



Photo: Rogerio M. Mauricio/LEAD

Cattle ranching and deforestation

Over the past quarter century, forests have been cleared from an area the size of India.

Particularly in Central and South America, expansion of pastures for livestock production has been one of the driving forces behind this wholesale destruction.

Deforestation causes incalculable environmental damage, releasing billions of tonnes of carbon dioxide into the atmosphere and driving thousands of species of life to extinction each year.

Effective policies are urgently needed to discourage expansion of livestock production in forest areas and promote sustainable grazing systems that will halt the cycle of degradation and abandonment on cleared forest lands.

During the 1990s, the portion of the globe covered by forests shrank by an estimated 94 000 square kilometres a year, an area roughly the size of Portugal. Most of the land that was cleared and burned was converted to growing crops and grazing livestock (*graph 1*). In Latin America, in particular, most of the deforested land ended up as pasture used to raise cattle in extensive grazing systems.

Typically, the deforestation process starts when roads are cut through the forest, opening it up for logging and mining. Once the forest along the road has been cleared, commercial or subsistence farmers move in and start growing crops. But forest soils are too nutrient-poor and fragile to sustain crops for long. After two or three years, the soil is depleted. Crop yields fall. The farmers let the grass grow and move on. And the ranchers move in.

Little investment is needed to start raising cattle on cheap or abandoned land where grass is already growing. And the returns can be high, at least for a while. After just five to 10 years, overgrazing and nutrient loss turn the rainforest land that was once a storehouse of biological diversity into an eroded wasteland.



Short-term profits, long-term costs

The entire sequence of destruction and degradation, from lush forest to barren wasteland, often takes less than a decade. The environmental damage it wreaks is largely irreversible and will be felt worldwide for generations. Converting cleared forest lands to pasture frequently compounds the damage. The environmental impact of deforestation and pasture conversion includes:

Carbon dioxide emissions - Clearing and burning of forests releases billions of tonnes of carbon dioxide and other greenhouse gases into the atmosphere each year. Experts estimate that deforestation causes roughly one-quarter of all human-induced carbon emissions. Since trees absorb carbon from the atmosphere and convert it to woody tissue, deforestation also contributes to the buildup of greenhouse gases by destroying valuable “carbon sinks”. Pastures populated only by native grasses and cows absorb significantly less carbon than most other agricultural systems, including pastures planted with highly vigorous grasses or with shrubs and trees to provide fodder.

Loss of biodiversity - Tropical forests host more than 13 million distinct species, representing more than two-thirds of all the world’s plants and animals. Experts estimate that in the course of a decade between two and five percent of all rain forest species will become extinct, largely as a result of habitat loss caused by deforestation. Monoculture pastures are inhospitable to many species of birds and invertebrates that require diverse habitats.

Soil degradation - Fragile forest soils can support an abundance of life only because fallen leaves and branches provide nutrients, because the forest canopy protects them against the scorching sun and torrential rains, and because extensive root structures prevent erosion. When the trees are gone, the soil quickly becomes depleted. Native grasses provide few nutrients and little protection for the soil and overgrazing accelerates nutrient loss and erosion.

Water pollution - Forests often serve as nature’s water purification plants, as rain water percolates through soil held in place by the complex root structures of several layers of trees. Without the protective forest canopy and roots, the soil loses its capacity to retain water and is often

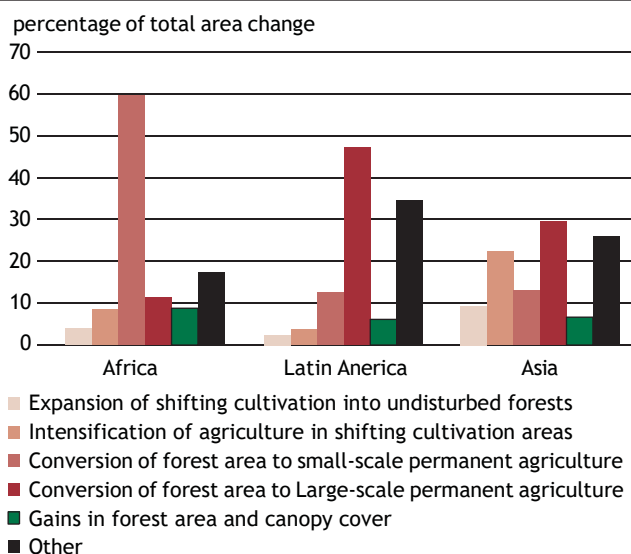
washed away into streams and rivers.

