR research i (where "sustainable" incorporates the the environmental protection constraint; and "net" income means benefits actually captured by the farmer net of the associated costs of achieving the benefits; the benefits can come from policy gains as well as productivity increases; values appropriately adjusted to present value (PV) terms through use of appropriate discount rate).

I_{pop} = index for number of poor people gaining or benefiting from (A x Yi), weighted for: (a) degree of poverty affected (e.g., proportion "poorest of the poor"); and (b) extent to which those other than the producers of (A x Yi) gain from lower prices due to (A x Yi);

OF_i = measure of net gain from off-farm activity in A due to research i, weighted for the extent to which poor people benefit from the gain (again, in PV terms);

S_i = spillover impacts, or externality impacts (in PV terms);

G_i = measure of gain from research i, (which, given the left side of the equation, is a measure of production increase, or net income increase, due to the research, weighted for a poverty alleviation objective);

As mentioned, this formulation considers poverty alleviation impacts *with a focus on agricultural, forestry, or fisheries production.* If we limit consideration to marginal agricultural lands (MAL), then A of course would reflect the particular MAL area being considered. However, as discussed below, the formulation can be used to look (at least conceptually) at all types of land (both FAL and MAL).

In this format, we are asking the following question: given the potential area for crop x or y, what kind of per hectare income increase could be generated by research related to this crop? (Obviously, in order to identify a relevant A, we have to have some particular crop(s) in mind.)

Targeting research investment to a given marginalized population

We also can change the formulation to make the primary objective be poverty alleviation. This then would be the primary determinant of G_i for a given CGIAR research investment, i, in terms of a given target population of poor or marginalized people (some farmers, some perhaps not). If one takes a poor people focus and looks at research investment from that perspective, then the following formulation might be more appropriate:

$$(Pop_i \times Y_{pop}) + S_i = G_i \qquad (2)$$

where,

Pop_i = population of poor people targeted by research i; (the population could be associated with any number of characteristics that relate to poverty)

Y_{pop} = average per capita net benefit flow gain for Pop_i due to CGIAR research i (such research could be focused on crops and other things that could generate benefits)

S_i and G_i = as before, except G now is expressed in terms of poverty alleviation measure;

Given the above formulations, which apply equally to "marginal" as to "non-marginal" lands, there is no necessary reason why, for a given (A_i x Y_i) or (Pop_i x Y_{pop}), the CGIAR should be interested more in marginal vs. non-marginal lands, except *if the marginal lands (defined by A) have proportionally larger populations of poor people who can gain from changes due to the research*[1], i.e., the I_{pop} that applies is higher; or Pop_i for the marginal lands is higher, other things being equal. These I_{pop} and Pop_i conditions define "marginal areas" (MA) used in the study regardless of whether the lands on which this population lives is biophysically marginal or favoured.

From a strategic public investment point of view, maximizing returns (G) per unit of scarce CGIAR resource ($R) may be regarded as a rational criterion for allocation; (where $R is the amount invested to get the response G). Thus, we have a measure of *research investment efficiency* as follows:

Research investment efficiency. This could be measured by G_i per $ of CGIAR and associated research expenditure, when both are appropriately discounted to the same point in time:

$(G_i/\$R_i)$ = research efficiency; (3)

We would want to find that set of research opportunities that maximizes G for the research budget (i.e., we would seek to maximize the net present worth of the research investment).

We can further modify this formulation to look at the *social cost-effectiveness* of research investments - which should be the ultimate objective sought, once we have eliminated all those potential research investments that have Gi < $R.

Social cost-effectiveness or "impact". $(G_i/\$R_i)$ only considers the efficiency element, i.e., production of the research results. The real aim is to get research in place in the farmer's fields or in the forest or on the grazing lands. Thus, we need to introduce E_i, or the extension and transfer costs, to come out with an array of opportunities ordered on the basis of:

$G_i/(\$R_i+\$E_i)$ (4)

Adding $E to the equation assumes that the CGIAR is interested in research applied on the ground as an ultimate test of success - the $E may not come from the CGIAR, but has to be considered, since it is a necessary cost of getting research in use. This also raises a question on the need for research into institutional determinants of $E.

Finally, we also have the strategic question of equity, or distribution of benefits, as a criterion for allocation. If the calculations of G_i in relation to $R and $E do not produce results that are

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[1] Also, aside from this question of research efficiency, there is a question of distribution of benefits. This is taken into account by the equation above through I_{pop} and the discount rate used.

acceptable, then the decision-makers need to go back and discuss and possibly readjust I_{pop} or the discount rate.

The Panel puts forth the above formulation only as an annex, since it represents only the beginning thinking for a broader discussion of priority setting. However, the Panel felt it worth including in its report, since it does provide a conceptual perspective on the differences and similarities that exist when one focuses on a land/productivity measure of research return versus a poverty alleviation measure.

ANNEX IV

CURRENT CGIAR ACTIVITIES

As part of the Study a desk analysis of current allocation of CGIAR research resources to the different land types identified in Annex II was undertaken. In addition to estimating total research investments in the different agricultural quadrants (i.e., I to IV), the analysis was also expected to identify allocation patterns among the 12 CGIAR activity categories across land types, if any.

Available information on research expenditures by projects funded by the CGIAR System is very rarely presented in terms of targeted "land domains". Actually, a brief characterisation of the natural resource base on which projects focus their activities is not a descriptor in the standard format used for the 1997 compilation of CGIAR Research-Project Details (1997 R-PD). As a consequence, the exercise was run in two phases. The first sought to elicit from the CGIAR Centres information on project agroecological targets, in terms of relevant moisture zones, as characterized by length of growing period (LGP), and soil classes (SCs), and on activity patterns across land targets. The second phase attempted to re-calculate project resource allocations in relation to the identified land types, as well as to assess their stated poverty alleviation focus in terms of objectives, outputs and beneficiaries.

1. Methodology

Project information was taken from the CGIAR 1997 R-PD, Centres' 1997 Programme Plans and Funding Requirements (PP&FRs) and Medium Term Plans (MTPs). ICLARM, IPGRI and ISNAR and most of IFPRI's projects were not included in the analysis. Data was used to estimate project resource allocation to moisture zones - as represented by LGPs - and research activities within six geographical regions. Among-region estimates followed Regional Expenditures in Table 3 of the PP&FRs, while LGP estimates were based on the FAO's agro-ecological zones information for the different regions. Activity shares were taken from "standards" presented in Table 1a of the PP&FRs.

Estimates of resources allocated to CGIAR activities within regional LGPs were then submitted to the corresponding Centres for their verification. They covered 279 projects out of a total of 374 projects endorsed for 1997, accounting for 80% of the total CGIAR budget. Resources allocated to LGPs within regions were reviewed by most Centres, but only one provided information on soil domains. None indicated changes in the standard share of activities when the project target moved across different land types.

In the second phase research expenditures were allocated to land types (quadrants). The basic assumption was that Centres allocate their resources in proportion to the importance of the area and land use covered by SCs within regions and LGPs in which they operate. Project budgets were then subjected to the following allocation process:

- first, among regions and LGPs, in correspondence with resources allocated by Centres to LGPs within regions;

- second, among land types within LGPs (Table 1), in proportion to soil classes - which were grouped as soils with no physical constraints (No. 10), with high production potential (Nos. 3-6), and those with low potential (Nos. 1-2 & 7-9)

assuming no major land development to improve land quality;

- third, between land types I and II, according to LGP-specific proportions of lands under QI and QII in relevant countries of the region.

Table 1: Rules to Allocate Research Resources to Land Types

Moisture Environment	Soil Classes[1] Any of (3-6/10)	NoConstraint (10)	HiPotential (3-6)	LoPotential (1-2/7-9)
Irrigation	Q I/Q II			
LGP 75-120 days		QIII	Q III	Q IV
LGP >120 days		Q I/Q II	Q III	Q IV

[1] See Annex II for description of soil classes

An unbiased application of this method requires that the actual soil classes in the project land areas are known. Unfortunately, as no information could be provided by Centres on the project soil domains, we were compelled to apply the proportions among SCs within LGPs from the FAO/Land and Water Division database. As these are the same as those used to calculate land shares among quadrants in Annex II, proportions of land types (quadrants) and estimated resource allocations are bound to be correlated.

