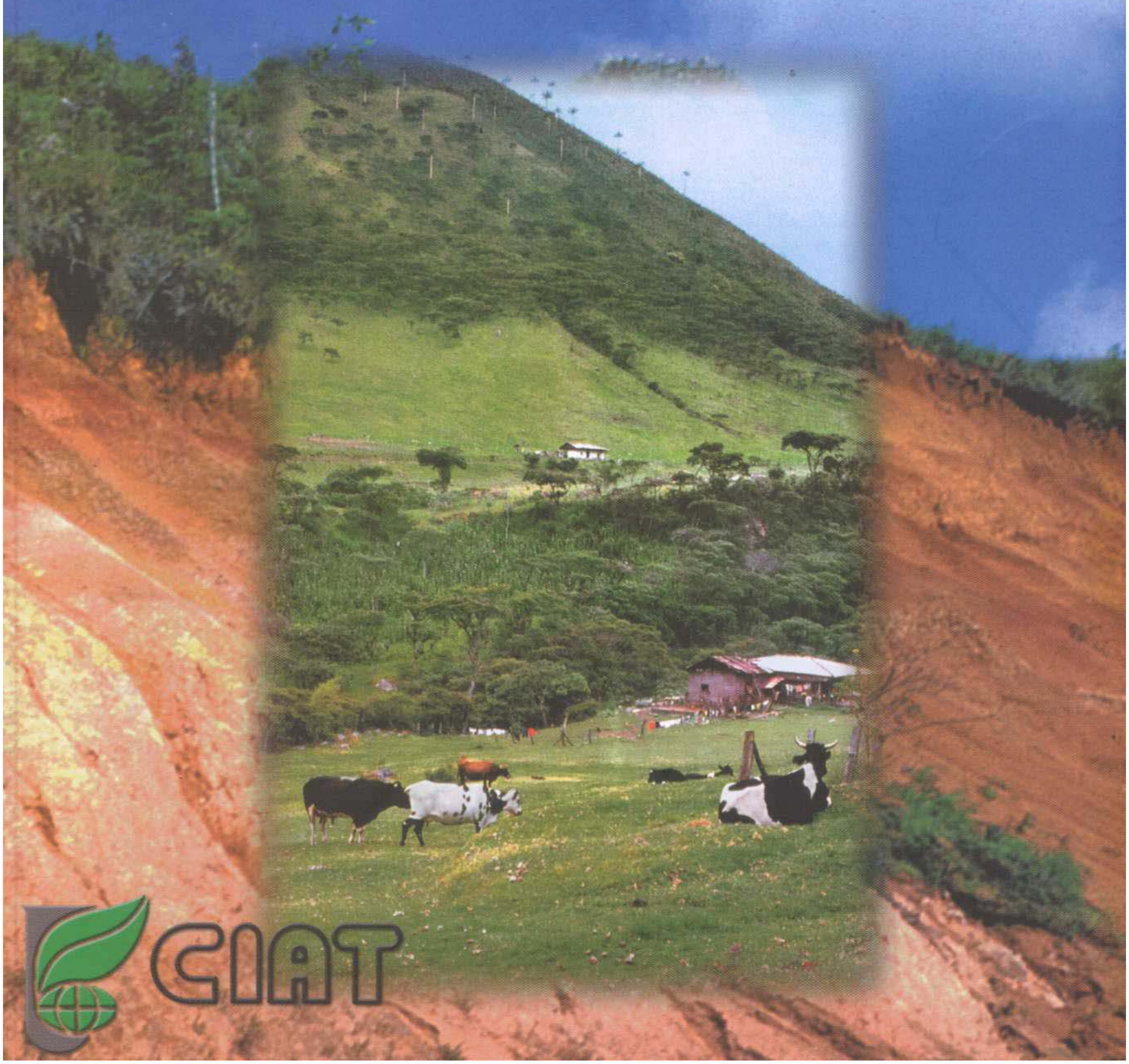
Conceptual Framework

An Innovative Approach to Prevent, Reduce, and Reverse Land Degradation in the Tropics



CIAT

The International Center for Tropical Agriculture (CIAT, its Spanish acronym) is one of 16 food and environmental research organizations known as the Future Harvest centers. The centers, located around the world, conduct research in partnership with farmers, scientists, and policymakers to help alleviate poverty and increase food security while protecting the natural resource base. The Future Harvest centers are principally funded through the 58 countries, private foundations, and regional and international organizations that make up the Consultative Group on International Agricultural Research (CGIAR).

