HAMBURGER CONNECTION HANGOVER:

Cattle pasture land degradation and alternative land use in Central America

L. Szott, M. Ibrahim and J. Beer

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List of acronyms

AFE-COHDEFOR	Administración Forestal Estatal, Coorporación Hondureña de Desarrollo Forestal
ANCGAP	Asociación Nacional de Criadores de Ganado Puro
BANADESA	Banco Nacional de Desarrollo (Honduras)
BANRURAL	Banco Rural (Guatemala)
CATIE	Centro Agronómico Tropical para Investigación y Enseñanza
CEAR	Comisión Nacional para la Atención de Repatriados, Refugiados, y Desplazados (Guatemala)
CEPAD	Centro Evangélico de Alianza Denominacional (Nicaragua)
CIAT	Centro Internacional para Agricultura Tropical
CONAGRO	Consejo Nacional Agropecuario (Nicaragua)
CONAGAN	Comisión Nacional Ganadera de Nicaragua
CONAMA	Comisión Nacional del Medio Ambiente (Guatemala)
CONAP	Consejo Nacional de Areas Protegidas (Guatemala)
COREDUR	Consejo Regional de Desarrollo Urbano y Rural (Guatemala)
CUDEP	Centro Universitario del Petén
CURLA	Centro Universitario Regional del Litoral Atlántico
DICTA	Dirección de Ciencia y Tecnología Agropecuaria (Honduras)
DIGESA	Dirección General de Servicios Agrícolas (Guatemala)
DIGESEPE	Dirección General de Servicios Pecuarios (Guatemala)
EAP	Escuela de Agricultura Panamericana (Zamorano)
FAGANIC	Federación de Asociaciones Ganaderos de Nicaragua
FAO	Food and Agriculture Organization of the United Nations
FENAGH	Federación Nacional de Agricultores y Ganaderos de Honduras
FHIA	Fundación Hondureña de Investigación Agrícola
FONAPAZ	Fondo Nacional para la Paz
FONDEPRO	Fondo para el Desarrollo de la Producción (Honduras)
FONDILAC	Fondo Nicaraguense para la Industria Láctea
FYDEP	Empresa Nacional para el Fomento y Desarrollo del Petén
GTZ	Deutsche Gesellschaft Für Technische Zusammenarbeit
ICTA	Instituto de Ciencia y Tecnología Agropecuaria (Guatemala)
IHIMV	Instituto Hondureño de Investigación Médico Veterinaria
IICA	Instituto Interamericano de Cooperación para la Agricultura
INA	Instituto Nacional Agraria (Honduras)
INAB	Instituto Nacional de Bosques (Guatemala)
INRA	Instituto Nicaraguense de Reforma Agraria
INTA	Institución Nacional de Transformación Agraria (Guatemala)
INTA	Instituto Nicaraguense de Tecnología Agropecuaria
MAG	Ministerio de Agricultura y Ganadería (Nicaragua)
MAGA	Ministerio de Agricultura, Ganadería, y Alimentación (Guatemala)
MARENA	Ministerio del Ambiente y Recursos Naturales (Nicaragua)
NITLAPÁN	Instituto de Investigacion y Desarrollo de la Universidad Centroamericana
PDBL	Proyecto de Desarrollo de Bosques Latifolios (Honduras)

PDI	Plan de Desarrollo Integrado (Guatemala)
PMS	Proyecto Manejo de Recursos Naturales de Petén
PNDR	Programa Nacional para Desarrollo Rural (Nicaragua)
POSAF	Programa Socioambiental y de Desarrollo Forestal (Nicaragua)
PROSELVA	Programa para la Protección del Bosque Tropical del Petén
SAG	Secretaria de Agricultura y Ganadería (Honduras)
SEDA	Secretaria de Estado en el Despacho del Ambiente
SEGEPLAN	Secretaria General del Consejo Nacional de Planificación Económica (Guatemala)
SENASA	Servicio Nacional de Sanitación Agropecuaria
UCA	Universidad Centroamericana (Nicaragua)
UNA	Universidad Nacional Agraria (Nicaragua)
UNAG	Unión Nacional de Agricultores y Ganaderos (Nicaragua)
UNILECHE	Unión Nicaraguense de Productores de Leche
UPANIC	Unión de Productores Agropecuarios de Nicaragua
USAC	Universidad de San Carlos (Guatemala)
USAID	US Agency for International Development

Executive Summary

In the past few decades, pasture expansion into the humid lowlands of Central America has increased greatly and has raised a great deal of concern about deforestation and potential land degradation. However, little information exists on the type or extent of ecological and environmental damage connected with cattle grazing in this region. In this document, we examine three regions considered to be "hot spots" of cattle raising in humid Central America: central Nicaragua, the Petén of Guatemala and northern Honduras. We attempt to estimate the amount of degraded pasture present, areas most affected or at risk, and the degree, forms and causes of degradation. Based on this analysis we identify potential alternative forms of land use and some of the requirements needed to put them into practice.

The definition and quantification of pasture degradation in the regions were difficult because of the following: 1) maps of actual land use are often out of date and there is little information on the amount of degraded pasture, or pasture in general, in the targeted regions; 2) there is a paucity of published data, at either the local or regional scales, regarding soil or vegetation properties, such as pasture composition, soil compaction or amount of bare soil, which can serve as indicators of the degree of land degradation associated with cattle; 3) there are few studies for the target areas of how such properties or degradation evolve with time under grazing management or alternative land uses; and 4) compounding the problem of the absence of data, the term 'degradation' itself is ill-defined, leading to the use of different indicators by different people (e.g. compacted or eroded soils, pastures of low productivity for those invaded by weeds, shrubs and bushes). This confusion is due, in part, to the complexity of the processes involved in pasture degradation.

Due to the lack of concrete data, we developed a number of crude estimates of pasture degradation. These estimates suggest that there are between 600 000 and 900 000 ha of pastureland that are likely to be at least partially degraded in the three regions. Central Nicaragua contributes more than half of that total, with northern Honduras and the Petén, Guatemala contributing about equally to the remaining area. Critical areas include: the Muy Muy - Waslala - Rio Blanco triangle and the hills and lowlands on the eastern side of the central cordillera in Nicaragua; the Las Cruces - Sayaxché - Las Pozas and San Luis - Poptún corridors, the Dolores - Lake Petén - Melchor triangle, and the La Libertad savanna in the Petén; and the coastal hillsides and plains, and the Aguán river valley in northern Honduras. A major reason for the uncertainty associated with these estimates is the lack of precise information regarding total pasture areas. In addition, there is virtually no information about the degree of degradation in different regions, the type of degradation (soil compaction, infertility, erosion, bare soil, or colonization by weeds or secondary vegetation), nor the relation of degradation types or rates to differences in soils, grazing pressure, rainfall, slope or management. More in-depth analyses are needed to refine estimates of pasture area and land degradation and to estimate the degree and type of degradation present.

Causes of pasture degradation are varied and occur at a number of scales including national (e.g. laws, regulations, incentives) and local (e.g. access, infrastructure, security) factors that affect producers ability to invest in more intensive or environmentally friendly management practices. Proximate causes include lack of capital, farmer strategies (e.g. land speculation, prestige), lack of appropriate knowledge and disincentives created by framework conditions. Given labor and capital constraints,

cattle are one of the few available options which provides a modest return based on minimal investment, flexibility in productive output, productive use of marginal lands, reduction in risk due to climatic fluctuations, ease of liquidation, a source of savings and prestige. Farmers do not perceive or inadequately value the environmental degradation accompanying cattle raising, or do not receive incentives and techniques needed to avoid or mitigate this damage. Improved technologies exist but are often not applied. The solutions to this enormously important land use problem will certainly require interventions at both national and local levels in socio-cultural-economic factors.

The future panorama for livestock and investment-dependent improvements in grazing systems is decidedly cloudy. Profits margins have shrunk and there is little national or international support for activities that are perceived as environmentally destructive and inefficient in terms of employment generation and resource use. Moreover, low international prices are expected to continue, which will make it hard for low productivity grazing systems to compete for land and capital with other export orientated systems. In the absence of stimuli to adopt improved alternatives, many cattle producers are likely to continue the *status quo*, banking on the future appreciation in the value of land as it grows scarce. Such conditions may result in even lower levels of investment and may be expected to eventually lead to increased poverty and environmental degradation, especially on hillsides. At the national level, it needs to be asked whether these countries, amongst the poorest in the world, can afford such inefficiencies in labor, land and the use of their natural resources. On the other hand, significant numbers of farmers may want to change their production systems, but may not have the necessary institutional support, capital or knowledge to successfully establish new and unfamiliar alternatives. In their case, the outlook for farm livelihood and the environment is equally grim.

Alternatives to current pasture and livestock management, and the means for ensuring their successful adoption, are needed. Obviously, these alternatives must fill, at least partially, the biophysical and socioeconomic niche occupied by cattle in current farming systems while reducing environmental degradation and improving farm productivity and/or profitability. Key questions are: how can grazing systems be changed in order to avoid their negative effects (e.g. soil degradation), and at the same time increase and diversify farm productivity? What are the technical problems involved in achieving these changes? How might these changes be accomplished in ways that are economically and socially acceptable? What economic, ecological or institutional changes or incentives will induce technological or institutional innovation and investment in the resource base?

A first step in designing and implementing a program aimed at pasture reconversion is to gather better regional scale information on current forms of land use, especially pasture area, and how those uses or resource states change over time. Analyses of the quantities and states of grazing areas, based on a combination of satellite imagery, ground truthing and GIS techniques, will improve diagnoses, help plan and target technology development and dissemination activities, and facilitate impact assessment.

Generation and dissemination of technologies and information, driven by farmer needs and demand, should focus on: identifying agroecological constraints or specific information needs in each zone; developing or adapting appropriate technologies to local conditions; increasing farmer and decision maker awareness of the economic and ecological values of potential alternatives (e.g. secondary forest management); augmenting the technical and managerial proficiency of farmers or farmer groups to enable them to put those alternatives into practice; and overcoming the lack of ecologically appropriate knowledge or attitudes.

Potential alternatives should be suited to different levels of land, capital, or labor availability and agroecological conditions. Most promising are silvopastoral or agrosilvopastoral systems, which include cattle together with other productive activities, as well as systems based on perennial crops or secondary or plantation forest management in which the importance of cattle is reduced or even eliminated. Given the characteristics of most small and medium-sized farming systems, such alternatives should have low labor and capital requirements, low risk and relatively short periods of return. However, since perennial crops and timber trees often require relatively large capital investments and/or a relatively long time to yield their benefits, a major challenge is how they can be introduced into actual farming systems with the above limitations.

Silvopastoral or agrosilvopastoral systems in which cattle and pastures are combined with trees, shrubs and other crops, may have the greatest probability of adoption. They represent the least amount of change from current grazing systems and offer the greatest probability of ensuring income and cash flow during the phase of tree establishment. More intensively managed, more productive pastures can free land and produce capital needed for investment in other alternatives including forest management, without jeopardizing farmer income. Three broad research lines for developing silvopastoral systems include pasture improvement, tree or perennial crop selection and management, and interactions of trees with annual crops or pastures. The identification of actual research themes within these areas should be based on a process of diagnosis and evaluation that includes the full and active participation of relevant stakeholders.

Perennial crops have many of the same niche requirements of current pasture-based grazing systems and may be more profitable than the latter. They may help diversify income, add value per unit land, improve cash flow and reduce risk. However, they may be more demanding in terms of: initial investment, maintenance and labor; payback periods may well be longer than for cattle; and flexibility in product output and ease of liquidation are often reduced, and market risk may be high.

The management of secondary forests or tree plantations may be attractive alternatives to grazing systems when large quantities of land are found in semi- or completely abandoned pastures, or when government incentives for reforestation or secondary forest management or conservation exist. Large areas of young secondary forests in abandoned pasture, such as those in Nicaragua, represent an opportunity to redirect farmer development pathways towards more sustainable options. These systems are more attractive when incentives are paid for CO_2 fixation and biodiversity conservation. As a low cost strategy, the establishment or enrichment of such forests should rely on the manipulation of ecological processes. Key questions needing answers are related to how beneficial ecological processes already underway can be amplified or channeled in order to increase the economic output of valuable fruits, timber, firewood, medicinal plants, secondary forest products or forages, thus effectively converting these lands into productive agroforests.

In extensive areas of degraded pastures where potential seed sources are distant, secondary successional processes may be too slow for many small and medium farmers to consider. Under these conditions plantation establishment may be viable but it requires relatively high establishment and maintenance costs without a rapid return on the investment. Interplanting trees and crops in a taungya system can reduce these costs. Screening of existing data bases (e.g. MIRA in CATIE) related to tree performance, and analysis of national and international timber markets, should be essential steps in the process of formulating species recommendations. Low cost management techniques relying on locally available resources (e.g. the use of animals for weed control) also need to be identified and tested. Promoting participation in government incentive programs for reforestation or secondary forest management or conservation can also reduce farmer costs.

In order to increase the effectiveness and leverage of limited national resources and donor funds, programs of technology generation and transfer should focus on the strengthening of community and farmer capacity. Farmer capacity to develop and implement the above mentioned alternatives can be increased, and technology transfer costs reduced, by emphasizing participatory techniques such as farmer observation and experimentation, farmer-to-farmer training, or the formation of local para-technicians with appropriate backstopping provided by research or training entities. The project should also build upon the experience and activities possessed by projects, programs and organizations already active in these areas.

Many aspects of the technology generation and dissemination should include greater attention to the socioeconomic processes associated with farmer decision making. Programmes should attempt to: take into account farmer decision making related to natural resource use and pasture degradation; clarify the constraints to adoption of alternative systems in specific circumstances; incorporate the environmental and socioeconomic costs and benefits associated with pasture land degradation and alternatives to grazing; and quantify their impact. At larger scales, an increasing focus on national and international markets creates a need for more forward-looking analyses of current and projected markets and more sophisticated market support for products originating in alternative systems (e.g. projection of demand; information on product norms or standards and processing techniques). The results from such market intelligence systems need to be made easily available to decision makers and farmers.

Private sector institutions, such as NGO's and producer organizations, are likely to play an increasingly important role, both in the generation and dissemination of information and technology as well as in assuring the availability of germplasm, inputs and credit which will be needed to promote alternative production systems. However, the organization and administration of these institutions, especially community and producer organizations, needs to be strengthened in order to increase technical and administrative capacity and to gain commercial leverage. Changes or strengthening of public institutions may also be needed to improve systems of generation and dissemination of technical or market information, improve transportation or commercial infrastructure, or offer financial incentives to stimulate the establishment and adoption of new technologies.

Finally, given the exogenous nature of many of the factors which exert control on grazing systems or their alternatives, changes in policies related to land tenure, commercial chains, credit, financial incentives for certain crops or types of land use, and greater coordination among state and private sectors should be encouraged. Although more specific in-depth policy analysis is needed for each region, such policies should establish a general framework that stimulates improved profitability, more efficient use of resources and capacity strengthening of producers, rather than result in specific regulations, price supports, quotas, etc.

Given the quantity and geographic distribution of degraded pasture in the regions studied, and the limited resources available to attack the problem, prioritization of areas and farmers within each region becomes necessary. Programs targeting the generation and dissemination of information and technology should initially focus on farms with about 35-150 ha. These farms account for a large proportion of the pastures and cattle in the regions studied. Moreover, their owners are likely to have a sufficient level of resources to be able to invest in alternatives without jeopardizing family well-being. Systems targeted for change should include those that are most common; i.e. diversified farms with dual purpose cattle and extensive grazing systems oriented to dual purpose cattle or cattle development.

High priority target areas should include the Muy Muy - Waslala - Rio Blanco triangle in central Nicaragua; the Las Pozas - Sayaxché - Las Cruces axis and the Lake Petén - Melchor - Dolores triangle in the Petén, Guatemala; and small diversified farms on the hillsides of the coastal plain and inland valleys and medium-sized farms with extensively grazed pastures in the Aguán valley in the department of Colón in northern Honduras.

Key partners are likely to include government research and extension institutions, local universities or research institutions (e.g. the CIAT Hillsides Program in northern Honduras and Nitlapán in central Nicaragua) and local NGO´s or projects such as the Broadleaf Forest Development Project in northern Honduras or the BMZ-GTZ assisted projects in the Petén.

CHAPTER 1. Introduction

Deforestation and pasture expansion

Almost two decades have past since attention was drawn to the linkage between the expansion of Latin America's pastures and the loss of its tropical forests *via* the so-called 'hamburger connection' (Myers, 1981). Although the causes of widespread deforestation were much more complex than originally made out, and differed greatly among regions (Browder, 1988), it is clear that cattle and pastures replaced large amounts of tropical forest during the decades of the 60s, 70s and 80s, especially in Central America (Tables 1 and 2).

Table 1. Cattle populations in Central America (millions of heads).

Country	Year								
	1950	1963	1970	1978	1984	1986	1992	1995	1997
Nicaragua	1,1	1,3	2,2	2,8	--	1,6	2,2	2,6	2,65
Guatemala	1,0	--	1,7	2,1	--	--	2,2	2,1	--
Honduras	0,9	--	1,2	1,8	2,7	--	2,1	--	--

Source: Kaimowitz (1996), Cajina (1996), MAG (1998a), MAGA (1997), IICA (1994), AFE-COHDEFOR (1994); ---- = NA..

Overall, expansion of the cattle industry, however, came largely to a halt in the mid-1980's (Tables 1 and 2). Decreases in world prices for beef and milk, pressure from environmental groups, withdrawal of agricultural subsidies and credit, increased foreign competition, civil wars or rural violence, reductions in buying power and internal demand of Central American consumers, and changes in dietary preferences at the domestic and international levels served as disincentives to the continued growth of pasture lands and cattle herds (Kaimowitz, 1996). However, such seeming stagnation masks rather large geographic shifts of cattle, from drier areas with good soils on the Pacific coast to less populated humid rainforest areas with more fragile, and sometimes poorer soils, thus continuing a process begun decades earlier (Table 3). These changes have been driven by a variety of forces: competition for fertile lands from more profitable export crops, demographic expansion and migration of resource-poor farmers to less populated areas, greater availability of low-priced land in high rainfall zones, decrease in productivity of existing pastures and land speculation (Kaimowitz, 1996).

Table 2. Pasture area in Central America (millions of ha).

Country	Year								
	1950	1963	1970	1978	1983	1986	1991	1995	1997
Nicaragua	0,8	1,8	2,3	3,4	4,0	2,7	2,7	3,8	4,2
Guatemala	0,8	--	1,0	1,1	1,3	--	1,4	1,3	--
Honduras	0,8	--	1,2	1,3	1,6	--	1,5	--	--

Source: Kaimowitz (1996), Cajina (1996), MAG (1998a), MAGA (1997), ---- = NA

Table 3. Geographical location (provinces) of cattle expansion (1950-1993) in Nicaragua, Guatemala and Honduras.

Country	Period		
	1950s	1960s/1970s	1980s/1990s
Nicaragua	Matagalpa Nueva Segovia	Chontales Jinotega Matagalpa Nueva Guinea Rio San Juan	Jinotega Zelaya
Guatemala	Escuintla Jutiapa Santa Rosa	Alta Verapaz Chiquimula Izabál Quiché Petén Zacapa	Petén Izabál
Honduras	Copán Cortés El Paraíso Olancho Sta. Bárbara	Atlántida Colón Choluteca El Paraíso Olancho Yoro	Colón El Paraíso Olancho Yoro

Source: (Kaimowitz, 1996)

These geographical changes in grazing areas have raised a great deal of concern related to the loss of biodiversity and the increased susceptibility of lands with high rainfall, soil chemical limitations and steep slopes to degradation caused by grazing (Kaimowitz, 1996). Indeed, this concern is so prevalent that one is hard put to find a document related to cattle grazing, forest conversion or natural resource use in Central America that fails to mention degradation caused by cattle.

Does widespread degradation in humid areas due to cattle really exist? If so, what are its causes, where is it concentrated and which areas are most at risk? What is the general status of cattle raising in these regions? Do suitable alternatives to present systems of cattle and pasture management exist and what sorts of opportunities exist for implementing them?

This study attempts to answer or to at least provide information germane to such questions. Given the breadth of cattle raising in Central America and the limited resources available for this study, our fact-finding activities concentrated on the humid areas of central Nicaragua, the Petén of Guatemala and the Atlantic coast of Honduras. These regions are considered by most local and international experts to be 'hotspots' of cattle raising in humid areas of Central America.

Methods

There are few published up-to-date reports on the status of the cattle industry at the national or regional levels for the above-mentioned countries, and even less information on the status of pastures or soils under grazing. Consequently, the following analysis is a rough approximation of the present status of cattle raising in the regions mentioned and the actual or potential levels of degradation associated with this activity. It is based largely on interviews of local academicians; government functionaries, technicians and field personnel; international experts and scientists; staff and field personnel of NGO's and internationally funded development projects; and representatives of livestock associations. Reviews of government statistics, project documents, agricultural surveys, and international reports and publications complemented the interviews.

Among published documents, Kaimowitz (1996) has produced an excellent policy study of deforestation and livestock in Central America that serves as a guiding principle for this manuscript. Detailed information about cattle grazing in Nicaragua can be found in the diagnostic survey of agricultural production in the interior of the country (Nitlapán, 1995), the study of farmer typologies (Maldidier and Marchetti, 1996), the analysis of livestock production (Cajina, 1996), the current plan for the national livestock program (MAG, 1998b), the institutional and legal analysis of the livestock sector (Arguello Salinas, 1996) and the political framework for the 1998-1999 agricultural cycle (MAG, 1998a).

Less baseline documentation exists for Guatemala and Honduras. In Guatemala, the analyses of the livestock sector by IICA (1994) and Vargas (1998), results of the National Agricultural Survey (MAGA, 1997), the diagnosis of the Petén (SEGEPLAN, 1993) and changes in land use (CONAP *et al.*, 1996) are valuable reference materials. For Honduras, there are almost no studies of farm characterization at the regional level, technological level, or market orientation, nor analyses of decision-making of livestock producers (Pomareda *et al.*, 1997). Nevertheless, relevant information can be found in the diagnosis of the livestock sector (Pomareda *et al.*, 1997), analysis of natural resource use on hillsides (Humphries, 1996), the current policy in the agricultural sector (SAG, 1998), the proposal for the diver-

sification of cattle ranches on the Atlantic coast (Matute, 1998) and the analysis of the legal framework affecting forests and other natural resources (AFE-COHDEFOR, 1994).

