



Centro Agronómico Tropical de Investigación y Enseñanza

**REDUCING THE VULNERABILITY OF CENTRAL
AMERICA TO NATURAL DISASTERS BY IMPROVING
AGRICULTURE AND NATURAL RESOURCE
MANAGEMENT**

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SECTION 1

2. REDUCING THE VULNERABILITY OF CENTRAL AMERICA TO NATURAL DISASTERS BY IMPROVING AGRICULTURE AND NATURAL RESOURCE MANAGEMENT: II. CATIE's Perspective and Possible Areas for Intervention ¹

Introduction

The severity of the recent Hurricane Mitch challenged Central America to focus more carefully on the nature of and what could be done to cope better with such type of disasters in the future. CATIE, a regional institution with mandate for research and capacity building on improving the use and protection of natural resources for the sustained benefit of the population, has been one of the most active bodies in facilitating these analyses in the wake of the Hurricane.

This paper is part of CATIE's on-going efforts. It is based on the results from a series of consultations, many facilitated by CATIE itself, and analyses made on the recent hurricane and its consequences, but also on a deeper study of the ecological, social, infrastructural and economic characteristics of the affected areas in regard to their preparedness and vulnerability to natural events such as Hurricane Mitch.

This paper argues that the final devastation of a Hurricane Mitch type of disaster is determined by the intensity of the natural phenomena, but also by the protection - or lack of it - that affected areas and populations enjoy from:

- the natural environment and resources, and
- the social and economic organization, infrastructure and specific institutional safeguards that complement the natural ones.

Since the frequency and intensity of the natural disasters are not preventable, many interviewed organizations during the consultation process argued that the social and economic determinants of natural phenomena should be the focus of concern for future plans and activities in Central America.

2 | The research for this paper also shows that there is no clear evidence of institutional safeguards, and that on the contrary the social and economic structure and organizations in the region seem to be further weakening the already weak natural safeguards. Furthermore, the present situation shows that only a minor portion of the population live within fairly protected areas or conditions. The majority of the people and specially the poor rural populations, have been left out or marginalised from such "protection". Most

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of the rural poor live in and work in areas that are the most fragile and exposed to the consequences of the natural disasters, thus they also seem to be contributing directly to the degradation of the resources and weak natural disaster safeguards there. For this reason, this paper further argues that two important and related priority tasks for Central Americans and their supporters are:

- to improve on the socio-economic determinants of vulnerability to disasters with a focus on protecting and using at full potential the natural safeguards, such as the natural environment and resources, and
- to incorporate the majority of the rural poor in the process.

2 In response and through this paper, CATIE sketches a long-term vision and effort for itself and key partners in the region. The vision is to foster and support adjustments in policies in the public and private sectors, improvements in the sustainable use and management of natural resources in key watersheds of the region, and the incorporation of the poor in these changes with a view to also eradicating marginalisation and poverty among the majority in the rural areas.

Accordingly, after this introduction the paper focuses on the following: the devastation and lessons from Mitch; the post Mitch analysis and rationalization; the concept and determinants of vulnerability to natural disasters in the region and; a natural resources centered and poverty eradication focussed long-term effort to diminish regional vulnerability to natural disasters.

Hurricane Mitch and lessons learned

Among the recent natural disasters that have struck Central America, Hurricane Mitch will have an important place in history. It was one of the worst weather-related disasters that has affected this region in terms of losses of human lives, destruction of infrastructure and natural resources and losses of agricultural produce. Diagnostic studies were readily available after the impact of the hurricane, but the effects and mainly the impact of this phenomenon on the social, economic and environmental setting of the region will be experienced for many years to come.

More than 11 000 people lost their lives during the hurricane, mostly poor women and children. A significant share of the 28 251 missing persons probably should be added to the above figure. Since the hurricane affected mostly poor rural areas with inadequate infrastructure, 2 270 000 persons lost their homes.