2. Results

Table 2 shows how CGIAR resources are being allocated across land types within the six geographical regions. Tentative shares are based on estimates of resources allocated by each of 279 projects to the agroecological focus(i) of their activities.

Table 2: SHARE OF CGIAR-WIDE PROJECT RESOURCES AMONG LAND TYPES WITHIN REGIONS (as percentages of total within region)

Regions	Land Types (Quadrants) I	II	III	IV	Globally
E&S-AFRICA	26.2%		57.4%	16.3%	18.1%
W&C-AFRICA	29.9%		57.2%	12.9%	23.1%
S&SE-ASIA	27.5%	14.6%	34.1%	23.7%	32.3%
WANA	21.2%	25.3%	27.0%	26.4%	11.0%
LAC (MesoAmerica)	32.5%	14.1%	27.7%	25.7%	4.7%
LAC (SouthAmerica)	12.6%	15.8%	59.1%	12.4%	10.8%
GLOBALLY	26.0%	10.0%	45.0%	19.0%	100.0%

Notwithstanding the methodological reservations, shares indicate that about one third of CGIAR resources are invested on the favourable agricultural lands of Qs I and II (FALs), and the

remaining two thirds to the so-called marginal agricultural lands (MALs) of Qs III (45%) and IV (19%). This means that 70% of the resources allocated to MALs are directed towards those MALs that have a high productivity potential if the biophysical and socioeconomic constraints are removed. Considering, however, that Q III MALs in which Centres operate include productive areas such as the cracking "black cotton" soils of India and eastern Africa, the poorly drained "inland valleys" of West Africa and the infertile "Cerrados" of Brazil, it could also be concluded that three quarters of CGIAR resources are being applied to increase the sustainable productivity of lands with high agroecological potential (Qs I-II, and tracts of Q III).

Table 3 presents regional estimates on how resources are shared among CGIAR research activities within favourable and marginal lands. Given the opportunities for CGIAR's research on the marginalized poor identified in Chapter 4, the 12 categories are clustered into four *ad-hoc* groups of activities addressing such opportunities.

Activities on *Biodiversity Conservation and Enhancement* (grouping Act. 1 & 7) represent resources allocated to improve biological alternatives, while those under *Sustainable Production Systems* (grouping Act. 2-6) address requirements for "intensification through diversification". *Policy activities* (Act. 8) deal with institutional constraints, *Collaboration with NARS* (Act. 9-12) contribute to the requirement for new partnership mechanisms advocated in recommendations 3-4.

As no information was provided by the Centres to indicate whether proportions among activities changed with regions and LGPs, estimates in Table 3 are based on the standard values across land types. This would explain why global activity shares remain essentially the same between land types. Should proportions be different at operational levels, shares of projects covering more than one agroecology would not represent actual resource allocation.

The same picture appears to emerge from the regional data, the exception being that of WANA. Estimates for this region show a substantial increase in Biodiversity and Collaborative activities for research on MALs, while activities on Sustainable Systems and Policy decrease. Despite this, reflections on the preliminary analysis would suggest that current activity categories may not be sensitive enough to indicate actual resources allocated to alleviating constraints affecting poverty processes. Thus, activities in biodiversity enhancement to improve nutrient utilization by plants could be aimed at either nutrient-rich (FALs) or nutrient-poor lands (MALs). In the same vein, Sustainable Systems research could be aimed at increasing the long-term economic efficiency of monocropping enterprises, or at identifying opportunities for diversified systems.

An assessment of CGIAR resources focused on the marginalized rural poor would require, therefore, information on the extent to which projects are explicitly targeted at poverty alleviation in MALs. An examination of the 374 projects endorsed for 1997 shows that only 92 projects appear to be targeted directly at poverty alleviation on MALs (25%), and 37 of them are partially targeted (10%). Of the remaining 245 projects, 27 are targeted at poverty alleviation in FALs (7%), and 218 projects are not explicitly targeted to poverty alleviation (58%).

Table 3: REGIONAL CGIAR RESEARCH ACTIVITIES ACROSS LAND TYPES (as percentage of totals within region)

	CGIAR Research Activities				
Land Types	Biodiversity Conservation/ Enhancement (Act. 1 & 7)	Sustainable Production Systems (Act. 2-6)	Policy (Act. 8)	Collaboration with NARS (Act. 9-12)	GLOBAL
		AFRICA			
Qs I&II - FALs	29	45	9	17	34
Qs III&IV - MALs	30	46	7	17	46
		ASIA			
Qs I&II - FALs	34	46	8	12	38
Qs III&IV - MALs	35	42	9	14	29
		WANA			
Qs I&II - FALs	23	53	11	13	14
Qs III&IV - MALs	30	42	4	25	9
		LAC			
Qs I&II - FALs	28	41	17	14	14
Qs III&IV - MALs	29	47	8	16	16
		GLOBAL			
Qs I&II - FALs	30	46	10	14	100
Qs III&IV - MALs	31	44	8	17	100

ANNEX V

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ANNEX VI

LIST OF ACRONYMS AND ABBREVIATIONS

ASB	Alternatives to Slash-and-Burn
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIFOR	Centre for International Forestry Research
CPR	Common Property Resources
E & S Africa	Eastern and Southern Africa
FAL	Favoured Agricultural Lands
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographical Information System
HPEPR	High Potential for Expansion Based on Research
HPUV	High Present Agricultural Use Values
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICLARM	International Centre for Living Aquatic Resources Management
ICRAF	International Centre for Research in Agroforestry
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
INRM	Integrated Natural Resource Management
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
ISNAR	International Service for National Agricultural Research
LAC	Latin America and Caribbean
LGP	Length of Growing Period
LPEPR	Low Potential for Expansion Based on Research
LPUV	Low Present Agricultural Use Values
LZI	Low or Zero Intensity of Agricultural Use
MA	Marginal Area

MAL	Marginal Agricultural Lands
ML	Marginal Land
MTP	Medium Term Plan
NARS	National Agricultural Research System
NGO	Non-Governmental Organization
NRM	Natural Resource Management
PP & FR	Programme Plans and Funding Requirement
PPR	Private Property Resources
R & D	Research and Development
R - PD	Research-Project Details
SC	Soil Classes
SWNM	Systemwide Nutrient Management Initiative
S & SE Asia	South and South-east Asia
TAC	Technical Advisory Committee to the CGIAR
UNDP	United Nations Development Programme
WANA	West Asia and North Africa
W & C Africa	Western and Central Africa

SDR/TAC:IAR/98/21

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

A Framework for Prioritizing Land Types in Agricultural Research

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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A Framework for Prioritizing Land Types in Agricultural Research

The Report of the Study of CGIAR Research Priorities for Marginal Lands[1] (the Marginal Lands Report), noted that many different terms are used to designate the productive capacity of land. With the aim of achieving greater uniformity of terminology, the Report presented a six-celled matrix for evaluating land-related issues. This paper takes the principles, which the Marginal Lands Study adopted for its examination of the relation between marginal lands and rural poverty, and develops them as a conceptual framework for more-general use by the CGIAR in its priority setting. Land is defined as an area of the earth's surface which comprises the major biophysical attributes that influence land use, including the atmosphere, soil, geology and hydrology, plant and animal populations, and the results of past and present human activity such as terracing, drainage and irrigation.

The CGIAR has adopted the practice of setting its priorities and strategies according to the poverty weighted values of commodities and sectors, with allowance for important modifying factors such as those that influence the probability of success in research[2]. These principles could also be applied to prioritizing the System's work on different types of land. Alston, Norton and Pardey[3] have listed four efficiency criteria for estimating the expected benefits from commodity research programs: current value of production, maximum yield increase (or decrease prevented) if the research were successful, probability of research success, and the likely rate and extent of adoption of its results. The framework outlined in this paper would assist in assigning values to these criteria, so that potential benefits could be estimated for research on different categories of land. Information about the likely costs of such research would be needed for a prospective cost/benefit analysis.