The link between deforestation and cattle ranching is strongest in Latin America. In Central America, forest area has been reduced by almost 40 percent over the past 40 years. Over the same period, pasture areas and the cattle population increased rapidly (*graph 2*).

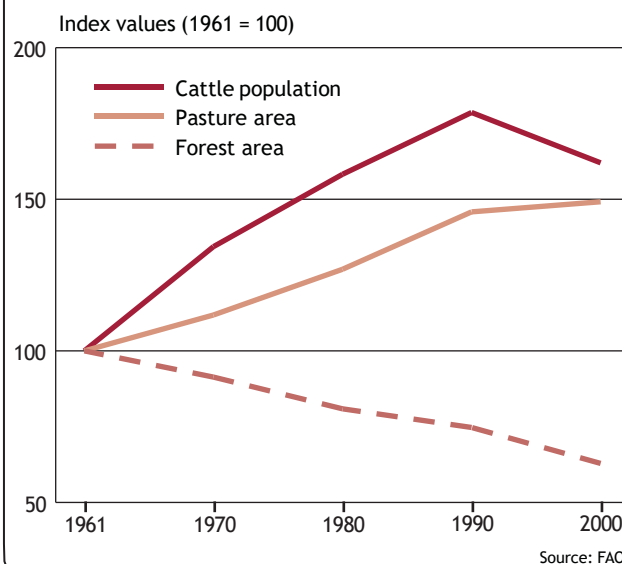
The Livestock Environment and Development Initiative (LEAD - www.lead.virtualcentre.org) recently used a sophisticated system for modelling land use change to predict the scale and location of deforestation and pasture expansion for the year 2010. The results confirm that extensive grazing of cattle will continue to expand, mostly at the expense of forest cover. If the projections are accurate, by the year 2010 cattle will be grazing on more than 24 million hectares of land that had been forest a decade earlier. Nearly two-thirds of the deforested land will be converted to pasture. The study produced a map highlighting “hotspots” of forest clearing and pasture expansion that can be used to focus the agenda for policies and research (*see map, facing page*).

A substantial and increasing share of deforested cropland is also dedicated to expanding livestock production through intensive, large-scale production of soybeans and other feed crops. Between 1994 and 2004, land area devoted to growing soybeans in Latin America more than doubled to 39 million ha, making it the largest area for a single crop, far above maize, which ranks second at 28 million ha. This trend has been driven mainly by the sharp increase in demand for livestock products, which led to a tripling of global meat production between 1980 and 2002. Most of this increased production came from large-scale, intensive livestock operations in China and other East Asian countries, where land scarcity has led producers to rely increasingly on imported feed. This demand for feed, combined with other factors, has triggered increased production and exports of feed from countries like Brazil where land is relatively abundant, partly as a result of deforestation. Some of the policies highlighted here may help to address the role of increased feed production in deforestation, but a full discussion of the problem and of policy options for dealing with it fall outside the scope of this brief.

1 - Percentage of forest area change by change process, 1990-2000



2 - Forest area, pasture area and cattle population in Central America, 1961-2000



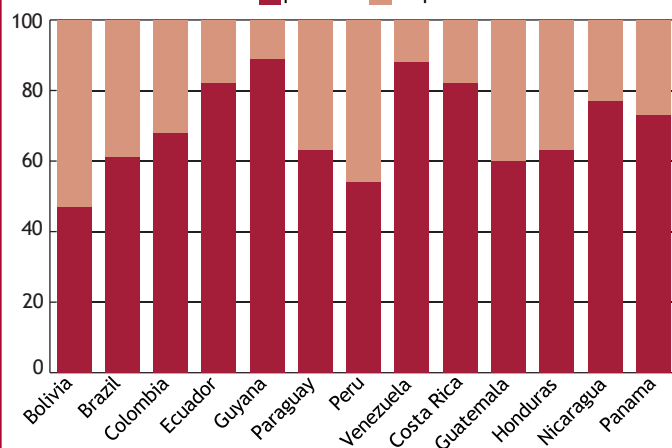
Projected deforestation hotspots and diffuse deforestation areas, 2000-2010