Losses in agricultural produce have been calculated at more than 1300 million US dollars. According to several sources, the damage caused to natural resources such as forest cover, biodiversity, soils properties and water

quantity and quality have not so far been properly estimated. These losses are probably much higher and their negative effects more lasting than those of the agricultural sector.

It has been estimated that for 1999 and as a consequence of Hurricane Mitch the average growth of the GDP of Central America will be reduced to 2.9 % instead of the expected figure of 5.9 %.

The main lesson learned from the experience of the devastation of the Hurricane and others natural phenomena in the region, is that Central America, in addition to its extreme vulnerability to natural disasters, is generally incapable to react on time to cope with the aftermath.

After the Hurricane it has been also more strongly suggested that the status of natural resources and mainly widespread deforestation, mismanagement of important watersheds and, farming in the hills are among the several factors that contributed to the high incidence of floods and landslides after the intense rains and strong winds of the Hurricane.

From a socio-political perspective the main lesson is that the real reason for the intensity and extent of the devastation caused by disasters similar to Mitch are perhaps more deeply rooted in the social system than in the physical phenomena itself.

A post-Mitch analysis and rationalization

CATIE as a leading regional institution with mandate for agriculture and natural resources in Central America has been continually collaborating with the countries affected by Hurricane Mitch by either providing technical assistance or advice on how to better cope with the negative effects of this phenomena. Immediately after the Hurricane struck the region, CATIE's outreach programmes assisted the countries with support for diagnostic studies and later mainly with support for project preparation and submittal.

Given CATIE's commitment to national organizations of agriculture and natural resources of Central America, it was thought that their views on how to deal with this natural disaster should be taken into consideration before any attempt to formulate and implement a regional program.

To identify the long-term view of technicians, farmers and scientists with regard to reduction of vulnerability, a set of interviews to representatives from national organizations were carried out by CATIE during January and part of February 1999. Four workshops with the participation of non-governmental organizations (NGOs), government institutions and farmer's associations, were held at each of the four most affected countries. Both social and ecological disciplines were well represented among technicians and scientists at each country meeting.

Later the most relevant issues highlighted by local institutions were also discussed with regional and international organizations with offices in the Region. Additional discussions were also held with groups of NGOs in Honduras (2) and Nicaragua.

In total more than 120 technicians and farmers participated in meetings, workshops and seminars organized by CATIE in the countries and at headquarters early in 1999.

The following are some issues introduced more frequently by participants when discussing the effects of Hurricane Mitch, ecological vulnerability and possible lines for collaboration.

Short or long-term interventions: to either rehabilitate from the effects of Hurricane Mitch or reduce regional vulnerability with a long-term programme

The majority of the participants in the national workshops agreed on a long-term program perspective towards vulnerability reduction instead of short-term projects to rehabilitate from a single natural event. This long-time perspective could include some short-term activities too, but as part of longer-term program on vulnerability reduction. It was argued in several countries, particularly in Nicaragua, that the stress-like effect of the prolonged drought caused by El Niño was probably more negative for the economy of the poor rural inhabitants than the impact-like effect of Hurricane Mitch.

This long-term approach for vulnerability reduction was also strongly supported by all regional organizations consulted.

The questions of the need to address a transition phase between specific activities aimed to rehabilitation and activities aimed at a long-term transformation towards less regional vulnerability still remain open although this transition phase was frequently mentioned as an important topic for further discussions.

Relief aid was discussed on several occasions and while all scientists agreed about the positive short-term humanitarian role of relief, they were also concerned about the possible role of relief in reinforcing the *status quo*. The argument put forward was that in the long-term, relief could produce more marginalisation and greater disaster susceptibility by hindering adjustments to future natural hazards and increased dependence. This argument also has been discussed at several international fora elsewhere and recently in the Region. There is the tendency among several international organizations to act guided mainly by humanitarian reasons. This approach is certainly valuable from an ethical perspective, but the Region must embark on a long-term effort to create a regional Central American culture of prevention and risk reduction as an important component of a more sustainable economic development.