Finally, the sections on processes of degradation and alternatives owe much to the proceedings of meetings on the establishment and renovation of pastures (Lascano and Spain, 1991) and livestock and natural resources in Central America (Homan, 1994); the study of the economics and adoption of agroforestry in Central America (Current *et al.*, 1995); and a series of papers outlining a framework for the analysis of natural resource use in Honduras (Scherr and Hazell, 1994; Scherr *et al.*, 1996; Pender *et al.*, 1998).

Outline of this document

In the following Chapter, we present a brief history of cattle raising and its importance in each of the individual regions, discuss forms and processes of degradation, and attempt to estimate the area of degraded pastures in each of the regions (Chapter 2). In Chapter 3, we describe the main ecological and socioeconomic characteristics of predominant cattle-based systems and their management and their consequences for degradation. Since cattle-based systems are largely similar in the three regions, we prefer to present a general overview of cattle and pasture management, at the same time drawing attention to what we consider to be significant variants or differences among regions. In Chapter 4, we then consider various alternatives to grazing, outline the needs of a program for generating and disseminating alternative forms of land use, and attempt to identify target areas and groups and potential partners. Finally, in the Annexes we present additional information related to the legal and institutional framework affecting cattle and pasture management in each country.

We hope: 1) that this document will provide scientists, NGO personnel, decision makers, institutional representatives and donors with a better understanding of the extent and nature of pasture degradation in humid Central America and what can be done to reduce or mitigate such damage; 2) to identify critical areas where further information or action is needed; and 3) stimulate further analysis and the development, validation and promotion, together with rural communities, of socio-economicaly and ecologically sustainable alternatives to present forms of pasture and animal management.

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CHAPTER 2. Importance of cattle and land degradation in humid Central America

Historical Importance of Livestock at the National Level

The government supported land settlement schemes, land speculation, easy credit, and growth (Table 2) and shifts in human populations resulted in a major expansion of cattle (Table 1) and pasture land in Central America during the three decades prior to 1980. Since the 1980s, however, cattle populations and pasture area have stagnated or decreased in Honduras and Guatemala. In these countries, loss of access to the US market and declining *per capita* income of national consumers, especially, led to decreases in milk and beef demand and production for international and national markets and a concomitant decrease in the contribution of these commodities to national agricultural production. These commodities represent currently about 12% of agricultural production in Honduras (Pomareda *et al.*, 1997) and about 15% in Guatemala (Vargas, 1998).

Nicaragua also suffered a large decrease in cattle production during the 1980s. The civil war which lead to violence and insecurity in rural areas, low prices paid for beef, the sale of breeding stock to neighbouring countries, and expropriation of large farms (Kaimowitz, 1996; Nitlapán, 1995) led to the decimation of cattle herds and abandonment of grazing lands. By the early 1990s, abandoned pastures had reverted to approximately 1,1 million ha of 'scrub forest' in dry zones and 900 000 ha of forest fallow in humid areas (INTECFOR, 1993). In contrast to Honduras and Guatemala, however, the arrival of peace and favorable export markets for milk and milk products, especially to El Salvador, stimulated the recolonization of these abandoned areas and the conversion of new areas of forest in the eastern humid lowlands to pasture. Nevertheless, large areas of abandoned pastures (1,3 million ha) have yet to be reclaimed and active pastures are of low productivity, since current stocking rates (<0,75 animals ha^{-1}) are still lower than traditional levels (approximately 0,9 animals ha^{-1}). Similarly, exports of cattle-based products have increased tremendously since 1992, but have attain levels reached in the late-1970"s (Cajina, 1996). Currently cattle contribute about 20% of Nicaragua´s agricultural production (Cajina, 1996; MAG, 1998a).

The three regions targeted in this study, the central region of Nicaragua, the Petén of Guatemala, and the northern coast of Honduras, all make major contributions to the cattle sector in their individual countries. A description of these regions, the importance of cattle in each, and estimates of land degradation are given in the following sections.

The Central Region of Nicaragua and the importance of Cattle

The central region of Nicaragua, comprised of the departments of Estelí, Nueva Segovia, Madriz, Matagalpa, Jinotega, Boaco, and Chontales, is the main cattle raising region of Nicaragua (Nitlapan, 1995) (Figure 1). The central region is climatically and topographically diverse. Annual rainfall increases in an easterly direction, ranging from less than 1 000 mm in the west to 3 000 mm or more in the east. Elevations decrease in a southeasterly direction and towards the plains surrounding Lake Nicaragua, from 1 500 m above sea level (masl) to less than 200 masl.

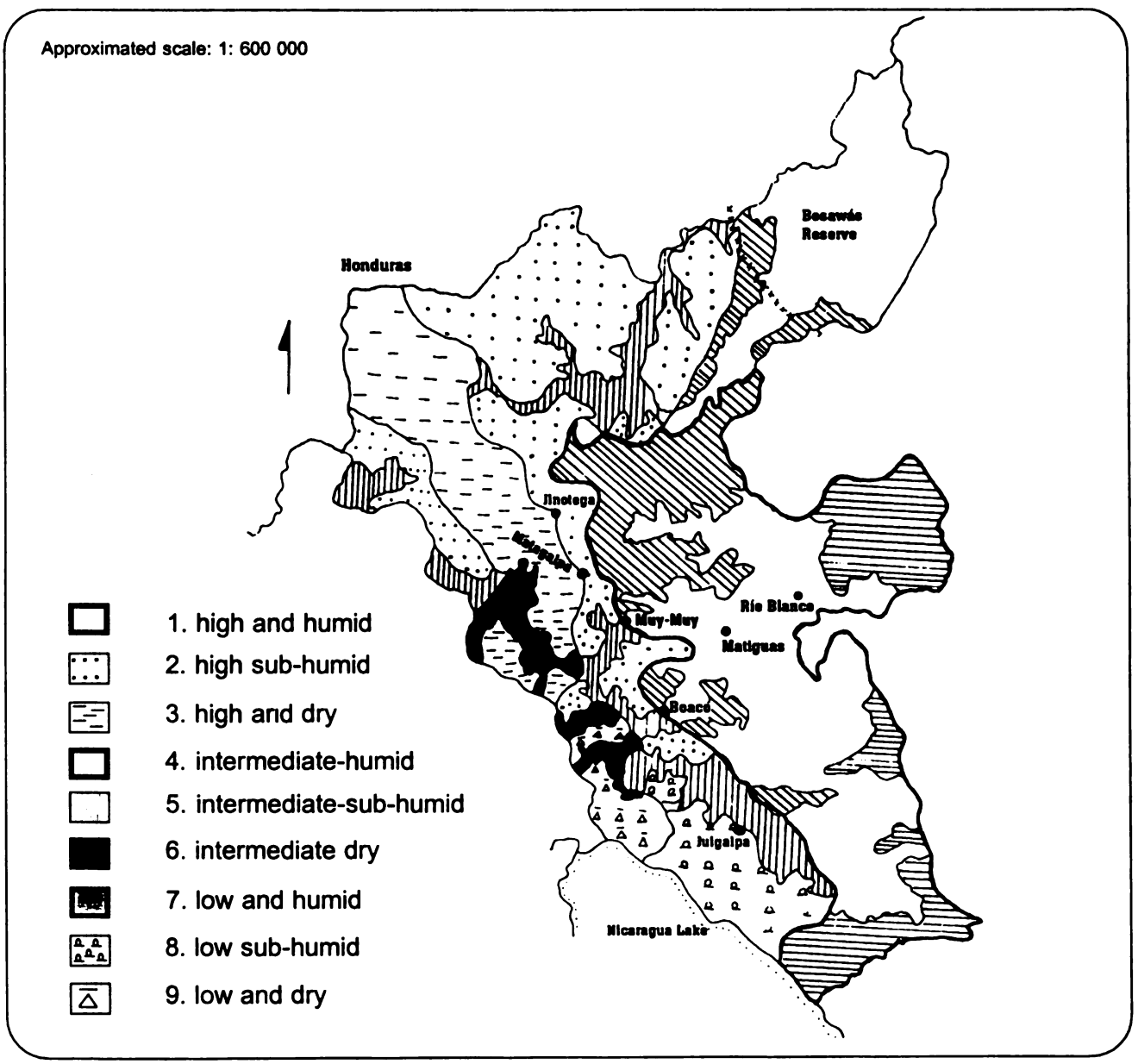

Figure 1. The central region of Nicaragua.

In the north, fertile soils (rendzinas = mollisols, eutric cambisols = inceptisols and entisols, and luvisols = alfisols) are mixed with shallow lithosols or acidic, infertile dystric nitosols (alfisols and ultisols), cambisols (dystropepts) and orthic acrisols (ultisols). In higher rainfall areas and lower topographic positions to the southeast, the predominant soils are humic acrisols (humults) (Maldidier and Marchetti, 1996; Vázquez-Morera, 1999). The acid soils (ultisols) are characterised by low available P and this has been identified as one of the factors associated with pasture degradation (Toledo, 1994).

Agroecologically, the region can be divided into the highlands (500 to 1 500 masl, 1 200 mm or more annual rainfall), inter-montane valleys (200 to 500 masl, 1 000 to 1 600 mm annual rainfall), the humid hills and lowlands (< 500 masl, > 1 600 mm annual rainfall) and the dry zones (< 1 000 mm annual rainfall) (Nitlapán, 1995). The western part of the region, opened up to agricultural production more than 50 years ago, is characterized by large coffee or cattle farms (*latifundios*). The more humid eastern area was settled between 30 and 50 years ago and tends to be dominated by small and medium-sized coffee and cattle farmers in the north, and medium and large cattle producers in the south (Maldidier and Marchetti, 1996).

The importance of cattle in central Nicaragua

In 1994 approximately 1,2 - 1,5 million head of cattle grazed about 60%, or 1,4 million ha, of land on 24 000 farms in this region (Nitlapán, 1995). However, such numbers must be treated cautiously due to difficulties in estimating pasture area and cattle populations caused by seasonal movements of cattle between humid and dry areas and the recent expansion of the cattle industry. Between 1992 and 1995, approximately 130 000 ha of new pasture were put into production in the region, and 240 000 ha of abandoned pasture were recovered (Nitlapán, 1995). Most (approximately one million head) of the cattle in the region are found in the departments of Boaco, Chontales and Matagalpa; they account for 40% of the national herd (INTA, 1997).

The characteristics of cattle farms in the central region of Nicaragua by agroecological zone and farmer type is shown in table 4. Fifty-nine percent of farms are found in the Highland areas which accounts for 45% of the total area under cultivation whereas values of the lowland areas are 29,6 and 45%, respectively. According to Flores (1994), 37% of the cattle and 22% of the farms are found in the humid hills and lowlands where the average farm size is about 70 ha.

Small (< 35 ha) farms account for about 87% of the total farm area in the region. Medium-sized (35-140 ha) farms contain a relatively small proportion of the total number of farms (12%), but 36% of the farm area (Table 4) (Nitlapán, 1995). In the valleys and humid hills and lowlands, more than two-thirds of the farm area are in pastures, but the latter account for 85% to 90% of the cultivated area. The importance of pastures also increases with farm size: pastures account for about 30% of the total farm area in small farms, 60% in medium-sized farms and 75% in large farms. More than 90% of the cultivated area in medium and large farms is occupied by pasture, in small farms this percentage ranges between 37% and 70% (Nitlapán, 1995).

Medium-sized farmers are a key economic group since they manage a large share of the total cattle herd (43%, compared to 35% and 22% by large and small producers, respectively) and generate the majority of livestock-derived income in the region. Medium and small producers are responsible

for 47% and 32%, respectively, of the value of milk produced, whereas medium and large farmers produce 45% and 38% of the gross value of meat (INTA, 1997; Nitlapán, 1995). Medium and large producers tend to derive the majority of their income from animal and meat production, whereas milk and milk products are important income sources for smaller farmers (Nitlapán, 1995). The accessible highlands and the accessible lowlands each contribute about 20% to 25% of the gross value of milk and meat produced in the region. The non-accessible areas account for about 45 and 25% of the total value of meat and of milk production, respectively (Nitlapán, 1995).

Table 4. Characteristics of cattle farms in the central region of Nicaragua, by agroecological zone and farmer type.

Zone	Number of farmers	Number of ha ($x10^3$)	Pasture index	Capital ($/farmer)	Gross production ($/farmer/yr)	Gross livestock production ($/ha/yr)
Highlands, accessible	23 176	738	0,71	11 150	6 090	66
Highland, non-accessible	8 714	358	0,67	10 280	2 080	19
Valleys	5 910	229	0,86	14 770	3 510	93
Lowlands, accessible	5 876	412	0,89	22 790	4 660	67
Lowlands, non-accessible	10 020	685	0,89	19 440	4 010	76
Farm type	**Number of farmers**	**Number of ha ($x10^3$)**	**Pasture index**	**Capital ($/farmer)**	**Gross production ($/farmer/yr)**	**Gross livestock production ($/ha/yr)**
Small (<35ha)	56 450	1,19	0,37-0,70	5 750	2080	53-117
Medium (35-140 ha)	7 508	1,11	0,92	48 360	12 300	63
Large (>140 ha)	704	0,78	0,92-0,99	312 030	129 710	37

Source: Nitlapán, 1995.
Notes: data include all farmers, not just cattle producers. Pasture index = pasture area/combined area of pasture, crops and fallows.

The Petén

The Petén covers an area of approximately 35 800 km² of which more than half is within the Maya Biosphere Reserve (21 130 km²) in the north and scattered reserves in the south (Figure 2). The Petén's climate is classified as sub-tropical humid to very humid without a well-defined dry season. Rainfall varies between 1 200 and 3 000 mm annually and generally increases in a southerly direction (SEGEPLAN, 1993).

Three distinct landscapes can be identified: 1) the Lacandon fold, which dominates the northern half of the Petén, presents the roughest relief and is characterized by karst landscape where dissected plateau (150-650 masl) are separated by depressions, conic sinkholes and plains; 2) the interior low plains, found in the south, are the result of erosion and filling in of the karst landscape with slightly undulating relief and low elevation (less than 200 masl); and 3) the Maya Mountains which are found from Melchor south, along the frontier with Belize. In this latter region, there is an almost flat, intermontane pine savanna around Poptún; to the south, near San Luis, the topography is undulating with elevations between 160 and 300 masl; and to the north, the relief is very broken with elevations between 200 and 1 000 masl (De Koninck, 1987; SEGEPLAN, 1993).

Soils in the Petén can be divided into two large groups: those that are well drained and fertile, but often rocky, shallow or found on steep slopes, are principally rendzinas. Poorly drained heavy clay soils (vertisol, gleysols and cambisols) are found on the plains and depressions. They are fertile but are chiefly used for grazing because their high clay content and plasticity present physical problems for agriculture (De Koninck, 1987; SEGEPLAN, 1993). These heavy soils are also very susceptible to soil compaction (Alegre and Lara, 1991). Among the plains are 70 000 ha of savannas as well as alluvial soils along the rivers of the interior plains. The savannas are found between La Libertad to Santa Ana and include acidic cambisols and chromic luvisols, with eutric cambisols in poorly drained areas. The pine savannas of the Poptún plains are found on acidic well-drained sticky clays. The soils along the alluvial plains of the rivers of the interior plains are flooded periodically and are classified as either vertic cambisols, or gleysols and fluvisols, depending on the degree of drainage (De Koninck, 1987; SEGEPLAN, 1993).

The importance of cattle in the Petén

Cattle raising in the Mayan Biosphere Reserve is very limited and hence this area is not considered in this study. Cattle have played a major role in land settlement in the Petén. Cattle husbandry, albeit at relatively low (6 000 head) levels, has been the principal activity of the historic population centers in the central savannas of the Petén - Dolores, La Libertad, San Francisco and Santa Ana (Figure 2). However, with the creation by the military of the National Enterprise for Promotion and Development of the Petén (FYDEP) in 1959, and the opening of the main road to Guatemala City in 1969, human and cattle populations in other parts of the Petén began to increase rapidly. This increase was fueled by land pressure in other regions of Guatemala and land speculation (MAGA/GTZ, 1997; SEGEPLAN, 1993). Under these conditions, extensive cattle grazing became the cheapest way to control large areas of land while land prices appreciated (Kaimowitz, 1996).

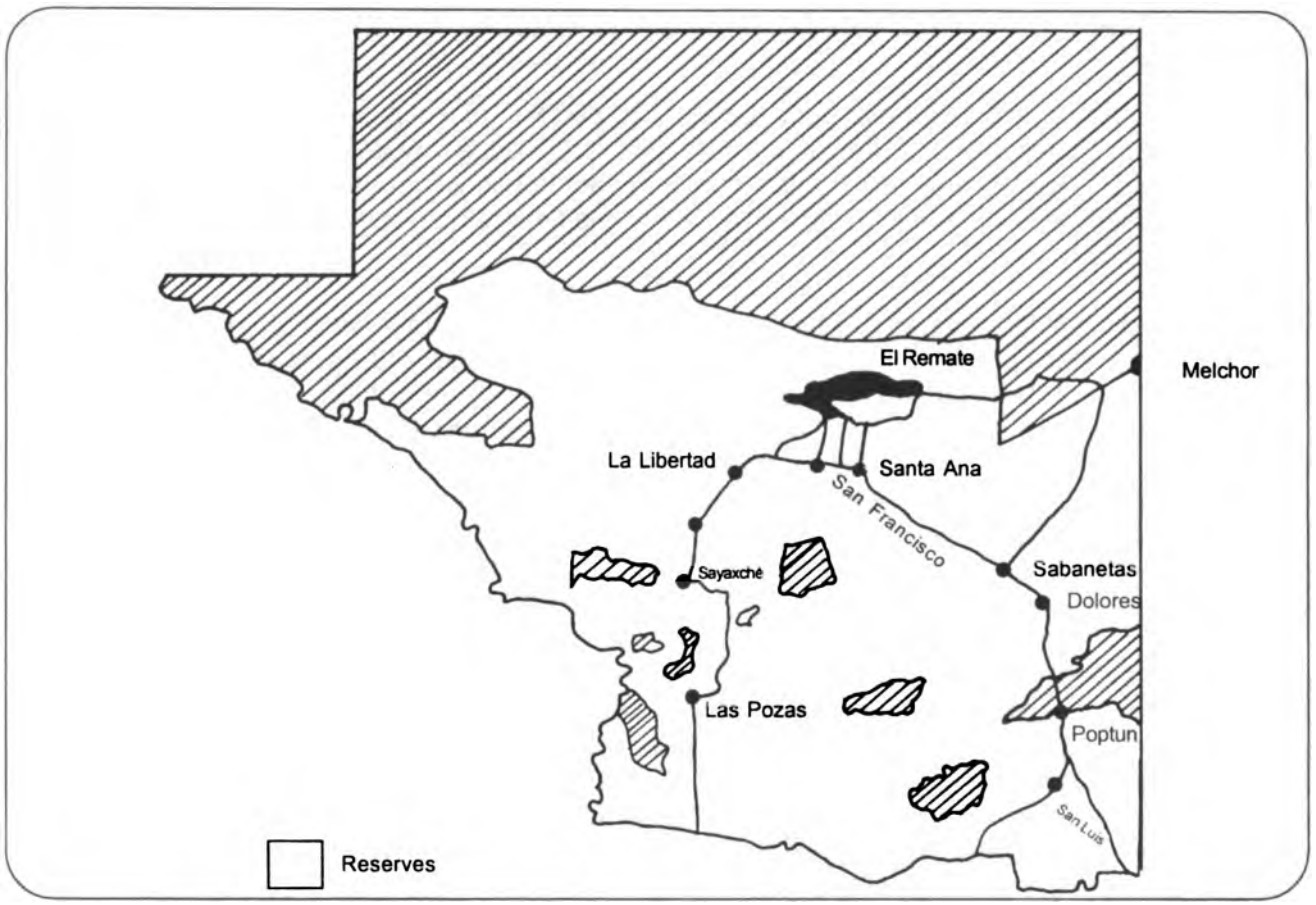

Figure 2. Biosphere reserves (shaded areas) and population centers in the Petén, Guatemala (De Koninck, 1987; MAGA/GTZ, 1997).

During this period, FYDEP parceled out annually 500 to 1000 concessions (*parcelamientos*) of between 45 to 675 ha each, the majority to persons from other regions of Guatemala who lacked ecologically appropriate knowledge for the sustained management of these lands. As part of its program, FYDEP promoted livestock development in four areas: the savannas of La Libertad; Las Cruces and the Rio Subín; the alluvial plain on the right bank of the Rio Pasión; and the alluvial valley of the Rio Mopán. Within these areas, La Libertad (58 000 ha allotted with an average farm size of 550 ha), Salsipuedes/Mopán/Chiquibul (average farm size 191 ha), San Luis (average size 278 ha), Sayaxché (average size 160 ha) and El Cambio (average size 518 ha) are areas notable for large allotments (SEGEPLAN, 1993).

As a result of FYDEP's activities and immigration to the Petén, between 1972 and 1993 the area in pasture grew at an annual rate of 6,4%. In 1987, planted pastures covered about 152 000 ha, in addition to 45 000 ha in the savannas and 15 000 ha in pinelands; by 1996, pastures probably covered 225 000 to 300 000 ha or more, about 10% of the Petén (CONAP *et al.*, 1996; MAGA, 1994). Cattle populations increased from 74 178 (3.7% of the national herd) in 1979 to between 226 000 to 500 000 head (11% to 20% of the national herd) in 1996 (CONAP *et al.*, 1996; MAGA, 1994) (Figure 3). Despite widely different current estimates of herd size, it is clear that this change represents the greatest absolute and relative increase in cattle in any department of Guatemala.