In 2002, CIAT received support from the following donor countries: Australia, Belgium, Brazil, Canada, Colombia, France, Germany, Iran, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, Peru, South Africa, Spain, Sweden, Switzerland, Thailand, the United Kingdom, and the United States of America.

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CIAT also receives funds for research and development services provided under contract to a growing number of institutional clients.

Introduction

Land degradation is the reduction of economic or ecological outputs of ecosystems. This global problem is worsening because of increasing human pressures that place excessive demands on natural systems. At present, about 35% of agricultural land in Asia and 45% in South America is degraded, and even larger areas are afflicted in Africa (65%) and Central America (74%). [1]

Livelihoods of resource-poor farmers in the fragile lands in the tropics are the most vulnerable. Land degradation diminishes the resilience of agro-ecosystems to withstand drastic changes and reduces the number of land management options that are both sustainable and profitable. While responses to land degradation are many, viable solutions remain few. Numerous well-intentioned research and development (R&D) projects have been ineffective because of an incomplete understanding of underlying social, ecological, institutional, economic, and policy factors that lead to land degradation.

CIAT and partners will conduct innovative research to improve the success of projects addressing land restoration of degraded lands. Combining local perspectives and scientific inquiry will enable the prioritization of viable and adoptable technologies and management responses that enhance agro-ecosystem health, and increase the profitability of degraded lands. These proactive efforts save money in the long term.

[1] Heerink, N., van Keulen, H. and Kuiper, M. (eds.) 2001. Economic Policy and Sustainable Land Use: Recent Advances in Quantitative Analysis for Developing Countries. New York, Springer Physika-Verlag.

Problem Statement

Understanding fundamental, dynamic causes of land degradation is crucial. Land degradation reflects a combination of biophysical processes and socioeconomic driving factors, such as:

- Land conversion, including forests and wetlands;
- Agricultural management practices, including nutrient mining or inappropriate irrigation, tillage, cropping, or livestock systems;
- Policies that allow or encourage destructive practices; and
- National and regional economic systems that provide land users with few incentives to improve management systems.

Forms (and signs) of degradation can include:

- Losses of natural plant and animal biodiversity;
- Losses of soil nutrients, soil organic matter, and soil biological organisms;
- Increased soil toxicities associated with natural (e.g., aluminum) or human (e.g., salinization due to irrigation) causes;
- Soil erosion, compaction, and decreases in water-holding capacity; and
- Weed infestations.

These biophysical forms of degradation can be quantified, measured, and compared.

Systems differ in their output potentials, susceptibility to degradation, and prospects for recuperation. For example:

- Farmers sustainably produce vegetables on volcanic soils in central, highland Java. Requirements were an existing urban demand for vegetables, and cheap chicken manure. Projects attempting to introduce high-value crops in other densely populated areas of SE Asia have failed because of a lack of markets, and soil nutrient problems.

- Amazon settlers on areas of better soils in Rondonia successfully produce perennial crops and dairy products. Requirements were urban demand and road access. However, settlers farming the more predominant marginal soils in the Amazon, or Asia's sloping, highly acidic soils, face severe degradation with few alternatives.

- Beans in Latin America contribute to crop diversity and maintenance of soil quality. In sub-Saharan Africa, however, root rot disease devastates bean harvests. In response, many farmers reduce or eliminate bean cultivation, thus losing both the contribution to soil quality, and cash income.

Land degradation has no global, silver bullet solutions. Building sustainable systems is largely a site-specific process. The degrees of degradation, whether accelerating or decelerating, and the importance of exacerbating or problem-solving factors, differ with site and situation. International agriculture research systems can help by providing technological components and tools that help local stakeholders identify what is likely to work and where.

Responses to Land Degradation

Researchers agree that preventing the long-term impacts of degradation on productivity and environmental quality is a major challenge. Social scientists additionally warn that land use decisions to "over-exploit" resources may be perfectly rational. Land managers often accept degradation as a price they must pay to achieve higher priority objectives.

Public policies, such as agricultural credit, taxes, quotas, subsidies, and protective tariffs, often hinder rather than facilitate adoption. National Agricultural Research Systems (NARS) and donor policies themselves may also inadvertently deter the development of sustainable technologies by placing excessive emphasis on short-term and easily quantifiable outcomes.

Policies attempting to benefit both the environment and the poor are difficult to formulate and implement. Policies that alter free market forces can lead to perverse environmental and social outcomes. Incentives to promote land restoration, for example, may encourage degradation by those interested in obtaining short-term benefits of these same policies. Benefits may go to the wealthy if "creative" policy interpretations are permitted.