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Existing diagnostic evaluation on the effect of Hurricane Mitch and the future capacity for damage analysis

The real value of existing diagnostic studies of the effects of Hurricane Mitch on agriculture and natural resources was frequently questioned, mostly by scientists. It was argued that due to the urgent need to assess the impact of the Hurricane, the national authorities were forced to act rapidly using whatever method and personnel available at that moment.

All scientists from the affected countries agreed on the need for reliable environmental indicators that could be used for diagnostic purposes. This lack of indicators is a need expressed long before Hurricane Mitch and independently from any other natural disaster.

In addition to indicators, the need for practical methods and trained personnel to value natural resources was also expressed. Without these methods no market value could be given to natural resources losses. In fact the monetary value of the damaged caused by the Hurricane Mitch to the natural resources of the Region remain up to now largely unknown and it will probably remain so for many years to come.

Lack of relevant indicators is also the main cause for the lack of information about effects of natural disasters on water quantity and quality together with aquatic life.

The total or partial destruction of forest biomass by natural disasters affects plants and animal biodiversity in an unknown manner. From a global perspective, Central America is an area whose richness in biodiversity and genetic resources is unique. This richness should be maintained for the benefit of mankind, but again both the knowledge and the methods to evaluate losses in biodiversity are largely lacking.

Finally from the social and economic point of view, better analysis about the effect of natural disasters on the economy of poor people and on the relationship between rural poverty, natural resource degradation, basic food production and vulnerability should be conducted.

Food crops in Central America, mainly maize, beans and sorghum are produced by poor farmers that cultivate small plots in the hills. A significant share of those farmers are located on the Pacific side of Central America where rural poverty and natural resource degradation combine to make agriculture a risky activity. At least in two countries, the spatial distribution of small farms that produce basic food and the high incidence of damage caused by the Hurricane Mitch coincide. This means that not only rural inhabitants are vulnerable but that food security for the cities and the entire countries depends largely on a highly vulnerable social and ecological setting.

From an ecological perspective it was stated that more attention should be given to the study of hillsides agriculture and the possible ways to rehabilitate

this highly degraded dry environment. From the economic point of view it was pointed out that the new development paradigm suggest that small holders constitute the growth pole whose dynamic push can bring about a surge in overall economic growth. Consequently, these farmers should be the subjects of more investment in the form of incentives for better natural resource management and technical assistance to increase production.

A technical approach to reduce ecological vulnerability

The discussions on the best way to approach the reduction of ecological vulnerability almost always concentrated on two important and closely related issues:

X to reduce the existing gap between potential and actual land use in Central America as a way to attain a more sustainable natural environment and,

X to improve the manner in which watersheds are presently managed

Central America is one of the areas in the world where the gap between best-potential and actual land use is the widest. Adequate land use policies, communal participation and the application of existing technologies and methods will help to decrease vulnerability by reducing this gap.

Not only because recent natural disasters affected mainly watersheds, but because the topographic characteristics of Central America so indicates, most professionals consulted agreed that watersheds rehabilitation and improvement is the more practical approach to follow when attempting to reduce ecological vulnerability.

The watershed is an ecological system with natural boundaries. It encompasses the very important production system of hillsides agriculture and consequently all the complex interactions between ecological and socio economic factors in this type of agriculture. By including hillside agriculture, the watershed approach to reduce vulnerability allows for improvements in both food production and natural resource management within an ecological framework. The present emphasis of hillsides agriculture improvement on the internal dynamics of the system, that is so common in Central America, will be complemented and enhanced by including considerations about its interdependence with other ecosystems, within the context of watersheds

The need to improve the capacity of local scientists and technicians on watershed management was often highlighted during the workshops. Both the improvement in skills of biological as well as social scientists should be emphasized in the future if financial resources become available for better watershed management at regional level.

The generation of new knowledge by demand-oriented research and the adaptation to local conditions of technological components was also mentioned as necessary complements for a long-term programme on vulnerability reduction in Central America.