1. Background

In the Marginal Lands Report, the six-celled matrix was defined by the present value of land use on one axis, and on the other, the potential for enhancement of production through research. Three levels of present use value were identified:

- high present use value - favoured agricultural lands,
- low present use value - marginal agricultural lands,
- lands at low or zero intensity of use.

Two levels of potential to expand production based on research were identified, high and low. Figure 1 reproduces the table that was presented in the Marginal Lands Report.

2. Issues in the Development of a Generalized Framework

In developing these principles for more-general use by the CGIAR, TAC recognized the following issues. Firstly, in the real world there tends to be continuous variation from zero to high in both the present value of land use and the potential to enhance its productivity through research.

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1 TAC (1997a). Report on the Study of CGIAR Research Priorities for Marginal Lands. Working Document SDR/TAC:IAR/96/18.1, TAC Secretariat, FAO, Rome.

2 TAC (1997b). Medium Term Resource Allocation 1998-2000: Centre Proposals and TAC Recommendations. Document SDR/TAC:IAR/97/6, TAC Secretariat, FAO, Rome.

3 Alston, J M, Norton, G W and Pardey, P G (1995) *Science Under Scarcity*. pp.477-8. Cornell University Press: London.

While the six quadrants* are helpful in visualizing the characteristics of the different types of land, it is a matter of choice as to where the dividing lines are drawn.

Secondly, the Marginal Lands Report defined the potential to expand production in terms of research only. While research is the primary interest of the CGIAR, there are arguments for preceding the analysis of research priorities with a review of the potential benefits from investments of all kinds. It may be that for well-known socioeconomic reasons (not needing further research) existing technologies are not being used to enhance the value of production. Alternatively, further research may be required to find out why apparently suitable technologies are not being used.

Generally, two main sets of factors determine the scope for enhancement of value of land use through investment. Firstly, there are the biophysical attributes of soil, climate and terrain. Man-made physical capital, such as the provision of irrigation water and the terracing of steep slopes, also could be included here. Secondly, there are socioeconomic elements associated with (a) the creation, dissemination and utilization of knowledge, (b) access to inputs, markets and credit facilities, (c) output/input ratios, and (d) a group of motivational factors determined to a large extent by the incentives created by society and its economic, cultural and other institutions.

In other words, and as developed more fully in the TAC Marginal Lands study, the actual realization of the potential for improvements in production or productivity depends on people having control over *land* (use rights), and specifically on their *knowledge* of what can and needs to be done; their access to the *resources* required to implement what needs to be done; and their *incentives* to do what needs to be done.

Thirdly, the point needs to be made that the present productive value of any particular area of land depends greatly on what it is used for. Land that is too dry for cropping may be very profitable for grazing ruminant livestock. In more humid climates, terrain that is unsuitable for cultivation of annual crops may be well suited to perennial tree crops and forests. So there will be a different matrix for each type of land use in agriculture and forestry.

Fourthly, it must be recognized that in practice the productivity of agricultural land can also be reduced. The use of land for agriculture sets in train a set of potentially degrading processes (a downward movement in Figure 1), which have to be countered if value is not to be lost. While investment in research is usually thought of in the context of enhancing land value, it can also serve to prevent or reduce potential loss of value.

During the past 150 years, agricultural research has continually expanded the opportunities for productivity enhancement, often far beyond the intrinsic value of the land for agriculture when it was first used for that purpose. However, the possibility that these inherent degrading processes will reduce the productive value of agricultural land has been of increasing global concern recently, under the rubric of sustainability.

Finally, there does not appear to be any strict logical relationship between lands at low or zero present intensity of use (for any particular form of agriculture or forestry) in quadrants 5 and 6 of Figure 1 and those in the other four quadrants of the matrix. Land that is available for future development, say grazing land with good potential for grain cropping, could in theory translate into any of quadrants 1 to 4 when developed for that purpose.

* The terminology of the Marginal Lands Report has been adopted here.

3. The Proposed Framework

With these issues in mind, TAC proposes that the Group adopt a modified version of the scheme described in the Marginal Lands Report. The priority of any particular category of land would be rated by plotting its present productivity per unit area of land, against the potential for change through investment in research. This is equivalent to using quadrants 1 to 4 of Figure 1 without the dividing lines, and reversing the direction of the axis for potential to expand production. Another important change would be to define the X axis to include prevention of degradation, rather than enhancement of production only, as in Figure 1. This is consistent with sustainability reasoning, by allowing for investment in research that forestalls loss of productivity through land degradation. Land that is awaiting development would be classified into a single separate category, noting that in practice there is likely to be a spectrum of feasibility, from land that is available immediately using existing technologies and under existing investment conditions, through to land that would become attractive for development only after the discovery of new technologies or under the pressure of increased demand. Having a separate category of land awaiting development, instead of quadrants 5 and 6 set in a fixed relationship to the rest of Figure 1, allows newly-developed land to fall anywhere in the graph of productivity against potential returns from research.

The location of any particular land type within the framework of Figure 2 is very likely to change with time. Implementation of improved technologies will move land from the bottom right of the figure towards the top left of it. Thus, the adoption of green revolution technologies in Asia over the period 1961 to 1990 lifted average rice yields from 1800 to 3700 kilograms a hectare[1]. In the process, the potential benefit from further investment in conventional agricultural research was sharply reduced, at least for those lands using the new technologies at levels close to their economic optima, and with the existing stock of basic knowledge. Some significant scientific breakthrough, say in yield potential or in resistance to pests, diseases or soil constraints, was then needed to move the most productive green revolution rice lands back towards the right hand side of Figure 2. Moreover, research to prevent degradation of such high-yielding lands may then have offered a more attractive investment than yield enhancing research. Generally, unchecked degradation will move lands downwards in Figure 2, to the right for those kinds of degradation with good potential for reversal through research, to the left for those lacking that potential.

4. How the Framework Might Be Used

In order to use the efficiency criteria described by Alston, Norton and Pardey, it is necessary to know the total area of each category of land as well as its current productivity per unit area. This permits current values of production to be calculated. The other three criteria, the maximum increase (or decrease forestalled) if the research were successful, the probability of such success, and the likely rate and extent of adoption, can all be factored into the potential benefits achievable through investment in research.

One of the greatest difficulties in attempting to set agricultural research priorities objectively is the lack of reliable global data sets. In the case of agricultural land, reasonable data are likely to be obtainable on area and current productivity, but at present the potential change achievable through research can be estimated only on the basis of well informed judgement. Because of deficiencies in existing knowledge of values for the efficiency criteria in research, in most cases it may be possible to agree only on the relative rankings of different types of land on the X axis, without it being possible to assign any exact values to them.

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[1] Plucknett, D L (1993) Science and Agricultural Transformation. IFPRI Lecture Series No. 1.

Members of the CGIAR may find most value in assessments of the relative priorities of research on different classes of land within the mandated region of a single centre and the national systems with which it works. Agro-Ecological Zones (AEZs) would be one obvious basis of comparison. Another would be on political boundaries, because of the powerful influence of social and institutional factors on the implementation of new agricultural technologies. Also, the data permit poverty weightings to be made only for political boundaries at present.

The following paragraphs offer some very preliminary suggestions of questions that would be worth asking about the priorities of different land types for production of annual grain crops, ruminant livestock and forests.

In the case of croplands, one of the triggers for TAC's review of the marginal lands issue was the perception by some people that they warranted a higher priority in CGIAR research than they had hitherto received. It is true that the major impact of green revolution cropping technologies has been in irrigated areas, and the possibility that some categories of rainfed land may now offer a higher rate of return on research deserves serious consideration. The highest immediate priority may be for socioeconomic research to understand better why the biophysical components of the very successful green revolution technologies have not been used to a greater extent on rainfed cropping lands. Government policies may be part of the answer. In developing countries, irrigated agriculture has generally been subsidized much more heavily than rainfed agriculture.

The case for additional CGIAR crop and livestock research to enhance the productivity of marginal lands is questionable. The information available to the Marginal Lands Review indicated that they had certainly not been neglected by the centres. Indeed, the Report argues strongly that the primary problem of poor people in low potential croplands is not technology as such, but deficiencies in the prevailing institutional and policy arrangements.