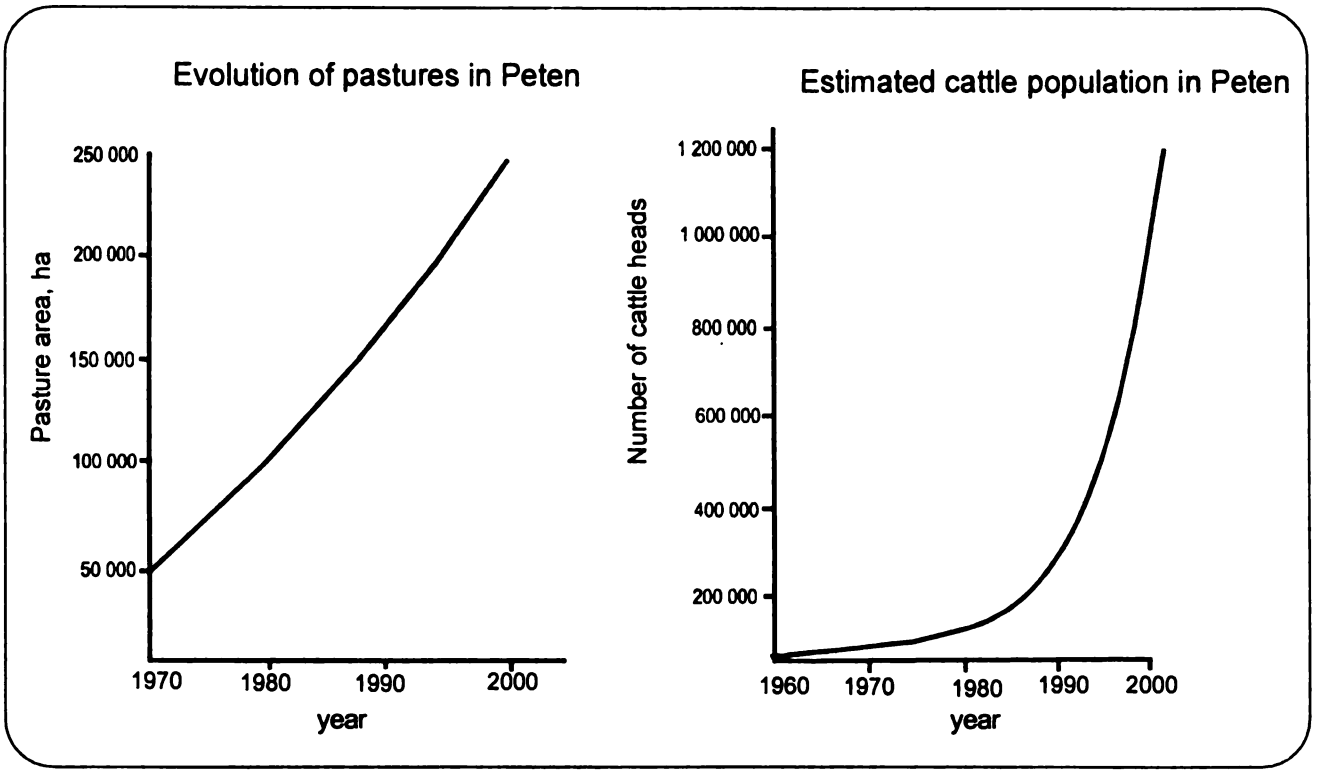

Figure 3. Changes in pasture area and cattle populations in the Petén, Guatemala (adapted from CONAP *et. al.*, 1996).

Within the Petén, the areas used for cattle grazing are generally the fertile, badly drained alluvial soils, the plains and the more acidic savannas. Slopes and areas of karst topography have smaller cattle populations since drainage is largely subterranean and surface water is scarce (SEGEPLAN, 1993). Since the principal limiting factors for agriculture (adequate drainage) and livestock (availability of superficial water) are very different there is little competition for land between these activities.

Cattle raising is most important in the following areas: the savannas of La Libertad, between the Lacandon fold and the alluvial plains of the Rio Pasión; the Sayaxché, San Luis and Dolores municipalities; and the alluvial plain east of the Mopán river mainly as a result of these areas' strategic location for trade with neighboring countries, their relatively long settlement history, FYDEP policies and agroecological conditions. Within these areas, cattle are concentrated in the traditional colonial centers in the savannas: around Lake Petén-Itzá; an area extending from the west of La Libertad to Santa Ana and Laguna Oquevix, including La Libertad, San Francisco and Santa Ana; the San Luis-Dolores axis; and an old area north of Sabaneta and Santo Toribio in the direction of Mango. Other newer grazing areas, corresponding to FYDEP livestock colonization schemes, include: the Mopán project, along the El Remate-Melchor and Melchor-Sabaneta highways; Las Cruces (around the town and near the highway); the Machaquilá project along the highway from Poptún to Triunfo; along the Santa Elena-El Remate highway, near Paxcamán; the Sayaxché-Las Pozas stretch of the Sayaxché-Cobán highway; near Petén-Itzá lake; the banks of the Pasión river; and the ejidos[1] of San Luis and Dolores (SEGEPLAN, 1993).

Cattle-related activities differ by zone. Cattle raising and fattening are important in the Sayaxché area, whereas in the savannas and other zones with less pasture and water, activities are more oriented to cattle raising only. The areas of San Luis and Melchor are intermediate to these two extremes. The Flores, San Jose, San Andres, Poptún and San Luis areas have a mixed vocation of agriculture-livestock. Farms oriented to milk production are mainly found in the municipalities of El Chal, San Luis, Melchor, and to a lesser degree, in La Libertad. Agroforestry or perennial crops occupy little land in the Petén (MAGA, 1994; SEGEPLAN, 1993).

At present, the majority of the cattle raised annually (60,000 to 100,000 head) are exported to other parts of Guatemala or to Mexico, with about 10% consumed locally. Annual meat production from the region probably has a value of more than $20 million; commercial milk production is insignificant in comparison (MAGA, 1994; SEGEPLAN, 1993).

Northern Honduras

The departments of Atlántida and Colon are the most important cattle areas in northern Honduras. This region is warm and humid with annual rainfall ranging between 1750 and 4000 mm on the coastal plains and mountains, but decreases to between 1200 and 1800 mm per year in the inland valleys that penetrate the inland mountain ranges. These valleys (1,242 and 2,353 km^2 in Atlantida and Colon, respectively; AFE-COHDEFOR, 1994) are potentially the most productive areas in northern Honduras.

Soils on the coast and alluvial plains have little to moderate slopes, fine to medium or sandy texture on old beaches, and can be fertile (alfisols) or relatively deep and acidic (ultisols). On the hillsides, where the majority of the slopes exceed 30%, the soils are shallow and acidic. Soils in the valleys are mainly fine fluvisols (mollisols); nitosols (typic tropohumults) are found on the lower slopes and lithosols, nitosols and cambisols (inceptisols) on the mid and upper slopes (FAO, 1977; Váques-Morera, 1999).

The importance of cattle in northern Honduras

Atlántida and Colón account for 13% of the national cattle herd and 11% of the national area in pasture (Matute, 1998) (Table 6). As a result of agrarian reform, timber extraction, road construction, agricultural and livestock activities, and the inability of COHDEFOR to regulate the occupation of national forest lands, these departments lost over 70% of their forest cover between 1962 and 1990 (AFE-COHDEFOR, 1994; Humphries, 1996; Matute, 1998). A large percentage of deforested land is now under extensive pasture.

Within these departments, the principal regions for livestock activities are the coastal plain and the Lean valley in the department of Atlántida, and the Aguán valley in the departments of Colón and Yoro (Figure 4) (Pomareda *et al.*, 1997). Atlántida and Colón are nationally important for beef production since they generate about $8 million annually (Matute, 1998). These departments also produce

[1] Commonly managed by people.

23% of national milk production and supply the greater part of the milk to the "controlled milk circuit" where milk is collected along well-defined routes by two large processing plants that distribute 60% of the pasteurized milk in the country. Milk production generates about $33 million annually and generates more than 20 000 jobs (Matute, 1998).

Table 6. Cattle farms, pasture land, cattle and annual milk production in the northern region of Honduras and at the national level.

	Farms		Pasture land		Animals		Milk production	
Region	**Number**	**%**	**10^6 ha**	**%**	**Number 10^6**	**%**	**1000 liters/day**	**%**
Atlantida and Colón	8 344	8	0,17	11	0,27	13	300	23
National Total	99 911	100	1,53	100	2,08	100	1300	100

Source: National Agricultural Census, 1993; Matute, 1998.

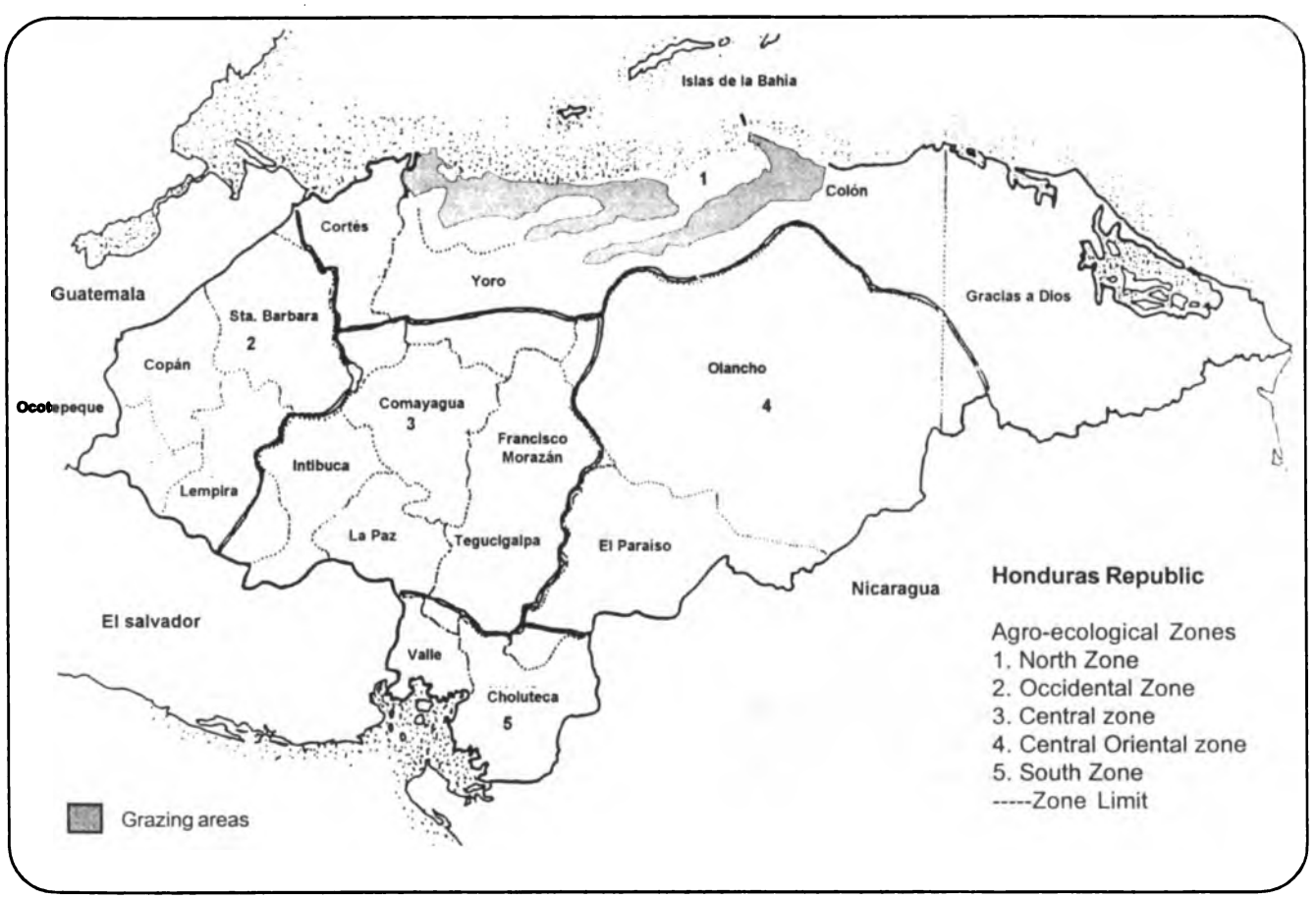

Figure 4. Principal cattle raising regions of northern Honduras (Pomareda *et al.*, 1997).

Pasture degradation

It is important to define pasture degradation before attempting an analysis of the total area of degraded pastures in the target areas.

Pasture degradation can be defined as a negative change in pasture condition, associated with negative ecological and environmental changes, or simply as a decrease in pasture quality leading to a reduction in animal productivity.

Pasture condition (quality) is the sum of various parameters (e.g. botanical composition, vegetational cover) in relation to an economic and environmental optimum. Degradation can be a reduction in vegetational cover or soil fertility, the loss of desirable or the invasion of undesirable species.

The economic optimum of most agricultural landuse systems in market economies is highest with monocultural agriculture with optimal inputs of fertilizers, crop protection and management. However, this is not true for extensive pastoral landuse, nor in terms of environmental or ecological consequences. The ecologically optimal pasture condition is a botanical composition consisting of many species (natural and improved species), combined with other forms of biodiversity (e.g. trees, soil fauna, birds and wild animals). However this will be at the cost of short-term animal productivity, and the profitability of livestock farms will depend on trade-offs between a loss in animal production and additional benefits from biodiversity etc. including subsidies that society and/or the consumer is willing to pay.

Perhaps the most common proximate causes of pasture land degradation are over-grazing and frequent burning, which lead to soil compaction, nutrient and organic matter loss, reduced nutrient availability (especially N and P) and a diminished capacity to transport and retain water in the soil profile. These processes reduce pasture growth and the capacity of forage species to recover from grazing, and eventually lead to decreased pasture persistence, loss of soil cover, increased erosion, increased susceptibility to pests and diseases, and the colonization of the pasture by oftentimes unproductive weeds or trees which are better adapted to marginal soil conditions (NAS, 1992; Serrao, *et al.*, 1979; Toledo and Morales, 1979) (Figure 5).

Paradoxically, another less-recognized cause of pasture degradation is that caused by underuse. Where stocking rates are insufficient or pastures are unused for long periods of time, pasture species may become less palatable and nutritious and may also allow the invasion of unpalatable weeds, shrubs or trees that can replace more desirable forages. However, under these conditions land quality should be maintained and pasture productivity can be restored with improved management.

The various stages of pasture degradation can be classified based on readily observable properties of the pasture (Table 7). The classification includes both qualitative (type of degradation) as well as quantitative (degree of loss of productivity) characteristics, but is more applicable to the processes of pasture degradation caused by over-grazing.

Table 7. Characteristics of pasture degradation caused by over grazing.

		Degradation	
Stage	**Characteristics**	**Loss of productivity (%)**	**Level**
1	Loss of height, volume and quality of pasture	< 25	Slight
2	1 + reduced soil cover and appearance of new plants	25-50	Moderate
3	2 + presence of broad-leaved weeds and beginning of erosion	50-75	Strong
4	3 + increase of weeds, erosion and loss of soil cover	> 75	Very strong

Adapted from Spain and Gualdrón, 1991

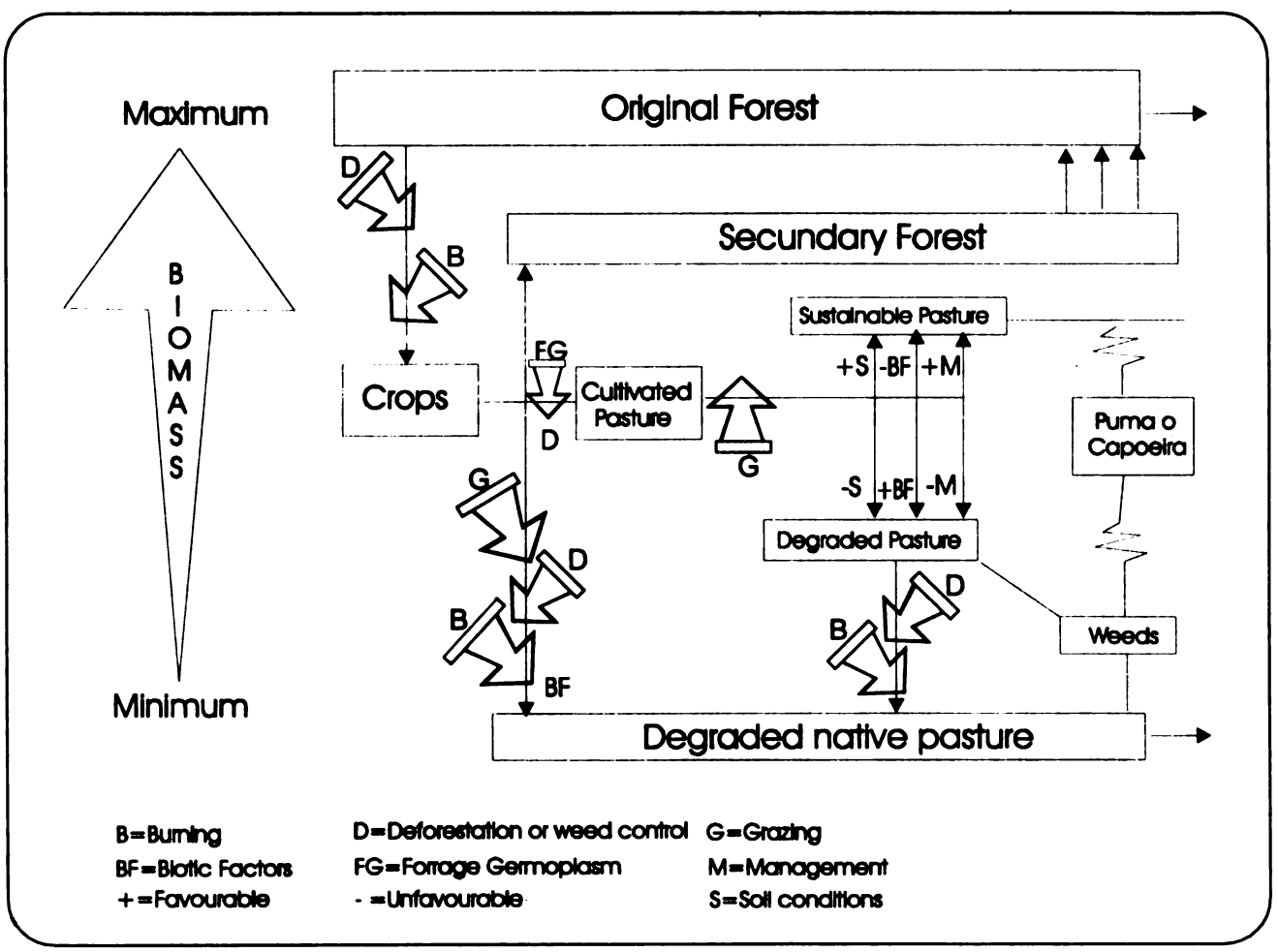

Figure 5. Vegetation dynamics in humid tropical pastures (adapted from Toledo, 1994).

Methods to estimate pasture degradation

For various reasons, the definition and quantification of pasture degradation in Central America is difficult: 1) maps of actual land use are often out of date and there is little information on the amount of degraded pasture, or pasture in general, in the targeted regions; 2) there is a paucity of published data, at either the local or regional scales, regarding soil or vegetation properties, such as pasture composition, soil compaction or amount of bare soil, which can serve as indicators of the degree of land degradation associated with cattle; 3) there are few studies of how such properties or degradation evolve with time under grazing management for the areas of interest; and 4) compounding the problem of the absence of data, the term 'degradation' itself is ill-defined, leading to the use of different definitions (compacted or eroded soils, pastures of low productivity, or those invaded by weeds, shrubs and bushes) by different people. This confusion is due, in part, to the complexity of the processes resulting in pasture degradation described above.

Due to the lack of data, we developed a number of crude estimates of pasture degradation in Central America. Proceeding from the general to the more specific, these methods included: 1) the application of large-scale estimates of percentage pasture degradation to current pasture area in each region; 2) a method in which we assumed that 50% of the pastures present in the early 1990's are now degraded as a result of grazing in fragile sites, inadequate input use and management during long periods of time; 3) for each region, a comparison of average stocking rates and those under better (e.g. that practiced by small farmers), but not optimal, management may be indicative of reductions in productivity due to degradation; and 4) comparisons of maps, for the most part at large scales, of actual and potential land use in order to identify lands where grazing is in conflict with appropriate land use and hence degradation is more probable. Due to the uncertainty, errors, or limited coverage associated with these methods, all estimates should be treated cautiously.

Literature values for pasture degradation

Estimated rates of pasture degradation found in the scientific literature were applied to the estimates of pasture land cited previously in order to estimate the amount of degraded pasture in each region. This method entails two major assumptions. First, that values for degradation in the literature are comparable to those in the regions discussed in this report. Secondly, that the area of pastures in each region are well quantified. On both counts, there is a large degree of uncertainty.

At the global level, losses of pasture productivity have been estimated at 4% (Oldeman, 1998). In Central America, degradation of pasture or soil under pasture, or reductions in pasture productivity, have been estimated at between 3% and 60% (Kaimowitz, 1996; Oldeman, 1998; Scherr, 1998). Moreover, there is a high degree of uncertainty associated with the amount of land presently under pasture due to recent processes of pasture abandonment and partial recovery, seasonal use of grazing land, and the lack of periodic and reliable monitoring of land use. Application of a degradation rate of 30% to present estimates of pasture land (1,4 million ha in central Nicaragua, 300 000 ha in northern Honduras, and 225 000 ha in the Petén), suggests that there are 67 000 ha of degraded pasture in the Petén; 90 000 in northern Honduras, and 420 000 ha in Central Nicaragua (Table 8).

Table 8. Estimates of area (ha) of degraded pastures in central Nicaragua, northern Honduras and the Petén, Guatemala.