3 - Share of deforested land converted to pasture and cropland, 2000-2010

Percentage of total deforested land projected to be converted to

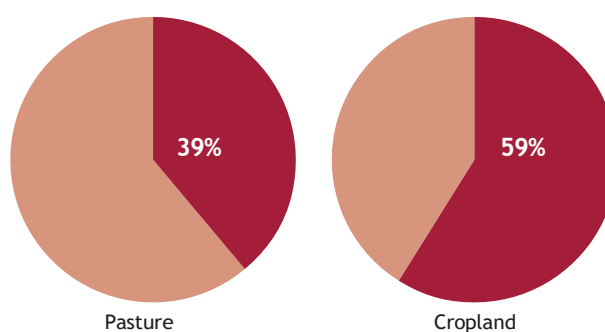
■ pasture ■ cropland



4 - Share of deforested land in hotspots (deforestation in closed forest) and diffuse deforestation areas (deforestation in fragmented forest), 2000-2010

Percentage of total pasture/cropland expansion into forest expected to take place in deforestation hotspots and diffuse deforestation areas.

■ hotspots ■ diffuse deforestation areas



Source: LEAD

Setting the policy agenda

Destruction of forest lands through conversion to pasture takes place in distinct areas and stages.

The large-scale burning clearly visible in satellite images and occasional television reports occurs mainly along the “agricultural frontier”, where farmers and ranchers invade previously intact forests. But a great deal of deforestation also occurs in areas where forests have already been fragmented by fields, pastures and settlements. The LEAD projection of pasture expansion in South and Central America concludes that less than half the area deforested between 2000 and 2010 will be located within hotspots (*graph 4 and map*).

Destruction of forest areas also occurs in two distinct stages - the initial clearing of the forest as trees are felled and burned and the rapid degradation and abandonment of the land that almost inevitably follows.

To be effective, policies must address the specific realities and challenges of deforestation, not only on the forest frontier but in areas of diffuse deforestation.

A study in Mexico, for example, found that conversion of forest lands at the frontier is driven predominantly by price incentives. The calculations are simple. Forest land is cheap. Cattle can be raised on land with very low productivity and with very little investment in inputs and contracted labour. And they can be transported and marketed relatively easily, providing a great deal of economic flexibility and income-generating capacity with far less investment and risk than other land use options. This makes cattle raising a very attractive and convenient proposition, even where productivity per animal or per hectare is low - which is almost always the case on cleared forest lands.

In areas with medium forest cover, on the other hand, the study found that deforestation was driven mainly by poverty. Frequently, smallholders expanded further into marginal forest lands to make up for the declining fertility and productivity of their existing fields and pastures.

Policy decisions must be based on an understanding of the factors driving deforestation and on the participation of stakeholders in these different areas. And they must also target not only the initial clearing of the forests but the subsequent destruction of the fields and pastures that have been cleared.

Halting the cycle of soil degradation and abandonment is important on two counts. It can prevent further losses of environmental resources and even restore some of the capacity of former forest lands to serve as nature's storehouses for atmospheric carbon and biodiversity. And by keeping existing pastures and farm lands fertile and productive, it can reduce pressures for further invasion of forest lands.

Technical options are available that can slow the pace of deforestation and halt, or even reverse, the process of pasture degradation. Large-scale, commercial livestock operations can shift from extensive grazing systems towards more intensive production based on improved breeds, feeds, pastures and animal health. A comprehensive policy approach is required, however, both to ensure that more intensive production does not simply stimulate increased forest clearing to grow feed crops and to minimize other

environmental and public health problems often associated with poor manure management in industrial systems (see *Livestock Policy Brief 02*).

Smallholders can be encouraged to raise livestock along with a variety of annual and permanent crops in mixed farming and agroforestry systems that protect the soil with year-round cover and replenish it with recycled nutrients. Silvopastoral approaches in which pastures are planted with improved grasses, fodder shrubs and trees can prevent soil degradation, improve watershed management and provide a varied habitat for a wide range of biodiversity.

In the long run, these approaches can help prevent deforestation and soil degradation and can ensure that livestock are better fed and more productive. In the short run, however, they may require investments larger than impoverished smallholders can afford or than ranchers and speculators are prepared to make as long as clearing forest lands remains a low-cost, low-risk alternative.

Improved technology can be a key element in reducing pressure on tropical forests, but only in the context of policies that make the investment in adopting sustainable techniques more attractive and the returns on deforestation less so. One benchmark study found that policies were four times more effective than technology in slowing the advance of the agricultural frontier.