Concern about land degradation seems to have motivated much of the external interest in CGIAR research priorities for grazing lands used for ruminant livestock production. Although the very large area of grazed rangeland that is too dry for cropping or for growing improved forages does not support a large proportion of developing-country livestock or people, its research priority versus that of higher rainfall regions needs to be assessed objectively. Despite the pathetic appearance of arid grazing lands during prolonged drought, they can recover rapidly in subsequent periods of normal rainfall[1]. In the current state of knowledge, most experts would assess them as offering relatively low potential rates of return from investment in agricultural research.

There is a significant area of land in sub-Saharan Africa awaiting development for ruminant livestock production, if the constraint of trypanosomiasis could be overcome. This category of land has, by implication, received a high priority in CGIAR investments. The chief question mark over current biotechnical research on trypanosomiasis has attached to its probability of success, not the priority of the associated land type.

There has been very limited interest in comparisons of land types for tropical forestry. A far more important question is that of research priorities amongst alternative forms of land use within the same land type, notably in the remaining forests of the humid tropical lowlands. The framework of Figure 2 could be adapted to this purpose. Much of the land that was deforested in South America during the last two decades went into ruminant livestock production, whereas cropping and logging

[1] de Haan, C, Steinfeld, H and Blackburn H (1997). Livestock and the Environment. Finding a Balance. European Commission Directorate-General for Development, Development Policy, Sustainable Development and Natural Resources.

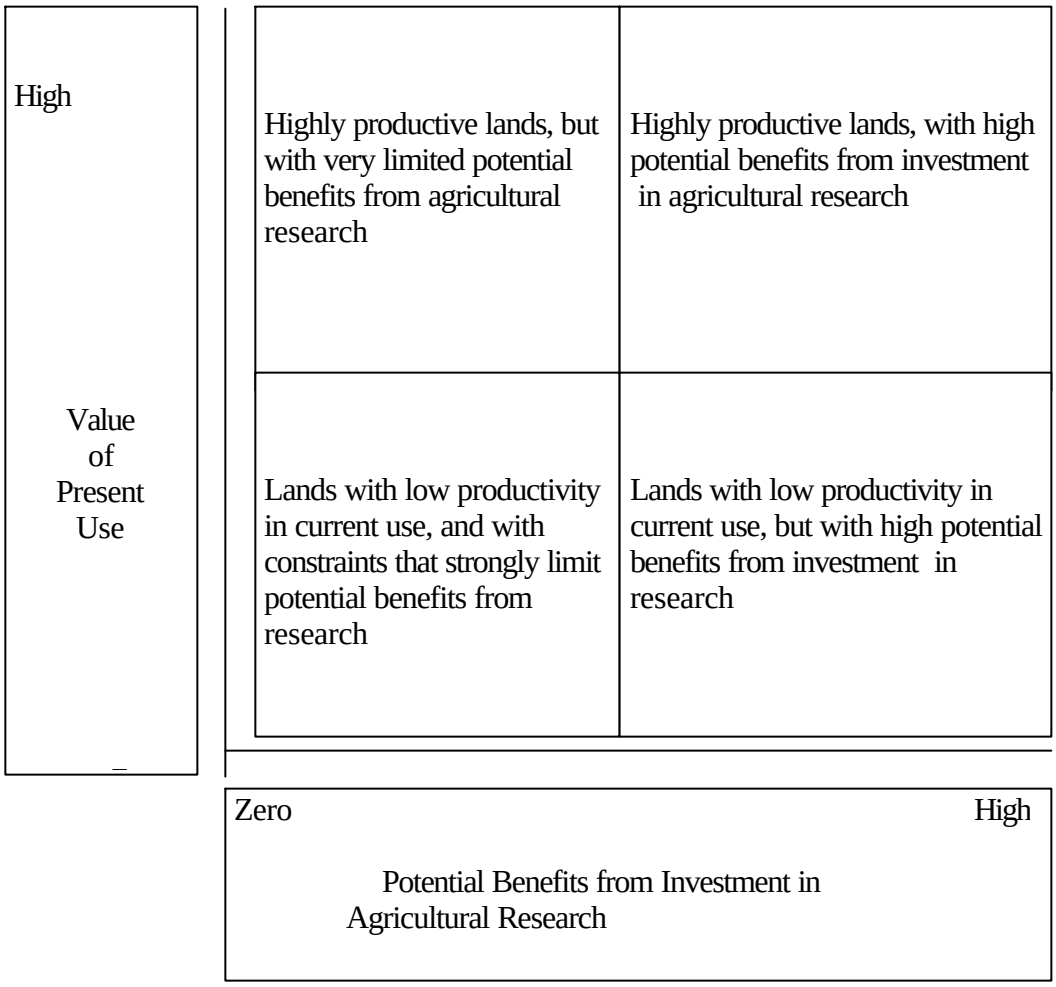
were the major causes of deforestation in Asia and sub-Saharan Africa[1]. The critical issue of prioritization is to estimate relative rates of return from research on the use of lowland rainforest for conservation of biodiversity plus production of non-wood products, versus that from research on the use of the same land for logging, for forestry plantations, for tree crops (agroforestry), or for annual food crops. The challenge is to find common units of measurement that allow conservation of biodiversity to be plotted along with subsistence and dollars on the value axis.

[1] Alexandratos, N (Ed.) World Agriculture: Towards 2010. An FAO Study. (New York: John Wiley and Sons, 1995)

Figure 1. Table 2.2 from TAC Working Document: Report of the Study on CGIAR Research Priorities for Marginal Lands. SDR/TAC:IAR/96/18.1

Present Use Value	High Potential to Expand Production Based on Research (High PEPR)	Low Potential to Expand Production Based on Research (Low PEPR)
Favoured Agricultural Lands (PUV High)	QUADRANT I Irrigated Lands Rainfed Lands	QUADRANT II Irrigated Lands Rainfed Lands
Marginal Agricultural Lands (PUV Low)	QUADRANT III Rainfed Lands	QUADRANT IV Rainfed Lands
Lands at Low or Zero Intensity of Use (LZI)	QUADRANT V Forest and Woodland	QUADRANT VI Dry and Arid Lands

Figure 2. A framework for prioritizing land types in agricultural research.



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CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

TECHNICAL ADVISORY COMMITTEE

Rural Poverty and Land Degradation: A Reality Check for the CGIAR

TAC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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RURAL POVERTY AND LAND DEGRADATION: A REALITY CHECK FOR THE CGIAR

By

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August 1998

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SUMMARY

Understanding of the intricate processes of poverty and land degradation is still extremely limited. Definition, in each process, is driven largely by the perceptions of those analyzing the phenomena. Each group brings its own strong perceptions to bear. The lack of clear conceptualization, the observed heterogeneity and the diverse perceptions of those attempting the exercise complicate 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 well-defined and relatively homogeneous situations. Such comparable observations are generally not available. 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 a fuller understanding of the complex interaction of the two processes naturally leads on from a more comprehensive understanding of the individual processes, it too suffers from all the problems impeding a deeper understanding of each.

The aggregate information available is not very useful for making judgments about poverty and land degradation. Evidence from the few available micro-level studies is mixed and often 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 the poor except through the cost implications of different conservation technologies and the incentive structures that influence adoption.

Theoretical considerations are often cited as to why the poor can be expected to behave in ways that are land degrading. However, these considerations can generally apply just as well to the non-poor and can be explained by overall low levels of development. The pressures arising out of the processes of economic development that might induce people to degrade the land have be classified, in the literature, as those related to: increases in population; declines in common property resources; interest rate changes; and technology transfers.

However, the literature also includes considerable theoretical and empirical evidence that indicates that the response to population pressures and market forces, in the long run, is an endogenous process of adaptation towards sustainable behavior.

At the household level much more research, in a variety of settings over a reasonable length of time, is needed for a fuller understanding of decision-making processes, especially in terms of the relationship with land. Such research should ideally be built on detailed household-level longitudinal socioeconomic surveys with specific land use and

quality assessment modules. Only then will it be possible to differentiate behavior by poverty status. The CGIAR is well placed to support such research.