		Area of degraded pasture (ha)			
Method	**Degradation rate**	**Central Nicaragua**	**Northern Honduras**	**Petén Guatemala**	**Total**
Regional estimates from literature	30%	420 000	90 000	67 000	577 000
"Old" pastures	50%	700 000	80 000	85 000	865 000
Differences between average stocking rates and those under better management.	Variable (shown in parentheses for each region)	490 000 (35%)	170 000 (57%)	140 000 (63%)	800 000
Pastures present on inappropriate land.	N/A	600 000 - 700 000	NA	170 000	> 770 000 - 870 000

Additionally for the Petén, we used a dynamic model developed by Toledo and Morales (1979) to estimate that more than 50% of pastures (100 000 ha) have suffered moderate and strong degradation (Table 9). Pastures in savanna ecosystems were not included in the estimates because these are more sustainable although they result in low animal productivity. Estimates were not made for Nicaragua and Honduras because of inadequate data.

Table 9. Area of degraded pastures in the Petén, Guatemala according to the degree of degradation

Degree of degradation	**Area (ha)***	**(%)**
* Undegraded	9 500	5,8
Slight	48 100	29,6
Moderate	63 000	38,7
Strong	42 000	25,8
Total	162 600	100

*Pasture area for 1996; area under savanna ecosystems not included (Description of degradation level shown in Table 7).

Old pastures are apt to be degraded

This method assumes that with little or no inputs, or management, pasture productivity, and especially that of improved species, will decline greatly within five to eight years after establishment (Kaimowitz, 1996; SEGEPLAN, 1993). Since inputs and management are deficient in all three regions, we assume that 50% of the pasture present in the early 1990s (about 170 000 ha in the Petén, 1,4 million ha in central Nicaragua and 160 000 ha in northern Honduras) will be degraded. This suggests that there are about 85 000 ha of degraded pasture in the Petén, 700 000 ha in Nicaragua and 80 000 ha in northern Honduras. The estimate of percentage degradation in central Nicaragua is similar to values reported by Kaimowitz (1996). Furthermore, an additional 120 000 ha of more recently established pasture in the regions may be undergoing degradation.

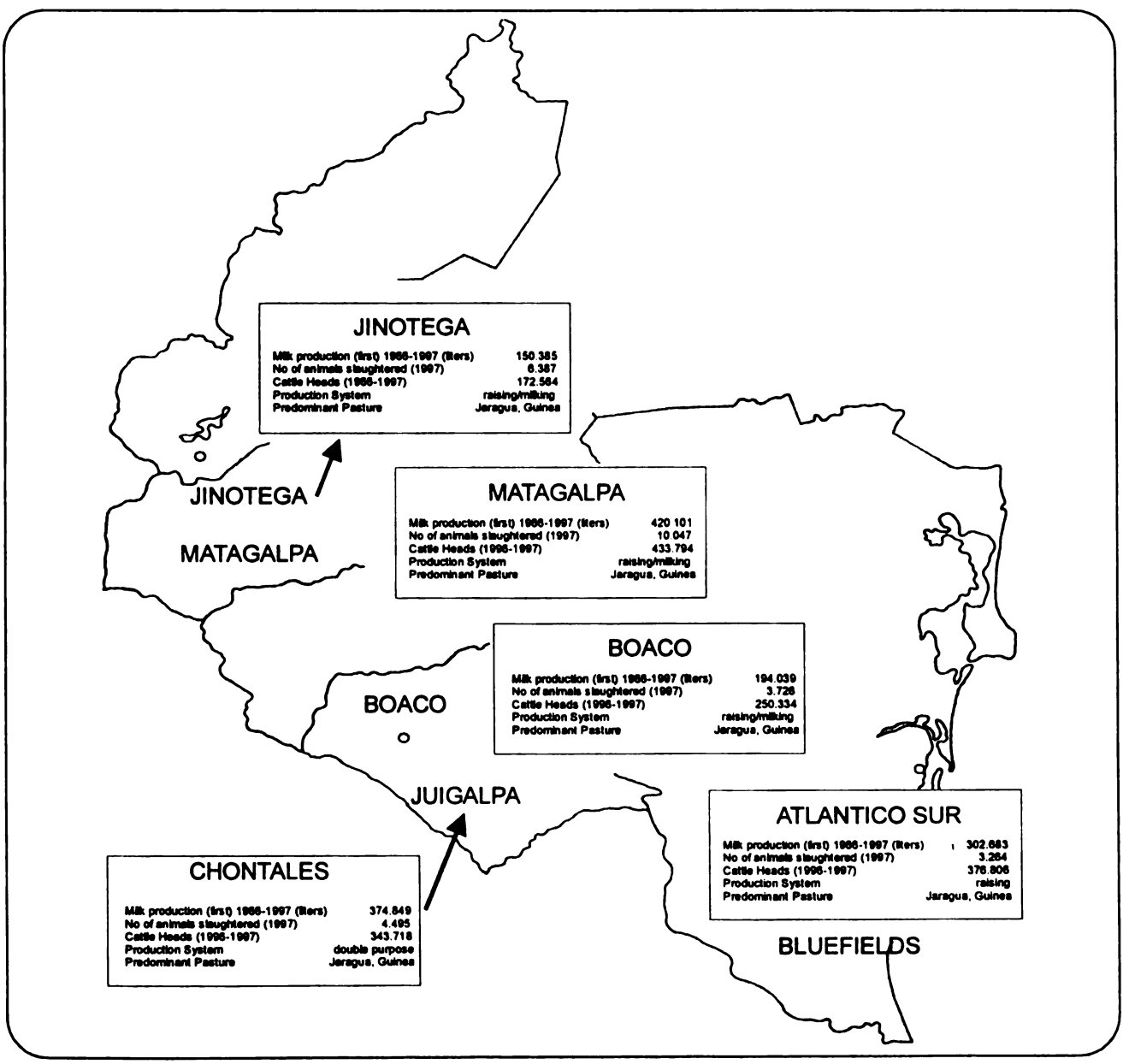

Figure 6. Cattle populations in Nicaragua , 1996-1997.

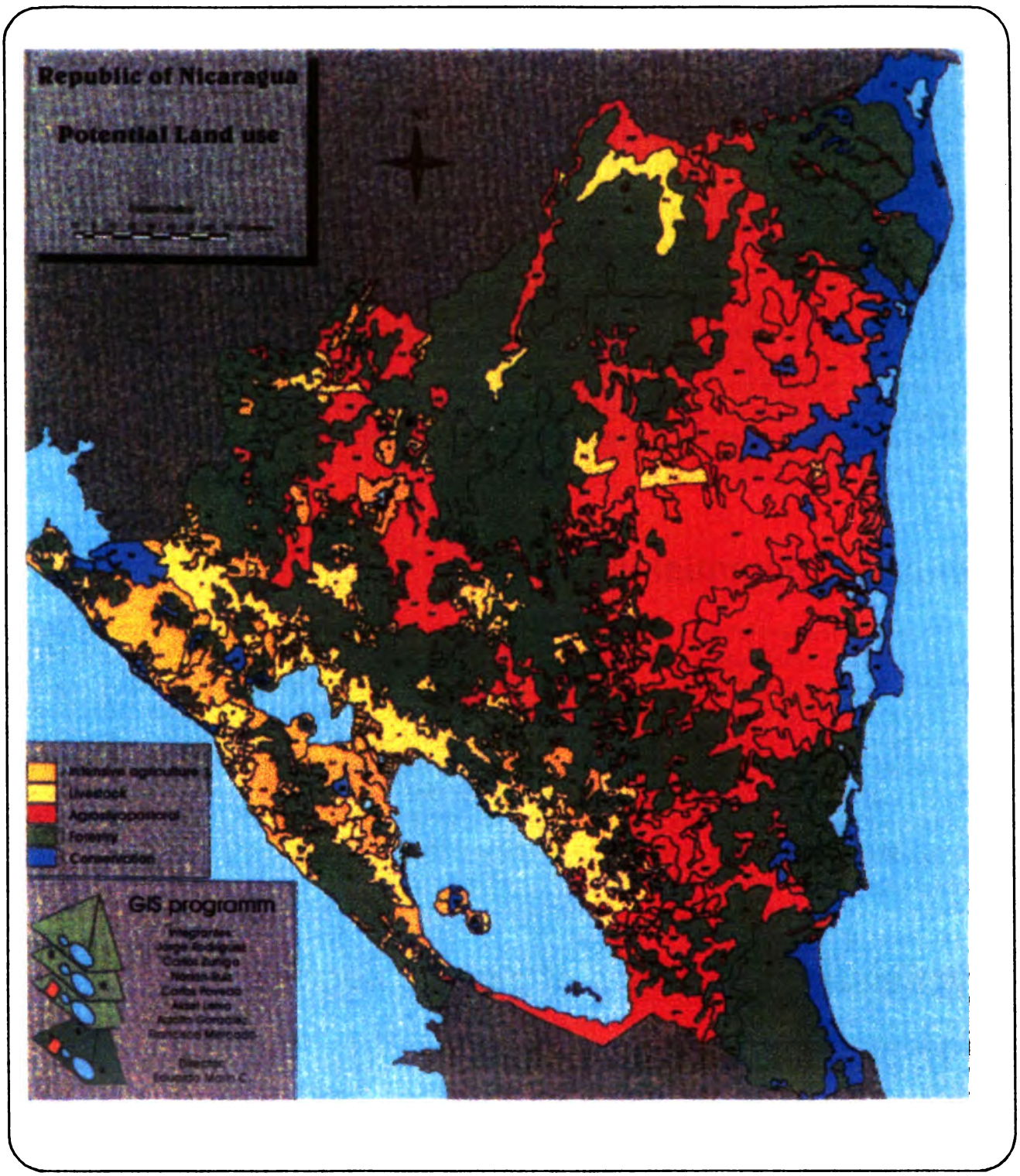

Figure 7. Potential land use in Nicaragua. (INTA, 1998)

Comparison of average stocking rates with those under good management

The average stocking rate in each of the regions was compared with stocking rates on small farms or accessible areas where management tends to be better. This comparison may indicate how stocking rates change as a result of lower investment, and may be indicative of reductions in productivity due to degradation. Average stocking rates (Animal Units [AU] ha^{-1}) were: 0,7 to 0,8 in central Nicaragua, 0,5 to 0,9 in the Petén and 0,5 to 0,7 in northern Honduras. Stocking rates under better, but less than optimal management, were similar to national averages: 1,1 to 1,2 AU/ha in central Nicaragua, 1,9 AU/ha in the Petén and 1,4 AU/ha in northern Honduras. Comparison of the different rates for the same region suggests a loss of productivity of 35% in central Nicaragua, 63% in the Petén and 57% in northern Honduras. It should be noted, however, that stocking rates may be reduced in less accessible areas as a result of increased insecurity or unfavorable economic conditions. Furthermore, greater stocking rates on small farms or accessible areas may not be sustainable and may result in degradation sometime in the future.

Actual *vs.* potential land use

The fourth method for estimating actual or potential degradation is based on comparing land use capacity with actual land use. In central Nicaragua, about 40% to 50% of the livestock area in 1996-97 appears to be in conflict with land use capacity (Figures 6 and 7). In the Petén, maps for 1993 indicate that most of the pasture area was found outside of areas classified as suitable for pasture (De Koninck, 1987). Pasture land settled since 1993 is likely to present a similar degree of conflict (approximately 75%) since inappropriate land use has probably increased as a result of the abolition of FYDEP, human population growth and the difficulty of accessing lands classified for pasture. Thus about 600 000 to 700 000 ha of pasture in Nicaragua and 170 000 ha in the Petén are likely to be degraded or in danger of degradation. There are no data for actual land use in Honduras; recommended land use is shown in Figure 8.

Synthesis of estimates of pasture degradation

In summary, estimates for total pastureland degradation in the three regions fall between 600 000 and 900 000 ha (Table 8). Central Nicaragua contributes more than half of that total, with northern Honduras and the Petén contributing about equally to the remaining area. There is much uncertainty associated with these estimates, primarily due to the lack of precise information regarding existing pasture area which is the basis of all the estimates. In addition, there is virtually no information related to: the degree of degradation, such as that outlined in Tables 7 and 9; the type of degradation (soil compaction, infertility, erosion, bare soil or colonization by weeds or secondary vegetation); nor the relationship between degradation types or rates with differences in soils, grazing pressure, rainfall, slope or management.

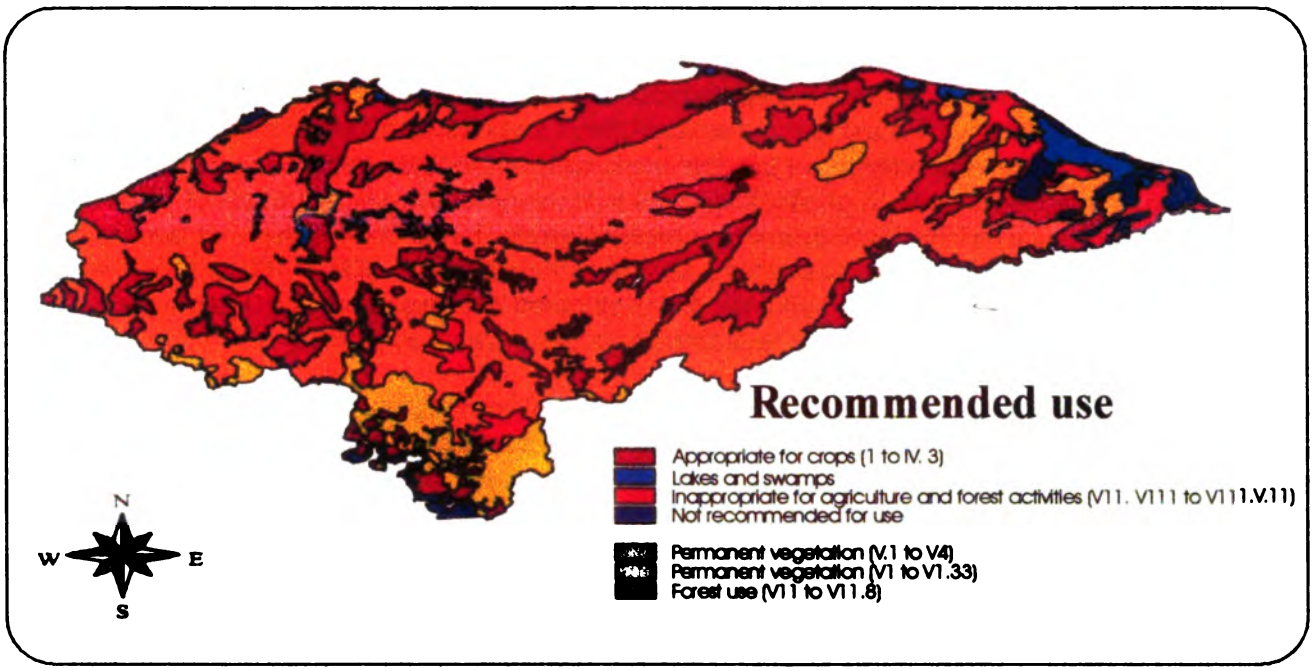

Figure 8. Recommended land use in Honduras (CIAT, 1997).

Types of degradation

It is possible to identify specific circumstances where different types of degradation would be more likely to occur. However, it is not yet possible to provide quantitative estimates of the amount of pastureland affected, due to the lack of disaggregation of cattle populations or pasture area within each region. Morever, degradation levels will not be homogeneous within a region, farm or even within any one pasture.

Soil compaction is likely to be associated with: 1) small, mixed farms in all regions; 2) areas in humid zones where large seasonal increases in cattle populations occur; 3) areas with a long history of grazing, such as the old agricultural frontier and *latifundio* areas of central Nicaragua and old livestock settlement areas in the savannas and FYDEP settlements of the Petén. Increased susceptibility to soil compaction may occur when there is poor drainage and/or reduced root growth and organic matter inputs due to low above and below ground turnover. These latter conditions are apt to be associated with low fertility sites and non-productive, bunch-type native or naturalized pasture such as *Hyparrhenia rufa* that is prevalent in all three regions. Some soils are more susceptible than others; e.g. clayey or loamy textured soils which lack appreciable amounts of self-mulching 2:1 clays, such as those found in alluvial valleys with medium to course sediments.

Low fertility is most likely with older, shallow, acidic soils subjected to repeated burning, which have been used for agriculture (including grazing) for long periods, and where humid conditions result in rapid rates of weathering and leaching. Erosion is apt to be a problem where slopes exceed 30% and rainfall is high. Finally, the invasion of undesirable secondary vegetation is prevalent where pasture are under-used or abandoned such as sites where soils are degraded and in many rural areas with problems of civil war leading to violence or insecurity.

In central Nicaragua, soil degradation is most likely on the eastern slopes and lowlands bordering the central mountains; i.e. a strip along the eastern cordillera which begins near the Muy Muy-Waslala-Rio Blanco area in the north, runs along a line east of Boaco and Acoyapa, and then follows the shores of Lake Nicaragua near Morrito (Figure 1). In this area, soil compaction, infertility and erosion are all likely to be high due to seasonally high stocking rates as a result of internal migrations of cattle (INTA, 1997), low inherent soil fertility, high rainfall and broken terrain. It has been noted that bare soil was frequent on the hills and plains in areas around Muy Muy and Matiguás (INTA, 1998). Moreover, the USAID country environmental profile indicates that watershed destruction and/or severe soil erosion are found in the upper watersheds between Matagalpa and Acoyapa (Figure 9).

Pastures invaded by weeds and other vegetation of poor forage quality, associated with understocking, may also be important in many areas of central Nicaragua. In the early 1990s, it was estimated that at the national level there were about 900 000 ha of forest fallow in humid areas derived from abandoned pastures (INTECFOR, 1993). Much of this area probably lies in the humid lowlands of the Central region, especially in old agricultural frontier areas where problems of rural violence and

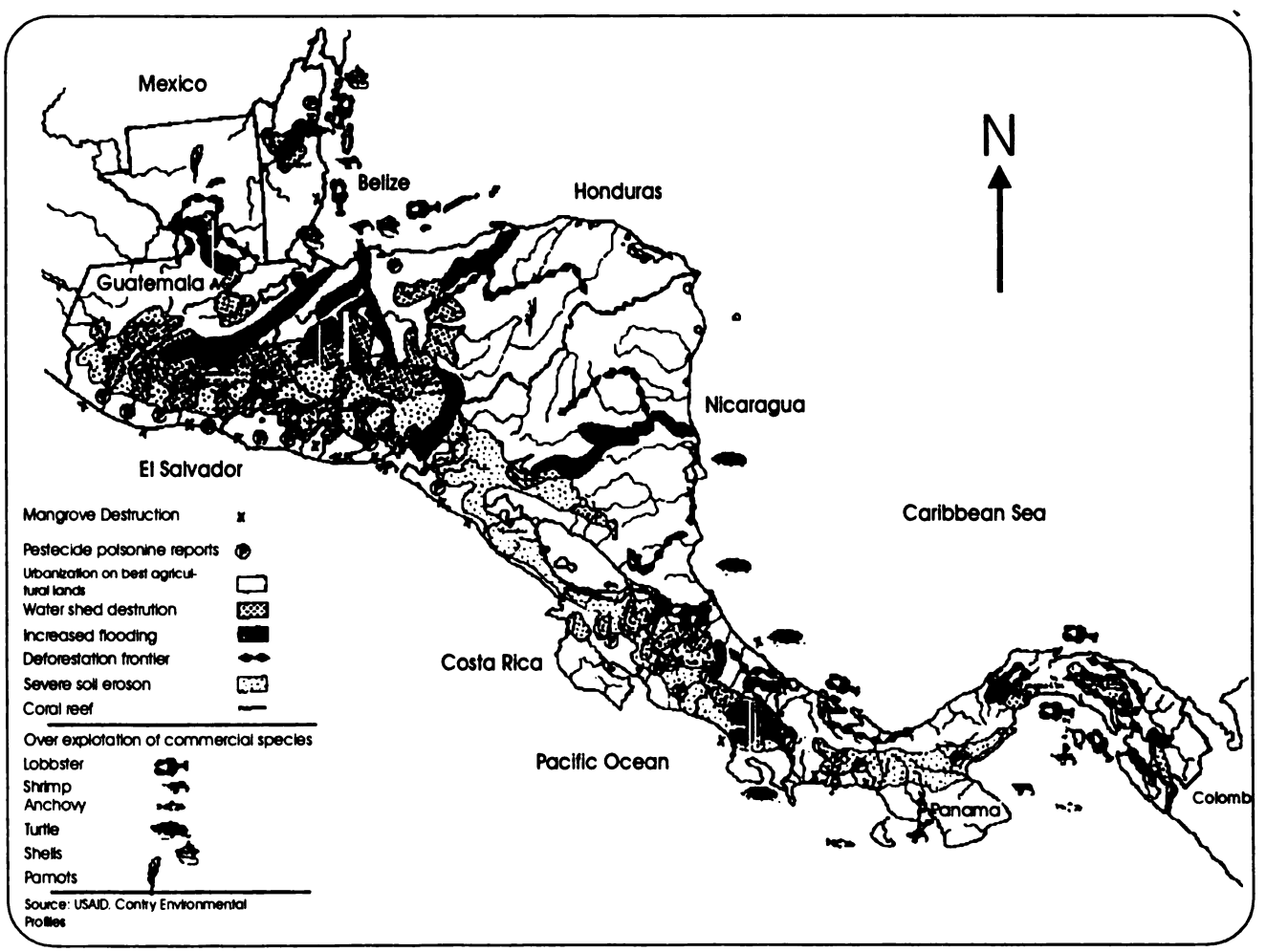

Figure 9. Environmental degradation in Central America.

insecurity still exist. Studies of two of the traditional livestock areas in the Central region corroborate the observation that few cattle are present in areas formerly used by livestock; e.g. in the Muy Muy - Matiguás area (INTA, 1998). Further east, in the Rio Blanco micro-region (INTA/CATIE, 1997), approximately 70% of the pastures were under-grazed, resulting in an excess of old forage and weeds, especially in San José and Bocana de Paiwas areas (INTA/CATIE, 1997). The latter study, which included areas around Mulukukú, El Auló, San José, Bocana de Paiwas and San Pedro, indicates that ground cover is dominated by grass and legume forage species (40 to 60% of ground cover), followed by litter (10 to 35% cover), weeds (about 10 to 20% of ground cover) and bare soil (usually 5 to 10%, except in San José and Bocana de Paiwas where it contributed to about 10 to 25% of the total ground area).