Linking technology demand and supply

Technologies developed to combat land degradation have rarely been adopted. Sustainable land management practices are often unattractive because of high initial investments, low returns, and long payback periods.

Connecting technology demand with supply requires advance analysis of how innovations perform in specific agro-ecosystem, socioeconomic, and policy contexts. Actions to link supply and demand are central to CIAT's proposed research approach (Figure 1).

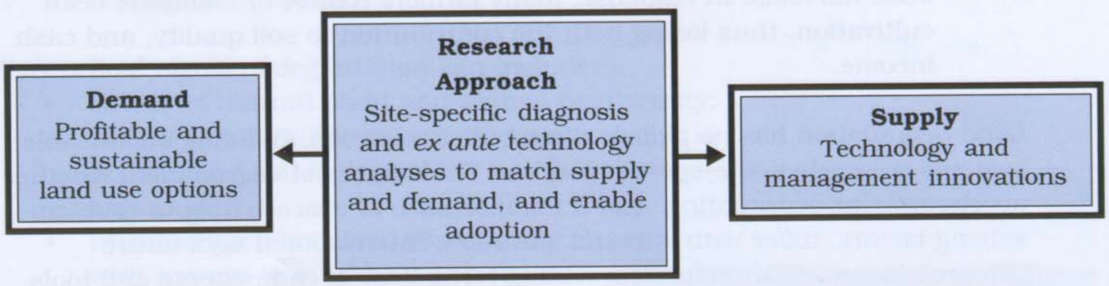

Figure 1. Research to connect technology demand and supply.

Biophysical measures of land degradation are necessary, but are insufficient to understand incentives underlying adoption decisions. *Ex-ante* analysis can discern whether biophysically sustainable technology and management options are:

1. Financially feasible to land users and only need to be better disseminated.
2. Marginally inferior to current practices, but could be adoptable in combination with other technologies or through small, targeted public investments, such as credit, infrastructure, or other public policy measures.
3. Inferior and unadoptable without major public investment.

Ex-ante analysis should include comprehensive, participatory diagnosis of local sites. The linking of scientific and local knowledge provides a better understanding of the biophysical and socioeconomic constraints that need to be addressed before adoption can occur. For example, analysis of inequality, gender differences, or ethnicity can facilitate development of targeted, more adoptable technologies.

Research approach to link R&D initiatives

Land rehabilitation initiatives require a comprehensive approach that comprises distinct, but linked, R&D components:

1. Site-specific contexts of agro-ecosystems lead to different types and dynamics of land degradation (Link 1). Contextual analysis assesses biophysical and socioeconomic driving forces, such as soil and water resources, policy, markets, and available technologies.
2. Traditional Consultative Group on International Agricultural Research (CGIAR) and NARS work addresses the linkage between the types of land degradation, and their effects upon agricultural production (Link 2).
3. Recent integrated natural resource management (INRM) and sustainable livelihood approaches have improved our understanding of the dynamic links among land degradation, and their ultimate effects on human welfare (Link 3).
4. Effective R&D responses require an understanding of all components of land degradation and their links in a cumulative manner (Links 1-4).
5. Research and development responses focus on changing the underlying context that gives rise to degradation, for example, through policy change, or lessening the impact of human action on the resource base (e.g., by more sustainable agricultural technologies). Predictive monitoring and evaluation provide for adaptive management cognizant of key cause and effect relations (Link 1-5).

Figure 2 shows a summary of these links.