The CGIAR can also facilitate much greater interaction between the different “actors” to bring realism where uninformed perceptions prevail, especially in the area of land degradation. Such

interactions will lend much greater realism to the understanding of issues that have important implications for the present and future of humankind. These interactions should naturally build on existing understanding, so as not to reinvent the wheel. The broad research agenda on poverty and land degradation can only be well defined after a reasonable period over which such understanding is established.

Such research can only enhance the efforts within the CGIAR System on integrating commodity research with natural-resource management considerations. This emphasis is properly placed and relevant. The CGIAR is a key forum for addressing the global dearth of knowledge about the implications of land degradation. A research agenda is needed that makes good use of the available information in order to better focus on poverty alleviation through the integration of commodity and natural-resource management research. Its relevance must be enhanced through the collection and use of more disaggregated information.

Rural Poverty and Land Degradation: A Reality Check for the CGIAR

1. BACKGROUND

Based on an in-depth evaluation of available information, the study on CGIAR Research Priorities on Marginal Lands[1] concludes 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 states 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" [Nelson et al. (1997)]. It thus put rural poverty at the center of the stage[3].

Within this overall sharper focus on the need to understand more fully 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.[4] 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 [Nelson et al. (1997)].

[2] Lack of comfort with the definition of marginal areas purely in terms of climate, soils and terrain was obvious for several years. For example, Crosson and Anderson (1993) had suggested an alternative definition based on productivity potential. Their discomfort had also extended to the allocation of research resources for such areas. From a purely economic point of view these authors had pointed out that 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 report concludes 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.

[4] 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.[1] This perception is strongly evident in the writings of the multilateral development agencies such as the World Bank[2] and the International Fund for Agricultural Development[3] (IFAD).

The present study is a 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 in 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 unresolved issues ranging from difficulties in conceptualization and definition. to those of 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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[1] 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 the poor, regions with relatively better levels of development can also contain significant proportions of poor people. 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.

[2] For example, "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)].

[3] For example, 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)].

There are numerous difficulties associated with definition, measurement and maintenance of analytical rigor. Attempts at rigorous analysis 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.

The short- and long- term implications of land degradation are not very clear [see Scherr and Yadav (1995)].[1] 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 past 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.[2] Even less clear and limited is the understanding of the interactions of poverty and land degradation.[3]

This study is organized as follows: Initially the understanding on each process is evaluated. Issues connected with definition and measurement are highlighted and currently available empirical estimates are presented. Next the existing state of knowledge about the relationship between poverty and land degradation is evaluated. The empirical evidence 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 final section.

1.1 Defining Land Degradation and Sustainability

There are several definitions of land degradation. Land[4] degradation is generally defined as the reduction in the soil's ability to contribute to crop production [Blaikie and 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

[1] 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, along with their implications for policy [Scherr, Jackson and Templeton (1995)].

[2] Conclusion of the World Bank's workshop on the "Future Of Poverty Analysis In The Bank", March 16, 1997 reported in Malik (1997).

[3] 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.

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

degradation can take many forms.[1] Land degradation[2] effects are often 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.[3] The heterogeneity of the situations and the complex and changing (over time) interaction of the several processes involved have negative implications for precise measurement.[4]

Concern with land degradation has heightened due to the increasing focus in policy circles on sustainability. There are several definitions in use for sustainability in

agriculture which leads to some confusion There is a need for a clear and widely agreed upon perspective.[5] Existing definitions can be broad and all encompassing. For example sustainability is defined as meeting the needs of the present generation without compromising the ability of the future generations to meet their own needs [The World Commission on Environment and Development[6] (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

[1] Scherr (1998) classifies these to include: crusting, compaction, sealing, wind erosion, water erosion, devegetation, over-tillage, impeded drainage, waterlogging, reduced waterholding capacity, reduced infiltration, salinization, alkalinization, acidification, nutrient leaching, removal of organic matter, burning of vegetative residues, nutrient depletion, over-application 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.

[2] Degradation and erosion are not the same although the terms are often used interchangeably. Erosion is only one (though probably the most well known and significant) possible form of degradation [Pagiola (1994)].

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

[4] 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 in 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)].

[5] The lack of an agreed perspective is brought out forcefully in the discussion on conceptual issues relating to sustainable growth of agriculture by 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.

[6] Generally referred to as The Brundtland Commission

avoiding the expansion of agriculture to steep hillsides or marginal soils that would rapidly erode [World Resources Institute (1982)].

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

This lack of an agreed perspective on sustainability has implications for how land degradation is defined, measured and analyzed

There is general recognition that data on the physical processes of land degradation as well as on its economic and social consequences are sparse [Scherr and Yadav (1995)]. Earlier reviews of the evidence 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. Available 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 socioeconomic 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 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.[1] On the other hand complacency,[2] based upon the phenomenal increase in agricultural (especially food) production during the past 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 noted, 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.[3] 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[4] was

set up under a coalition of international agencies in 1994. Its objective was to better understand the problems of land degradation. This program seeks to "develop a set of natural resource indicators: statistics or measures that help 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[5]) 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.[6] While the

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[1] 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.

[2] 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.

[3] 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)].

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

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

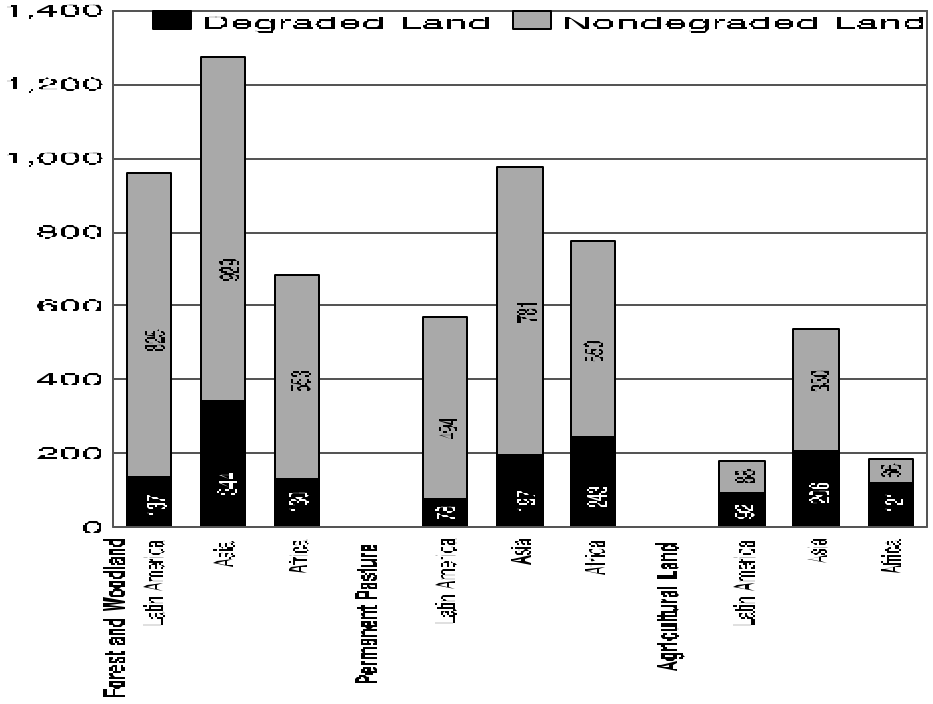
[6] Studies listed in Scherr (1998) by methods used for assessment of soil degradation impacts include: Qualitative assessments: Pagiola and Dixon (1997), Oldeman et al. (1991), van Lynden and Oldeman (1997), Seghal and Abrol (1994) and Dregne (1990, 1992). Biophysical models of degradation-yield relationships: 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),

GLASOD exercise was designed to study the problem at the 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 estimating land degradation. While the methodology is basically the same as that for the GLASOD study, it permits analysis at the national level while the GLASOD was focused on a larger regional level.

The GLASOD study estimated that nearly 2 billion hectares of the 8.7 billion hectares of vegetated area (agricultural land, pasture, forest and woodland) (22.5 percent) have been degraded since the mid century. This study estimated that 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. The GLASOD estimates indicate that nearly one-half of this vegetated area is under forest, of which about 18 percent is degraded; 3.2 billion hectares is under pasture, of which 21 percent is degraded and nearly 1.5 billion hectares is in cropland, of which 38 percent is degraded. Water erosion is the principal cause of degradation. Wind erosion is an important cause, particularly in dry lands and areas where land forms are conducive to high winds.