In the Petén, maps produced by Koninck (1987) and SEGEPLAN (1993) on soil depth and relief in relation to grazing areas allow rough approximations of areas where erosion may occur. In general, erosion may be of less importance in the Petén than in the other regions, due to the rapid drainage and relative exclusion of cattle from karst hills. It may be a problem in the areas around Sabaneta, San Luis and between Santa Ana and La Libertad. Shallow soils (15-40 cm) in the areas from Sabaneta to Santa Ana, the Lake Petén-Melchor axis, around San Luis, and between Sayaxché and Las Pozas may also be affected by grazing. In addition, a USAID country environmental profile indicates watershed degradation or erosion in the area east of Sayaxché (Figure 9). Compaction may be a problem in most of the areas presently under grazing except the Sabaneta-Santa Ana corridor, south of San Luis, and the right bank of the La Pasión river between Las Pozas and Sayaxché (De Koninck, 1987). Finally, soil acidity is found in the savannas west of La Libertad, east of Las Cruces and southwest of San Luis.

In northern Honduras, soil compaction is most likely on smaller farms located in the river valleys or coastal plain, which are near roads or milk circuit routes where land use pressure is greater. Soil acidity is more prevalent on the lower slopes of the northern mountains. The risk of erosion is relatively low on the coastal plain, due to relatively flat topography, and in the interior parts of the main river valleys, where annual rainfall is less than 1 500 mm. A greater erosion risk exists on the hillsides, where farms are small, soils are shallow and slopes are steep, rainfall is greater, pasture species are less productive and grazing pressure is greater. Areas with especially high risk of erosion due to high rainfall and steep slopes are the hills and mountains bordering the northern coast; erosion on the hillsides bordering the interior river valleys may be less, because annual rainfall is lower, but still significant. COHDEFOR has identified various areas that have been degraded as a result of agriculture and livestock activities. These include: the Cangrejal river watershed in the department of Atlántida and Tocoa in Colón (AFE-COHDEFOR, 1994). A USAID country environmental profile also indicates that watershed degradation is present in the upper Aguán watershed (Figure 9).

In summary, pastures occupy large areas of land in each region and many of these, between 600 000 and 900 000 ha, are likely to be degraded. The critical zones include: the Muy Muy - Waslala - Rio Blanco area and the hills and lowlands on the eastern side of the central cordillera in Nicaragua; the Las Cruces - Sayaxché - Las Pozas and San Luis - Poptún corridors, the Dolores - Lake Petén - Melchor triangle, and the La Libertad savanna in the Petén; and the coastal hillsides and plains and the Aguán river valley in northern Honduras. More in-depth analyses are needed to further refine estimates of pasture area and land degradation in these zones, and to estimate the degree and type of degradation present.

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CHAPTER 3. Systems of cattle and pasture management

Introduction

In order to understand the reasons behind land degradation associated with cattle grazing, and the potential of alternative systems, it is important to examine the characteristics of cattle and pasture systems, farmer constraints and strategies, and how they affect cattle and pasture management. These themes form the focus of this Chapter.

Cattle-Based Systems

Dual-purpose systems (*i.e.* beef and milk production) are important in all three regions, whereas the importance of more specialized dairy or fattening systems varies regionally. In the dual-purpose system, calves continue to take milk directly from the cows until the calf is weaned. Female calves without any abnormality are generally reared for replacing adult cows that are culled. Male calves are sold at weaning or are flattened. The latter occurs on larger farms which have land resources for both milk and flattening operations.

Dual-purpose systems are incorporated into two types of farms: 1) diversified (animals and basic grains and/or coffee), intensive, smallholder-managed systems for milk-calf production in which, due to land limitation, weaned calves, excess steers and older cows are sold for meat, but income from milk usually exceeds that from meat; and 2) extensive grazing systems managed by small and medium-sized farmers, where calves are sold 6-12 months after weaning, and income from meat and milk are similar.

Generally, dual-purpose farms emphasize either milk or beef depending on: 1) demand, stability and relative prices of beef and milk; 2) the natural environment, which favors certain systems; 3) the genetic make-up of the livestock; 4) farmer resources; 5) access to markets; and 6) transportation infrastructure (Pomareda *et al.*, 1997). Small farmers are usually more oriented to milk production than larger farmers. In general, the relative importance of meat production increases with isolation and distance from the markets (MAG, 1998b).

Other, more vertically integrated, cattle development and fattening or dairy systems are typically managed by medium and large farmers. Dairy farms are usually located near principal towns and roads, whereas meat-based systems are found in humid and inaccessible areas. Due to their reduced number, specialized systems are of lesser importance than the others mentioned above (Maldidier and Marchetti, 1996).

In central Nicaragua, diversified dual-purpose operations are found mainly in the highlands and account for about 11% of the total number of livestock farms present in the region. Dual-purpose extensive grazing systems and cattle development and fattening operations, both found primarily in the humid areas, account for about 48% and 26% respectively of the total number of livestock farms. There are few specialized dairy or fattening farms in this region.

Official estimates in 1997 of the total cattle population in the Petén were 226 000 head (MAGA, 1997a) other estiamtes are as high as 500 000 head (MAGA, 1994; CONAP *et.al.* 1996). According to the 1997 estimates, nearly all of the cattle in the Petén were found on farms larger than 45 ha (Table 10) (only 35% of all farms in the region but they account for 86% of farming areas) which concentrate on dual-purpose operations or fattening. Presumably, the remainder of the cattle is found on small or medium farms belonging to communal ejidos or cooperatives or farms that are illegally settled and not legally registered (CEAR/IICA, 1992; Gaitán Flores, 1994; MAGA, 1997b; MAGA/GTZ, 1997; SEGEPLAN, 1993). Smaller farms usually have a mixed agriculture and dual-purpose livestock orientation with only a limited area in pasture (Table 11). The mean stocking rate (calculated from table 9) of pastures in the Petén is only 0,8 head ha^{-1}, which is a good indication that cattle are managed in a very extensive way with little use of inputs. Under similar conditions, well managed improved silvopastoral pastures can support three to four animals ha^{-1} (Jansen *et al.* 1997). This suggests that the establishment of silvopastoral systems in the Petén could permit the same level of animal production with additional benefits (timber, services, biodiversity etc.), on only one farm third of the area currently being used for cattle production thus liberating lands for reforestation programs.

Table 10. Categorization of farms dedicated to cattle in the Petén, Guatemala 1996.

				Milk		Dual Purpose		Cattle development		Fattening	
Farm size (ha)	Number of farms	Total in number of cattle in each class	Total area in each class (ha)	Total number of farms	Total number of cattle in each class	Total number of farms	Total number of cattle in each class	Total number of farms	Total number of cattle in each class	Total number of farms	Total number of cattle in each class
<7	12	94	29	1	4	6	36	-	-	5	54
7-45	33	437	596	-	-	31	414	-	-	2	23
>45	3549	225,923	280,000	290	10,585	1475	68,425	126	15,327	1658	131,586

Source: MAGA, 1997a.

In northern Honduras, farms on the coastal plains, inter-montane valleys and lower slopes of the mountains are large and devoted primarily to cattle, but often include basic grains, traditional perennial crops such as cocoa or coffee, or new industrial crops, especially oil palm. Those on the upper hillsides or steep (up to 70%) slopes are small, more diversified, and subsistence oriented and include basic grains, dual-purpose cattle, and perennial crops such as coffee, citrus or cocoa; milk and cheese production is the most important economic activity (Humphries, 1996; Matute, 1998). Among farms dedicated to cattle, the emphasis on beef, milk or dual-purpose systems varies geographically: in Atlántida, milk and dual-purpose farms are about equal in importance; in Colón, most farms are dual-purpose (Table 12).

Table 11. Land use in municipal ejidos in the Petén, Guatemala 1996.

Municipality	Total area	Forest	Guamil[2]	Crops	Pastures	Other
			ha			
Dolores	11 250	3 375	1 350	4 500	1 575	450
Flores	10 800	n.d.	n.d.	n.d.	n.d.	n.d.
La Libertad	12 510	6 130	3 127	3 253	n.d.	n.d.
Melchor	12 735	4 457	1 528	3 184	2 282	1 273
Poptún	11 430	n.d.	n.d.	800	n.d.	2 972
S. Andres	11 520	922	10 022	n.d.	230	346
Sta. Ana	11 250	n.d.	n.d.	n.d.	n.d.	n.d.
S. Fran.	11 250	5 625	3 375	1 125	1 012	113
S. Jose	11 430	2 515	5 372	2 629	229	686
S. Luis 1	11 475	n.d.	n.d.	n.d.	n.d.	n.d.
Sayaxché	11 250	7 875	900	1 912	338	225

MAGA/GTZ, 1997. n.d. no data.

Table 12. Cattle farm orientation in northern Honduras, 1993 (Farms with one or two oxen used for traction are not included in the classification).

		Meat		Milk		Dual Purpose	
Dept.	Total # of cattle Farms	# of Farms	%	# of Farms	%	# of Farms	%
Atlan.	4 811	75	2	2 173	45	2 383	50
Colón	3 533	127	4	118	3	3 086	87
Total	8 344	202	2	2 291	27	5 469	66

Source: Pomareda *et al.*, 1997; Matute, 1998.

[2] Guamil: is common word used in Guatemala for short fallows.

Farmer Constraints and Strategies

Diversified smallholder systems face a number of constraints which limit intensification: a dependence on family labor, marginal quality of land (infertile or shallow soils or steep slopes), little capital, deficient access to markets and transportation problems. As an economic strategy, farmers are usually involved in agricultural and livestock activities that are complementary in time and are oriented towards food security. They often seek to maximize returns per unit of labor invested. Their medium term goals include increasing farm size, in order to increase profits per unit labor and to have land to leave to their children, rather than to increase production per unit area via intensification. This is especially true in inaccessible areas where inputs and equipment are scarce and markets are distant (Maldidier and Marchetti, 1996).

Extensive grazing systems are predominantly managed by medium-sized producers and are less diverse and more commercially oriented than those of small farmers. Medium-sized farmers seek to maximize profitability, as well as to assure family food security and the best return from their own labor. Hence they grow agricultural crops and produce beef, milk and cheese for both consumption and sale in systems that permit the full use of family labor as well as hired labor. Producers with greater endowments of capital or land may also develop or fatten small lots of purchased animals (Maldidier and Marchetti, 1996). In addition, they often use part of their capital in local commercial activities where they usually function as intermediaries in the buying, selling or transportation of agricultural products. Their medium-term goals are to invest in the education of at least one of their sons and to accumulate more land for their other children. As such, they often prefer to expand land area instead of intensifying management. Their principal limitation is labor (Maldidier and Marchetti, 1996).

Producers with medium and large vertically integrated systems usually have more than 200 ha distributed among two or three farms in different agroecological zones. They tend to focus on livestock development and fattening, often buying lots of young animals from other producers. In areas with good market access or those in close proximity to towns, these activities are often combined with milk production (Maldidier and Marchetti, 1996). These producers have a high level of available resources. Unlike the other two types of farmers, who live on their farms and use large amounts of family labor, large landowners usually live off-farm and are more involved in supervision and administration of wage labor rather than work directly on the farm. Smaller producers within this group may have limited non-agricultural commercial activities, whereas the larger producers often have large investments in commercial or industrial activities. A key element of the economic strategy of this group is to capture subsidies *via* credit, tax incentives and favorable exchange rates. Principal limitations of these systems include their low efficiency in the absence of subsidies and their dependency on bank financing (Maldidier and Marchetti, 1996). Typical characteristics of these systems in Nicaragua are shown in Table 13.

Table 13. Characteristics of cattle raising systems in central Nicaragua.

Farm type (ha)	Labor	Number of cattle	Invest-ment (S/ha)	System orientation	Stocking rate (*AU/ha)	Chief output	Forest (ha)	Total annual income ($)	% Non-agric. income	Annual Investe-ment ($)	Annual work intensity (man-day/ha)	Annual inputs costs ($/ha)
Small (<35)	Family.	50-100 total; 10-30 cows	20-86	Calves-milk; subsistence agriculture	1,4-2,1	Milk < (20-40 gal/day)	<28	800-2 900	0	400-1 800	7-28	1,4-2,3
Medium (35-280)	Family wage/labor	70-200 total; 20-50 cows	74-86	Calves-cattle development milk: Development partial fattening; subsistence agriculture	<1,0	Milk (60-80 gal/day); cheese	10-50	4 200-8 600	Varies	High	8-14	1,4-2,8
Large (>280)	Wage labor	400-1000 total 30-150 cows	114-172	milk-calves-cattle develop-ment fattening; fattening alone	<1,0	Milk; cheese; meat	Varies	10-50% profit	Varies	High	3-8	1,4-2,8

Pasture and Animal Management

Despite differences among producers in farm size, available resources and economic strategies, the level of investment and input use in livestock and pasture management in all regions is low, resulting in low levels of technical indices for animal production, health, and reproduction.

Average stocking rates for the three regions are about 0,5 - 0,9 {AU} ha^{-1} (one animal unit {AU}=400 kg LW). They are greater in areas with transportation and market infrastructure (1,1-1,2 AU ha^{-1}) and among small producers (1,4 to 1,9 AU ha^{-1}) than in relatively isolated areas (0,3 AU ha^{-1}) or among medium or large producers (0,5 to 0,9 AU ha^{-1}) (Barquin Alvarado, 1996; Humphries, 1996; Matute, 1998; Nitlapán, 1995; PDBL, no date). Stocking rates on the savannas of the Petén are especially low (0,2 to 0,5 AU ha^{-1}) due to low plant productivity associated with infertile soils (Cabrera *et al.*, 1997).

In general, producers in all categories invest little in animal nutrition. Pastures are usually established directly or after one or two years of crops on land cleared from forest *via* slash and burn methods. Native grasses and naturalized species such as *Panicum maximum* (asia), *Hyparrhenia rufa* (jaragua), *Paspalum* sp and *Ischemum indicus* (retana) are most common. Retana appears to be spreading rapidly in some areas. About 20% of the pastures consist of improved species, although 40% to 47% of the pastures in the "milk circuit" of northern Honduras may consist of improved grasses (Humphries, 1996). Improved pasture species most commonly include *Cynodon nlemfuensis* (stargrass), *Andropogon gayanus* (gamboa), and *P. maximum* with growing importance of *Brachiaria* spp., and are found most frequently on dairy farms (Table 14). As a result of infrequent weeding, annual burning, the lack of fertilization and the absence or inadequate control of rotational grazing, the persistence and productivity of improved species declines after a few years (González Suárez and Miranda Báez, 1996; INTA/CATIE, no date; Nitlapán, 1995; Zeledon, 1998). However, new genotypes of Brachiarias (e.g. *Brachiaria humidicola*, *B. brizantha* and *B. dictyonuera*), that are better adapted to ecological conditions in Central America, have been selected recently and are now grown commercially (Argel and Keller-Grein, 1996).

Table 14. Pasture areas in the Petén, Guatemala 1996.

				Naturalized pasture		Recently introduced pasture	
Farm size (ha)	**Total number of farms**	**Total area (ha)**	**Average farm size (ha)**	**Area (ha)**	**Main species**	**Area (ha)**	**Main species**
< 7	12	29	2,4	28	N	1	Bb
7-45	33	596	18,1	427	N	169	Br
> 45	3 549	280 000	78,9	100 510	N	179 490	Cn

Notes: N = naturalized or native grasses including *Hyparrhenia rufa*; Bb = *Brachiaria brizantha*; Br = *B. ruzizensis*; Cn = *Cynodon nlemfuensis* (MAGA, 1997a).

Supplements are not commonly used. Apart from table salt, other minerals, cut-and-carry forages, silage or concentrated feeds are seldom provided, except on large farms having a greater level of resources. Cut-and-carry forages are also used by small and medium producers on the "milk circuit" in northern Honduras where increased competition between agroindustries and ranchers for land has recently favored intensification of land use (DICTA, 1998; Humphries, 1996). Small farmers, in comparison, may use more autochthonous sources of feed such as crop residues, rejected bananas, fruits, tubers and roadside grazing (González and Miranda Báez, 1996; Nitlapán, 1995). During the dry season, medium and large farmers may resort to forest or fallow grazing or the temporary transfer of cattle to more humid areas (Maldidier and Marchetti, 1996; SEGEPLAN, 1993).

The investment in animal health is similarly small and largely confined to infrequent vaccinations, deparasitization and vitamin supplements (González Suárez and Miranda Báez, 1996; INTA, 1997;Nitlapán, 1995). Such investments are much more common among large and medium-sized owners than among small producers, but paradoxically do not appear to translate into improved indices of animal health compared to those of stock managed by small farmers. This may be due to problems related to the timeliness or effectiveness of the measures applied and to more intensive animal care among small livestock owners.

There is also little investment by producers in the management of animal reproduction or genetic improvement of stock. The majority of the cattle are Brahman or Brown Swiss crosses with creole breeds (INTA, 1997). With greater emphasis on meat or less favorable conditions for milk, the orientation shifts towards Zebu breeds and meat production, with milk as a sub-product. Recently, even in areas with a high concentration of milk production, cross-breeding with Zebu breeds has become more frequent due to uncertainty in the milk market and increases in the prices of inputs (Pomareda *et al.*, 1997).

Due to poor health and nutrition, animals gain weight slowly and produce small quantities of milk. Animals often need 3,5 to 4 years to reach 400 kg liveweight (LW), primarily as a result of poor animal nutrition (Jansen *et al* 1997). Average annual liveweight gains range from 12 kg/ha in the savannas of the Petén, to 58 kg/ha in other areas of the Petén, and 80 to 105 kg/ha in northern Honduras (Barquin Aldecoa, 1996; Díaz Navas, 1989; PDBL, no date; SEGEPLAN, 1993). The savannas are characterised by unproductive native species that are of high fiber and low crude protein concentration which is one of the principal reasons for their low animal productivity (Lascano and Estrada 1989).

Daily milk production ranges from about 2 to 4 liters/animal, but is greater in humid areas (up to 6,5 liters/animal), among small producers and controlled circuit or more specialized producers. For example, in Honduras the average daily milk production is 2 liters/animal at the national level, 4 liters/animal in the department of Atlántida and 5 liters/animal among controlled circuit producers (DICTA, 1998; Matute, 1998; Pomareda *et al.*, 1997). Generally better technical indices among small farmers may be due to more individualized and timely animal care as well as the relatively greater use of resources per animal (Cajina, 1996; Galeano Cruz and Sandoval, 1997; González Suárez and Miranda Báez, 1996; Nitlapán, 1995; Sandoval, 1998). An exception was found with small farmers on marginal hillsides in northern Honduras, where daily milk production ranges about 1 to 2 liters/animal (Matute, 1998; PDBL, no date).

Besides low animal productivity, seasonal production of forage is responsible in variation in animal production during the year. For example, in sub-humid zones milk yields in the dry season are only 40 to 60% those observed in the wet season (6-7 liters/animal/day). This is related to the lack of feed or forage substitutes and the reduction in the use of feed supplements due to increases in their costs and uncertainty in markets for products (Pomareda *et al.*, 1997).

Low and seasonal productivity reduce the profitability of cattle raising despite low investment and low labor costs. Average gross profits on capital are less than 2-3% per year (Pomareda *et al.*, 1997) and profits are usually less than $100/ha (PDBL, no date). The establishment of fodder trees in seasonally dry areas can help solve the problems of a feed shortage in the dry season and improve animal productivity and farm income with environmental benefits (Camero *et al.*, 1999; Ibrahim *et al.*, 1999).

Causes of Pasture Land Degradation

A number of driving forces or constraints at various hierarchical scales act as disincentives to investment in cattle or pasture management. They also encourage extensive, low input and low productivity grazing systems which exploit natural resources and lead to their degradation (Homan, 1994; Simpson, 1994; Pomareda *et al.*, 1997) (Figure 10). Besides the degradation of pasturelands, these forces also produce other environmental and socioeconomic ripples such as the loss of vegetation, biodiversity, soil and water quality, increased deforestation, use of marginal lands and poverty.

At the international level, these factors include:

- low prices associated with market liberalization;
- high prices for inputs;
- decreasing consumer preferences for beef and milk products;
- stringent international sanitary or environmental standards for cattle-based products; and
- growing foreign competition.

Limitations at the national level include:

- low internal demand for cattle products, especially for high quality products which could com mand better prices, as a result of declining incomes associated with structural adjustment;
- weak transportation, storage and distribution, processing, quality control and commercialization systems;
- a lack of institutional coordination, including legal impediments, within the public agricultural sector and between the state and the private sector, in order to formulate, integrate and implement policies and activities that benefit or provide incentives to the cattle industry;
- a lack of credit or economic incentives for capital demanding or long-term improvements in land use or those that require large investments;
- insecure land tenure or legal impediments to certain forms of land use; and

• a vacuum in research, extension or monitoring activities created by the withdrawal of the public sector from these areas and a lack of capacity on the part of private organizations, such as livestock producer associations, to assume these roles.

Farm or community level constraints include:

- rural violence or insecurity, uncertain future returns in investments and a lack of secure property rights which affect willingness to invest;
- lack of effective communal organizations;
- limited labor availability and capital;
- the use of extensive pastures as a speculative strategy for capitalization, not production, which results in a decreased importance being given to soil and pasture management, and hence a reluctance to invest;
- a lack of economic incentives (poor economic returns, lack of political or institutional support) or high costs (inputs, knowledge) associated with improved practices;
- agroecological constraints such as high rainfall, infertile soils or steep slopes; and
- a lack of knowledge of degradation processes or more appropriate management techniques, especially in the case of immigrants from different ecological zones.