Addressing the connection between livestock production and deforestation requires comprehensive policy initiatives on many fronts. As a starting point, that means eliminating any vestige of policies that actually fanned the flames of deforestation in many countries until recently. Examples of such policies include:

- unconsidered road building projects that open forested areas for mining, logging, settlement and commerce;
- tax policies and subsidies intended to support expansion of beef production and exports as a way to accelerate economic growth and strengthen trade and foreign exchange balances;
- migration and colonization projects intended to alleviate population pressure and poverty by making land available to households willing to migrate to forest areas with low population density;
- land titling schemes that encouraged deforestation by allowing expropriation of “under-utilized” forest lands and awarding farmers and ranchers legal ownership of lands that they have cleared and occupied. Because livestock production requires relatively little start-up capital compared to raising crops, it was often perceived as an easy way to establish ownership, both by ranchers and by land speculators.

Many countries have already eliminated such policies as a first step toward slowing the advance of the agricultural frontier. A variety of other policies for stemming the overall process of deforestation can also help reduce the conversion of forest lands to pasture, including measures to

- improve land use planning. This requires in-depth monitoring and analysis of deforestation to identify causes and effects and pinpoint the areas at greatest risk. Armed with this knowledge, policymakers can establish clear restrictions on land use, identify critical areas that should be protected and use a variety of taxes,

regulations, incentives and other policy instruments to discourage deforestation and encourage sustainable livestock production on more suitable lands;

- discourage road construction and improvement in most forest areas. Experience proves that where roads go, deforestation is almost sure to follow;
- establish and enforce protected areas, employing participatory processes that involve neighbouring communities;
- create buffer zones around protected areas and biological corridors between remaining patches of forest, within which cattle raising is prohibited or strictly limited;
- expand indigenous land rights and develop common property regimes to support sustainable use and management of forest resources by non-indigenous people;
- adjust land tax policies to discourage deforestation. Levying higher taxes on fields and pastures than on forested lands can discourage deforestation and encourage landholders to retain or restore forest cover on watersheds and marginal lands;
- prohibit or eliminate subsidies for credit that encourages conversion of forest to pasture, particularly in agricultural frontier regions. This might be accomplished in a variety of ways, such as prohibiting credit for cattle, or for ranchers whose herds exceed a specified number of animals, or for farms located in areas where the risk of deforestation is high.

All of these policies could help slow the advance of the agricultural frontier. Their impact can be amplified by implementing policies and promoting technologies to reduce diffuse deforestation and prevent soil degradation on cleared forest lands. Here, too, the policy options are many and varied, including measures to:

- improve conditions and opportunities behind the agricultural frontier. Upgrading human services and rural infrastructure and creating more opportunities for non-farm employment in existing rural communities could reduce the attraction of pioneering on cleared forest land.
- remove distortions that favour traditional, grass-based monocultures over silvopastoral systems.
- use zoning regulations to control where and how intensively livestock can be raised. If highland areas with steep slopes cannot support grazing for more than five or six years, for example, use can be restricted to reforestation or growing fodder banks and permanent crops that keep the soil permanently covered. On other lands, limits can be set for the number and size of livestock permitted, based on the vulnerability of the land to soil degradation and erosion.
- support improved access to credit for smallholders. Poor livestock producers often resort to clearing more forest land because they cannot afford the investment needed to adopt more productive and more sustainable technologies on their existing lands. Making credit more readily available and affordable would allow them to make such investments.
- support research and extension to develop and

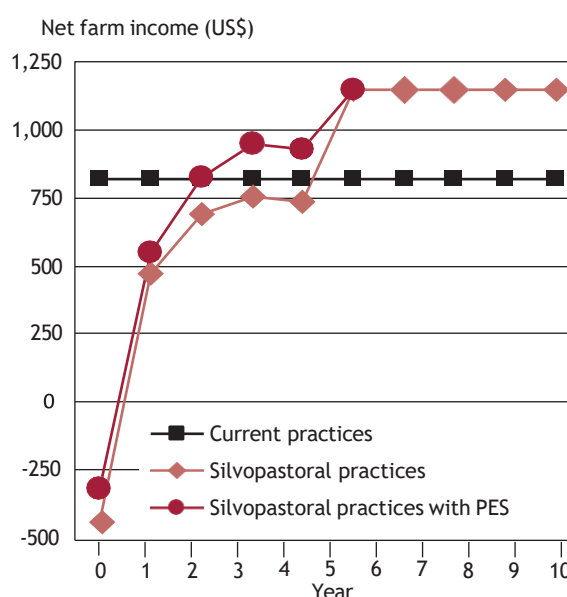
promote ways of increasing sustainable production that use land less extensively than current production methods. Extension efforts are essential for small landholders to acquire and properly use an integrated package of technologies, including improved genetics, more sustainable and productive grazing and pasture management practices, and better animal health management and reproductive control. If they lack the knowledge and resources to adopt the entire package of improved management techniques, traditional extensive grazing techniques are likely to remain the most affordable and profitable option.