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

Chemical degradation, such as salinization and nutrient loss, is often the result of cropping practices. It accounts for a smaller overall 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. Forest land degradation is most extensive in Asia, affecting 27 percent of forest land compared with 19 percent in Africa and 14 percent in Latin America [GLASOD estimates reported by Scherr (1998)].

Land degradation can lead to declining potential yields on the farm. But, fertilizer use or changing the land use can hide the effects of this degradation for long periods. As such 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 of land degradation generally cover only a short period of time, any measurable effect on crop yields could however, take long periods to appear because of the cumulative nature of land degradation.

For developing countries the literature on land degradation is even more qualitative and less rigorous than that available for developed countries. The difficulty of modeling complex farming systems and the lack of necessary data both contribute to this paucity.[1] Most glaring is the lack of knowledge of the effects of degradation on social welfare. "Most of the technical literature on the socioeconomic 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)]. Studies at the household level that attempt to rigorously verify differences in behavior between the poor and the non-poor with respect to land are generally difficult to find. This paucity results in large part from the inadequacy of the available data.[2]

Given some of the problems described above, there is an urgent need for a research agenda that builds up from a large number of case studies. In order to ensure common perspectives, such a research program should involve the biophysical scientists, the socioeconomic experts and the land users working closely together. Use of consistently defined household-level socioeconomic panel (longitudinal) surveys that have specific land-quality assessment modules in several of the "hot spots[3]" could provide effective answers.[4] 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,[5] concludes that "many studies examine the gross impact of degradation on crop production[6] [but] very few

[1] 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)].

[2] 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 less favored rainfed 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 de Walle (1996)].

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

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

[5] 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. (1992), Pimentel et al. (1993), Steiner and Herdt (1993), Crosson (1994), Agcaoli et al. (1995), Dyson (1996), Stocking and Benites (1996), Crosson (1997) and Scherr and Yadav (1995)

[6] 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. 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 calculates 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.

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.[1] A detailed review of the results and methodological aspects of these studies is available in Scherr (1998) and is therefore not attempted here. However, results from the IFPRI simulations reported by her 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 malnourished under the assumptions of severe degradation. The baseline 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 can produce downturns of a similar magnitude. These results highlight another 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.

1.2 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 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

[1] 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)].

			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; bureaucratic	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)

The authors find that these approaches are neither sequential nor mutually exclusive. The present emphasis on 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 approach has also re-emerged 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 biophysical 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.

1.3 Defining Poverty

Poverty is increasingly viewed as a multidimensional concept. It has social and psychological effects that prevent people from realizing their potential [IFAD (1992)]. Measurement of poverty can include material deprivation, isolation, alienation, dependence, and lack of participation or freedom of choice of assets, vulnerability and insecurity.[1] Introducing several such dimensions can seriously complicate the measurement problems. That is why most measurement is based on material deprivation[2] generally linked to the inability of incomes to meet basic nutritional demands.

Poverty is, thus, operationally defined as the inability to attain a minimal standard of living.[3] Generally a consumption-based[4] poverty line is used and estimates are made of the head count index, the poverty gap ratio and a severity of poverty index.[5] 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[6] (PPIs). The World Bank is currently considered to be the largest

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[1] 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 pre-empted by large, primarily export-oriented commercial farms [IFAD (1992)].

[2] Material deprivation can be reflected in serious protein and 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)].

[3] 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)]

[4] Expenditures are found to be better measures of welfare than incomes especially at the lower ends of the income distribution because these reflect the household's ability to borrow to smooth consumption.

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

[6] Non-income measures of welfare can include anthropometric measurement especially of vulnerable groups such as children under the ages of five and pregnant and lactating mothers. The World Bank augments these direct income and non-income measures of poverty with information on socioeconomic 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

repository of information on poverty in the world[1]. The research work at the Bank has confirmed that, in order to answer the question of how the poor have participated in the general improvements, it is necessary to move from aggregate data to more disaggregated survey-based household-level data. Without such disaggregated data it is impossible to conduct rigorous analysis of the decision-making processes of poor households[2].

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 socioeconomic information through household representative income and expenditure surveys. 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 differences in minimum calorie requirements across regions due to differences in body structures, climate and levels of physical activity.[3] 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.

While considerable headway has been made at improving the quality of the aggregate poverty information there is still considerable variability in quality.[4] This variability was confirmed by a

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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.

[1] The World Bank has mandated that detailed poverty assessments be undertaken for all its client 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.

[2] Especially as these relate to the relationship with land.

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

[4] 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)].

recent report of the Operations Evaluation Department of the World Bank (1996).[1] And 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.

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.[2] 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 smallholders, landless, nomadic pastoralists, ethnic

[1] 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.

[2] This full 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, artisinal 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)].

groups, artisanal fishermen, refugees and households headed by women. The IFAD study contains an extensive classification of different types of poverty processes, the type of poverty that is produced, and the segments of the rural population affected by these, for 42 of the least developed countries. While this classification is helpful; given the nature of the data on which it is based, it is only indicative of the types of aggregate patterns. Given the heterogeneity of types that it indicates and the extremely aggregate available data that it marshals the study does not help in rigorously answering specific questions or in furthering the understanding of the interaction of the poverty and land degradation processes.

This IFAD (1992) study remains to date the most extensive analysis of its kind available in the literature on rural poverty. Based on information for the late 1980s, this study estimated 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[1] while population rose by 60 percent. This growth has, however, not been uniformly distributed.[2] 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 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.

The lack of comparable estimates of poverty over time makes it difficult to evaluate trends. However, based on heroic attempts to obtain comparable and consistent data sets, the consensus appears to be that growth, even when it is associated with rising inequality, has led to poverty reduction [Fields (1980), 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. 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 available studies agree that agricultural growth (especially growth and stabilization of

[1] 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.

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

food staples production) is likely to benefit poor people.[1] There is some evidence to indicate that the level of initial inequality of incomes and of assets determines the degree to which growth is translated to reduction in poverty [Lipton and Ravallion (1995)]. The evidence on the relationship of growth to inequality is however, mixed.

The World Bank Policy Research Department has an active program focusing on establishing consistent patterns in the relationship between growth, inequality and poverty. Deininger and Squire (1996) and Ravallion and Chen (1997) present results based on household data sets for a number of countries. While these "new" household data sets represent improvements in quality and coverage it is important to bear in mind the differences in definitions in the underlying data sets on which these estimates are based. While the authors do consistently warn users to keep such inadequacies in mind, it is easy to loose sight of these warnings and focus only on the aggregate results that are brought out. Mindful of the limitations such as the lack of tests for sensitivity and robustness and the large number of factors identified by the authors that could affect cross country comparisons, the study by Deininger and Squire (1996) could find no systematic link between growth and changes in inequality. The study found, however, a strong positive relationship between growth and reduction in poverty. A later study by Ravallion and Chen (1997) uses a larger number of household surveys to define "spells" from 67 countries between 1981 and 1994 to conclude that changes in inequality and polarization were uncorrelated with changes in average living standards. The results of the relationship between inequality and growth were at best mixed. However, "almost always poverty fell with growth in average living standards and rose with contraction" [Ravallion and Chen (1997)].

The relationship of poverty and land is intimate, given the prevalence of poverty in 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)]. Typically, the share of agriculture in gross domestic product in the low-income countries is about 30 percent while the proportion of total labor force in agriculture is about 68 percent. The corresponding figures for the industrial market economies are 6 and 2 percent, respectively [World Bank (1997)].

Quibria and Srinivasan (1991), in a comparative study of seven Asian developing countries in the late 1980s, 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)]. The welfare of rural non-farm households also depends substantially on the forward and backward production and 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 agricultural products most anti-rural-poverty strategies for production activities are based substantially on agriculture" [Lipton and Ravallion (1995)].