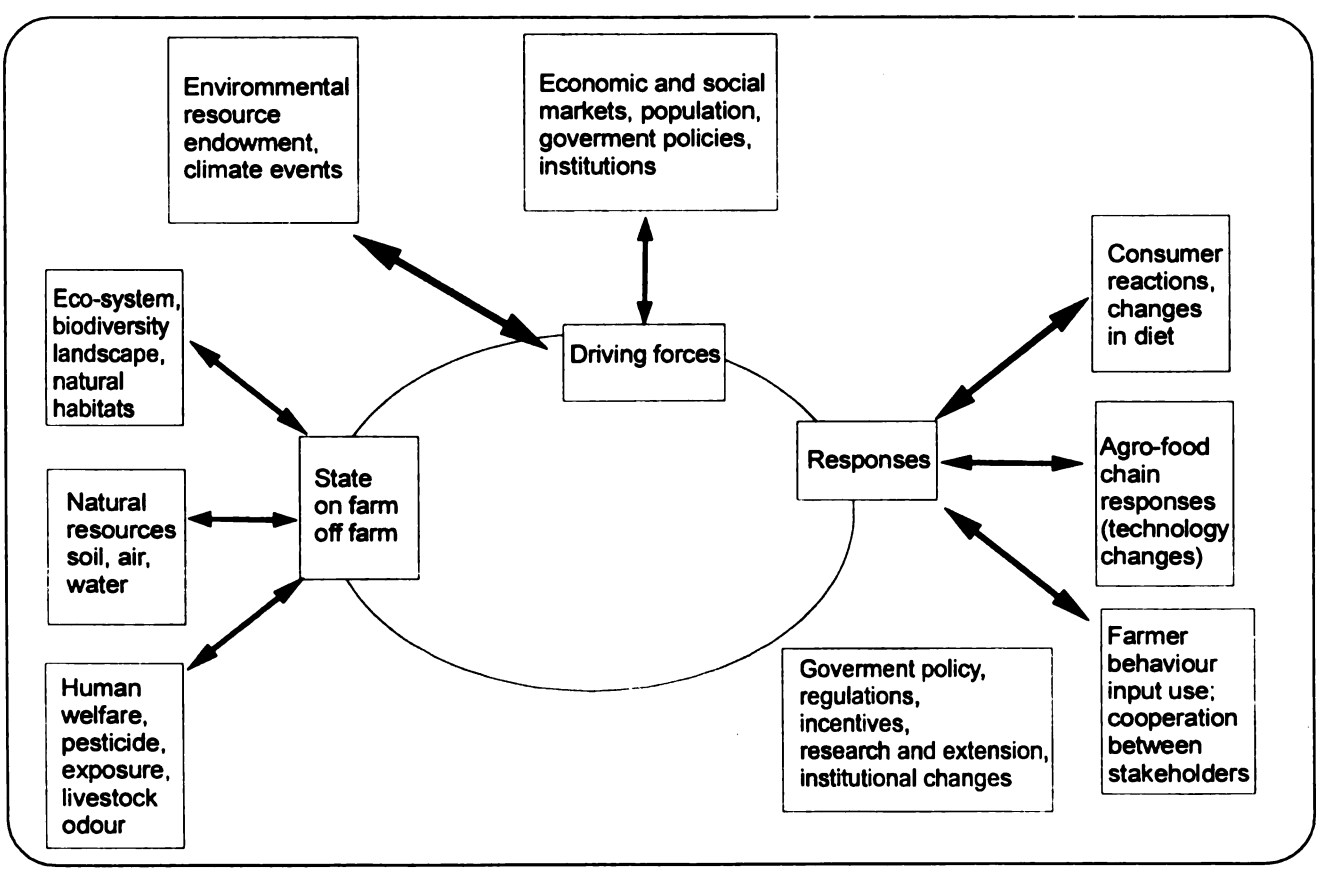

Figure 10. Forces and factors affecting natural resource use by farmers (Adapted from de Haan *et.al.*, 1997).

Low capitalization (low profitability and a lack of credit or incentives), limited labor availability, deficient knowledge systems (technical assistance institutions, inappropriate ecological knowledge or ignorance of improved management techniques), the use of marginal lands, and management objectives (land speculation, prestige) at odds with sustained resource use, are responsible for low productivity and environmental degradation in many areas (Pomareda *et al.*, 1997; Vargas, 1998) (Table 15). Given the labor, land and capital constraints, cattle are one of the few options available which provide: 1) a modest return based on minimal investment; 2) flexibility in productive output; 3) productive use of marginal lands; 4) reduction in risk due to climatic fluctuations; 5) easy liquidation of investments; and 6) a source of savings and prestige.

In many areas of the Petén and northern Honduras, for example, cattle raising is a low cost titling strategy to control large areas of land and protect it from squatters while owners profit from increasing land prices (Kaimowitz, 1996; de Haan *et al.*, 1997). In many parts of Latin America, cattle ranching is viewed as a "way of life" with significant prestige value regardless of its profitability (McCorkle, 1994). It is also viewed as a way to reduce risk (animals often can tolerate climatic fluctuations better than crops, their marketing is more flexible and they serve as a form of insurance) or the costs and intensity of labor without affecting family income (Humphries, 1996). These attitudes towards land and cattle as a low-cost, low-risk source of wealth or prestige contribute to the aspiration of many small and medium-sized producers to increase the size of their holdings instead of investing in inputs or pasture improvement (Nitlapán, 1995).

Clearly, cattle producers are not perverse. Most are probably making rational use of their resources under the institutional, legal, economic, technical and knowledge-based constraints that they face. Farmers do not perceive or inadequately value the environmental degradation accompanying cattle raising, or are unable to apply the knowledge and techniques needed to avoid or mitigate this damage.

Table 15. Constraints on cattle farmers in selected regions of humid Central America. (Scherr et al., 1996)

Constraint	Scale	Central Nic.	Petén Guat.	North Hond.	Comments
Lack of secure land tenure, property titles	National Regional	3	5	3	Affects access to credit, willingness to invest
Lack of credit	National Regional Local	4	4	4	Decreases investments
Lack of incentives (tax credits, debt exchange, etc.) to promote livestock management or alternatives	National Regional	4	3	5	Reforestation or forest management incentives in all regions. Exchange of livestock debt for reforestation in Nic. Implemented in Guat. only.
Legal impediments to other forms of land use	National	3	3	4	Mainly applies to agrarian reform beneficiaries; usually entails land clearing to claim or keep property.
Absence or non-implementation of land-use planning	National Regional	5	4	5	
Weak commercialization systems and poor infrastructure	National Regional	3	3	4	Results in low prices to producers, large price swings, inadequate storage and distribution centers, lack of quality and health standards
Limited research and extension capacity	National Regional	3-4	5	4	
Limited coordination between state and private sector actors	National Regional Local	3	4-5	4-5	
Traditional attitudes, socio-cultural values, or ecologically inappropriate knowledge	Local	4	4	4	Use of inappropriate knowledge is more problematic in Guat. and Hond.
Rural violence or insecurity	Regional Local	4-5	3	3	
Farmer knowledge of improved technologies or alternatives	Local	4	4	3	Refers chiefly to improved pasture use. In all regions, farmers are relatively unaware of tree value or management
Seasonality of production	Regional Local	3-4	3	4	In Nic., depends on zone. In Hond., the problem is especially relevant to milk production.
Lack of effective local organizations	Local	?	4	4	

Ranking scale: 5 = common or in high degree, 1 = rare or in low degree

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Chapter 4. Recuperation of Degraded Pasture Land

Introduction

As a result of deforestation related to the "hamburger connection", cattle are often depicted as enemies of the forest and destroyers of natural resources. This negative image has contributed to the loss of political and financial support for cattle farming at both the international and national levels, despite cattle's widespread and critical importance as a source of savings, income, insurance, food, fertilizer, fuel and risk reduction for many farm families (Saad *et al.*, 1997). Moreover, the withdrawal of this support has come at a critical juncture, as cattle producers are being buffeted by lower prices, increased competition, and changing consumer preferences and demand generated by the economic winds of market globalization and liberalization. At the same time, they find themselves without recourse to the government subsidies, credit and technical assistance which originally stimulated the Central American cattle industry and which, in an appropriate form, might have helped them to adapt their systems to the new economic order.

Thus the future panorama for livestock and investment-dependent improvements in grazing systems is decidedly cloudy. Profit margins have shrunk and there is little national or international support for activities that are perceived as environmentally destructive and inefficient in terms of employment generation and resource use. Moreover, low international prices are expected to continue, which will make it hard for low productivity grazing systems to compete with other export orientated systems for land and capital. In the absence of stimuli to adopt improved alternatives, many cattle producers are likely to continue the *status quo*, banking on the future appreciation in the value of land as it grows more scarce (Leon, 1994). Such conditions may result in even lower levels of investment and may be expected to eventually lead to increased poverty and environmental degradation, especially on hillsides. At the national level, it needs to be asked whether these countries, amongst the poorest in the world, can afford such inefficiencies in labor, land and other natural resources. On the other hand, significant numbers of farmers may want to change their production systems, but may not have the necessary institutional support, capital or knowledge to successfully establish new and unfamiliar alternatives. In their case, the outlook for farm livelihood and the environment is equally grim.

Clearly, alternatives to current pasture and livestock management, and the means for ensuring their successful adoption, are needed. Obviously, these alternatives must fill, at least partially, the biophysical and socioeconomic niche occupied by cattle in current farming systems while reducing environmental degradation and improving farm productivity and profitability. As seen in the previous Chapter, such niches are determined by a complex web of social, cultural, economic, political and institutional factors, acting at various scales that influence the actions or decisions of communities and individual producers (see Table 15). These factors must be addressed in order to reverse or prevent and destructive land use practices. More profound analyses of community and on-farm decision making, and the constraints or opportunities which influence them at various hierarchical levels, are needed.

Table 16. Incentive structure for farmer investment in natural resources for production (Scherr and Hazell, 1994).

Knowledge	1. Farmer knowledge of investment needs or options to reserve resource degradation	Recent settlement in ecozone	Improve design of settlement programs	○
		Rapid pace of land use change	Reserch on new technologiy	●
		Poor information exchange	Improve inter-farmer communications	○
		Failure to perceive environmental externalities and effects	Extension re options	○
			Envirommental Education	○
Economic Importance of resource	2. Farming plays an economically important role in household livelihood	Off-farm business interests	Land taxes to encourage tenancy or sale	□
		Small farm size leading to dependence on wage labor	Interventions in labor markets	□
	3. Degraded resource plays an economically important role in farm production system	Allocation of resources to higher productivity, non-degrade plots	Land management requirements	□
			Taxes on degraded lands	□
Willingness to invest Long-Term	4. Long-Term horizons	Acute subsistence insecurity	Food aid, social security	□/○
		Unusual short-term profit opportunities from resource mining	Price stabilization	□
	5. Security of future investment return	Limited land or water rights	Property rights reform	□
		Temporary settlement	Incentives for permanent settlement	□
		High production risks	Technology to reduce risks	●
			Insurance for production risks	○
Capacity and mobilize resources	6. Sufficient inputs for investment	Lack of labor	Incremental land use charges	●
		Lack of cash	Improve infraestructure to reduce input costs	□/○
		Lumpiness of investments	Improve input and credit markets	□
		Lack of planting materials	Economic linkages with urban and agricultural regions	□
		Lack of equipment or tools	Organization to mobilize local resources	○
	7. Flexibility in resource management	Land use restrictions or requirements	Regulatory reform	◘
			Reduce costs of compliance and transactions	◘

Table 16 continuation....

Economic Incentives	8. Attractive returns to resources investments	Low productivity technology	Technology improvement	○
		Artificially low product prices	Mantain competitive agricultural prices	□
		Low financial value of natural vegetation	Substitute perennials with marketables products	●
		Subsidized alternatives for resources (for example water, chemicals, national forest timber	Reduce subsidies	□
			Improve infraestructure and institutional support for markets	□
Institutional support	9. Group action to invest or benefit from investment or organize land use to attain envirommental aims (for example, local credit cops, taxing authorities)	High transaction costs	External inputs to reduce transaction costs(for example NGOs)	○
		Regulatory obstacles on local organizations	loosen controls on local organization	○
		Weak institutional development	Catalize and support local institutions	○
		Unequal effects of externalities or costs of group action		
		Inadequate information on activities and envirommental effects or options	Support local and regional resources planning and conflict resolutions	○

● Technical interventions
○ Institutional interventions
□ policy interventions

Framework conditions that affect Pasture-Based Systems

Clearly, key questions related to current grazing systems are: how might grazing systems be changed in order to avoid their negative effects (e.g. soil degradation) and increase farm productivity? What are the technical problems involved? How might these changes be accomplished in ways that are economically and socially acceptable? What economic, ecological or institutional changes, or incentives, will induce technological or institutional innovation and investment in the resource base?

Such changes can be driven by the development of more profitable or environmentally friendly technologies and modifications in local markets, institutions and policies which increase the farmers' options and facilitate investment in land improvements (Scherr *et al.*, 1996) (Table 16). They would be aided by improvements in social organization and local access to knowledge. Changes in actual grazing systems, i.e. their development pathways, will depend on the driving factors and conditions that constrain the responses or options of producers including farm type, orientation and available resources (Pender *et al.* 1998). Nevertheless, given an appropriate set of policies, incentives and technologies, widespread changes in grazing systems, on an order similar to what occurred when pastures replaced forests, could be achieved.

Environmental monitoring

The present study has shown the paucity of useful information related to pasture area, let alone pasture degradation. A first step in designing and implementing a program aimed at pasture reconversion is to gather better regional scale information on current forms of land use, especially pasture area, and how those uses or resource states change over time. Analyses of the quantities and states of grazing areas, based on a combination of satellite imagery, ground truthing and GIS techniques, will improve diagnoses, help plan and target technology development and dissemination activities, and will facilitate impact assessment. It may also contribute to implementing more general and effective environmental and natural resource monitoring systems in Central America.

On a smaller scale, information on how and at what rates degradation occurs under different soil, topographic and management conditions is needed to provide a basic understanding of system dynamics which may help target different land use interventions. This knowledge should complement and enrich that produced by remote environmental monitoring systems.

Technology generation and dissemination

Generation and dissemination of technologies and information should be driven and guided by farmer demand and needs, and hence will depend on farmer participation in the diagnosis of constraints and the formulation and evaluation of potential solutions. An adaptive research and extension program should focus on: 1) identifying agroecological constraints or specific information needs in each zone; 2) developing or adapting appropriate technologies to local conditions; 3) increasing farmer and decision maker awareness of the economic and ecological values of potential alternatives (e.g. secondary forest management); 4) augmenting the technical and managerial proficiency of farmers or farmer groups to enable them to put those alternatives into practice; and 5) overcoming the lack of ecologically appropriate knowledge or attitudes. This programme must be complemented by interventions at the national level to remove disincentives and promote incentives, as discussed above under "Framework conditions".

Technologies developed or adapted should be suited to different levels of land, capital or labor availability and agroecological conditions. Given the characteristics of most small and medium-sized farming systems, such alternatives should have low labor and capital requirements, low risk and relatively short periods of return. Promising options for reducing environmental degradation and increasing productivity include more diverse silvopastoral or agrosilvopastoral systems, which include cattle as well as other productive activities, and systems based on perennial crops or secondary or plantation forest management in which the importance of cattle is reduced or even eliminated. However, since perennial crops and timber trees often require relatively large capital investments and/for a relatively long time to yield their benefits, a major challenge is how they can be promoted in actual farming systems given the above limitations.

Silvopastoral Systems

Silvopastoral or agrosilvopastoral systems, in which cattle and pastures are combined with trees, shrubs and other crops, may have the greatest probability of adoption. They represent the least amount of change from current grazing systems and offer the greatest probability of ensuring income and cash flow during the initial phase of tree establishment. Compared to pure grazing systems, silvopastoral systems may help alleviate problems related to soil compaction (Belsky *et al*, 1993), low nutrient status (Velasco *et al*, 1999) and seasonality of forage and livestock production (Ibrahim *et al* 1999). Their greater biological diversity may also help diversify production and increase income or savings (Botero *et al,* 1999). Silvopastoral systems may perhaps be best viewed, from a large farmer perspective, as a transition from extensive livestock-based systems to those based on more productive perennial crops, and from a small farmer perspective, as an option for increasing system diversification.

Three broad research lines for developing silvopastoral systems include: 1) pasture improvement; 2) tree or perennial crop selection and management; and 3) interactions of trees with annual crops or pastures. The identification of actual research themes within these lines should be based on a process of diagnosis and evaluation that includes the full and active participation of relevant stakeholders.

More intensively managed, more productive pastures can free land and produce capital needed for investment in other alternatives without jeopardizing farmer income. Nevertheless, in view of the nature and constraints on the cattle-based systems studied, alternatives for the establishment, enrichment or maintenance of more productive pastures should require low costs and inputs and should be based on land use planning at the farm level to avoid intensification of pasture and animal management on unsuitable sites such as steep hillsides. Such techniques (Ayarza and Spain, 1991; Aluja *et al.*, 1991) have a greater chance of being adopted by cattle producers than other, more expensive, high labor or high input pasture recuperation technologies (Vera and Guzmán, 1991; Aluja *et al.*, 1991).

Within the context of low input technologies, special attention needs to be paid to the man-ipulation and management of natural ecological processes and vegetation. Low cost, locally available tools that should be investigated include: 1) the controlled use of fire; 2) shade tolerant pasture germplasm resistant to extremes in moisture; 3) leguminous cover crops that also serve as forages, protect soil, and increase nitrogen in animal-tree mixtures; and 4) development of management tools for establishing trees in pastures. Research results from the Amazon (Uhl *et al.*, 1988; Nepstad *et al.*, 1990, 1991; Arevalo *et al.,* 1998) and from the Central America region (Ibrahim and Schlönvoigt 1999) need to be validated in each target zone. Locally derived alternatives, such as using *Mucuna* to recover soil fertility under pasture and rejuvenate lands compacted by cattle grazing (CONAP *et al.*, 1996), should also be investigated. Given the prevalence of dual-purpose systems managed by small and medium farmers, methods to make these systems more profitable or less environmentally destructive need to be developed. Potential themes include increasing stocking rates through the use of improved forages and increasing positive interactions between livestock and crops or trees in order to restore ecosystem health and intensify agricultural production.

Research on perennial fruit crops or timber trees for silvopastoral systems should concentrate on selecting high value commercial species that can tolerate the presence of cattle, for estab-lishment as living fence post or borderlines, and in pastures. Improved, low input management and processing

techniques for these species also need to be developed (see below). Species selection should be targeted to specific farmer strategies, availability and access to markets, labor and capital availability, farmer planning horizon and local agroecological conditions, and should include active farmer participation giving importance to their selection criteria which may differ from the agro-ecological criteria used by institutions. Since the ability of these systems to mitigate soil compaction and erosion often depends on species, spatial distribution and management techniques, technologies will have to be fine-tuned by farmers for specific situations. In some cases, such as the PDBL project in northern Honduras, economic and ecological analyses of many candidate species and technologies have already been carried out (PDBL 1995); this information needs to be adapted to other agroecological conditions.

Research on interactions between trees and crops or pastures should result in the identification of farm niches where such interactions can increase productivity, reduce environmental degradation, or decrease risk within the limitations imposed by capital, land or labor. Examples may include: 1) interactions of multi-purpose leguminous cover crops/forages with cattle and trees; 2) N_2-fixing timber species within pastures; 3) grazing of tree plantations or enriched secondary forest; and 4) seed dissemination of timber species *via* cattle. Research, such as that being carried out by Nitlapán in Nicaragua, on increasing the spatial and temporal presence of trees in grazing systems, by relying in large measure on ecological processes, is needed.

Perennial Crops

Perennial crops have many of the same niche requirements of current pasture-based grazing systems, and may be more profitable than the latter. Once established, they may help diversify income, add value per unit land, improve cash flow and reduce risk. However, they are often: 1) more demanding in terms of initial investment, maintenance and labor; 2) payback periods may well be longer than for cattle; and 3) flexibility in product output and ease of liquidation are often reduced, and market risk may be high (Hernandez Auerbach, 1995; Current *et al.*, 1995).

Again, a key question is how such plantations can be established and provide adequate income flows to the farmer. Farmers often prefer less intensive systems and the acceptable degree of management intensity is likely to vary inversely with farm size. Establishment of perennial crops *via* taungya or in line plantings, in which interactions with pastures or annual crops are minimized, are ways to ensure income from crops or cattle during the phase of tree establishment. One of the first steps is to screen potential perennial crops or timber species based on their ecological requirements and economically important characteristics, using the selection criteria of the farmers.

In the final analysis, the adoption of these alternatives will depend on how economic (local product scarcity, existence of markets, suitable prices for tree-based products, and the timing of yields and income flows) and technical characteristics (e.g. germplasm availability, ease of propagation and management, options for multiple use, interactions with other farm components, knowledge requirements) mesh with constraints on land, labor or capital, and institutional or technical support proffered on behalf of these alternatives (Current *et al.*, 1995). Since cattle producers typically possess little knowledge with regard to tree management (Ortíz Valverde, 1996; González Suárez and Miranda Báez, 1996), farmer training or technical backstopping on perennial or timber crop establishment and management will be needed as well as planting materials.

Forest Management or Conservation

The management of fallows, secondary forests or tree plantations may be attractive alternatives to grazing systems when large quantities of land are found in semi- or completely abandoned pastures or when government incentives for reforestation or secondary forest management or conservation exist. Large areas of young secondary forests in abandoned pasture, such as those in Nicaragua, represent an opportunity to redirect farmer development pathways towards more sustainable land use options.

As a low cost strategy, the establishment or enrichment of such forests should rely on the manipulation of ecological processes. Key questions needing answers are related to how beneficial ecological processes already underway can be amplified or channeled in order to increase the economic output of valuable fruits, timber, firewood, medicinal plants, secondary forest products or forages; and thus effectively converting these lands into productive agroforests. More information is needed on: 1) the composition and growth rates of secondary forests; 2) costs and benefits of technologies for improving these forests; and 3) farmer attitudes, objectives and constraints related to forest management.