Rural poverty and communal participation

Considering the close relationship between the state of natural resources and rural poverty in Central America, most institutional aspects related to better farming and natural resource management for vulnerability reduction were discussed within the framework of the new rural development paradigm of poverty alleviation.

The rapid degradation of the natural resource base of the rural poor of the Region is significantly worsening their poverty. Rural poverty alleviation is a pre-condition to achieve better natural resource management and therefore a more equitable and sustainable rural development in the region.

Regional investment to reduce rural poverty should always be combined with investment on the enhancement of their natural resource base, otherwise the number of those that suffer from poverty in the rural areas of Central America will continue to grow and their natural resources will be further degraded.

Decentralization and the importance of local governments in promoting balanced and equitable development was frequently stressed during several meetings about grassroots organizations and their role as promoters of better agricultural and natural resource management. Given their spatial distribution and remoteness, local governments and NGOs are the main bodies with which the rural poor interact, therefore the financial and technical support to these local organizations is a key factor to reduce poverty and improve the state of the natural resources. Close to local governments are the NGOs that have been for quite long time empowering the rural poor of Central America. Many studies carried out on NGOs in the region, showed their importance in conducting small scale-projects on agriculture and natural resources. These studies also showed the crucial need of these organizations for better support services, particularly training in technical matters. The need to support relevant NGOs was clearly stated by many participants in the workshops organized by CATIE in each country affected by Hurricane Mitch. This need was also stressed by regional and international institutions during the regional workshops.

Strong support to local governments and NGOs should be the key element to reach the objectives of any long-term program for vulnerability reduction by improving agriculture and natural resource management in the near future

The concept and determinants of vulnerability reduction. The rationale for a long-term perspective

Central America may be considered a hazardous scenario from the point of view of natural disasters. In the last 36 years, 100 natural disasters with significant negative effects on the economy and the population have struck the Region. The incidence of these natural disasters seem to be increasing since according to data from OFDA/AID², 2.5 disasters/year affected the region between 1960 and 1988, while 3.7 disasters/year were recorded for the period between 1988 and 1996.

These disasters have taken the form of earthquakes, tropical storms, hurricanes (including a Tsunami in Nicaragua), floods, mudslides and droughts in particular that have caused the loss of thousand of lives, crop damages totaling billions of US dollars, destruction of infrastructure (roads and communications, mainly) and even entire cities.

During the period 1960-1974, natural disasters reduced the GDP of Central America by 2.3%, according to data from CEPAL³. Given the relatively high regional 3.0% rate of population increase, natural disasters are now responsible for a significant share of the present regional economic stagnation and put the future of the regional economy at risk.

³ Comision Economica para America Latina

The Region is particularly vulnerable to two types of natural disasters: seismic activity and weather-related natural disasters

Seismic activity

Central America is located in a geographic zone where five of the earth's tectonic plates converge. The existence of these plates is in large measure responsible for the extremely high seismic activity of the region. In fact the region is one of the most active zones of the world in terms of seismic activity. Strong earthquakes have destroyed the old capitals of Guatemala and Nicaragua. Major earthquakes with thousand of people killed have been recorded also for El Salvador.

Along the region a chain of almost eighty volcanoes running from Mexico to Panama, with at least twenty of them active, adds another ingredient of volcanic vulnerability to the region. In addition to the classical seismic activity, volcanic eruptions cause damages to properties and important changes in topography, soil properties, water quality, chemical contamination, human health and unknown effects on biodiversity.

Weather-related natural disasters

Only about 10% of all tropical storms developed in the Caribbean reach Central America, but it seems that the region is particularly prone to host the most damaging ones. Tropical storms and hurricanes from the Pacific Ocean rarely struck the Isthmus, but there are many records of heavy losses due to these storms.

Almost 70% of the surface area of Central America drains to the Atlantic side of the Region, where seasonal floods caused by monsoon-like precipitation result in inundation and swampy conditions during the wet season.