The lack of land and rural poverty are generally observed to coexist [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

[1] Some examples where agricultural growth is not necessarily pro-poor also exist [see Cohen (1975)]. 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 avenues for the poor to participate in the growth process.

contracts and the role of land titling.[1]

Improved equity and efficiency are generally put forward as justifications for land redistribution. Operationally, the implementation of such programs has been strongly affected by political realities. Redistribution implies increasing intensification with possible negative consequences for land degradation. At the same time, redistribution is expected to improve access to credit so necessary for the use of inputs. This can facilitate investments in land-improving and maintaining technologies.

Tenancy reforms are also advocated on the basis of equity and efficiency. Such reform can however, also increase landlessness through large-scale eviction as evidenced in South Asia. And within the different forms of tenancy arrangements, a move away from share cropping arrangements can imply a reduction in traditional risk sharing arrangements with potential resultant pressures for resource degradation.

Land titling can have both positive and negative effects. The African experience bears this out. Theoretically, land titling is considered important for increasing tenure security with a view to improving investment in land and water conservation. It is also held to improve access to capital inputs and the adoption of permanent crops. It further provides the collateral for ensuring increased access to institutional credit and for promoting land markets deemed to be so essential for the development of commercial agriculture. Lack of title can bias the farmer's decision towards short-cycle crops. Operationally, however, the wealthier farmers can exercise their influence to obtain greater rights [IFAD (1992)]. Such titling can lead to likely negative effects on women through increased cultivation of commercial crops that men generally tend to control [von Braun and Kennedy (1986)].

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, 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 and 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 (1997a, p. 89)].

Rural poverty also implies that the "wrong crops" may be grown. In sub-tropical conditions most export crops (except cotton and groundnuts) tend to be less damaging to 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.[2]

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

[2] However, the fact that women control food while men control cash crops can generally translate into reduced incomes of women with increasing commercialization and to the resultant deterioration in the

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 with Longhurst (1989)]. Lack of alternative sources of employment can lead displaced families to scavenging off the land 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 deficient. 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 generalizability 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.

1.4 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[1] 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.

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nutritional status of the families [see for example von Braun and Kennedy (1986)].

[1] 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 reported in Henninger (1997)]. These have proved useful in the work of the international agricultural research centers.

Henninger (1997) notes that 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 standards after controlling for non-geographic characteristics. These he terms as spatial poverty traps.

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 [Henninger (1997)]. 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 socioeconomic 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 mapping exercises is constrained by the aggregate level of the available comparable information. Ranking of countries and territories according to the rural poverty dimension needs 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 [e.g., ICARDA (1997].

2. POVERTY AND LAND DEGRADATION

Lipton (1997a) states forcefully that it is irrational to expect people to knowingly behave in ways that destroy resources necessary for their survival or that of their future generations[1] unless very strong pressures to do so are present.[2] He lists four such pressures generally discussed in the literature.[3] These include (1) increases in population as mortality falls but fertility declines lag

[1] 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)].

[2] The World Bank maintains a similar position. "The poor do not willfully degrade the 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 p. 30)].

[3] 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 resource intensive technologies; ineffective regulation of common property resources; land tenure systems that do

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.[1]" 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 may continue to increase.

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

2.1 Impact of Degradation on the Poor[2]

The poor generally have access only to areas that have higher risk for health and income generation.[3] 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 happen both directly through, for example, lower yields per unit of labor or land 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

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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)].

[1] 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.

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

[3] 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 resources. 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)].

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.[1] Non-replenishment of soil nutrients leads to soil exhaustion as fuel wood supplies diminish and animal manure is increasingly used as a fuel substitute. Poverty forces a trade-off between the immediate demands for fuel for cooking and heating and manure for the land. The time-preference argument suggests that the immediate and urgent needs be satisfied. Mortimore (1989) shows how soil exhaustion occurs when certain nutrients are taken from the soil but are not replenished naturally or artificially with fertilizers. A homogenous crop, usually a cash crop, grown repeatedly on the same piece of land can lead to soil exhaustion.[2] Increasing population pressures on land can also lead to shortened fallow periods and this coupled with the farmer's inability to apply variable inputs more intensively because of poverty, can lead to decreased soil productivity. Productivity, especially, in open-access natural resources or of resources under deteriorating common property management may often decline due to over-use.

2.2 Poverty Impact on Resource Management

Poverty is generally assumed to impose short time horizons.[3] Theoretically this results from the poor having high rates of pure time preference which lowers the ability to forego consumption today. This leads to using up savings previously set aside for later consumption and to borrowing if access to credit is available. The implications of a high subjective discount rate are rapid resource extraction to meet present income or consumption needs and low investment in natural resources to improve future returns. Overgrazing of pastures and shortening of fallow periods can result from the high subjective discount 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.[4] The empirical evidence on whether the poor really do have high rates of time preference is limited and sketchy.[5]

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

[1] 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)].
[2] 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)].
[3] This is not to say that short time horizons are exclusive to the poor.
[4] 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, indicate that soil conservation is viable in nearly 70 percent of the land area.
[5] 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.

outcomes for the more certain ones. Risk aversion amongst farmer is widely documented [e.g., 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.[1] 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.[2] 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)].

2.3 The Links Between Poverty and Land Degradation – Mixed Empirical Evidence

The study by Grepperud (1997) concludes that in the relationship between poverty, land degradation and climatic uncertainty it is unclear whether poverty in general induces farmers to manage their resources poorly in the long run. The study by Scherr, Jackson and Templeton (1995) also 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 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 look at the problem in terms of the behavior of small-scale farmers and land degradation. Southgate (1988) maintains that small-scale farmers have been the main agents responsible for land degradation activities. He states that market and institutional failure were the primary causes for farmers adopting non-sustainable practices. Pagiola (1995) shows

[1] 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 dependent strategies.

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

how government price controls on agricultural goods in Kenya have not provided incentives for the small-scale 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-scale farmers' willingness to forgo short-term income gains even under price and famine pressure to pursue long term sustainable management strategies. The existence or non-existence of secure land tenure systems might explain the contradiction 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 that they do not own [see, for example, Southgate (1988), Mink (1993), Repetto et al. (1989)].

2.4 Household Level Effects of Degradation

Change in agricultural practices can have primary and secondary effects on the environment. Von Braun (1997) describes the relationship between agricultural change and the eventual effects at the household level through these environmental effects. Such 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. 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.

2.5 Conceptualizing the 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. 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.