In extensive areas of degraded pastures where potential seed sources are distant, secondary successional processes may be too slow for many small and medium farmers to consider. Under these conditions, plantation establishment may be desirable, but it requires a relatively high establishment and maintenance cost without a rapid return on the investment. Interplanting trees and crops in a taungya system can reduce these costs. Screening of existing data bases (e.g. MIRA in CATIE) related to tree performance, and analysis of national and international timber markets, should be essential steps in the process of formulating species recommendations. Low cost management techniques relying on locally available resources (e.g. the use of animals for weeding) also need to be identified and tested.

Participation in government incentive programs for reforestation or secondary forest management or conservation can also reduce farmer costs. These programs exist, some within the framework of credits for carbon sequestration, in Nicaragua and Guatemala, but not Honduras where such programs are impeded by land tenure regulations. Given the actual low economic profitability of pasture-based systems and the financial incentives offered by the Nicaraguan and Guatemalan governments for forest management or conservation, the latter options may be viewed favorably by many producers who presently manage extensive grazing systems. This conclusion is supported by studies of the valuation of land by small farmers in the Peruvian Amazon and the actual performance of such programs in Costa Rica. Smith *et al.* (1997) indicate that present values of payments to be made during 15 years, which small farmers in the Peruvian Amazon require in order to covert agricultural land to secondary forest or agroforestry systems, are about \$500 and \$300 ha^{-1}, respectively. These payments appear to be feasible given present outlays (approximately \$10 ton $C^{-1}yr^{-1}$) of many joint implementation carbon sequestration programs (Smith *et al.*, 1997) as well as present returns from cattle raising. Moreover, forest conservation incentive programs in Costa Rica, which currently pay out about \$230 ha^{-1} (non-discounted) during 5 years, have been widely accepted by farmers. Similar programs in Guatemala currently offer between about \$400 and \$2 300 ha^{-1} (non-discounted) depending on the area involved, for 5 years of natural forest management, \$380 ha^{-1} for reforestation, and about \$600 ha^{-1} (non-discounted) for 5 years of plantation maintenance (INAB, 1997). Given the low level of economic return on many pasture areas (for example, usually less than 2% in

Honduras), these payments may be sufficiently large in order to induce livestock owners to allow conversion of grazing land to secondary forest. However, further research is needed to better understand how and why farmers respond to such incentives and what is the minimum level required for the incentive to be accepted. Should conversion to forest not be feasible or desired, under-grazed systems may be reconverted to more productive pastures or other crops *via* a "hoof and tooth" strategy of heavy grazing followed by planting.

Information transfer and strengthening of farmer capacity

More effective information transfer, training and support systems are needed to disseminate useful technology and information to farmers, and increase their ability to analyze, evaluate and make critical adjustments in its use. Farmers in all regions voice the need for greater training and technical assistance, and such information is often associated with increased productivity (Nitlapán, 1995; Nolasco Rosa, 1998), but national research and extension systems have little presence in the regions studied.

In order to increase the effectiveness and leverage of limited national resources and donor funds, programs of technology generation and transfer should be based on farmer participation and should build upon the experience and activities possessed by projects, programs and organizations already active in these areas. Farmer capacity to develop and implement the above mentioned alternatives can be increased, and technology transfer costs reduced, by emphasizing participatory techniques such as farmer observation and experimentation, farmer-to-farmer training, or the formation of local para-technicians with appropriate backstopping provided by research or training entities. Dissemination techniques need to be adapted to producer constraints, abilities, and needs. For example, survey data suggest that larger producers may be more willing to invest in new technologies due to their better access to credit or ability to assume the investment or risk. Small farmers, whose main concern is subsistence, may be less able or willing to undertake drastic changes in their production systems. As a result, large farmers may be more disposed to institute major changes over large areas whereas small farmers may prefer a gradual, more piecemeal approach to the adoption of alternatives. Clearly these preferences have important implications for the type of extension program implemented.

Socioeconomic analysis

Many aspects of the technology generation and dissemination process discussed above imply a greater understanding of socioeconomic processes associated with farmer decision making. Studies should attempt to: 1) better understand farmer decision making related to natural resource use and pasture degradation; 2) clarify the constraints to adoption of alternative and systems; and 3) outline the environmental and socioeconomic costs and benefits associated with pasture land degradation, and with alternatives to grazing, and quantify their impact. For example the following studies may all be relevant: 1) studies of interactions among credit availability, farmer resources, characteristics of alternative systems and degree of technology adoption; 2) gender analysis of farm decision making and resource management; and 3) the analysis of impact of different information transfer systems.

At larger scales, an increasing focus on national and international markets creates a need for more forward-looking analyses of current and projected markets and more sophisticated market support for products originating in alternative systems (e.g. projection of demand, information on product norms or standards, processing techniques). The results from such market intelligence systems need to be made available to both decision makers and farmers.

Institutional development and strengthening

Private sector institutions, such as NGO's and producer organizations, are likely to play an increasingly important role, both in the generation and dissemination of information and technology as well as in assuring the availability of germplasm, inputs and credit which will be needed to promote alternative production systems. The experience or presence of such groups can help reduce the costs and risks of adopting new practices and have been shown to be associated with increases in productivity (DICTA, 1998). However, the organization and administration of these institutions, especially community and producer organizations, needs to be strengthened in order to increase technical and administrative capacity and to gain commercial leverage.

Changes or strengthening of public institutions may also be needed to improve systems of generation and dissemination of technical or market information, improve transportation or commercial infrastructure, or offer financial incentives to stimulate the establishment and adoption of new technologies. Some financial incentives for the adoption of alternatives (e.g. carbon credits) have already been mentioned in the case of secondary forest management or conservation, but other non-traditional (and non-governmental) schemes for providing credit or inputs (e.g. debt for reforestation swaps, community credit institutions) need to be considered. In general, greater collaboration and coordination among private sector organizations, government institutions and projects presently active at both regional and local levels will be necessary to help achieve a critical mass of institutional resources and expertise that can be harnessed in the pursuit of common goals in target regions.

Policy

Finally, given the exogenous nature of many of the factors which exert control on grazing systems or their alternatives, changes in policies related to land tenure, commercial chains, credit, financial incentives for certain crops or types of land use, and greater coordination among state and private sectors may stimulate greater adoption of alternative land use systems. However, it is clear that many livestock producers will readily change their grazing systems to perennial crops even without government intervention, as evidenced by the rapid conversion of pastures to oil palm and the diversification of small hillside farmers in the PDBL project in northern Honduras. Although more specific, in-depth policy analysis is needed for each region, in general the aim of such policies should be to establish a framework that eliminates disincentives (Table 16) and stimulates improved profitability, more efficient use of resources, and capacity strengthening of producers, rather than providing specific regulations, price supports, quotas, etc.

Target areas and farms

Given the quantity and geographic distribution of degraded pasture in the regions studied, and the limited resources available to attack the problem, prioritization of areas and farmers within each region is needed. Criteria used to select target areas and farm types may include: 1) the type and geographic importance of degradation; 2) representativity of the proposed target area and farm type; 3) the ability and willingness of the communities and owners to invest in improved technologies; 4) the probability of an ecologically and economically important impact of the technological changes proposed; 5) physical accessibility; and 6) a critical mass of other institutions or projects working in the area of interest.

The information we have gathered in this report suggests that work should initially focus on farms of about 35 to 150 ha in area. These farms account for a large proportion of the pastures and cattle in the regions studied. Moreover, their owners are likely to have a sufficient level of resources to be able to invest in alternatives without jeopardizing family well being. Systems targeted for change should include those that are most common; i.e. diversified farms with dual purpose cattle and extensive grazing systems oriented to dual purpose cattle or cattle development. The former system is apt to be managed by smaller producers, while extensive grazing systems are usually associated with larger farms and farmers. On the other hand, the following systems or farmers would be excluded: 1) large landowners due to their limited number and ability to tap other sources of technical assistance; 2) farmers whose chief interest is land speculation, due to their probable reluctance to invest in alternatives to grazing; and 3) specialized dairy farms, since they are small in number and usually more intensively managed.

If possible, two or three pilot communities should be targeted in each region. In central Nicaragua, these areas include the Muy Muy - Waslala - Rio Blanco triangle and areas south; i.e. humid hills and lowlands along the eastern side of the central cordillera in the departments of Boaco, Chontales and Matagalpa (Figures 1 and 9). This area has a high concentration of cattle, a humid climate, is topographically diverse, and has been designated by MAGA as a priority area. Within this area, the Muy Muy - Matiguás - Waslala - Rio Blanco area may have the highest priority due to its long history of grazing, accessiblity, topographical features, variety of types of degradation and the presence of other institutions.

In the Petén, potential target areas include the Las Pozas - Sayaxché - Las Cruces axis, the savannas around La Libertad, the Lake Petén - Melchor - Dolores triangle, and the Poptun - San Luis area. Among these sites, the Las Pozas - Sayaxché - Las Cruces axis and the Lake Petén - Melchor - Dolores triangle may have highest priority due to their accessibility, variety of types of degradation, institutional presence, and connection to international markets (Figures 10). Work in the savanna areas is not proposed because, in some cases, they have been grazed at low but sustainable levels for hundreds of years, and due to the low inherent productivity, it would be difficult to develop economically viable alternatives to cattle grazing in these areas.

In northern Honduras, two target areas and farming systems appear most relevant: 1) small diversified farms on the hillsides of the coastal plain and inland valleys which have a high erosion risk; and 2) medium-sized farms with extensively grazed pastures in the Aguán valley in the department of Colón.

Key actors and information sources

Given the nature of the forces contributing to pasture degradation, any program devoted to providing alternatives to grazing should direct attention to: 1) institutional and policy strengthening, formation and administration; 2) training of producers and strengthening of their organizations; and 3) the generation and dissemination of technical information. Below, we attempt to identify, institutional actors in each of the three countries that have a potentially important role to play in either the implementation of alternatives or as sources of information about farming systems, farmers or technologies. More details on these institutions and their programmes are given in Annex 1.

In Nicaragua, potential partners include those active in research or rural development, such as INTA and the National Livestock Program of MAG, the CIAT Hillsides Program, the National Program for Rural Development (PNDR), the Micro-regional Development Project of Rio Blanco (PRODERBO), CATIE, the National Agrarian University (UNA), the Central American University (UCA) and the research and policy institute, Nitlapán (Instituto de Investigación y Desarrollo de la Universidad Centroamericana). Potentially important private sector groups include: the Federation of Livestock Producers of Nicaragua (FAGANIC), the National Union of Farmers and Livestock Producers (UNAG), and the National Livestock Commission of Nicaragua (CONAGAN). The potential collaboration of other NGO's working with farmers or institutional development requires consideration.

In the Petén, the General Directorate of Livestock Services (DIGESEPE) of MAGA, the National Institute of Agrarian Transformation (INTA), and the General Secretariat of the Economic Planning Council (SEGEPLAN) are key state institutional players and sources of information. The Petén University Center (CUDEP) is the main local academic institution and serves as local counterpart for many internationally funded research and development projects. Some of the faculty from the University of San Carlos in Guatemala City may also serve as potential counterparts or information sources. Non-governmental organizations working in institutional strengthening or farmer organization in potential target areas include the Socioeconomic Reactivation of the Agricultural Cooperatives of Repatriates of Usumacinta, Pasión and La Machaca, and the Sustainable Natural Resource Management (PMS) Projects funded by Germany. The BMZ-GTZ also funds projects on institutional strengthening and agroforestry near Sayaxché.

In northern Honduras, governmental technical assistance and information institutions have offices in Atlántida and Colón. These include the Directorate for Agricultural Science and Technology (DICTA) of MAG and the State Forestry Administration - Honduran Corporation for Forest Development (AFE-COHDEFOR) that provides technical assistance for forest management, regeneration and protection of private and communal (*ejido*) forests. In addition, the Honduran Foundation for Agricultural Research (FHIA) is involved in research on important annual and perennial commercial export crops such as cocoa, bananas, plantains and black pepper and can serve as an important source of information and germplasm. Academic institutions that may make potential contributions include the Regional University Center of the Atlantic Coast (CURLA), the Panamerican Agriculture School (EAP/ Zamorano) and the John F. Kennedy Technical School. However, research and extension activities of these institutions in northern Honduras are currently limited. In the private sector, important institutions or projects include: the National Federation of Livestock Producers of Honduras (FENAGH) which represents 10 producer organizations and more than 1,300 producers in the region (see Table 19, Annex 1). FENARGH also participates with DICTA in a program to provide privatized forms of technical assistance to groups of small and medium-sized milk producers in Colón and Atlántida. The Broadleaf

Forest Development Project (PDBL) is perhaps the most longstanding and influential project in the region. The purpose of the Project is to reduce deforestation in the Atlántida region *via* the promotion of forest management, agroforestry systems, the sustained use of natural resources and the strengthening of the capacity of local institutions and groups of small farmers in 29 communities. This project has produced a great deal of detailed information on farming systems and the performance of different technologies and alternative systems, most of them based on trees. It also maintains germplasm banks of native trees that are commonly found in agroforestry systems (PDBL, 1995). The CIAT Hillsides Program mainly works outside the region of interest, but its geographically referenced geophysical and socioeconomic database for Honduras (CIAT, 1997) and experience with participatory tools and methodologies for natural resource management in Honduras and other countries, could be valuable contributions. The Livestock Fund of Honduras, S.A., a private enterprise with mixed capital operated by groups of small and medium-sized producers, currently has five ranches under direct control and provides technical assistance to members. Finally, although many NGO's work in Honduras, it appears that few are active in Atlántida or Colón. Further work is needed to identify potential local NGO partners.

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ANNEX 1. Institutions and projects in the regions of interest

Nicaraguan Institutions and Projects

The institutional and regulatory setting for the Nicaraguan livestock and agricultural sector is complicated. A variety of government institutions and NGO projects are involved in agriculture, natural resource use and management, and rural development activities which have indirect or direct impacts on cattle production. Moreover, the state agricultural sector is in the process of extensive revision and reorganization. The overall goal of these changes is to increase productivity, profitability and well-being of the rural sector *via*: land titling; stimulation of credit in rural areas; promotion of rural development (including provisions for financial aid in the form of coupons for the capitalization of farms and the purchase of infrastructure, inputs and services); an increase in the generation and transfer of technology; improvements in commercial and rural infrastructure; and the administration and management of forest resources (MAG, 1998a).

State institutions

Under the present system, five state institutions form part of the **National Council for Agriculture (CONAGRO)**, an entity whose purpose is to provide coordination and consultation within the agricultural and livestock sectors. These institutions include the Ministry of Agriculture and Livestock (MAG), the Ministry of Natural Resources (MARENA), the National Program for Rural Development (PNDR), the Nicaraguan Institute for Agrarian Reform (INRA) and the Nicaraguan Institute for Agricultural Technology (INTA) (MAG, 1998a).

The Ministry of Agriculture and Livestock (MAG) has responsibility for formulating, organizing, regulating and executing government policies and activities related to agriculture and livestock. The chief responsibility for livestock lies with the National Livestock Program.

Recently formulated objectives of the **National Livestock Program** include: to improve the efficiency and productivity of livestock in order to increase profitability, family food security, and national livestock herds, *via* elements which affect the prices received by the producer, increases in animal productivity and reductions in the costs of production. The Program contemplates activities in training of producers and technical personnel, technical assistance, promotion, infrastructure development and improvement, and coordination, using existing state and non-governmental channels (Table 17). Priority areas include: animal genetics and reproduction; animal nutrition; marketing and commercialization; quality control; animal health; silvopastoral systems (including forage banks, grazing in forest plantations and natural regeneration of degraded grazing areas) and infrastructure. The target population includes cattle producers, mainly in Chontales, Boaco and Matagalpa, having 7 to 175 ha of land and 15 to 150 animals. Innovative aspects of the Program include the formation of Centers for the Promotion of Livestock Development in the above departments, and the creation of a fund for direct financing of part of the cost of inputs for cattle producers in order to stimulate the adoption of new technologies (Table 18) (MAG, 1998b).

Table 17. Potential cooperating institutions in Chontales, Matagalpa-Jinotega, and Boaco in training, technical assistance and financing programs aimed at the adoption of improved livestock technologies (MAG, 1998b).

Chontales	Matagalpa-Jinotega	Boaco
PMA-Lechero	Asn. Gan. Matiguas	Asn. Gan. Boaco
*Asn. Gan. de Chontales (ASOGACHO)	Asn. Gan. Rio Blanco	Coop. Masiguito
Asn. Gan. La Libertad	Asn. Gan. San Ramon	Coop. Cerro Alegre
Asn. Gan. Cuapa	Coop. El Tuma-La Dalia	Coop. San Francisco
Asn. Gan. Acoyapa	Coop. Esquiplas	PMA-Lechero
Asn. Gan. Sto. Domingo	Soc. Gan. de Matagalpa (SOGAMAT)	PRODEGA
Asn. Gan. Villa San Francisco	CEE Waslala	INTA
Asn. Gan. San Pedro	PRODERBO	NGO´s
Asn. Gan. Comalapa	PNDR	
Coop. Sto. Tomas	PROLACSA	
Coop. Ayote	INTA	
Coop. Muelles	CARE	
Coop. Rama		
PRODES		
UNAG		
PNDR		
PRA-DC		
NGO´s		

* ASN= Association; Coop= Cooperative; Gan= Ganadero Cattle rancher ; Soc= Society

Table 18. Livestock sector inputs which can be partially financed by the Nicaraguan National Livestock Program (MAG, 1998b).

Item	Description	Programme contribution	Producer contribution	Notes
Paddocks	Establishment of pastures, fences, etc.	50% to a maximum of $100/0.7 ha	50%	Will aid a maximum of 2,8 ha. 7 500 producers total
Infrastructure	Milking infrastructure	70% to a maximum of $700	30% (labor)	1 428 producers total
Breeding bulls	Purchase and interchange of breeders	50% of cost of breeders of national origin or 30% of breeders of foreign origin to a maximum of $500	50% or 70%	Purchase of 1 breeder (in exchange for 1 bull). 5 000 producers total
Insemination	Provide semen	100% to a maximum of $10/dose	0%	Will provide a maximum of 30 doses to each producer. Producer assumes cost of insemination. 1 000 producers total
Animal health	Provide vaccinations and deparasitization	50% to a maximum of $3,5/animal/yr	50%	Maximum of 40 animals per producer. 10,000 producers
Mineral salts	Provide mineral salts	50% to a maximum of $6 per animal/yr	50% Salts for a maximum of 40 animals per producer. 10 000 producers	

The Nicaraguan Institute for Agricultural Technology (INTA) is the arm of MAG responsible for generation and transfer of agricultural, agroforestry and livestock technology. Its main clients include small and medium-sized farmers. The soil, water, agroforestry, and the livestock and pasture programs of INTA will generate and transfer technology related to the management and improvement of pastures and livestock, the production of seed of forage species, soil and water conservation, and agroforestry technologies (including living fences and barriers, windbreaks and home gardens) (MAG, 1998b). At the present time, however, the livestock program of INTA is limited by restrictions on budget and personnel. In the Chontales, Boaco, Zelaya and Rio San Juan region, the program currently involves only about 2% of the livestock producers (INTA, 1997).

In addition, INTA will also be responsible for administering a fund established by the government to finance technology research (FAITAN). Governmental and non-governmental organizations, universities and consultants, both foreign as well as national, are invited to submit competitive proposals in the following priority areas: genetic improvement of crops and animals, integrated management in silvopastoral systems, agroforestry development and the environment, and systems and technologies for agricultural diversification. There are also plans to reactivate, with CONAGAN, the National Center for Genetic Improvement and to strengthen the humid zone research station in Nueva Guinea (MAG, 1998a).

The National Program for Rural Development (PNDR) has a number of projects with relevance to livestock activities in central Nicaragua. These include: the Micro-regional Development of Rio Blanco (PRODERBO), the Milk Development Program (PMA), Rural Livestock Development (PRODEGA) and the Program of Poles of Development (POLDES).

Programs of the **Ministry of Natural Resources (MARENA)** of relevance to livestock activities include: the **Socioenvironment and Forestry Development Program (POSAF)** which promotes silvopastoral systems (forage trees and living fences) in small and medium-sized farms in the San Francisco and Molino Norte watersheds in the department of Matagalpa (POSAF, 1997); the Center for Forest Genetic Improvement and Seeds; the Agricultural Frontier project (CCAD), the Reform of Natural Resource Policy (PROTIERRA) and the Program for Assistance to Environmental Management (MAG, 1998a).

The Nicaraguan Institute for Agrarian Reform (INRA) has an indirect effect on livestock activities through its activities in land surveying, titling and tenure.

Nicaraguan and foreign universities impinge on the livestock sector through their research and education programs related to livestock and pasture management. Nicaraguan universities include the **National Agrarian University (UNA),** the **Central American University (UCA)** and the **Polytechnical University (UPOLI)**. Within the UCA, a semi-autonomous research and policy institute, **Nitlapán (Instituto de Investigación y Desarrollo de la Universidad Centroamericana)**, is active in 6 programmatic areas including: applied research; studies of rural development; financing for local development (microcredit to producers); productive reconversion (diversification and appropriate technologies, with credit for agroforestry, living fences, animal traction and non-traditional crops such as organic sesame and broom sorghum); and formation of promoters of rural development. The Institute also provides consultant services in these areas. It presently has activities in the Rio Blanco/ Matiguás area.

Collaboration with foreign universities or scientific institutes includes the University of Florida/ Gainesville, Texas A&M University, and perhaps most importantly, the **Tropical Agriculture Center for Research and Higher Education (CATIE)**.

NGO´s and projects

The Nicaraguan countryside is flooded with projects managed or promoted by private organizations and NGO´s. At least 40 private organizations provide assistance to 15 000 small and medium-sized farmers. Of these, eight of them administer close to 50 projects worth $523 million (MAG, 1998b). Other organizations involved in technical assistance or training include producer organizations. They serve mainly small and medium-sized farmers, while NGO´s work almost exclusively with the latter. Regardless of the organization involved, training is concentrated on farmers in accessible areas.