In the Pacific side of the region, the Atemporales or periodic heavy precipitation cause flash floods that affect the short and abrupt watersheds of this highly degraded part of Central America. Because watersheds of this Pacific side are relatively small, steep, cleared of absorptive vegetation and over grazed, heavy precipitation in the form of monsoons tend to overflow the rivers resulting in rapid and short surges in water flows. During the rest of the year the Pacific side of the region remain under a semi-arid condition.

With regard to droughts in Central America, a special mention should be given to El Niño that has caused highly significant losses to agriculture and animal production in the impoverished Pacific side of the region and heavy floods in an extensive part of the Atlantic basin. Recently, Central America has been exposed to the effects of two El Niño phenomena, in 1993-94 and

1997-98. These droughts have affected the entire region but their impacts were particularly severe on the Pacific side of Central America where the rural poor are more vulnerable to droughts due to their cumulative effects year after year.

In addition to these effects on agriculture, the heating of the Pacific waters totally distorts artisan as well as industrial fishing patterns. The rise of the water levels makes the coastal infrastructure more vulnerable, as happened in 1997 in many coastal areas of the Region.

The status of natural resources. A brief description

Given the known link between natural resource degradation and susceptibility to natural disasters, better natural resource management and improvements in the way agroecosystems are managed, among other benefits, will significantly contribute to decrease regional ecological vulnerability.

Throughout Central America the single most important ecological change that is taking place as a result of demographic pressures and economic trends is the rapid and continued conversion of forest into other forms of land use. Deforestation has increased in the last decades at an alarming rate, except in Costa Rica where this trend is reversing. Although in a global dimension the forest losses of Central America are small, they represent an astounding rate of change that exceeds by far, in percentage terms, the annual tropical forest loss of Brazil and other countries that contains the bulk of the tropical forest and are cited as undergoing rapid deforestation. There are many causes for deforestation in the region, but by far the most important is the need for land to produce food for the growing population and the land ownership and tenure patterns of the region. All other stresses on land and forest arise from these root causes. Deforestation has serious implications for the long-term productive management of the land and water resources in this region that heavily depends on natural resources for its economic development.

The loss of the forest cover is one of the main causes of the high incidence of landslides during and after heavy precipitation.

Soil degradation is the subsequent problem of deforestation. Soil erosion is more prevalent in the Pacific than in the Caribbean side of Central America due to its more concentrated pattern of precipitation, highly erosive soils, the steep slopes of the Pacific watersheds, the absence of natural vegetative cover and the high concentration of population and livestock.

Although soil erosion is also high on the Atlantic side of the Region, the main cause of erosion here is not population pressure but land clearing which often culminates with loss of soil fertility.

By far the most affected part of Central America with regard to natural resources is the area located in the vicinity of the Bay of Fonseca on the Pacific side. Other localities also under the influence of the dry trade winds and steep topography suffer severe and frequent droughts and are undergoing a rapid desertification process. The dry and semi-arid neotropical forests existing on the Pacific Slope and in areas away from the coast although still under the climatic influence of the dry winds from the Bay of Fonseca, represent the major, most endangered tropical ecosystems of Central America. The total spread of these forests is now reduced to a small fraction of the original area. Less than 0.1% of the original dry forest and a very similar proportion of the native semi-arid vegetation is currently confined to this area; the rest was eliminated by man for one reason or another, mostly for agricultural purposes.

A long-term effort to reduce regional vulnerability to natural disasters by centering on natural resources management and rural poverty alleviation.

Considering the views of the majority of representatives from NGOs, farmer's associations and official institutions, the collaboration that they expect from CATIE to reduce ecological as well as social vulnerability in the Region, should center on watershed improvement within a landscape perspective. This approach should also include hillside agriculture.

To improve the management of watersheds in Central America, an aggressive long-term regional programme should be launched in the Region. To ensure the sustainability of this effort, this programme should put emphasis on human resources development and on the development of new knowledge, about both technical and socio-economic aspects, particularly methodologies, of watershed management.