- encourage formation of participatory producer associations. Particularly for smallholders, such associations can improve access to credit, extension and animal health services needed to intensify sustainable production. And they can also empower producers to participate more effectively in formulating and implementing policies that:

- promote more sustainable grazing systems, including silvopastoral approaches that can improve both environmental quality and productivity (*see box, pages 6-7*);

- create a legal, institutional and financial framework to support payment for environmental services. Compensating farmers and ranchers for their contribution to environmental “public goods” can encourage them to protect or restore forests in watersheds and marginal lands and to adopt more sustainable grazing systems on their pastures. The environmental benefits to carbon sequestration, biodiversity conservation and watershed management can be substantial. And the payments required to give farmers the resources and incentive to adopt more sustainable practices can be modest. Once farmers have made the decision and initial investment, experiments with payment for environmental services in silvopastoral grazing systems suggest that the payments may be needed for only a few years until the new system becomes more productive and profitable than the old (*graph 5 and see box on pages 6-7*).

5 - Effects of payment for environmental services (PES) on silvopastoral systems



Source: The World Bank

Silvopastoralism and Payment for Environmental Services in action

On nearly 300 small and medium-sized farms in Costa Rica, Nicaragua and Colombia, farmers are planting trees, fodder shrubs and live fences in and around the pastures where their cattle graze. Their efforts are being supported by training and incentive payments from the Integrated Silvopastoral Approaches to Ecosystem Management Project, with backing from the Livestock Environment and Development Initiative (LEAD) and the Global Environment Facility. Early results suggest that the combination of payments for environmental services with silvopastoral techniques for sustainable livestock production is paying off both for the ranchers and for the environment.

Silvopastoralism can yield major improvements in both environmental quality and livestock productivity. Some of the main environmental benefits include:

- carbon sequestration - trees and shrubs function as a “carbon sink”, absorbing climate-warming carbon dioxide from the air and depositing it as solid carbon, both in the soil and in woody tissue;
- biodiversity conservation - silvopastoral systems create a rich and varied habitat that hosts a wide variety of

wild birds, invertebrates and native forest plants;

- water infiltration and watershed management - wooded pastures retain more water, reducing surface runoff of muddy water and improving the quality and flow of water from springs, wells and water courses;
- soil retention - In hilly areas, the presence of a variety of trees and shrubs with different root lengths anchors soil in place, helping to reduce erosion and prevent landslides;
- improved soil productivity - fodder shrubs and legumes return atmospheric nitrogen to the soil and trees’ root systems recycle nutrients from deep in the soil where grasses never reach.

Indirectly, silvopastoralism also reduces pressure for deforestation by halting the cycle of soil depletion and abandonment that drives ranchers to look for greener pastures on newly deforested land.

The payoff for ranchers and farmers can also be substantial. Once they have been established, silvopastoral systems can support significantly more animals per hectare