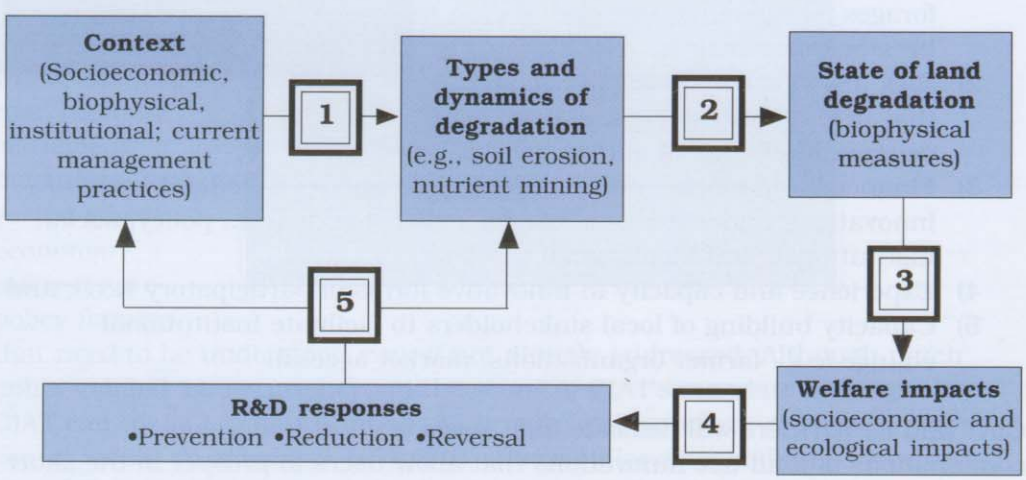

Figure 2. A conceptual approach including components of the land degradation problem and required links of research and development (R&D) responses.

Program Description

Goal

To Improve economic and ecological productivity of degraded lands.

Purpose

To generate technical, institutional, and policy innovations to restore degraded agricultural lands, and to enhance the health of ecosystems and livelihoods of smallholders.

General Approach

Research and development can best address land degradation through prevention, reduction, and reversal strategies. CIAT will build upon its traditional strengths of reducing and reversing land degradation in the humid and subhumid tropics. These strengths include:

1) Development and dissemination of multiple stress-adapted crops and forages for sustainable crop-livestock systems;
2) Risk analysis with predictive models that help identify changing, future degradation hotspots and vulnerable populations;
3) Financial and market analyses that distinguish viable land use innovations under dynamic site-specific contexts (e.g., policy, social, institutional, and biophysical);
4) Experience and capacity in innovative forms of participatory R&D; and
5) Capacity building of local stakeholders to facilitate institutional change (e.g., farmer organizations, market access).

CIAT and its partners will dedicate high levels of effort to develop combinations of land use innovations that allow users to prosper in the short term as they put in place the technologies that yield major economic and environmental benefits over the longer term. Obviously, the success of these

R & D activities will depend on the genuine participation of target or client communities.

Significant efforts will also be direct towards to understanding and responding to policy-related drivers of land degradation. Enhanced coordination between CIAT and partners will improve the ability of local stakeholders to lobby policymakers for change. Monitoring outcomes and adapting/adjusting policies to meet stated objectives can better ensure implementation of appropriate policies. Stakeholder input and capacity building of local partners are essential.

Proposed Strategies

CIAT will conduct activities according to prevention, reduction, and reversal strategies that are linked to multi-faceted *ex-ante* assessments (Table 1):

Prevention strategy: For areas currently showing little degradation and for areas of high social or environmental value (e.g., tropical forests), policy interventions are key to the *prevention* of undesirable land conversion and subsequent degradation. Under-pricing of timber and/or land, fixed water charges, road building, settlement incentives, and vested global economic interests are policy failures that need to be understood even if not directly addressed. Although much policy-related issues are beyond the scope of CIAT's mandate and expertise, CIAT can make key contributions to broader policy reform processes. The center would spend about 10% of its efforts on land rehabilitation in these areas. Tropical forests (e.g., the Amazon) and wetlands (e.g., the Pantanal of South America) would be of particular project concern.

Reduction strategy: For agricultural areas showing moderate degradation, "traditional" CG and NARS work on sustainable land management would continue to attempt to *reduce* degradation trends exacerbated by population growth and poverty.

Research and development tactics will maintain and improve the profitability of agricultural systems by introducing needed technologies (e.g., locally adapted, multiple stress tolerant germplasm) and management practices. Perhaps 30% of CIAT's work with its partners on addressing degraded lands would be allocated to such objectives. These R&D initiatives will be conducted mainly in selected hillside crop and livestock systems of South America and Asia.

Reversal strategy: Although overlapping with the above, restoration or *reversal* of land degradation faced by the poorest on the most vulnerable systems is the biggest challenge. Research and development advances are at higher risk because numerous problems must be addressed simultaneously. New crop and forage components adapted to major biotic and abiotic constraints, and innovative technical management options, are crucial. Again, sustaining or improving livelihoods in the shorter term while longer-term innovations become effective will be a part of any proposed intervention. Dramatic changes in policy environments and market access may also be necessary. About 60% of CIAT's efforts with its partners would be allocated to recover systems facing severe degradation. Targeted areas include degraded lands in sub-Saharan Africa; eroded hillsides in Central America, the Caribbean and Asia; *Imperata* grasslands in SE Asia; and degraded pastures in the Amazon and tropical savannas.