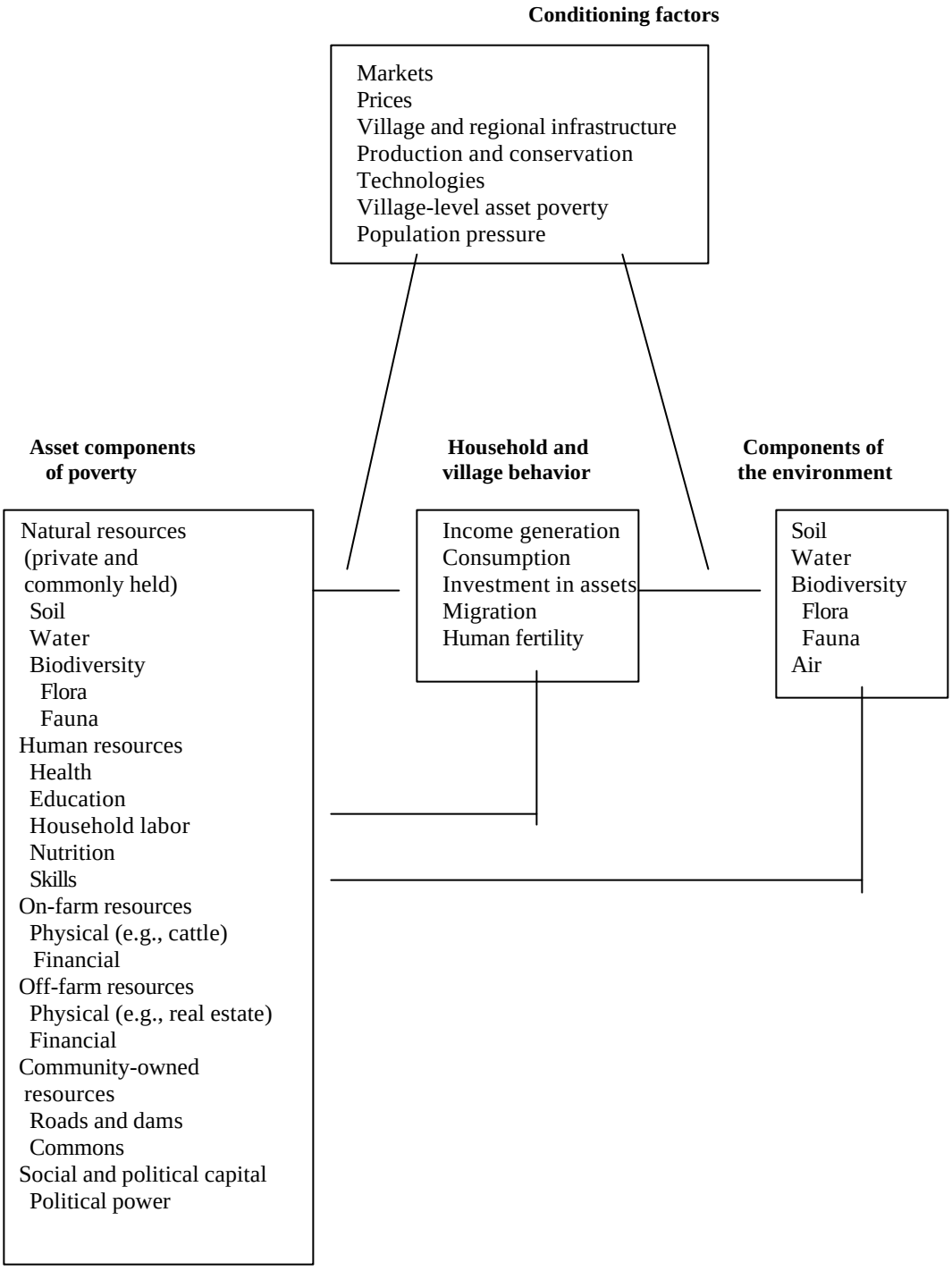
This conceptualization leads to innovative policy implications. In comparing traditional productivity investments such as irrigation, fertilizer and modern seeds with conservation investments (such as bunds, terraces, windbreaks and practices such as organic matter application) the study finds that the 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 water flow 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 the Vosti and Reardon (1997) manner sets a much higher cutoff than the conventional definition. Implicit in this conceptualization is the assumption that sizeable resources[1] over and above meeting bare subsistence consumption and production are required by the poor to address issues of resource degradation. While this model provides an interesting tool for conceptualizing some of the complexities involved; it also highlights the trade-off between the depth and detail of understanding and concomitant data requirements; and, the

[1] 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)].

inadequacy of available methodology and resources for measurement.

Figure 2. Poverty and environment links



Source: Vosti and Reardon, 1997.

Duraiappah (1996) also presents an interesting conceptual model for analyzing the many

complex inter-relationships between poverty[1] and environmental degradation. For simplicity he postulates four possible, though not mutually exclusive relationships[2]. 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: first from within the sector due to decreases in agricultural productivity, and second from the fuelwood-manure relationship. In the first case, there is evidence of declining agricultural productivity in degraded lands causing indigenous poverty, which in turn forces many 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.
Durriapah 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 and ignore its causes.

[1] He defines indigenous poverty as poverty caused by environmental degradation and exogenous poverty as that caused by factors other than environmental degradation.
[2] He postulates three crucial initial conditions: 1) no environmental degradation, 2) no indigenous poverty and 3) the possibility of the existence of exogenous poverty.

3. SUSTAINABLE LAND USE MANAGEMENT

Much of the literature that assumes that poverty leads to degradation cannot explain instances of (materially) poor communities living sustainably with their environment for centuries. Induced innovation theory suggests that degradation at least in the long run may be self-correcting as resource scarcity and rising private and/or social costs from degradation induce the development and use of new agricultural and resource management practices[1] [Hayami and Ruttan (1985) and Boserup (1965)].

The 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

[1] "Farmer–based innovation" describing the evolutionary process of adapting production technology to changes in factor scarcity is reported in a number of studies [for example, see Binswanger 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 1800s 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 1940s, 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. Pingali, Bigot and Binswanger (1987) document a similar 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 and Mortimore (1994)]. 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. Place and Hazell (1993) found that the binding constraints to agricultural productivity were in fact lack of improved technology and inadequate access to credit.

human managed resources (for example agro-forestry, forest plantations and managed reserves). Most of the observed degradation can be explained by assuming that the innovative responses of phases three or four have not occurred. In many cases it can be shown that these have been delayed due to a number of conditions.

However, there is considerable controversy over the adoption of conservation strategies. One school of thought maintains 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[1] but analysis of these instances have not yet provided clear guidance to policy makers, researchers or developers to enable more general adoption of these technologies [World Bank (1991a)]. The other school maintains that the lack of adoption of conservation technologies results from a lack of incentives.[2] "The success of conservation measures is highly dependent on farmers receiving crop yield and economic benefits in the first or second season after implementation" [FAO (1989)]. This debate highlights the need to understand more fully why resource users do what they do, and how they reach decisions on resource use and environmental management [Biot et al. (1995)]. This debate does not differentiate between the behavior of poor versus non poor.

4. IMPLICATIONS FOR POLICY

In the heterodox 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[3] 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)]. This approach focuses more on what the TAC report terms "marginal areas" and seems to

[1] 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 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)].

[2] 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].

[3] 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)].

ignore the fact that land degradation can easily affect the green revolution and other high productivity areas also[1].

Despite the fact that some argue that regions with marginal climates and soils are not rewarding to biophysical scientists and that there is not much scope for research on contours and terraces there seems to be considerable scope for agricultural research especially in the social science aspects. 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. 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 [e.g., 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 of the major organizational challenges facing the future of international agricultural research.[2]

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

[1] I am thankful to Ted Henzell, formerly of TAC for highlighting this distinction.
[2] see the March 1993 Report of the Center Director's Working Group on Ecoregional Approach (Annex 1, p.3)

farm and find other technical and institutional means to reduce the damages of sediment downstream.

TAC (1997) indicates four cases of NRM where the System should concentrate its resources because user incentives are weakest there. These are cases where:

- Benefits accrue over a long time,
- Benefits accrue remotely,
- Benefits are relatively difficult to identify, and
- Benefits accrue to different persons than those who bear the cost of management.

TAC (1997) also highlights the criteria for assessing the relative importance of the substance of proposals for NRM research in the CGIAR system. Its first criterion is that the research should contribute to poverty alleviation and environmental protection and/or enhancement. Answers to several questions identified by Scherr (1998) can help to clarify process of priority setting in the area of poverty and land degradation. Specifically answers to questions such as:

> Who are the principal resource users? What are their actual (as opposed to theoretical) incentives for investment and dis-investment 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 effective policy making.

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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APPENDIX 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 intensification	Northern Mexico Highland irrigation systems South American irrigation zones		Subhumid Central American hillsides Semi-arid Andean Valley Haiti Cerrados of Brazil

APPENDIX 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 pollution in high density areas and coastal areas Pollution from peri-urban 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 (pumping for 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 Lower Amazon Basin Itapua, Paraguay Pacific rainforest of Colombia and Ecuador Chaco region	Overgrazing in Haiti Northeast Brazil Lower Amazon Brazil Overgrazing in Caribbean Basin lowlands	Paramo water scarcity	Banana plantation pollution Santa Cruz, Bolivia, intensive agriculture Peri-urban agriculture in Mexico City

Atlantic lowlands of Central America			

Source: Scherr and Yadav (1995)

APPENDIX 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

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

these requirements. Their class of poverty indices takes the following form:
where Z_p denotes the poverty line, Y_i the expenditure or income of the i-th 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 $[Z_p - Y_i]/Z_p 1$, 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.

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

Alternatively, with $\alpha = 1$, the poverty index P_α becomes:
where I is the "income gap ratio", i.e., the mean income gap of the poor $(Z_p - \overline{Y})$ - where $\overline{Y} = \sum Y_i/q$ 2 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 $\alpha = 2$.

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

If $\alpha = 2$, the poverty index becomes[1]

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.

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