Land use change types with carbon and biodiversity indices

	Land use types	Carbon index	Biodiversity index	Total
	Natural pasture without trees	0.1	0.1	0.2
	Improved pasture without trees	0.1	0.4	0.5
	Unshaded semi-perennial crops	0.3	0.2	0.5
	Natural pastures, low tree density	0.3	0.3	0.6
	Natural pasture with recently planted trees	0.3	0.3	0.6
	Live fences, recently established	0.3	0.3	0.6
	Improved pastures with recently planted trees	0.3	0.4	0.7
	Monoculture fruit tree plantation	0.3	0.4	0.7
	Gramineous fodder bank	0.3	0.5	0.8
	Improved pasture with low tree density	0.3	0.6	0.9
	Fodder bank with woody species	0.4	0.5	0.9
	Natural pasture with high tree density	0.5	0.5	1.0
	Diversified fruit tree plantation	0.6	0.5	1.1
	Multi-story live fence or windbreak	0.6	0.5	1.1
	Diversified fodder bank	0.6	0.6	1.2
	Monoculture timber plantation	0.4	0.8	1.2
	Shade-grown coffee	0.6	0.7	1.3
	Improved pasture with high tree density	0.6	0.7	1.3
	Natural bamboo stands	0.5	0.8	1.3
	Diversified timber plantation	0.7	0.7	1.4
	Early secondary growth	0.6	0.8	1.4
	Riparian forest	0.8	0.7	1.5
	Intensive silvopastoral system	0.6	1.0	1.6
	Disturbed secondary forest	0.8	0.9	1.7
	Secondary forest	0.9	1.0	1.9
	Primary forest	1.0	1.0	2.0

The Integrated Silvopastoral Approaches to Ecosystem Management Project

than natural or improved pastures. In addition, fodder and fruit from trees and shrubs provide a more nourishing diet for their animals. Better fed livestock produce more milk and meat and higher profits for their owners.

Mature silvopastoral systems can also provide significant savings for farmers. The high nutritional value of fodder reduces the need and cost of purchasing commercial feeds. Use of nitrogen-fixing plants means they can also cut their expenditures on nitrogen fertilizers. And halting the rapid degradation of their pastures increases the value of their landholdings for use either as collateral for loans or for eventual sale.

The economic benefits often extend beyond the farmers themselves. Establishing and maintaining silvopastoral systems requires significantly more labour than traditional grazing systems, providing employment opportunities for poor and landless peasants. And again there is an important environmental fringe benefit - poor people who can find work on existing farms are less likely to invade the forests in search of land.

The environmental, economic and social benefits of silvopastoralism are many and manifest. But two obstacles stand in the way of widespread adoption by farmers - lack of knowledge and the need for a substantial initial investment.

Planting and maintaining silvopastoral pastures requires knowledge of the nutritional value, nitrogen-fixing capacity and nutrient and water requirements of a wide variety of plants unfamiliar to most cattle ranchers. In addition, farmers who could benefit from adopting silvopastoral techniques are rarely aware of the potential cost savings and gains in productivity. But they do know that the start-up costs can be high. Establishing a silvopastoral system may mean planting thousands of plants per hectare and require substantial investments of time and money.

That's where payment for environmental services comes in. Rather than attempting to extract payment from ranchers for the environmental damage caused by deforestation, this approach focuses on the potential for well-managed pastures to reduce carbon-dioxide in the atmosphere, protect biodiversity and improve watershed management.

The payments are not big. In the best case, a hectare of silvopastoral land may fix 5 to 10 tonnes of carbon a year. So in a scheme where farmers receive roughly US\$5 for every tonne of carbon removed from the atmosphere, a 15 hectare ranch might collect around US\$375 for carbon sequestration and a comparable amount for biodiversity conservation. The total payout might amount to around US\$2 per day.

Clearly payments for environmental services do not offer a way out of poverty in and of themselves. They are not intended to. The expectation is that even relatively small payments will encourage farmers to make the initial investment and help them stick with it through the first few years until they reach the tipping point at which the silvopastoral system becomes more profitable than their previous grazing practices.

The Project compensates farmers for improvements that increase carbon sequestration and biological diversity on their lands. Rather than attempting to weigh the amount of carbon or count the number of birds on each farm, the payment scheme is based on the value of environmental services provided by implementing sustainable land uses.

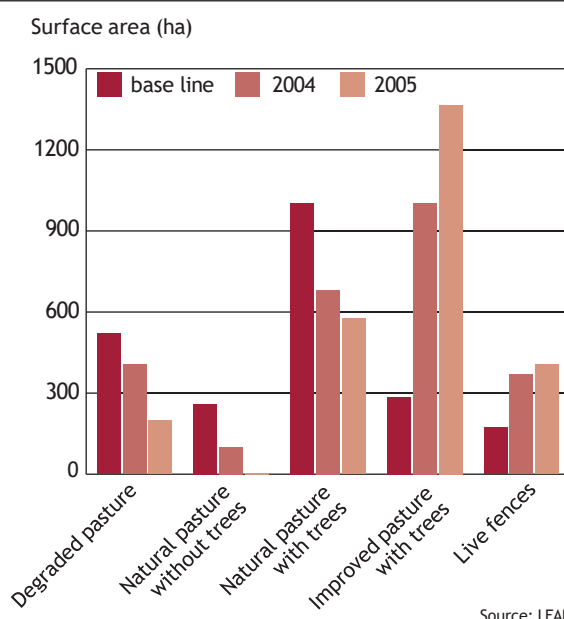
The project defined 28 main land use types, ranging from degraded pastures that offer no environmental benefits through intensive silvopastoral systems to mature forests rich in carbon-fixing and biodiversity. Each land use type was assigned an index value between 0 and 1 for both carbon sequestration and biodiversity (see chart, page 6).