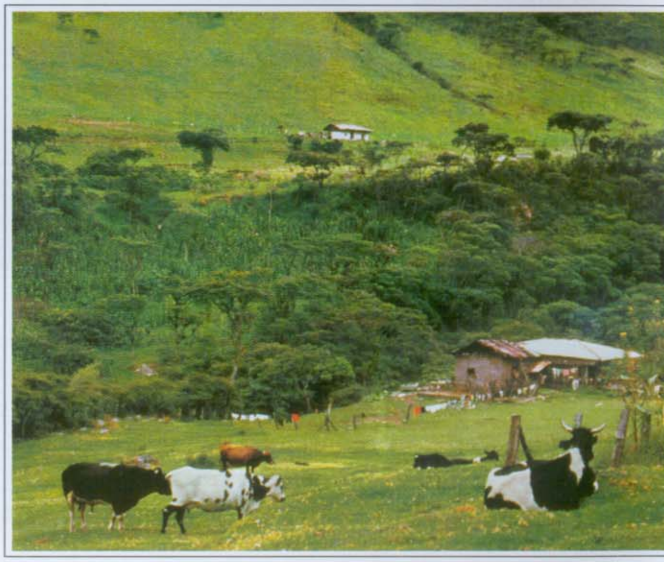

Table 1. The scope of proposed land rehabilitation research and development (R&D).

Strategy	R&D tactics	R&D partners	CIAT priority (% effort)
Prevention/ conservation	• Predictive analysis of risks and vulnerability • Policy and institutional consultations	Many: global, national, and local	10
Reduction	• Predictive analysis of risks and vulnerability • Improved, adapted crop and forage germplasm and management technologies • *Ex ante* assessments of technologies, policies, and institutions	NARS, nongovernmental organizations (NGOs), private sector, and government policymakers (agricultural and non-agricultural)	30
Reversal	• New combinations of technologies, systems, based on multiple stress adapted germplasm and institutional relationships • *Ex ante* assessments of technologies and contexts • Probabilities of success decision criteria	NARS, NGOs, government policymakers	60

Outputs

Outputs and activities correspond to the themes of problem analysis; technology and systems development; *ex-ante* analysis of technology offerings and risk assessments; and research, adaptation, dissemination, and scaling.

1. Site-specific problems analyzed; analytical tools developed and applied

- Information on the dynamics of degradation and restoration of tropical agricultural lands synthesized and shared through R&D networks.
- Involvement of communities, NARS partners, local policymakers, and nongovernmental organizations (NGOs) in the diagnosis of land

degradation, market opportunities, and definition of suitable technological options for restoring degraded lands.

- Hotspots of vulnerable livelihoods and natural systems from land degradation identified and characterized.
- Institutional and policy shortcomings that inhibit adoption of sustainable technologies, or that promote destructive land uses, identified and factored into R&D.

2. Technology and systems developed

- Multiple stress-adapted crop and forage germplasm developed and integrated into crop-livestock systems with local participation.
- Site-specific management strategies developed with local participation
- Market and institutional innovations developed with local partners.

3. Risk assessed and profitability analyzed

- Diagnostic tools for early warning of land degradation vulnerability developed and disseminated to appropriate users.
- *Ex-ante* economic and ecological assessment of technologies conducted, and results incorporated into research strategies.
- Profitability of innovative technological options demonstrated

4. Research adapted, disseminated, and scaled up and out

- Continual monitoring and *ex-post* impact analyses conducted to frequently modify R&D activities.
- Policymakers accessed with local stakeholders to remedy institutional and policy failures/constraints that lead to land degradation.
- NARS, NGOs, and government bodies trained and empowered to extend project outputs beyond their initial implementation niches.

Impact

The research approach proposed by CIAT will have numerous impacts ranging from improving the lives and livelihoods of resource-poor farmers to changing the operations of research and policy organizations. Combinations of short- and long-term adoptable and profitable technologies will enable smallholder farmers to improve their livelihoods and become more resilient to system changes, while improving and protecting the agro-ecosystems on which they depend. Systematic analysis of site-specific contexts and predictive modeling of development scenarios will identify research priorities, appropriate partners, and technological solutions. Comprehensive understanding of the dynamic biophysical and socioeconomic forces that underlie land degradation, combined with participatory R&D, will foster better public and private decisions on investment and management opportunities to restore degraded lands.