Private sector agriculture and livestock organizations include: the **Federation of Livestock Producers of Nicaragua (FAGANIC),** the **Nicaraguan Union of Milk Producers (UNILECHE),** the **National Union of Farmers and Livestock Producers (UNAG)** and **Campesino-A-Campesino.** Of these, FAGANIC and UNAG are probably the most important in terms of area of coverage, numbers of members or activities aimed at livestock and pasture improvement. These 6 organizations form a national confederation of livestock producers, **CONAGAN,** whose purpose is to promote the livestock sector and its members. CONAGAN has been responsible for collaborating with MAG in the reactivation of the National Center for Animal Genetic Improvement, the National Pasture and Livestock Programs, and the Nicaraguan Livestock Producer magazine. Recently the Commission has begun to reorganize its strategy in order to assume more responsibility for technical assistance, genetic improvement, and animal nutrition and health, previously assumed by the state (Arguello Salinas, 1996).

Legal framework

There are a variety of laws that attempt to regulate the inventory of cattle and which provide sanitary standards for milk and meat (Arguello Salinas, 1996; MAG, 1998a). However, laws most relevant to alternatives to grazing include recent changes in forestry legislation. These changes include: the billing of forest extraction industries for the reforestation of exploited timberlands; changes in bank regulations so that clients no longer have to deforest in order to show possession of lands for which credit is requested; the establishment of programs designed to bring together indigenous communities and researchers in the management of forests and degraded lands; the reforestation of eroded lands with timber, forage or multi-purpose trees (especially in exchange for debt of livestock owners); and the management of secondary forests. New regulations will also encourage the use of silvopastoral systems in livestock systems and the establishment of forest plantations for energy, pulp, paper and fiber (plywood) (MAG, 1998a).

Institutions and Projects in the Petén

State Institutions

All state Ministries, as well as other institutions, are present in the Petén. There are also some 40 NGO's and other groups. The majority of the projects and NGO's present are involved in activities in or around the Maya Biosphere Reserve and pay relatively little attention to the southern Petén. In general, institutional leadership at the regional as well as community levels is weak. The main institutional actors concerned with land use, natural resources and agriculture are described below (MAGA, 1997; MAGA/GTZ, 1997; SEGEPLAN, 1993).

The Ministry of Agriculture, Livestock and Food (MAGA) has a vice-minister assigned exclusively to the Petén. The Ministry puts a high priority on the stabilization, reactivation and modernization of agricultural production. The MAGA contains the **General Directorate of Livestock Services (DIGESEPE),** which executes agricultural and livestock development projects, the **Agricultural Science and Technology Institute (ICTA),** which coordinates and conducts agricultural research, and the **General Directorate of Agricultural Services (DIGESA),** which is dedicated to coordinate and develop agricultural extension services. The latter two institutions are not active in the Petén.

The National Forest Institute (INAB) is charged with executing forest policy and promoting development of forestry *via* sustainable forest management, reforestation, industrial activities and the promotion of forest research by universities and other entities.

The National Council of Protected Areas (CONAP) is responsible for national policy related to biodiversity and the national system of protected areas (SIGAP).

The National Commission of the Environment (CONAMA) is responsible for coordinating and advising all the activities related with environmental protection and improvement in the Petén. Since it lacks equipment and personnel, its actual function is more oriented towards representation and coordination.

The National Institute of Agrarian Transformation (INTA) assumed the responsibilities of FYDEP upon its dissolution. The Institute is in charge of land surveys, colonization projects and land titling.

The General Secretariate of the Economic Planning Council (SEGEPLAN) coordinates the public administration of the Petén, elaborating program plans and integrated development projects at the sector and regional level. Within this context, SEGEPLAN has provided important input in the elaboration of the Plan of Integrated Development (PDI) and the Program for the Protection of the Tropical Forest of the Petén (PROSELVA) in the southern part of the department.

The Rural Bank (BANRURAL) is the state financial institution that provides credit to farmers.

The Petén University Center (CUDEP) has as its mission: research, teaching and extension. The University has a center for documentation, a small library, and an experimental farm for demonstrations of agricultural, livestock and agroforestry technologies. CUDEP also acts as counterpart to

the Maya Center, CATIE, CARE and other NGO´s in various projects related to agroforestry or natural resources.

At the municipal and department levels, there are **Councils of Urban and Rural Development (COREDUR)** which are mixed state - private committees to promote social and economic development at the department and municipal levels. The lack of clear political guidelines for the local Development Councils has contributed to a lack of effectiveness with regard to the sustainable use of natural resources (SEGEPLAN, 1993).

NGO´s and Projects

In general, community organizations are not very strong except among the Kechís indigenous group who are most concentrated in Sayaxché and San Luis. This is due, in large measure, to the diversity of origin of many of the inhabitants, large internal migrations in the Petén, and the desire of many of the settlers to eventually return to their site of origin (Cabrera *et al.*, 1997; SEGEPLAN, 1993).

There are a number of important projects and NGO´s operating in the Petén (MAGA, 1997; MAGA/GTZ, 1997). The majority of their activities, however, are centered on the Maya Biosphere Reserve.

The Maya Center Project is a private non-profit NGO, funded by USAID and other private donors, that is dedicated to research and extension related to integrated and sustainable land use systems including agricultural, livestock and forestry. Besides having its own technical personnel, the Center also receives technical assistance from: the University of San Carlos, Guatemala; CATIE; MAGA; and the Rodale Institute. The Center has six programs: soil use and management; regenerative or sustainable agriculture; animal production; forest management; Maya agroecosystems; and rural extension. It is presently working with five communities in the Biosphere Reserve buffer zone in the Usumacinta region. Actual activities related to animal or pasture management are limited to evaluation of grass and legume forage germplasm and silvopastoral systems.

The Socioeconomic Reactivation of the Agricultural Cooperatives of Repatriates of Usumacinta, Paslón and La Machaca is a project, funded by Germany, resulting from cooperation among the National Peace Fund (FONAPAZ), the National Commission for Attention to Repatriates, Refugees and Displaced Persons (CEAR) and IICA. It provides individual or community agricultural credit, technical assistance and training to returning refugees. It covers 22 cooperatives (CEAR/IICA, 1992; MAGA, 1994).

The Sustainable Natural Resource Management Project (PMS) is a government project within MAGA and INAB, funded by Germany. It provides technical assistance in the sustainable management of natural resources at the municipal level and promotes community participation. Its objective is to generate and aid the implementation of plans for the integrated management of natural resources, with the participation of local ejido communities, in priority pilot areas. It assists with natural resource inventories and the preparation of management plans, and with institutional and community capacity building and development. Activities currently include 10 communities in the Sayaxché ejido, and the "Manos Unidos" cooperative (Gaitán Flores, 1994).

Conservation International (PROPetén) aims to promote the social and economic well being of the inhabitants of the Maya Biosphere Reserve through the rational use of natural resources. Although it works mainly in the Reserve, activities of potential interest include: reforestation, forest management, ecological enterprises, geographic information, monitoring and evaluation systems, environmental policy and legislation, and community organization and training.

The Nature Conservancy (Programa Petén) works within the Biosphere Reserve to develop local institutional capacity.

CARE (Proyecto Educaremos) forms part of a larger project (MAYAREMA), executed by CARE, PROPetén, CONAP and the Nature Conservancy, focussed on the management and conservation of the Biosphere Reserve. Educaremos is a project of environmental education, agroforestry extension and land titling in the northwestern Petén.

CATIE-OLAFO works in two communities within the Biosphere Reserve and is oriented to developing diversified forest management and agroforestry technologies.

GTZ funds a number of projects: an agroforestry project near Sayaxché with the Manos Unidos cooperative and a project of institutional strengthening of CONAMA (MAGA/GTZ, 1997).

Legal framework

For many years, the Petén was not incorporated clearly and explicitly in national policies since the region was under the semi-autonomous administrative unit of FYDEP. This attracted settlers interested in exploiting the natural resources with little respect for the laws (SEGEPLAN, 1993). In the case of livestock, land was almost given away.

Although the legal base in the Petén has changed, these attitudes still exist and are encouraged by the lack of effective law enforcement. Serious deficiencies include: the existing chaos in tenancy associated with legally ceded lands as well as those controlled by squatters; the lack of control of DIGEBOS with regards to deforestation; the lack of resources to extend the program of CONAP to the south; the lack of research or extension services; and the lack of control of the international borders of the Petén which contributes to the illegal exploitation of its resources (MAGA, 1994; SEGEPLAN, 1993).

The laws which most affect natural resource use in the Petén are those related to forestry, land tenure and the environment, and include the Law of CONAP, the Forestry Law, the Law of INTA, the Law of CONAMA, the Law of Petén Lands, and Decree 102-70. Most natural resource conservation policies have been oriented towards the prohibition of tree cutting (SEGEPLAN, 1993).

The Forestry Law names the state as the administrator and guarantor of the use and conservation of both public and private forests, with the exception of protected areas. All forest use is regulated by laws. Permits for tree cutting are allocated, *via* public bids, for concessions on public lands, and licenses for private forests. The latter are non-transferable and ought to include a management plan. According to this law, the concessionaire is responsible for reforestation but a number of loopholes in the law mean that this is rarely done in practice. In reforestation projects involving industrial or energy

plantations, usufruct rights are given to the concessionaire. Reforestation or forest management projects can also benefit from incentives if legal occupancy can be proved.

The Law of Land Adjudication and Tenancy outlines the rights and requirements related with the program of land concessions. The law gives preference to inhabitants of the Petén, to landless campesinos from other regions, as well as illegal squatters involved in productive activities on state lands. Some of the requirements of this law which affect land use are: the need to show an investment within one year after arrival; the stipulation that forests on areas destined for agricultural use be exploited first; the need to maintain forest reserves on an area equal to 20% of the total extension; the establishment of allotments no larger than 45 ha per associate of cooperatives and 675 ha in the case of persons or corporations; and the requirement of payment for land received. Concessions are non-transferable for a period of 20 years, after which time a title can be emitted. On the other hand, such rights can be rescinded if the lands have been abandoned for more than six months or if there is no effective use within one year after arrival. The latter thus favor use of deforestation, short rotation fallows or pastures; they do not favor the sustained use of forest or long rotation fallows since uncleared land is subject to recision or invasion. Land clearing is, then, considered an "improvement" and thus contributes to increases in land prices.

Institutions and Projects in Northern Honduras

State institutions

State institutions with activities directly related to livestock include the following (see AFE-COHDEFOR, 1994; IICA, 1995; SAG, 1998; Matute, 1998; Pomareda *et al.*, 1997).

The Secretary for Agriculture and Livestock (SAG) is in charge of policy and norms for the agriculture and livestock sector. Its current objectives are to improve sustainable rural and agricultural development by: 1) improving the access of small and medium farmers to technical assistance services, strengthening **the National Agricultural Technology Research and Extension System (SNITTA), the Agricultural Science and Technology Directorate (DICTA)**, and the **National Agriculture and Livestock Health Service (SENASA)**; 2) facilitating access to credit *via* promotion of a rural financing system composed of state and private institutions; 3) facilitating access to and guaranteeing secure land tenure *via* increases in the surveying and titling programs; 4) guaranteeing free trade both within and outside Honduras and improving the market information system; and 5) strengthening communication and interaction between the state and private agricultural sectors. Lack of funding has diminished the effectiveness of the laboratories and field personnel.

DICTA provides technical assistance and technology transfer to small and medium-sized farmers. These services were recently reorganized in three programs that differ in degree of privatization and in information transfer modalities. In the Commercial Extension Systems (SETs), private extension services provide the brunt of technical assistance to small groups of farmers. The Integrated Technical Assistance Systems (SATI) are more oriented towards crops than livestock and private extension services provide assistance to large groups of farmers. Finally, Extension Systems for Basic Agricultural Technology (SITABs), in which the state provides assistance to large groups of farm-

ers, are aimed primarily at subsistence farmers on hillsides. In Atlántida and Colón, DICTA is presently working, in collaboration with FENARGH and CIDA, with 7 SETs and 1 SITAB to improve the productivity of milk production operations among about 140 small and medium-sized farmers. At the national level, it is promoting seed production of improved pasture species *via* the PROPASTO program.

The Honduran Foundation for Agricultural Research (FHIA) is located on the northern coast and is involved in research on important annual and perennial commercial export crops such as cocoa, bananas, plantains and black pepper. It also maintains germplasm banks, manages an agroforestry demonstration-training farm and has included species trials of potential fruit and timber tree components of agroforestry systems on its experimental station close to La Ceiba.

The State Forestry Administration - Honduran Corporation for Forest Development (AFE-COHDEFOR) pertains to the agricultural sector. COHDEFOR is responsible for managing, regenerating and protecting national forests; supervising, controlling, promoting and providing technical assistance for forest management, regeneration and protection of private and communal (*ejido*) forests; and administering protected areas, wildlife and timber sales from national lands. Under Law 31-92, COHDEFOR no longer controls private or communal forests, but is responsible for approving and supervising requisite forest management plans for these lands. Lack of resources prevents COHDEFOR from complying fully with these responsibilities at the national or local levels.

The Office of the Environment of the Secretary of State (SEDA), created in 1993, is responsible for emitting norms and controlling and prosecuting illegal activities related with the following: environmental impact studies, the national system of protected areas, land use planning, and forest and watershed management. As such, many of its activities conflict with those of AFE-COHDEFOR.

The National Agrarian Institute (INA) is involved in land grants and titling, creation of a land bank for landless farmers, elimination of conditions which discriminate against women as a beneficiary of agrarian reform, and creation of seed capital in order to provide inputs for two years to recipients of land.

The National Agricultural Development Bank (BANADESA) has, in the last decade, greatly decreased its traditional participation in agricultural credit activities, as a result of the Law for the Modernization and Development of the Agricultural Sector (LMDSA). It has been replaced by private financial institutions and subsides to reduce interest rates for cattle raising have been eliminated. In recent years, one-third of its portfolio has gone towards livestock-related activities, but high rates of interest and low profitability of cattle raising have limited demand and disbursements.

Other institutions which, to a lesser degree, offer credit are: Industrial and Agriculture Financing (FIA), INA, savings and loan cooperatives, commercial vendors of agricultural products, NGO´s , private development organizations (PDOs), community banks and informal loan organizations. However, their coverage is limited and their financial sustainability is questionable.

Regional University Center of the Atlantic Coast (CURLA) has an educational program in agronomy at the BA level, but does little research or extension. It maintains germplasm banks in collaboration of the Broad-leaf Forest Development Project (PDBL).

SAG, INA, IHMA, BANADESA, IHCAFE and AFE-COHDEFOR also compose the Council for Agricultural Development (CODA) and the Agriculture Sector Technical Committee (COTESA) for the analysis, planning, coordination and evaluation of agricultural policies (SAG, 1998).

NGO´s and projects

The National Federation of Livestock Producers of Honduras (FENAGH), which represents more than 50 organizations of producers. Ten of these exist in the region and represent more than 1 300 producers, with a typical farm size of 105 ha and 150 head of cattle (Table 19). FENARGH has an agreement with SAG to administer records of animal genealogy. It also participates with DICTA in a program, funded by CIDA, to provide privatized forms of technical assistance to groups (SETs and SITABs) of small and medium-sized milk producers in the Departments of Yoro, Colón, Atlántida, El Paraíso, Copán and Olancho.

Table 19. Associations of Livestock Producers, Atlantic Coast of Honduras.

Association	Location	Number of Members
AGAA	La Ceiba, Atlántida	600
AGAT	Tela, Atlántida	150
AGADES	Sabá, Colón	60
AGAE	Bonito Oriental, Colón	75
AGAI	Ilanga, Colón	19
AGATC	Tocoa, Colón	130
ACISON	Sonaguera, Colón	23
COMVAL	Tocoa, Colón	45
ASAGANF	Nueva Florida, Yoro	44
SAGO	Olanchito, Yoro	150
TOTAL		1 296

Matute, 1998

The Broadleaf Forest Development Project (PDBL), funded by the Canadian International Development Agency (CIDA-ACDI), and implemented in cooperation with SAG, DICTA, AFE-COHDEFOR and INA, is perhaps the most longstanding and influential project in the region. The purpose of the Project is to reduce deforestation in the Atlántida region *via* the promotion of forest

management, agroforestry systems and the sustained use of natural resources, and the strengthening of the capacity of local institutions and groups of small farmers in 29 communities. Activities related to agroforestry include: reforestation and soil conservation on slopes; farming systems analysis; farm planning, resource mapping and management; nursery and germplasm banks; technical guides and financial analyses of a host of agroforestry, forestry, agricultural and livestock interventions; technology transfer; and training. In the context of silvopastoral systems, PDBL promotes: paddock management; the use of cut-and-carry sugar cane and improved forages; the establishment of living fences; and the planting of forage shrubs and trees in and around cropping and pasture areas. The project has had a good deal of success with crop diversification and also has worked on the improvement of fallows and the enrichment of shade tree strata in multi-strata systems. In general, it has produced a great deal of detailed information on farming systems and on the performance of different technologies and alternative systems, most of them based on trees. It also maintains germplasm banks (PDBL, 1995).

The CIAT Hillsides Program seeks mainly to develop, with farmer participation, more sustainable alternatives for natural resource management by small and medium-sized farmers on hillsides in Yoro. The Project has generated a geographically referenced geophysical and socioeconomic database for Honduras (CIAT, 1997) based largely on existing information sources and documents. Other potentially valuable resources include CIAT's experience with participatory tools and methodologies for natural resource management.

The Livestock Fund of Honduras, S.A. is a private enterprise with mixed capital (the state, participating producers and USAID). The Fund is operated by groups of producers to raise and sell livestock (about 25 000 head/year). It currently has five ranches under direct administration (one each in Colón, Atlántida, and Cortés), with the participation of 600 members, the majority being small and medium-sized producers. The Fund provides technical assistance to members and has a program for in-kind credit; it also participates in the SETs of DICTA.

The Pan-American Agriculture School (EAP/Zamorano) is mainly involved in training and education at the BA and Agronomic Engineer levels. It is the only Honduran educational institution that is active in research in pasture and livestock management, but its activities in northern Honduras are limited.

The John F. Kennedy Technical School trains students in agronomy.

The Credit Fund for the Development of Production (FONDEPRO) administers and channels medium and long-term credit *via* financial intermediaries to various sectors, including agriculture. In 1995, 66% of total credit was assigned to the latter.

The Food and Agriculture Organization (FAO) and the **Interamerican Institute for Cooperation in Agriculture (IICA)** are involved in agricultural research and policies, largely at the national or regional levels.

NGO's . According to Valle (1993) there are 63 NGO's that work in the agricultural sector and 76 environmental NGO's . The most important NGO's are: **CARE, Foster Parents Plan, World Neighbors, Global Village**, the **Honduran Association of Ecology**, and **World Vision**. The majority have activities in community organization and development, and training; some are involved in agroforestry (CARE and AHE), mainly with small farmers. Very few of these organizations have activities in the regions of interest.

Legal framework

(see AFE-COHDEFOR, 1994)

In general, the legal framework for land tenure and use, and natural resource management, is confusing, contradictory, and in many cases suffers from poor implementation. Land use is largely regulated by the Agrarian Reform Law as well as the Forestry Law, the Law of Creation of COHDEFOR, the General Forestry Regulations, the General Law of the Environment, Law 31-92, and the Law of Forest Incentives. The Agrarian Reform Law established limitations to property rights. It stipulated that land ceded to agrarian reform beneficiaries ought to be used efficiently and in harmony with its social function. Due to its vagueness, this law often obliges total use (i.e. clearing) since only 10% of allotted land can have forest cover regardless of its use capacity. Natural forest and long-term fallows are in general considered "unused" or "unimproved" land and therefore can be expropriated. Clearly, this affects the conservation of natural resources, natural forestry management, and generates uncertainty with regard to investments in productive activities.

Other laws that regulate the use of land include:

Law 31-92, which stipulates that owners of private or ejido forests must submit a management plan to COHDEFOR for approval and that cut forests must be replanted within two years. This law also states that COHDEFOR no longer controls all forests in Honduras nor is it responsible for timber commercialization;

the General Law of the Environment, which regulates, *via* land use planning, environmental impact studies and legal prosecution, human activities that affect the environment and land use; and

the Law of Forest Incentives for forest management, protection and reforestation, passed in 1994, which promised to provide important stimulus to forest establishment and management. Unfortunately, this law has yet to be implemented.

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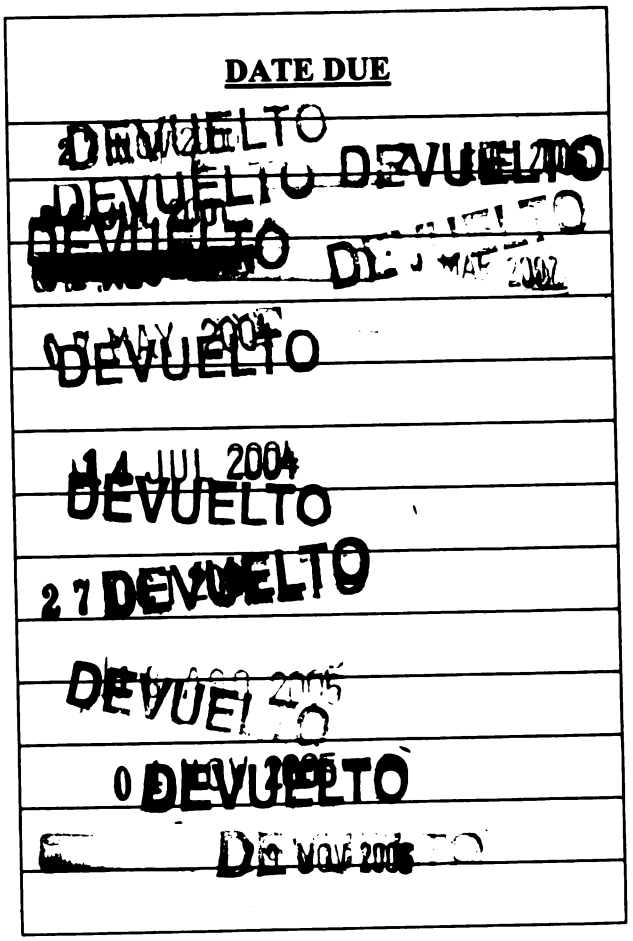
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