As a regional organization with mandate for agriculture and natural resources, training, education and research, CATIE is well positioned to act as convenor and provide a regional hub for improvement in watershed management that include human resource formation and research on this subject.

CATIE has more than --- years of experience in watershed management in the region and has trained more than ----- professionals directly in watershed management or on related disciplines such as agroforestry, tropical forest management, wildlife conservation and hillsides agriculture.

Three closely related lines for collaboration will complement the main focus on watershed improvement.

- to support with technical and financial services the intermediary role of local governments and NGOs to enhance their capacity to develop improved watershed management practices with the participation of the communities.

From an institutional point of view and due to the complexity of the ecological and social factors involved, it should be kept in mind that no single institution, public or private, national or international, can make significant headway on its own with the task of improving agriculture and natural resource management in an environment where rural poverty is the main feature. Institutional pluralism is the key to success in dealing with complex issues such as the interaction between rural poverty and natural resource management.

At the community level, a broad-base coalition of forces will certainly be necessary where local governments, NGOs and farmer's associations are the natural partners. Local governments and the NGO community have a particular role to play given their familiarity with rural people and local resources. These two types of organizations are in excellent position to open and maintain a dialogue with the local community about the need to rehabilitate and transform natural resources within a watershed framework and to obtain feedback from the people about the effects of the possible interventions.

The potential role of local governments in promoting better land use systems and consequently more sustainable watersheds is better understood by considering the spatial distribution of watersheds. Forest improvement and better soil and water conservation practices cannot be carried out in patches; it has to be area-based. Consequently collective actions are required to achieve the agreement of all users of forest and services provided by the watersheds. Local governments can provide a forum for bargaining and reduce conflicts between the different watershed users.

This social process can be further reinforced by inputs from regional technical organizations such as CATIE. The combined efforts of local grassroots organizations with national and regional technical organizations will provide the foundations for identifying and develop improved options for natural resource conservation and transformation that are economically viable, ecologically sustainable and socially acceptable.

- to develop new scientific knowledge in both social sciences and ecological aspects to support of a more sustainable agriculture and natural resources management within a watershed perspective

Presently, there are several projects being carried out in the Region aimed at improving the way watersheds are managed. These national investment projects on watersheds have significant positive local value, but important components are missing at the regional level, namely:

- the comparative analysis of different projects to derive general principles that will serve as common ground for national and regional policy

formulation and setting of rural development strategies for areas where watersheds are the main ecological feature.

- the development of methodologies for both social and ecological aspects of watershed management that can be applied for new projects and consequently reduce their implementation costs.
- the generation of new knowledge, technological components and methodologies to decrease the regional dependence on technical support from elsewhere and the cost of constantly adapting technical components.

These largely missing components are vital to sustain, at a regional level, the present and future efforts to improve the Central American watersheds.

Information and long-term data analyses capacity

- One of the main features of most rural development projects and particularly watersheds management projects in the Region is their lack of continuity after the external funds stop. Due to insufficient and faulty information systems, most national experiences and lessons learned are lost after the project ends. A considerable amount of regional and international information on watershed management is already existing at CATIEs information center that could be enhanced and therefore used to facilitate comparative analysis and derivation of general principles after *ex-post* analysis of past experiences. CATIE could develop new information systems and already have experience in developing knowledge systems that could facilitate and reduce the cost of implementing new projects and the accuracy of *ex-ante* analysis. These information systems, plus the practical experience of social scientists will also facilitate the analysis and promotion of relevant proven methodologies

A view to the Pacific side of Central America

With regard to the development of new knowledge and policy guidelines, it should be kept in mind that although most water from the region drains to the Atlantic side of Central America, the concentration of population and poverty plus the degradation of natural resources calls for attention to the Pacific side in terms of overall resource allocation and improved practices for watershed management.