In order to monitor progress and calculate payments for environmental services, the Project established a baseline land use and index value for each parcel of land. Follow-up surveys are conducted each year to identify parcels where farmers have changed the land use profile by planting improved grass, trees or shrubs. After adjusting the index values for parcels where the land use has changed, the total number of points for the farm is calculated again and the farmer is paid for every incremental point.

Follow-up surveys have found significant increases in sustainable land uses. In Costa Rica, participating farmers have reduced the area of degraded pasture by more than 60 percent and have increased the area of improved pasture with trees almost five-fold (graph 6).

Total payments to farmers in all three countries increased from US\$63 000 in 2003 to US\$166 000 in 2004. And payments for Costa Rica and Nicaragua alone topped that figure in 2005, reaching US\$170 000 even before payments had been issued in Colombia. Since the beginning of the project, an estimated 25 000 tonnes of carbon have been removed from the atmosphere. And more than 500 species of birds, one quarter of which are considered to be vulnerable or endangered, have been observed nesting and feeding on farms that have adopted sustainable land uses.

6 - Land use changes in Costa Rica, 2003-2005



Livestock production and deforestation - key policy options

The quest for more land to graze cattle and grow livestock feed has been a driving force behind the destruction of tropical forests, particularly in Latin America. Deforestation releases billions of tonnes of carbon dioxide and other greenhouse gases into the atmosphere and causes the extinction of tens of thousands of species every year. Livestock production compounds the damage. In a few short years, overgrazing, compaction and nutrient loss turn cleared forest lands into eroded wastelands.

Effective policies can help slow the pace of deforestation and promote sustainable grazing systems that reduce carbon emissions and protect biodiversity. Policy options include:

- ▶ Discouraging road construction and improvement in most forest areas;
- ▶ Employing land use planning and zoning, backed with taxes, regulations and incentives, to protect forest areas and encourage sustainable livestock production on more suitable lands;
- ▶ Adjusting land tax policies to levy higher taxes on fields and pastures than on forested lands;
- ▶ Supporting research, extension and training for more sustainable grazing systems, including silvopastoral techniques that can simultaneously increase livestock production and protect the soil against nutrient depletion, compaction and erosion;
- ▶ Using payments for environmental services to promote sustainable practices. Modest payments for carbon sequestration, biodiversity conservation and watershed management can encourage farmers to maintain forest cover on marginal lands and to invest in more sustainable grazing systems for their pastures.

FAO Livestock Policy Briefs

Facing the opportunities and challenges of the livestock sector

Rapid growth of livestock production in recent years has fueled hopes for accelerated economic development, fears of increased social inequity and environmental degradation, and recognition that comprehensive and effective policies are required to ensure that continued expansion of the livestock sector contributes to poverty alleviation, environmental sustainability and public health.

Papers in this series of Livestock Policy Briefs explore issues related to livestock production, identify policy options that can be considered and highlight examples of approaches that have proven successful.

The Livestock Policy Briefs series has been prepared by the Livestock Information, Sector Analysis and Policy Branch (AGAL) of the Animal Production and Health Division of the Food and Agriculture Organization of the United Nations.

Additional information, including electronic versions of briefs that have been published, can be found at:
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For further information about the Livestock Policy Briefs series, please contact:

Henning Steinfeld
Chief, AGAL
Food and Agriculture Organization
Rome 00100, Italy
henning.steinfeld@fao.org

For further information about the topic covered by the present brief, please contact

Mauricio Rosales
Manager, LEAD Virtual Research and Development Centre
Food and Agriculture Organization
Rome 00100, Italy
mauricio.rosales@fao.org



Livestock Information,
Sector Analysis and Policy Branch
Animal Production and Health Division