The Pacific side is the most densely populated area of the region where poverty and pressure for land are more acute in Central America. These drought-prone areas occupy more than 27% of the total land area of the region. Since population tends to concentrate in the Pacific side of Central America, these dry areas account for 80 percent of the cities with more than 35 000 inhabitants each.

Although the present degree of attention of CATIE to the humid tropics should probably continue, the attention to the Pacific side, particularly to watersheds located in the semi-arid zone of the Region, implies the development of knowledge and methods to rehabilitate this highly degraded environment. This Pacific side is characterized by numerous rivers and streams that pour directly into the ocean forming diverse micro watersheds in a steep topography.

From a land use perspective, research to determine the carrying capacity of representative sites within this dry ecosystem should be conducted to provide guidelines for policy formulation and setting sound strategies for rural development programs in the Central American semiarid tropics. The aim will be to identify, test and promote land use systems that, even though possessing low inherent biomass productivity, are nevertheless environmentally suited to the fragility of this specific environment.

From the biodiversity point of view the restoration of native ecosystems is a long-term objective whose basic knowledge needs to be developed and understood now. Reforestation with native species of trees and shrubs in selected micro watershed or other sources of water, plus regeneration of secondary forests has been identified as a way initiate the restoration of the ecological equilibrium and consequently ecological sustainability in the semiarid.

Transition agriculture for the Hills of Central America

Agriculture is practiced intensively in the slopes of Central American watersheds both in the Pacific and Atlantic sides. In fact these hillsides farmers are now producing most of the food crops consumed daily by the population. However, the practice of this type of agriculture, mainly through soil erosion, is negatively affecting the present status of most watersheds in Central America. Thus the improvement of production systems in the hillsides has not only a sustainability and equity justification, but also a profound economic and environmental implication for most countries whose food security and water supply depends strongly on the performance of these farmers on the hills.

From a landscape perspective, improved land use systems should be developed, mostly based on perennial plants or combination of perennial plants with food crops that provide more permanent coverage to the soil in the hillsides. Several possibilities exist for agroforestry or agrosilvopastoral combinations that will help to improve production and better sustain the natural resource base.

However, for poor and land-tenure insecure farmers that year after year produce only food crops, the transition from the present form of production to a form based on perennial plants is a very difficult task. The technical and

economic implications of this transitional phase have not been sufficiently studied and together with marketing of the perennials are the most important bottlenecks for the successful establishment of perennial production systems in the hills.

Socio-economic research on the possible effects of different agricultural and environmental policies should be conducted to promote the establishment of perennials and thus better protect the natural resource base of the hillsides.

Socio-economic research on the status of rural poverty in selected localities of Central America, particularly those environmentally more degraded will provide valuable information on the poverty/natural resource degradation interaction, that will in turn facilitate policy and policy instruments formulation.

Testing, possibly on a reduced scale, of different policy instruments such as incentives for reforestation and for CO₂ sequestration, compensation for environmental services, improved markets for non-wood forest products and others will also provide valuable information for national policy formulation and the interaction between agriculture and the natural resource base in the hills.

- **to train on a short-term bases and educate at the post graduate level a cadre of Central American professionals and para-professionals that will on time to take over the full responsibilities of national activities on watershed and agriculture management at their countries.**

In spite of the present efforts to train and educate professionals at the post graduate level, their number and skills are still not sufficient to cope with the task ahead to rehabilitate and transform agriculture and natural resources to reduce ecological vulnerability. The demand for short courses on topics such as agroforestry, silvopastoral systems, project formulation and evaluation, principles of biodiversity, participatory agriculture and others is well above the present capacity of CATIE.

International financial support to educate professionals at the post graduate level has been reduced in the last years in favor of short-term training. Although short-term training has a key role to play, several disciplines such as environmental economics, agricultural and environmental policy analysis, environmental administration, landscape analysis and development, environmental impact assessment, valuation of environmental assets and others, calls for a more conceptual and long term professional education that will only be provided by a graduate school such as CATIE's, to complement the short-term training effort.